

Seedling Emergence and Growth of *Terminalia superba* Eng. EL. Diels under Different Light Conditions
O.O. Olayode

Bio-prediction of Egg Weight and Egg Component Parts at Different Ages in Small-sized Japanese Quails using Pre-broken Egg Traits as Regressors
S.O.K. Fajemilehin

Profitability Analysis of Cow Meat Marketing in Ado Metropolis, Ekiti State Nigeria
S.O.W. Toluwase and A.O. Kolawole

Compatible Taper Equations for Teak (*Tectonagrandis*) Plantation in Aramoko Forest Reserve, Ekiti State, Nigeria
A.S. Faniseyi, O.G.E. Arowosoge and E. Ajayi

Nutrient Composition of *Coptodon zillii* in the Dams in Ekiti State, Nigeria
B.J. Akin-Obasola and O.T. Adu

Evaluation of Agro-industrial Wastes as Organic Nutrient Sources for Growth and Yield of Okra (*Abelmoschus esculentus* L Moench)
S.O. Omotoso, M. Aluko and A.F. Kehinde-Fadare

Influence of Community Perception on Tourism Acceptability of Osun Osogbo Sacred Grove, Nigeria
B.O. Adetola and G.D. Osanyinleye

Efficiency and Profitability of Sawn Wood Marketing in Ondo State, Nigeria
O.V. Oyerinde

Prevalence of Gastro-intestinal Parasites in Small Ruminants Slaughtered in Ado Ekiti, Southwest Nigeria
D.B. Adelabu

Granitic Soils of Ikole: Properties, Classification, Genesis, Agricultural Potentials and Sustainable Management
K.S. Ogunleye, A.S. Fasina, O.J. Omoju, D.A. Oluwadare, A.K. Oluleye and U.O. Ogbonnaya

Bird Species Diversity in the Royal Forest Reserve in Eggua, Southwestern Nigeria
J.O. Orimaye, E.F. Okosodo, O.O. Ogunyemi

Effects of Raw Velvet Bean Seed Meal on Haematology and Serum Biochemical Parameters of Juvenile Catfish, *Clarias gariepinus*
J.B. Olasunkanmi, O.O. Bamidele, E.K. Ajani, I.E. Ezeagu and J.A. Adeyemi

Evaluation of Infrastructure and Animal Supply Logistics of the Abattoir in Ado-Ekiti Local Government of Ekiti State, Nigeria
A.D. Adelabu, F.A.S. Dairo, and J. Ojo

Effect of Broca1 Fertilizer Amended with Cocoa Pod Husk on Growth and Dry Matter Yield of Cocoa (*Theobroma cacao* L.) Seedlings in Ibadan, Nigeria
O.S. Ibiremo, M.O. Adenekan and O.A. Ojo

Performance Characteristics and Carcass Quality of Broilers Chicks under High Stocking Density and Fed Vitamin E Supplemented Diet
O.A. Adebiyi, T.O. Adepo and M. Adegbenro

Meat Quality and Chemical Composition of Broiler Chicken Produced in an Ideal Protein Concept using Most Limiting Amino Acid
O.F. Alamuoye and O.M. Sanusi

Physical Characteristics of the Strains of West African Dwarf Goat in Ogun State
F.A. Aluko, A.A. Ageh, A.M. Akanji, A.M. Ogungbesan and G.A. Adeleke

Insecticidal Activity of Essential Oils from Three Plant Seeds against *Beetle* (*Dermestes maculatus*) in Smoke-dried Catfish (*Clarias gariepinus*)
A.I. Adebayo, O.O. Fapohunda and R. Saka

Response of Broiler Chicken Fed Diets Containing Tithonia diversifolia Leaf Meal Supplemented with Polyzyme, Fibrolytic Enzymes as Additives
T.A. Oluwasola

Threats to the Conservation of West African Manatee in Pandam Wildlife Park, Plateau State, Nigeria
O.S. Odewumi, E.A. Agbelusi and O.A. Bello-Olusoji

Potentials of Unripe Mature Pawpaw Fruit (*Carica papaya*) Meal as Alternative Dietary Carbohydrate Source for Catfish (*Clarias gariepinus*) Fingerlings
B.W. Obe and O.L. Ajayi



An International Journal

Journal

OF RESEARCHES IN AGRICULTURAL SCIENCES

Formerly known as Agricultural Sciences Research Journal

ISSN: 2006 - 0041

Code: RAS 2008

MARCH, 2016 EDITION

VOLUME 4 ISSUE 1

SEPTEMBER, 2016 EDITION

VOLUME 4 ISSUE 2

EKITI STATE UNIVERSITY

**JOURNAL OF RESEARCHES IN
AGRICULTURAL SCIENCES**

VOL. 4 NO 1 & 2 2016

RAS Editorial Office

Faculty of Agricultural Sciences
Ekiti State University,
Ado-Ekiti, Nigeria.

E-mail:

jras.foas@gmail.com
foas.jras@eksu.edu.ng

ISSN:

All rights reserved. No part of this Journal May be reproduced, stored in a retrieval system, or transmitted in any form or any means: electronic, mechanical, photocopying recording or otherwise without the written permission of the Editor- in-Chief.

Published by:

EDITORIAL

This edition of the Journal of Researches in Agricultural Sciences is a reflection of two major changes that have taken place, since the last edition. First, three erstwhile universities in the state (University of Ado-Ekiti, University of Education, Ikere-Ekiti and University of Science and Technology, Ifaki-Ekiti) which had agriculture in their programmes were merged into one - Ekiti State University, Ado-Ekiti. Second, the Board of Editors of the Journal published by the Faculty of Agricultural Sciences was re-constituted with the mandate to revive the Journal and ensure the regular publication of pre-determined volumes per year. Thus, the Journal had been re- packaged to accommodate the ever-expanding curriculum in agriculture and the activities of researchers in meeting the current challenges encountered in the drive for food and nutrition security.

The articles in this edition have been blind peer-reviewed in line with the time-honoured tenets of international research journalism. It has become obvious that the desire to re-register the presence of the Journal in the academic community through online publication in response to the expansion in readership/referencing, subscription and submission of articles. The website being designed will offer the interested researches the opportunity to visit the Journal online for needed information. This development would guarantee the regular publication of the Journal.

The Editorial Board appreciates the concern of the Dean and Board of the Faculty of Agricultural Sciences on the need to revive the Journal. The efforts of all contributors who promptly attended to comments made during the review process and the reviewers who took the time to add value to the quality of the papers submitted for publication are appreciated. It is our desire to get better with each edition.

Thank you.

Professor O. J. Ayodele
Editor-in-Chief

AIMS AND SCOPE

The Journal of Researches in Agricultural Sciences publishes original articles and reviews in agriculture and related interdisciplinary studies that explore and exploit the production of food for mankind. It also publishes scientific works related to strategic and applied studies in all aspects of agricultural science.

The Journal publishes regular issues as well as special issues including symposia, conferences etc.

EDITORIAL BOARD

Professor O. J. Ayodele	Editor-in-Chief
Professor E A. S. Dairo	Assistant Editor-in-Chief
Dr. (Mrs.) A. M. Apata	Assistant Editor-in-Chief
Professor A. O. Fasuyi	Associate Editor
Dr. Tope Jegede	Associate Editor
Dr. F O. Osundare	Assistant Editor
Dr. A. O. Borisade	Assistant Editor
Dr. (Mrs.) O. O. Olayode	Assistant Editor
Dr. J. O. Orimaye	Business / Distribution Manager

EDITORIAL ADVISERS / CONSULTING EDITORS

Professor F A. S. Dairo	-	Ekiti State University, Ado-Ekiti
Professor A, S, Fasina	-	Ekiti State University, Ado-Ekiti
Professor T Oluwagbemi	-	Kogi State University, Ayingba
Professor V. A. Aletor	-	Federal University of Technology, Akure
Professor A. Olayinka	-	Obafemi Awolowo University, Ile-Ife
Professor A. O. Ogunkunle	-	University of Ibadan, Ibadan
Professor R. D. Aladesanwa	-	Federal University of Technology, Akure
Professor E. O. Idowu	-	Obafemi Awolowo University, Ile-Ife
Professor G. E. Onibi	-	Federal University of Technology, Akure
Professor B. Olufemi	-	Federal University of Technology, Akure
Professor E. O. Adeparusi	-	Federal University of Technology, Akure
Professor J. O. Ariyo	-	Federal University of Agriculture, Abeokute
Professor I. O. O. Aiyelaagbe	-	Federal University of Agriculture, Abeokute
Professor J. S. Ogeh	-	University of Benin, Benin
Professor M. G. Solomon	-	University of Calabar, Calabar
Professor I. A. Ayodele	-	University of Ibadan, Ibadan
Professor PA. Okunye	-	Federal University of Agriculture, Abeokuta
Professor A. Omotayo	-	Federal University of Agriculture, Abeokuta

Instructions for authors

Please note that the Instructions include guidelines that are specific to the Journal of Researches in Agricultural Sciences.

Author representations

Submission of a manuscript implies that: the work described has not been published before; it is not under consideration for publication anywhere else; and its publication has been approved by all co-authors(if any) as well as by the responsible authorities at the institution where the work has been carried out.

Online submission

Authors must submit their manuscripts online via the Journal of Researches in Agricultural Sciences Editorial Manager at jras.foas@gmail.com or foasjras@eksu.edu.ng

Regular articles

Regular articles report original research on, or techniques for studying, the fundamental relationships between natural resources utilization and agricultural productivity.

Articles in special issues

Special issues are collections of themed articles, sometimes arising from conferences, symposia or other notable scientific events. Only full papers of the same standard as regular articles will be considered for publication in special issues.

Articles submitted to the Journal for inclusion special issues are subjected to the same editorial processes as regular articles.

Reviews

Review articles are intended to be comprehensive summaries of topical issues in particular aspects of agricultural science. Prospective authors of reviews should contact the Editor-in-Chief before preparing such articles.

Manuscript format

Cover letter

All submissions must include a cover letter that includes:

- i. A confirmation of author representations that the work described has not been published before; it is not under consideration for publication anywhere else and publication has been approved by all co-authors.
- ii. A statement of the novelty and significance of the work and the relevance to the mission of the Journal of Researches in Agricultural Sciences.
- iii. Names, affiliations and E-mail addresses of at least three suitable referees together with a brief statement of why they are qualified to evaluate the manuscript. Referees should be selected from institutions other than those of the author(s).
- iv. Approval from the ethics communities of the author(s) institution for the techniques/ methodology and materials used.

Title page

The title page should include:

- * The name(s) of the author(s), with symbols to link each name with the author's institutional affiliation and an asterisk to denote the corresponding author.
- * A concise and informative title
- * The affiliation(s) and address(es) of the author(s)
- * The E-mail address and the telephone number of the corresponding author

Abstract

The abstract should be 150 to 250 words. The content should state the main purposes and research questions of the study, the methods used, the main results, and the key conclusions.

Keywords

Authors should provide 4 to 6 keywords which can be used for indexing purposes.

Main body

Manuscripts describing original research will typically include the following sections: *Introduction*: a concise, up-to-date description of the background to provide a general reader of the Journal with enough context to understand the research being presented and its significance, as well as providing a clear statement of the research question and any hypotheses being explored. *Materials and Methods*: techniques, materials, and equipment described in sufficient detail for another trained researcher to be able to reproduce the experimental work reported. Methods that are identical to published procedures should be summarized and include a citation to the original work. *Data Analysis*: in submissions that have a significant theoretical or mathematical component, a description of the analytical procedures may be required.

Results: a description of the analyses and measurements related to answering the central research questions.

Discussion: the interpretation of the results, considering their significance and putting them into a wider context through comparison with previously published research. The use of a combined “Results and Discussion” section is preferred as the format for the journal.

Conclusions: a concise statement of the main conclusions drawn from the research reported in the manuscript.

Acknowledgments: a list of people who contributed to the work in the manuscript but who are not named in the author's list, and a list of funding sources that supported the research presented.

Text

Text formatting

Manuscript should be submitted in Microsoft Word.

Use a normal, plain font (e.g. 12-point Times New Roman) for text.

Use italics for scientific names.

Use the automatic page numbering function to number the pages.

Do not use field functions

Use tab stops or other commands for indents, not the space bar.

Use the table function, not spreadsheets, to make tables.

Use the equation editor or Math-Type for equations.

Save your file in docx format (Word 2007 or higher) or doc format (older Word versions).

Headings

No more than three levels of displayed headings should be used.

Abbreviations

Abbreviations should be defined at the point of first use and be used consistently thereafter. Abbreviations defined in the abstract should be redefined in the main body of the submission.

Scientific style

Internationally-accepted signs and symbols for units (SI units) should be used throughout. Negative exponents should be used instead of slash, e.g., m s^{-2} rather than m/s^2

Nomenclature: In so far as possible, authors should use systematic names similar to those used by Chemical Abstracts Service or IUPAC.

References

The list of references should only include works that are cited in the text and that have been published or accepted for publication. Personal communications and unpublished works should only be mentioned in the text.

Reference should be arranged in alphabetical order (APA format) of authors' names at the end of the paper. Each should be given in the following form: authors' names, year of publication, the title of paper, the title of the journal in full and italicized, volume, number, first and last page e.g.

Braimah, A.K. (2000). Land evaluation for sorghum. *Nigerian Journal of Soil Science* 12:4-11

Kilmer, V.J. (1990). Handbook of Soils and Climate in Agriculture. CRC Press, Boca Raton.

In the text, reference should be given by the name of the author, followed by the year of publication in brackets; the letters, a b, etc. should be used to distinguished btween papers published by the same author in a single year.

Seedling Emergence and Growth of *Terminalia superba* Eng. EL. Diels under Different Light Conditions

O.O. Olayode,

Department of Forest Resources and Wildlife Management,

Ekiti State University, Ado-Ekiti

E-mail: olufunke.olayode@eksu.edu.ng

Abstract

One of the ecological factors essential to the growth and survival of tropical forest tree species is availability of light in terms of amount, quality and duration. The effects of direct light (DL), low light (LL) and medium light (ML) on seed germination and seedling growth of *Terminalia superba* were investigated. Seeds were soaked in water under ambient conditions for 24 h and sowed under the three light conditions. Germination occurred earlier at 13 days after sowing (DAS) under LL and DL but ML caused a delay till 15 DAS while germination was completed at 25, 29 and 33 DAS under LL, DL and ML respectively. The seedling height increased over the assessment period and varied significantly among the light conditions with LL producing the tallest plants. Mean collar diameter increased over the assessment period and was highest under LL except at week 12 but the values did not differ significantly from the other light conditions. The number of leaves increased and ranged between 7.11 and 15.56, 8.11 and 17.00 and 8.78 and 16.89 under DL, ML and LL respectively but the highest values under ML were similar to the other light conditions. The good germination and growth performance suggest that *Terminalia superba* would withstand shade at the early stage and can be incorporated into agroforestry and mixed plantation systems.

Key words: *Terminalia superba*, light conditions, germination, emergence, seedling growth

Introduction

Plant growth is influenced by many environmental factors, one of which is light through the direct effects it plays in photosynthesis and phototropism. These roles make light a fundamental part in plant establishment, growth and regeneration of tropical evergreen and deciduous forests (Phonguodume et al., 2012). Henmann and Hugh (2010) observed that the surrounding vegetation and habitat environment, especially light and temperature, affect the ecological and physiological responses of tropical rainforests.

Tree growth had increased with light or gap size (Balderrama and Chazdon, 2005; de Gouvenain et al., 2007; Herault et al., 2010) but tree species differ in light requirements especially at the seedling (early growth) stage. The growth rates of tropical tree species vary among the species and in response to resources availability, especially light, soil moisture and nutrients and individual conditions such as size and vigour (Dalling et al., 2004; Herault et al., 2010). The light that reaches the forest floor in a forest ecosystem varies depending on the forest structure. The knowledge of light requirements of tropical tree species will determine the

suitability for mixed forest plantations, agroforestry and even how such species can be incorporated in ecological restoration.

Phonguodume et al. (2012) stated that there is limited information about the effect of light intensities on growth and biomass allocation of tree species. Guenniet al. (2008) reported that shade tolerance of species adapted to open habitats will depend on the capacity of the plants to adjust morphologically and physiologically to a given level of irradiance. At the ecosystem level, reduced irradiance has a considerable impact on plant productivity. Wright and van Schaik (1994) opined that correlations between plant performance and irradiance suggest that light limits many tropical forest trees.

Terminalia superba is a large tree in the family Combretaceae and is native to West Tropical Africa (Burkill, 1985). It is commonly called Black Korina while the local names in Nigeria are Afara (Yoruba) and Baushe (Hausa). It has potential importance in paper making, offering the capability of producing a relatively wide range of pulps (Dupuy and Mille, 1993). The wood is normally creamy white with no noticeable distinction between the sapwood and

heartwood (Groulez and Wood, 1985). The wood is soft to medium-hard, light in weight, somewhat weak, easy to saw and machine. It also accepts paints and varnish well (Lamprecht, 1999). It is used in plywood manufacture, furniture and joinery, for plinths, mouldings, general fittings and door faces (Lemmens *et al.*, 1995). The fibre of *Terminalia superba* has potential importance in paper making, offering the capability of producing a relatively wide range of pulps. The leaves serve as diuretic and roots as laxative (Neuwinger, 2000). The bark is also used for dyeing textiles black. The bark decoction and macerations are used in traditional medicine to treat wounds, sores, haemorrhoids, diarrhoea, dysentery, malaria, vomiting, gingivitis, bronchitis, aphthae, swellings, ovarian troubles, expectorant and anodyne (Neuwinger, 2000). Furthermore,

Materials and Methods

Seed collection and germination of *Terminalia superba* seeds under different light conditions

Matured seeds of *Terminalia superba* were obtained from the Seed Store of Forestry Research Institute of Nigeria (FRIN), Ibadan. Fifty-four seeds of *Terminalia superba* were pre-treated by soaking them in water at room temperature for 24 h and sown in seed trays placed under three light conditions: Direct Light (DL), Medium Light (ML) and Low Light (LL). The seedlings under DL were without any form of shade; seedlings under ML were covered with a box of single-layered mosquito net and those under LL were covered with a box of double-layered mosquito net. Germination count was done daily until no further germination took place for about one week.

Results

Germination of *Terminalia superba* seeds under different light conditions

Table 1 shows the germination of *Terminalia superba* seeds under the light conditions. Germination began 13 days after sowing (DAS) under DL and LL but was delayed to 15 DAS under ML. Germination was

Terminalia superba was identified in Nigeria to have high potential for the development of integrated crop-livestock (sheep and goats) agroforestry technologies based on fodder yield and concentrations of crude protein as well as lignin (Orwa, 2009).

Terminalia superba is a highly valued timber tree of the semi-deciduous and closed wet forest formations of West and Central Africa. It is a pioneer species that regenerates well after forest exploitation with the seedlings abundant along roadsides and in forest gaps (Kimpouni, 2009). This is an indication of the light requirements. Therefore, an intensive investigation of the germination responses of *Terminalia superba* seeds and seedlings to varying range of light conditions is crucial to its wide use in plantation establishment across different ecosystems.

Seedling growth of *Terminalia superba* under the light conditions

Twelve (12) uniformly-growing seedlings under each light condition were pricked out into polythene pots previously filled with topsoil in three replicates in a completely randomized design. The seedlings were watered daily in the morning and growth assessment was carried out after one week at fortnight intervals for twelve weeks. The growth variables measured were seedling height, seedling collar diameter and number of leaves. The data collected were subjected to one-way Analysis of Variance (ANOVA) and the treatment means separated.

completed at 25 DAS under LL, 29 DAS under DL and 33 DAS under ML. The germination percentage was the same (73%) under shade (ML and LL) and higher than DL (60%).

Table 1: Mean germination percentage and rate of *Terminalia superba* seeds

Light conditions	Start of Germination (DAS)	End of Germination (DAS)	Germination Percentage (%)
Low light (LL)	13	25	73
Medium light (ML)	15	33	73
Direct light (DL)	13	29	60

DAS = Days after sowing

Seedling growth of *Terminalia superba* under the different light conditions*Seedling height*

Table 2 shows the heights attained by the seedlings under the different light conditions. Seedling height values were significantly different from one another under the light conditions across the assessment period. At 2 weeks, LL gave the tallest seedlings and differed from DL only but there was no significant difference between ML and LL. At 4, 6 and 8 weeks, the tallest seedlings were produced under

LL which differed significantly from the other light conditions. There was no significant difference between DL and ML. There was no significant difference between ML and LL at 10 and 12 weeks but these were significantly different from DL. The highest mean seedling heights were obtained at 12 weeks with values of 37.02cm under DL, 36.92cm under ML and 35.58cm under LL.

Table 2: Mean seedling height (cm) of *T. superba* under different light conditions across assessment period

Assessment period (weeks)	Direct light	Light conditions Medium light	Low light
2	5.50 ^b	6.37 ^{ab}	7.41 ^a
4	7.97 ^b	8.54 ^b	10.15 ^a
6	10.87 ^b	11.43 ^b	13.29 ^a
8	15.83 ^b	16.76 ^b	19.28 ^a
10	22.37 ^b	25.20 ^a	26.29 ^a
12	37.02 ^b	36.92 ^a	35.58 ^a

Note: means with the same letter(s) in each row are not significantly different at $\alpha = 0.05$

Seedling collar diameter

The mean seedling collar diameter values under the different light conditions are shown in Table 3. The highest collar diameter was obtained under LL over the assessment period but the values were not significantly

different from ML and DL. The highest mean seedling collar diameter (1.21mm) obtained at 12 weeks under ML was not significantly different from 0.99mm and 0.84mm under LL and DL respectively.

Table 3: Mean seedling collar diameter of *T. superba* under the light conditions during assessment period

Assessment period (weeks)	Direct light	Light conditions Medium light	Low light
2	0.36 ^a	0.38 ^a	0.39 ^a
4	0.47 ^a	0.51 ^a	0.52 ^a
6	0.59 ^a	0.59 ^a	0.60 ^a
8	0.69 ^a	0.71 ^a	0.71 ^a
10	0.86 ^a	0.76 ^a	0.85 ^a
12	0.84 ^a	1.21 ^a	0.99 ^a

Note: means with the same letter(s) in each row are not significantly different at $\alpha = 0.05$

Number of leaves

The mean number of leaves under the different light conditions at 2, 6, 8 and 10 weeks was not significantly different from one another (Table 4). However, at 4 weeks, seedlings under LL produced significantly higher number of leaves than DL but both did not differ from ML. At 12 weeks, there was no significant difference

in the number of leaves under ML and LL conditions but these significantly differed from DL. The highest mean number of leaves was obtained at 12 weeks with a value of 17.00 under ML followed by 16.89 under LL and 15.56 under DL. The seedlings placed under DL produced the least number of leaves throughout the assessment period.

Table 4: Mean number of leaves of *T. superba* seedlings for the light conditions across assessment period

Assessment period (weeks)	Direct light	Light conditions	
		Medium light	Low light
2	7.11 ^a	8.11 ^a	8.78 ^a
4	7.78 ^b	8.78 ^{ab}	9.11 ^a
6	10.00 ^a	10.67 ^a	10.89 ^a
8	11.89 ^a	13.34 ^a	13.22 ^a
10	13.55 ^a	14.67 ^a	14.77 ^a
12	15.56 ^b	17.00 ^a	16.89 ^a

Note: means with the same letter(s) in each row are not significantly different at $\alpha = 0.05$

Discussion

The highest germination percentage of *Terminaliasuperba* seeds was observed under LL and ML conditions but LL favoured earlier initial germination at 13 DAS compared to 15 DAS under ML. Olayode and Olatunji (2014) had observed that low light condition produced the highest germination percentage in *Parkia biglobosa* seeds. Similarly, the highest cumulative germination of *Chrysophyllum albidum* seeds was obtained under forest canopy whereas the highest germination percentage of *Irvingia gabonensis* seeds was under 100% light intensity indicating variable and species-dependent effects of light intensity on seed germination (Onyekwelu *et al.*, 2012). This study shows that seeds of *T. superba* can germinate well under different light conditions since all the light conditions ensured above 50% germination percentage. Seedling height, collar diameter and number of leaves were enhanced by ML followed by LL. This is in contrast to the report by James and Bell (2000) that low light (10% light) reduced growth, biomass and leaf area in two *Eucalyptus globulus* ssp. *Globules* (James and Bell, 2000). DL had the least values for number of leaves, seedling height and collar diameter across the assessment period, suggesting that for best the growth of *Terminaliasuperba* seedlings, some amount of shading may be needed. It is also possible that the variations in seedling growth characteristics occurred as a result of the differences in light conditions. Light as a climatic factor is vital to plant growth and determines where different species are found because of the key role in plant community dynamics (Olayode and Olatunji,

2014). Shade tolerance has been extensively studied in forests because competition for light and interspecific differences in shade tolerance are important determinants of forest structure and dynamics (Gravel *et al.*, 2008). The results of this study are an indication that *Terminaliasuperba* can be readily adopted in agrisilviculture since it would be able to withstand shade at the early stage without any adverse effects on growth. Orwa *et al.* (2009) earlier reported the high potentials of *Terminaliasuperba* for the development of integrated crop-livestock (sheep and goats) agroforestry technologies in Nigeria based on the fodder yield and concentrations of crude protein as well as lignin.

Conclusion

Low light favoured seed germination of *Terminaliasuperba* in terms of earliness which was similar to direct light but the germination percentage of low and medium light conditions was the same. Therefore, it is recommended that the seeds should be sown in shaded environment in order to enhance earliness and total germination percentage. Low light condition increased the number of leaves, height and collar diameter of the seedlings but the differences from medium light were not significant as the seedlings aged. The performances of the seedlings showed that *Terminaliasuperba* can be successfully raised under different light conditions although partial shading is recommended in order to obtain high germination percentage and best growth at the early stage.

References

- Balderrama, S. and Chazdon, R.L. (2005). Light-dependent seedling survival and growth of four tree species in Costa Rican second-growth rain forests. *Journal of Tropical Ecology* 21(4): 383-395.
- Burkill, H.M. (1985). The Useful Plants of West Tropical Africa. 2nd Edition. Volume 1, Families A-D Royal Botanic Gardens, Kew, Richmond, United Kingdom. 960pp.
- Dalling, J.W., Winter, K. and Hubbell, S.P. (2004). Variation in growth responses of neotropical pioneers to simulated forest gaps. *Functional Ecology* 18: 725-736.
- deGouvenain, R.C., Kobe, R.K. and Silander, J.A. (2007). Partitioning of understorey light and dry-season soil moisture gradients among seedlings of four rainforest tree species in Madagascar. *Journal of Tropical Ecology* 23: 569-579.
- Dupuy, B. and Mille, G. (1993). Timber Plantations in the Humid Tropics of Africa. FAO Forestry Paper. No. 98.
- Gravel, D., Canham, C.D., Beaudet, M. and Messier, C. (2010). Shade tolerance, canopy gaps and mechanisms of coexistence of forest trees. *Oikos* 119(3): 475-484.
- Groulez, J. and Wood, P.J. (1985). *Terminalia superba*: A Monograph. Centre Technique Forestier Tropical, France and Commonwealth Forestry Institute, England.
- Guenni, O., Seiter, S. and Figueroa, R. (2008). Growth responses of three *Brachiaria* species to light intensity and nitrogen supply. *Tropical Grasslands* 42: 75-87.
- Hennmann, B. and Hugh, D.S. (2010): Late-glacial and Holocene vegetation, climate and fire dynamics in the Serra dos Orgaos, Rio de Janeiro State, Southeastern Brazil. *Global Change Biology* 16: 1661-1671.
- Herault, B., Ouallet, J., Blanc, L., Wagner, F. and Baraloto, C. (2010). Growth responses of neotropical trees to logging gaps. *Journal of Applied Ecology* 47: 821-831.
- James, S.A. and Bell, D.T. (2000). Influence of light availability on leaf structure and growth of two *Eucalyptus globulus* sp. *globulus* provenances. *Tree Physiology* 20: 1007-1018.
- Kimpouni, V. 2009. *Terminalia superba* Engl. Diels, (Internet) Record from PROTA4U. Lemmens, R.H.M.J., Louppe, D. and Otena- Amaoko, A.A. (Eds). PROTA (Plant Resources of Tropical Africa)/Resources Vegetales de l'Afrique Tropicale, Wageningen, Netherlands. (<http://www.prota4u.org/search.asp>).
- Lamprecht, H. (1989). Silviculture in the Tropics: Tropical Forest Ecosystems and Their Tree Species: Possibilities and Methods for their Long-term Utilization. Dt. Ges. für. Techn. Zusammenarbeit (GTZ) GmbH, Eschborn. (Translated by Brose, J. et al.)
- Lemmens, R.H.M.J., Soerianegara, I. and Wong, W.C. (eds.) (1995). Plant Resources of South-east Asia. No. 5(2). Timber Trees: Minor Commercial Timbers. Backhuys Publishers, Leiden.
- Neuwinger, H.D. (2000). African Traditional Medicine: A Dictionary of Plant Use and Applications. Medpharm Scientific, Stuttgart, Germany. 589pp.
- Olayode, O.O. and Olatunji, A.O. (2014). Seedling emergence and growth of African locust bean (*Parkia biglobosa* R. Br. Ex (G. Don)) under different light conditions. *Journal of Tropical Forest Resources* 30: 102-112.
- Onyekwelu, J.C., Stimm, B., Mosandl, R. and Olusola, J. A. (2012). Effects of light intensities on seed germination and early growth of *Chrysophyllum albidum* and *Irvingia gabonensis* seedlings. *The Nigeria*

Journal of Forestry 42(1&2): 58-67.

Orwa, C., Mutua, A., Kindt, R., Jamnadass, R. and Anthony, S. (2009). Agroforestry Database: A Tree Reference and Selection Guide. Version 4.0. (<http://www.worldagroforestry.org/sites/treedatabases.asp>). Accessed on 25th July, 2017.

Phonguodume, C., Lee, D.K., Sawathvong, S., Park, Y.D., Ho, W.M. and Combalicer, E.A.

(2012). Effects of light intensities on growth performance, biomass allocation and chlorophyll content of five tropical deciduous seedlings in Lao PDR. *Journal of Environmental Science and Management*. Special Issue 1: 60-67.

Wright, S.J. and van Schaik, C.P. (1994). Light and the Phenology of Tropical Trees. *American Naturalist* 143(1): 192-199.

Bio-prediction of Egg Weight and Egg Component Parts at Different Ages in Small-sized Japanese Quails using Pre-broken Egg Traits as Regressors

S.O.K. Fajemilehin,

Department of Animal Production and Health Sciences

Faculty of Agricultural Sciences

Ekiti State University, Ado-Ekiti, Nigeria

E-mail address:

Abstract

The present study was conducted on eggs of Japanese quail reared on deep litter at the Teaching and Research Farm, Ekiti State University, Ado-Ekiti. Three hundred eggs were randomly selected for the measurement of egg weight (g), egg length (cm) and egg width (cm); and broken to collect data of shell weight (g), albumin weight (g) and yolk weight (g) at different ages. A number of equations were developed to predict the egg weight and post-broken traits from pre-broken traits at the different ages. The prediction equations of egg weight at different ages showed that the associations were significant ($P < 0.01$) and positive with adjusted R^2 at 22.1-25.9, 17.1-19.5 and 31.6-36.6% for egg length, egg width and egg length + width respectively. Egg shell weight was predictable with sufficient accuracy ($P < 0.01$) from egg weight + egg length ($R^2 = 8.1-9.3\%$); egg weight + egg width ($R^2 = 7.7-9.1\%$) and egg weight + egg length + egg width ($R^2 = 8.8-10.1\%$) across the ages. Egg albumin was predictable ($P < 0.01$) from egg weight + egg length ($R^2 = 71.5-76.3\%$); egg weight + egg width ($R^2 = 71.9-77.9\%$) and egg weight + egg length + egg width ($R^2 = 73.1-79.3\%$). The weight of egg yolk was predictable ($P < 0.01$) from egg weight, length and width ($R^2 = 69.9-78.2\%$); from egg weight and width ($R^2 = 61.4-66.8\%$) and from egg weight and length ($R^2 = 40.0$ to 48.3%). This study showed that *in vivo* prediction based on single trait was not as reliable compared to the use of more than one trait.

Key words: Deep litter, Japanese quail, post-broken, prediction equations,

Introduction

One of the major products of laying birds is the egg which can be used for breeding, sold to augment the farmers' financial needs or eaten to supply cheap and readily available animal protein (Orji *et al.*, 1998; Khurshid *et al.*, 2003). The main components of an egg are shell, albumin and yolk (Abanikanda and Leigh, 2007) which exist in varying proportions among the different poultry species. However, the important traits that are measurable in avian eggs include the egg weight, width and length; shell weight, thickness and strength; albumin weight and height; and yolk weight and height. The egg weight, width and length are usually determined before breaking the eggs while information on the other traits can only be obtained after breaking the egg. Broken eggs are not useful, so it is imperative to develop some prediction equations that could provide information on shell weight, yolk weight and albumin weight without breaking eggs.

Information on egg weight along with egg width and length will further open the domain for trying out various prediction equations in order to determine the post-broken traits of eggs. Egg weight was easily predictable from egg length and width because of the positive association among these traits (Farooq *et al.*, 2001). The egg weight is an important trait which influences egg quality as well as grading (Farooq *et al.*, 2001) while the shell, though non-edible, serves as a protective medium for the edible internal components- the albumen and yolk. The yolk contains all the fat and most of the vitamins in the egg while the albumin contains all the protein. Egg length is the long border of an egg while the egg width is the short border because the length predominate the width.

The relationship existing among these egg component traits can be exploited for genetic improvement strategies. The *in vivo* prediction based on single trait has been challenged because of its unreliability compared

to the use of more than one trait (Raji *et al.*, 2009). It is, therefore, the aim of this study to provide information on the relationships

between egg weight, shell, albumin and yolk weights and how these traits can be used singly and jointly in accurate predictions.

Materials and Methods

This study was carried out at the Aviary Unit, Teaching and Research Farm, of Ekiti State University, Ado-Ekiti. The eggs were collected from one hundred layers of Japanese quails at 8.00 am and 5.00 pm daily at week 6, 10, 14, 18, 22, 26, 30, 34, 38, 42 and 46 of age. Three hundred eggs were randomly selected to measure the egg weight (g), egg length (cm), egg width (cm); and broken to determine the shell weight (g), albumin weight (g) and yolk weight (g) at the different ages. The egg weight was determined using a digital scale sensitive to 0.01 g by gently placing the whole egg on the flat surface of the scale. Measurements of the internal components were obtained by carefully making an opening around the sharp end of the egg, large enough to allow passage of both the

albumin and the yolk through it without mixing their contents together. The yolk was carefully separated from the albumen and the weights determined on wet basis. Regression analysis of the traits was carried out at different ages using SPSS version 18, 25 statistical packages.

The following model was used for prediction of egg weight, shell weight, albumin and yolk weights using egg length, width and egg weight as independent variables in different cases:

$$\hat{Y} = \beta_0 + \beta_1 SW + \beta_2 AW + \beta_3 YW + e$$

where, $\hat{Y}$ is the response variable,

β is the intercept,

$\beta_1, \beta_2, \beta_3$ are the partial regression coefficients, SW, AW and YW are shell weight, albumen weight and yolk weight, respectively e is the residual term.

Results and Discussion

Prediction of egg weight from egg length and width

The prediction equations of egg weight from egg length, egg width and egg length + egg width at different ages in small-sized Japanese quails are presented in Table 1. The association of egg length and width singly and jointly with egg weight was significant ($P < 0.01$) and positive similar to results obtained by Farooq *et al.* (2001) such that egg weight was predictable with sufficient accuracy. The ranges of adjusted R^2 values for egg length, egg width and egg length + width as predictors of egg weight are 22.1-25.9%, 17.1-19.5% and 31.6-36.6% of the fitted models across the ages, respectively. The range of values obtained in this study agrees with the 23.13%, 17.81% and 31.86% reported by Khurshid *et al.* (2003) for egg length, egg width and egg length + egg width, respectively and the R^2 of 21.10% for egg length and 16.82% for egg width reported by Fajemilehin (2008). Comparing the R^2 values of the predictors, it is clear that using the two traits jointly gave higher

accuracy than using the traits singly as reported by Raji *et al.* (2009) that *in vivo* prediction based on single trait is not as reliable compared to the use of more than one trait. However, any one of the equations in the table can be used for predicting egg weight from egg length at the equivalent age.

Predicting shell weight from egg weight, length and width

The shell weight cannot be accurately known until the egg is broken and the internal contents which include the thin membrane, albumin and yolk are removed. Nevertheless, prediction equations can be developed to obtain information about this trait pre-broken. Table 2 shows the prediction equations of egg shell weight from egg weight, egg length and egg width at different ages in small-sized Japanese quails.

Table 1: Prediction equations of egg weight (μ) from egg length (y_1) and egg width (y_2) at different ages in small-sized Japanese quails

		Egg length (y_1)	R^2 (%)	Egg width (y_2)	R^2 (%)	Egg length + Egg width
R^2 (%)						
Wk 6	$\mu = 7.447 +$	23.2	$\mu = 4.940 +$	16.5	$\mu = 8.027 + 1.104(y_1) -$	34.6
Wk	$0.986(y_1)$	23.3	$0.774(y_2)$	18.6	$0.143(y_2)$	31.6
10	$\mu = 4.172 + 0.935$	25.4	$\mu = 5.688 + 0.830$	17.1	$\mu = 4.122 + 0.726(y_1) +$	36.6
Wk	(y_1)	25.9	(y_2)	17.8	$0.273(y_2)$	35.5
14	$\mu = 3.424 + 0.923$	23.5	$\mu = 3.891 +$	19.5	$\mu = 6.290 + 1.484(y_1) - 0.$	32.8
Wk	(y_1)	22.1	$0.577(y_2)$	18.6	$668(y_2)$	35.7
18	$\mu = 6.117 + 0.$	23.0	$\mu = 8.228 + 0.$	19.3	$\mu = 9.334 + 2.170(y_1) -$	33.8
Wk	$614(y_1)$	25.8	$204(y_2)$	17.8	$1.738(y_2)$	35.3
22	$\mu = 7.169 + 0.$	22.4	$\mu = 4.687 +$	18.1	$\mu = 4.172 - 0.744(y_1) +$	34.2
Wk	$322(y_1)$	23.9	$0.525(y_2)$	18.5	$1.191(y_2)$	32.9
26	$\mu = 5.372 +$	24.2	$\mu = 4.717 +$	18.8	$\mu = 5.537 + 1.007(y_1) -$	32.6
Wk	$0.989(y_1)$		$0.593(y_2)$		$0.029(y_2)$	
30	$\mu = -14.797 +$		$\mu = -44.084 +$		$\mu = -31.528 + 0.282(y_1) +$	
Wk	$0.564(y_1)$		$0.565(y_2)$		$0.304(y_2)$	
34	$\mu = 0.585 +$		$\mu = 9.209 +$		$\mu = -0.061 + 1.491(y_1) -$	
Wk	$0.569(y_1)$		$0.062(y_2)$		$1.142(y_2)$	
38	$\mu = -85.500 +$		$\mu = 75.938 -$		$\mu = -73.232 + 0.898(y_1) -$	
Wk	$0.967(y_1)$		$7.022(y_2)$		$0.075(y_2)$	
42	$\mu = -3.259 +$		$\mu = 1.683 +$		$\mu = -4.164 + 0.840(y_1) +$	
Wk	$0.961(y_1)$		$0.692(y_2)$		$0.212(y_2)$	
46	$\mu = -17.266 +$		$\mu = -8.583 +$		$\mu = -19.852 + 0.705(y_1) +$	
	$0.855(y_1)$		$0.666(y_2)$		$0.263(y_2)$	

Eggshell weight was predictable with sufficient accuracy from egg weight + egg length ($P < 0.01$, $R^2 = 8.1-9.3\%$); egg weight + egg width ($P < 0.01$, $R^2 = 7.7-9.1\%$) and egg weight + egg length + egg width ($P < 0.01$, $R^2 = 8.8-10.1\%$) across the ages. The result agrees with the findings of Fajemilehin (2008) who obtained negative association between egg weight and shell weight and positive associations with egg length and width with R^2 of 8.8% when the three traits were used as regressors and 7.4%, 8.2% and 8.4% respectively when egg length, egg width and egg weight were used singly as a regressor in helmeted guinea fowl. However, the R^2 values obtained in this study are higher than the R^2 of 7.1-7.85% reported by Khurshid *et al.* (2003) in Japanese quails.

Predicting weight of egg albumin from egg weight, egg length and egg width

Table 3 shows the prediction equations of egg albumin weight from egg weight, egg length and egg width at different ages in small-sized Japanese quails. The weight of egg albumin was predictable from egg weight + egg length ($p < 0.01$, $R^2 = 71.5-76.3\%$); egg weight + egg width ($P < 0.01$, $R^2 = 71.9-77.9\%$) and egg weight + egg length + egg width ($P < 0.01$, $R^2 = 73.1-79.3\%$) with enough accuracy. The result agrees with the findings of Khurshid *et al.* (2003) who noted that weight of egg albumin was predicted from egg weight + egg width ($p < 0.01$, $R^2 = 72.75\%$); egg weight + egg length ($P < 0.01$, $R^2 = 72.24\%$) and egg weight + egg length + egg width ($P < 0.01$, $R^2 = 72.71\%$).

Table 2: Prediction equations of egg shell weight (μ_1) from egg weight (y_3), egg length (y_1) and egg width (y_2) at different ages in small-sized Japanese quails

width (y_3)	Egg weight (y_3)+length R^2 (%)	R^2 (%)	Egg weight (y_3)+width (y_2)	R^2 (%)	Egg weight (y_3) + length (y_3) + width (y_3)
Wk 6	$\mu_1 = 37.211 - 4.779(y_3) +$ 4.458(y_1)	8.8	$\mu_1 = 6.92 - 1.458(y_3) +$ 1.386(y_2)	8.7	$\mu_1 = 20.642 - 3.129(y_3) + 1.945(y_1) +$ 1.058(y_2)
Wk 10					
Wk 14	$\mu_1 = 4.482 - 0.984(y_3) + 0.624$ (y_1)	8.6	$\mu_1 = 5.997 - 1.557(y_3) +$ 1.393(y_2)	8.0	$\mu_1 = 7.377 - 2.258(y_3) + 0.730(y_1) +$ 1.415(y_2)
Wk 18					
Wk 22	$\mu_1 = 5.489 - 0.429(y_3) -$ 1.114(y_1)	8.9	$\mu_1 = 10.407 - 0.400(y_3) -$ 0.346(y_2)	7.1	$\mu_1 = -33.787 + 5.170(y_3) - 8.461(y_1) +$ 3.538(y_2)
Wk 26					
Wk 30	$\mu_1 = 1.802 - 0.408(y_3) +$.572(y_1)	7.3	$\mu_1 = -0.088 - 0.139(y_3) +$ 0.405(y_2)	7.6	$\mu_1 = 35.644 - 4.447(y_3) + 9.575(y_1) -$ 7.287(y_2)
Wk 34					
Wk 38	$\mu_1 = 8917.644 - 0.403(y_3) -$ 0.747(y_1)	9.3	$\mu_1 = 9142.523 - 0.198(y_3) -$ 0.848(y_2)	9.1	$\mu_1 = 9218.540 - 0.263(y_3) - 0.317(y_1) -$ 0.530(y_2)
Wk 42					
Wk 46	$\mu_1 = 9.684 - 4.750(y_3) +$ 4.032(y_1)	8.2	$\mu_1 = 3.312 - 0.914(y_3) +$ 0.253(y_2)	8.5	$\mu_1 = 9.498 - 4.699(y_3) + 3.943(y_1) +$ 0.063(y_2)
	$\mu_1 = 1.128 - 0.819(y_3) +$ 0.229(y_1)		$\mu_1 = 2.202 - 0.666(y_3) -$ 0.042(y_2)		$\mu_1 = 6.810 - 0.743(y_3) + 1.284(y_1) -$ 1.187(y_2)
	$\mu_1 = 12.328 - 0.142(y_3) -$ 0.898(y_1)		$\mu_1 = 11.581 - 0.609(y_3) -$ 0.711(y_2)		$\mu_1 = 12.309 - 0.216(y_3) - 0.754(y_1) -$ 0.126(y_2)
	$\mu_1 = 2.499 + 1.238(y_3) -$ 0.258(y_1)		$\mu_1 = -2.159 + 1.299(y_3) +$ 0.344(y_2)		$\mu_1 = -2.159 + 1.299(y_3) + 0.344(y_2)$
	$\mu_1 = -6.151 - 2.402(y_3) +$ 2.309(y_1)		$\mu_1 = 2.633 - 0.235(y_3) +$ 0.077(y_2)		$\mu_1 = -12.379 - 3.591(y_3) + 3.090(y_1) +$ 0.632(y_2)
	$\mu_1 = 7.378 - 0.431(y_3) -$ 0.602(y_1)		$\mu_1 = 4.407 - 0.869(y_3) -$ 0.115(y_2)		$\mu_1 = 7.986 - 0.357(y_3) - 0.601(y_1) -$ 0.112(y_2)

Predicting weight of egg yolk from egg weight, length and width

Table 4 shows that the weight of egg yolk was predictable with from egg weight, length and width ($P < 0.01$, $R^2 = 69.9-78.2\%$); from egg weight and width ($P < 0.01$, $R^2 = 61.4-66.8\%$); and from egg weight and length ($P < 0.01$, $R^2 = 40.0$ to 48.3%). This result is similar to the report by Khurshid *et al.* (2003) using egg weight and width to predict the weight of egg yolk.

References

- Abanikannda, O.T.F. and Leigh, A.O. (2007). Allometric relationships between composition and size of chicken table eggs. *International Journal of Poultry Science* 6(3): 211-217.
- Fajemilehin, S.O.K. (2008). Predicting post-broken traits using the pre-broken traits as regressors in the eggs of helmeted guinea fowl. *African Journal of Agricultural Research* 3 (8): 578-580
- Farooq, M., Mian, M.A., Ali, M., Durrani, F.R., Asquar, A. and Muqarrab, A.K. (2001). Egg traits of Fayomi bird under subtropical conditions. *Sarad Journal of Agriculture* 17: 141-145.
- Khurshid, A., Farooq, M., Durrani, F.R., Sarbiland, K. and Chand, N. (2003).

Conclusion

1. Egg length and width can individually be used for prediction of egg weight but the prediction was better when egg length and width were used as regressors.
2. Each of albumin and yolk weight was predictable with enough accuracy from egg weight, length and width.
3. Also, egg shell weight was predictable with enough accuracy from egg weight, length and width.
4. Using the predictors jointly was more accurate in predictions compared to using them individually

Predicting egg weight, shell weight, shell thickness and hatching chick weight of Japanese Quails using various egg traits as regressors. *International Journal of Poultry Science* 2 (2): 164-167.

Orji, B.I., Igbodi, C. and Oyke, P.J. (1998). The effects of pre-incubation storage embryonic growth of rate mortality, hatch ability and total incubation period of fowl egg. *Nigerian Journal of Agricultural Science* 3: 99-103.

Raji, A.O., Igwebuike, J.U. and Usman, M.T. (2009). Zoometrical body measurements and their relation with live weight in matured local muscovy ducks in Borno State Nigeria. *ARPJN Journal of Agriculture and Biological Science* 4(3): 58-62

Table 3: Prediction equations of albumin weight (μ) from pre-broken traits singly and jointly at different ages in small-sized Japanese quails

	Egg weight (y_3) + length (y_1) width (y_2) R^2 (%)	R^2 (%)	Egg weight (y_3) + width (y_2)	R^2 (%)	Egg weight (y_3) + length (y_3) +	
Wk 6	$\mu_3 = 69.89 - 4.839(y_3) +$ $4.602(y_1)$	73	$\mu_3 = 14.357 - 1.411(y_3) +$ $1.431(y_2)$	72.	$\mu_3 = 39.513 - 3.137(y_3) + 2.017(y_1) +$ $1.092(y_2)$	73.1
Wk 10	$\mu_3 = 10.411 - 0.680(y_3) +$ $0.680(y_1)$	71.5	$\mu_3 = 15.900 - 1.304(y_3) + 1.519(y_2)$	73.	$\mu_3 = 20.906 - 2.069(y_3) + 0.796(y_1) +$ $1.543(y_2)$	73.5
Wk 14	$\mu_3 = 12.211 - 1.594(y_3) + 0.$ $709(y_1)$	72.4	$\mu_3 = 10.440 - 1.304(y_3) + 0.$ $283(y_2)$	8	$\mu_3 = 17.415 - 2.825(y_3) + 2.615(y_1) -$ $0.918(y_2)$	73.9
Wk 18	$\mu_3 = -5.450 - 0.167(y_3) +$ $1.022(y_1)$	73.2	$= -16.853 + 0.286(y_3) + 0.$ $853(y_2)$	3	$\mu_3 = -63.504 + 2.239(y_3) - 4.339(y_1) +$ $4.339(y_2)$	74.3
Wk 22	$\mu_3 = 15.450 - 0.196(y_3) +$ $0.884(y_1)$	75.8	$\mu_3 = 4.839 + 0.763(y_3) - 0.$ $741(y_2)$	71.	$\mu_3 = 15.340 - 0.238(y_3) - 1.011(y_1) +$ $0.157(y_2)$	75.1
Wk 26	$\mu_3 = 8.258 - 1.157(y_3) +$ $1.497(y_1)$	74.5	$\mu_3 = -0.248 + 0.458(Y_3) +$ $0.633(y_2)$	5	$\mu_3 = 13.419 - 1.862(y_3) + 2.734(y_1) -$ $0.873(y_2)$	71
Wk 30	$\mu_3 = 3.224 + 0.550(y_3) +$ $0.471(y_1)$	72.9	$\mu_3 = 12.678 + 0.520(y_3) -$ $0.806(y_2)$	9	$\mu_3 = -1.907 + 0.485(y_3) - 0.443(Y_1) +$ $1.028(y_2)$	
Wk 34	$\mu_3 = 10.793 + 0.912(y_3) -$ $0.776(y_1)$		$\mu_3 = 34.248 - 1.701(y_3) - 2.143(y_2)$ $\mu_3 =$	77.	$\mu_3 = 10.257 - 0.129(Y_3) + 1.249(Y_1) -$ $1.775(Y_2)$	
Wk 38	$\mu_3 = -20.548 - 1.486(y_3) +$ $1.776(y_1)$		$27.150 - 0.829(y_3) + 0.047(y_2)$ $\mu_3 = 8.023 - 0.930(y_3) + 0.246(y_2)$	5	$\mu_3 = 30.478 - 1.854(y_3) + 0.208(y_1) -$ $2.088(y_2)$	
Wk 42	$\mu_3 = 11.696 - 2.162(y_3) +$ $1.421(y_1)$			73.	$\mu_3 = 0.739 - 2.894(Y_3) + 1.902(Y_1) +$ $0.389(Y_2)$	
Wk 46	$\mu_3 = -1.161 - 1.356(y_3) +$ $0.690(y_1)$			72.	$\mu_3 = -5.516 - 1.516(Y_3) + 0.688(y_1) +$ $0.243(y_2)$	

Table 4: Prediction equations of yolk weight (μ_4) from pre-broken traits at different ages in small-sized Japanese quails

	Egg weight (y_3) + length (y_1) width (y_3) R^2 (%)	R^2 (%)	Egg weight (y_3) + width (y_2) R^2 (%)	R^2 (%)	Egg weight (y_3) + length (y_3) + length (y_3) + R^2 (%)
Wk 6	$\mu_4 = 53.060 - 4.822(y_3) +$ 4.554(y_1)	40.3	$\mu_4 = 10.149 - 1.429(y_3) +$ 1.416(y_2)	62.9	$\mu_4 = 29.588 - 3.137(y_3) + 1.996(y_1) +$ 1.080(y_2)
Wk 10	$\mu_4 = -1.720 + 0.901(y_3) -$ 0.938(y_1)	47.9	$\mu_4 = -3.869 + 1.162(y_3) -$ 1.370(y_2)	0	$\mu_4 = -8.608 + 2.163(y_3) - 1.043(y_1) -$ 1.402(y_2)
Wk 14	$\mu_4 = 11.456 - 1.621(y_3) +$ 1.177(y_1)	42.1	$\mu_4 = 6.785 - 0.745(y_3) + 0.366(y_2) -$ 6.422 - 0.972(y_3) - 0.090(y_2)	67.6	$\mu_4 = 48.769 - 6.632(y_3) + 8.942(y_1) -$ 3.739(y_2)
Wk 18	$\mu_4 = 6.254 - 0.917(y_3) - 0.119$ (y_1)	43.3	$\mu_4 = 0.485 + 0.969(y_3) -$ 0.305(y_2)	62.4	$\mu_4 = 4.879 - 0.505(y_3) - 1.037(y_1) +$ 0.742(y_2)
Wk 22	$0.831 + 0.966(y_3) - 0.487(y_1)$ $\mu_4 =$	47.3	$\mu_4 = 1.909 - 0.174(y_3) +$ 0.392(y_2)	63.3	$\mu_4 = 0.608 + 0.709(y_3) - 1.275(y_1) +$ 0.974(y_2)
Wk 26	$\mu_4 = 21.605 - 6.103(y_3) -$ 6.231(y_1)	45.1	$\mu_4 = -3.011 - 0.295(y_3) +$ 0.652(y_2)	62.6	$\mu_4 = 21.030 - 6.024(y_3) + 6.093(y_1) +$ 0.097(y_2)
Wk 30	$\mu_4 = -0.138 - 0.381(y_3) +$ 1.013(y_1)	47.8	$\mu_4 = -1.227 + 0.661(y_3) +$ 0.652(y_2)	61.4	$\mu_4 = 0.780 - 0.367(y_3) + 1.208(y_1) -$ 0.219(y_2)
Wk 34	$\mu_4 = -1.574 + 0.222(y_3) +$ 0.845(y_1)	48.3	$\mu_4 = 6.711 - 1.664(y_3) - 0.808(y_2)$)	$\mu_4 = -1.57 + 0.209(Y_3) + 0.871(Y_1) -$ 0.023(Y_2)	
Wk 38	$\mu_4 = 0.783 - 1.522(y_3) +$ 0.606(y_1)		$\mu_4 =$ -17.572 + 1.166(y_3) - 0.493(y_2)	$\mu_4 = 6.711 - 1.664(y_3) - 0.808(y_2)$ $\mu_4 = -23.925 + 0.788(y_3) + 0.348(y_1) -$ 0.431(y_2)	
Wk 42	$\mu_4 = -39.842 - 0.022(y_3) +$ 0.881(y_1)		$\mu_4 = -0.154 + 0.392(y_3) +$ 0.294(y_2)	$\mu_4 = -7.815 - 0.705(y_3) + 1.286(y_1) +$ 0.288(y_2)	
Wk 46	$\mu_4 = -6.252 - 0.514(y_3) +$ 1.289(y_1)				

Profitability analysis of cow meat marketing in Ado metropolis, Ekiti State Nigeria

S.O.W. Toluwase and A.O. Kolawole

*Department of Agricultural Economics and Extension Services,
Ekiti State University,*

E-mail: sowtoluwase@yahoo.co.uk; sunday.toluwase@eksu.edu.ng.

Abstract

The marketing of cow meat in Ado - Ekiti metropolis of Ekiti State, Nigeria, was studied to determine its profitability and examine the factors affecting the marketing margin. One hundred and twenty (120) cow meat sellers were randomly selected in five markets purposively as respondents to well-structured and validated questionnaire. Descriptive statistics was used to analyze the socio-economic characteristics of the cow meat marketers; the profit function was used to determine profitability while the factors affecting cow meat marketing margin were determined with regression analysis. The results show that cow meat marketing is dominated by males (81.7%) aged 37 years on the average and 75% with some forms of formal education. Cow meat marketing was profitable in the study area with average profit realized per kg at N140.17. Transportation cost, rentage cost and middlemen profit had significant effects on the marketing margin. It is recommended that government should site more abattoirs close to major cow meat markets to reduce transportation cost and the price to consumers.

Keywords:- Profitability, analysis, cow-meat, marketing.

Introduction

The livestock sub-sector is characterized by the traditional systems of production, processing and marketing thereby limiting the output and consumption level of livestock products in Nigeria. The per-capita meat consumption at approximately 6.4 kilogram (kg) per year compared to China (23 kg), Canada (65 kg) and United States of America (95 kg) reflects the resultant low level of animal protein intake. In order to ensure adequate intake level of animal protein by the teeming population, output has to be substantially increased (Suleiman *et al.*, 2013).

The ability of the average Nigerian family to sustain animal protein consumption has become a sensitive indicator for assessing not only the physical, but also the economic well-being of the nation. The livestock industry is beclouded with limitations ranging from inadequate production inputs to poor management and inefficient marketing. The demand pool generated in the industry through rapid increase in population and per-capita incomes, relative prices and availability of substitutes, greatly expanded taste preference and nutritional education (Okaiyeto, 1999)

needs to be matched with equivalent development in management and technical expertise.

The shortage of animal protein is severe in Nigeria with current estimated per-capita supply being less than 35% of recommended daily requirement. The situation is more critical in the southern part of Nigeria where the failure of the livestock sector to expand production means that the current rising demand cannot be met by adequate supplies. For beef to get to the consumer, just as other agricultural products, there must be a well-organized marketing system. Cow meat purchasing and consumption patterns vary substantially among the people. Factors like characteristics of the consumer, characteristics of the products, buying practices and trade practices motivate people in making purchasing decision. Consumer preferences and consumption pattern are the main determinants of the demand for the various quantities and qualities of meat products. Not much has been known about the pricing efficiency/profitability in the marketing of cow meat in Ado-Ekiti metropolis. Moreover, not much research work has been done in this area to determine the cost of marketing of beef and the consequent benefit

to the marketers in the study areas.

However, this study aims to;

- i. describe the socio-economic characteristics of cow-meat marketers in Ado metropolis;
- ii. estimate the profitability of cow-meat marketing in the study area;
- iii. analyze the factors affecting marketing margin of cow-meat; and
- iv. identify the constraints to cow-meat marketing in the study area.

Methodology

The study was carried out in Ado Ekiti, the capital of Ekiti State. Ado-Ekiti metropolis is characterized by both perfect and imperfect market whereby there are many cow-meat sellers at different geographical spots. A multi-stage sampling procedure was used to select the cow meat marketers. The first stage involved the random selection of five (5) cow meat markets in Ado-Ekiti metropolis. The second stage involved the selection of 24 sellers from each market for a total of one hundred (120) respondents. Data for the study were collected from primary and secondary sources. The primary data were sourced through the aid of well-structured questionnaire and interview schedule. The secondary sources of data were textbooks, journals, reports and the internet. The data collected were analyzed using descriptive and inferential statistics such as frequency counts, percentages and regression. The profit function was used to estimate the profitability of cow meat marketing.

The profit function is given by

$$\pi = TR - TC \dots\dots\dots (1)$$

where:

π = Profit function

TR = Total revenue

TC = Total cost (which includes cost of transportation, packaging, market charges, storage and middlemen profits)

Multiple regression analysis was used to determine the factors affecting marketing margin of cow meat marketers.

The implicit and explicit postulations of factors affecting cow meat marketing model are

shown by:

$$Y = F (X_1, X_2, X_3, X_4, X_5, X_6) \dots\dots\dots (2)$$

$$Y = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + \mu \dots\dots\dots (3)$$

where: Y = Magnitude of the marketing margin of beef ($P_2 - P_1$)

P_2 = Seller's Price, P_1 = Buyer's Price

b_0 = Intercept

X_1 = Transport cost (Naira)

X_2 = Packaging cost (Naira)

X_3 = Marketing charges (Naira)

X_4 = Storage cost (Naira)

X_5 = Middle-men profit (Naira)

X_6 = Rentage cost (Naira)

μ = Stochastic error term

Results and Discussion

Socio-economic characteristics of cow meat marketers

Table 1 shows that majority of the respondents were male (81.7%) and within the age group of 30 and 45 years (83.33%) while 10.83 percent and 5.84 percent were below 30 and above 45 years of age respectively. The mean age of the respondent at 37.10 years implies that respondents would still have the energy for active involvement and smooth operation required in cow meat marketing. This relates to fact that an individual's performance efficiency or productivity declines with increase in age (Oseni, 2011). This makes cow-meat marketing business a male-dominated enterprise as observed by Ebowore and Idoge (2013). Fig. 1 shows that majority (86.70 percent) was married indicating that the family can complement the profit from the business and which is enough to cater for the needs of household members. This finding contradicts Ebowore and Idoge (2013) who obtained a higher percentage of respondents in cow meat marketing being not married in Oshimili Local Government Area, Delta State. The household size of 35.8 percent of the respondents was 1-3, 4 in the family 34.2 percent of the respondents and 5-6 in 30 percent of the respondents. The mean household size was 4 such that cow meat marketers had manageable family sizes which may assure extra helping hands in the operations.

Table 1: Distribution of cow meat marketers by their socio-economic characteristics

Variables	Freq.	Percent.
Age (years)		
Less than 30	13	10.83
30--35	40	33.33
36--40	36	30.00
41--45	24	20.00
Above 45	7	5.84
Gender (dummy)		
Female	22	18.30
Male	98	81.70
Household size		
1	3	2.50
2	16	13.30
3	24	20.00
4	41	34.20
5	18	15.00
6	18	15.00
Educational level		
No formal education	30	25.0
Primary education	71	59.20
Secondary education	19	15.80
Marketing experience (years)		
Below 6	3	2.50
6 – 10	46	38.30
11 – 15	38	31.60
16 – 20	17	14.20
Above 20	16	13.30
Marketing form		
Retailers	68	56.70
Wholesalers	16	13.30
Both	36	30.00

Source: Field survey, 2016.

Most of the respondents had formal education as 59.2 and 15.8% finished in primary and secondary schools. This desirable development will increase awareness and adoption of new marketing strategies and enable them to take business decisions that can enhance market performance. Majority of the respondents (69.9%) had business experience between 6 and 15 years, 25% had between 1 and 5 years of experience while 14.20 and 13.3 percent of the marketers had 16-20 and >20

years of business experience. The mean year of experience in cow meat business at 14.4 years is important as it plays very key roles in every human endeavor and the basis of success and progress even as the likely outcomes of the lack are low production and income for farmers (Mafimisebi *et al.*, 2012). Two types of intermediaries were encountered in cow meat marketing; retailers who sell small quantities and wholesalers which accounted for 56.70 and 13.3% while 30% sells on the basis of both. This result showing majority of the respondents as retailers is similar to the findings of Ebowore and Idoge (2013) that retail marketing of beef is the commonest form of beef marketing in Delta State.

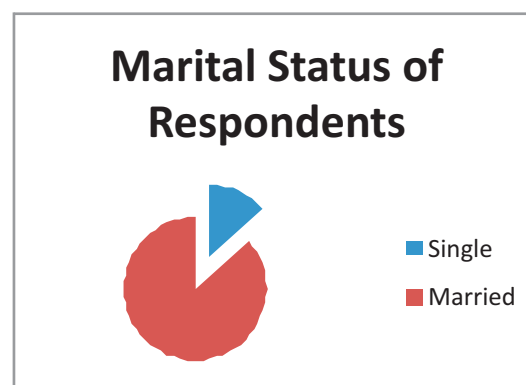


Fig. 1: Pie chart showing the marital status of respondents

Table 2: Gross Margin

Analysis	
Variable (Kg)	Value ₦ (per Kg)
Cost of Purchase (farm gate price)	538.83
Transportation cost	15.00
Packaging cost	10.50
Market charges	25.00
Storage cost	18.00
Middlemen profit	155.00
Total Variable Cost	762.33
Total Revenue	902.50

Source: Field survey, 2016.

Profitability of cow meat marketers

Table 2 shows that the beef marketers incurred total variable costs of N762.33 which include cost of purchase, transportation cost, packaging, storage and middle men profit and generated revenue of N902.50 per kg of cow meat. Since the items of cow meat marketing are variable (i.e. negligible fixed cost), gross margin was estimated to be the profit. A profit margin of N140.17 per kg of beef was obtained showing that cow meat marketing is profitable in the study area.

Factors Influencing marketing margin of cow meat

Table 3 shows the regression analysis of factors affecting marketing margin of cow meat. The adjusted R^2 was 0.969 for the independent variables while the F-cal (620.781) was significant suggested that the model is a good fit. Rentage cost and middlemen profit were significant at 5% and 1% respectively. This implies that these independent variables have significant effect on the marketing margin. The independent variables which exhibited positive coefficient values are packaging cost, storage cost and market charges such that the increase in

their costs will increase the marketing margin of marketers. The negative coefficient variables of transport cost, rentage cost and middlemen profit whose increase in value will reduce the marketing margin of cow meat

The result in Table 4 gives the following equation: $Y = 28.954 - 0.003X_1 + 0.054X_2 - 0.010X_3 + 0.001X_4 - 0.947X_5 - 0.000X_6$

The negative coefficient of transportation cost means that it has a negative impact on the marketing margin. The positive coefficient for packaging (0.054) implies that when 1 kg of beef is well packaged, it attracts higher prices thereby increasing the marketing margin. The market charges and storage costs have positive coefficients (0.000) and (0.001) respectively such that whenever market charges and storage costs are high, the marketing margin also rises. The middlemen profit and transport costs have negative coefficients of -0.947 and -0.003 respectively. This means that an increase in middlemen profit and transport cost will reduce the marketing margin because what should have accrued to the marketers will be paid to the middlemen and this will be passed on to the consumers. The outcome is that the customer would pay more for 1 kg of cow meat.

Table 3a: Linear regression of the factors influencing marketing margin of cow meat marketers

Model		Unstand. Coeff.		Stand. Coeff.	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	28.954	8.434		3.433	.001
	Transport cost	-.003	.003	-.119	-1.210	.229
	Packaging cost	.054	.092	.065	.585	.560
	Rentage cost	-.010	.005	-.060	-1.874	.064
	Storage cost	.001	.001	.041	1.390	.167
	Middlemen profit	-.947	.019	-.958	-49.671	.000
	Market charges	.000	.001	.011	.676	.501

a. Dependent Variable: market margin of beef Unstand Coeff. = Unstandardized Coefficients
Stand. Coeff. = Standardized Coefficients.

Table 3b: ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1666769.964	6	277794.994	620.781	.000 ^a
	Residual	50566.702	113	447.493		
	Total	1717336.667	119			

a. Predictors: (Constant), market charges, storage cost, middlemen profit, rentage cost, transport cost, packaging cost.

b. Dependent Variable: market margin of cow meat

Constraints faced in cow meat marketing

The problems militating against the effective and efficient marketing of cow meat in the study area are shown in Table 4. High transportation cost was the most serious constraint (74.17%) as its rising value will increase the marketing margin per kg of cow meat on the sellers' side but the higher price per kg of cow meat can make the consumers to purchase lower quantities of cow meat. The risk of spoilage as a problem of beef marketing (66.67%) becomes more critical for unsold stock due to erratic power supply. Inadequate storage facilities were also identified as a limitation to effective cow meat marketing. The cow meat

marketers cannot afford appropriate storage facilities and this is compounded by unstable power supply and the recent hike in electricity tariffs. More than half (53.33%) of the marketers lamented about the recent hike in market charges associated with the revenue drive of the government in Ekiti State. Also, half of the respondents opined that there were no credit facilities available to boost cow meat business. Other constraints include the existence of numerous sellers indicating the homogeneity state characterized by a perfect market. This made 43.33% to complain about some sellers charge or agree to sell at favorable prices due to familiarity or closeness of customers.

Table 4: Constraints faced by cow meat marketers

Constraints	Frequency (%)
Transportation cost	89 (74.17)
Risk of spoilage	80 (66.67)
Inadequate storage facilities	72 (60.00)
Market charges	64 (53.33)
Inadequate credit facilities	60 (50.00)
Price discrimination	52 (43.33)
Too many sellers	45 (37.50)

Source: Field survey, 2016. *Multiple Responses

Conclusion

This study examined the profitability of cow meat marketing in Ado-Ekiti metropolis, Ekiti State, Nigeria. It looked at the socio-economic characteristics of 120 cow-meat marketers, cost and returns, marketing channel, marketing margin and the constraints to cow-meat marketing. Cow meat marketing is male-dominated and the mean age of the respondents was 37.10 years who were mostly literates. The profit margin of N140.17 per kg of cow meat showed that cow meat marketing is profitable in the study area. Rentage cost and middlemen profit had the most significant effects on the marketing margin. The constraints to cow meat marketing rated high transportation cost as the most serious as it will increase the marketing margin of a kilogram of cow meat on the sellers' side but as the price/kg increases, the consumers may choose to purchase lower quantity of cow meat.

Recommendations

From this study, some recommendations emerge:

- The government should ease transportation and storage facilities
- problems, as to facilitate quality of the product which attracts buyers.
- The cow meat marketing infrastructure should be developed and modernized to include transportation, appropriate storage facilities and constant power supply.
- Government should site more abattoirs close to major beef markets to reduce transportation cost and consumer price.
- Producers and marketers alike should be encouraged to form co-operatives for the purpose of helping members in thrift and credit access.

Acknowledgement

The effort of Mr. Bobade Blessing during the data collection process for this study is hereby appreciated.

References

- Ebewore, S.O. and Idoge, D.E. (2013): Analysis of beef marketing in Oshimili South Local Government Area, Delta State, Nigeria. *Journal of Natural Sciences Research* 3(2): 104-111.
- Mafimisebi, T.E., Oguntade, A.E., Fajeminsin, N.A. and Ayelari, P.O. (2012): Local knowledge and socio economic determinants of traditional medicines' utilization in livestock health managements in South West Nigeria. *Journal of Ethnobiology and Ethno medicine* 8(2); pp 123-126
- Okaiyeto, P.O. (1999) Economics and marketing implications in livestock production. An invited paper at Workshop on Poverty Alleviation through Sustainable Livestock and Poultry Production held at College of Animal Science, Mando Road, Kaduna May 3-5, 1999.
- Oseni, J.O. (2011). Effects of Deregulation Policy on Cocoa Marketing in Ondo State, Nigeria. Unpublished Ph.D Thesis, The Federal University of Technology Akure, Nigeria.
- Suleiman, M, Isiaka, M, and Ishaku, A (2013). Socioeconomic factors influencing profitability of cattle marketing in Gombe metropolis, Nigeria. *International Journal of Scientific and Technology Research*. 2(12): 288-292.

Compatible Taper Equations for *Tectonagrandis*plantation in Aramoko Forest Reserve, Ekiti State, Nigeria

^{*1}Faniseyi, A.S., ¹Arowosoge, O.G.E., ²Ajayi, E.

¹Department of Forest Resources and Wildlife Management, Ekiti State University, Ado-Ekiti.

²Department of Forestry and Wildlife Management, Adekunle Ajasin University, Akungba-Akoko, Nigeria

Corresponding Author: asfaniseyi@yahoo.com

Abstract

The study was carried out to generate compatible stem taper equations for the *Tectonagrandis* (Teak) plantation in Aramoko Forest Reserve, Ekiti State, Nigeria. The age series used for the study were 15, 17, 20, 23, 26, and 30 years old, and three plots of 20 x 20m were randomly selected from each age series. The diameter at breast height (dbh) of all trees within each was measured and grouped into 4 classes; 10-20, 20-30, 30-40 and 40-50cm. The tree with the closest dbh to the mean dbh in each diameter class was selected for felling. The diameter at the ground level (D_G), 15 cm (D_{15}), 30 cm (D_{30}) and 45 cm (D_{45}) were measured before felling while, the stump height (SH) and total length were measured after felling. Descriptive statistical analysis was used to summarize the data collected. The taper equations generated for 10-20, 20-30, 30-40 and 40-50 cm; $d^2 = \left(D^2 - 1.784 \left(\frac{h}{H} - 1 \right) - 20.978 \left(\frac{h^2}{H^2} - 1 \right) \right)$ $D^2 = D^2 \left(10.264 \left(\frac{h}{D} - 1 \right) - 34.239 \left(\frac{h^2}{D^2} - 1 \right) \right)$, $D^2 = D^2 \left(10.916 \left(\frac{h}{D} - 1 \right) - 46.935 \left(\frac{h^2}{D^2} - 1 \right) \right)$, $D^2 = D^2 \left(-13.296 \left(\frac{h}{D} - 1 \right) - 27.513 \left(\frac{h^2}{D^2} - 1 \right) \right)$ respectively were assessed using F-ratio, Root Mean Square of Error (RMSE), Adjusted coefficient of determination (R^2_{adj}). The taper equations were satisfactory based on the various criteria used for assessment and validation, and are recommended for estimating the taper of the teak trees in the plantation.

Keywords: Taper equations, Teak, Aramoko Forest Reserve

Introduction

Teak (*Tectoniagrandis*) is a tropical hardwood tree in the family Verbenaceae, native to South and South East Asia and is commonly found as a component of monsoon forest vegetation. It is a large deciduous tree, growing up to 30 – 40 m tall (Robertson, 2002). Teak is one of the important timber tree species in the world with qualities which include: attractiveness in colour and grain, durability, ease of seasoning without splitting and cracking, ease of working and carving, resistance to termite, fungi and weathering as well as suitability for all aspects of household constructions (Kaosa-ard, 1998).

Teak has been widely established in plantations throughout the tropics from the 1850s due to its good timber qualities, market demand, ease of domestication and cultivation. It has gained a worldwide reputation on account of the attractiveness and durability of its wood. Thus, its demands have prompted the establishment of its plantations within and beyond its native countries (Bhat, 2000). As an

exotic species, teak has been established in many countries in Asia (Sri Lanka, Bangladesh, Thailand and China); Africa (Ghana, Nigeria, Ivory Coast, Senegal, Togo, Benin, Sudan and Tanzania); Central America (Puerto Rico and Panama) and South America (Brazil and Ecuador) for the production of high quality poles and timber, with varied degrees of success (Ball *et al.*, 1999).

Nigeria has established several teak plantations, especially in response to the afforestation programme. Kollert and Cherubini (2012) reported that India, Indonesia, Myanmar, Ghana and Nigeria accounted for 87% of the 1.3 million hectares (ha) of teak plantations in the world. Nigeria had about 146,000 ha of teak plantation in 2012 and was second to Ghana with 214,000 ha as the largest in tropical Africa.

Stem taper can be defined as the rate of narrowing of diameter along the stem of a given tree (Muhairwe, 1999). A taper equation describes the entire profile of the stem. Aloet *al.*, (2011) opined that taper is the degree to which

trees stem decreases in diameter as a function of increase in tree height. Taper equation is a mathematical function which predicts the diameter of the stem of an individual tree at any distance along its stem. Thus, taper equation can describe changes in diameter along the tree stem and therefore, provide estimates of dimension of logs that can be cut from a stem. Taper equations have been used for more than a century by foresters to express tree form in terms of easily measured characteristics (Perez *et al.*, 1990). The importance of taper equations becomes evident from the fact that they are needed to estimate tree growth which is crucial to the sustainable management of forest plantations (Bi, 2000; Lee *et al.*, 2003; Shaw *et al.*, 2003).

Reliable methods for estimating taper profile of growing stock are always needed for sustainable management of forest plantations. Hence research has continued in the development of taper equations. This study was, therefore, carried out to develop taper equations for different diameter classes of *Tectonagrandis* Plantation in Aramoko Forest Reserve, Ekiti State, Nigeria.

Materials and Method

Study area

The study was carried out in the Teak (*Tectonagrandis*) Plantations at Aramoko Forest Reserve in Ekiti West Local Government Area (LGA) of Ekiti State, Nigeria. Aramoko Forest Reserve is located between latitude 7.73622°N and 7.76710°N and between longitude 5.04523°E and 5.05729°E in South-western Nigeria.

Method of data collection

A reconnaissance survey of Teak Plantations in Aramoko Forest Reserve was carried out with a view to determining the suitability of the stands for subsequent sampling operations. Six age classes: 15, 17, 20, 23, 26, 30 years old trees in Aramoko Forest Reserve were selected for the study. Three sample plots of 20 × 20m were randomly selected from each age class. The height (Ht) and the diameter at breast height (dbh) of all the trees in the sample plots were measured using Spigel Relaskop and girth tape respectively. The diameters at the top (D_t) and at the middle (D_m) were measured using

Spigel Relaskop while the diameter at the base (D_b) was measured using girth tape. The trees in each sample plot were divided into four dbh classes: of 10–20, 20–30, 30–40 and 40–50 and the tree with the dbh closest to the mean dbh of each class was selected for felling. The diameter of the tree at ground level (D_G) and at 15 cm (D_{15}), 30 cm (D_{30}) and 45 cm (D_{45}) above ground was measured using girth tape. After felling, the stump height, total length of the tree and the diameter along the stem was measured at intervals of 5cm.

Data analysis

The relationship between diameter at individual relative height and explanatory variable for this study followed the equation developed by Jaroslaw (2002) which is expressed as;

$$d_h = b_0 + b_1 X_1 + b_2 X_2 \dots\dots\dots 1$$

where; d_h = relative diameter at height (h_j)

b_0 = equation constant

b_1, b_2 = equation parameters of estimation of diameter at relative height (h_j)

X_1, X_2 = independent variable correlated with estimated diameter.

If d_h is Y, then $Y = \beta_1 X_1 + \beta_2 X_2$

$$\text{If } d = \frac{D^2}{D^2}, d_1 = \left(\frac{h}{D} - 1\right) \quad d_2 = \frac{h^2}{D^2} - 1$$

$$\text{If } \frac{D^2}{D^2} = d_1 \left(\frac{h}{D} - 1\right) + d_2 \left(\frac{h^2}{D^2} - 1\right) \dots\dots\dots 2$$

$$D^2 = D^2 d_1 \left(\frac{h}{D} - 1\right) + D^2 \left(\frac{h^2}{D^2} - 1\right) \dots\dots\dots 3$$

where D = diameter at breast height of the tree (dbh)

H = total height of the tree

d = diameter at height (h) of the tree

h = height at diameter (d) of the tree

β_1, β_2 = Regression parameters

All regression models were generated using Microsoft excel and Statistical package for social sciences (SPSS21.0 for windows) and were assessed using significance of regression equation (F-ratio), Adjusted coefficient of determination (Adjusted R^2), Root Mean Square Error (RMSE).

Results

The summary of the taper equation data for *Tectonagrandis* plantations in Aramoko Forest Reserve is presented in Table 1. The total height (TH) of the trees ranged from 8.3 to 16.3 m; diameter at breast height of the trees ranged from 15.5 to 41.1 cm while the total length (TL)

ranged from 7.6 to 15.5 m. The stump height (H_{st}) ranged from 0.5 to 1.25m, diameter at the ground level (D_G) ranged from 20.3 to 52.5 cm while diameter at 15 cm (D_{15}), 30 cm (D_{30}) and 45 cm (D_{45}) above the ground level ranged from 18.8 to 50.0 cm; 17.3 to 47.5 cm; and 16.1 to 44.2 cm respectively

Table 1: The summary of the taper equation data for *Tectonagrandis* plantation

Age (Yrs)	dbh Class	dbh (cm)	TH (m)	H_{st} (m)	TL (m)	D_G (cm)	D_{15} (cm)	D_{30} (cm)	D_{45} (cm)
15	10-20	15.5	8.3	0.75	7.6	23.5	21.8	20.6	18.8
15	20-30	23.0	12.7	0.84	11.8	30.0	28.6	26.3	24.2
17	10-20	17.4	9.0	0.9	8.1	26.0	25.2	24.6	24.0
17	20-30	22.3	9.2	1.25	8.0	27.8	26.0	25.6	24.2
20	10-20	18.2	13.9	0.5	13.1	29.0	26.3	23.0	21.9
20	20-30	25.4	15.9	0.55	15.3	33.0	31.3	28.9	27.0
20	30-40	33.9	14.05	0.55	13.5	47.7	44.5	41.7	37.5
23	10-20	15.9	10.7	0.6	10.1	20.3	18.8	17.3	16.1
23	20-30	26.3	13.0	0.7	12.3	36.0	34.4	32.4	31.4
23	30-40	32.7	14.9	0.8	14.1	45.3	43.0	40.5	38.0
26	10-20	17.8	10.9	0.5	10.4	22.5	21.0	20.3	18.4
26	20-30	26.5	13.4	0.62	12.8	36.5	34.9	31.0	29.5
26	30-40	33.4	13.6	0.7	12.9	42.5	40.0	38.3	35.0
30	10-20	19.0	13.7	0.5	13.2	26.5	24.3	23.0	21.4
30	20-30	25.8	14.7	0.7	14.0	34.3	31.8	29.0	27.5
30	30-40	35.2	14.2	0.7	13.5	47.0	44.5	40.7	38.3
30	40-50	41.1	16.3	0.8	15.5	52.5	50.0	47.5	44.2

Where dbh = Diameter at the Breast Height, TH = Total Height, H_{st} = Stump Height, TL = Total Length

D_G = Diameter at the ground level, D_{15} = Diameter at the 15 cm above the ground level

D_{30} = Diameter at the 30 cm above the ground level, D_{45} = Diameter at the 45 cm above the ground level.

The regression models generated for the diameter classes presented in Table 2 were significant ($p < 0.05$) and found appropriate

using the criteria for model appropriateness (Adjusted R^2 , F-ratio, RMSE). The form of each taper equation for each diameter class in the study area is presented in Table 3.

Table 2: Taper Equations developed for *Tectonagrandis* based on diameter class in Aramoko Forest Reserve, Ekiti State, Nigeria.

Diameter Class (cm)	Regression Parameters		Std Error	Criteria for model Assessment		
	β_1	β_2		R^2_{Adj}	F-ratio	RMSE
10-20	1.784	-20.978	0.304	0.989	1234.175*	1.48
20-30	10.264	-34.239	0.279	0.984	5256.778*	2.45
30-40	10.916	-46.935	0.273	0.980	663.770*	3.73
40-50	-13.296	-27.513	0.277	0.983	879.475*	3.71

* All regression parameters are significant at 5% ($p < 0.05$)

Table 3: Taper Equation for each diameter class in Aramoko Forest Reserve, Ekiti State, Nigeria

Diameter Class (cm)	Taper Equation
10-20	$d^2 = D^2 \left(1.784 \left(\frac{h}{H} - 1 \right) - 20.978 \left(\frac{h^2}{H^2} - 1 \right) \right)$
20-30	$d^2 = D^2 \left(10.264 \left(\frac{h}{H} - 1 \right) - 34.239 \left(\frac{h^2}{H^2} - 1 \right) \right)$
30-40	$d^2 = D^2 \left(10.916 \left(\frac{h}{H} - 1 \right) - 46.935 \left(\frac{h^2}{H^2} - 1 \right) \right)$
40-50	$d^2 = D^2 \left(-13.296 \left(\frac{h}{H} - 1 \right) - 27.513 \left(\frac{h^2}{H^2} - 1 \right) \right)$

Discussion

The development of stem taper equations for the different diameter classes of *Tectonagrandis* in Aramoko Forest Reserve of Ekiti State was based on the equation form used to estimate the relative diameter at individual height whose explanatory variable is expressed by the relationship between relative diameter height (d_h) at relative height ($\frac{h}{H}$) (Sharma and Oderwald, 2001). The taper equations developed in this study used all the measured tree diameters in the existing plantation thereby enabling the whole diameter range and by extension taper variations, in the plantations to be captured.

The analysis of variance for the taper equations for the four diameter classes showed that the adjusted R^2 values were high for all the diameter class which ranges from 0.980 to 0.989. The highest adjusted R^2 (0.989) was obtained for 10-20 cm diameter class while the lowest (0.980) was obtained for 30-40cm diameter class. All the variables used for fitting taper functions were significant. It was observed that height-diameter relationship varied from stand to stand. Dorado *et al.*, (2010) had observed that height and diameter varies from stand to stand and even within the same stand and the relationship is not constant over time. Thus, a single equation may not capture all the possible taper variations that exist within a forest

stand. This was the view of Brooks *et al.*, (2005) that most taper equations do not adequately cater for variability found in any population. This informed the fitting of five taper equations for teak plantations in the study area.

All the taper equations generated for the diameter classes were significant suggesting that irrespective of the diameter class, the diameter at the base of the tree (D_b) differed significantly from the middle (D_m) and the top (D_t) of the tree which indicated the tapering nature of *Tectonagrandis*. The results are similar to taper equations obtained for *Eucalyptus pilularis* and *Eucalyptus grandis* in New South Wales, Australia (Muhairwe, 1999).

The taper equations developed for different diameter classes would minimize the level of variance and error that can arise from the change between the classes and within each class. Bi and Long (2001) had concluded that the evaluation of prediction accuracy over 10 diameter classes showed that the local bias of relative prediction is mostly ± 0.015 within any stem section. Also since the taper equations provide accurate estimates of diameter along a tree stem (Li and Weiskettel, 2010), the taper equations developed in this study would predict the diameter of individual *Tectonagrandis* tree at a given height.

Conclusion

The taper equations generated in this study have been tested with the various assessments for model formulation and found to exhibit good fit. The evaluation based on

different criteria such as significance of regression equation (F-ratio), adjusted coefficient of determination (Adjusted R^2), Root Mean Square Error (RMSE) showed that the taper equations met the requirements and can be suitable for sites with similar ecosystems.

References

- Alo, A. A., Onyekwelu, J.C. and Akindele, S.O. (2011). Taper equations for *Gmelina arborea* in Omo Forest Reserve, southwestern Nigeria. *Applied Tropical Agriculture* 16 (1 and 2): 120 - 127.
- Ball, J.B., Pandey, D. and Hirai, S. (1999). Global overview of teak plantations. In: Regional Seminar on Site, Technology and Productivity of Teak Plantations. Chiang Mai, Thailand, 26–29 January 1999:11–34.
- Bhat K. M. (2000). Timber quality of teak from managed tropical plantations with special reference to Indian plantations. *Bios et Forêts des Tropiques* 263(1):5-29.
- Bi, H. (2000). Trigonometric variable-form taper equations for Australian Eucalyptus. *Forest Science* 46 (3): 369-409.
- Bi, H. and Long, Y. (2001). Flexible taper equation for site-specific management of *Pinus radiata* in New South Wales, Australia. *Journal of Forest Ecology and Management* 148:79-91.
- Brooks, J. R., Lichun, J. and Jingxin, W. (2005). Compatible taper and volume equations for yellow-poplar in West Virginia. *Forest Ecology and Management* 213:399-409.
- Dorado, F.C., Diéguez-Aranda, U., Anta, M.B., Rodríguez, M.S and von Gadow, K. (2010). A generalized height-diameter model including random components for radiata pine plantations in northwestern Spain. *Forest Ecology and Management* 229: 202-213.
- Fang, Z. and Bailey, R.L. (1999). Compatible volume and taper models with coefficients for tropical species on Hainan Island in southern China. *Forest Science* 45: 85-100.
- Fang, Z. B. Borders, E. and Bailey, R.L. (2000). Compatible volume-taper models for loblolly and slash pine based on a system with segmented-stem factors. *Forest Science* 46: 1-12
- Jaroslaw, S (2002). A taper model for Norway spruce (*Picea abies* L. Karst). *Electronic Journal of Polish Agricultural University, Forestry Series*, 5(2): 1-14.
- Kaosa-ard, A. (1998). Overview of problems in teak plantation establishment. In: Kashio, M. and White, K. (ed.) Second Regional Seminar on Teak Series; RAP Publication-1998/05, 249pp.
- Kollert, W. and Cherubini, L. (2012). Teak Resources and Market Assessment 2010. FAO Planted Forests and Trees Working Paper FP/47/E, Rome, 42pp. Available at <http://www.fao.org/forestry/plantedforests/67508@170537/en/25th>
- Lee, W., Seo, J., Son, Y., Lee, K. and Von Gadow, K. (2003). Modelling stem profiles for *Pinus densiflora* in Korea. *Forest Science and Management* 172:69-77.
- Li, R. and Weiskittel, A.R. (2010). Comparison of Stem Taper Equations for Predicting Diameter and volume of Balsam Fir, Red Spruce and White Pine in the Acadian Region. CFRU Technical Report 18 pp.
- Muhairwe, C.K. (1999). Taper equations for *Eucalyptus pilularis* and *Eucalyptus grandis* for the north coast in New South Wales, Australia. *Forest Ecology and Management*, 113: 251-269.
- Perez, D.N., Burkhart, H.E. and Stiff, C.T. (1990). A variable-form taper function for *Pinus oocarpa* Schiede in Central Honduras. *Forest Science* 36: 186–191.
- Perex, D. (2008): Growth and volume equations developed from stem analysis for *Tectona grandis* in Costa Rica *Journal of Forest Science* 20(1):66-75.
- Sharma, M. and Oderwald, R.G. (2001). Dimensionally compatible volume and taper equations. *Canadian Journal of Forest Resources*. 31:797-803.
- Shaw, D.J., Meldahl, R.S., Kush, J. S. and Somers, G L. (2003). A Tree Taper Model based on Similar Triangles and Use of Crown Ratio as a Measure of Form in Taper Equations for Long Leaf Pines. USDA, Southern Research Station: General Technical Report, SRS-66. 8pp.

Influence of Community Perception on Tourism Acceptability of Osun Osogbo Sacred Grove, Nigeria

B.O. Adetola and G.D. Osanyinleye

*Department of Ecotourism and Wildlife Management,
Federal University of Technology, Akure, Ondo State, Nigeria
E-mail: .*

Abstract

The influence of community perception on tourism acceptability in Osun Osogbo Sacred Grove (OOSG) was investigated using questionnaire and in-depth interview. The population of the study consisted of the local communities around the grove from which 200 respondents were randomly selected. Data collected were analysed descriptively (frequency, percentages, means and standard deviation) while the hypotheses of the study were tested using Multinomial Logit Regression. The OOSG has various attractions amongst which festival (4.59) had the highest mean score followed by historical buildings and monuments (4.46) while sculpture had the least (3.75). Tourism activities in OOSG have created both positive and negative perceptions of tourism development among the local communities as measured through the economic and social perceptions of the impacts. The mean score ranking showed that employment opportunities (4.11), increase in income (3.97) and improved public security (3.93) were economic impacts while social impacts were increased entertainment (4.15), positive influence on cultural activities (4.08) and increased residents pride in indigenous culture (4.05). The negative influence on cultural activities and increase in prostitution were the negative perceptions of the host community that have significant effects on tourism acceptability ($p < 0.05$). The need to sensitise community stakeholders in tourism of its potential positive impacts is essential and effective measures should be developed to address the negative impacts in order to ensure sustainability of the destination.

Keywords: Tourism, community, impacts, attractions, acceptability, Osun Osogbo Sacred Grove

Introduction

Tourism has become the global leisure activity that relies mainly on the physical environment. Wall and Mathieson (2006) defined tourism as the study of people away from their usual environment, of the establishment which answers to the prerequisite of travellers and of the influences that they have on the economic, physical and social well-being of their host. Tourism is based on the economic and social processes and changes that are occurring in the environment of the societies where tourists come from and its development in the destinations focuses on the use of natural and cultural resources which generate impacts. The environment in which tourism occurs is the key component in tourism development and the attributes of an environment can either be viewed as natural and/or cultural (Holden, 2008).

Tourism development takes place where

the natural/cultural environments are attractive and desirable. Rocks, mountains, streams, beaches, flora and fauna are examples of the natural environment that attract large numbers of tourists. The cultural environment entails the part of the environment that is man-made and developed. The material components of the cultural environment are purpose-built structures and sites, caves, historical buildings, architectural features and ancient monument. The non-material components of the cultural environment are the culture of the people which entails the folklores, dance and carnivals.

Smith (2001) defined host communities as people who live in the vicinity of the tourist attraction and are either directly or indirectly involved with, and/or affected by the tourism activities. Tourism involves some elements of interaction between the tourist and the destination environment. The consequences of these interactions can lead to positive and

negative perceptions of the impact of tourism on the local communities which can be known through a personal encounter with the host communities, knowing their beliefs and perception about tourism in their locality. The impacts of tourism can be sorted into several categories, the most common ones are: economic, environmental and socio-cultural impacts (Cook *et al.*, 2006). Each of these categories includes positive and negative perceptions. Thus, community and tourism developers must balance the opportunities and concerns of all stakeholders by working against conditions where positive impacts benefit one part of the community (geographic or social) and the negative impacts hurt another (Kreag, 2001).

The uniqueness of Osun Osogbo Sacred Grove (OOSG) with its natural and cultural attractions is that it has gradually evolved from local significance to a regional and global dimension since its declaration as World Heritage Site by UNESCO in 2005. The need to assess the host communities' acceptance of tourism activities in OOSG is of necessity in order to achieve sustainable tourism development at the site. The influence of negative perceptions on tourism acceptability was tested in the study

Materials and Methods

Study area

The study was carried out in Osun Oshogbo Sacred Grove in Osun State. Osun State is located between 6° 55' to 8° 15' N and 4° 10' to 5° 10' E and on a relatively flat plain of about 250m above sea level within the western Nigeria plains. The annual average temperature ranges between 21.4 and 31.1°C, and mean annual relative humidity is about 77.1% (based on 1980-2007 data from the Nigerian Meteorological Agency). Its vegetation is the tropical rainforest type such that the area favours the cultivation of cash crops and food crops. Although there are people from other parts of Nigeria, the major sub-ethnic groups in Osun State are Ife, Ilesha, Oyo, Ibolo and Igbomina. Yoruba and English are the official languages and the people practice Islam, Christianity and Traditional Religious worship.

Data collection and analysis

The study employed both qualitative

and quantitative methods of data collection. The instruments used for this study are questionnaire and oral interview which was guided by interview schedule. Osogbo and Olorunda Local Government Areas (LGA) are the closest to the grove. There are ten political wards close to the grove in the LGAs in which each is distinctively distributed along seven streets. Residents 18 years and above in each of the streets were sampled. Two hundred (200) respondents (100 respondents each from Osogbo and Olorunda LGAs) were purposively sampled for the study. In-depth interviews were conducted with key informants and staff of OOSG. The data were analyzed using descriptive statistics of frequencies, percentages, means and standard deviation while multinomial logit regression analysis was carried out to identify the factors influencing tourism acceptability.

Result and Discussion

Socio-demographic characteristics of respondents and tourism awareness

The findings show that there were more male respondents (55%) than the females which is consistent with the 2006 Census (NPC, 2006) and estimates by CIA (2014) that put the sex ratio of the country's total population at 1.06:1.00 male/female. Most of the respondents (66.5%) were 20-49 years old which agrees with Nigeria's age distribution in 2008 that indicated the dominant age group at 15-64 years (NMEC, 2008). Thus, the participation of both the young and relatively-aged in this study would give the results a balanced view and thereby complement the earlier work by Olatunji and Ezenagu (2016) which gave a similar report for tourism promotion in Osun State. The religious inclinations of respondents show that 44.0 and 43.5% practiced Christianity and Islam respectively. Oladokun *et al.* (2014) had reported 37.0% as Christians in Osogbo metropolis which is lower than the result in this study. A higher percentage (59%) of the respondents was married which indicates that majority of the residents were emotionally stable with household size of mainly 1 to 5. The educational attainment of the respondents shows 31% without formal education while 16, 23.5, 26 and 3.5 had primary, secondary, tertiary and adult/vocational education

respectively. The literacy level at 69.0% is higher than the national estimated literacy rate of 61.3% (CIA, 2014) but the literacy distribution pattern indicates that the study area is not really an urban setting and it is still developing. The sample population had most as indigenes (58.5%) and 41.5% as immigrants. Also, most of the respondents were traders (27.5%) followed by civil servants (17%), artisans (16.5%) and farmers (9.5%). This shows that the communities are dominated by traders whose businesses are sustained by the presence of the grove and the high patronage from visitors. All the respondents were aware of tourism development at the grove because the Osun Osogbo Festival is a yearly activity which is the most celebrated compared to other religious festivals around the grove. It pulls a considerable number of tourists adding directly and/or indirectly to the social and economic life of the people.

Attractions in Osun Osogbo Sacred Grove as identified and ranked by residents

Tourist attractions in the destination were identified as sanctuaries and shrines, the festivals, forests and grove, traditional war fence, traditional arts and craft which fall under cultural and natural environment (Table 2). This distribution of tourist attractions complements Aremu, (2001) that the development and projection of Nigeria's natural and cultural resources would remain the centerpiece of tourism awareness in Nigeria. Festival (4.59) had the highest mean score and was seen as the major attraction by the respondents followed by Historical Buildings and Monuments (4.46), Sanctuaries and Shrines (4.37) while Sculpture had the least (3.75). This agrees with Fakiyesi (2008) that Nigeria possesses natural and cultural resources which are capable of attracting tourists.

Table 1: Socio-demographic characteristics of respondents at Osun Osogbo Sacred Grove

Variables	Freq (N)	Percent (%)
Gender		
Male	110	55.0
Female	90	45.0
Age		
0-19	2	1.0
20-29	54	27.0
30-39	33	16.5
40-49	46	23.0
50-59	41	20.5
60andabove	24	12.0
Marital Status		
Single	50	25
Married	119	59.5
Divorced	12	4.0
Widowed	8	6.0
Separated	1	5.5
Household Size		
1-5	118	59
6-10	71	35.5
11-15	11	5.5
Level of Education		
Non-formal	62	31.0
Primary	32	16.0
Secondary	47	23.5
Tertiary	52	26.0
Adult/Vocational	7	3.5

Occupation

Artisan	33	16.5
Farmer	19	9.5
Trading	55	27.5
Civil Servant	34	17.0
Retiree	9	4.5
Others	50	25.0

Religion

Christianity	88	44.0
Islam	87	43.5
Traditional Worshipper	24	12.0
No Religion	1	0.5

Ethnic Origin

Indigene	117	58.5
Immigrant	83	41.5
Awareness of Tourism Devt. in OOSG	20	100

Table 2: Summary of various Tourist Attractions in Osun Osogbo Sacred Grove As described by the Respondents

VARIABLES	SA	A	U	D	SD	Mean	ST.DEV.	Rank
Sanctuary and Shrine	123	55	7	9	6	4.37	0.97	3rd
Sculpture	36	100	48	13	3	3.75	0.87	8th
Traditional Arts and Craft	97	67	22	8	6	4.18	0.99	5th
Forests/grove	105	73	11	7	4	4.32	0.89	4th
Theatres	49	82	53	13	3	3.79	0.93	7th
Historic Buildings and Monuments	110	81	2	6	1	4.46	0.72	2nd
Festivals	135	58	3	1	3	4.59	0.69	1st
Traditional War Fence	57	94	34	11	4	3.93	0.93	6th

Perception of Economic Impacts by Respondents

Table 3 presents the respondents' perceived opinions of the economic impacts of tourism activities in OOSG on the host communities. The mean score ranking shows that the higher scores were for the perceived economic impacts which include: employment opportunities (4.11), increase in income (3.97), better public security (3.93) and attraction of small-scale industry (3.89). The lower scores are for the economic impacts that the respondents disagreed with and these are: deterioration of quality of life (2.07), increase in cost of land (2.11), increase in prices of goods (2.14) and increased transportation cost (2.19). Onyebinama *et al.* (2008) had noted that tourism development tends to attract residents away from their traditional economic activities

such as farming, fishing. This is because it generates employment (direct, indirect and induced). Overall, the respondents agreed that tourism has the tendency to increase the quality of life, attract small scale industries and provide job opportunities. This is because some of the respondents are involved in tourism activities as small retail shop owners, transportation providers and artisans which bring direct economic benefit to them. This has informed the support towards tourism development in the grove (Fig. 1). According to Gursoy and Rutherford (2004), residents tend to view tourism as a tool that creates job opportunities and generates additional revenue for local community and government. Generally, the residents perceived that tourism increases their quality of life (Besculides *et al.*, 2002).

Table 3: Perception of Economic Impact of Tourism Development on Host Communities

Variables	SA	A	U	D	SD	Mean	ST.DEV.
Employment Opportunities	77	97	7	9	10	4.11	1.02
Increased Income	56	111	11	15	7	3.97	0.98
Improved Infrastructures	17	38	19	84	42	2.52	1.25
Standard of Living Quality of Life	16	55	24	67	38	2.72	2.49
Creation of Variety of Jobs	24	152	5	14	5	3.88	0.79
Electricity Supply	18	32	9	73	68	2.30	1.33
Water Supply	13	26	7	87	67	2.16	1.21
Transportation Cost	8	30	18	80	64	2.19	1.16
Increased in Cost of Land	5	26	22	79	68	2.11	1.09
Deterioration of Quality of Life	7	24	12	89	68	2.07	1.09
Increase in Price of Good	12	20	15	89	64	2.14	1.15
Road Condition	2	39	10	82	67	2.14	1.11
Increased Tourism help community grow	30	140	9	14	7	3.86	0.87
Health and Safety are more Secured	41	117	24	14	4	3.89	0.88
Attraction of Small Scale Industry	31	132	23	11	3	3.89	0.78
Better Public Security	49	112	23	8	8	3.93	0.94
Overcrowding	61	80	29	18	12	3.80	1.14

Perception of Social Impacts by Respondents

Most of the respondents agreed that tourism was the major reason for increased entertainment in their community, had positive influence on cultural activities, increased residents' pride in local culture and provision of more recreational opportunities with mean scores of (4.15, 4.08, 4.05 and 4.03 respectively). Majority of the respondents disagreed to difficulty in getting tickets during the tourist peak season (2.23) since the festive celebration is opened to everybody. This corroborates the findings of Besculides *et al.* (2002) on the residents' perceptions of the

cultural benefits of tourism. A higher percentage of the respondents agreed to the negative social impacts of tourism development which include: increased traffic congestion (3.96), increased prostitution (3.96) and increase in crime rate (3.94), especially during the peak tourist season (Table 4). Drawing from the social exchange theory which stated that individuals will engage in exchange if the resulting rewards are valued and the perceived cost does not exceed the perceived rewards (Brunt and Courtney 1999). The respondents viewed the rewards higher than the cost which informed the positive impact.

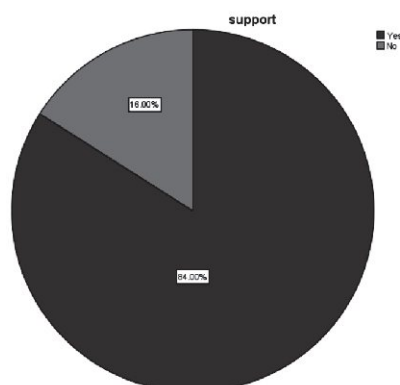
**Figure 1: Respondent Support for tourism activities in Osun Osogbo Grove**

Table 4: Perception of Socio Impact of Tourism Development on Host Communities

Variables	SA	A	U	D	SD	Mean	ST.DEV.
Increased Entertainment	69	106	11	7	7	4.15	0.92
Difficulty in getting ticket	8	28	8	57	99	2.23	1.21
Recreational Opportunity	28	155	7	7	3	4.03	0.67
Increased Residents Pride	41	139	10	4	6	4.05	0.77
Negative Influence on Cultural Activities	32	101	15	16	36	3.47	1.34
Positive Influence on Cultural Activities	41	139	13	4	3	4.08	0.69
Meeting Tourists is a life Enriching Experience	33	129	17	15	6	3.92	0.89
Cultural Exchange is Valuable	38	126	19	11	6	3.95	0.88
Increase in Prostitution	50	109	11	21	9	3.96	1.05
Crime Problem	50	103	15	24	8	3.94	1.06
Traffic Congestion Problem	50	106	14	23	7	3.96	1.03
Increased Gambling	44	104	24	20	8	3.88	1.02
Increased Noise Level	54	98	22	19	7	3.96	1.03

Influence of Negative Perception of the Respondents on Tourism Acceptability in Osun Osogbo Sacred Grove

The multinomial logit regression used to assess the perception of the host community on tourism acceptability (Table 5) involved the negative perception items as the independent variable and their support for tourism as the dependent variable which carries the multiple option of “yes or no” as shown in Fig. 1. The Likelihood Ratio Statistics of the regression model presented reveals that increase in transportation cost, increase in cost of land, increase in cost of goods and services, deterioration in the quality of life, deterioration of road condition, negative influence on cultural activities, increase in prostitution, increase in crime, increase in traffic, increase in gambling and increase in noise level

are the 11 negative perception items included in the model. The items negative influence on cultural activities and increase in prostitution were significant ($p < 0.05$). This implies that increase in prostitution and the negative influence of tourism on cultural activities were the only significant variable influencing tourism acceptability and can also influence the acceptability of tourists and tourism development in the area. This agrees with Jurowski and Uysal (2002) that negative economic, together with social and environmental factors, will influence resident perceptions of tourism and their support for tourism development

Table 5: Effects of negative perceptions of the Multinomial Logit Regression on tourism acceptability

Effect	Model Fitting criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	Df	Sig.
Intercept	81.619 ^a	0.000	0	.
Increased transportation	84.177	2.558	4	.634
Increased cost of land	85.968	4.349	4	.361
Increased price of goods	85.584	3.965	4	.411
Deterioration of quality of life	83.913	2.295	4	.682
Deterioration of road	84.302	2.683	4	.612
Negative influence on cultural activity	95.808	14.189	4	.007
Increased prostitution	95.488	13.869	4	.008
High crime	87.704	6.085	4	.193
Traffic problem	89.818	8.199	4	.085
Increased gambling	89.403	7.784	4	.100
Increased noise	86.941	5.322	4	.256

Significant at $p < 0.05$

Conclusion

This paper has examined the influence of communities' perception on tourism acceptability in Osun Oshogbo Sacred Grove. Both natural and cultural resources were identified as major attractions in the grove capable of attracting a large number of tourists and as such creating impacts on the host communities. Tourism at the grove has been perceived to have both positive and negative impacts on the host communities in terms of economic and social changes. Moreover, the

respondents viewed the rewards higher than the cost which was responsible for the positive impact and support towards tourism development in the grove. The negative influence on cultural activities and increase in prostitution were the two negative perceptions that had significant effects on tourism acceptability in the grove. These negative perceptions are capable of threatening the survival of tourism destinations if measures and policies are not developed to address the negative issues.

References

- Aremu, B.A. (2001). Cultural and Eco-Tourism Development in Nigeria. Ibadan: *Hole Publications* 5(2): 15-18
- Besculides, A., Lee, M.E. and McCormick, P.J. (2002). Residents' Perceptions of the cultural benefits of tourism, *Annals of Tourism Research* 29(2): 303-319
- Brunt, P. and Courtney, P. (1999). Host perceptions of sociocultural impacts. *Annals of Tourism Research* 26(3): 493-515
- CIA, (2014). The World Fact Book, Central Intelligence Agency, Washington, DC, 2014
- Cook, R.A., Yale, L.J. and Marqua, J.J. (2006). *Tourism: The Business of Travel*. 3rd Edition. New Jersey: Prentice Hall.
- Fakiyesi, T. (2008). Economic Acceleration of Nigeria through the Development of Tourism industry. Retrieved on 08/08/2010. Available on www.responsibletravel.Org/resources (6.)
- Gursoy, D., and Rutherford, D.G. (2004). Host attitudes toward tourism: An improved structural model. *Annals of Tourism Research* 31(3): 495-516
- Holden, A. (2008). *Environment and Tourism*. 2nd edition. Canada: Routledge.
- Jurowski, C., Uysal, M., and Williams, R.D. (2002). A theoretical analysis of host community resident reactions to tourism. *Journal of Travel Research* 36(2): 3-11
- Kreag, G. (2001). *The Impacts of Tourism*. Retrieved on 16/05/2010. Available on <http://www.seagrant.umn.edu/tourism/pdfs/ImpactsTourism.pdf>
- NMEC, (2008). Non-formal Education in Nigeria: Policy Issues and Practice. National Commission for Mass Literacy, Adult and Non-formal Education Abuja. UNICEF Nigeria Publications, 15p.
- NPC, (2006). Population and Housing Census of the Federal Republic of Nigeria: National and State Population and Housing Tables; Vol. 1; National Population Commission Publication, 326pp
- Oladokun, O.J, Ololajuloja, J. and Oladeji, O.I. (2014). Analysis of factors enhancing special needs for people participation in recreation and cultural tourism activities in Osogbo Metropolis in Osun State Nigeria. *Journal of Social Sciences* (20) 5: 318-514
- Olatunji T.T. and Ezenagu N. (2016). An evaluation of selected attractions in Osun State for tourism promotion.

- Journal of Tourism, Hospitality and Sports* 15(3): 213-513
- Onyebinama, C.O., Ngoka I.S. and, Emezie N.A. (2008). Museums and young people: The heritage of pride. *African Journals Online* 5(2): 107-112
- Smith, S.L. (2001). Measuring the economic impact of visitors to sport tournament and special events. *Annals of Tourism Research* 28(3): 829-831.
- Wall, G. and Mathieson, A. (2006). *Tourism: Change, Impacts and Opportunities*. England: Prentice Hall.

Nutrient Composition of *Coptodon zillii* in the Water Dams in Ekiti State, Nigeria

B.J. Akin-Obasola, and O.T. Adu,

Department of Fisheries and Aquaculture Management,

Ekiti State University, Ado Ekiti, Nigeria

E-mail: bola.akinobasola@eksu.edu.ng

Abstract

Fish is one of the cheapest sources of animal protein and essential nutrients required in human diets. The recommendation of new species of fish for human consumption should only be made after assessing the nutritional qualities. Ten (10) samples of *Coptodon zillii* were collected from each of Ureje, Ero, Egbe and Itapaji dams in Ekiti State, South western, Nigeria and frozen immediately. The samples were analyzed for proximate composition and contents of amino acids. *Coptodon zillii* protein content was not significantly different among the dams but varied between 51.05 to 55.26% in the order of Ureje > Itapaji > Egbe > Ero dams. The moisture content was similar among the fish collected from the dams at 25.33-25.95%. The fat content was highest in fish from Itapaji and Egbe dams while fish from Ureje dam contained the highest ash (12.21%). The essential amino acid analysis revealed that arginine values were not significantly different ($P < 0.05$) among the fish from Ureje, Ero and Egbe dams; isoleucine was highest in fish from Ureje and not different between Egbe and Ero dams; leucine was highest at Egbe dam while histidine, methionine, cystine, tyrosine and valine were not significantly different among the dams. The nutrient composition of *Coptodon zillii* varied with location and was comparable with the limits obtained for other species which provided the basis for recommending the fish as fit for human consumption.

Keywords: *Coptodon zillii*, dams, proximate composition, amino acids, Ekiti State

Introduction Fish is one of the potential sources of animal protein and essential nutrients for the maintenance of a healthy human body especially in developing countries (FAO, 1994, Fawole et al., 2007). In Nigeria fish constitute 40% of the total dietary animal protein intake and total annual consumption is more than 1.36 million tons (Abdullahi, 2007). Furthermore, the fisheries industry has a demand and supply deficit of over 60% and so a serious development challenges. One of these is the steady decline in capture fisheries sources due to normal global trends and the aggravation by specific local disturbances in Nigerian coastal and offshore waters. This scenario has led to a shift in focus to inland water resources especially for aquaculture, which efforts have yielded encouraging results in the past few years (Abdullahi, 2007). This upward trend is expected to continue.

Fish is an excellent source of protein, compared to other sources, as can be seen from its amino acid composition and protein digestibility (Louka et al., 2004). Fish is generally appreciated as one of the healthiest and cheapest sources of protein and it has amino

acid composition that is higher in cysteine than most other sources of protein (Duffus, 1980). Fish meat contains significantly low lipids and higher water than beef or chicken and is favoured over other white or red meats (Onyiah et al., 2010). The nutritional value of fish meat comprises the contents of moisture, dry matter, protein, lipids, vitamins and minerals plus the caloric value of the fish (Elagba et al., 2010).

The nutritional composition of fish varies greatly from one species and individual to another depending on age, feed intake, sex and sexual changes connected with spawning, the environment and seasonal factors. Nutrients are chemical substances for example protein and vitamin found in food that can be digested and absorbed and used to promote body functions. They are sources of nourishment that can be metabolized by an organism to give energy and build tissue. Macronutrients provide the bulk energy for an organism's metabolic system to function while micronutrients provide the necessary cofactors for metabolism to be carried out. The fish's chemical composition can be affected by many factors, including species, environmental condition, fish size, level of protein in the diet and feeding rate (Ogata and Shearer, 2000).

African cichlids formerly referred to as “tilapia” represents a paraphyletic species assemblage belonging to the haplotilapine lineage which is globally important for aquaculture. In the past, tilapia was a large genus of cichlid fishes including all species with the common name tilapia but today the vast majority is placed in other genera: *Coptodon*, *Coelotilapia*, *Heterotilapia*, *Paracoptodon* and *Pelmatilapia* (Dunz and Schlieven, 2013). *Coptodon zillii* is a common fish in most freshwater of the rivers, dams and ponds in Nigeria. The fish is of high commercial values and marketing trends indicates higher demand for this freshwater species (Balogun and Adebayo, 1996). The Redbelly tilapia, now known as *Coptodon zillii* is indigenous to the Northern hemisphere of the African Continent and Palestine According to Leo *et al.* (2013), it is found in the tropical and subtropical Africa, Near East and West Africa. Cichlid (*Coptodon zillii*) is one of the major freshwater fishes cultured in Ekiti State and it serves as the main fresh water fish protein source for the people hence, the need to have data on the nutrient composition of cichlids found in all the dams in Ekiti for the purpose of record keeping, policies and decision-making.

A new species should be recommended for human consumption only after assessing its nutritive value with regards to nutritional qualities especially the content of omega-3-fatty acid that helps to reduce the risk of cardiovascular disease (Ajayabhaskar *et al.*, 2002). The objectives of this study are to: analyze the physicochemical parameters, investigate the nutrient composition of *Coptodon zillii* and compare the nutrient composition of the four dams in Ekiti State

Materials and Method

Study area

Ekiti State is located between latitude 7° 15' and 8° 05'N and between longitudes 4° 51' and 5° 45'E The state enjoys tropical climate with two distinct seasons and these are rainy season (April-October) and the dry season (November-March). The temperature ranges between 21° and 28°C with high humidity. Tropical forest exists in the southern and central portions while derived savannah occupies the northern periphery.

Collection of samples:

Fresh and live fish samples were collected from

the four dams in Ekiti State, Nigeria: Egbe dam (7.36- 7.61°N, 5.36-5.57°E) in Egbe-Ekiti, Gbonyin Local Government Area (LGA); Ero dam (7.99°N, 5.19°E) in Ikun-Ekiti, Moba LGA; Itapaji dam (7°55'-7°58'N, 5°25'-5°28'E) in Itapaji-Ekiti, Ikole LGA; and Ureje dam (7°37'N, 5°13'E) in Ado-Ekiti, Ado LGA. Forty (40) samples of *Coptodon zillii* samples, at 10 pieces from each dam, were collected. Water samples were taken and analyzed using the Claude (1979) method.



Plate 1: *Coptodon zillii*

Dissolved oxygen was determined using oxygen meter, pH was determined using pH meter and temperature was determined using thermometer.

The fish samples were thoroughly washed with tap water and distilled water and drained under folds of filter paper and dissected to remove the intestines, guts and bones. The head was discarded. The samples were homogenized with an electric food blender. The proximate composition of the fish fillets was determined according to the method described in AOAC (1990) for moisture, ash, crude protein, crude fat and carbohydrate.

Five (5) fish samples from each dam were oven-dried at 105°C for 24 h, finely powdered and sieved for the determination of amino acid composition in acid hydrolysate (6 mol.l⁻¹HCl under reflux for 24 h at 110°C) using an automatic Amino Acid Analyser (LKB 4151 Plus, Biochrom Ltd., Cambridge, UK). Tryptophan was determined colorimetrically after hydrolysing the samples in 4.2 mol.l⁻¹NaOH (Fischl, 1960).

The data obtained from the study were analyzed using SPSS, version 21. Analysis of variance (ANOVA) table was used to check for statistical significant differences in means of crude protein, ash, moisture content and carbohydrates of *Coptodon zillii* tissue.

Results

The pH of water from Egbe, Ero and Ureje dams was similar and significantly different from Itapaji (Table 1). The water temperature at Itapaji dam was lower than the other three dams

which had similar values. Dissolved oxygen was highest at Ero dam, but did not differ significantly from the other dams. The conductivity was highest at Ero and Ureje dams but water at Ureje dam was not significantly different from Itapaji dam.

Table 1: Water quality parameters of the dams in Ekiti State

	pH	Temperature	DO ₂ (mg/l)	Conductivity
Egbe dam	7.91±0.03	27.53±0.01	7.73±0.05	1.57±0.01
Ero dam	7.94±0.05 ^a	27.43±0.03 ^a	8.27±0.07 ^a	1.87±0.03 ^a
Ureje dam	7.93±0.07 ^a	27.53±0.04 ^a	7.93±0.04 ^{ab}	1.83±0.05 ^{ab}
Itapaji dam	7.47±0.04 ^b	26.97±0.06 ^b	7.63±0.02 ^b	1.63±0.02 ^{bc}

Using DMRT, values with the same superscript ($P<0.05$) are not significantly different.

The protein content of *Coptodon zillii* was highest at Ureje dam (55.26±0.40) while the least was at Ero dam (51.05±0.00), but the values were not significantly different among the dams (Table 2). Fat content was highest at Itapaji

and Egbe dams and differed significantly from Ero and Ureje dams. The ash content was highest at Ureje dam and differed significantly from the other dams which had similar values. The moisture content was the same for fish from the four dams.

Table 2: The proximate analysis of the tissue of *Coptodon zillii* samples from the dams in Ekiti State.

	%Fat	%Moisture	%Ash	%Protein
Egbe dam	20.89±0.51 ^a	25.33±0.00	8.30±0.30 ^b	53.02±0.32
Ero dam	16.25±0.16 ^b	25.65±0.03	6.93±0.00 ^b	51.05±0.00
Ureje dam	14.71±0.14 ^b	25.83±0.02	12.21±0.66 ^a	55.26±0.40
Itapaji dam	20.18±0.99 ^a	25.95±0.99	8.53±0.38 ^b	53.30±0.40

Values with the same superscripts ($P<0.05$) are not significantly different.

In Table 3, arginine content did not differ among Egbe, Ero and Ureje dams but was significantly lower at Itapaji dam. Histidine was similar in the four dams. Isoleucine was highest in Ureje and did not differ between Egbe and Ero dams. Leucine was highest at Egbe dam. Methionine, Cystine and valine showed no significant

differences among the fish samples from the four dams. Phenylamine was significantly different between the dams while threonine was not significantly different between Egbe and Ero dams but differed in Ureje and Itapaji dams. Tryptophan was highest in Itapaji dam but the same in Egbe, Ero and Ureje dams.

Table 3: Essential amino acid composition of *Coptodon zillii* from the dams in Ekiti State.

Essential amino acid	Egbe dam	Ero dam	Ureje dam	Itapaji dam
Arginine	86±0.05 ^a	84±0.03 ^a	88±0.06 ^a	80±0.04 ^b
Histidine	35±0.06 ^a	32±0.09 ^a	28±0.07 ^a	26±0.05 ^a
Isoleucine	55±0.08 ^a	54±0.04 ^a	62±0.02 ^b	58±0.06 ^c
Leucine	97±0.01 ^a	88±0.05 ^b	90±0.03 ^b	94±0.02 ^c
Methionine	31±0.08 ^a	29±0.09 ^a	33±0.05 ^a	35±0.07 ^a
Cystine	45±0.03 ^a	40±0.07 ^a	38±0.06 ^a	42±0.04 ^a
Phenylamine	69±0.02 ^a	59±0.06 ^b	62±0.04 ^b	65±0.09 ^b
Threonine	71±0.08 ^a	73±0.02 ^a	66±0.04 ^b	70±0.01 ^c
Tryptophan	15±0.02 ^a	15±0.04 ^a	13±0.01 ^a	20±0.05 ^b
Valine	68±0.06 ^a	66±0.04 ^a	70±0.08 ^a	74±0.07 ^a

Discussion

Coptodon zillii from the four dams in Ekiti State showed variations in nutrient composition. The moisture content (25.33-25.95%) is higher than 7.07-11.14% reported by Olele et al. (2012) in three species of fish. Also, Fawole et al. (2007) obtained lower moisture content (5.25-10.14%) for *Chrysichtys nigrodigitatus*, 5.80% for *Sarotherodon galilaeus*, 7.90% for *Heterotis niloticus* and 6.03-8.02% for *Auchenoglanis biscutatus*. Effiong and Fakunle (2011) obtained a value of 8.80% for *Bagrus bayad* and 11.28% for *Lates niloticus*.

The crude fat content of fish in the four dams varied between 14.71 and 20.89% which is lower than 25.04-35.07% in *Gnathonemustamandua* (Olele et al., 2012) but the upper value is comparable with 20.18-20.89% in *Cyprinus specularis* and 16.07-20.07% in *Cyprinus carpio* (Keriko et al., 2010). The crude fat contents were 17.16-39.06% in *Chrysichtys nigrodigitatus* and 18.30-37.02% in *Tilapia mossambicus* (Adefemi, 2011) while Effiong and Fakunle (2012) obtained 18.22 to 36.56% fat in *Lates niloticus*. The amount of fat observed from this study is high and this is very important because it contributes to the reduction in cardiovascular diseases and may also lead to improvement in learning ability (Nordov et al., 2001).

The fish from Ureje dam has the highest ash content with a value of 12.21% which falls within the range of 6.26-26.26% in *Gnathonemustamandua* reported by Olele

(2012). This is in close agreement with the report of Adefemi (2011) that *Tilapia mossambicus* and *Clarias gariepinus* contained 7.58-24.52% and 6.40-23.06% ash respectively. Onyia et al. (2010) and Olayemiet et al. (2011) obtained the range of 5.0-21.41% and 6.09-23.06% in *Oreochromis niloticus* and *Auchenoglanis biscutatus* respectively.

The protein content (51.05-55.26%) which did not differ among the fish from the four dams is higher than the values obtained in *Auchenoglanis biscutatus* whose highest contents at 6.32 to 16.31% exceeded those of three other fish species. The protein content is also not comparable with 8.31-15.18% in *Chrysichtys nigrodigitatus* (Oyelese, 2006); 5.26-16.99% in *Ailiacoila* (Mazumber et al., 2008) and 9.14-12.23% in *Tilapia mossambicus* (Adefemi, 2011). These differences may be attributed to fish size, differences in fish environment, their consumption or absorption capacities, their ability to metabolize and utilize essential nutrients (from their diet or from the local environment) and incorporate them into their body (Adewoye and Omotosho, 1997).

The high percentage of crude protein observed in this study could be attributed to the fact that the fishes from the dams are not underfed and have access to favorable and unpolluted environment. A new species should be recommended for human consumption only after assessing the nutritive value of the species with regards to its nutritional qualities therefore this study has helped in providing a little update in *Coptodon zillii* nutrient composition in Ekiti State which varied from location to location.

References

- Abdullah, A.Y. (2007). Evaluation of Land-based Freshwater Fish Farming Potentials in Nigeria: An Approach through the Use of Geographic Information System (G.I.S.). PhD Thesis in Zoology (Fisheries), Department of Biological Sciences, Faculty of Science University of Abuja, Nigeria.
- Adefemi, O.S. (2011). Chemical composition of *Tilapia mossambicus* from major dams in Ekiti State, Nigeria. *African Journal of Food Science* 5(10): 550-554.
- Adewoye, S.O., Fawole, O.O. and Omotosho, J.S. (2003). Concentration of some selected elements in some freshwater fishes in Nigeria. *Science Focus* 4: 106-108.
- Ajayabhaskar, D. (2002). Nutritional Evaluation

- of Molluscan Sea Food. PhD Thesis, Annamalai University, India. 129pp.
- AOAC (1990). Official Methods of Analysis of the Association of Analytical Chemists (15th edition). Airlington: Association of Official Analytical Chemists. Section 969. 33pp.
- Claude, E. (1979). Water Quality in Warm Water Fish Ponds: 20-72.
- Duffus J.H. (1980). Environmental Toxicology. Published by Edward Arnold, London. 164pp
- Dunz, A.R. and Schliewen, U.K. (2013). Molecular phylogeny and revised classification of the haplotilapiine cichlid fishes formerly referred to as tilapia. *Science Direct Molecular Phylogenetics and Evolution Journal* 68 (1): 64-86.
- Balogun, M.A. and Adebayo, F.E. (1996). Flesh yield and aspects of chemical composition of the flesh of some commercially important fresh water fish species in Nigeria. *Journal of Agricultural Technology* 4(1):33-40
- Effiong, B.N, Fakunle, J.O. (2011). Proximate and mineral composition of some commercially important fishes in Lake Kainji, Nigeria. *Journal of Basic Applied Science Resources* 1(12): 2497-2500.
- Elagba, M.H.A., Al-Maqbaly, R. and Mohamed, M.H. (2010). Proximate composition, amino acid and nutrient contents of five commercial Nile fishes in Sudan. *African Journal of Food Science* 4(10): 650-654.
- FAO (1994). *Programme for Intergrated Development for Artisanal Fisheries in West Africa. Technical Report, Food and Agriculture Organisation of the United Nation, Rome: 3-39.*
- Fawole, O.O. Ogundiran, M.A., Ayandiran, T.A. and Olagunju, O.F. (2007). Mineral composition in some selected fresh water fishes in Nigeria. *Journal of Food Safety* 9: 52-55.
- Fischl, O.O.(1960). Mammalian Protein Metabolism. Volume 3, Edited by Murro, H.N.: 505-506.
- Keriko, J.M, Chege, C.W, Magu, M.M. Mwachiro, E.C., Murigi, A.N., Githua, M.N. and Kareru, P. G. (2010). Fish lipid contents and classes of selected fish species found in Lake Naivasha (Kenya) and the fish feeding habits of the lake inhabitants. *African Journal of Pharmacy and Pharmacology* 4(10): 745-753.
- Leo, N. and Matt, N. (2013). *Tilapia mariae* Boulenger, 1899: U.S. Geological Survey, Non-indigenous Aquatic Species Database, Gainesville, FL: 1-15
- Louka, N., Juhel, F., Fazileau, V. and Loonis, P. (2004). A novel colorimetry analysis used to compare different drying fish processes. *Food Control* 15: 327-334.
- Mazumder, M.S.A., Rahman, M.M., Ahmed, A.T.A., Begum, M. and Hossain, M.A. (2008). Proximate composition of some indigenous fish species in Bangladesh. *International Journal of Sustainable Crop Production* 3(4): 18-23.
- Naglis, T.H., Mayer, W.E., Samonte, I.E., McAndrew, B.J. and Klein, J. (2011). Classification and phylogenetic relationships of African Tilapine fishes inferred from mitochondrial DNA sequences. *Molecular Phylogenesis and Evolution* 20(3): 361-374.
- Nordov, A.R., Marchioli, H.A and Videbaek, J.(2001). N-3 poly-unsaturated fatty acids and cardiovascular diseases. *Lipids* 36: 21-29.
- Ogata, H.Y. and Shearer, K.D. (2000). Influence of dietary fat and adiposity on feed intake of juvenile red sea bream *Pargus major*. *Aquaculture, Amsterdam* 189: 237-249.
- Olayemi FF, Adedayo M R, Bamishaiye E I, AwagUEF (2011). Proximate composition of catfish (*Clarias gariepinus*) smoked in Nigerian stored products research institute (NSPRI): Developed kiln. *Int. J. Fisheries and Aquaculture*. Vol. 3(5), pp. 95-97, Available online at <http://www.academicjournals.org/IJFA>
- Olele. N.F. (2012). Nutrient composition of *Gnathonemustamandua*, *Chrysichtys nigrodigitatus* and *Auchenoglanis biscutatus* caught from River Niger. *Nigerian Journal of Agriculture, Food and Environment* 8(2): 21-27
- Onyia, L.U., Millam, C., Manu J.M. and Allison,

D.S. (2010). Proximate and mineral composition of some freshwater fish in Upper River Benue, Yola, Nigeria. *Continental Journal of Food Science and Technology* 4: 1-6

Oyelese, O.A. (2006). Implication of carcass quality and condition factor to the processing of some selected freshwater fish family. *Journal of Fisheries International* 1(2-4): 132-135.

Insecticidal Activity of Essential Oils from Three Plant Seeds against Beetle(*Dermestes maculatus*) in Smoke-dried Catfish (*Clarias gariepinus*)

I..A, Adebayo, O.O. Fapohunda and R. Saka,

Department of Fisheries and Aquaculture Management,

Faculty of Agricultural Sciences,

Ekiti State University, Ado Ekiti, Ekiti State

E-mail: olawumi.fapohunda@eksu.edu.ng

Abstract

This study was conducted to determine the insecticidal activity of essential oils extracted from the seeds of *Piper guineense*, *Monodora myristica* and *Aframomum melegueta* against adults of the beetle, *Dermestes maculatus*, on smoke-dried catfish, (*Clarias gariepinus*) during storage. The beetle was least tolerant to *P. guineense* oil which recorded 100% mortality within the first week of the experiment. *M. myristica* oil recorded 100% mortality for beetles on catfish in the second week while *D. maculatus* was most tolerant of *A. melegueta* oil which attained 100% mortality in four weeks. *P. guineense* and *M. myristica* oil extracts were more effective than *A. melegueta* oil extract, though it was observed that *M. myristica* attained 100% mortality in the second week of experiment, the moisture absorption by smoke dried catfish was higher than that of *A. melegueta* which obtained 100% mortality in the fourth week of experiment.

Keywords: Insecticidal activity, essential oils, catfish, *Dermestes maculatus*.

Introduction

Fish is highly perishable which necessitates its processing and preservation especially in the tropics where high temperature and humidity accelerate the spoilage and bio-deterioration immediately after catch or death. Fish post-harvest losses in Nigeria have been estimated at 30-40% (FAO, 2004). This susceptibility of fish to damage has necessitated the direction of efforts, primarily, towards the preservation of fish for human consumption. However, poor handling, inadequate processing facilities, lack of ice or storage facilities, remoteness of the fishing villages to urban market centres, poor transportation system and poor distribution channels have drastically reduced fish utilization in the tropics (Ames, 1992).

In developing countries, fish is preserved either by salting, smoking or sun-drying and fermentation. Smoke is produced by the process of incomplete combustion of wood in order to impart a characteristic flavour and colour to the fish. In addition, smoking increases the shelf life of fish as a result of the combined effects of cooking, dehydration, anti-microbial and antioxidant activity of several of the smoke constituents mainly formaldehyde, carboxylic acid, phenols. Often, smoke-dried fish is eaten without further cooking (Asita, 2000).

Despite the availability of these preservation methods, fish is still highly susceptible to bio-deterioration which does not depend on microbes, enzymes and fat oxidation only but also on insect pest infestation, especially in cured fish (Balogun, 1992). Insect infestation is a serious spoilage agent and fish that is not properly cured can harbour large populations of maggots and blowfly whose developments are enhanced by high moisture content (Dobie et al., 1991).

Infestation by insects could cause up to 50% loss of weight and occurs during different stages of drying of the fish product. As drying continues, the adult *Dermestes maculatus* and *Necrobraruffipies* lay eggs on fish and the emerging larvae feed on the fish flesh which may break up. Observation suggests that the fish needs to be at least surface-dried before *Dermestes maculatus* can commence the laying of eggs. After drying, infestation by *Dermestes maculatus* and *Necrobraruffipies* and mites increases rapidly and this continues during storage and transportation. These pests feed on flesh causing loss in weight and quality, especially with the appearance of insects and maggots. Dried fish can be de-infested by heat treatment such as re-smoking or the use of solar driers. Some beetle larvae are killed by exposure to temperature of 50°C for 15 minutes.

Treatment may include heavy salting which protects the fish against attacks by the larvae of the beetle and decrease the body weight of the adult *Dermestes maculatus*.

There appears to be some degree of variability in the susceptibility of different fish genera to *Dermestes maculatus*, for example, *Clarias* and *Tilapia* are easily infested while *Heterobranchius* and *Synodontis* are somewhat more resistant. Fish of fresh water origin are more frequently attacked probably due to the rather poor salt tolerance of this species. Development of the larvae is apparently impossible on fishmeal with a salt level as high as 10%.

Efforts to reduce losses from insect infestation by the use of insecticides have not been fully adopted due to the hazardous nature of these chemicals to health and toxicity at high doses to users (Balogun, 1992). In order to eliminate much of these problems, plant-derived

insecticides which are bio-degradable, environment-friendly, cheap, available and affordable to fish farmers and processors have been proposed (Adedire and Lajide, 1999).

In Nigeria, despite the availability of cured fish, high losses still occur due to infestation by beetle (*Dermestes maculatus*). Peasant farmers are unable to purchase synthetic insecticides due to the high cost but instead tend to substitute these with naturally-occurring insecticides applied mainly as powders or oils as they are readily available, relatively cheap and safer (Lale, 1995). This study was conducted to evaluate the insecticidal activity of the essential oils extracted from the seeds of common plants: *Piper guineense*, *Monodora myristica* and *Aframomum melegueta* against the adults of the beetle (*Dermestes maculatus*) on smoke-dried catfish (*Clarias gariepinus*) during periods of storage.

Materials and Methods **Insect culture and maintenance**

The founding insect culture of *Dermestes maculatus* was collected in smoke-dried catfish (*Clarias gariepinus*) that was stored in 3-litre plastic containers at the laboratory of

Ekiti State University, Ado Ekiti, Nigeria.

The culturing jars were kept at ambient temperature condition. The jars were disinfected in laboratory drying cabinet at 70°C for 1 hour and allowed to cool to room temperature.

Plant materials and extraction of essential oils

Piper guineense (Black Pepper)

West African pepper, also known as Ashanti pepper, Benin pepper, false cube, guinea cube, uziza pepper or Guinea pepper is a perennial, glabrous woody climber up to 20 m high. The dried fruits of *Piper guineense* are prolate spheroids and generally bear a reddish tinge. The pepper fruit contains 5.8% piperine which is responsible for the "heat" or pungency; and large amounts of beta-caryophyllene that is being investigated as an anti-inflammatory agent. The fruit also contains significant proportions of myristicin, elemicin, safrole and dillapioil. Research has shown that Ashanti pepper has preservative and anti-oxidant properties and was most effective among three West African pipers for preservation of catfish.

Monodora myristica (African Nutmeg)

African nutmeg, Jamaican nutmeg or calabash nutmeg (*Monodora myristica* Dunal) is a tropical tree of the family Annonaceae or

custard apple family of flowering plants. The fruit is a berry of 20cm diameter and is smooth, green and spherical and becomes woody. Inside the fruit, the numerous oblongoid, pale brown and 1.5cm long seeds are surrounded by a whitish fragrant pulp. The seeds contain 5-9% of a colourless essential oil.

Aframomum melegueta (Alligator Pepper)

Aframomum melegueta, commonly known as grains of Paradise, melegueta pepper or alligator pepper is a member of the family Zingiberaceae. This spice is an herbaceous perennial plant native to swampy habitats along the coast of West Africa. Its trumpet, shaped, purple flowers develop into 5-7cm long pods containing numerous small, reddish brown seeds. The pungent, peppery taste of the seeds is caused by aromatic ketones (6)-paradol (systematic name: 1-(4-hydroxy-3-methoxyphenyl)-D-decan-3-one). The seeds of *Piper guineense*, *Monodora myristica* and *Aframomum melegueta* were purchased from the market in Ado Ekiti, Ekiti State. The seeds

were dried in a laboratory drying cabinet at 40°C for 8 hours and ground in an electric grinder (Retsch GmbH, J 657 HAAN). Oil extracts from the milled seeds were obtained in a Soxhlet apparatus using petroleum ether at 40-60°C and concentrated in the water bath at 60°C.

Preparation of Fish Samples

The smoked fish samples were dried in the laboratory drying cabinet at 60°C for 6 hours to ensure adequate drying and the initial weights were recorded.

Experimental Procedure

The whole dried catfish (*Clarias gariepinus*) was put into separate plastic jars and 10 insects were randomly introduced to each jar. The jars were covered with muslin cloth so as to allow aeration for the beetle. The oil extracts

were applied to the fish by measuring 1.5ml of each extract and applied to the fish with the aid of a 2ml syringe while the control consisted of introducing the beetles into the fish sample without applying any oil. The treatments were in three replicates and the experiment was conducted at room temperature of 27-30°C, photo period (13L: 11D) and relative humidity (60% ± 5). The experiment was carried out on the laboratory shelf for 30 days.

The fish weight loss and the number of live adult beetles were measured daily for the first 14 days and on the 30th day. The fish weight loss was calculated as the difference between the initial weight and final weight of the fish at the end of the experiment. The data were subjected to analysis of variance (ANOVA) and Duncan's Multiple Range Test was used for the mean separation at 5% probability level.

Results

The initial and final weights of smoked catfish (*Clarias gariepinus*) and change in weights (%) caused by *Desmestesmaculatus* infestation under the treatment of different plant oil extracts are shown in Table 1. The initial weight of the fish was 164.73 g in the control and varied between 177.97 to 195.33 g in fish treated with the oil extracts. The final weight of fish in the control was 99.37 g while fish treated with the oil extracts varied between 180.20 and 196.47 g such that the change in weight was negative in

the control but positive in the other treatments. The weight change was least in *Piper guineense* and *Aframomum melegueta* 0.385% and 0.578% respectively while *Monodora myristica* had 1.253% compared to -39.68% in the control treatment (Table 1). The percentage adult mortality of *Dermestes maculatus* subjected to different plant oil extracts is shown in Table 2 at the end of four weeks. Also, Table 3 presents the effect of test oil extracts on adult mortality of *D. maculatus*

Table 1: Effect of plant oil extracts on weight change of smoked catfish (*Clarias gariepinus*) infested by *Dermestes maculatus*

Mean	Control	<i>A. melegueta</i>	<i>M. myristica</i>	<i>P. guineense</i>
Initial Weight	164.73 ± 6.54	195.33 ± 7.39	177.96 ± 6.962	189.700 ± 11.24
Final Weight	99.367 ± 6.23	196.467 ± 7.89	180.20 ± 10.66	190.43 ± 9.53
Weight change	-65.36	+1.13	+2.23	+0.73
% Weight change	-39.68	0.578	1.253	0.385

Each value is a mean of triplicate samples [±].

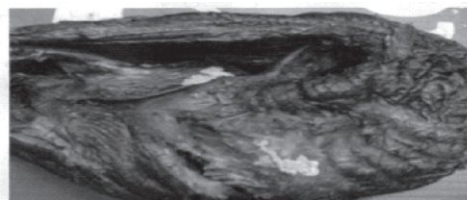


Table 2: Effect of plant oil extracts on adult mortality of *Dermestesmaculatus*

	Control	<i>A. melegueta</i>	<i>M. myristica</i>	<i>P. guineense</i>
Mean no of adult	10.00	10.00	10.00	10.00
% adult mortality	16.67	100.00	100.00	100.00

Each value is a mean of triplicate sample

In the experiment, it was observed that the mortality rate of the insects introduced in the fish treated with *Piper guineense* was quick because all the insects in the cultured jars died within the first week of experiment, while the insects in the fish treated with *M. myristica* died within two

weeks of the experiment and insects in the fish treated with *A. melegueta* died during the fourth week of the experiment. This showed that the extracts from *P. guineense* and *M. myristica* are more effective than that from *A. melegueta*. In the control, it was also observed that 6 insects died naturally

Table 3: Effect of test oil extracts on adult mortality of *Dermestesmaculatus*

Plant Extract	No of Adult Introduced	Mean No. of Adult	No of Dead Adult	% of Mortality
A1	10	10.00	10	100.00
A2	10	10.00	10	100.00
A3	10	10.00	10	100.00
M1	10	10.00	10	100.00
M2	10	10.00	10	100.00
M3	10	10.00	10	100.00
P1	10	10.00	10	100.00
P2	10	10.00	10	100.00
P3	10	10.00	10	100.00
C1	10	10.00	3	30.00
C2	10	10.00	2	20.00
C3	10	10.00	1	10.00

Discussion

Plant-derived pest control agents have been extracted for use for over a century. For example, nicotine, pyrethrin and rotenone have been used as insecticides while several medicinal plants and spices have also been used as pest control agents (Lale, 1995). In the attempts to screen some selected indigenous plants as stored product pest control agents, the use of extracts was generally more potent than the dry powder for the control of *Dermestesmaculatus*. The potential insecticidal effect of vegetable oil extract has been demonstrated (Odeyemiet *al.*, 2000). The activity of plant oils might be due to their repellency, chemical toxicity or physical properties rendering change in surface tension within the egg (Bhaduri *et al.*, 1990). The thin oil layer restricts oxygen supply to insects causing interferences with normal respiration and so results in suffocation.

From this study, the mortality rate of the

beetles in the fish treated with *Piper guineense* was 100% within the first week of the experiment while 100% mortality was observed in the second week with *Monodorummyristica* but the beetles in the fish treated with *Aframomummelegueta* recorded 100% mortality in the fourth week. This performance of *Piper guineense* is a further proof that plants belonging to the family Piperaceae possess some form of insecticidal activity (Adedire and Lajide, 1999). It has been noted that *Piper guineense* and *Monodorummyristica* possess contact toxicity, fumigant, ovi position inhibition, ovicidal and larvicidal activities (Adedire and Lajide, 1999). Ofuya *et al.* (1992) observed that the crude extract of *Monodorummyristica* has ovicidal, larvicidal and anti-ovipositional effect on the cowpea bruchid (*Callosobruchusmaculatus*). The active ingredient in *Piper guineense* has been attributed to the presence of chavicine, and piperine (Lale, 1995). *Piper guineense* and

Monodoramyristica extracts have hot peppery taste and pungent smell and may act through contact with the insects.

The initial and final weights of fish in the control treatment showed that the loss of weight was substantial. This is because of the high level of insect infestation. The insects had destroyed the fish by feeding on it thereby reducing the weight and subsequently the quality. On the other hand, there was a slight increase in the weights of the fish treated with oil extracts of *Aframomummelegueta*, *Monodoramyristica* and *Piper guineense*. This was due to moisture absorption through the exposed muslin cloth over the jar.

The results show that *Piper guineense* and

Aframomummelegueta were the most effective against the adult of *Dermestesmaculatus* and prevent fish damages as indicated by the low change in weight while *Monodoramyristica* was least effective. Earlier reports show that the insecticidal activity of essential oils varies in relation to the stage of development of the insect, the species and the plant origin of the essential oil (Tuncet *al.*, 2000; Negahbanet *al.*, 2007). Although *Monodoramyristica* attained 100% mortality in the second week of the experiment, the moisture absorption was higher than with *Aframomummelegueta* which attained 100% insect mortality in the fourth week. The results obtained from administering these oil extracts suggest an alternative method of environment-friendly pest control of smoked catfish.

Conclusion and Recommendation

The results from this study suggest the possibility of using the oil extracts of *Piper guineense* and *Monodoramyristica* as biodegradable insecticide against *Dermestesmaculatus* thereby reducing the damage caused by the beetle to smoke-dried fish. The oil extracts of *Piper guineense* and *Monodoramyristica* can provide new materials to be used in bio-rational management of insect pests. It is interesting to note that both *Piper guineense* and *Monodoramyristica* are normally used as spices in food preparations. Hence, the use of these plant materials guarantees safety to fish consumers and simultaneously provides insecticidal activity against *Dermestesmaculatus* due to its biodegradable properties. The use of plant extractives from *Piper guineense*, *Monodoramyristica* and *Aframomummelegueta* could be a plausible means to control insect pest attack of smoked fish and so reduce wastage and damage to fish during storage. The optimum concentration and active ingredients of these

plant seeds which are toxic to the various stages of insect development and control in *Dermestesmaculatus* need further investigation. The use of oil extracts against beetle infestation of smoked-dried catfish may be most acceptable considering the ready availability of the seeds, relatively cheap price and the safety for human consumption compared to the synthetic insecticides. *Piper guineense*, in particular, is recommended for its piperine content whose effect is felt almost immediately after application and so restricts the deterioration of smoked-dried fish and minimizes moisture absorption which is the major problem of smoked preserved fish. In the absence of *Piper guineense*, *Monodoramyristica* should be used to mitigate deterioration due to the beetle infestation in storage while the weight gain was minimal and would not support bacterial infestation. Thus, smoke-dried fish would be kept for longer period of time as the two oil extracts would guarantee longer shelf-life.

References

- Adedire, C.O. and Ajayi, T.S. 1996. Assessment of the insecticidal properties of some plant extracts as grain protect ants against the maize weevil *Sitophilus zeamais* (Mot.). *Nigerian Journal of Entomology* 13: 93-101.
- Adedire, C.O. and Lajide, I. 1999. Toxicity and oviposition detergency of some plant extracts on cowpea storage bruchlid, *Callosobruchus maculatus* Fabricus. *Journal of Plant Disease and Protection* 106(6):647-653.
- Ames, G.R. 1992. Traditional and modern post-harvest technologies for increased food and supply from inland fisheries in Africa. Proceedings of the Symposium of Post-Harvest Fish Technology, Cairo, Egypt. FAO-CIFA Technical Paper, 19: 11-17.
- Asita, A. 2000. Protection of smoked-dried fish from fungi infestation by wood smoke differing in mutagenic potencies. *Discovery and Innovation* 12 (1/2):85-87.
- Balogun, A.M. 1992. Fish handling and quality control. In: Cows, I.G. (Ed.) *Aquaculture Development in Africa. Training and References Manual for Aquaculture Extensionist* Published by Commonwealth Secretariat, London: 290-318.
- Bhaduri, N., Gupta, D. P. and Rams, B. 1990. Effect of vegetable oils on the oviposition behaviours of *Callosobruchus maculatus* (Fabricus). In: Fujii, K., Gatehouse, A.M., Johnson, C.D., Mitchell, R. and Yosida T. (Eds.), *Bruchids and Legumes: Economics, Ecology and Co-Evolution*: 81-84.
- Dobie, P., Haines, C.P., Hodges, R.J., Prevett, P.F. and Rees, D.P. 1991. Insects and Arachnids of Tropical Stored Products: Their Biology and Identification. Natural Resources Institute, Kent. U. K. 248pp.
- FAO, 2004. The State of World Fisheries and Aquaculture (SOFIA) PART 1: World Review of Fisheries and Aquaculture Food Agriculture Organization, Fish Rep, Rome.
- Lale, W.E.S. 1995. An overview of the use of plant products on the management of stored products coleopteras in the tropics. *Post-Harvest News and Information* 6:69-75.
- Negahban, M. Moharramipour, S. and Sefidkon, F. 2007. Insecticidal activity of essential oils from *Artemisia sieberi* Besser against three stored-product insects. *Journal of Stored Products Research* 43: 123-128.
- Odeyemi, O.O., Owode, R.A. and Akinkurolere, A. 2000. Toxicity and population suppression effects of *Parkia clappertoniana* on dried fish pests (*Dermestes maculatus* and *Necrobium rufipes*). *Global Journal of Pure and Applied Science* 6(2):191-195.
- Ofuya, T.I., Okoye, B.C. and Olola, A.S. 1992. Efficacy of crude extract from seeds of *Monodora myristica* (Gaertn). Dunal as surface protectant against *Callosobruchus maculatus* (F.) attacking seeds in storage. *Journal of Plant Disease and Protection* 99, 528-532.
- Tunc, I., Berger, B.M., Erler, F. and Dagli, F. 2000. Ovicidal activity of essential oils from five plants against two stored-products insects. *Journal of Stored Products Research* 36: 161-168

Performance Characteristics and Carcass Quality of Broilers Chicks under High Stocking Density and Vitamin E Supplemented Diets

¹O. A, Adebisi, ¹T. O. Adepo and ²M. Adegbenro,.

¹Department of Animal Science, University of Ibadan, Nigeria

²Department of Animal Production and Health,

The Federal University of Technology, Akure, Nigeria.

E-mail: adepotayo@yahoo.com

Abstract

Two hundred and seventy day-old broiler chicks were randomly divided into five treatments in three replicates of 10 birds.m⁻² (0.1 m².bird⁻¹) in Treatment 1 (positive control) and Treatment 2 (negative control), 3, 4 and 5 with 20 birds.m⁻² (0.05 m².bird⁻¹). Treatments 1 and 2 had no dietary Vitamin E supplementation while Treatments 3, 4 and 5 had Vitamin E supplementation at 50, 100 and 150 mg.kg⁻¹ respectively. At the end of the experiment, carcass characteristics: cold shortening (CS), thermal shortening (TS), cooking loss (CL), shear force (SF) and water holding capacity (WHC) of the birds were determined. There were no significant changes in the weight gain and final weight of the birds fed the different diets but the feed conversion ratio (FCR) was highest in the birds fed dietary Treatment 2 (3.29) compared to those on Vitamin E supplemented diets. The WHC was not significantly different in the raw (58.43-59.43%) and cooked meat (59.02-59.51%) for all the treatments. The birds in Treatment 2 had the highest CS (3.50%) compared to those on Vitamin E supplemented diets (2.45-2.55%). The SF of the birds was not significantly different in all treatments with mean values at 3.35-3.60%. The implication from the results is that broiler chicks can be stocked up to 20 birds.m⁻² without adverse effects provided the diet is supplemented with 100 mg.kg⁻¹ Vitamin E.

Keywords: Stock density, Vitamin E, carcass quality, broilers

Introduction Poultry farmers often increase stock density in the desire to attain higher profit but this always results in the building up of heat that consequently leads to heat stress. Several methods are available to alleviate the effect of high environmental temperatures and increased stocking density on the performance of poultry. Since it is expensive to cool animal buildings, such methods are mainly focused on the manipulation of the diets. In this regard, Vitamin E is used in the poultry diet because of the identified benefits of Vitamin E supplementation to laying hens during heat stress (Bollengier-Lee *et al.*, 1999; Sahinet *al.*, 2001) and also because Vitamin E levels are reduced during heat stress (Feenster, 1985; Boliengier-Lee *et al.*, 1999; Sahinet *al.*, 2002).

Vitamin E has been recognized as an essential nutrient for growth and health of all species of animals. The diverse roles of Vitamin E are due to its involvement on nutritional myopathy, prostaglandin biosynthesis and immune responsiveness (Lin *et al.*, 1996). One of the most important properties of Vitamin E is

its antioxidant function. When animals are fed diets rich in unsaturated fatty acids which are susceptible to peroxidation, the Vitamin E deficiency is augmented. Supplementation of animal diets with tocopherols increases the content of this natural antioxidant in animal food products and prevents lipid peroxidation in broiler meat (Ajuyah *et al.*, 1993). Therefore, the objective of this study was to evaluate the effects of optimal dose of Vitamin E supplementation on the performance and carcass quality characteristics in broilers reared under increased stocking density

Materials and Methods

Three hundred (300) day-old Arbor Acre strain of broiler chicks procured from a reputable hatchery in Ibadan, Nigeria were brooded together for one (1) week under the same feeding regime. Two hundred and seventy (270) started chicks were selected and used for this study carried out at the Teaching and Research Farm of the University of Ibadan,

Ibadan for four (4) weeks. The birds were randomly divided into five treatments at 30 birds in Treatment 1 (positive control) while Treatments 2 (negative control), 3, 4 and 5 contained 60 birds. The birds in Treatment 1 were further divided into three replicates of 10 birds each while the birds in Treatments 2 to 5 were subdivided into 20 birds per replicate. All the pens were bedded with wood-shaving litter and equipped with feeders and waterers.

The birds fed dietary Treatment 1 had a spacing of 10 birds.m⁻² (0.1 m².bird⁻¹) without Vitamin E supplementation (positive control) while those in Treatment 2 had a stocking density of 20 birds.m⁻² without Vitamin E supplementation (negative control) while

Treatments 3-5 had Vitamin E supplemented diets at 50, 100 and 150 mg.kg⁻¹ respectively. The basal compositions of the experimental diets are shown Table 1.

Feed intake and weight gain data were recorded on weekly basis while feed conversion ratio was calculated from values obtained from feed intake and weight gain. At the end of the feeding trial, nine (9) birds were randomly chosen from each treatment (3 birds per replicate) and slaughtered for carcass quality evaluation. The design of the experiment was completely randomized design (CRD). All data collected were subjected to statistical analysis of variance (ANOVA) procedure of SAS, 1999.

Table 1: Gross composition of experimental diets (% DM)

Ingredients	T1 (Positive control)	T2 (Negative control)	T3 (50 mg.kg ⁻¹ Vit. E)	T4 (100 mg.kg ⁻¹ Vit. E)	T5 (150 mg.kg ⁻¹ Vit. E)
Maize	58.00	58.00	58.00	58.00	58.00
Groundnut cake	21.00	21.00	21.00	21.00	21.00
Palm kernel cake	1.00	1.00	1.00	1.00	1.00
Fish meal	2.00	2.00	2.00	2.00	2.00
Soybean meal	14.60	14.60	14.60	14.60	14.60
Bone meal	2.40	2.40	2.40	2.40	2.40
Premix	0.30	0.30	0.30	0.30	0.30
Salt	0.30	0.30	0.30	0.30	0.30
Lysine	0.30	0.30	0.30	0.30	0.30
Methionine	0.20	0.20	0.20	0.20	0.20
Vitamin E (mg/kg)	0.00	0.00	50.00	100.00	150.00
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
Crude Protein (%)	23.00	23.00	23.00	23.00	23.00
Metabolizable energy (kcal/kg)	3019.27	3019.27	3019.27	3019.27	3019.27
Crude fibre (%)	3.30	3.30	3.30	3.30	3.30
Calcium (%)	1.05	1.05	1.05	1.05	1.05

Results

There were no significant differences ($P > 0.05$) in the weight gain and final weight of birds fed the different dietary treatments as shown in Table 2. Nevertheless, the highest final weight (0.78 kg) and highest weight gain (0.64 kg) were recorded in birds on Treatment 5 and Treatment 4, respectively. The highest feed intake (1.91 kg) was recorded in birds on Treatment 2 and lowest (1.58 kg). The feed conversion ratio (FCR) was influenced by the dietary treatments. The least FCR (2.45) was observed in birds on Treatment 4 while highest FCR (3.72) was observed in birds on Treatment 5.

Table 3 shows the effects of stocking density and different levels of Vitamin supplementation on carcass quality of broiler chickens. There were no significant differences ($P > 0.05$) in the water holding capacity (WHC) of the raw and cooked, and shear force (SF) among all the treatments. The highest WHC (raw) at 59.43% was observed in birds on treatment 1 and the lowest (raw) at 58.43% was observed in birds on treatment 2 while highest and lowest WHC (cooked) was 59.51% and 59.02% in birds fed diet treatments 2 and 1, respectively. The cold shortening (%), cooking loss (%) and thermal shortening (%) were

influenced ($P > 0.05$) by the treatments. The highest cooking loss (40.02%) was observed in birds on diet treatment 2 and lowest (37.05%) was observed in birds on diet treatment 5. The highest cold shortening (3.50%) was recorded in

birds on treatment 2 and lowest (2.45%) in birds on treatment 3. The highest thermal shortening (37.61%) was recorded in birds on treatment 5 and lowest (26.56%) in birds on treatment 2.

Table 2: Effect of stocking density and different levels of Vitamin supplementation on performance characteristics of broiler chicks

Parameters	T1 (Positive control)	T2 (Negative control)	T3 (50mg/kg Vit. E)	T4 (100mg/kg Vit. E)	T5 (150mg/kg Vit. E)	SEM
Initial weight(kg)	0.12	0.10	0.10	0.11	0.11	
Final weight (kg)	0.75	0.68	0.68	0.68	0.78	0.13
Weight gain (kg)	0.63	0.58	0.57	0.64	0.43	0.43
Feed intake (kg)	1.59 ^c	1.91 ^a	1.76 ^b	1.58 ^c	1.60 ^c	1.03
Feed conversion ratio	2.52 ^a	3.29 ^b	3.08 ^b	2.45 ^a	3.72 ^b	1.56

Discussion

Kennedy *et al.* (1992) examined the productivity of 168 broiler birds fed diets containing either 50 mg/kg or 180 mg/kg dietary Vitamin E and found that at the greater level of supplementation, the productivity was 8.4% greater as a result of improvement in FCR and higher average weight gain. Similarly, Sahin and Kucuk (2001) observed that dietary Vitamin E inclusion resulted in greater performance of Japanese quails reared under heat stress (34°C). The Vitamin E supplementation was able to ameliorate the effect of heat stress that would have resulted from the overstocking. The low FCR in the vitamin supplemented group is also in agreement with Villar *et al.* (2002) that the feed efficiency increased statistically with vitamin supplementation.

Meat quality evaluation is important in production (Barbera and Tossone, 2006) and carcass quality is the measure of carcass palatability and acceptability to the consumer (Renand and Fisher, 1997). The cooking loss was observed for birds fed diets supplemented with Vitamin E. This shows that the anti-oxidation effect of the Vitamin E resulted in the reduction of cooking loss. This will, however,

affect the optimal eating quality and this is of great importance to the catering industry. The cooking loss depends on the raw meat quality as reported by Asalyng *et al.* (2003) and meat with high cooking loss will have lower WHC as shown in this result. The WHC values fall within the range of 42.22-66.97% reported for scalded, single and conventionally dressed rabbit carcasses (Omojola and Adeshinwa, 2006).

The WHC in birds fed the negative control diet was reduced because the birds were subjected to stress which might have increased the water loss by panting resulting into a reduction in the space within the myofibrillar protein network with a consequent decrease in water lowering the WHC. The differences in shear force may represent changes in the elastic characteristics of the connective tissue of different muscles which had different mechanical properties (Robertson *et al.*, 1984). The non-significant differences between the values observed in the results could be a function of age of the birds (4 weeks); the birds were still growing with the muscles not fully developed such that the Vitamin E supplementation did not produce any noticeable change.

Conclusion

In this study, Vitamin E supplementation at 100 mg.kg⁻¹ with increased stock density (0.05 m².bird⁻¹) compared favourably with birds on the positive control (0.1 m².bird⁻¹) in the efficiency of

feed utilization. The stocking density of broilers chicks can be up to 20 birds. m² provided the diet is supplemented with 100 mg.kg⁻¹ Vitamin E.

References

- Ajuyah, A.O., Hardin, R.T. and Sim, J.S. (1993). Effect of dietary full-fat flax seed with and without antioxidant on the fatty acid composition of major lipid classes of chicken meats *Poultry Sc.*; 1993, 72; 125-16
- Aslyng, D.N., Berjerholm, C., Ertbjerg, P., Bertram C.H. and Andersen R.I. (2003). Cooking loss and juiciness of pork in relation to raw meat quality and cooking procedure and food quality preference. *Meat Science* 14: 277-288
- Barbera, S. and Tassone S. (2006). Meat cooking shrinkage: Measurement of a new meat quality parameter. *Meat Science* 39: 234-238.
- Bollengier-Lee S., Williams P.E.V. and Whitehead C.C. (1999). Optimal dietary concentration of Vitamin E for alleviating the effect of heat stress on egg production in laying hens. *British Poultry Science* 40: 102-107
- Feenster R. (1985). High temperatures decrease Vitamin utilization. *Misset Poultry*: 38-41.
- Kennedy, D.G., Rice D.A., Bruce, D.W., Goodall E.A. and Mclroy S.G. (1992). Economic effects of increased Vitamin E supplementation of broiler diets on commercial broiler production. *British Poultry Science* 33: 1015-1023.
- Lin, Y.L. Juan, I.M., Chen, Y.L., Liang, Y.C. and Lin, J.K. (1996). Composition of polyphenols in fresh tea leaves and associations of their oxygen- radical-absorbing capacity with antiproliferative actions in fibroblast cells. *Journal of Agriculture and Food Chemistry* 272: 1433-1436
- Omojola, B. and Adesehinwa, A.O.K. (2006). Meat characteristics of scalded, signed and conventionally dressed rabbit carcasses. At International Digital Organisation Scientific Information, online vol.1 No 1: CCC-C
- Renard, G. and Fisher, A.V. (1997). Comparison of methods for estimation carcass fat content of young charolis bull in performance testing station. *Livestock Production Science*: 51: 205-213
- Robertson, J., Ratcliff. D.P.E., Bouton, P.V., Harris and Shorthose, W.R. (1984). Effect of cooking temperature and age on the shear properties of beef and buffalo meat. *Journal of Food Science* 49: 1163-1166
- Sahin, K. and Kucuk, O. (2001). Effects of Vitamin C and Vitamin E on performance, digestion of nutrients, and carcass characteristics of Japanese quails reared under chronic heat stress (34°C). *Journal of Animal Physiology and Animal Nutrition* 85: 335-342.
- Sahin K., Kucuk O., Sahin N. and Sari M. (2002). Effects of Vitamin C and Vitamin E on lipid peroxidation status, some serum hormone, metabolite, and mineral concentrations of Japanese quails reared under heat stress (34°C). *Journal of Vitamin Nutrition Research* 71: 91-100.
- Sahin K., Sabin N., Onderci M., Yaralioglu S., and Kucuk, O. (2001). Protective role of supplemental Vitamin E on lipid peroxidation, Vitamins E, A and some mineral concentrations of broilers reared under heat stress. *Veterinary Medicine-Czechoslovakia* 46: 140-144.
- SAS Institute 1999: SAS User's Guide: Statistics. SAS Institute Inc., Cary, NC
- Villar, P.G, Diaz, C.A, Avila, G.E, Guinzberg, R., Pablos, J. L. and Pina, E. (2002). Effects of dietary Supplementation with Vitamin C or Vitamin E on growth performance in broilers. *American Journal of Veterinary Research* 63 (5): 573-576.

Evaluation of Infrastructure and Animal Supply Logistics of the Abattoir in Ado Local Government Area of Ekiti State, Nigeria

A.D. Adelabu, F.A.S. Dairo and J. Ojo,

Department of Animal Production & Health Sciences,

Faculty of Agricultural Sciences, Ado-Ekiti, Nigeria

Corresponding author: babatunde.adelabu@eksu.edu.ng

Abstract

Ado Local Government Area (LGA) is the only LGA in Ekiti State that has standard abattoir. This study was conducted to evaluate the infrastructural facilities, nature of stakeholders and animal supply logistics as factors of service quality in the abattoir operations. Fifty (50) stakeholders were randomly selected as respondents to well-structured questionnaire and interview schedule on the activities in the abattoir. The respondents were mainly males (90%), married (86%), and aged 30-49 years (58%) and with fairly high literacy level (60 and 20% had secondary and tertiary education respectively). The functionality of the lairage, slaughter hall and slab were rated as fair and satisfactory by 6 and 50% of the respondents respectively; the cold room and condemned rooms were not functional while 98% rated the rail system as bad. There was no electricity supply while water availability and reticulation were poor. The average of 60 animals slaughtered weekly consisted of White Fulani (41.3%), Sokoto Gudali (30.3%) and Red Bororo (23.9%) sourced from neighbouring states at ₦51,000-90,000 (30%) and ₦91,000-130,000 and transported in trucks/lorries. The carcass/cut parts are transported through unconventional means. Ante-mortem and post-mortem inspections are carried out by qualified personnel who recorded Fascioliasis (48%), Tuberculosis (42%) and Foot and mouth disease (8%) as the most prevalent. The infrastructure and management need improvement while the butchers should be trained in animal handling, slaughtering and meat processing procedures to enhance meat hygiene and revenue generation in the abattoir.

Keywords: Abattoir, infrastructure, cattle, diseases, breed, stakeholders, law, policy

Introduction

Man has shown considerable level of concern to the quality of meat he consumes right from the days of ancient civilization in Egypt when laws enacted categorised pig and cow meat as unclean meat for human consumption and sacred respectively (David-West, 2002). In Nigeria, the attempt to monitor the quality of meat started in 1967 and the Legislation for Meat Inspection passed in 1970 (David-West, 2002). This has led to the evolution of various edicts for meat hygiene for live animals (ante-mortem) and slaughtered ones (post-mortem) in the supply chain of meat to the public. The quality and standard of foods in Nigeria has been a serious concern to virtually all the stakeholders namely, the government that formulate policies, professionals in the livestock industry (animal scientists, veterinarians, marketers, butchers, food scientists, environmentalists and the consumers). This is

against the backdrop of observable lapses in the provision of adequate facilities for meat production and even where they exist it is flawed with poor level of hygiene.

Farm animal slaughtering and processing at most abattoirs in Nigeria are largely of traditional settings (where slaughtering and processing is done near streams or rivers that basically serve as sources of potable water and waste disposal in the same location) despite the various existing laws promulgated to ensure safety of meat from the abattoirs (Adesemoye *et al.*, 2006; Nwanta *et al.*, 2008). This is as a result of inadequate availability of modern facilities and proper training of the stakeholders who, in most instances, are still attached to the inefficient traditional techniques. The supply of animals for slaughtering and the entire abattoir chain process to meet requisite standard for the production of quality meat for public consumption needs more to be desired even

where such facilities exist.

The 1999 Federal Constitution empowers every state in Nigeria to establish, operate and maintain abattoirs under their respective Local Government Areas (LGAs). The drive for increased internally-generated revenue in the states and political styles of successive administrations has incapacitated the LGAs in the performance of these statutory functions. The service quality output in abattoirs, slaughter houses or slabs has been a factor of the availability of credible sources of supply of the animals, qualification or training exposure of the

stakeholders and most importantly, the standard of the facilities for meat production taking cognizance of the hygiene and environmental issues. Out of the 16 LGAs in Ekiti State, Ado LGA is the only one in which standard abattoir/slaughter slab exists. This study was a survey of the abattoir, slaughter hall and slaughter slabs with a view to evaluating the functionality and efficiency of the facilities available, sources of supply of the animals and the nature of the stakeholders involved in the meat processing chain.

Materials and Methods **Description of the study location**

The study was carried out in Ado LGA of Ekiti State in the south western Nigeria. The state capital, Ado-Ekiti, mainly comprises the entire LGA but there are about 64 adjoining villages, farmsteads and quarters (www.ekitistate.gov.ng). The population was 313,690 according to the 2006 Population Census (NPC, 2017). The town is located on longitude 5°16'E and latitude 7°40'N and experiences tropical climate characterized by two distinct seasons: wet and dry seasons between March-November and November-March. The ecological features support the rainforest vegetation and the predominant agrarian society.

Data collection and interpretation

The selection of the survey site was by purposive sampling technique while the fifty (50) respondents to well-structured questionnaire and interview schedule were randomly selected within the abattoir premises on personal contact and available information. The management office of the abattoir was also visited to obtain answers on administrative questions. The data were subjected to descriptive statistics of frequency counts, percentages and ranking.

Results

The social status of the 50 respondents/stakeholders running the day-to-day activities in the Ado-Ekiti abattoir is shown in Table 1. The respondents comprised 90% male and 10% female and most were married (86%). The age distribution showed that most of the respondents were 30-39 years old (34%) followed by 40-49 and 50-59 years old at 24 and 18% respectively.

Only 2 and 6% of the respondents belonged to ≤ 20 and ≥ 60 years respectively. Most of the respondents/stakeholders (60%) had secondary school education, 20% attended tertiary institutions and 16% had primary school education while 4% did not have formal education.

A breakdown of the stakeholders shows the following:

1. Marketers- are the people engaged in buying from the merchants but sell to the butchers and others. They usually operate kraals where the animals are kept in the cattle market. They constituted 2% of the respondents.
2. Butchers- are involved in the slaughtering, processing of the meat and retail of carcass or meat to the public. The butchers were 72% of the respondents.
3. Livestock Officers- are public officers, usually qualified Animal Scientists, involved in the management/administration of the abattoir at various levels and constituted 8% of the respondents.
4. Veterinary Surgeons/Animal Health Officers- are public officers responsible for health and other hygiene management issues such as inspection of meat and disease control at the abattoir. They were 8% of the respondents.
5. Revenue Officers- made up 2% of the respondents/stakeholders and are public officers or Consultants with the responsibility of collecting revenue in the form of rates and taxes for the government.
6. Cleaners- are responsible for cleaning the abattoir environment on daily basis after

- usage and made up 2% of the respondents
7. Gardeners- constituted 2% of the respondents and with the main function of weeding, maintaining the environment and ensuring it is not bushy.
- Security- made up 2% of the respondents and to guard and secure the premises.

Table 1: Social status of the stakeholders in Ado-Ekiti abattoir

Sub-title	Frequency	Percentage	Ranking
Gender			
Male	45	90	1
Female	5	10	2
Marital status			
Married	43	86	1
Widowed	7	14	2
Single	-		-
Divorced	-		-
Age (years)			
<20	1	02	6
20 – 29	8	16	4
30 – 39	17	34	1
40 – 49	12	24	2
50 – 59	9	18	3
>60	3	06	5
Educational status			
No formal education	2	04	4
Primary education	8	16	3
Secondary education	30	60	1
Tertiary education	10	20	2
Types of stakeholders			
Marketer(s)	1	02	4
Butchers	36	72	1
Livestock Officers	4	08	2
Veterinary Surgeon/Animal Health Officer	4	08	2
Revenue Officer/Consultant/Manager	1	02	4
Cleaner (s)	1	02	4
Gardener	1	02	4
Security	1	02	4

The functionality of the infrastructural facilities in the abattoir: lairage, slaughter hall or slabs and others as listed in Table 2 was rated as “Good”, “Fair”, “Bad” and “Satisfactory.” The lairage was rated as fair or good by 36% and 28% respectively while 26% opined that it was just satisfactory. The slaughter hall/slab was fair to good by 6% and 44% respectively while 50%

rated it as satisfactory. Almost all the respondents (98%) rated the rail system/hangers for meat processing as bad or non-existent while the cold/chilling room, detained room, condemned room were present but adjudged as bad by 49% and 50% of the respondents respectively.

Table 2 Infrastructural facilities available in the abattoir

Facilities & functionality	Availability	Frequency	Percentage	Ranking
a. Lairage				
i. Good	√	14	28	2
ii. Fair		18	36	1
iii. Bad		5	10	4
iv. Satisfactory		13	26	3
b. Slaughter slab				
i. Good	√	22	44	2
ii. Fair		3	6	3
iii. Bad		0	0	4
iv.		25	50	1
c. Rail system/Hangers				
i. Good		0		
ii. Fair	X	1	2	2
iii. Bad		49	98	1
iv. Satisfactory		0		
d. Cold/Detained/condemned Rooms	X			
i. Good		0	0	4
ii. Fair		0	0	4
iii. Bad		50	100	2
iv. Satisfactory		0	0	4
e. Drainage system				
i. Good	√	15	30	2
ii. Fair		22	44	1
iii. Bad		1	4	2
iv. Satisfactory		12	24	3
f. Water system				
i. Good	√	19	38	1
ii. Fair		16	32	2
iii. Bad		3	6	4
iv. Satisfactory		12	24	3
g. Electricity supply				
i. Good		6	12	2
ii. Fair	√	4	8	4
iii. Bad		35	70	1
iv. Satisfactory		5	10	3
h. Hides & skin? Disinfection facilities/First aid/Fire prevention				
i. Good	X	01	2	2
ii. Fair		49	98	1
iii. Bad		0		
iv Satisfactory		0		
Cleaning of the abattoir				
Regularly after operation	47	94	1	1
Occasionally after operation	3	6	2	2

The drainage system was rated as good and fair by 30 and 44% of the respondents respectively. The availability of water at the abattoir was rated good, fair and satisfactory by 38, 32 and 24 % of the respondents. Electricity

supply was bad as rated by 70% of the respondents while 94% indicated that cleaning of the abattoir was done regularly after slaughtering or usage of the abattoir.

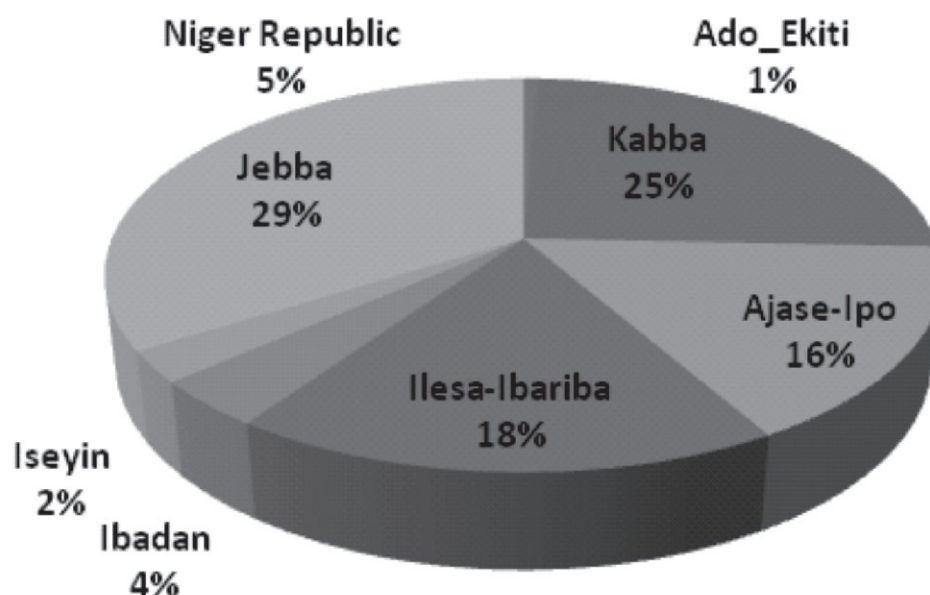


Fig. 1: Sources of supply of animals slaughtered in the abattoir

There were 8 sources of cattle supply to the abattoir (Fig. 1): Kabba, Ajase-Ipo, Ilesa-Ibariba, Ibadan, Jebba, Iseyin, and Ado-Ekiti. Merchants also trade cattle from Niger Republic to marketers. Some of these towns/villages are the neighbours to Ekiti State while Niger Republic is across the northern border to Nigeria. Fig. 1 shows that 25% of cattle slaughtered in the

abattoir came from Kabba, 17.9% from Ilesa-Ibariba, 5.13% from Niger Republic and 0.64% from Ado-Ekiti. Fig. 2 shows that the highest breed of cattle slaughtered was White Fulani (41.3%) followed by SokotoGudali (30.3%), Red Bororo (23.9%), Keteku (2.75%) and Uda (1.83%).

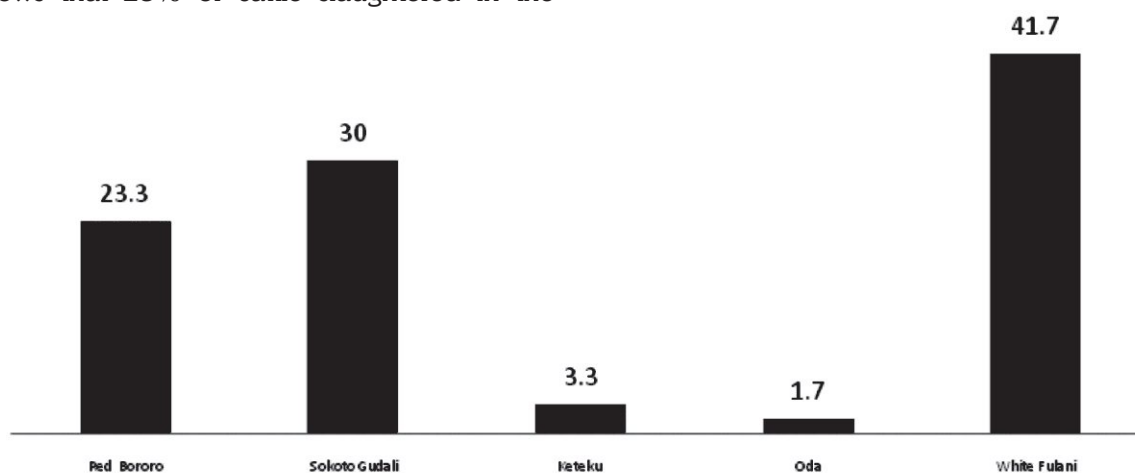


Fig. 2 Estimate of percentage of breeds of cattle slaughtered in the abattoir

The modes of transportation of the cattle to the abattoir and the carcass/cut parts/meat to the retail market are shown in Table 3. Most of the respondents (96%) used trucks/lorries to transport animals while 2% used taxi or car boots and 2% moved them on hoof. None of the respondents used the recommended cooling

van to transport the carcass/cut parts/meat to the retail market or shops. Most of the respondents (72%) moved carcass/cut parts/meat by taxis/pick-up van/private vehicles of the butchers; 20% used motorcycles while others carried meat on bicycles or on the head to nearby retail outlets

Table 3: Mode of Transportation of cattle to and meat from the abattoir

Mode of Transportation	Frequency	Percentage	Ranking
Live animals			
Hoof	1	2	2
Lorry	48	96	1
Car/taxi boot	1	2	2
Carcass and Cut part/meat			
Cooling van	0		
Motor cycle (Okada)	10	18.52	2
Pick up van/private car	18	33.33	1
Taxi	18	33.33	1
Others (Bicycles/foot)	8	14.81	3

Table 4: Average costs of slaughtered cattle and cut part/meat per kg (₦)

Range of cost	Frequency	Percentage	Ranking
51,000 – ≤90,000	15	30	2
91,000 – ≤130,000	26	52	1
131,000 – ≤170,000	9	18	3
Price of meat kg ⁻¹			
1000	10	20	2
1100 - ≤1200	38	76	1
1200	2	4	3

Table 5: Types of diseases found in the animals slaughtered and schedule of meat inspection

Name of disease	Frequency	Percentage	Ranking
Fascioliasis	24	48	1
Cysticercosis	0	0	
BSE	0	0	
TB	21	42	2
FMD	4	8	3
CBPP	0		
Meat inspection			
Ante- mortem			
Yes	43	86	1
No	7	14	2
Post –mortem			
Yes	46	92	1
No	4	8	2

Table 4 shows the average purchase price from the cattle market as ₦51,000-90,000, ₦91,000-130,000 and above ₦130,000 indicated by 30, 52 and 18% of the respondents respectively. Meat was retailed at ₦1,100-1,200 per kilogram (kg) by 76% of the respondents, below ₦1,200 per kg by 20% and above ₦1,200 per kg by 4%.

The diseases encountered in the abattoir are shown in Table 5. Fascioliasis was reported as the most prevalent by 48% of the respondents followed by Tuberculosis (42%) and Foot-and-mouth disease (8%). The professionals carried out ante-mortem and post-mortem inspections as indicated by 86% and 92% of the respondents respectively.

Discussion

Ado-Ekiti is a fast growing state capital that has the prospect of becoming a metropolis attracting investors which would require the upgrade of infrastructural facilities to meet the rising food needs of the population. The dominance of males in the abattoir business is expected because it involves a lot of physical strength input that ranges from tethering of animals, walking it, slaughtering and the butchering processes. Therefore, strong men usually in their youth have the physique that supports or meets the energy demands of the local and traditional procedures. Salifu and Teye (2006), Adzitey (2011) and Ntanga (2013) had noted that young and middle-aged men of 30-50 years are solely involved in the marketing and slaughtering/butchering business. Thus, the finding of the involvement of 6% of the respondents being above 60 years of age agrees with the report of Adzitey *et al.* (2011). Most of the respondents were married with the men often supported by their wives in the cleaning of offal, roasting or skinning for processing the soft coat ('ponmo;') and cow legs ('bokoto'). The abattoir business appeared less attractive to the singles or widow and the few met were probably the wives of deceased merchants or butchers. Information gathered indicated that some butchers inherited the trade or craft as family business which was probably responsible for the trend observed in the educational status. With 80% educated beyond the primary school education, the literacy level of the respondents is high probably because the parents took advantage of the education policy in the state. This availed the children a minimum of senior secondary school education before becoming part of the family business or taking over completely from their fathers perhaps for lack of employment opportunities. However, none of the respondents had formal professional training which constitutes an area of critical need (FAO, 2007; Bhandare *et al.*, 2009)

The butchers formed 72% of respondents because it is the most commercialized downstream sector of the abattoir business in Nigeria. The slaughtering capacity of about 60 cattle per week in the abattoir explains the lack of cattle merchants but only one (1) marketer. Information has it that most of the butchers doubled as marketers or merchants by forming

small groups to purchase cattle for slaughtering on ad hoc basis and on mutual trust. The number of livestock officers and veterinary surgeons was adequate but seriously incapacitated and limited in carrying out major professional and management functions largely due to inadequate facilities and bureaucracy. Revenue collection by the state appointed consultant's representative affected the daily routine management of the abattoir towards the achievement of the standard operation procedure (SoP) as outlined in steps for meat processing in the document of Codex Alimentarius (1990). Abattoir control and management are the constitutional responsibilities of the LGA but the calsh of interest in revenue generion has them to tap the resources efficiently. The cleaners and security hired by the butchers gave functional maintenance of the environment rather than when government workers were involved which paid off and ensured more hygienic and clean work place.

The infrastructural facilities available include the lairage and slaughter hall/slab but which were adjudged fair in functionality. The lairage has not used for the purpose for which it was built (as at the time of this study) while other inadequacies include poor fencing and bad floor construction. This could be due to the number of animals for slaughtering which averages just 60 per week. The consequence is that the animals were not fully rested from transportation and without ante-mortem examination within the short time, diseases like Tuberculosis and Fascioliasis will be missed thereby leading to foetal wastages and public health hazard whose treatment, eradication and control would be at huge cost to government (Ogwuegbuet *al.*, 1987; Oyekunle *et al.*, 1992; Abdulkadir, 2008). The slaughter hall floor is poorly constructed with inadequate drainage system, poor visibility due to lack of electricity. The cold room, condemned meat rooms, rail system and hanger were rated as bad and non-existing because of their dilapidated conditions. The non-functional cold room means that there is no facility for cold storage of leftover meat and would suggest the possibility of a high incidence of harmful bacteria contamination and poor shelf life of meat products (Lawan *et al.*, 2013; Adzitey *et al.*, 2014; Fearon *et al.*, 2014). The drainage system

was fair in functionality but obviously would require improvement. The open drainage system was used with run-offs into a sewage tank located 50 meters from the slaughter hall. Water supply system was not reticulated in the premises so that buckets were used to fetch water. Since there was no electricity, generators are occasionally used to pump water from the bore hole to the overhead tank. The poor nature of the infrastructural facilities agrees with the reports of other researchers in the different geopolitical zones of Nigeria (Frimponget *al.*, 2012; Lawanet *al.*, 2013; Akpabioet *al.*, 2015).

The animals are purchased mostly from Jebba, Kabba, Ilesa-Ibariba and Ajase-Ipo in Kwara State at distances of 50 to 250 kilometres to Ado-Ekiti using truck/lorry transportation in journeys that take at least 8 hours considering the poor conditions of the roads and extortion by unscrupulous law enforcement and revenue mobilization agents. This is contrary to the welfare policy for the animal for slaughtering which should not be transported for more than 8 hours (Gebresenbetet *al.*, 2011). The animals are cruelly tied in groups of 5-7 for transport during which they undergo a lot of stress before arrival at to the destination. This has consequences on the quality of meat and non-ambulatory animals though the incidence was not recorded during the study because most of the animals were slaughtered within 24 hours of arrival. The carcass/cut parts were not transported in standard cooling vans but rather in sacks or openly in the booths of cabs or private vehicles, motorcycles and bicycles. These transport modes predispose the meat to

contamination such that the quality is compromised as indicated by Fearonet *al.* (2014) in Ghana. There is need for the enactment and enforcement of laws that stipulate or guide transportation of carcass in hygienic manner in Ekiti State, as done recently in Lagos State of Nigeria. The breeds commonly purchased for slaughtering were in the order: White Fulani>SokotoGudali> Red Bororo. The choice of White Fulani was informed by its being the commonest breed in the cattle markets.

The purchase price of live cattle was mainly between ₦91,000 and ₦130,000 while the cost of the carcass cut part was between ₦1,100 and ₦1,200 per kg. These show the level of variation and instability in the retail prices which depend on changes in the purchase prices in the cattle markets.

Conclusion

Abattoir standards and management require serious attention in Ekiti State to ensure provision of up-to-date facilities needed in the handling of animals for slaughtering to avert health hazards. There is need for formal professional training of the stakeholders in animal handling, slaughtering and meat processing. In addition, the necessary papers that will accelerate the enactment of relevant laws and development of policy frameworks which address animal welfare for provision of good quality meat through this vibrant downstream sector (meat business) must be put in place

Reference

- Abdulkadir, U., Jiya, E.Z. and Kosu, S.A. (2008) Survey of foetal wastages: A case study of Makurdi Abattoir in Benue State from 1997 to 2002. *Pakistan Journal of Nutrition* 7(3): 450-452
- Adesemoye A.O., Opere B.O. and Makinde S.C.O. (2006) Microbial content of abattoir wastewater and its contaminated soil in Lagos, Nigeria. *African Journal of Biotechnology* 5(20): 1963-1968
- Adzitey, F., Teye, G.A. and Dinko, M.M. (2011). Pre and post-slaughter animal handling by butchers in the Bawku Municipality of the Upper East Region of Ghana. *Livestock Research for Rural Development*. 23, Article #39. Retrieved July 17, 2017, from <http://www.lrrd.org/lrrd23/2/adzi23039.htm>
- Adzitey, F., Teye, G.A. and Boateng, F.E. (2014) Whole egg of chicken as a binder in beef burger. *Ghana Journal of Science, Technology and Development* 1(1): 18-16
- Bhandare, S.G., Paturkar, A.M., Waskar, V.S. and Zende, R.J. (2009). Bacteriological screening of environmental sources of contamination in an abattoir and the meat shops in Mumbai, India. *Asian Journal Food Ag-Industry* 2(03): 280-290.
- Codex Alimentarius, (1993). Code of Hygiene practice for meat (CAC/RCP 58- 2005) http://www.codexalimentarius.net/download/standard/10196/cxp_058e

- David-West, K.B. (2002): Abattoir management and public health. In: *Proceedings of National Workshop on Abattoir Management and Public Health organized by the Nigerian Veterinary Medical Association at Women Development Centre, Abuja, Nigeria. 27-28th June, 2002:6-7.*
- Ekiti State Government of Nigeria (2017) www.ekitistate.gov.ng
- FAO (2007). Meat Processing Technology for Small to Medium Scale Producers. <http://www.fao.org/docrep/010/ai407e/ai407e00.htm>
- Frimpong, S., Gebresenbet, G, Bosona, T., Bobobee1, E., Aklaku, E. and Hamdu, I. (2012). Animal supply and logistics activities of abattoir chain in developing countries: The case of Kumasi Abattoir, Ghana. *Journal of Service Science and Management* 5: 20-27
- Gebresenbet, G., Bosona, T.G., Ljungberg, D. and Aradom, S. (2011). Optimisation analysis of large and small-scale abattoirs in relation to animal transport and meat distribution. *Australian Journal of Agricultural Engineering* 2 (2): 31-39
- NPC (2017) Federal Republic of Nigeria 2006 Population and Housing Census Priority Table III. Population Distribution by Sex, State, Local Government Area and Senatorial District National Population Commission, Abuja. www.population.gov.ng/Publications/RecentPublications
- Ntanga, P.D. (2013). Assessment of microbial contamination in beef from abattoir to retail meat outlets in Morogoro municipality, Tanzania. M.Sc Thesis submitted to Sokoine University of Agriculture. Mororogo, Tanzania: 35-37
- Nwanta, J.A., Onunkwo, J.I., Ezenduka, V.E., Phil- Eze, P.O. and Egege, S.C. (2008) Abattoir operations and waste management in Nigeria: A review of challenges and prospects. *Sokoto Journal of Veterinary Sciences* 7(2): 61-67
- Oyekunle, M.A., Olubango, O.O. and Fasina, O.E. (1992). Foetal wastage in abattoirs and its implication situation report from Ogun State, Nigeria. *Nigerian Journal of Animal Production* 19: 57-63.
- Ogwuegbu, O.S., Oke, B.O., Osuagwuth, A.I.A, Akusu, M.U. and Aire, T.A. (1987). Preliminary survey on kid losses at a typical abattoir in Ibadan. Abstract 12th Annual Conference of Nigerian Society of Animal Production: 71.

Meat Quality and Chemical Composition of Broiler Chicken Produced on Ideal Protein Concept Using the Most Limiting Amino Acid

O.F. Alamuoye, and O.M. Sanusi,

Department of Animal Production and Health Sciences,
Ekiti State University, Ado-Ekiti

E-mail: oluwatoyin.alamuoye@yahoo.com

Abstract

The ideal protein concept based on the most limiting amino acid is the standard to meeting the amino acid requirements for optimum growth and development of poultry bird. Lysine is the second most limiting amino acid in the diets of poultry birds. This study was conducted to evaluate the effects of dietary lysine on the muscle quality and chemical composition of 288 broiler chickens. Six experimental diets were formulated such that Diet 1 (control) contained 20% crude protein and supplemented with DL-methionine and L-lysine while Diets 2, 3, 4, 5 and 6 contained 20, 17, 14, 11 and 8% crude protein with amino acids supplementation respectively. Two hundred and eighty eight (288) day-old Arbor Acres broiler chicks were randomly assigned into 6 dietary treatments in four replicates using a completely randomized design (CRD) and each replicate contained 12 birds. The birds were subjected to the feeding trial for 56 days. Sample birds were weighed before slaughter and properly drained of blood. The carcass was scalded, eviscerated and dissected into major cuts. The results show that the pH of drum stick muscle differed significantly ($p < 0.05$) among the treatment diets while the pH of breast and thigh muscles was not affected ($p > 0.05$). The water holding capacity was not significantly influenced ($p > 0.05$) as simulated amino acid diets increased for all muscles types. The study revealed that *feeding simulated amino acids with varying levels of crude protein significantly influenced the moisture, crude protein, fat and mineral (ash) contents in breast muscle of broiler chicken*.

Keywords: amino acids, simulated protein, meat quality, chemical composition, broiler chicken

Introduction

The amino acid requirements of poultry are influenced by dietary, environmental and genetic factors (Schutte and De Jong, 1999). The essential amino acids are supplied in the diets and sufficient quantities of non-essential amino acids must also be supplied to prevent the conversion of these essential amino acids into non-essential amino acids (Applegate, 2008). The insufficient supply of amino acids in relation to the needs of the animal could lead to excess of the least limiting amino acid consumed by animals being de-aminated and converted to energy rather than towards body protein synthesis and this breakdown will result in higher nitrogenous excretions (Applegate, 2008). The absorbed amino acids are very important for tissue protein synthesis in time and in a ratio that matches the amino acid requirements of individual tissues (Wecke and Liebert, 2013).

In practical poultry diets lysine is the second limiting amino acid (Schutte and De Jong, 1999). The quest to meeting the actual required amino acids needed for optimum performance in birds is to raise the birds on simulated amino acids diets that will not constitute problems to growth and development. The formulation of least-cost low-protein diets supplemented with synthetic amino acids to meet or exceed the minimum standards is one important goal of the nutritionist (NRC, 1994). Adequate nutrition plays an important role in muscle composition either by a greater or lesser extent (Bogosavljevic-Boskovic *et al.*, 2006; Bogosavljevic-Boskovic *et al.*, 2011). Therefore, this study is aimed at investigating the effects of feeding simulated protein concept using the most limiting amino acid (lysine) on the meat qualities and chemical composition of broiler chicken.

Material and Methods *Animal management and Sample collection*

The experiment was conducted in an open-sided deep litter poultry house at the Teaching and Research Farm, Ekiti State University, Ado-Ekiti, Nigeria. Two hundred and eighty eight (288) day-old Arbor Acres broiler chicks were used for the study. The chicks were weighed and randomly assigned into six experimental diets. Feed-grade amino acids sourced from Ajinomoto Animal Nutrition were included in the formulated diets used for the treatments. The control (diet 1) contained 20% crude protein and supplemented with DL-methionine and L-lysine while diets 2, 3, 4, 5 and 6 had crude protein inclusion level at 20, 17, 14, 11% and 8% crude protein respectively (Table 1). The experimental diets were formulated such that feed-grade amino acids were used to meet the crude protein deficiencies. The dietary treatments were replicated 4 times and each replicate contained 12 birds. Feeds and water were provided *ad-libitum* and the feeding trial lasted for 56 days. The feeds were

withdrawn from the birds overnight prior slaughtering at end of the feeding period. The birds were weighed before slaughtering and the blood was properly drained. The carcass was scalded, eviscerated and dissected into major cuts. Muscle pH was measured 45 minutes post-mortem by inserting the probe of a digital pH meter (Knick Portamess ® 910, Germany) into the *Pectoralis major* (breast), drum stick and thigh. The dissected carcasses were weighed and chilled at 4°C for 24 hours. The water holding capacity (WHC) was based on the percentage of free water in meat (Grau and Hamm, 1953).

Laboratory analysis

The proximate composition of the thawed breast muscles was determined for moisture, fat, protein and ash, according to the standard procedures in AOAC (2005).

Statistical analysis

All data were subjected to one-way analysis of variance (ANOVA) and mean separation was based on the Duncan's Multiple Range Test using Minitab statistical package (Minitab, 2007).

Results and Discussion

The pH of drum stick muscle was significantly influenced ($p < 0.05$) by the treatment diets. The pH of breast muscle of birds fed Diets 1, 2 and 3 was higher than the values obtained in birds fed Diets 4, 5 and 6, while pH of thigh muscles was higher in birds fed Diets 1, 2 and 4 than birds fed Diets 3, 5 and 6. Tang *et al.* (2007) and Dou *et al.* (2009) had observed that pH₄₅ of the breast muscle was not affected by lysine inclusion in broiler diets. The high pH values observed in all muscles types at 45 minutes postmortem were within the normal range and showed that the process of glycolysis was on-going. This might be due to the fact that

the birds were not stressed prior and during slaughtering. Besides, feeding the different levels of lysine did not constitute stress. Higher muscle pH results in shorter shelf-life of meat quality (Apple *et al.*, 2004) and would enhance higher water binding capacity of the muscle.

The breast muscles of birds fed Diet 3 had the highest water holding capacity (WHC) ($68.33 \pm 2.06\%$) while the lowest was obtained in Diet 6 ($58.59 \pm 3.16\%$). The WHC of drum stick muscles was higher in birds fed Diet 3 ($65.63 \pm 11.96\%$) than those fed other treatment diets. Table 1: Feed composition of the experimental diets ($\text{g} \cdot 100\text{g}^{-1}$)

Ingredients	Control	Crude protein reduction/ Amino acid supplementation				
	Diet 1 20%	Diet 2 20% CP	Diet 3 17% CP	Diet 4 14% CP	Diet 5 11% CP	Diet 6 8% CP
Maize	65.4	61.1	56.8	57.3	57.1	59.1
*SBM	28.0	32.0	25.3	19.8	13.0	6.0
Fish meal (72% CP)	2.0	-	-	-	-	-
Rice husk	-	-	8.0	10.0	15.0	20.0
Palm oil	-	-	3.0	6.0	8.0	8.0
Bone meal	2.5	2.5	2.5	2.5	2.5	2.5
Oyster shell	1.0	1.0	1.0	1.0	1.0	1.0
Salt	0.3	0.3	0.3	0.3	0.3	0.3

Premix	0.5	0.5	0.5	0.5	0.5	0.5
Amino acid supplementation						
Lysine	0.15	1.0	1.0	1.0	1.0	1.0
Methionine	0.15	0.7	0.7	0.7	0.7	0.7
Threonine	-	0.7	0.7	0.7	0.7	0.7
Tryptophan	-	0.2	0.2	0.2	0.2	0.2
Calculated composition						
CP(%)	19.9	19.9	17.0	14.1	11.0	7.7
ME (kcal.kg ⁻¹)	2933.1	2890.7	2891.1	2926.3	2918.9	2899.2
Fat (%)	3.9	4.1	6.2	8.1	9.2	10.0
Moisture content (%)	3.8	3.6	3.5	3.3	3.1	2.9

*SBM- soyabean meal; CP- crude protein; ME – metabolisable energy

Table 2: pH and water holding capacity (WHC) of broiler chicken fed an ideal protein concept using most limiting amino acid

Parameter	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6
pH						
Breast	6.15±0.23	6.17±0.19	6.24±0.41	6.05±0.25	5.99±0.09	5.77±0.15
Drum Stick	6.25±0.05 ^a	6.17±0.18 ^a	5.95±0.09 ^{ab}	6.15±0.13 ^a	6.04±0.08 ^a	5.95±0.20 ^{ab}
Thigh	6.24±0.15	6.23±0.10	6.02±0.17	6.21±0.28	6.03±0.08	6.02±0.14
WHC(%)						
Breast	62.93±11.82	61.05±7.81	68.33±2.06	64.27±6.16	67.07±9.74	58.59±3.16
Drum Stick	59.16±3.4	56.84±11.80	65.63±11.96	59.01±6.98	62.60±1.93	61.22±6.00
Thigh	57.45±4.06	54.40±10.91	63.68±4.76	64.30±13.89	68.41±12.22	58.45±4.84

Mean± Standard deviation; a, b, means along the same row with different superscripts differ significantly (P<0.05).

The WHC of thigh muscles ranged from 54.40±10.91% to 68.41±2.22% in Diet 2 and Diet 3 respectively (Table 2). The values observed 56.90±6.22% obtained for broiler chicken (Apple *et al.*, 2004). The treatment diets had no significant effects (p>0.05) on WHC of the muscle types of broiler chickens. The WHC was consistently higher in breast muscles than drum stick and thigh muscles. The high WHC observed in this study might be due to the presence of amino acids that leads to the development of myofibrillar protein which has high water binding capacity in the muscles. The WHC is one of the most important factors of meat quality for the consumer and processor (Gunter and Peter, 2007) as it plays important roles in improving eating quality such as tenderness, juiciness and chemical composition of the meat. However, it may contribute to rapid development of spoilage organisms thereby reducing meat shelf life. The factors such as pH, sarcomere length, ionic strength, osmotic pressure and development of rigor mortis influence the WHC by altering the cellular and extracellular components (Offer and Knight,

1988; Northcutt *et al.*, 1994).

Table 3 shows the proximate composition of breast muscle portion of broiler chicken fed the treatment diets. The birds fed the treatment diets influenced significantly (p<0.05) chemical composition of the breast muscle. The birds fed Diet 6 had the highest moisture content (77.33±0.44%) while the least value was obtained from Diet 1 (72.34±0.70%). The protein content ranged from 20.63±0.44% in Diet 6 to 23.21±0.28% in Diet 1. The highest value of ether extract was obtained from birds fed Diet 1 (2.71±0.58%) with the least value was from birds fed Diet 6 (1.22±0.24%). The ash content of the breast muscles ranged from 0.83±0.21% in Diet 6 to 1.73±0.15% in Diet 1. The protein content of breast muscles of broiler chicken fed the dietary treatments observed in the present study was closer to the findings of Horniakova and Abas (2009) and fell within the range of 21.9 to 23.5% obtained by Zlender *et al.* (1995) for breast muscle of broiler chicken and the value of 22% protein reported by Bogosavljevic-Boskovic *et al.* (1999) in broiler chicken.

Table 3: Proximate composition of breast muscle of broiler chicken fed simulated protein (%)

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6
Moisture Content	72.34±0.70 ^c	74.11±0.9 ^b	76.16±0.74 ^a	74.40±0.86 ^b	75.35±0.46 ^b	77.33±0.44 ^a
Crude Protein	23.21±0.28 ^a	22.57±0.46 ^a	20.83±0.51 ^c	22.75±0.86 ^a	22.18±0.51 ^{ab}	20.63±0.44 ^{bc}
Ether Extract	2.71±0.58 ^a	2.21±0.61 ^{ab}	1.73±0.36 ^{ab}	1.67±0.35 ^{ab}	1.45±0.51 ^{ab}	1.22±0.24 ^b
Ash	1.73±0.15 ^a	1.11±0.37 ^{ab}	1.28±0.14 ^{ab}	1.17±0.10 ^{ab}	1.02±0.40 ^b	0.83±0.21 ^c

Mean ± Standard deviation; a,b,c, means along the row with different superscripts differ significantly (P<0.05)

The protein values obtained in the study differ from the findings of Thim *et al.* (1997) who observed higher protein content in broiler chicken fed diets of high level of crude protein of plant source. The ether extract had lower values than 3.9 to 8.4% obtained by Zlender *et al.* (1995) and higher than values reported by Horniakova and Abas (2009) for breast muscle of broiler chicken. The ash content was low which agrees with the report of Horniakova and Abas (2009) for breast muscle of broiler chicken fed amino acid-based diets. The ash indicates muscle mineral content. These minerals are associated with the organic compounds involved in the muscle contraction process and the values increase as the animal grows. The chemical composition of muscle tissue of major primal cuts is important in determining nutritional quality of meat and suitability for human consumption (Ristic, 1999; Bogosavljevic-Boskovic *et al.*, 2003).

References

- AOAC (2005). Official Methods of Analysis of AOAC International (eds. W. Horwitz). 18th edition, Gaithersburg, MD.
- Apple, J.K., Maxwell, C.V., Brown, D.C., Friesen, K.G. Musser, R.E., Johnson, Z.B. and Armstrong, T.A. (2004). Effects of dietary lysine and energy density on performance and carcass characteristics of finishing pigs fed ractopamine. *Journal of Animal Science* 82: 3277-3287.
- Applegate, T.J. (2008) Protein and Amino Acid Requirements for Poultry. Purdue University Roselina Angel-University of Maryland, College Park, USDA NRCS CIG Program: 1-11
- Bogosavljevic-Boskovic, S., Gajic, I. and Gajic, Z. (1999). The influence of rearing systems on basic tissue share and muscle chemical structure in broilers. Proceedings of 45th International Congress of Meat Science and Technology, 01August, 1999; Yokohama, Japan: 510-511.
- Bogosavljevic-Boskovic, S., Kurcubic, V., Petrovic, D.M. and Radovic, V. (2006). The effect of sex and rearing system on carcass composition and cut yields of broiler chickens. *Czechoslovakia Journal of Animal*

Conclusion

The study showed that the feeding regime affected the proximate composition of breast muscles. The pH of breast and thigh muscles varied but was not significantly influenced by dietary treatments. The variation of pH observed in breast and thigh muscles followed the same trend with the increase in the level of crude protein in the diets. The WHC varied among dietary treatments in all muscles types evaluated. The pH, WHC and chemical properties of muscle types of broiler chicken fed simulated protein diets compared satisfactorily with birds placed on control diets. Also, the study indicated that meat derived from the broiler chicken fed simulated protein could meet the nutritional requirements of the consumer.

Acknowledgement

We acknowledged the staff of the Department of Animal Production and Health Science, Ekiti State University, Ado-Ekiti, for the provision of live birds and lysine used for the study and the help of Mr. Alofe and Mr. Aluko for the analyses of the samples.

- Science* 51(1): 31-38.
- Bogosav Ijevic-Boskovic, S., Gajic, Z., Mitrovic, S. and Djokovic, R. (2003). Meat quality parameters selected in yield of carcasses and parts of broilers from two non-industrial rearing systems. *Proceedings of 49th International Congress of Meat Science and Technology*, Brazil: 41-42.
- Bogosav Ijevic-Boskovic, S., Zlatina, P., Petrovic, D.M., Doskovic, V. and Rakonjac, S. (2011). The effect of rearing system and length of fattening period on selected parameters of broiler meat quality. *Archiv fur Geflugelkunde* 75 issue 3.
- Dou, T.C., Shi, S.R. Sun, H.J. and Wang, K.H. (2009). Growth rate, carcass traits and meat quality of slow-growing chicken grown according to three raising systems. *Animal Science Papers and Reports* 27(4): 361-369.
- Gunter, H. and Peter, H. (2007). Meat Processing Technology for Small- to Medium-scale Producers. Food and Agriculture Organization of the United Nations, FAO Regional Office for Asia and the Pacific, Bangkok, RAP Publication: 1-50
- Horniakova E. and Abas, K.A. (2009). Influence of low levels of protein and sex on carcass traits and nutrient content in broiler meats. *Slovak Journal of Animal Science* 42(2): 75-78
- Minitab (2007). Minitab Version 16.1. Minitab Inc., State College, PA, USA
- NRC (1994). Nutrient Requirements Council of Poultry. 9th Revised Edition. National Academy of Science, Washington, DC.
- Northcutt, J. K., Foegeding, E.A. and Edens, F.W. (1994). Water holding properties of thermally pre-conditioned chicken breast and leg meat. *Poultry Science* 73:308-316
- Offer, G. and Knight, P. (1988). The structural basis of water-holding capacity in meat. Part 2: Drip losses. In: Lawrie, R. (Ed.). *Developments in Meat Science*, Volume 4. Elsevier Science Publications, London: 173-243.
- Ristic, M. (1999). Sensory and chemical criteria for broiler meat of different breeds from alternative livestock keeping. *Proceedings of XIV European Symposium on the Quality of Poultry Meat*, 19-23 September, 1999, Bologna, Italy: 291-294.
- Schutte, J.B. and De Jong, J. (1999). Ideal amino acid profile for poultry. In: Brufau, J. and Tacon, A. (Ed.). *Feed Manufacturing in the Mediterranean Region: Recent Advances in Research and Technology. C I H E A M (C a h i e r s O p t i o n s Mediterraneennes; n. 37)* Zaragoza: 259-263
- Tang M. Y., Ma, Q.G., Chen, X.D. and Ji, C. (2007). Effects of dietary metabolizable energy and lysine on carcass characteristics and meat quality in Arbor Acres broilers. *Asian-Australian Journal of Animal Science* 20(12): 1865-1873.
- Wecke, C. and Liebert, F. (2013). Improving the reliability of optimal in-feed amino acid ratios based on individual amino acid efficiency data from N balance studies in growing chicken. *Animals* 3: 558-573
- Zlender B., Holcman, A. and Rajar, A. (1995). The effect of provenance of chickens on dressing percentage and meat composition. *Research Reports Biotechnical Faculty University of Ljubljana, Agricultural Issue (Zootechnica), Supplement 22*, 3rd International Symposium Animal Science Days. Perspectives in the Production of Various Kinds of Meat, 26-29 September, Bled, Slovenia

Physical Characteristics of the Strains of West African Dwarf Goat in Ogun State, Nigeria

F.A. Aluko, A.A. Ageh, A.M. Akanji, A.M. Ogungbesan and G.A. Adeleke,

Department of Animal Production,
Olabisi Onabanjo University, Ayetoro, Ogun State, Nigeria

Abstract

Six hundred and sixteen male and female West African Dwarf (WAD) goats comprising gold (135), black (111), buckskin (162), Chaimose (58), Swiss markings (25), white (20), Dalmatian (46) and chocolate (59) strains were used to determine the trend of inheritance for qualitative traits. The physical characteristics observed were: beard (Br^d), non-beard (Br^+), wattle (Wa^w), non-wattled (Wa^+), polled (Ho^p), horned (Ho^+), blue eye (BL), gold eye (bl). Wattle, beard, pollness and blue eye are dominant physical characteristics. The possession of wattle was more in Swiss markings (72.0%), Chaimose (68.90%), chocolate (65.91%), white (65.0%) and gold (62.90%). while more of the strains possessed horns (>80%). The generated Hardy-Weinberg frequencies for wattle, beard, pollness and blue eye were low. The gene frequency of the recessive non-wattle allele was 0.79, 0.80, 0.77, 0.84, 0.85, 0.81, 0.78, 0.81 in the gold, black, buckskin, Chaimose, Swiss markings, white, Dalmatian and chocolate WAD goat respectively. The gene frequency of the recessive non- polled (horned) allele was 0.94, 0.95, 0.99 and 0.96 in Swiss markings, white, Dalmatian and chocolate respectively. The gene frequency of the recessive non-beard allele was 0.88, 0.96, 0.93 and 0.93 in gold, black, buckskin and Chaimose. The frequency of the dominant eye allele is 0.02, 0.02, 0.21, and 0.21 in the gold, black, buckskin and Chaimose. There is a need to conserve these adaptive features (horn, wattle) in the strains of WAD goat.

Keywords: WAD goat, Strains, allele, frequency, horn, wattle, bear

Introduction

There are about 300 breeds and types of goats widely distributed around the world with the majority found in the tropics and subtropics where they play very important role in agriculture and are used for various social obligations (Alaku, 2010). The diverse appearance is mostly superficial and established during the embryonic stages of development thereby limiting the size and complexity of the animal (Anon, 2015b). The diversity among breeds and the genetic variation within breeds contribute equally to the genetic variation found among animals within the species (ILRI, 2014). The variation within breeds is less vulnerable to loss but breeds are easily irretrievably lost when they are considered to be commercially non-competitive (ILRI, 2014).

The physical expression of a trait in an individual is the phenotype (Klug *et al.*, 2006). These traits showing the simplest type of inheritance are a qualitative trait. The absence of horns is caused by the expression of a dominant allele (Ho^p) which is the polled allele while the

horns presence is caused by (Ho^+) wild allele (Lauvergne *et al.*, 1987). Animals utilize their horns in a variety of ways. They may be used in fighting, for defense from predators. Horns may be used in feeding such as to root in the soil or strip bark from trees. Some animals with horns use them for cooling, the blood vessels in the bony core allowing the horns to function as a radiator. Many animals use horns in displays during courtship (Anon, 2016). Wattles are part of chicken's heat regulation system. The wattles and combs are thick with capillaries and veins for the overheated blood to pass through. It is air cooled as it passes through these blood vessels. In turn, this cooler blood reduces the chicken's internal temperature (Chester, 2016). Wattles on Nigerian Dwarf goat are simple hair, covered appendages of flesh hanging from the throat area (Anon, 2014a). Wattle is dominant and the locus was named wattles (Wa) and has two alleles: wattled (Wa^w) and (Wa^+) wild or recessive allele (Lauvergne *et al.*, 1987). Wattles are due to a dominant autosomal locus with variable expression (Machado *et al.*, 2000). Sometimes,

wattles are placed somewhere other than the usual “under the jaw on the neck” (Anon, 2014a).

Asdell and Smith (1928) have shown that beard trait is controlled by an autosomal gene and it depends on sex. The trait is dominant in males and recessive in females (Lauvergne *et al*, 1987). Adedeji *et al* (2006) reported that some female WAD goats have beards which may result from the secretion of excess of male hormone (androgen) (Odubote, 1994). The locus is named Br and has two alleles: bearded (Br^d) and (Br^+) wild (Lauvergne *et al*, 1987). Unlike in the case of humans, blue eye (BL) in goats are dominant and the gold eye (bl) is recessive. Blue eye does not cause any health issues. In a very rare case, there have been reports of Nigerian goats having one blue eye and one brown eye (Anon, 2014b). The Nigerian dwarf goat has blue eyes but the gold colour/brown (recessive) is occasionally encountered (Anon, 2010).

The ability of the WAD goat to survive under adverse environmental conditions with low inputs and disease risk is attributed to the possession of adaptive traits, which have a positive effect on the genetic superiority or adaptability of the breed (Odubote, 1994). Characterization of WAD goat population for these adaptive features is important for its genetic improvement and the conservation of its genetic resources. Some studies have been carried out on the adaptive features of WAD goat population and that characterization for qualitative traits at various times in the humid zone of Nigeria both on-farm and free range (Odubote, 1994; Ozoje, 1998; Adedeji *et al*, 2006; Yakubu *et al*, 2010). However, there is a need to further characterize the breed of WAD goat in which several strains have emerged. The aim of this study is to characterize the strain of WAD goat populations based on their physical body characteristics.

Materials and Methods

The study area is the entire Ogun State, Nigeria which comprises of twenty local government areas located in Ijebu, Remo, Egba, and Yewa Divisions. Each local government area represented a stratum in which three towns were purposively selected. WAD goats within each town were used for the experiment. The sample size was 616 male and female WAD goats on which four physical characters were observed: presence (Br^d) or absence (Br^+) of

beard, presence (Wa^w) or absence (Wa^+) of wattle, presence (Ho^+) or absence (Ho^p) of horns and blue (BL) or gold (bl) or blue-gold eye colour. The data were analyzed using simple descriptive statistics of percentages and frequency distribution; the frequencies of the recessive alleles were calculated using Hardy-Weinberg equilibrium (Falconer and Mackay, 1996).

Table 1: Frequency of a particular allele in gold, black, buckskin and chaimose WAD goat

Variables	Gold			Black			Buckskin			Chaimose		
	FC	FPA	%	FC	FPA	%	FC	FPA	%	FC	FPA	%
		135			111			162			58	
Wattled	50	0.21	37.04	44	0.20	39.64	67	0.23	41.36	18	0.16	31.03
Non-wattled	85	0.79	62.96	67	0.80	60.36	95	0.77	58.64	40	0.84	68.07
Horned	117	0.95	86.58	100	0.95	90.09	142	0.94	87.65	53	0.97	91.38
Polled	18	0.05	13.32	11	0.05	9.91	20	0.06	12.35	5	0.03	8.62
Beard	32	0.12	23.70	9	0.04	8.11	25	0.07	15.43	7	0.07	12.07
Non-beard	103	0.88	76.30	102	0.96	91.89	137	0.93	84.57	51	0.93	87.93
Eye colour												
Blue	6	0.02	4.44	6	0.02	5.41	16	0.05	9.88	4	0.04	6.90
Gold	129	0.98	95.56	105	0.98	94.59	146	0.95	90.12	54	0.96	93.10
Blue and gold	0	0	0	0	0	0	0	0	0	0	0	0

FC = Frequency, FPA= Frequency of a particular allele, % =Percent

The frequency of the dominant wattle allele in gold, black, buckskin and chaimose is 0.21, 0.20, 0.23, and 0.16 respectively. Swiss markings, white, Dalmatian and chocolate is 0.15, 0.19, 0.22, and 0.19 respectively. The frequency of a dominant polled allele in gold, black, buckskin and chaimose is 0.05, 0.05, 0.06, and 0.03. In the Swiss markings, white, Dalmatian and chocolate, the frequency of a

dominant polled allele is 0.06, 0.05, 0.01 and 0.04. In the gold, black, buckskin and Chaimose, the frequency of dominant beard allele is 0.12, 0.04, 0.07, and 0.07. The frequency of the beard allele in Swiss markings, white, Dalmatian and chocolate is 0.02, 0.08, 0.14, 0.03. The frequency of the dominant eye allele (blue eye) in gold, black, buckskin and Chaimose is 0.02, 0.02, 0.21, and 0.21.

Table 2: Frequency of particular allele in Swiss markings, white, Dalmatian and chocolate WAD goats

Variables	Swiss markings			White			Dalmatian			Chocolate		
	FC	FPA	%	FC	FPA	%	FC	FPA	%	FC	FPA	%
	25			20			46			59		
Wattled	7	0.15	28.00	7	0.19	35.00	18	0.22	39.06	20	0.19	33.80
Non-wattled	18	0.85	72.00	13	0.81	65.00	28	0.78	60.76	39	0.81	65.91
Horned	22	0.94	88.00	18	0.95	90.00	45	0.99	97.65	54	0.96	91.26
Polled	3	0.06	12.00	2	0.05	10.00	1	0.01	2.17	5	0.04	8.45
Beard	1	0.02	4.00	3	0.08	15.00	12	0.14	26.04	4	0.03	6.76
Non-beard	24	0.98	96.00	17	0.92	85.00	34	0.86	73.78	55	0.97	92.95
Eye colour												
Blue	3	0.06	12.00	3	0.08	15.00	2	0.02	4.34	4	0.03	6.76
Gold	22	0.94	88.00	17	0.92	85.00	44	0.98	95.48	55	0.97	92.95
Blue and gold	0	0	0	0	0	0	0	0	0	0	0	0

The frequency of the dominant eye allele (blue eye) in the Swiss markings, white, Dalmatian, chocolate is 0.06, 0.08, 0.02, and 0.03. Wattle, beard, pollness, and blue eye are dominant physical/qualitative characteristics. The generated Hardy-Weinberg frequencies for these traits are low which agrees with the findings of Yakubu *et al.*, (2012) that the frequencies of both WAD and Red Sokoto goats for wattle, beard and pollness were quite lower than the expected Mendelian value of 0.75. The low values may be due to inbreeding that keeps occurring within the small population (households) and random mating that takes place in the larger populations (between towns within the local governments in Ogun State) without a consistent selection and culling of

undesired characters. However, this large population is also under the influence of migration and selection which aid the introduction of new genes into larger population but these new genes are often in favour of the recessive genes coming from the various strains of WAD goats. One advantage of inbreeding when carried out for a period of time within the small population is that it tends to create lines or strains of animals that are uniform in type or in some other desirable characteristics and genes which can be transmitted with greater uniformity. However, the known shortcoming is that it increases the chances that recessive genes will appear during the early generation before the attainment of homozygosity.

Conclusion

Horn and wattle are the adaptive physical features in the strains of WAD goat. This study has determined the frequency of the dominant and recessive qualitative alleles in the strains of WAD goat. The presence of horn and

wattle was more in >80% the strains of WAD goat. Further studies should be carried out on the effect of these adaptive features in the production and reproductive performance of these strains of WAD goat.

References

- Adedeji T.A., Ojedapo L.O., Adedeji S.O., Aderogba T.A., Abdullah A.R. (2006). Characterization of traditionally reared West African Dwarf goats (WAD) in the derived savannah zone of Nigeria. *Anim. Vet. Adv.* 5: 686-688
- Alaku, S.O. (2010). Goat. In: Introduction to Animal Science. Jee Communications: 169-197
- Anon (2010). Eye Colour of Goat. www.nigeriandwarfcouours.weebly.com/eye
- Anon (2014a). What are Wattles? In: www.wattlegenetics.nigeriandwarfcouours.weebly.com/wattles.html.
- Anon (2014b). Eye Colours of the Nigerian Dwarf Goat. www.dwarfcouours.weebly.com/eye-colors.html.
- Anon (2015a). What is the definition of animal diversity? <http://answers.yahoo.com/question/?qid=20100619092412AA6g8ny>
- Anon (2015b). Animal Diversity. Animal diversity web. animaldiversity.org/
- Anon (2016). Animal Uses of Horns. Horn (anatomy). New World Encyclopedia. www.newworldencyclopedia.org/entry.
- Asdell, S.A. and Buchanan-Smith, A.D. (1928). Inheritance of color, tassels, and horns in goats. *Journal of Heredity* 19: 425-430.
- Chester, J. (2016). What are the functions of wattles on chickens, pets and animals? mom.me/FarmAnimals.
- Falconer, D.S. and Mackay, T.F.C. (1996). Introduction to Quantitative Genetics. 4th edn. Longman. 464pp.
- ILRI (2014). Diversity in animal genetic resources invaluable for future developments. AGTR. Animal Genetics Training Resources. (International Livestock Research Institute) www.agtr.ilri.cgiar.org/index.php?option=com-content&view=article....Klug, W.S., Cummings, M.R. and Spencer, C.A. (2006). Mendelian Genetics. In: Concepts of Genetic. Pearson Education, Inc: 39-65.
- Lauvergne, J.J., Renieri, C., and Audiot, A. (1987). Estimating erosion of phenotypic variation in a French goat population. *Journal of Heredity* 78, 307.
- Machado, M.M.T., Chakir, M. and Lauvergne, J.J. (2002). Genetic distances and taxonomic trees between goats of Ceara State Brazil and goats of the Mediterranean Region Europe and Africa. *Genetics and Molecular biology* 23: 121-125.
- Odubote, I.K. (1994) Influence of Qualitative Traits on the Performance of West African Dwarf Goats. *Nigerian Journal of Animal Production*, 21, 25-28.
- Yakubu, A., Raji, A.O. and Omeje J.N. (2010). Genetic and phenotypic differentiation of qualitative traits in Nigerian indigenous goat and sheep populations. *ARPAN Journal of Agricultural and Biological Science* 5(2): 58-66

Prevalence of Gastro-intestinal Parasites in Small Ruminants slaughtered at a Selected Slaughter Slab in Ado Ekiti, Southwest Nigeria

D.B. Adelabu.

Department of Animal Production and Health Sciences,
Ekiti State University, Ado Ekiti, Ekiti State, Nigeria
E-mail: babatunde.adelabu@eksu.edu.ng

Abstract

This study was carried out to determine the prevalence of gastrointestinal parasites in small ruminants (sheep and goats) slaughtered at Atikankan slaughter slab, Ado Ekiti. Faecal samples collected directly from the rectum of 108 slaughtered animals (sheep and goat) were sampled between May and July, 2015. Faecal floatation and sedimentation techniques were employed on faecal samples. The results reveal that 69(63.9%) animals were found to be parasitized by gastrointestinal parasites. Four genera of GIT parasites were identified, *Strongylessp*, *Strongyloidespapillosus*, *Monieziasp*, *Coccidia sp.* with prevalence of 37%, 30%, 19%, and 5.5%, respectively. *Strongyles* species had the highest prevalence among the GIT parasites while *Moniezia species* had the lowest. In GIT infections the females were the most parasitized. Statistical analyses ($P > 0.05$) indicated a relationship between sex and infection of animals. The study revealed the existence of GIT parasites in small ruminants' slaughtered Atikankan slab in Ado Ekiti, southwestern part of Nigeria.

Keywords: Gastrointestinal parasites, Ado Ekiti, Prevalence, ruminant

Introduction

Small ruminants form an important economic and ecological niche in agricultural systems of rural communities across developing countries. This is because small ruminants make a very valuable contribution to household income, especially to the poor in the rural areas (Oluwatayo and Oluwatayo, 2012). The growing demand to meet the protein need of the populace has placed small ruminants in vantage position as an alternative to beef. Sheep and goats contribute in no small measure to meat production in Nigeria (Adewuyi and Adu, 1983) Small ruminants especially goats is an essential component of traditional ceremonies like marriages, naming ceremonies in traditional African societies. The ability of small ruminants to convert the indigestible cellulose to animal protein added to the advantage of being able to raise them within a small space has also encourage their husbandry (Saiful Islam and Taimur, 2008). It has been estimated that goats and sheep provide up to 30% of the meat and 15% of the milk supplies in sub-Saharan Africa (Bikilaet al., 2013). In recent times, the benefits derived from small ruminants were notably below expectation owing to low

productivity(Jatauet al., 2011).One important culprit of this low productivity is gastrointestinal parasitic infections,which has constituted a major drawback to the production of small ruminants in the tropics and especially in Africa through reduction of weight gain, reduced nutrient utilization, lower meat, milk and wool production, involuntary culling and cost of treatment and mortality (Kumsa and Wosseene, 2006).Estimated losses as a result of intestinal helminthoses of sheep and goat in Nigeria were put at 60million dollars annually (Akerejolaet al., 1979).In Nigeria, Small ruminants are often reared extensively; this gives rise to scavenging thereby predisposing such animal to parasitic infections (Adediranet al., 2014). Prevalence of gastrointestinal parasitic infestation in small ruminants may be influenced by several host factors such as age, sex, body weight, plain of nutrition, immune status and breed of animal (Bhat et al., 2012),as well as environmental factors of temperature, rainfall, humidity andhusbandrypractices.In order to improve small ruminant production, epidemiology of parasitic infection needs to be fully understood to enable appropriate control measure to be instituted. However, several studies have been

conducted, to determine the prevalence of gastrointestinal parasites in small ruminants in Nigeria but little is known of the prevalence in

the study area. This study therefore aims at determining the prevalence, species of gastrointestinal parasites, in slaughtered small ruminants in Ado Ekiti, Ekiti State, Nigeria.

Materials and Methods Study Area

The study was conducted in Ado Ekiti. Ado Ekiti, is the capital of Ekiti State located on Latitude 07°14'North of the equator and Longitude 05°25' East of the Greenwich Meridian. It comprises 64 communities with a population of 308,621, according to 2006 population census (www.ekitistate.gov.ng/2015). It enjoys two seasons in the year, the raining season (April - October) and the dry season (November - March). It is bounded on the North and West by Ifelodun/Irepodun Local Government and East and South by Gbonyin, Ikere and Ekiti South West Local Government. Its longest North-South extent is 16km and the longest East- West stretch is about 20 km (www.ekitistate.gov.ng/2015).

Study Site

The study was conducted at Atikankan Slaughter Slab in Ado Ekiti. The slaughter slab is located down the Erekesan Market, along Ogbon Ado Street, in Ado Ekiti. Atikankan Slaughter Slab is the only small ruminant abattoir in Ado Ekiti. The butchers here are made up predominantly of the Hausa origin of Nigeria followed by few butchers of the Yoruba ethnic group. Animals slaughtered from which samples were taken were West African Dwarf (WAD) goats and sheep and the Red Sokoto goats and are majorly from the northern part of the country with fewer numbers from neighboring towns and villages from Ekiti. Slaughter commences from 7.30 am every day. Prior to commencement of the study, an awareness visit was made to seek the cooperation of the butchers. During the study, the slab was visited twice a week between the hours of 7:00AM and 9:00AM each day.

Collection of Faecal Sample

Faecal Samples were collected from the rectum of each slaughtered animal by the use of disposable hand gloves and placed in a clean polythene bag. The samples were properly

labeled and transported immediately to the laboratory on ice pack for examination of parasite eggs using floatation and sedimentation method.

Processing of Faecal Sample:

(i) Floatation Method

Saturated sodium chloride solution was used with a specific gravity of 1.20. Three grams of faecal materials were weighed into a container and 30mls of saturated sodium chloride added. The faeces and floatation fluid was thoroughly mixed with a spatula. The suspension was then poured through a tea strainer into a test tube supported by a stand and the test tube was gently topped up with suspension that left a convex meniscus at the top. A cover slip was then carefully placed at the top and the test tube allowed to stand for 20 minutes. The cover slip was again carefully lifted and placed on a clean slide. The slide was examined under the microscope at X10 and

Table 1: Prevalence of gastrointestinal parasi slaughtered sheep and goats

X40 magnification (Urquhart, 1997).

(ii) Sedimentation

Three grams of faeces was weighed into a container and 50mls of tap water added and thoroughly mixed with a spatula. The suspension was filtered using a tea strainer into another container. The filtered material was then poured into a test tube and allowed to sediment for about 30 minutes and the supernatants were removed. The sediment was re-suspended in 5mls of water and allowed to stand for another 5 minutes while the supernatant was discarded. A drop of methylene blue was added to the sediment in a stand. The dyes stained the faecal particles deep blue with trematodes eggs which was left unstained. Sediments were examined under the light microscope at X10 and X40 magnification for presence of trematodes ova (Urquhart, 1997).

Identification of parasite

Parasites were identified according to

morphological characteristics of the shape, colour and size of eggs using the Thienpoint Key (Thienpoint *et al.*, 1979).

Data Analysis

Data obtained were analyzed using simple percentages and Chi (x²) square was used to determine the relationship between infection and sex of animals ($P > 0.05$) using SAS statistical package (SAS, 1988)

Result

Out of the total of 108 faecal samples collected, 96(63.9%) were positive for gastrointestinal parasites. The WAD sheep had the highest prevalence 19(86.4%) followed by Red Sokoto Goat 11(64.7%) and WAD goat is the least 39(56.5%) as indicated in Table 1. Out of the 96(63.9%) positive small ruminants for gastrointestinal infection, the females had a prevalence of 65(65.0%) while male had a

prevalence of 4(50.0%) (Table 2). The gastrointestinal parasites observed in this study were *Strongylesp*, *Strongyloidespapillosus*, *Moniezia sp.*, and coccidian oocyst. *Strongylesp* has the highest prevalence 40(37.0%), followed by *Strongyloidespapillosus* 33(30.6%), *Coccidia* oocyst 21(19.4%) and *Moniezia sp.* 6 (5.6%) is the least

Table 1: Prevalence of gastrointestinal parasites in relation to breed of slaughtered sheep and goats

Breed	No. Examined	No. Positive (%)
Red Sokoto Goat	17	11(64.7)
WAD Goat	69	39(56.5)
WAD Sheep	22	19(86.4)
Total	108	69(63.9)

WAD = West African Dwarf

Table 2: Prevalence of gastrointestinal parasites in relation to sex of slaughtered sheep and goats

Sex	No. Examined	No. Positive (%)
Male	8	4(50.0)
Female	100	65(65.0)
Total	108	69(63.9%)

Table3: Distribution of gastrointestinal parasite in slaughtered Sheep and Goat

Parasite	No. Examined	No. Positive (%)
<i>Strongylesp</i>	108	40(37.0)
<i>S.papillosus</i>	108	33(30.6)
<i>Coccidiasp</i>	108	21(19.4)
<i>Monieziasp</i>	108	6(5.6)

Discussion

The 63.9% prevalence level for gastrointestinal parasite recorded in the study is in agreement with previous studies (Nwigweet *et al.*, 2013, Adejimiet *et al.*, 2015) both recorded a prevalence level of 69.0% and 73.5%, respectively. From the investigation, *Strongyloidespapillosus*, *Strongylesp*, *Moniezasp* and *coccidia sp.* were the gastrointestinal parasites observed in the study. This agreed with the report of Gadahiet *et al.* (2009) and Nwigweet *et al.* (2013) who noted that the most pathogenic helminths and protozoan parasites in the intestinal tract of small ruminants are *Strongyle sp.*, *Strongyloidespapillosus*,

Moniezasp. and *Coccidia sp.* The high incidence of infection recorded in this study may be attributed to season. April to June is the peak of the raining season in the study area, which provides favourable agro-climatic conditions like heavy rainfall, thick vegetation, high humidity and high temperature which support the development of the pre-parasitic stages of the parasites in the host environment as well as the abundance of the intermediate hosts (Kucha *et al.*, 2011) The high prevalence of coccidian parasite in the animals might be as a result of untidy environment in which the animals are kept and overcrowding which present a conducive atmosphere for multiplication of this

parasite. The low prevalence of gastrointestinal parasite in WAD goat, compared with Red Sokoto goats and WAD sheep, could be as result of breed resistance to parasitic infections. WAD goats has beenfound to be endowed with the capacity to resist trypanosome infection and nematode infection more effectively than any known breed of goat (Cheijina and Behnke, 2012) The high prevalence of gastrointestinal parasitic infections in the female agreed with the result of (Dagnachewet *al.*, 2011; Nwigweetal., 2013 and Adediranet *al.*, 2014). Females have been found to be more susceptible to parasitic infection than the male, due to exposure to stress under different conditions like pregnancy and lactation (Soulsby, 1982).

References

- Adediran, O.A., Adebiyi, A.I., Uwalaka, E. C. (2014). Distribution of Gastrointestinal Helminthoses of small Ruminants in Ibadan, South-Western Nigeria: Role of Traditional Rearing System. *Nat. Sci.* 12(9):25-29
- Adejimi, O.O., Adejimi, J.O., Falohun, O.O., Adejoro O.R, Dauda, W.J (2015). Prevalence of gastrointestinal parasites of goats in Ibadan, Southwest, Nigeria. *World Journal of Agricultural Research*, 3(2): 49–51
- Adewuyi, A.A., and Adu, I.F. (1983). Seasonal Variation of Some Level of Blood Components of some indigenous and Cross breed of Sheep. *Tropical Animal Production*, 9: 223 -230
- Akerejola O. O., Schillhorn Van Veen T. W., Njoku C. O. (1979): Ovine and Caprine diseases in Nigeria: A review of economic loss. *Bul. Anim. Hlth. Prod. Afr.*, 27(1), 65-69.
- Bikila, E. Yeshitla, A., Worku, T., Teka, F., and Benti, D. (2013). Epidemiology of Gastrointestinal Parasites of Small Ruminants in Geshi District, Southwest Ethiopia. *Advance in Biological Research*, 7(5):169-174
- Chiejina, S.N. and Behnke, J.M. (2011). The unique resistance and resilience of the Nigerian Dwarf goat to gastrointestinal nematode infections. *Parasites and Vectors*, 4(12):
- Dagnachew, S., Amamute, A. and Temesgen, W. (2011). Epidemiology of gastrointestinal helminthiasis of small ruminants in selected sites of North Gondar zone, Northwest Ethiopia. *Ethiop. Vet. J.*, 15: 57-68.
- Gadahi, J. A. Arsyed, M. J. Ali, Q Javaid, S B, and Shah, S. I. (2009). Prevalence of gastrointestinal of sheep and goat in and around Rawalpindi and Islamabad. *Pakistan vet. World*, 2(2):51-53
- Jatau, I.D., Abdulganiyu, A., Lawal A.L., Okubanjo, O.O. and Yusuf, K.H. (2011). Gastrointestinal and haemoparasitism of sheep and goats at slaughter in Kano, Northern-Nigeria. *Sokoto Journal of veterinary Sciences*, 9(1):7-11.
- Kucha, J. A., Chisti, M. Z., Zaki, M.M., Rasool, S. A.D.M., Ahmad, J. and Tak, H. (2011). Some Epidemiological Aspects of Fascioliasis among Cattle of Ladakh. *Global Veterinaria*, 7: 342 - 346
- Kumsa, B and Wossene, A (2006) Abomasal nematodes of small ruminants of Ogaden region, eastern Ethiopia: Prevalence, worm burden and species composition. *Revue Méd. Vet.*, 157 (12):27-32
- Nwigwe, J. O., Njoku, O.O., Odikamnoro. O. O. and Uhio, A. C. (2013). Comparative

Conclusion and Recommendation

This study has shown that small ruminants slaughtered at Ado Ekiti harboured *Strongyloides papillosus*, *Strongyle* sp, *Moniezasp* and *coccidia* sp. as the major gastrointestinal parasites.

There is a need to carry out awareness education amongst the butchers and farmers on the risk associated with gastrointestinal parasite infection of small ruminants. Control measures such as biosecurity measures, strategic anthelmintic administration and zero grazing should be encouraged.

Acknowledgement

The author gratefully acknowledges the immense contribution of Mr Irefin Opeyemi and the cooperation of the butchers at the Atikankan slaughter slab, Ado-Ekiti to the successful conduct of this research.

- study of intestinal helminth and protozoa of cattle and goats in Abakaliki metropolis of Ebonyi State, Nigeria. *Advances in Applied Science Research*, 4(2):223-227.
- Oluwatayo, I. B. and Oluwatayo, T. B. (2012) Small Ruminants as a Source of financial Security: A case Study of women in Rural Southwest Nigeria. IMTFI Working Paper 2012 -2
- Saiful Islam, K.B.M., and Taimur, M.J.F.A. (2008). Helminthic and Protozoan internal Parasitic infection in free Ranging Small Ruminants of Bangladesh. *Slov. Vet. Res.*, 45(2): 67-72
- SAS User's Guide Statistics. SAS Inc. Cary, North Carolina 1998 Edition.
- Soulsby, E.J.L. *Helminths, Arthropods and Protozoa of domesticated animals*. Bailliere, Tindall and Cassel, London 1982; 809
- Thienpoint, D., Rochete, F., Vanparijis, O. F. (1979). *Diagnosing Helminthosis through Coprophagical examination*. Jansssen Research Foundation Beerse, Bengium.
- Urquhart, G.M., Armour J., Duncan J.L. Dunn, A.M. and Jennings, F.W. (1997). *Veterinary Parasitology* 2nd edition Balckwell Science.

Bird Species Diversity in the Royal Forest Reserve in Eggua Southwestern Nigeria

¹J.O.Orimaye,²E.F. Okosodo,¹O.O. Ogunyemi, ²B.A. Owolabi and ³J. Eveso,

¹Department of Forest Resources and Wildlife Management,
Ekiti State University, Ado-Ekiti

²Department of Ecotourism and Wildlife Management,
The Federal University of Technology, Akure

³Department of Forestry and Wildlife Management
Federal University, Gashua, Yobe State
E-mail: jacob.orimaye@eksu.edu.ng

Abstract

The 350-hectare privately-owned Royal Forest Reserve, Eggua in Southwestern Nigeria is under threat from anthropogenic activities. The abundance and diversity of avian species should be known so as to create the awareness on the need for conservation of the forest reserve. This study was carried out to assess the abundance and diversity of birds in the reserve. The reserve was divided into two blocks based on land use type. The point count method was used to collect data on bird species diversity in five counting stations per block for six months at three months in the dry season (November, February, and March) and three months in the wet season (June, August, and September) in 2015. There were 483 individual birds spread across 64 different species and 27 families. The dominant family was *Ploceidae*, comprising 8 bird species, followed by *Accipitridae* and *Pycnonotidae* with 7 and 6 bird species respectively. The relative abundance of bird species was higher in the woodland block (0.26 and 0.22) than in forest block (0.15 and 0.13) in both seasons of the year. The diversity index showed that bird species were more diverse in the dry season (3.89) than the wet season (3.81) in the study area.

Keywords: Home range, avian species, habitat fragmentation, diversity, conservation

Introduction.

Forest conservation is a major challenge in West Africa countries because the forest resources are sources of livelihood for the rural dwellers and given the rapid population growth which increased demands for these resources the trend is likely to continue (Fargione *et al.*, 2009). The creation of protected areas has been the conventional methodology for conservation planners and has through which 11.5% of the earth surface was successfully created for this purpose. Despite this achievement, the existing protected areas are insufficient when consideration is given to both species and habitat representativeness (Rodrigues *et al.*, 2006) even as prospects for the expansion of the protected areas are almost non-existent in the near future (Musters *et al.*, 2000).

Agricultural expansion and increased intensification of the production process have brought associated impacts on bird habitats. The recent increases are the major drivers in the loss of birds and biodiversity globally through destruction and degradation of habitats (Norris,

2008). Thus, research began to focus on understanding how bird populations can be conserved within farmlands (Askins *et al.*, 2007). Currently, a key societal challenge is how to produce the needed food, fibre, and energy while sustaining bird populations and other biodiversity.

Out of 902 threatened birds that utilize forest ecosystems, 93% occur exclusively in the tropics (Bird Life International, 2000). Therefore, tropical forests harbouring the maximum number of endemic bird areas are also home to the highest range-restricted bird species in the world (Fahrig, 2003). Unfortunately, the tropical rainforest of West Africa is facing serious threat from anthropogenic activities as over 70% of the rural inhabitants are heavily dependent on it for sustenance.

The Royal Forest Reserve is a privately-owned forest reserve located in Eggua in Yewa Local Government Area, Ogun State, Nigeria. There serve has not been adequately studied with regards to the faunal biodiversity. Popoola

(2007) proposed the need to study the Royal Forest Reserve as was attempted in 1977 but to which the donor agency could do nothing due to the political situation on ground then. Preliminary information indicates that the Royal Forest Reserve is richly endowed with renewable natural resources: plant species and wildlife (terrestrial, aquatic and avian) which must be conserved to enhance the development of the reserve and the adjoining communities. In view of the impact of biodiversity conservation on quality of life, economic development, and sound environment, there is need to embark on studies to provide baseline information for strategic development of the reserve (Popoola, 2007). This study was, therefore, carried out to assess the bird species diversity of the Royal Forest Reserve, Eggua in southwestern Nigeria.

Materials and Methods

Study area

The study was conducted in Royal Forest Reserve, Eggua (6° 55'-7° 20' N and 3° 45'-4° 32' E) located in Yewa North Local Government Area, Ogun State along the Benin-Nigeria border. The reserve occupies a land area of 350 hectares (ha) and falls within the semi-seasonal

equatorial climatic zone characterized by distinct wet and dry seasons with mean annual rainfall of 1,940 mm and average minimum and maximum temperature of 27.80°C and 30.17°C respectively. The relative humidity is high all the year and generally above 80% during the wet season but between 60-80% during the dry season. The soils are predominantly ferruginous tropical, typical of the variety found in intensively-weathered areas of basement complex formations in the rainforest zone of South-western Nigeria. The soils are well-drained, mature, red, stony and gravely in the upper parts of the topo sequence. The texture of topsoil in the reserve is mainly sandy loam (Onyekwelu et al., 2008). The natural vegetation is tropical rainforest characterized by emergent trees with multiple canopies and lianas. Some of the most commonly found trees include African teak (*Melicia excelsa*), pod mahogany (*Azela bipindensis*), bark cloth tree (*Antiaris africana*), *Brachystegia nigerica*, ironwood (*Lophira alata*), African walnut (*Lovoa trichiliodes*), *Terminalia ivorensis*, black afara (*Terminalia superba*), and African whitewood (*Triplochiton scleroxylon*).

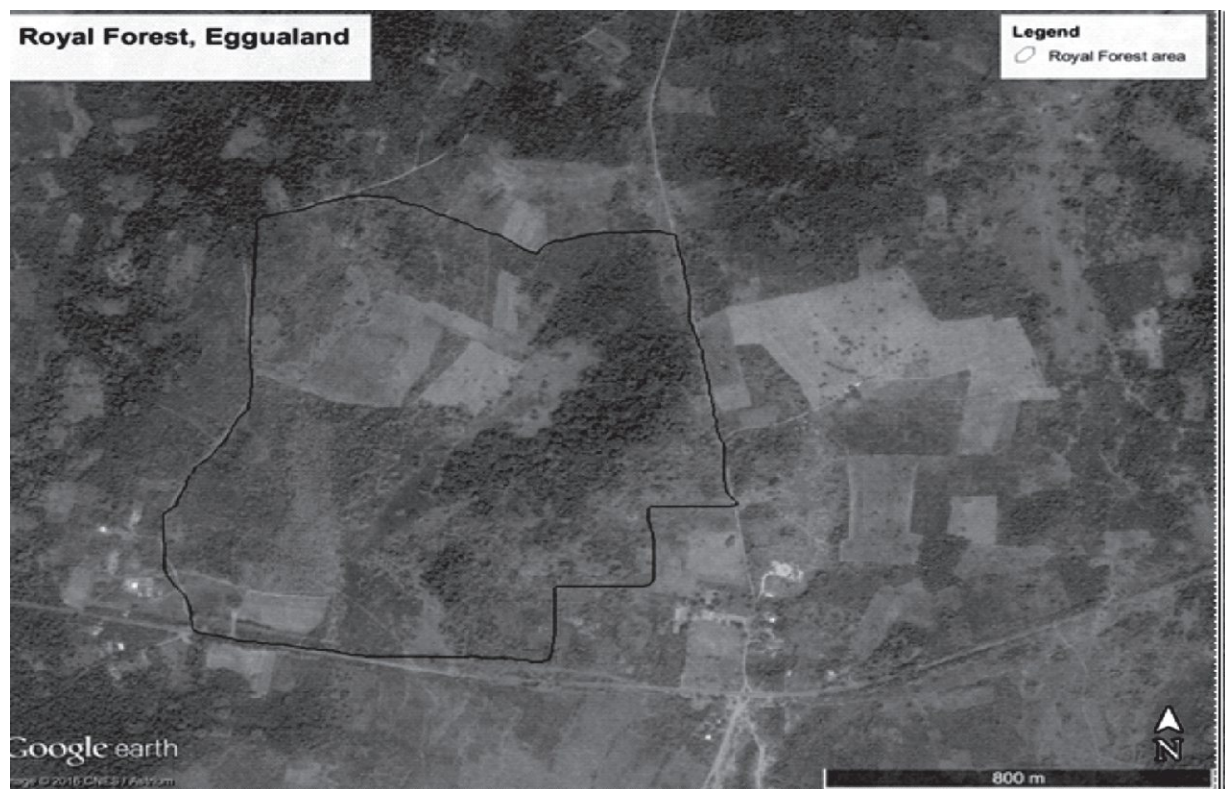


Figure 1: Map of the Study Area

Bird survey methods

The reserve was divided into two blocks based on land use type. The Forest block (150 ha) and the Savannah woodland block (150 ha) were mapped and the Point count method (Sutherland, 2009) was used to collect data on bird species diversity and abundance in the blocks. Counting bands of 50m radius were used in the stations and the minimum distance between two counting stations was 200 m. In all, 10 counting station were used at 5 stations per block. On arrival at the sites, there was a waiting period allowed for the birds to settle before recording the birds seen or heard for a predetermined time (usually 20 minutes). Bird calls were also recorded with a voice recorder and played back later for confirmation. Physical features of birds sighted but could not be identified immediately were taken and Field Guidebook of West African Birds (Burrow and Demey, 2013) was used for identification of the species while bird calls were used to confirm the presence of nocturnal bird species. Data were collected within 2 days in a week for six months

covering three months in the dry season (November, February, and March) and three months in the wet season (June, August, and September) in 2014.

Data analysis

The data collected were subjected to analysis with descriptive statistics and the computer PAST Model Version 3 (Hammer *et al.*, 2001) was used to determine bird species diversity.

Results

Table 1 shows the checklist of bird species in the Royal Forest Reserve, Eggua. Three hundred and eighty-three (383) individual birds consisting of 235 and 148 in the dry and wet seasons respectively spread across 65 species and 27 families were recorded. The family *Ploceidae* had the highest number (8) of bird species followed by *Accipitridae* and *Pycnonotidae* with 7 and 6 bird species respectively (Fig. 2). The relative abundance of bird species was higher in the dry season (0.26 and 0.22) than in the wet (0.15 and 0.13) respectively (Fig. 3).

Table 1: The Checklist of Bird Species of Royal Forest Reserve, Eggua

Family	Scientific names	Common Name	Habitat Type
Accipitridae	<i>Polyboroides typus</i>	African Harrier Hawk	Forest/Woodland
	<i>Avicedacuculoides</i>	African Cuckoo Hawk	Forest/Woodland
	<i>Stephanoaetus coronatus</i>	Crowned Eagle	Woodland
	<i>Micronisus gobar</i>	Gabar Goshawk	Woodland
	<i>Kaupifalcomonogrammicus</i>	Lizard Burzard	Forest/Woodland
	<i>Gypsoeirax angolensis</i>	Palm Nut Vulture	Forest
	<i>Milvusaegyptius</i>	Yellow Billed Kite	Forest/Woodland
Alcedinidae	<i>Halcyon senegalensis</i>	Senegal Woodland Kingfisher	Woodland
	<i>Alcedocristata</i>	Malachite Kingfisher	Woodland
Apodidae	<i>Cypsiurus parvus</i>	African Palm Swift	Forest
	<i>Telacanthura melanopygia</i>	Black Spinetail	Forest
Ardeidae	<i>Bubulcus ibis</i>	Cattle Egret	Woodland
Bucerotidae	<i>Tockus nastus</i>	African Grey Hornbill	Woodland
	<i>Tockus fasciatus</i>	African Pied Hornbill	Forest
	<i>Bycanistes fistulator</i>	Piping Hornbill	Forest
Capitonidae	<i>Pogoniulus chrysocomus</i>	Yellow Fronted Tinkerbird	Forest
	<i>Pogoniulus bilineatus</i>	Yellow Rumped Tinkerbird	Woodland
Caprimulgidae	<i>Caprimulgus nigriscapularis</i>	Black Shouldered Nightjar	Wetland
Cisticolidae	<i>Camaroptera brachyuran</i>	Grey Backed Camaroptera	Woodland
	<i>Eremomela pusilla</i>	Senegal Eremomela	Woodland
	<i>Prinia subflava</i>	Tawny Flank Prinia	Woodland
	<i>Cisticola lateralis</i>	Whistling Cisticola	Woodland

Columbidae	<i>Treroncalva</i>	African Green Pigeon	Forest
	<i>Turtur afer</i>	Blue Spotted Wood Dove	Woodland
	<i>Streptopeliasemitorquata</i>	Red Eyed Dove	Woodland
	<i>Streptopeliavinacea</i>	Vinaceous Dove	Woodland
Cucunidae	<i>Centropussenegalensis</i>	Senegal coucal	Woodland
	<i>Ceuthcharesaereus</i>	Yellowbill	Forest/Woodland
Dicruridae	<i>Dicrurusadsimilis</i>	Fork Tailed Drongo	Forest
Estrididae	<i>Spermestescucullatus</i>	Bronze Mannikin	Forest/Woodland
	<i>Estrildamelpoda</i>	Orange Cheeked Waxbill	Woodland
<u>Falconidae</u>	<i>Falco ardosiaceus</i>	Grey Kestrel	Woodland
	<i>Falco tinnunculus</i>	Common Kestrel	Woodland
Meropidae	<i>Meropsalbicollis</i>	White Throated Bee Eater	Forest/Woodland
	<i>Meropspusillus</i>	Little Bee Eater	Forest/Woodland
<u>Motacillidae</u>	<i>Anthusleucophrys</i>	Plain Backed Pipit	Forest
	<i>Motacillaflava</i>	Yellow Wagtail	Woodland
Muscicapidae	<i>Terpsiphonerufiventer</i>	Red Bellied Paradise	Woodland
		Flycatcher	
Musophagidae	<i>Tauracopersa</i>	Green Turaco	Forest
	<i>Musophagaviolacea</i>	Violet Turaco	Forest
Nectariniidae	<i>Hedydipnacollaris</i>	Collard Sunbird	Forest
	<i>Cyanomitravertialis</i>	Green Headed Sunbird	Woodland
	<i>Cinnyriscoocinigaster</i>	Splendid Sunbird	Woodland
	<i>Numidameleagris</i>	Helmented Guinea Fowl	Woodland
Numididae			
<u>Phasianidae</u>	<i>Francolinusbicalcaratus</i>	Double Spurred Francolins	Forest
Ploceidae	<i>Ploceusmelanocephalus</i>	Black Headed Weaver	Forest
	<i>Malimbusscutatus</i>	Red Vented Malimbe	Forest
	<i>Malimbus erythrogaster</i>	Red Headed Malimbe	Forest
	<i>Euplectesafer</i>	Yellow Crowned Bishop	Woodland
	<i>Euplectesfranciscanus</i>	Northern Red Bishop	Woodland
	<i>Ploceussuperciliosus</i>	Compact Weaver	Woodland
	<i>Amblyospizaalbifrons</i>	Grosbeak Weaver	Forest/Woodland
	<i>Ploceuscucullatus</i>	Village Weaver	Forest
	<i>poicephalussenegalus</i>	Senegal Parrot	Woodland
	<i>Andropadusansorge</i>	AnsorgesGreenbull	Forest
	<i>Pycnonotusbarbatus</i>	Common Bulbul	Forest/Woodland
	<i>Phyllastrephalusiterinus</i>	Icterine Green Bull	Forest
	<i>Pryrrhurusscandens</i>	Leaflove	Woodland
Strigidae	<i>Chlorocichla simplex</i>	Simple Greenbull	Forest
	<i>Nicatorchloris</i>	Western Nicator	Forest
	<i>Strixwoodfordii</i>	African Wood Owl	Forest
	<i>Turdus pelios</i>	West African Thrush	Woodland
<u>Turdidae</u>			
	<i>Vidua chalybeate</i>	Village Indigobird	Woodland
Viduidae	<i>Viduamacroura</i>	Pin Tailed Whydah	Forest/Woodland

The bird species diversity index of the study area is shown in Table 2. Bird species were more diverse in the dry season compared to the wet season. Shannon diversity index was higher (3.89) in the dry season than 3.81 in dry season. Also, there were slightly more dominant bird species during the wet seasons (0.030) than the wet season (0.029) while Evenness index was somewhat close at 0.75 in the dry season and 0.77 in the wet season.

Table 2: Diversity indices of Bird Species of Royal Forest Reserve, Eggua, Ogun State

	Woodland	
	Dry season	Wet season
Taxa_S	65	59
Individuals	235	148
Dominance_D	0.029	0.030
Shannon_H	3.89	3.81
Evenness_e ^{H/S}	0.75	0.77

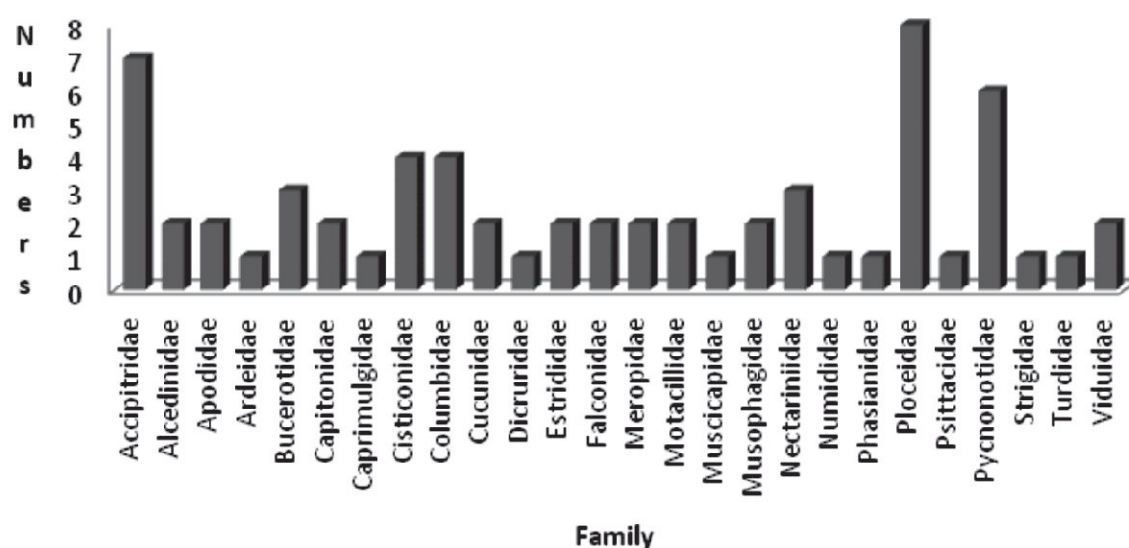


Figure 2: Families of Bird Species of Royal Forest Reserve, Eggua, Ogun State

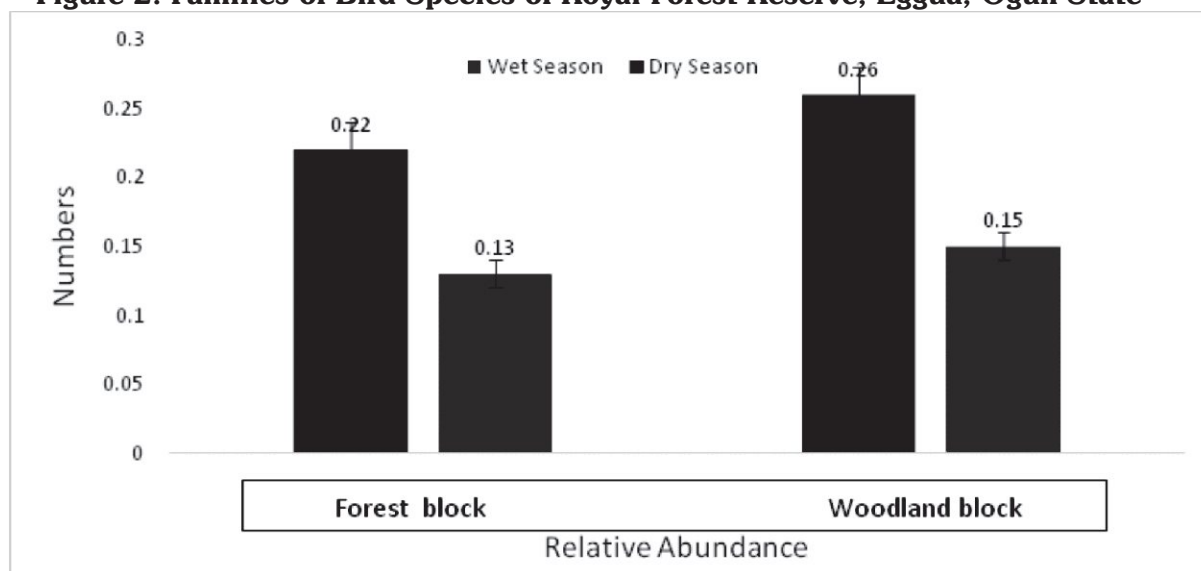


Figure 3: Relative abundance of Bird Species of Royal Forest, Eggua.

Discussion

The study established that Royal Forest Reserve, Eggua harbours a sizable number of bird species in the vegetation types ranging from the wetland, forest and savannah woodland

resulting from the transformation of the landscape by anthropogenic activities. Most of the bird species encountered appeared to have expanded their home range because of the ability to exploit and utilize more than one

habitat type and become abundant (Makelainen *et al.*, 2016). This pattern of bird species distribution was shown by the difference in species abundance within the two blocks.

Some woodland/savanna bird species, most of whom are seed eaters, were observed in the forest blocks suggesting that a lot of changes were taking place in the habitats. This is consistent with Cody (1985) who reported that the level of distribution of bird species in a habitat is normally as a result of an occurrence of plant species which support their population and to variation in species-specific requirements in the choice of habitats. In the forest block, rare species were observed that did not utilize the other vegetation blocks (Bas *et al.*, 2009). Thus, different groups of bird species seem to show variable responses to land uses. Insectivores are indicators of noticeable responses to land use. This result agrees with Matlock *et al.* (2003) that forest patches and protected areas in Sao Tome retained more bird species than agricultural landscapes. Furthermore, it has been reported that the multi-strata tropical agroforestry systems support higher bird diversity and populations than arboreal vegetation (Faria *et al.*, 2007; Bos *et al.*, 2009). Similarly, the observation by Herkert (2009) that the loss of habitats to urbanization reduced the quality of the remaining vegetation and this must have affected the population of avian species in the study area.

The higher relative abundance of avian species within the woodland agrees with Kormar

(2006) that higher abundance of bird species in cultivated areas due to increased food availability. Some savanna bird species were encountered in the forest area suggesting on-going human disturbance in the woodland area. Therefore, land use changes would result in the decline of rare species in the area (Manu, 2000). This is consistent with the findings of MacArthur and MacArthur (2001) that avian diversity increases with vegetation complexity. Pearson (1997) also observed that tropical wet evergreen forests support rarer bird species than other habitats. This is because the availability of nesting sites is one of the principal factors that determine the structure of bird community in the agricultural landscape (Söderstrom *et al.*, 2003).

Conclusion and Recommendation

The Royal Forest Reserve, Eggua is surrounded by settlements of agrarian communities whose residents engage in logging and conversion of forest land to crop farms as the major components of the on-going deforestation and forest degradation. However, these activities have the tendency to increase the extinction risk for many threatened and endangered bird species. Besides, urban settlements are catching up with the forest reserve from all directions making it look like an island in trouble. The management focus must concern the programmes designed to discourage bush burning, livestock grazing, deforestation and illegal farming in the Forest Reserve

References

- Askins, R.A. Chávez-Ramírez, F., Dale, B.C., Haas, C.A., Herkert, J. R., Knopf, F. L. and Vickery, P.D. (2007). Conservation of grassland birds in North America: understanding ecological processes indifferent regions. *Ornithological Monographs* 64: 1-46.
- Bas, Y., Renard, M., Jiguet, F. (2009) Nesting strategy predicts farmland bird response to agricultural intensity. *Agriculture, Ecosystems and Environment* 134: 143-147.
- Birdlife International (2000). Threatened Birds of the World. Lynx Edicions and Bird life International, Barcelona and Cambridge, United Kingdom: 2-22.
- Bos, M.M., Steffan-Dewenter, I. and Tschardtke, T. (2009). The contribution of cacao agroforests to the conservation of lower canopy and beetle diversity in Indonesia. *Biodiversity Conservation* 16:2429-2444.
- Burrow, N. and Demey. R. (2012). A Guide to the Birds of Western Africa". Princeton University Press
- Cody, M.L.(1985).An introduction to habitat selection in birds. In: Cody, M.L.(ed.) *Habitat Selection in Birds*. Academic Press Inc., London: 191-248.
- Fahrig L (2003). Effects of habitat fragmentation on biodiversity. *Annual Review of Ecology, Evolution and Systematics* 34:487-515.
- Fargione, J.E., Cooper, T.R., Flaspohler, D.J.,

- Hill, J., Lehman, C., McCoy, T., McLeod, S., Nelson, E.J., Oberhauser, K.S. and Tilman, D. (2009) Bioenergy and wildlife: threats and opportunities for grassland conservation. *Bio Science* 59: 767-777.
- Faria, D., Paciencia, M.L.B., Dixo, M., Laps, R.R. and Baumgarten, J. (2007). Ferns, frogs, lizards, birds and bats in forest fragments and shade cacao plantations in two contrasting landscapes in the Atlantic forest, Brazil. *Biodiversity and Conservation*. 16:2335-2357.
- Hammer, Ø.H., David, A.T. and Paul, D.R. (2001). Paleontological Statistics Software Package for Education and Data Analysis. *Palaeontologia Electronica* 4 Issue 1, Article 4. 9pp.
- Herkert, J.R. (2009) Response of bird populations to farmland set-aside programs. *Conservation Biology* 23: 1036-1040.
- Kormar, O. (2006) Ecology and conservation of birds in coffee plantations: A critical review. *Bird Conservation International* 16:1-23
- MacArthur, R.H. and MacArthur, J.W. (2001). On bird species diversity. *Ecology* 42: 594 - 598.
- Mäkeläinen, S., de Knegt, H.J., Ovaskainen, O., and Hanski, I.K. (2016). Home-range use patterns and movements of the Siberian flying squirrel in urban forests: Effects of habitat composition and connectivity. *Movement Ecology* 4: 5.
- Manu, S.A. (2000) Effects of Habitat Fragmentation on the Distribution of Forest Birds in South Western Nigeria with Particular Reference to the Ibadan Malimbes and Other Malimbes, Ph.D. Thesis. The University of Oxford.
- Matlock Jr., E.B., Rogers, D., Edwards, P.J. and Martin, S.G. (2003). Avian communities in forest fragments and reforestation areas associated with banana plantations in Costa Rica. *Agriculture, Ecosystems and Environment* 91: 199-215
- Musters, C.J.M., de Graaf, H.J. and Keurs W.J. (2000). Can protected areas be expanded in Africa? *Science* 287: 1759-1760
- Norris, K. (2008). Agriculture and biodiversity conservation: opportunity knocks'. *Conservation Letters*, 1(1), 2-11.
- Onyekwelu J.C., Mosandl, R. and Stimm, B. (2008), Tree species diversity and soil status of primary and degraded tropical rainforest ecosystems in South-Western Nigeria. *Journal of Tropical Forest Science* 20(3): 193-204.
- Pearson, D. (1977) Pantropical comparison of bird community: Structure of six lowland forest sites *Condor* 79: 232-244.
- Popoola, L. (2007). *Royal Forest Resort and Medicinal Herbs Farm Handbook*. Nigeria. Dreamwork Press. 3rd. Ed.
- Rodrigues, A.S.L., Andelman, S.J., Bakarr, M.I., Boitani, L., Brooks, T.M., Cowling, R.M., Roden house, N.L., Best, L.B., O'Connor, R.J., Bollinger, E.K. (1995). Effects of agricultural practices and farmland structures. In: Martin, T.E. and Finch, D.M. (eds.) *Ecology and Management of Neotropical Migratory Birds*. Oxford University Press, New York, USA: 269-293.
- Söderstrom, B., Kiema, S. and Reid, R. S. (2003). Intensified agricultural land-use and bird conservation in Burkina Faso. *Agriculture, Ecosystems and Environment* 99: 113-124.
- Sutherland, W.J. (2009). *From Individual Behaviour to Population Ecology*. Oxford University Press.

Evaluation of Agro-industrial Wastes as Organic Nutrient Sources for Growth and Yield of Okra (*Abelmoschus esculentus* L. Moench)

¹S. O. Omotoso, ² M. Aluko and ² A. F. Kehinde-Fadare,

¹Department of Soil Resources and Environmental Management,
Ekiti State University, Ado-Ekiti, Nigeria

²Department of Crop Production, Horticulture and Landscape Design,
Ekiti State University, Ado-Ekiti, Nigeria
E-mail: seguntoso@yahoo.com

Abstract

The indiscriminate disposal of large amounts of wastes generated in agricultural production and processing activities on land causes nutrient imbalance, increases salinity and decrease the pH in soils. These wastes can be properly handled and applied to the soil as sustainable waste management strategy that would reduce the menace of pollution. This study evaluated three wastes as sources of nutrients on the growth and yield of okra (*Abelmoschus esculentus* L. Moench) at the Teaching and Research Farm, Ekiti State University, Ado-Ekiti, Nigeria. The treatments were poultry manure (PM), palm oil mill effluent (POME) and cassava mill effluent (CME) applied at 15 t.ha⁻¹ each and control (no fertilizer). The experiment was laid out in a randomized complete block design (RCBD) in three replicates. Top soil (0-15 cm) samples collected before and after the trial were analyzed. Data were collected on plant height, number of leaves and leaf area, number of fruits, length and fresh weight of fruits. PM significantly ($P < 0.05$) gave the tallest plants (42.25 cm), highest pod length (4.53) and highest fresh pod yield (4.85 t.ha⁻¹) while POME gave the highest number of pods.plant⁻¹ (3.50). The improvement in soil chemical parameters was reflected in organic carbon and total nitrogen contents with the highest values at 7.2 and 1.8 g.kg⁻¹ respectively obtained in the plots treated with PM. PM and POME were superior to CME and have potentials to be used as alternatives to mineral fertilizers in okra production.

Keywords: Poultry manure, palm oil effluent, cassava waste water, pollution, okra

Introduction

Okra (*Abelmoschus esculentus* L.) is one of the most important vegetable crops grown in Nigeria for the fruits and leaves used as soup thickeners which may be served with rice and other food types. The fresh fruits are rich in vitamins, minerals and plant protein (Gopalan *et al.*, 2007, Arapitsas, 2008). It is cultivated under rainfed conditions and in irrigated areas on a wide range of soils but the yield is often limited by the use of low yielding varieties and poor soil fertility. Thus, the need to address the problem of inadequate nutrition necessitated the promotion of inorganic fertilizer use. Unfortunately, the continuous application of inorganic fertilizers at large rates has not sustained the desired yield at high levels due to soil acidity, nutrients imbalance and pollution of the environment (Ojeniyi, 2007). Besides, the scarcity of the right products at the right time coupled with the high cost, lack of technical know-how and low or lack of access to credit facilities reduce the farmers' dependence on these fertilizers (Banfule *et al.*, 2010). The use of organic materials is being promoted as the

alternative for improving the physical and chemical properties of soils in order to attain high crop yields with minimal undesirable impacts on the environment (Kondapaet *et al.*, 2009).

Agricultural production and processing activities are sources of crop- and livestock-based products with huge potentials to augment and improve the biological, physical and chemical conditions of the soil especially nutrient status (Omotoso and Johnson, 2015). The processing of fresh fruits to produce palm oil in palm oil processing mills and cassava tubers in cassava processing mill generate palm oil mill effluent (POME) and cassava mill effluent (CME) while large quantities of poultry droppings are generated daily by birds kept in broiler and egg-laying pens. The indiscriminate dumping and disposal of these wastes on the lands and water sources has implications for environmental pollution and reduction in soil quality for crop production. Hence, there is an urgent need for sound and efficient waste disposal and management strategies that will focus on environmental conservation and check

the deterioration of soil quality. Unfortunately, the utilization of these wastes in soil fertility management in Africa is minimal compared to countries like America and Asia (Agboola and Omueti, 1982). The strong advocacy for the use of renewable forms of energy and reduction in the costs of fertilization in crop production (Martinus and Vlek, 2001) has catalyzed the global resort to organic fertilizers.

The accumulation of these organic wastes increases the soil organic carbon content and so exerts positive influences on soil nutrients especially the long-term effects on the soil nitrogen (N) (Eneje and Ukwuoma, 2005). Poultry droppings (poultry manure, PM) have potentials for raising and sustaining the fertility of soils at high levels through the general improvement in the physical, biological and chemical properties. PM has a higher nutrient content compared to other sources of animal manure with one (1) ton (t) estimated to contain 30 kg N, 4 kg P and 24 kg (KARI, 2000). Besides, PM application provides all the necessary macro- and micro-nutrients in available forms to

ensure significant improvement in the growth development and yield of okra plants (Abou El-Magdet *et al.*, 2006). The application of PM also increased soil organic matter, N and P contents, cation exchange capacity and pH (Ayeniet *et al.*, 2008).

Farmers in Nigeria grow okra as rain-fed and irrigated crop with a wide range of organic materials at sub-optimal levels thereby obtaining low yields of the crop in the season. Since the cost of fertilizer is equally high and beyond the reach of resources-poor smallholder farmers, research attention has shifted to the evaluate agro-industrial and agricultural wastes for supplying the nutrients needed by crops. Although, POME and CME are environmental pollutants as far as the palm oil and cassava processing industries are concerned, they have enormous potentials as soil amendment for the supply of plant nutrients. This study was conducted to evaluate the efficiency of three agro-industrial wastes as nutrient sources on the growth and yield of okra (*Abelmoschus esculentus*, L. Moench)

Materials and Methods

The experiment was carried out at the Teaching and Research Farm, Ekiti State University, Ado-Ekiti, Nigeria 7°47'N, 5°22'E and 456 meters elevation above the sea level. The location is in the dry forest zone and experiences a warm sub-humid tropical climate with a distinct bimodal rainfall pattern. The wet season extends from late March to October with a dry spell in August while the dry season is between November and March. The mean annual rainfall, rainy days and temperature were 1,367.7 mm, 112 and 27°C, respectively. The soil of the study site has been classified as an Alfisol developed on basement complex rock, highly leached and with low to medium organic matter content (Fasina *et al.*, 2005). The site had previously been cultivated to some arable crops such as maize, yam and melon before it was left to fallow for some years.

Soil sampling and analysis

Soil samples were randomly collected from the top layer (0-15 cm) of soil after land preparation and bulked to form a composite. The sample was air-dried, crushed and allowed

to pass through a 2 mm sieve. The sample was analyzed for particle size distribution with the hydrometer method, pH in soil: solution ratio of 1:2 in 0.01M CaCl₂, organic carbon by the wet dichromate oxidation method and total N by the macro-Kjeldahl digestion method using the procedures described in Udoet *et al.* (2009). Available P was extracted with Bray P-1 extractant and determined by the molybdenum blue method. The exchangeable bases were extracted with neutral 1M NH₄OAc at a soil solution ratio of 1:10; Na, Ca and K were measured by flame photometry while Mg was read on Atomic Absorption Spectrophotometer. The exchangeable acidity was extracted with 1M KCl and titrated against 0.05M NaOH to a pink end point using phenolphthalein as indicator.

The PM and POME were collected from the Poultry Unit and Palm Oil Processing Unit of the Teaching and Research Farm, Ekiti State University, Ado-Ekiti while CME was collected from a cassava mill at Irasa, Ado-Ekiti. The treatments consisted of palm oil mill effluent (POME), cassava mill effluent (CME) and poultry manure (PM), each applied at 15 t.ha⁻¹

and control (no fertilizer)]. The experiment was laid out in a Randomized Complete Block Design in three replicates. The individual plot size was 4×3 m with 0.5 m paths between plots while the replicates were separated by 1 m paths. The waste materials were applied two (2) weeks before planting. Seeds of NHAe 47-4, an early-maturing variety adapted to Southwest, Nigeria and widely accepted by the farmers, were obtained from Institute of Agriculture Research and Training, Ibadan. Three (3) seeds were sown per hill at a spacing of 60×30 cm and later thinned to one seedling per stand at one week after germination.

Data collection

There were four (4) sampling times, at two-week intervals, starting from 2 weeks after planting (WAP). The following parameters were taken: plant height from the ground level to the tip of the highest leaf using a meter rule; number of leaves by visual counting and stem girth with a vernier caliper. The leaf area was determined by graphical method and the area multiplied by the total number of leaves to obtain the total leaf area per plant. At the end of six weeks after planting, plants were carefully uprooted from each plot. The roots were neatly removed, washed under running tap water and thereafter, shoots (stem and leaves) were separated and oven dried at 80°C to a constant weight for plant dry matter yield determination. The fresh and succulent (not hard) fruits were harvested at four-day intervals for a total of 7 harvests. The numbers and weights of fruit harvested in each plot were recorded while fruit length was measured with a meter rule.

Statistical Analysis

All the data collected were subjected to analysis of variance (ANOVA) using the

statistical analysis system (SAS, 2006) and the differences among treatment means were separated using Duncan's Multiple Range Tests (DMRT) at 5% level of probability.

Results and Discussion

The physical and chemical composition of the soil, PM, POME and CME are shown in Table 1. The soil was sandy loam (sand, 870 g.kg⁻¹, silt 80 g.kg and clay 50 g.kg⁻¹) slightly acidic (pH=5.6) with low total N (0.6 g.kg⁻¹) and available P (6.31 mg.kg⁻¹). The total N and available P values are low compared to the critical levels of 1.0 g.kg⁻¹ N and 10-12 mg.kg⁻¹ established for the soils in southwestern Nigeria (Adepetuet *al.*, 2014). The exchangeable Na, Ca, mg and K were 0.06, 2.42, 0.74 and 0.17 cmol.kg⁻¹ respectively. The exchangeable acidity and effective cation exchange capacity were 0.12 and 3.51 cmol.kg⁻¹ respectively. Using the critical level of 0.16-0.20 cmol.kg⁻¹ established for maize, the exchangeable K was low (FMANR, 1990). The PM was slightly alkaline (pH=7.70) and contained 31.6, 34.6 and 20.9 g.kg⁻¹ total N, P and K respectively. The POME was alkaline (pH=8.2) with total N, P and K at 20.5, 3.5 and 12.6 g.kg⁻¹ respectively. On the other hand, CME was strongly acidic (pH=4.1) with the N, P and K values at 18.0, 15.8 and 15.0 g.kg⁻¹ respectively. The level of exchangeable K at 0.2 cmol.dm⁻³ is considered adequate (Malavolta *et al.*, 1997) such that these organic materials, especially CME would serve as K sources and supports the view that the K contents of these effluents are sufficient to increase the levels of the nutrient in the soil and meet the demand of okra during the season.

Table 1. Properties of Soil, Poultry Manure, Palm Oil Mill Effluent and Cassava Mill Effluent used for the investigation

Soil characteristics	Soil value	Poultry manure	Palm oil mill effluent	Cassava mill effluent
Chemical properties				
pH(H ₂ O)	5.6	7.70	8.20	4.1
Organic matter (%)	1.62	-	-	-
Total N (%)	0.06	3.16	2.05	1.80
Available P (mg/kg)	6.31	3.46	0.35	1.58
Exchangeable bases (cmol/kg)				
Ca	2.42	3.60	0.94	1.48
Mg	0.74	1.06	0.57	0.62
K	0.17	2.09	1.26	1.50
Na	0.06	0.35	4.23	0.12
Exchangeable acidity	0.05			
ECEC	3.44			

Base saturation (%)	80.09
Physical properties (g/kg)	
Sand	870
Silt	80
Clay	50
Textural class	SL

SL= Sandy loam

The effects of organic wastes on okra growth parameters are shown in Table 2. The okra plants increased in height with age and those that received PM application were tallest throughout the periods of measurement. At 2 WAP, CME produced taller okra plants that were not significantly different from POME but the difference was significant at 4 WAP. POME produced significantly taller plants than CME at 6 WAP but the trend was reversed at 8 WAP when PM and CME gave similar plant heights. The tallest plants from PM at 8 WAP represented 7.29, 35.85 and 116.15% increase in plant height relative to CME, POME and control treatments respectively. Tiamiyuet *al.* (2012) had noted that PM application increased plant height due to its ability to increase nutrient fertility and water holding capacity of soils. Thus, the okra plant utilized the nutrients made available from the manures compared to the control whose plants were stunted. The stem girth increased with age and application of organic wastes at all sampling periods. There were no significant differences among the organic wastes at 2 WAP but as from 4 WAP, PM gave highest values while POME and CME were similar but significantly different from the control treatment. At 8 WAP, the application of PM gave the highest stem girth (3.70 cm) which was responsible for 38.06, 50.41 and 102.19% increase over POME, CME and the control respectively. However, the stem girth was not

significantly different between POME and CME while the thinnest plants (1.83 cm) were produced in the control treatment. The number of leaves produced by okra was highest with the application of PM at all sampling periods and was followed by POME. At 8 WAP, PM (34.7) was followed by POME (30.0) and CME (22.3) while the least (14.1) was produced by the control treatment which showed that PM produced 15.67, 55.61 and 146.10% more leaves than POME, CME and control respectively. The leaf area of okra was significantly increased by the application of the organic wastes and which differed throughout the sampling periods. The application of PM gave the highest leaf area at all sampling periods and was followed by CME which did not differ from POME at 4 and 6 WAP. At 8 WAP, PM gave the highest leaf area (327.0 cm²) followed by CME (207.63 cm²) and POME (158.88 cm²). The leaf area produced from PM application represented 57.5, 105.8 and 201.5% increase over CME, POME and control respectively. The results agree with Tindall (1992) that manure application resulted in luxuriant vegetative growth of crops and stressed the importance of applying nutrients during the vegetative growing stage of crops which would reflect in the increase of all growth parameters such as plant height, number of leaves produced and the effective leaf area.plant⁻¹

Table 2: Effects of organic fertilizer sources on plant height and number of leaves of okra

Treatment	Weeks After Planting			
	2	4	6	8
	Plant height (cm)			
Control	5.23c	9.30d	15.34d	19.60c
PM	9.13a	24.00a	31.87a	42.25a
POME	6.63b	12.62c	22.88b	31.10b
CME	7.25b	17.88b	20.25c	39.38a
Mean	7.06	15.95	22.59	33.08
SE±	1.83	4.29	7.72	8.16
	Number of leaves			
Control	2.60c	6.70c	10.30d	14.10c
PM	8.00a	18.60a	25.40a	34.70a
POME	6.30b	12.10b	20.60a	30.00b

CME	4.60b	10.50b	15.50c	22.30ba
Mean	5.38	11.98	17.95	25.28
SE±	0.30	0.66	0.75	0.48
Leaf area (cm ²)				
Control	10.37c	84.36c	106.81c	122.61c
PM	23.63a	244.25a	281.38a	327.00a
POME	12.06b	103.88b	139.75b	158.88b
CME	18.84a	106.38b	191.00ba	207.63b
Mean	16.23	134.72	179.74	204.03
SE±	4.99	42.83	105.2	94.79
Stem girth (cm)				
Control	0.41b	0.77c	0.96c	1.83c
PM	0.50a	1.53a	2.68a	3.70a
POME	0.50a	0.90b	1.98b	2.68b
CME	0.50a	0.99b	1.85b	2.46b
Mean	0.48	1.05	1.87	2.67
SE±	0.02	0.31	0.28	0.24

Mean values followed by the same letter(s) in the same column are not significantly different by DMRT at 5% level of probability. PM-poultry manure; POME-palm oil mill effluent; CME-cassava mill effluent

The effects of organic wastes on the dry matter yield of okra are shown in Table 3. The highest biomass yield (23.94 g) was obtained with the application of PM which represented 22.6 and 28.6% increase over POME and CME respectively. In the absence of the organic wastes, the biomass yield was the least (9.42 g). Premsekhar and Rajashree (2009) observed that the higher responses of okra to manure application could be attributed to improved physical and biological properties of the soil which resulted in better supply of available nutrients to the plants and so influenced dry matter production and assimilate partitioning. The highest dry matter production by PM could be due to the higher nutrient content whose eventual mineralization favoured the development of plant growth parameters which culminated in the biomass yield (Akanbiet *al.*, 2010). The availability of nutrients at the critical period of need in the right proportions would favour high photosynthetic activity and enhance dry matter production and yield. The effect of

the organic wastes on okra fruit yield and some yield components are shown in Table 4. The highest number of fruits (7.50) was recorded with POME application which represented 20.97, 275.0 and 118.46% increase over PM, CME and control respectively. The length of pods was highest in plants treated with PM (4.53 cm) followed by CME (3.82 cm) and POME (3.20 cm) while the control had the least (2.80 cm). The effect of the organic wastes on fresh fruit yield was significant and PM application produced the highest value (4.85 t.ha⁻¹) which was 87.88% increase over the control. Odeleyeet *al.* (2005); Omotoso and Shittu (2008) had reported high yield responses of okra to organic manure application. The superiority of PM could be attributed to its higher N and K contents compared to the other organic materials. Majanbuet *al.* (1986) had noted that N and K are the most important nutrients required for proper growth and fruit formation in okra.

Table 3: Effects of organic fertilizer sources on dry matter yield (g plant⁻¹) of okra

Treatment	Stem	Leaf	Root	Total Biomass
Control	2.83c	6.63b	0.96c	9.42c
PM	5.46ba	14.83a	3.65a	23.94a
POME	3.85b	13.9a	1.74b	19.53b
CME	7.36a	8.34b	2.88ba	18.58b
Mean	4.88	10.93	2.31	17.86
SE±	2.91	6.02	1.21	1.56

Mean values followed by the same letter(s) in the same column are not significantly different by DMRT at 5% level of probability. PM-poultry manure; POME-palm oil mill effluent; CME-cassava mill effluent

The chemical properties of the soil after cropping are shown in Table 5. PM and POME application caused increase in soil pH but CME decreased it. The soil pH increased from 5.6 to 6.7 and 6.8 with POME and PM application respectively while CME imparted greater acidity to the soil (pH=3.3). The increased acidity can impair the germination of seeds and subsequent growth of seedlings. Olorunfemi *et al.* (2007) had observed the low germination percentage of *Pennisetum americanum* with increase in the dosage of CME while maize (*Zeamays*) appeared to show some tolerance. The acid soil

condition would be attributed to the presence of hydrocyanic acid in the CME. Soil acidity has been identified as one of the major constraints to crop growth and production in the soils of the tropical region (Busari *et al.*, 2005) due to the usual accompanying effect of aluminium (Al) and manganese (Mn) toxicity, nutrient imbalance and deficiencies. The soil pH determines the availability of nutrients and the potency of toxic substances, especially the tendency for absorption of heavy metals at high levels and the accompanying health risks.

Table 4: Effects of organic fertilizer sources on number of pod, pod length and fresh pod weight of okra

Treatment	Number of Pod plant ⁻¹	Pod Length plant ⁻¹ (cm)	Fresh Pod yield (ton/ha)
Control	2.60c	2.84c	1.36c
PM	6.20ab	4.53a	4.85a
POME	7.50a	3.20b	2.58b
CME	2.00c	3.82ab	1.56c
Mean	4.58	3.60	2.59
SE±	1.16	1.01	0.48

Mean values followed by the same letter(s) in the same column are not significantly different by DMRT at 5% level of probability. PM-poultry manure; POME-palm oil mill effluent; CME-cassava mill effluent

The results show that POME and PM have great potentials as amendments for ameliorating acid soil conditions compared to CME. Akande *et al.* (2003) reported that the application of organic materials could ameliorate slightly acidic soils of the tropical region and thereby improve crop production. The improvement in the soil chemical parameters was observed in the significant increase in organic carbon and total N with the application of the organic wastes. The highest values of 7.2 g.kg⁻¹ organic carbon and 1.8 g.kg⁻¹ N were obtained in the PM-treated plots. Also,

Ca, Mg, Na and K increased significantly with the application of PM and POME relative to the control treatments. The regular application of PM increased soil pH and the availability of N, P, K, Ca and Mg which also enhanced their uptake. The benefits include reduced soil acidification, higher contents of exchangeable Ca and Mg, reduced free Al and Mn and promotion of P uptake and the correction of Zn and Fe deficiencies since the organic fraction in the manure is important in rendering Zn and Fe more available to plants (Brady and Weil, 2002).

Table 5: Effects of organic fertilizer sources on chemical properties of the soil after cropping

Treatments	pH (H ₂ O)	Org. C	Total N	Av. P mg/kg	Exchangeable Cations					CEC
Fertilizer		%			Cmol/kg					
					Ca	Mg	K	Na	H ⁺	
Initial	5.60	0.67	0.06	6.31	1.42	1.42	0.17	0.14	0.05	3.15
Control	5.60b	0.46a	0.12b	6.20c	1.80c	0.60b	0.19a	0.05b	0.14a	2.64b
PM	6.80a	0.72a	0.18a	12.20a	2.48a	1.60a	0.17a	0.08b	0.04b	4.33a
POME	6.70a	0.70a	0.16a	8.40.b	2.20b	0.58b	0.16a	0.06b	0.16a	3.00a
CME	3.60c	0.61a	0.04c	4.20d	1.20d	0.51b	0.14a	0.03c	0.18a	2.06b
Mean	3.80	0.58	0.13	0.75	1.92	0.82	0.17	0.06	0.16	3.00

Mean values followed by the same letter(s) in the same column are not significantly different by DMRT at 5% level of probability. PM-poultry manure; POME-palm oil mill effluent; CME-cassava mill effluent

Conclusion

The study has demonstrated the potentials of agro-industrial wastes as organic fertilizer for okra production. The application of these materials enhanced okra growth and development compared to the untreated plots. The tallest plants, highest pod length and fresh pod weight resulted from the application of PM. POME application gave the highest number of pods.plant⁻¹ (7.50). PM and POME improved

soil total N, available P exchangeable Mg, Ca, K and lowered exchange acidity. Thus, PM and POME can provide nutrients to the soil and would be close alternative to mineral fertilizers. The addition of these materials to soil can be a sustainable management strategy for fertility maintenance through lowering of the farmer's input cost by reducing the use of inorganic fertilizer with the advantage of clean environments

References

- Abou El-Magd, M.A., El-Bassiony, M. and Fawzy, Z.F.(2006). Effect of organic manure with or without chemical fertilizer on growth, yield and quality of some varieties of broccoli plants. *Journal of Applied Science Research* 2(10): 791-798.
- Adepetu, J.A., Adetunji, M.T. and Ige, D.V. (2014) Soil Fertility and Plant Nutrition. Jumak Publishers, Ring Road, Ibadan. 560pp.
- Agboola, A.A. and Omueti, J.A.I. (1982). Soil fertility problems and its management in tropical Africa. Paper presented at the International Institute of Tropical Agriculture Ibadan, Nigeria.Part 2. 215pp.
- Akanbi, W.B., Togun, A.O., Adediran, J.A. and Ilupeju, E.A.O. (2010). Growth, dry matter and fruit yield components of okra under organic and inorganic sources of nutrients. *American-Eurasian Journal of Sustainable Agriculture* 4(1): 1-13.
- Akande, M.O., Oluwatoyinbo, F.I., Adediran, J.A., Buari, K.W. and Yusuf, I.O. (2003). Soil amendments affect the release of P from rock phosphate and the development and yield of okra. *Journal of Vegetable Crop Production* 9(2): 3-9.
- Arapitsas, P. (2008). Identification and quantification of polyphenolic compounds from okra seeds and skins. *Food Chemistry*. 110: 1041-1045.
- Ayeni L. S., Adetunji, M.T., Ojeniyi, S.O., Ewulo, B.S., and Adeyemo, A.J. (2008). Comparative and cumulative effect of cocoa pod husk ash and poultry manure on soil and maize nutrient contents and yield. *American-Eurasian Journal of Sustainable Agriculture* 2(1): 92-97.
- Banful, A.B., Nkonya, E. and Oboh, V. (2010). Constraints to Fertilizer Use in Nigeria: Insights from Agricultural Extension Service. IFPRI Discussion Paper 01010. International Food Policy Research Institute, Washington DC, USA. 28pp
- Brady, N.C. and Weil, R.R. (2002). The Nature

- and Properties of Soils. 13th Edition. Pearson Education Publishers, New Delhi, India. 960pp
- Busari, M.A., Salako, F.K., Sobulo, R.A., Adetunji, M.T. and Bello, N.J. (2005). Variation in soil pH and maize yield as affected by the application of poultry manure and lime. Proceedings of the 29th Annual Conference of the Soil Science Society of Nigeria held from December 6-10, 2004: 139-142
- Eneje, R.C. and Ukwuoma, V.E. (2005). Plant and animal organic manure effects on vegetable and orchard farm Soils (Part 1): Effect on soil chemical properties. *Journal of Agriculture, Agricultural Technology and Environment* 1(1): PAGES?
- Fasina, A.S., Aruleba, J.O., Omolayo, F.O., Omotoso, S.O., Shittu, O.S. and Okunsanmi, T.A. (2005). Properties and classification of five soils formed on granitic parent material of humid South West, Nigeria. *Nigerian Journal of Soil Science* 15: 21-29.
- FMANR, (1990). Literature Review of Soil Fertility Investigations in Nigeria (in Five Volumes). Federal Ministry of Agriculture and Natural Resources, Lagos. 281pp
- Gopalan, C., Sastri, S. and Balasubramannian, B.V. (2007). Nutritive Value of Indian Foods, National Institute of Nutrition (NIN), KMR, India. Revised Edition Book 2. 156pp
- KARI, (Kenya Agricultural Research Institute) (2000): Soil Fertility Management Handbook for Extension Staff and Farmers, *Technical Notes Series* No. 5.
- Kondapa, D., Radder, B.M., Patil, P.L., Hebsur, N.S. and Alagundagi, S.C. (2009). Effect of integrated nutrient management on growth, yield and economics of chilli (Cv. Byadgidabbi) in a vertisol. *Karnataka Journal of Agricultural Science* 22(2): 438-440
- Majanbu, I. S., Ogunlela, V.B., Ahmed, M.K. and Olarewaju, J. D. (1985). Response of two okra varieties, yield and yield components as influenced by nitrogen and phosphorus application. *Fertilizer Research* 6 (3): 257-267.
- Malavolta, E., Vitti, G.C. and Oliveira, S.A. (1997). Evaluation of the Nutritional Status of Plants: Principles and Applications. 2nd Edition. Piracicaba: Brazilian Association for Research on Potash and Phosphate. 201pp
- Martinus, C.H.T. and Vlek, P.L.G. (2001). The management of organic matter in tropical soils: What are the priorities? *Nutrients Cycling in Agro Ecosystems* 61: 1-16
- Odeleye, E. O., Odeleye, O.M.O., Dada, O.A. and Olaleye, A.O. (2005). The response of okra to varying levels of poultry manure and plant population density under sole cropping *Journal of Food, Agriculture and Environment* 3 (38): 67-74.
- Ojeniyi, S.O. (2007). Use of wood ash to improve soil fertility and performance of okra (*Abelmoschus esculentus*). *Production Agricultural Technology* 3(2): 124-128.
- Olorunfemi, D., H. Obiaigwe and E. Okieimen, (2007). Effect of cassava processing effluent on the germination of some cereals. *Research Journal of Environmental Science*. 1: 166-172.
- Omotoso, S.O. and Johnson, O.Y. (2015). Growth and yield of two varieties of okra (*Abelmoschus esculentus* (L.) Moench) as affected by potassium fertilizer sources. *Journal of Biology, Agriculture and Healthcare* 5(8): 98-104.
- Omotoso, S.O. and Shittu, O.S. (2008). Soil properties, leaf nutrient composition and yield of okra (*Abelmoschus esculentus* (L.) Moench) as affected by broiler litter and NPK 15:15:15 fertilizers in Ekiti State, Nigeria. *International Journal of Agricultural Research* 3: 140-147.
- Premsekhar, M. and Rajashree, V. (2009). Influence of organic manure on growth, yield and quality of okra. *American Eurasian Journal of Sustainable Agriculture* 3(1): 6-8.
- SAS, (2006). Institute Lac, SAS/STAT User's Guide: Version 6, Fourth Edition, Carry, NC. SAS Institute Inc. 2: 846.
- Tiamiyu, R.A, Ahmed, H.G. and Muhammad, A.S. (2012). Effect of sources of organic manure on growth and yields of okra (*Abelmoschus esculentus* L.) in Sokoto, Nigeria. *Nigerian Journal of Basic and Applied Science* 20 (3): 213-216
- Tindall, H.D. (1993). Vegetables in the Tropics. Macmillian Education limited, London, UK.
- Udo, E.J., Ibia, T.O., Ogunwale, J.O., Ano, A.O. and Esu, I.E. (2009). Manual of Soil, Plant and Water Analysis. Sibon Books Ltd, Lagos. 183pp.

Effect of Broca 1 Fertilizer Amended with Cocoa Pod Husk on Growth and Dry Matter Yield of Cocoa (*Theobroma cacao* L.) Seedlings at Ibadan, Nigeria.

¹O. S., Ibiremo, ²M. O., Adenekan and ¹O. A., Ojo

¹Cocoa Research Institute of Nigeria, Ibadan

²Federal College of Agriculture, Moor Plantation, Ibadan

E-mail: femiibiremo@yahoo.com

Abstract

The search continues for the appropriate fertilizers whose use will increase yield in the predominantly smallholder cocoa production systems in Nigeria. A greenhouse study was carried out at Cocoa Research Institute of Nigeria, Ibadan to evaluate the effects of Broca 1 fertilizer amended with ground cocoa pod husk (CPH) on the growth and dry matter yield of cocoa (*Theobroma cacao* L.) seedlings. The treatments consisted of a control, CPH at 2.5 and 5.0 kg N.ha⁻¹ (CPH_{2.5}, CPH_{5.0}), Broca 1 (at 26 kg.ha⁻¹), CPH_{2.5} + Broca 1 and CPH_{5.0} + Broca 1. The treatments were applied at four weeks after planting as Completely Randomized Design (CRD) in four replications. The parameters measured were plant height, number of leaves, stem diameter, leaf area and dry matter yield. CPH amended with Broca 1 significantly ($P < 0.05$) promoted growth parameters and dry matter yield of cocoa seedlings compared to the control. Application of Broca 1, CPH_{2.5} and CPH_{5.0} significantly ($P < 0.05$) increased the height, stem diameter, number of leaves, and leaf area of cocoa seedlings compared to the control. CPH_{5.0} + Broca consistently gave superior growth performance of cocoa seedlings in terms of height, leaf area and dry matter yield throughout the period of study. The contribution of Broca 1 to total dry matter yield of cocoa seedlings was 61% and its application with CPH applied to supply 5 kg N.ha⁻¹ indicated its potential as a promising fertilizer for cocoa seedling production in Nigeria.

Keywords: Broca 1, organic fertilizer, cocoa pod husk, dry matter yield

Introduction

Cocoa (*Theobroma cacao* L.) is a major cash crop in Nigeria where its production and export contribute significantly to the national economy and poverty alleviation (Folayan *et al.*, 2006; Ibiremo *et al.*, 2014). The annual output is about 270,000 tons (t) of dry cocoa beans with productivity largely dependent on natural soil endowment as fertilizers are not part of the predominantly smallholder production system. Ogunlade *et al.* (2009) had observed that over 85% of Nigerian cocoa farmers do not use fertilizers and this has impacted negatively on cocoa productivity. However, recent studies have indicated that fertilizer application is inevitable for high returns in cocoa production as obtained in Ghana and Cote d'Ivoire by Dutch Sustainable Initiative (IDH). The results showed that after one year of fertilizer application, the foliage on degraded farms was widely rebuilt and productivity doubled making it one of the solutions to the problems faced by cocoa farmers and companies (Francois and Serge, 2012).

There are different fertilizer types (liquid and solid) available in the input markets and are being utilized by farmers for cocoa production in Nigeria. Cocoa pod husk (CPH) has been used as organic fertilizer for the cultivation of arable and tree crops (Oladokun, 1986; Ibiremo *et al.*, 2012). The high potash content (2.85-3.2% K₂O) makes it a potential asset for ameliorating acid soils. Besides, CPH lightens heavy soils, acts as a humus-forming base and increases the soil organic matter and nutrient uptake (Tejeda *et al.*, 2006). CPH can be applied alone or in combination with inorganic fertilizers to enhance its efficiency (Adeniyi and Ojeniyi, 2006; Ibiremo, *et al.*, 2010).

Broca 1 is a new fertilizer formulation that has been used extensively to enhance cocoa growth and productivity in some cocoa-producing West African countries. Therefore, the next logical step is to evaluate the effect of this fertilizer alone and in conjunction with CPH on the growth of cocoa seedlings. The objective of this study was to determine the effects of Broca 1 fertilizer at the recommended rate and the

amendment with ground CPH on the growth and dry matter yield of cocoa (*Theobroma cacao* L.) seedlings at Ibadan, Nigeria.

Materials and Methods

A greenhouse study was carried out at Cocoa Research Institute of Nigeria, Ibadan (lat. 7° 25' N, long. 3° 25' E) in 2014 to investigate the effects of CPH and Broca 1 fertilizer on the growth and dry matter yield of cocoa (*Theobroma cacao* L.) seedlings. The CPH was obtained from the Fermentary Unit, air-dried and milled. Soil samples (0-30 cm depth) were randomly collected from an old cocoa plot, bulked to a composite sample, air dried and sieved using 2 mm mesh. The soil sample was analyzed for particle size distribution using the hydrometer method (Gee and Bauder, 1986), soil pH (1:1 soil/water) using a glass electrode system (Ogunwale and Udo, 1998) and organic matter by dichromate oxidation method. The exchangeable cations were extracted with neutral normal ammonium acetate solution; Na, K and Ca were determined with flame photometer while the Mg was read on an Atomic Absorption Spectrophotometer. The exchangeable acidity (H^+ and Al^{3+}) was measured from 0.01 M KCl extracts by titrating with 0.01M NaOH (Igwe, *et al.*, 2005). Total N was determined using the macro-Kjeldahl method (IITA, 1982) while available P was extracted with Bray P-1 extractant and the amount measured with the molybdenum blue method on a spectrophotometer at 882 nm (Ogunwale and Udo, 1998). The total N, P and K contents of CPH were determined following the methods described in IITA (1982) while the manufacturer's specification was taken as the nutrient content of Broca 1.

Five kilograms (kg) of the soil were weighed into each of 36 pots used for the experiment and watered to field capacity. Fresh cocoa seeds were sown into the soil, covered thinly with soil and watered daily. The treatments: a control, CPH at 2.5 kg N.ha⁻¹

(CPH_{2.5}), CPH at 5.0 kg N.ha⁻¹ (CPH_{5.0}), Broca 1 (at 26 kg.ha⁻¹), CPH_{2.5} + Broca 1 and CPH_{5.0} + Broca 1 were applied at four weeks after planting as a Completely Randomized Design (CRD) in four replications. The following parameters were measured at 4, 8 and 12 weeks after treatment (WAT): plant height, number of leaves, stem diameter at 5 cm from the soil surface, leaf area based on leaf length and breadth and multiplied by a factor of 0.4 (Adenikinju, 1974) and dry matter yield. Data collected were analysed using analysis of variance (ANOVA) and treatment means were separated with Duncan Multiple Range Test (DMRT) at 0.05 level of probability.

Results and Discussion

Table 1 shows the properties of the soil used for the study. The content of 842, 86 and 72 g.kg⁻¹ of sand, silt and clay respectively classifies the soil textural class as sandy loam. The silt + clay is very inadequate to sustain seedling growth particularly during the dry season (Egbe *et al.*, 1989). The nearly neutral pH of 6.72 falls within the acceptable range of 5-7.5 and so would ensure the availability of N, P and K in the soil needed to promote the optimum growth and survival of cocoa (Egbe *et al.*, 1989). The total N (2.3 g.kg⁻¹ soil) and organic carbon (20.30 g.kg⁻¹ soil) are moderate such that additional N would be needed for improved productivity. The acceptable limit of soil organic matter for cocoa is 30 g.kg⁻¹ (Egbe *et al.*, 1989) which means that large amounts of organic manure (fertilizer) would be needed to improve the growth of cocoa. The available P at 11 mg.kg⁻¹ is considered moderate being slightly above 10 mg.kg⁻¹ soil established as the critical available P level for soils in of Nigeria (FMANR, 1990) suggesting that the application of P fertilizer may not be necessary at present. The exchangeable Na, Ca, and K were 0.42, 7.0 and 0.26 cmol.kg⁻¹ respectively.

Table1: Physical and chemical characteristics of the soil used for the study

Properties	Values
Sand (g/kg)	842
Silt (g/kg)	86
Clay(g/kg)	72
Textural class	Sandy Loam
pH	6.72
N (g.kg ⁻¹)	2.30
Available P (mg.kg ⁻¹)	10.64
K (cmol.kg ⁻¹)	0.26
Ca (cmol.kg ⁻¹)	7.0
Na (cmol.kg ⁻¹)	0.41
Organic carbon (g.kg ⁻¹)	20.30

The nutrient compositions of the CPH and Broca 1 fertilizer are presented in Table 2. The CPH was almost neutral (pH=6.8) and contained very low amounts of N and P while Ca, K and Na contents were 2.45, 4.8, and 0.68

cmol.kg⁻¹ respectively. Broca 1 has no N but contained P and K at 150 g.kg⁻¹ each and 270, 25, 15 and 4 g.kg⁻¹ of Ca, Mg, S and Zn respectively.

Table 2: Nutrient compositions of fertilizer materials used for the study

Properties	Cocoa Pod Husk (g.kg ⁻¹)	Broca 1 (g.kg ⁻¹)
Ca	24.5	270.0
K	48.0	150.0
pH	6.80	Nd
Na	102.23	Nd
N	9.50	Nd
Organic carbon	243.20	Nd
Mg	2.40	25.0
S	Nd	15.0
Zn	Nd	4.0
P	1.10	150.0

Nd =not determined

The height of cocoa seedlings was significantly ($p < 0.05$) affected by the application CPH, Broca 1 and CPH combined with Broca 1 at 4, 8 and 12 WAT compared to the control (Table 3). At 4 WAT, the control and CPH_{2.5} + Broca 1 were similar but gave shorter plants than other treatments. At 8 WAT, cocoa seedling height was significantly ($p < 0.05$) increased by the application of CPH_{2.5} and CPH_{5.0} + Broca 1

produced the tallest plants while Broca 1, CPH_{2.5} + Broca 1 and CPH_{5.0} + Broca 1 were taller but not significantly different from the control. At 12 WAT, CPH_{5.0} + Broca 1, Broca 1 and CPH_{2.5} + Broca 1 produced the tallest seedlings which did not differ from CPH_{5.0}. The application of CPH with or without Broca 1 fertilizer increased the height of cocoa seedlings by 27 % compared to the control at 12 WAT.

Table 3: Effect of ground cocoa pod husk and Broca 1 fertilizer on height of cocoa seedlings in Ibadan, Nigeria

Treatment	4 WAT	8 WAT	12 WAT
Control	17.18 ^b	20.68 ^c	27.43 ^b
CPH _{2.5}	20.27 ^a	28.53 ^a	38.27 ^a
CPH _{2.5} + B1	18.78 ^{ab}	23.18 ^{bc}	29.47 ^b
CPH _{5.0} + B1	20.87 ^a	28.10 ^a	38.60 ^a
CPH _{5.0}	21.00 ^a	26.87 ^{bc}	33.03 ^{ab}
B1	20.77 ^a	25.15 ^{bc}	38.48 ^a

Means having the same letter (s) in a column are not significantly different ($P < 0.05$) according to Duncan's Multiple Range Test.

Legend

CPH_{2.5}- CPH applied at 2.5 kg N.ha⁻¹, CPH_{5.0}- CPH applied at 5.0 kg N.ha⁻¹, B1- Broca 1 applied at 26 kg.ha⁻¹; WAT=Weeks after treatment application

The application of CPH with or without Broca 1 did not affect the stem diameter of cocoa seedlings at 4, 8 and 12 WAT (Table 4). However, at 4 WAT, CPH_{5.0} improved the stem diameter of cocoa seedling by 22% compared to the control. Similarly, sole Broca 1 improved the stem diameter of cocoa seedling by 22.7 %

compared to the control at 8 WAT. At 12 WAT, the stem diameter ranged from 0.65 in the control to 0.77 cm in CPH_{5.0} and Broca 1 which indicated improvement of the stem diameter by 18.5 % compared to the control. The improvement in the seedling height over the control indicated the effectiveness of the Broca 1 when CPH was added which is consistent with the findings of Adeniyi and Ojeniyi (2005) and Akanbi *et al.* (2012) that the integrated use of organic with inorganic fertilizers gave taller cocoa seedlings with higher stem diameters.

Table 4: Stem diameter of cocoa seedlings as influenced by cocoa pod husk and Broca 1 fertilizer at Ibadan, Nigeria

Treatment	4WAT	8WAT	12 WAT
Control	0.39a	0.51a	0.65a
CPH _{2.5}	0.47a	0.63a	0.75a
CPH _{2.5} + B1	0.47a	0.64a	0.72a
CPH _{5.0} + B1	0.36a	0.62a	0.75a
CPH _{5.0}	0.50a	0.64a	0.77a
B1	0.39a	0.66a	0.77a

Means having the same letter (s) in a column are not significantly different ($P < 0.05$) according to Duncan's Multiple Range Test.

Legend

CPH_{2.5}- CPH applied at 2.5 kg N.ha⁻¹, CPH_{5.0}- CPH applied at 5 kg N.ha⁻¹, B1- Broca 1 applied at 26 kg.ha⁻¹; WAT=Weeks after treatment application

The application of CPH and Broca 1 increased the number of leaves of cocoa seedlings, but this

was not significant (Table 5). CPH_{5.0} alone or in combination with Broca 1 fertilizer increased the number of leaves of cocoa seedlings by 18.4 % compared to the control. Similarly, at 8 WAT, CPH_{5.0} + Broca 1 increased the number of leaves by 7.02 % compared to control. At 12 WAT, CPH_{2.5} + Broca 1 improved the number of leaves by 18.0 % compared to control. The average number of leaves of cocoa seedlings ranged from 13.67 in the control to 16.67 with CPH_{2.5} + Broca 1.

Table 5: Effect of CPH and Broca 1 on the number of leaves of cocoa seedlings in Ibadan, Nigeria

Treatment	4WAT	8WAT	12WAT
Control	7.67a	9.67a	13.67a
CPH _{2.5}	7.67a	11.17a	16.17a
CPH _{2.5} + B1	7.83a	11.00a	16.67a
CPH _{5.0} + B1	8.17a	11.83a	15.50a
CPH _{5.0}	8.17a	11.67a	15.50a
B1	7.50a	11.33a	15.83a

Means having the same letter (s) in a column are not significantly different ($P < 0.05$) according to Duncan's Multiple Range Test.

Legend

CPH_{2.5}- CPH applied at 2.5 kg N.ha⁻¹, CPH_{5.0}- CPH applied at 5 kg N.ha⁻¹,
B1- Broca 1 applied at 26 kg.ha⁻¹; WAT=Weeks after treatment application

The application of CPH and Broca 1 fertilizer was not significant on the leaf area of cocoa seedlings at 4 WAT (Table 6). At 8 WAT, the application of CPH and Broca 1 separately

and in combination gave similar effect on leaf area and all were significantly ($p < 0.05$) better than the control treatment. At 12 WAT, the leaf area of cocoa seedlings was 76.03 cm² in the control and increased to 100.90 cm² in CPH_{5.0}+Broca 1 but the treatments were not significantly different. The leaf area produced at CPH_{5.0}+Broca 1 represented 32.7% increase above the control treatment.

Table 6: Effect of CPH and Broca 1 fertilizer on the leaf area of cocoa seedling in Ibadan, Nigeria

Treatment	4WAT	8WAT	12WAT
Control	34.47a	48.21c	76.03a
CPH _{2.5}	38.59a	76.21ab	97.23a
CPH _{2.5} +B1	35.42a	64.79ab	99.97a
CPH _{5.0} +B1	44.98a	77.23a	100.90a
CPH _{5.0}	38.20a	69.42ab	92.21a
B1	41.40a	74.08ab	97.19a

Means having the same letter (s) in a column are not significantly different ($P < 0.05$) according to Duncan's Multiple Range Test.

Legend

CPH_{2.5}- CPH applied at 2.5 kg N.ha⁻¹, CPH_{5.0}- CPH applied at 5 kg N.ha⁻¹,
B1- Broca 1 applied at 26 kg.ha⁻¹; WAT=Weeks after treatment application

The dry matter yield of cocoa seedlings was significantly ($P < 0.05$) improved by the application of CPH with or without Broca 1 compared to control (Table 7). CPH_{5.0} + Broca 1 treatment produced the highest leaf dry matter yield which was significantly different from the control treatment only. The stem dry matter yield of cocoa seedlings was significantly ($P < 0.05$) improved by the application of CPH and Broca 1 and the combination compared to control. The root dry matter yield of cocoa seedlings was significantly ($P < 0.05$) increased by CPH and

Broca 1 fertilizer compared to the control. Only CPH_{5.0}+Broca 1 differed significantly from the control. Ajayi, *et al.* (2007) had observed that CPH ash alone or in combination with mineral fertilizer increased the growth and nutrient uptake of kola seedlings compared to NPK fertilizer alone. The contribution of the test fertilizer (Broca 1) to the total dry matter yield of cocoa seedlings was calculated as 60.87% based on comparison of the total dry matter yields in the control and the test fertilizer applied alone. The comparison of Broca 1 with the highest dry matter yield produced with CPH_{5.0}+Broca 1 shows a contribution of 18.28%. These marked contributions imply that the test fertilizer has potentials and should be considered as the fertilizer to recommend for the production of cocoa seedlings.

Table 7: Influence of ground cocoa pod husk and Broca 1 fertilizer on the leaf dry matter yield of cocoa seedlings in Ibadan, Nigeria

Treatment	Dry matter yield			Fertilizer Contribution (%)
	Leaf	Stem	Root	
Control	2.43b	0.74b	0.74b	-
CPH_{2.5}	3.90ab	1.61a	1.44ab	
CPH_{2.5}+B1	3.13ab	1.39a	1.35ab	
CPH_{5.0}+B1	4.10a	1.52a	1.82a	
CPH_{5.0}	3.21ab	1.23a	1.31ab	
B1	3.36ab	1.51a	1.42ab	60.87

Means having the same letter (s) in a column are not significantly different ($p < 0.05$) according to Duncan Multiple Range Test.

Legend

CPH_{2.5}- CPH applied at 2.5 kg N.ha⁻¹, CPH_{5.0}- CPH applied at 5 kg N.ha⁻¹, B1- Broca 1 applied at 26 kg.ha⁻¹; WAT=Weeks after treatment application \

Conclusions and Recommendations

Broca 1 fertilizer fortified with or without cocoa pod husk improved the growth and dry matter yield of cocoa seedlings compared to the control treatment. Cocoa seedlings that received Broca 1 applied at 26 kg.ha⁻¹ fortified with CPH at 5 kg N.ha⁻¹ were consistently superior in growth performance in terms of height, leaf area and dry matter yield throughout the period of study. Thus, the application of the test fertilizer (Broca

1) with CPH applied at the rate equivalent to 5 kg N.ha⁻¹ would be recommended for cocoa seedling production in Nigeria. Despite Broca 1 being a very promising candidate fertilizer, there is need for further field evaluation to provide the information needed to assist in recommending it for cocoa cultivation in Nigeria.

Acknowledgements

The authors are very appreciative of the technical assistance of Mr J.A. Adebayo of Soils and Plant Nutrition Section, Cocoa Research Institute of Nigeria, Ibadan; and equally thank Dr M.O. Ogunlade for providing the test fertilizer used in this study.

References

- Adenikinju, S.A. (1974). Analysis of growth patterns in cocoa seedlings as influenced by bean maturity. *Experimental Agriculture* 10: 141-147.
- Adeniyi, O.M and Ojeniyi, S.O. (2005).** Effect of poultry manure, NPK 15:15:15 fertilizer and combinations of reduced level on maize growth and their chemical properties. *Nigerian Journal of Soil Science* 15: 34-41.
- Akanbi, O.S.O., Famaye, A.O., Ipinmoroti, R.R., Ibiremo, S.O., Ojeniyi, S.O., Taiwo, N., Adejobi, K.B., Ojewale, E.O. and Oyewusi, I.K. (2012). Evaluation of sole and combined effects of NPK fertilizer, cocoa pod husk and oil palm bunch ash on the growth and dry matter yield of cocoa. *International Journal of Applied Research and Technology* 1(6): 172-177.
- Ajayi, C.A., Awodun, M.A. and Ojeniyi, S.O. (2007). Comparative effect of cocoa pod husk ash and NPK fertilizer on soil and root nutrient content and growth of kola seedlings. *International Journal of Soil Science*; 2: 148-153.
- Ayeni, L.S., Adetunji, M.T., Ojeniyi, S.O., Ewulo, B.S. and Adeyemo, A.J. (2008). Comparative and cumulative effect of cocoa pod husk ash and poultrymanure on soil and maize nutrient contents and yield. *American- Eurasian Journal of Sustainable Agriculture* 2 (1): 92-97.
- Egbe, N.E., Ayodele, E.A. and Obatolu, C.R. (1989). Soils and nutrition of cacao, coffee, kola, cashew and tea. *Progress in Tree Crops Research*. 28-38.
- Folayan, J.A, Daramola, G.A. and Oguntade, A.E. (2006). Structure and performance evaluation of cocoa marketing institutions in SouthWestern Nigeria: An economic analysis. *Journal of Food, Agriculture and Environment*. 4: 123-128
- Francois, R. and Serge, B. (2012). Cocoa and Fertilizers in West Africa. CIRAD UMR Innovation.: 1-5. Complete Study on <http://www.idhsustainabletrade.com/cacao-fertilizer-use>
- Gee, G.W. and Bauder, J.W. (1986). Particle size analysis. In: Klute A. (Ed.) *Methods of Soil Analysis, Part 1*. American Society of Agronomy, Madison W.I. 9: 91-100.
- Ibiremo, O.S. (2010). Effect of organic fertilizer fortified with phosphate fertilizers and arbuscular mycorrhizal fungi inoculation on the growth of cashew in two ecologies in Nigeria. *Journal of Agricultural Science* 1 (2): 101-107

- Ibiremo, O.S., Daniel, M.A., Iremiren, G.O. and Fagbola, O. (2011). Soil fertility evaluation for cocoa production in south-eastern Adamawa State, Nigeria. *World Journal of Agricultural Sciences* 7 (2): 218-223).
- Ibiremo O.S., Ogunlade, M.O., Oyetunji, O.J. and Adewale, B.D. (2012). Dry matter yield and nutrient uptake of cashew seedlings as influenced by arbuscular mycorrhizal inoculation, organic and inorganic fertilizers in two soils in Nigeria. *Journal of Agricultural and Biological Sciences*. 7 (3): 196-205
- Ibiremo, O.S., Akanbi O.S.O., Oloyede, A.A. and Adewale, B.D. (2014). Comparative evaluation of NPK fertilizer sources on the growth and yield of cocoa in Ibadan, Nigeria. *World Journal of Biology and Biological Sciences* 2(3): 062-066
- Igwe, C.A., Zarei, M. and Stahr, K. (2005). Mineral and elemental distribution in soils formed on the River Niger flood plain, Eastern Nigeria. *Australian Journal of Soil Research* 43: 147-158.
- IITA (1982). Automated and Semi-automated Methods for Soil and Plant Analysis. Manual Series No 7, International Institute of Tropical Agriculture, Ibadan, Nigeria. 33pp.
- Odedina, S.A., Odedina, J.N., Ayeni, S.O., Arowojolu, S.A.A., Adeyeye, S.D. and Ojeniyi, S.O. (2003). Effect of types of ash on soil fertility nutrient availability and yield of tomato and pepper. *Nigerian Journal of Soil Science* 13: 61-62.
- Ogunlade, M.O., Oluyole, K.A and Aikpokpodion, P.O. (2009). An evaluation of the level of fertilizer utilization for cocoa production in Nigeria. *Journal of Human Ecology* 25(3): 175-178
- Oladokun, M.A.O. (1986). The use of cocoa pod husk as fertilizer for maize production in Nigeria. *Nigerian Journal of Agronomy* 1: 103-109.
- Ogunwale, J.A and Udo, E.J. (1990). A Laboratory Manual for Soil and Plant Analysis. Agronomy Department, University of Ibadan, Ibadan. : 201-206.
- Tejeda, M., Gareia, C., Gonzalez, J.L. and Hernandez, M.T. (2006). Organic amendment based on fresh and composted beet vinasse: Influence on physical chemical and biological properties and wheat yield. *Soil Science Society of America Journal* 70: 900-908.
- Wessel, M. (1971). Fertilizer Requirements of Cocoa (*Theobroma cacao* L) in South-western Nigeria. Communication 61, London: Department of Agriculture and Natural Resources, Royal Tropical Institute.

Efficiency and Profitability of Sawn Wood Marketing in Ondo State, Nigeria

O. V. Oyerinde,

Department of Forestry and Wood Technology,
Federal University of Technology, Akure, Nigeria.

Email: ovoyerinde@futa.edu.ng

Abstract

The study was carried out to assess the marketing efficiency and profitability of sawn wood in three purposively selected Local Government Areas (LGAs) of Ondo State, Nigeria. The study covered seven wood markets across the 3 selected LGAs. *Primary data were collected with the aid of well-structured questionnaire administered on 105 randomly selected sawn wood marketers.* Data collected on demographic characteristics of the sawn wood marketers, annual income generation, annual variable costs etc. *were analyzed using descriptive statistics, gross margin and marketing efficiency.* The results indicate that the market was dominated by literate married women who obtained credit mainly from personal savings. The market was characterized by many buyers and sellers reflecting a pure competitive structure such that prices were determined by purchase price, supply and demand forces and cost of transportation. Market associations existed among the marketers and to which 85.7% of them belong. *The marketing challenges include:* inadequacy of logs for processing in sawmills, high *transportation cost, insufficient shed in the market squares,* inadequate credit facilities and mischievous act of the task force and timber contractors. *Majority (83.8%) of the marketers used hired vehicles to transport products.* Sawn wood marketing is profitable and efficient. Terere Market had the highest annual gross margin (₦807,000) and efficiency of 1.91 while Owo Central Market had the least gross margin (₦459, 000) and efficiency (1.73).

Keywords: Sawn wood, marketing, gross margin, marketing efficiency, Nigeria

Introduction

Forests offer a variety of products among which wood is the most prominent. Wood is the versatile basic raw material used as timber, fuel wood, plywood, pulp and paper by numerous labour intensive industries like sawmills, plywood and veneer (FAO, 2004). Sawmills account for 93.32% of the total number of wood based industries in Nigeria (Fuwape, 2001). In sawmills, logs are sawn into planks of different sizes for distribution and marketing locally in designated sawn wood markets and sawmills.

Sawn wood represents about 56% of the log output from the sawmills in different parts of Nigeria (Fuwape, 1989). Timber is derived from round logs through conversion operation is carried in the sawmill industries. The derivation of timbers from logs and its processing into final products require various activities that involve middlemen who buys from the producer or wholesaler (forest owners or government) and sell to the retailers and finally to the consumers. Sometimes the sawmill owners function as wholesalers while the retailers buy processed wood and sell to the final consumers. These

activities culminate into what constitutes wood marketing.

Sawn wood is used for various purposes throughout Nigeria and its prices are fundamental pre-requisite for socio-economic development of the country (Aiyelaja *et al.*, 2013). Several thousands of households in Nigeria derive income from forest-based micro enterprises such as carpentry and furniture production which rely on sawn wood as raw material (Onefeli, 2011). Sawn wood marketing sustains the livelihoods of several thousands of households in Nigeria through all the activities that enable it to flow from the producer to the consumer.

Timber trade accounts for a large proportion of total agricultural share of international economics which contributes to socio-economic development (Toledo, 2006). Although, the market price of sawn wood is subject to regular fluctuations due to general ban on exploitation of timber species. The price varies from one location to another and also from one season to another. Locally, sawn wood

processing and marketing contribute to livelihood sustainability through employment and cash income in the rural and urban communities in Nigeria (Aiyeloja *et al.*, 2013). Wood marketing has engaged a high number of the urban and rural populace with varying degrees of involvement and resource status (Sambe *et al.* 2016). The level of participation in wood marketing even defies gender bias as both sexes are found at every stage of the processes involved perhaps as a measure of the lucrateness of the business. Therefore, this study seeks to examine the socio-economic characteristics of sawn wood marketers in the study area, evaluate the efficiency of sawn wood marketing, carry out a cost and return analysis for determining the profitability of sawn wood business and also identify the constraints militating against sawn wood business.

Methodology Study area

The study was carried out in Ondo State of Nigeria which lies between longitude 4°30' and 6°E and latitude 5°45' and 8°15'N that enjoys distinct rainy season (March -October) and dry season (November-March). The annual rainfall of 1,515-2,000 mm and high atmospheric humidity produce a humid to sub-humid agro-ecological zone characterised by lowland and dry forest vegetation dominated by tall tree species. There are forest reserves located at Oluwa, Ogbese, Owo, Akure and Ipele. The presence of trees in the state has stimulated the development of several sawmills and sawn wood markets that deal in species which include: *Lophira alata*, *Azizelia africana*, *Melicia excelsa*, *Khaya ivorensis*, *Terminalia superba*, *Ceiba pentandra*, *etc.*

Data collection

Purposive sampling technique was adopted in the selection of three Local Government Areas (LGAs) of Ondo State: Akure South, Owo and Akoko North-East. Seven sawn wood markets with large number of sawn timber marketers were selected from the 3 LGAs headquarters: Akure, Owo, and Ikare-Akoko respectively. Four sawn wood markets

were chosen from Akure, two from Ikare-Akoko and one from Owo, based on the level of sawn wood marketing activities in the area. The selected markets were Aje Igboro, Road Block, Oke Aro, Oke Ijebu in Akure, Terere and SevenSeven in Ikare-Akoko (77) and Owo Central Market in Owo. Ten percent of the marketers in markets visited was interviewed based on information from a pre-survey conducted to obtain the list of marketers which served as the sampling frame. Key informants in each market assisted during the data collection. Sixty (60) copies of the questionnaire were administered in Akure, 15 in Owo and 30 in Ikare-Akoko. Information about the age, household size and their experience in the business, source of capital for the business, mode of transportation, cost items, pricing and problems facing the marketing of sawn wood were collected.

Data analysis

Data obtained were analysed using simple statistical analysis of frequencies, percentages and averages. Gross margin analysis was used to determine the profitability of the trade vis-à-vis cost and return analysis.

Gross margin = Total Average Revenue – Total Variable Cost (1)

Marketing efficiency refers to maximization of the ratio of output in marketing. This study adopted the technique of Olukosi and Isitor (2005) for determining marketing efficiency as shown in equation 2:

Marketing Efficiency = Total Revenue/ Cost of Marketing (2)

Total Revenue = Gross Income

Cost of Marketing = (Transportation, taxes, association dues, loading and offloading, and gifts).

Results and Discussion Socio-demographic characteristics of the respondents

Table 1 shows the socio-demographic characteristics of the respondents. Most of the sawn wood marketers (82%) were females. The gender profile makes the marketing of sawn wood female-dominated which contradicts the findings of Alfred and Akintade (2002) that sawn

wood marketing was male-dominated. Also, Aiyeloja *et al.* (2013) had observed that the males constituted 100% of the sawn wood marketers in Port Harcourt, Nigeria. The respondents were mainly between 40-49 years old (42.9%) followed by 30-39 years of age (35.2%) which means that 78.1% of the sawn wood marketers falls within the age bracket of 30 and 49 years. This agrees with Izeke and Izeke (2011), Aina *et al.*, (2012) and Aiyeloja *et al.*, (2013) that most of the people involved in sawn wood marketing activities were of average age who are vibrant, energetic and can positively influence marketing. The respondents were mainly married (76.2%) while the single respondents accounted for 13.3%. The married ones are likely to be more serious about the business because of their financial needs to feed, train the children and take care of the family (Mafimisebi *et al.*, 2000). Since the households of the respondents depend on wood marketing for their livelihood, greater commitment to the market conduct is expected in the study area. The household size of the marketers ranged from 1-5, 6-10 and above 10 persons at 38.1,

58.1 and 3.8% respectively. The marketers with medium (6-10) to large (above 10) sizes are more likely to devote a larger percentage of their profits to household welfare and would be expected to have lower capacity for savings (Alfred and Akintade, 2002). All the respondents were literate with 23, 64.4 and 12.6% attaining primary, secondary and tertiary education respectively. The implication is that the level of education would make the respondents have reasonable trading experience to manage their business effectively. The level of education attained not only increases productivity but also enhances the ability to understand and adopt methods of operations (Sambe *et al.*, 2016). Aiyeloja *et al.* (2013) also obtained similar results but differed from Alfred and Akintade (2002) who observed that wood marketers were mainly illiterates. The level of literacy will enable them to access market information on price variation and changes circulated to the sellers. In addition, they could easily adopt new innovations and also help in communication and effective projection of the enterprise

Table 1: Socio-demographic characteristics of the respondents

Variables	Categories	Frequency	%
Sex	Male	19	18
	Female	86	82
Age (years)	Less than 30	12	11.4
	30-39	37	35.2
	40-59	45	42.9
	50-59	8	7.6
	Above 60	3	2.9
Marital status	Single	14	13.3
	Married	80	76.2
	Divorced	5	4.8
	Widow/widower	6	5.7
Household size	1-5	40	38.1
	6-10	61	58.1
	Above 10	4	3.8
Highest educational qualification	No formal education	0	0
	Primary school certificate	24	23
	Secondary school certificate	68	64.4
	Tertiary education	13	12.6
Years of experience	1-5	24	22.9
	6-10	52	49.5
	Above 10	29	27.6

Source: Computed from field data, 2013

Majority of the marketers (49.5%) had 6-10 years of experience in the business while 27.6% had above 10 years. The increase in marketing experience helps marketers adapt to new positively marketing strategies (Benjamin and Victoria, 2012). It will also promote efficient marketing, especially on how to minimize cost.

Marketing activities

Table 2 shows that 90.5% of the respondents were wholesaler/retailers and 9.5% were retailers. Sawn wood business, apart from being run throughout the year, still gave most of the respondents time to engage in some secondary occupation. Majority of them (42.9%) engaged in farming, 30.5% engaged in other secondary occupations (tailoring, petty trading etc.) while only 26.7% had no secondary occupation. Logs are relatively scarce during the wet season due to the problems encountered in extraction and evacuation of round logs from the forest such that commercial farming is embarked upon to whirl away the time and to generate some revenue.

Table 3 shows that majority (51.4%) of the marketers earned ₦30,000-39,000 as monthly income, 28.6% earned ₦40,000-49,000, 11.4% earned ₦50,000-59,000, 4.8% earned less than

₦20,000 while 3.8% earned above ₦60,000. Table 4 shows that most of the respondents (83.8%) used hired trucks to transport goods from the sawmill to the sale depots, 11.4% used both hired and owned vehicles while only 4.8% used owned vehicles. This agrees with the findings of Alfred and Akintade (2002). It is expected that sellers who used owned-vehicles would maximize profit more than those who used hired vehicles. The use of hired vehicles has effect of increasing cost most of which would be passed on to the consumers. Also, majority of the marketers were wholesalers/retailers who preferred selling to both the retailers and consumers probably to maximize profit.

Pricing system of the sawn wood markets

Most of the respondents (85.7%) belonged to the Sawn Wood Marketers' Association to derive the benefits which include: unity in decision making, market control and supervision by all members of the association. They also gain recognition, cordial relationship and peaceful co-existence among members. Being a member of the association will help to have a stake in the activities going on in the sawn wood business and also give them the chance to express their views to the government in a unified voice. Some did not join the association (14.3%) due to lack of trust in the goals of such association.

Table 2: Categories of sawn wood marketers

Category	Frequency	%
Wholesaler	0	0
Retailer	10	9.5
Wholesaler/retailer	95	90.5
Total	105	100

Source: Computed from Field Survey, 2013.

Table 3: Average monthly income (Naira) of the wood marketers

Average monthly income (Naira)	Frequency	%
Less than 20,000	5	4.8
30,000-39,000	54	51.4
40,000-49,000	30	28.6
50,000-59,000	12	11.4
Above 60,000	4	3.8
Total	105	100

Source: Computed from Field Survey, 2013.

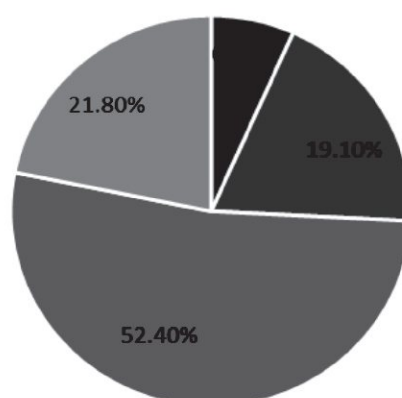
Table 4: Mode of transportation of sawn wood

Variables	Frequency	%
Hired trucks	88	83.8
Owned/ Hired trucks	12	11.4
Owned trucks	5	4.8
Total	105	100

Source: Computed from Field Survey, 2013.

Majority of the respondents (52.4%) sourced money (working capital) through personal savings, 21.9% sought for credit from Thrift/Co-operative Societies, 19.1% from friends/relatives while 6.7% sought from banks (Fig. 1). It is expected that the required input to attain marketing efficiency would be available if credits were obtained from dependable sources (banks and cooperative societies) but the respondents solely depended on personal savings probably due to high lending rates and the lack of collaterals required to acquire bank loans and exploitation in the form of interest by the co-operative societies.

The market structure for the sawn wood market was pure competition implying the existence of many buyers and sellers. Popoola *et al.* (2001) observed that the trade barriers to entry and exit to the forest products business were not as stringent as to critically affect the conduct of the market. Standard dimensions and grades are one of the factors affecting the conduct of the sawn timber market. According to Popoola *et al.* (2001), there were price differentials of forest products even within the same market and for no rational economic reasons or price decisions. This study, however, showed that the pricing policy in the study area was virtually the same for all the dimensions and grades of sawn timber.



■ Bank loan ■ Friends/Relatives ■ Personal savings ■ Thrift/cooperative societies

Figure 1: Sources of capital for the business

The results in Table 5 show that about 85.7% of the marketers determined their prices mainly by purchase price while 82.2% agreed that transportation cost was also a determinant; 51.4 and 50.5% of the marketers stated that the prices were determined by the seasonality and quantity purchased by buyers respectively while only 19.1% claimed that prices were determined by the quantity supplied. This indicates that supply and demand forces were major determinants of price in which the

consumer's bargaining power was not important. These results imply that price may not vary from marketer to marketer since the ability of a buyer to negotiate was not a determinant of price in the market. Majority of the respondents agreed that they used both open display (91.4%) and persuasive efforts (87.6%) to attract customers. There were no specific sharp practices identified in the markets.

Table 5: Pricing system of the sawn wood markets

Variables	Categories	Frequency	%
Price determination	Purchase price	90	85.7
	Transportation cost	86	82.2
	Seasonality	54	51.4
	Quantity purchase by customer	53	50.5
	Quantity supplied	20	19.1
	Consumer bargaining power	5	4.8
Advertisement Strategy	Open display	96	91.4
	Persuasive efforts	92	87.6

Source: Computed from Field Survey, 2013.

Market margin and efficiency analysis

Table 6 shows the market margin and efficiency analysis of the sawn wood markets in the study area. Sawn wood marketers in Terere market recorded the highest market margin of ₦807,000 while those in Owo recorded the lowest of ₦459,000. Profitability of an enterprise determines to what extent it can retain the practitioners because people go into a particular business to make profit. An enterprise is profitable when the gross receipts exceed costs. Each market recorded profit, which makes sawn wood marketing a highly profitable enterprise in the study area. With this high level of profitability, the accruable income becomes handy to sustain the household needs of food, shelter and children education.

The marketing efficiency for Terere, SevenSeven, Aje Igboro, Oke Ijebu, Road Block, Oke Aro and Owo Central market was 1.91, 1.90, 1.86, 1.85, 1.80, 1.76 and 1.73 respectively. The individual values exceed 1.0

and indicate that sawn timber marketing is efficient. Terere market was the most efficient (1.91) with every ₦1 invested in the business returning ₦0.91 as profit. This finding agrees with Kudi *et al.* (2006) and Kola-Oladiji *et al.* (2006) on the marketing margins and efficiency of agricultural and forestry products. A study on sawn wood marketing in Edo State, Nigeria showed the marketing efficiencies greater than 1 for all the selected markets (Izekor and Izekor, 2011). Grading increased the pricing and technological efficiency of sawn wood marketing as it improved market knowledge about price, reduce cost and improved quality.

However, the achievement of the sawn wood marketers was attained despite some constraints such as inadequacy of timber trees in the forest, mischievous behaviours on the part of members of the Task Force on Revenue from Forest Resources and timber contractors, inadequate credit facilities and high cost of transportation.

Table 6: Market margin and efficiency analysis of the sawn wood markets

Location	Total Gross Income (₦)	Total Variable Cost (₦)	Total Gross Margin (₦)	Market Efficiency
Akure				
1. Aje Igboro	1,591,000	853,000	738,000	1.86
2. Road Block	1,368,669	758,000	610,669	1.80
3. Oke Aro	1,390,000	788,000	602,000	1.76
4. Oke Ijebu	1,200,000	650,000	550,000	1.85
Ikare Akoko				

5. Terere	1,690,500	883,500	807,000	1.91
6. SevenSeven (77)	1,561,500	821,250	740,250	1.90
Owo				
7. Owo Central Market	1,091,000	632,000	459,000	1.73

Source: Computed from Field Survey, 2013.

Conclusion

Sawn wood marketing in the study area was dominated by married and literate women who as wholesalers/retailers sourced working capital mainly from personal savings. Most respondents belonged to the Sawn Wood Marketers' Association but engaged in other secondary occupations especially during the wet season. The market performance was effective and profitable based on the gross margin analysis and assessment of marketing efficiency. The identified constraints of the business were:

inadequacy of timber species in the forests, high transportation cost, inadequate credit facilities, mischievous behaviours of members of the Task Force and the timber contractors. As a solution to inadequacy of timber trees, more efforts of stakeholders are needed in regeneration and afforestation programmes, The Task Force on Revenue from Forest Resources should be advised to perform the duties officially and not to extort money from the marketers. The sawn wood marketers should be encouraged to form thrift/cooperatives societies to improve access to adequate credit facilities for members

References Aina, O.S., Ajilola, S., Bappah, M.T., Ibrahim, I. and Musa, I.A. (2012). Economic analysis of plantain marketing in Odigbo Local Government Area of Ondo State, Nigeria. *Global Advanced Research Journal of Agricultural Science* 1(5): 104-109.

Aiyelaja, A.A., Oladele, A.T. and Furo, S.B. (2013). Sustaining livelihood through sawn wood marketing in Port Harcourt, Nigeria. *International Journal of Science and Nature* 4(1): 84-89.

Alfred, S.D.Y. and Akintade, S.S. (2002): Factors influencing marketing and profitability of wood in Akure South Local Government Area of Ondo State, Nigeria. *Journal of Agriculture, Forestry and Fisheries*. 4: 5-8.

Benjamin, C.A. and Victoria, A.O. (2012). Marketing of agricultural produce among rural farm households in Nigeria: The case of sorghum marketing in Benue State. *International Journal of Business and Science*, 3(13): 92 - 97.

FAO. (2004). Reduced Impact Logging in Tropical Forests. Literature Synthesis,

Analysis and Prototype Statistical Framework. Forest Harvesting and Engineering Working Paper No.1. Food and Agriculture Organization of the United Nations, Rome, Italy. 148pp.

Fuwape, J.A. (1989). An assessment of wood conversion efficiency in some sawmills in Ondo State. *Nigerian Journal of Forestry*. 20(2): 44-48

Fuwape, J.A. (2001). The impact of forest industry and wood utilization on the environment *Journal of Tropical Forest Resource*. 17(2): 78-90

Izekor, D.N. and Izekor, O.B. (2011). Analysis of sawn timber enterprise in Benin metropolis, Edo State, Nigeria. *Nigerian Journal of Agriculture, Food and Environment*. 7(2): 19-23.

Kola-Oladiji, K.I., Adesope, A.A. and Adio, A.F. (2006). Profitability of marketing African bread fruit (*Treculia africana* Decne) in Ibadan metropolis. *Journal of Agriculture, Forestry and the Social Sciences* 4(1): 44-50

Kudi, T.M., Olukosi, J.O. and Ogungbile, A.O. (2006). Economic analysis of sesame

- marketing in Jigawa State, Nigeria. *Journal of Agriculture, Forestry and the Social Sciences* 4(1):22-31.
- Mafimisebi, T.E., Okunmadewa, I.Y. and Adebayo, S.K. (2000). Structure conduct and performance of sun-dried meat trade in Ibadan metropolis. *Journal of Technology and Education in Nigeria* 5 (1 &2): 68-75.
- Olukosi, J.O, and Isitor, S.U. (2005). Introduction to Agricultural Marketing Prices: Principles and Applications. 3rd edition. Living Book Series GU publications Abuja, Nigeria, 247pp.
- Onefeli, A.O. (2011). Forest contributions to rural livelihood and threats to their sustainability in Nigeria. In: Popoola, L., Ogunsanwo, O.Y. and Idumah, F. (Eds): Forestry in the Context of the Millennium Development Goals, Proceedings of the 34th Annual Conference FAN, Osogbo, Nigeria, 5-10 Dec., 2011. 270-276.
- Popoola, L. Rahji, M.A.Y. and Adesoye, P.O. (2001) Analyses of spatial and temporal variations in prices of some sawnwood in south western Nigeria. *Ghana Journal of Forestry* 10: 32-41.
- Sambe, L.N., Tee N.T. and Dagba, B.I. (2016). Analysis of timber market structure and efficiency in Benue State, Nigeria. *British Journal of Economics, Management and Trade* 15(1): 1-9.
- Toledo, D. (2006). Developing a sustainable trade. *ITTO Tropical Forest Update* 16(3): 15-17.

Granitic Soils of Ikole: Properties, Classification, Genesis, Agricultural Potentials and Sustainable Management

K.S. Ogunleye, A.S. Fasina, O.J. Omoju, D.A. Oluwadare, A.K. Oluleye, U.O. Ogbonnaya

*Department of Soil Science and Land Resources Management,
Faculty of Agriculture,
Federal University, P.M.B. 373, Oye Ekiti, Ekiti State, Nigeria
E-mail: kayode.ogunleye@fuoye.edu.ng*

Abstract

The sustainable use of soils requires in-depth knowledge of their genesis and properties. The soils derived from granitic parent rocks in Ikole-Ekiti, south-western Nigeria, covering 380 hectares of land, were mapped at a scale of 1:50,000 using conventional and remote sensing methods of soil survey to generate detailed information on the genesis and properties of the soils for their sustainable agricultural use and management. Seven soils were identified and classified. Four of the soils (IK1, IK2, IK3, and IK5) were Typic Plinthiudults, IK4 was classified as Kandic Plinthaquult while IK6 was a Plinthic Kandiuult and IK7 a Fluvaquentic Epiaquept. Using the FAO/UNESCO criteria, the soils were classified as Dystric Lixisol (IK1, IK2, IK3, and IK5), Ferric Lixisol (IK4), Plinthidic Lixisol (IK6) and Fluvisol (IK7). The dominant processes which influenced soil genesis within the study area include hydrolyte weathering, lessivation, plinthization, pedoturbation, episaturation, induration, braunification, erosion and colluvial deposition. The evaluation of the soils into suitability classes shows that the potentials for sustainable agricultural production are limited by natural features (slope and erosion). The recommendations for sustainable use and management of these soils include careful land development strategies, rotations involving legumes and cover crops and judicious use of organic materials, lime and fertilizers.

Keywords: Soil properties, granitic parent material, classification, genesis, sustainable management.

Introduction

Soil characterization provides the information needed for understanding the physical, chemical and mineralogical and microbiological properties of the soils we depend on to grow crops sustain forests and grassland as well as support homes and society structures (Ogunkunle, 2004). Amusan and Ashaye (1991) suggested that a consideration of the interaction of episodic landscape erosion and pedogenesis was required to explain soil genesis. In the basement complex area, there is a strong relationship between topographic position and soil genesis (Moorman, 1981). Previous efforts at understanding the genesis, chemical and mineralogical properties of soils formed on the basement complex have been fairly documented and showed that landscape position influences run off, drainage and soil erosion (Shobayo et al., 2013, Fasina, et al., 2015).

Agricultural sustainability requires the

characterization and evaluation of soils. These are important in understanding the factors which impose constraints to increased crop production under different land use types and for the adoption of suitable land management practices. Sharuet *al.* (2013) reported that coupling of soil characterization and classification provides a powerful resource for benefit of mankind especially in the area of food security and environmental sustainability. Also, Lekwaet *al.* (2004) reiterated that soil characterization provides the basic information necessary to create functional soil classification schemes and assess soil fertility in order to unravel some unique soil problems in an ecosystem. The effects of the composition of soil parent materials on pedogenesis processes have long been recognized. Therefore, this study was conducted to examine the properties, genesis, agricultural potentials and sustainable management of granitic soils located on different land use types in Ikole-Ekiti, Southwestern

Nigeria.

Materials and Methods

The location of the study area is Ikole-Ekiti in Ikole Local Government Area of Ekiti State, Nigeria. The GPS statement for the study sites (seven land uses) are as follows: Cashew (07° 48.196'N, 005° 29.796'E), *Gmelina* (07° 48.268'N, 005° 29.756'E), Fisheries (07° 48.306'N, 005° 29.566'E), Oil palm (07° 48.404'N, 005° 29.506'E), Banana (07° 48.456'N, 005° 29.508'E), Lowland (07° 48.405'N, 005° 29.414'E) and Fallow (07° 48.357'N, 005° 29.722'E). The survey area falls within the dry rainforest vegetation zone while the parent rocks belong to the basement complex rocks especially granite gneisses.

The study was conducted between February and June 2015. A combination of the conventional method of soil survey (rigid grid) and remote sensing was used. Digital data on landform model using the ASTER 30meter Resolution Digital Elevation Model (DEM) were projected to Universal Transverse Mercator (UTM) World Geodetic System (WGS) 84. The digital landscape data used were from the Vegetation and Land Use Project of Forestry Monitoring and Valuation and Coordinating Unit of the Federal Ministry of Environment. Digital geologic data were derived from the maps of the Geological Survey of Nigeria. Provisional photo-soil maps were obtained when the land form/land use and geology vector GIS layers were loaded into ArcGIS 10 and the spatial proximity function intersect was used to spatially merge the three into one layer. In this way, every single polygon has defined land-use

geology and landform data. The provisional soil photo maps were then taken to the field for detailed soil survey using rigid grid method in selected sampling sites and extrapolated for the whole study area. Soils with similar characteristics were grouped together as a mapping unit. Seven soil mapping units were identified and a profile pit was located and dug to represent each unit. The soil profiles were described and major diagnostic horizons were identified using the major morphological properties of soil colour, texture, structure, consistence, stoniness, mottles, cutans, and concretions. Soil samples collected from each horizon for analysis.

The samples were air-dried, sieved (<2mm) and analyzed for pH (in water), particle size distribution, organic carbon and total nitrogen (N) contents, available phosphorus (P), exchangeable cations (potassium, K; sodium, Na, calcium, Ca and magnesium, Mg) and exchangeable acidity following the methods described in Udo *et al.* (2009).

The representative profiles in the soil units were classified using the morphological properties and laboratory analysis data based on the criteria in the FAO/UNESCO (2014) and USDA (2014) classification systems. The agricultural potentials of the soil units were assessed using Land Capability Classification (LCC) as modified by USDA (Klingebiel and Montgomery, 1961).

Results

Morphological and physical properties

Seven soil mapping units were identified in the study area and denoted by IK1, IK2, IK3, IK4,

Table 1: Morphological Properties of the Soils of Ikole, Southwestern Nigeria
IK1

Horizon	Depth (cm)	Colour (dry)	Texture	Structure	Consistence	Concretions	Drainage	Mottles	Roots
A1	0 – 16	7.5YR 3/4	SCL	Mcsab	SL-st	A	Well drained	-	Ff
B21t	16 – 40	7.5YR5 /6	SC	Mcsab	Vst	MFe-Mn	“	-	Ff
B22t	40 – 63	7.5YR5 /8	C	Mcsab	Vst	Mfe-Mn	“	M	“
B23t	63 – 88	7.5YR5 /8	C	Mcsab	Vst	Ffe-Mn	“	Mp	“
B24t	88 – 150	5YR4/6	C	Mcsab	Vst	-	“	Fe	

IK 2

Horizon	Depth (cm)	Colour (dry)	Texture	Structure	Consistence	Concretions	Drainage	Mottles	Roots
A1	0 – 24	10YR4 /2	SCL	Mcsab	SL-st	MFe-Mn	Well drained	Mp	FFW
B21t	24 – 45	10YR7 /6	C	Mcsab	Vst	MFe-Mn	“	Mp	“
B22t	45 – 59	10YR7 /6	C	Mcsab	Vst	Mfe-Mn	“	-	“
B23t	59 – 79	10YR6 /8	C	Mcsab	Vst	MFe-Mn	“	Mp	“
B24t	79 – 120	10YR6 /8	SC	Mcsab	Vst	MFe-Mn	“	Mp	“

Highly concretionary from the top to the subsoil with evidence of structures at 45 – 59cm

Ik3

Horizon	Depth (cm)	Colour (dry)	Texture	Structure	Consistence	Concretions	Drainage	Mottles	Roots
A1	0 – 12	2.5YR4 /3	SCL	Mcsab	SL-st	Ffe-Mn	Well drained	-	Ff
A11	12 – 23	7.5YR4 /2	SL	Wccr	Ns	Ffe-Mn	“	-	Ff
B21t	23 – 43	10YR5/6	SCL	Mcsab	SL-st	Ffe-Mn	“	-	Ff
B22t	43 – 80	7.5YR6 /8	C	Mcsab	Vst	Ffe-Mn	“	Mcf (redish)	Ff
B23t	118 – 130	5YR5/8	C	Mcsab	Vst	-	“	-	-

IK 4

Horizon	Depth (cm)	Colour (dry)	Texture	Structure	Consistence	Concretions	Drainage	Mottles	Roots
A1	0 – 23	10YR4 /4	SCL	Mcsab	SL-st	-	Imperfectly well drained	ff	FFW
B21t	23 – 49	10YR5 /4	SCL	Mcsab	SL-st	MFe-Mn	“	ff	Mfw
A11	49 – 99	10YR7 /4	SCL	Mcsab	SL-st	-	“	Mcp (Yellowish)	Ff
B22t	99 – 118	2.5YR 7/6	SC	Mcsab	Vst	MFe-Mn	“	Mcp (Yellowish)	-
B23t	118 – 130	2.5YR 6/8	SCL	Mcsab	SL-st	-	“	Mcp (Yellowish)	-

Evidence of saprolytes

IK 5

Horizon	Depth (cm)	Colour (dry)	Texture	Structure	Consistence	Concretions	Drainage	Mottles	Roots
A1	0 – 25	10YR5/3	SCL	Mcsab	SL-st	-	Well drained	-	FFW
B21t	25 – 43	7.5YR4/2	SCL	Mcsab	SL-st	Ffe-Mn	“	Ff (reddish)	FFW
B21t	43 – 95	2.5YR7/4	SCL	Mcsab	SL-st	Mfe-Mn	“	Mcp (Reddish)	Ff
B22t	95 – 140	5YR5/8	C	Mcsab	Vst	MFe-Mn	“	Mcp (Reddish)	-

IK 6

Horizon	Depth (cm)	Colour (dry)	Texture	Structure	Consistence	Inclusive Concretions	Drainage	Mottles	Roots
A1	0 – 23	10YR4/2	SCL	Mcsab	SL-st	Ffe-Mn	Well drained	-	FFW
B21t	38 – 64	10YR6/4	SCL	Mcsab	SL-st	MFe-Mn	“	-	-
B21t	64 – 104	10YR7/4	SCL	Mcsab	SL-st	-	“	-	-
B22t	104 – 150	2.5YR6/4	C	Mcsab	Vst	MFe-Mn	“	Fu (Yellowish)	-

IK 7

Horizon	Depth (cm)	Colour (dry)	Texture	Structure	Consistence	Concretions	Drainage	Mottles	Roots
A1	0 – 6	10YR4/2	SCL	Mcsab	SL-st	-	Poorly	-	Mf
B21t	6 – 48	10YR5/1	SCL	Mcsab	SL-st	-	Poorly	Md (Yellowish red)	Mf
B21t	48 – 70	10YR4/3	SCL	Mcsab	SL-st	-	Poorly	-	-
B21t	70 – 80	10YR5/1	SCL	Mcsab	SL-st	-	Poorly	Fff (Reddish)	-

Key:

Structure: Mcsab = Medium coarse sub angular blocky; Wcc= Weak, coarse, crumb

Texture: LS = Loamy sand; SL = Sandy loam; SCL = Sandy clay loam; SC = Sandy clay; CL = Clay loam; S = Sand

Consistence: SL-St = Slightly sticky; Ns = non-sticky; Vst = Very sticky

Roots: Mfw = Many fibrous and woody; ff = few fibrous; Mf = many fibrous;

Ff = few fibrous; Ffw; few fibrous and woody;

Soil Unit IK1: The unit occupies the upper slope and the soils are deep, well drained, dark brown (7.5YR 3/4 dry) colour with sandy clay loam texture overlaying yellowish red (5YR 4/6 dry) clay subsoil and with moderate coarse sub-angular blocky structure throughout the profile. There was evidence of clay wash and deposition throughout the profile with the subsoil clay as high as 51.2%. Iron (Fe)-manganese (Mn) concretions were encountered at 40cm and downwards. Soil pH ranged from 4.77 on the surface to 4.42 in the subsoil. Soils of this unit contain low organic matter, total N and available P. The bulk density decreased somewhat with depth while porosity and moisture content increased

Soil Unit IK2: The unit was located on fallow and occupied the upper slope. It contains soils that are deep, well drained with sandy clay loam on the surface overlying clay/sandy clay subsoil. The soil colour ranged from dark-greyish brown (10YR 4/2) on top to brownish yellow (10YR 6/8) subsoil. The structural aggregates are moderate and the soil has many Fe-Mn concretions throughout the soil profile. The soil is weakly acidic (pH = 5.96) in the top soil and acidic (pH = 4.27) in the subsoil. The bulk density increased with depth to maximum value at 45-59 cm depth and decreased to values that exceeded those at 0-24 cm. The porosity decreased while moisture content increased but the least value was at 45-59 cm. The soils are low in cation exchange capacity, total N, organic matter and basic cations (Ca, Mg and K) while available P was 29.57 mg.kg⁻¹ on the surface and decreased for the rest of the profile.

Soil Unit IK3: The unit occupies the undulating middle slope positions of the landscape and contains deep soils which have few Fe-Mn concretions throughout the soil profile while many coarse reddish mottles were encountered at 80cm. The soil was strongly acidic (pH=5.2) in the layer and acidic (pH=4.86) in the subsoil and has low cation

exchangeable bases (Ca, Mg and K), total N and available P.

Soil Unit IK4: The unit occupies the middle to lower slope position on the landscape and consists of deep and imperfectly-drained soils with surface layer colour of dark yellowish brown (10YR4/4, dry) to olive yellow (2.5Y6/8, dry). The soil is a sandy clay loam with moderate coarse sub angular structure throughout the profile but many iron-manganese concretions were encountered at 49cm and 118cm depth while the numerous reddish and yellowish mottles encountered throughout the profile indicates apolytes. The soil pH ranged from 4.87 on the surface layer to 3.9 in the subsoil. The soil contains low exchangeable bases (Ca, Mg and K), organic matter, total N and available P.

Soil Unit IK5: The soil unit occupies the undulating middle slope position of the landscape and contains deep and well-drained soils which have sandy clay loam surfaces overlying clay in the subsoil. The soil colour is brown (10YR 5/3, dry) on the surface and yellowish red (5YR 5/8) in the subsoil and with has moderate, medium sub-angular blocky structure throughout the profile. Numerous Fe-Mn concretions were encountered from 43 cm while many coarse, prominent reddish mottles were found within the soil profile. The soil has high values for organic matter, Ca and CEC.

Soil Unit IK6: This soil unit occupies the lower slope position of the landscape and contains deep and well drained soils with dark greyish brown (10YR 4/2, dry) sandy, clay, loamy topsoil overlying light yellowish brown (2.5Y 6/4, dry) clay subsoil. Many Fe-Mn concretions were encountered from the surface down to 150cm while few yellowish mottles were encountered at 104-150cm depth. The soil pH was 4.69 on the surface and 4.22 in the subsoil. The soil contains low cation exchange capacity, K, Mg, and total N.

Soil mapping units	Land use Types with Depths	K	Na	Ca	Mg	P (mg/kg)	pH (H ₂ O)	% OC	% OM	Exch. Acidity (Cmol/kg)	% N	Sand (%)	Silt (%)	Clay (%)	CEC (Cmol/kg)	BS (%)
IK3	Gmelina 0-12cm	0.26	0.18	4.7	2	0.78	5.2	2.34	4.03	0.3	0.02	60.8	16	23.2	7.44	95.96
	Gmelina 12-23	0.08	0.19	2.4	1.1	0.23	3.27	1.47	2.54	8.4	0.13	60.8	22	SCL	12.17	30.98
	Gmelina 23-43	0.09	0.15	2.8	1.2	8.87	4.47	0.82	1.42	11.5	0.07	56.8	12	31.2 SCL	15.74	26.93
	Gmelina 43-80	0.11	0.19	3.7	1.3	1.32	4.47	0.65	1.12	9.05	0.06	44.8	9	47.2 C	14.35	36.93
	Gmelina 80 below	0.05	0.23	3.5	1.4	0.32	4.86	0.3	0.53	10.5	0.03	42.8	10	47.2 Ct	15.68	33.04
IK6	Banana 0-38	0.15	0.14	4.6	2.2	24.5	4.7	2.89	4.99	1.5	0.25	60.8	12	27.2	8.59	82.54
	Banana 38-64cm	0.05	0.2	4.6	2	0.47	4.75	1.24	2.15	3.1	0.11	60.8	12	SCL	9.95	68.84
	Banana 64-104	0.06	0.23	1.9	1.6	0.16	4.89	0.38	0.66	3.05	0.03	64.8	8	SCL	6.84	55.41
	Banana 104-150	0.12	0.2	3.9	1.4	0.47	4.22	1.05	1.82	6.75	0.09	48.8	12	SCL	12.37	45.43
	Cashew 0-16	0.08	0.17	3.6	1.3	7.16	4.77	1.11	1.92	1.35	0.16	52.8	16	31.2	6.5	79.23
IK2	Cashew 16-40	0.07	0.21	2.4	1	0.16	5.24	1.03	1.78	22.35	0.09	44.8	10	SCL	25.93	14.19
	Cashew 40-63	0.09	0.2	3	1.1	0.93	4.8	1.11	1.92	4.35	0.12	36.8	12	45.2 SC	8.74	60.87
	Cashew 63-88	0.05	0.18	3.6	1.4	3.19	4.85	0.48	0.83	10.09	0.03	40.8	12	51.2 C	15.32	34.14
	Cashew 88-150	0.16	0.22	1.8	0.8	0.16	4.42	0.59	1.02	0.75	0.06	32.8	16	47.2 C	3.73	79.89
	Fallow Land 0-24	0.17	0.16	2.8	1.2	29.57	5.96	1.61	2.77	6	0.14	68.8	8	51.2 C	10.33	41.92
IL1	Fallow Land 24 - 45	0.05	0.16	3.4	1.2	0.16	5.52	0.52	0.89	5.3	0.04	48.8	8	SCL	10.11	42.83
	Fallow Land 45 - 59	0.07	0.22	1.9	0.8	0.62	4.22	0.65	1.12	0.45	0.05	44.8	12	43.2 C	3.44	86.72
	Fallow Land 59 - 79	0.07	0.16	3.7	1.2	0.47	5.81	0.34	0.59	8.25	0.12	40.8	8	51.2 C	13.38	38.34
	Fallow Land 79 - 112	0.05	0.18	2.6	1.2	0.86	4.27	0.46	0.79	4.25	0.04	48.8	10	41.2 SC	8.53	47.25

IK4	Fisheries 0-23	0.1	0.48	2	1	4.12	4.87	1.3	2.25	0.5	0.11	64.8	10	25.2	4.08	87.74
	Fisheries 23-49	0.06	0.2	2	1	0.31	3.97	0.57	0.99	8.1	0.04	60.8	8	31.2	11.36	27.69
	Fisheries 49-99	0.04	0.21	1.8	0.7	0.46	4.39	0.38	0.66	1.5	0.03	60.8	16	23.2	4.25	64.71
	Fisheries 99-118	0.05	0.19	2.6	1.2	0.47	4.82	0.34	0.59	7.4	0.04	48	16	36.2 SC	11.44	35.31
	Fisheries 118 below	0.07	0.27	3.9	1.5	3.03	3.9	0.36	0.63	0.75	0.03	56.8	12	31.2	6.49	88.44
IK7	Low Land 0-6	0.38	0.25	5.1	2.2	2.41	5.03	2.24	3.86	11.45	0.19	56.8	20	23.2	19.38	40.92
	Low Land 6-48	0.23	0.21	4.5	2	1.56	4.21	0.5	0.86	1.45	0.04	60.8	12	27.2	8.39	82.72
	Low Land 48-70	0.11	0.26	2.2	1	1.4	3.95	0.59	1.02	0.4	0.05	64.8	10	25.2	3.97	89.92
	Low Land 70-80	0.08	0.2	2.5	1.1	0.16	4.97	0.34	0.59	7	0.03	68.8	10	21.2	10.88	35.66
	Oil Palm 0-25	0.27	0.21	7.1	3.4	5.52	5	2.49	4.29	8.35	0.22	60.8	16	23.2	19.33	56.80
IK5	Oil Palm 25-43	0.1	0.15	3.9	1.4	1.4	4.93	0.44	0.76	3.7	0.04	56.8	12	31.2	9.25	60
	Oil Palm 43-95	0.07	0.17	3.9	2	4.36	5.26	0.57	0.99	11.4	0.05	52.8	16	31.2 SCL	17.54	35.01
	Oil Palm 95-140	0.09	0.15	3.8	12	0.16	5.73	0.15	0.26	6.7	0.02	44.8	8	47.2 C	11.94	43.90

Table 3: Soil Physical Properties of Selected Land Use Types in Ikole -Ekiti

LAND USE	HORIZONS (cm)	BULK DENSITY (g/cm^3)	POROSITY (%)	MOISTURE CONTENT (%)
CASHEW (IK 1)	0 – 16	1.56	41.13	13.66
	16 – 14	1.65	37.74	21.73
	40 – 63	1.49	43.77	22.94
	63 – 88	1.40	47.17	25.03
	88 - 150	1.13	57.36	27.27
GMELINA (IK 3)	0 – 12	1.39	47.55	10.48
	12 – 23	1.86	29.81	22.64
	23 – 43	1.87	29.43	17.80
	43 – 80	2.16	18.49	18.53
	80 below	2.26	14.72	22.47
FISHERIES (IK 4)	0 – 23	1.64	38.11	18.09
	23 – 49	2.01	24.15	21.14
	49 – 99	2.14	19.25	12.04
	99 – 118	2.07	21.89	22.32
	118 below	2.20	16.98	10.92
OIL PALM (IK 5)	0 – 25	1.55	41.51	22.52
	25 – 43	2.07	21.89	16.69
	43 – 95	1.89	28.68	19.16
	95 – 120	1.8	32.08	25.33
BANANA (IK 6)	0 – 38	1.45	45.28	24.60
	38 – 64	1.87	29.43	15.79
	64 – 104	2.05	22.64	17.59
	104 – 150	1.75	33.96	22.63
LOWLAND (IK 7)	0 – 6	1.33	49.81	31.16
	6 – 48	1.73	34.71	14.39
	48 – 70	1.84	30.57	18.01
	70 – 80	2.12	20.00	16.89
FALLOW (IK 2)	0 – 24	1.43	46.04	15.15
	24 – 45	1.77	33.21	23.45
	45 – 59	2.26	14.72	13.70
	59 – 79	1.57	40.75	32.11
	79 -120	1.54	41.89	35.16

Table 4: Summary of soil classification according to USDA Soil Taxonomy, WRB System and Capability

Pedon	USDA System	WRB System	LCC
IK1	TypicPlinthudult	DystricLixisolIII _F	
IK2	TypicPlinthudult	DystricLixisolIV _{FS}	
IK3	TypicPlinthudult	DystricLixisolIII _F	
IK4	KandicPlinthaquult	Ferric LixisolIV _{FSW}	
IK5	TypicPlinthudult	DystricLixisolIII _F	
IK6	PlinthicKandiudult	PlinthicLixisolIV _{FS}	
IK7	FluvaquenticEpiaquept	FluviaCambisolIV _{FSW}	

Soil Unit IK7: The unit occupies the valley/bottom (lower) portion of the landscape and contains soils that are not deep ($\leq 80\text{cm}$) and poorly drained. The soil colour was dark/greyish brown (10YR 4/2, dry) on top overlying gray (10YR 5/1, dry) in the subsoil. The soil has sandy clay loam texture throughout the profile. The structural aggregates are moderate coarse sub-angular blocky with slightly sticky consistence. Many dominant yellowish red and reddish mottles were encountered at 48cm and 80cm. The water table was encountered at 80cm.

Soil Classification

The morphological, physical and chemical properties were used to classify the soils. Soil Unit IK1 is characterized by the presence of argillic horizon and low base saturation and classified as Ultisol. The udic moisture regime in the area makes it Udult at the suborder level, Plinthudult at the great group level because of the presence of plinthites within the 150 cm and a Typic Plinthudult at subgroup level. The corresponding classification based on the criteria of WRB (2014) is a Dystric Lixisol. Soil Unit IK2 and IK3 have the same features as IK1 and so classified as Typic Plinthudult or Dystric Lixisol. Soil Unit IK4 has low base saturation and argillic horizon (Ultisol) and experiences aquic conditions for some time in normal years in one or more horizons within 50cm of the mineral soil surface (Aquult), one or more horizons within 150 cm of the mineral soils surface has plinthite either forming a continuous phase or constituting one-half or more of the volume (Plinthaquult) while at the subgroup level, the

soil was classified as Kandic Plinthaquult and Ferric Lixisol. Soil Unit IK5 has similar characteristics as IK1, IK2 and IK3 and so classified as Typic Plinthudult and Dystric Lixisol. Soil Unit IK6 is an Ultisol and in suborder Udult (possesses Kandic horizon with an irregular decrease in organic carbon with an increase in depth) and so classified as Kandicudult and Plinthic Kandicudult because of 5% or more (by volume) plinthite in one or more horizons within 150cm of the mineral surface). The corresponding name from WRB (2014) is Plinthic Lixisol. Soil Unit IK7 has altered horizons, weak evidence of horizonation, presence of cambic B horizon, evidence of stratification from hill wash deposits and so classified as Inceptisol and suborder Aquept (aquic conditions for some time in normal year) and as Epiaquept (because of episaturation) and as subgroup Fluvaquentic Epiaquept (an irregular decrease in organic carbon content between 25cm and either a depth of 125cm below the mineral soil surface. The corresponding name is Fluvic Cambisol.

Agricultural Potentials of the Soils

Table 4 shows the assessment of the pedons based on LCC criteria. IK 1, IK 3 and IK 5 belong to Class III. Pedons IK 2, IK 4, IK 6 and IK 7 belong to Class IV_{fs}, IV_{fs}, IV_{fs}, respectively.

Discussion

The soils have argillans identified on the field just below the Ap horizons. The soils are well-drained and contain Fe-Mn concretions except in pedon IK7. The soil texture is sandy loam on the surface of all the profiles and overlies clay/sandy clay subsoil. This is clear

evidence that a lot of erosion and runoff has removed the Ap horizon as the topography is undulating such that the soils are very vulnerable to erosion. Thus, the land should not be exposed to the direct impact of rainfall as further exposure would cause the structurally-unbalanced subsoil to be eroded with attendant problems of leaching degradation and compaction.

Van Wambeke (1962) reported that "old" parent materials usually have a silt/clay ratio below 0.15 while silt/clay ratios above of 0.15 are indicative of "young" parent materials. The results obtained show that all the soils have silt/clay ratios of 0.16-1.27 indicating that the soils are relatively young with a high degree of weathering potential. Silt/clay ratios are relatively higher in the surface horizon and decrease indicating that the sub-soils horizons are more weathered than the surface.

Soil bulk density is influenced by differences in mineralogy, clay content and structural development. The values ranged from 1.33-1.64g.cm⁻³ in the Ap horizons and 1.13 - 2.26g.cm⁻³ in the subsurface horizons. Miller and Donahue (1990) had reported that the ideal bulk density is below 1.4 and 1.6g.cm⁻³ for clayey and sandy soil respectively. The soil bulk density is greater than 1.4g.cm⁻³ (cashew plantation- 1.56g.cm⁻³, oil palm- 1.55g.cm⁻³, Fallow- 1.43g.cm⁻³, banana- 1.45g.cm⁻³ and fisheries- 1.64g.cm⁻³). Root growth would be inhibited by high bulk density because of soil resistance to root penetration, poor aeration, slow movement of nutrients and water and buildup of toxic gases and root exudates (Tarawali *et al.*, 2001; Odunze, 2006). It is only the bulk density of the Lowland and Gmelina that appears fairly favourable for crop production while others must be managed carefully. The porosity ranged from 38.11-49.81% on the surface of all the soils. Fetter (1998) and Rien and Sposito (1991) had recommended that soils with over 50 and 45-50% porosity of the volume are good for agriculture. The values of porosity obtained in this study (except for Fisheries- 38.11%) indicate that these are good agricultural soils.

The surface soils are strongly acidic (pH=4.69) to slightly acidic (pH=5.96) and the pH decreased or increased irregularly with depth. Most of the values are outside the pH range of 5.5-7.0 preferred by most crops

(Landon, 1991). The factors suggested as being responsible for the acidic nature of the soils include heavy rainfall, the acidic nature of the parent rocks and the acidic precipitation around the study area. The annual rainfall in the study area is about 1300mm and most of which falls within five to seven months in the year. This pattern of rainfall distribution is considered adequate for leaching and colloid translocation.

Organic matter decreased irregularly with depth in all the pedons. The low organic matter content of the soils may be due to continuous cultivation and frequent burning of farm residues which tend to destroy much of the organic materials. The organic matter content should be increased through effective crop residue management and addition of organic manures.

Total N status of the soils was very low to medium (0.2-2.5 g.kg⁻¹). Similar results of very low to low N values have been reported by Fasina *et al.*, (2006) for some soils developed on granitic rock parent materials in Nigeria. The total N decreased with soil depth which can be attributed to the influence of continuous cultivation, a common practice on farmlands in Nigeria as accentuated by the removal of crop residues (Noma *et al.*, 2011). These soils will benefit from fertilizer application but the use of acid-forming fertilizers should be avoided. The exchangeable bases are low to medium and, in most cases, decreased with depth. Exchangeable Ca was the dominant base on the cation exchange complex (Table 3). The low to medium range of exchangeable bases is an indication of there latively poor basic nutrient status of the soils. The use of appropriate chemical fertilizers to ameliorate the deficiency of the exchangeable bases would be the rule for continuous and intensive sustainable crop production.

Hydrolytic weathering was observed as the major pedogenic process within the study area. The high rainfall, high soil temperature, and geo-chemical nature of the parent rocks seem to encourage hydrolytic weathering. Since precipitation is higher than 0.8PET, leaching of the basic cations is encouraged. High soil temperature and extreme leaching favour disilication and accumulation of Fe immobilized in ferric oxide forms under oxidizing conditions (Siever (1926). Most of the pedogenic processes

that occur within the study area are favoured by the humid conditions, free internal drainage and geomorphic stability over a prolonged period of time and strong weathering intensity (Beinroth 1982). Other pedogenic processes such as lessivation, braunification, flora and fauna pedoturbation, erosion, luration, mobilization and subsequent immobilization of Fe during redox cycles and cyclic change of climate are dominant in these soils.

Sustainable Management of the Soils

The Class III, indicated for pedons IK 1, IK 3 and IK 5 is moderately good and the soils can be used for regular cultivation of crops in a good rotation and if ploughed along the contour. The Class IV in Pedons IK 2, IK 4, IK 6 and IK 7 shows limitations imposed by natural features (slope, erosion and adverse soil wetness) to crop production. As a rule, the best use is for pasture or forestry but where crop production is envisaged, the limitations of soil fertility can easily be surmounted. The use of organic materials, crop and plant residues would minimize the limitations even as the land should not be left bare because of the erosive and undulating nature of the topography. The acidic nature of the soil warrants lime application. The low organic matter has to be substantially increased through effective use of leguminous crops in rotation or as cover crops as well as

judicious application of organic manures. The application of appropriate chemical fertilizers will solve the problem of the deficiencies of exchangeable bases. However, the acid-forming fertilizers must be avoided so as to prevent further acidification of the soils. These are the need to encourage post-harvest incorporation of plant residues into the soil instead of the usual practice of burning them off, and the use of minimum and conservation tillage because of the concretionary nature of Pedons IK1, IK2, IK3, IK4, IK5, and IK6.

Conclusion

On 380 hectares of land in Ikole-Ekiti soil units (IK1, IK2, IK3, IK4, IK5, IK6, and IK7) associated with seven land use types were identified. They were soils derived from the granitic (basement complex) rocks. The soils were mapped, characterized, classified and their genesis and agriculture potentials assessed. The soils are strongly acidic (3.27) to slightly acidic (5.96), highly weathered and with low inherent fertility in terms of exchangeable bases, organic carbon, cation exchange capacity, total N and available P. The topographic location of the soils have tremendous influences on the properties and the limit the potentials for crop production. The appropriate recommendations for the sustainable use of these soils were suggested.

References

- Amusan, A.A, and Ashaye, T.I. (1991). Granitic gneiss derived soils in humid forest tropical Southwestern Nigeria. I Genesis and classification. *Ife Journal of Agriculture*. 13:1-10
- Beinroth, F.H. (1982). Some highly weathered soils of Puerto Rico. I. Morphology, formation, and classification. *GEODERMA* 27: 1-73.
- FAO and UNESCO (2014). Soil Map of the World 1: 500,000 Legend Sheet and Memoirs. The United Nations Educational Scientific and Cultural Organization: 59pp.
- Fasina, A.S., Shittu, O.S., Omotoso, S.O. and Adenikinju, A.P. (2006). Response of cocoa to different fertilizer regimes on some selected soils of Southwestern Nigeria- Genesis, classification and sustainable management. *American- Eurasian Journal of Agriculture and Environmental Science* 2: 312-317.
- Fasina, A.S., Raji, A., Oluwatosin, G.A., Omoju, O., and Oluwadare, D.A. (2015). Properties, genesis, classification, capability and sustainable management of soils from Southwestern Nigeria. *International Journal of Soil Science* 10(3): 142-152.
- Fetter, C.W. (1998). Contaminant Hydrogeology 2nd Ed, Prentice Hall. New Delhi India. 500pp
- Klingebiel, A.A. and Montgomery, P.H. (1961). Land Capability Classification. Agriculture Handbook 210. Soil Conservation Service, U.S. Government Print Office, Washington D.C. 21pp
- Landon, J.R. (1991). Booker Tropical Soil Manual. A Handbook for Soil Survey and Agricultural Land Education in the Tropics and Subtropics. Longman, London, UK.

- 474pp.
- Miller, R.W, and Donahue, R.L. (1990). Soil: An Introduction to Soils and Plant Growth. Prentice Hall, New Delhi, India. 768pp.
- Moorman, F.R. (1981). Representatives of toposequence of soils in Southern Nigeria and their pedology. In: Greenland D.J. (Ed). Characterization of Soils in Relation to their Classification and Management for Crop Production. Clarendon Press, Oxford: 29.
- Noma, S.S., Tanko, I.I., Yakubu, M., Dikko, A.U., Abdullahi, A.A. and Audu, M.(2011). Variability in the physico-chemical properties of soils of Dundaye District, Sokoto State, Nigeria. Proceedings of the 45th Annual Conference of the Agricultural Society of Nigeria, October 24 - 28, 2011, Nigeria.
- Odunze, A.E. (2006). Soil properties and management strategies for some sub-humid savanna zone Alfisols in Kaduna State, Nigeria. *Samaru Journal of Agricultural Research* 22: 3-14.
- Shobayo, A.B., Raji, B.A., Malgwi, W.B., and Odunze, A.C. (2013). Classification and properties of soils developed on gneisses and schists in the northern Guinea savanna of Nigeria. *Nigerian Journal of Soil and Environmental Research* 11: 86-93.
- Sharu, M.B., Yakubu, M., Noma, S.S. and Tsafe, A.I. (2013). Characterization and classification of soils on an agricultural landscape in Dingyadi District, Sokoto State, Nigeria. *Nigerian Journal of Basic and Applied Sciences* 21: 137-147.
- Siever, R. (1962). Silica solubility at 0°- 200°C and the diagenesis of siliceous sediments. *Journal of Geology* 70: 127-150
- Tarawali, A.S., Larbi, A., Fernandez-Rivera, S. and Bationo, A. (2001). The Contribution of Livestock to Soil Fertility. SSSA Special Publication, Madison, WI: 281-304.
- Udo, E.J., Ibia, T.O., Ogunwale, J.O., Ano, A.O. and Esu, I.E. (2009). Manual of Soil, Plant and Water Analysis. Sibon Books Ltd, Lagos. 183pp.
- USDA, (2014). Keys to Soil Taxonomy. 12th Edn. United State Department of Agriculture, Washington DC. 360pp.
- Van Wanbeke, A.R. (1962). Criteria for classifying tropical soils by age. *Journal of Soil Science* 13: 124-132.
- World Reference Base (2014). International Soil Classification System for Naming Soils and Creating Legends for Soils Maps. World Soil Resources Report, No 106, FAO, Rome, Italy, 181pp.

Threats to the Conservation of West African Manatee in Pandam Wildlife Park, Plateau State, Nigeria

¹O.S., Odewumi, ¹E.A Agbelusi, and ²O.A., Bello-Olusoji

1: Ecotourism and Wildlife Management Department

2: Fisheries and Aquaculture Technology Department,

The Federal University of Technology, Akure

E-mail: owumisunday@gmail.com; osodewumi@futa.edu.ng;

Abstract

The study on the threats to the conservation of West African Manatee in Pandam Wildlife Park was carried out between 2011 and 2013. Questionnaire administration, oral interview and field survey methods were adopted. One hundred and twenty (120) copies of structured questionnaire were distributed to fishermen in Pandam, Aningo and Sabongida villages while oral interview was conducted for the park staff. Data on fishing pressure were collected from the number of boats and set nets, and the types of fishing gear used. Data obtained from questionnaire and field surveys and on fishing effort, expressed as the number of fishing nets sets in the dry and wet seasons, were pulled together and analyzed statistically. The threats from human activities include: fishing, lake cruising, killing of manatee, farming, cattle grazing and fuel wood/grass collection. Hunting is low while fishing activity is high and done all-year-round. The average of 58 fishing nets set daily in the wet season differed significantly from 120 fishing nets set in the dry season in Pandam Lake. Management issues include: low level of conservation education, high level of unskilled staff, poor funding and lack of protection equipment. The identified human activities and management issues would pose serious threats to the conservation of manatee in Pandam Lake, if not adequately addressed. A take-over of the park by the Federal government would ensure the effective protection of the resources, especially manatee.

Key words: Pandam Lake, conservation education, manatee, human activities, management issues

Introduction Many factors expose animals to threat and include: habitat loss/fragmentation, change in habitat quality, exploitation of species with a high economic value for meat, milk, fat, tusk and trade as well as migratory species (Barbout and Sastrapradja, (1995). Manatees have evolved in plant-munching peace, for millions of years, until humans arrived on the scene. Now the co-existence with humans in the same habitat has been detrimental to manatees whose populations have been severely reduced, and even exterminated in some areas.

Most manatee deaths are now attributable to human influence. The increases in human populations living in limited coastal wetland habitats have resulted in severe conflicts. As a result, many of the aquatic plants upon which manatees once depended have been lost. St. Aubin and Lounsbury (1990) attributed the reduction in the number of manatees and dugongs largely to habitat disturbances and hunting for their meat and fat,

drowning in canal locks or flood control structures. Other causes of death include: natural causes (cold, diseases and parasites, poison or toxins caused by *Gymnodinium breve*), water craft accidents, accidental entanglement in fishing nets, predation and pollution (US Fish and Wildlife Service, 2000). Manatees prefer shallow water and surface to breathe air, swim slowly, and like to doze and float just beneath the surface; which make them extremely vulnerable to boat hits. Deutsch *et al.* (2007) identified the major threats to survival of the species as habitat degradation and loss, illegal hunting, boat strikes, entanglement in fishing gear, entrapment in water control structures, pollution, disease, and human disturbance.

In West Africa, Powell (1996), Akoi (2004), Ofori-Danson (2009) and Aristide (2011) attributed the decline of the manatee population largely to hunting and incidental capture in fishing nets. In Nigeria, illegal poaching for meat and fat, reduction in volume of water, destruction of habitat and medicinal

values attached to West African manatee has been the major threat to the animal (Happold, 1987; Iwar, 2003 and Sodeinde, 2005). Thus, the West African manatee, *Trichechus senegalensis* has been listed in Appendix II of Convention on International Trade in Endangered Species of wild fauna and flora (CITES), as “vulnerable” by IUCN and “threatened” by CMS (Powell and Akoi, 2006). The seriousness of this threat has gained international attention over the past 15 years (Perrin, 2001; Diop 2005; Van Lavieren, 2005; Ita, 2005). However, during the 2005 UNEP/CMS Conserving Marine Mammals Side Event, much progress was made towards developing West African conservation strategy at the international level. UNEP/CMS (2005) reported the announcement that: international partners are joining forces to develop a comprehensive conservation strategy for the West African manatee throughout its range.

In Nigeria, Sykes (1974) (cited in Powell, 1996) reported that the manatee seeks refuge during the dry season when the water level in Benue River is reduced by finding and remaining in deep pools or lakes that are connected to the Benue River by temporary creeks. One of such areas is the Pandam Lake on the Deb River. As a result of this the Plateau State Government declared Pandam Lake a Manatee Sanctuary (Osakwe and Meduna, 1988). Pandam Wildlife Park may be one of the most

important habitats for the global conservation of the West African manatees and offers an opportunity to advance our breadth and depth of scientific knowledge related to insular populations of endangered species in general and West African manatees in particular. This study therefore examined the various factors/human activities that could threaten the effective conservation of West African manatee in Pandam Lake.

Methodology Study Area

Pandam Wildlife Park is one of the protected areas in Plateau State in the middle belt region of Nigeria (Fig. 1). It covers an area of 224 km² and is located 58 km along the Lafia-Shendam road to the north of Benue River and south of Plateau State (Ezealor, 2002; Akosim, 1997) in Quanpan Local Government area. It lies between 8°35' and 8°55'N and 8°00' and 10°00'E. It is bounded on the east by Namu and Knagarda, on the west and north by River Dels and in the south by Aningo and Pandam communities (Akosim, 1997). Rivers Dels and Li drain the entire area and join to make a Y-shape before emptying into River Benue. The land slopes gradually southwards and forms a basin- “Pandam Lake” wetland complex- of approximately 22 km² (Fig. 2). The entire park lies within the guinea savannah eco-zone. The wet season lasts from April to October and annual rainfall is 1,000–1,500 mm.

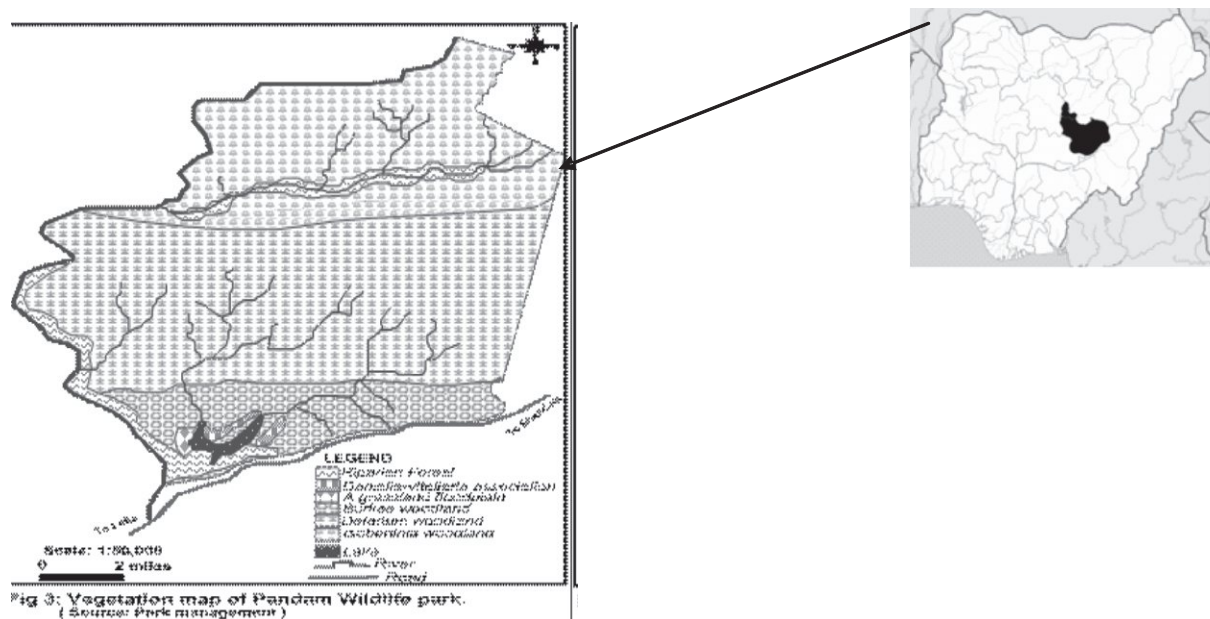


Figure 1: Map of Pandam Wildlife Park showing Pandam Lake

Materials and Methods

Two methods: questionnaire administration and field survey were adopted in this study. A total of one hundred and twenty (120) copies of questionnaire were distributed to the fishermen in Pandam (35), Aningo (20) and Sabongida (65) villages to investigate the hunting and fishing pressure in Pandam Lake. These include: manatee hunting intensity, fishermen-manatee related conflicts, the frequency of fishing, average number of net sets per fisherman, types of net used and the level of conservation awareness on manatee. Oral interview was conducted with the staff of the park to collect information on management issues (funding, frequency of conservation awareness campaign, knowledge of manatee conservation/rescue programme) that can affect the conservation of manatee in the park. The field survey involved visits to Pandam Lake to assess the types and the number of fishing nets set (fixed and almost permanent fishing nets placed by fishermen along the bank or across a portion of the lake that they visit almost every morning to remove entangled fishes) at each of the four locations within the Lake as well as the number of fishing boats seen. This was done both in the wet (July-September) and dry (January- March) seasons and for three years (2011-2013). The average length of each net was measured and, where hook and line were used, the average number of hooks on each line was counted. Other forms of human activities in and around the lake were also recorded.

Statistical Analysis

Data obtained from questionnaire were analyzed descriptively using graphs, bar and pie charts, tables, percentages and frequencies. The data on fishing effort, expressed as the number of fishing nets set in the dry and wet seasons, were pulled together and analyzed using t-test.

Results

The age of interviewees ranged from 21 to 80 years, with a mean age of 43.12 ± 1.24 . The mean age of fishermen in the three villages (Pandam, Aningo and Sabongida) were 50.8 ± 2.6 , 30.25 ± 1.37 , and 42.94 ± 1.38 years respectively (Table 1). The age class 31-40 years had the highest number of respondents, 31 (25.83%) followed by age class 20-30 years with 29 (24.17%) while age class 71-80 years has the lowest number of 5 (4.17%). The years of fishing experience in the three villages are: 31.67% (n=38) with 10-20 years' experience, 21.67% (n=26) had 21-30 years' experience, 26.67% (n=32) had 31-40 years' experience, 15.83% (n=12) had 41-50 years' experience, 3.33% (n=4) had 51-60 years' experience while 0.83% (n=1) had over 60 years' experience (Fig.2). None of them had formal education. The fishermen in Pandam village had 33.63 years of experience followed by fishermen in Sabongida (29.88 years) while fishermen in Aningo had the least (16.45 years) (Fig. 3). Majority of the fishermen (85%) in the three villages carry out their fishing activities all-year-round while 15% only fish during the dry season

Table 1: Frequency and percentage frequency of age of respondents in the three villages

Age class (years)	Frequency				Percentage
	PAN	ANI	SAB	TOTAL	
20-30	4	15	10	29	24.17
31-40	7	4	20	31	25.83
41-50	6	1	15	22	18.33
51-60	6	0	16	22	18.33
61-70	7	0	4	11	9.17
71-80	5	0	0	5	4.17
Total	35	20	65	120	100
Mean age of fishermen	$50.8a \pm 2.6$	$30.25c \pm 1.37$	$42.94b \pm 1.38$	$43.12b \pm 1.24$	

PAN= Pandam Village

ANI= Aningo Village

SAB= Sabongida Village

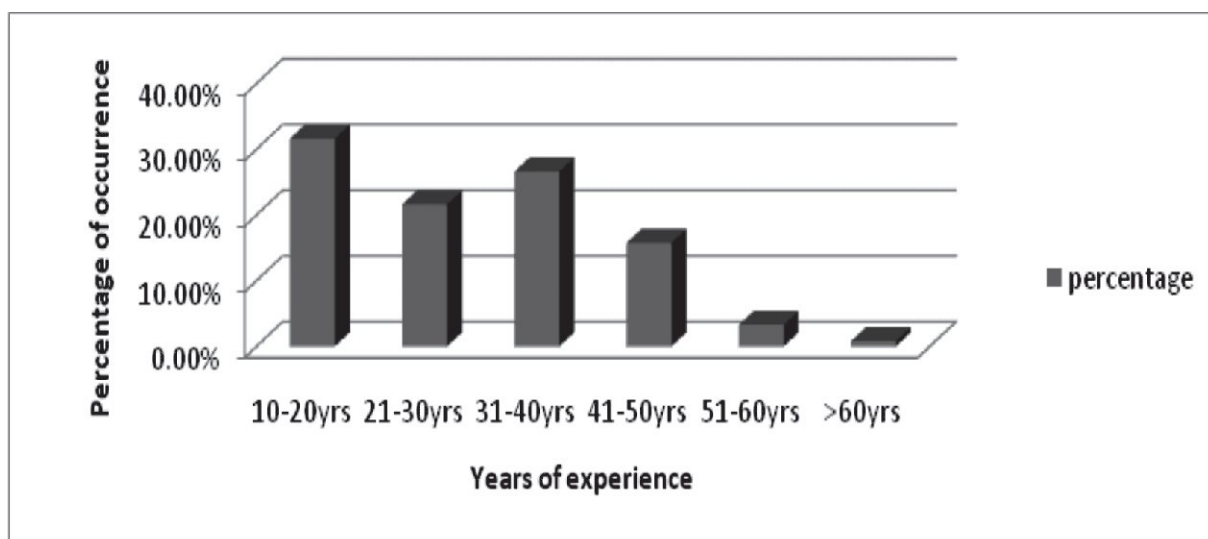


Fig.2: Summary of the years of experience of fishermen in the three villages

Human-manatee conflict

All the respondents 100% (n=120) had not seen a dead manatee in the past 5-10 years and their fishing nets had never retained manatees. However, manatee had torn the fishing nets of 34% (n=41) of the respondents 11-15 times within the last ten months (January- October, 2012), 29% (n=35) had their nets torn 16- 20 times, 20% (n=24) had their nets torn 6-10

times while 14% (n=17) and 3% (n=3) had their nets torn >20 times and 1- 5 times respectively (Fig.4). All the respondents agreed that the population of manatee had been increasing because of the reduction in hunting pressure and the habitat is conducive for reproduction. Only (0.83%) (n=1) of the respondents killed one manatee in March, 2012.

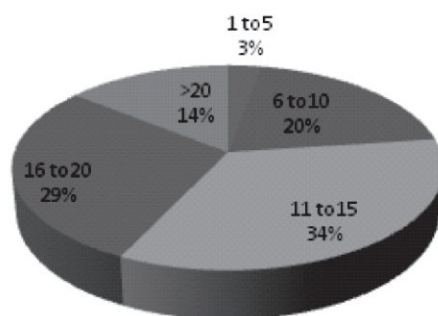


Fig.4: Number of fishing nets torn by manatee in Pandam Lake

Human activities in Pandam Lake

The major human activities carried out in Pandam Lake and its environment that may have either direct or indirect impact on manatee or the habitat include: fishing, lake cruising, illegal hunting of manatee, farming, cattle grazing and collection of fuel wood/ grass.

Fishing activities

Table 2 shows that, on the average, 58 fishing nets are set in the wet season and 120 fishing nets are set in the dry season in Pandam Lake and the difference between the seasons was significant ($t=3.182446$, $P=0.087$). The ZU arm

of the lake had the highest mean frequency of occurrence and percentage (26 ± 2.5 ; 44.83%) in the wet season followed by GU (20 ± 0.5 ; 34.48%), ML (9 ± 1.5 ; 15.52%) while the least (3 ± 0.5 ; 5.17%) was recorded in MS. In the dry season, MS had the highest number of fishing nets (50 ± 2.1 ; 41.67%) followed by ML (30 ± 0.1 ; 25%), GU arm (25 ± 4.2 ; 20.83%) while ZU had the least (15 ± 0.5 ; 12.5%). The types of nets set by the fishermen were hook and line and gill net/set net while the average length of each net was between 10-15m. They made use of monofilament netting materials and small mesh size. The mean number of fishing canoes

recorded in Pandam Lake in the wet season was 14 consisting of five (5) canoes each in GU and ZU, 3 canoes in the ML and 1 in MS. The mean

number of canoes recorded in the dry season was 25 with MS having the highest (10) followed by ML (7), GU (5) while ZU arm had the least (3).

Table 2: Fishing activity in Pandam Lake

Location	Number of fishing nets		Number of Canoe	
	Wet	Dry	Wet	Dry
MS	3±0.5	50±2.1	1±0.02	10±0.5
ML	9±1.5	30±0.1	3±0.03	7±1.5
GU	20±0.5	25±4.2	5±0.5	5±0.3
ZU	26±2.5	15±0.5	5±0.0	3±0.5
Mean Total	58*	120**	14	25

ML: Main Lake (Centre of the Lake), ZU: Zuzurfar arm of the lake, GU: Gurubudutse arm of the lake, MS: Manatee stream arm of the lake

Lake cruising is being carried out by the park for tourists in the dry season when the park is opened to tourists. Manatee hunting is low but still being carried out illegally by some of the fishermen in Pandam Wildlife Park. During the study, at least two (2) manatees were killed based on the evidence provided by the upper and lower jaw bones and oil extracted being sold to people. Farming activities are carried out outside the park but the farmers make use of herbicides and insecticides. Herds of cattle and sheep were mostly seen in Pandam Lake during the dry season. The park management allows the community to enter the park to collect fire wood and to cut long grasses used in making thatch huts.

Management Issues

Inadequate funding was the major problem of the park and this affected the staff activities such as conservation awareness education, and lack of protection equipment. Also, more than 80% of the park staff lacks knowledge about the ecology and the conservation strategies for manatee or the rescue methods for any stranded manatee.

Discussion

The fishing pressure could be a threat to manatee as the fishermen engaged in fishing twice daily (morning and evening) all-year-round using different fishing gears. Fishing pressure is high and fishing gear can pose risks to free-swimming and grazing manatees when discarded or left unattended. Fishing lines and hooks incidentally ingested during grazing can cause a manatee's digestive system to be affected enough to cause death. Infection and

possible amputation of appendages is possible when entwined in fishing lines. Net entanglement can lead to drowning especially for calves as they are usually not strong enough to free themselves from the mesh.

The low hunting pressure on manatee is attributed to the fact that Pandam Lake is in a protected area where access is somewhat restricted and there is a law banning the killing of the animal. This is responsible for the increase in the population of manatee in the Lake which would be responsible for some economic losses incurred when manatees tear their fishing nets, as earlier indicated by Aristide (2011). Also, high concentrations of manatee dungs carried by water waves are more frequently found around the ML and MS. The dung decomposes when it sinks to the bottom causing an increase in phyto- and zoo-planktons which in turn lead to increased fish production. Coincidentally, manatees are mostly sighted by the fishermen in GU and ZU where the feeding activities are more concentrated. Powell (1996) observed that the West African manatees are elusive and often move away from an activity centre to avoid human disturbance. Also at one location in Florida, the proportion of time Florida manatees spend in various behavioural states such as feeding, milling and traveling in critical habitats is related to ambient noise levels with manatees spending more time in directed behaviour (such as feeding) and less time in undirected behaviour (such as milling) when noise levels are high (Miksis-Olds and Wagner, 2011). Sander (1980) cited in Akoi (2004) reported that Dugongs in New Guinea feed at night in areas where they were hunted. Similarly, West Indian manatees in Honduras have been reported by

local residents to become nocturnal in response to human pressure (Rathbun *et al.*, 1983). Powell (1996) suggested that, due to human presence on water systems in Cote d'Ivoire, the West African manatee shifted its activity patterns and was more nocturnal. Studies in Florida and Costa Rica have shown that manatees have been known to avoid areas of high boat traffic, changing their behavioural state and moving out of a geographical area in response to approaching vessels (Buckingham *et al.*, 1999; Smethurst and Nietschmann, 1999; Miksis-Olds,

2011).

Hence, the following recommendations are crucial to improving the conservation status of manatees in Pandam Lake. The park should be taken over by the Federal Government for effective protection of the resources most especially the Pandam Lake; foster collaborative management of natural resources through a participatory approach; and favour the creation of local associations for the conservation of the West African manatee.

References

- Akoi, K. (2004). The ecology of the West African manatee in the lagoon complex of Fresco. In *Fishers and the West African manatee in the Fresco lagoon complex, Cote d'Ivoire, Common property, conflict and conservation*. PhD thesis, DICE, University of Kent at Canterbury, Kent, UK, Pp.365
- Akosim, C, Kwanga, B. T, Ali, A., and Mamman, G. S. (2007). Flora resources and structure in Pandam Wildlife Park, Pandam, Plateau State, Nigeria. *Agricultural Journal* 2 (6): 740-747.
- Akosin, C.(1997). Evaluation of Biodiversity Conservation and Management in Pandam Wildlife Park, Plateau State, Nigeria. PhD Thesis. Department of Wildlife and Fisheries Management, University of Ibadan, 232Pp.
- Aristide, K. (2011) Activity center, habitat use and conservation of the West African Manatee (*Trichechus senegalensis* link, 1795) in the Douala-Edea and Lake Ossa Wildlife Reserves. *M.Sc Thesis. Department of Animal Biology, University of Dschang, Republic of Cameroon*. Pp 133.
- Barbault, R. and Sastrapradja, S.D. (1995) Generation, maintenance and loss of biodiversity. In: Heywood, V.H. and Watson, R.T (Eds). *Global Biodiversity Assessment, United Nations Environmental Programme*. Press Syndicate of Cambridge University.
- Buckingham, C. A., Lefebvre, L. W., Schaefer, J. M., & Kochman, H. I. (1999). Manatee response to boating activity in a thermal refuge. *Wildlife Society Bulletin*, 27, 514- 522.
- Deutsch, C. J., Self-Sullivan, C., and Mignucci-Giannoni, A. A. (2007). *Trichechus manatus*. In 2007 IUCN red list of threatened species. Gland, Switzerland: International Union for Conservation of Nature and Natural Resources.
- Diop, M.D. (2005) New West African Manatee Conservation Project. In *Sirenews* No.44, October 2005. <http://www.sirenian.org/sirenews/44OCT2005.html>, downloaded 10 May 2006.
- Ezealor, U. (2002) Critical sites for Biodiversity Conservation in Nigeria. *Nigerian Conservation Foundation*, Lagos. 110 Pp.
- Happold, D.C.D. (1987) *The Mammals of Nigeria*. Oxford University Press, Oxford London.
- Ita, M. (2005) Will the spirit of the West African manatee live on? *Science in Africa*, January 2005. <http://www.scienceafrica.co.za/2005/January/manatee.html>, downloaded 10 May 2006.
- Miksis-Olds, J. L., and Wagner, T. (2011). Behavioral response of manatees to variations in environmental sound levels. *Marine Mammal Science* 27(1):130–148
- Ofori-Danson (2009) Conservation of West African manatee in Ghana. A paper presented at the West African manatee conservation capacity training program held at the Afram arm of the Volta Lake Ghana. Organized by NCRC, Ghana, and sponsored by Earth Watch International U.K. from 15th-29th November 2009.

- Osakwe, M. and Meduna, A. (1988) Management of the pigmy Hippopotamus and West African manatee in Jos Wildlife Park. *The Nigerian Field*. Vol.53:175-177.
- Powell, J.A. (1996) The Distribution and Biology of the West African Manatee (*Trichechus senegalensis* Link, 1795). Report to the Florida Marine Research Institute, 1008th Avenue SE, St. Petersburg, Florida 33701. March 1996.
- Powell, J.A. and Akoi, K. (2006) IUCN Red List Assessment. Draft Report to the IUCN Survival Commission. March 1996.
- Perrin, W.F. (2001) Conservation Status of the West African Manatee. *Sirennews* No.36, October, 2001.
- Rathbun, G. B., Powell, J. A and Cruz, G. (1983) Status of the West Indian manatee in Honduras. *Biological Conservation* 26: 301-308.
- Smethurst, D., & Nietschmann, B. (1999). The distribution of manatees (*Trichechus manatus*) in the coastal waterways of Tortuguero, Costa Rica. *Biological Conservation*, 89, 267-274.
- Sodeinde, O.A (2006). The manatees in Nigeria: Its status, demography, natural history and role in aquatic ecosystems. In: Proceedings on Conservation of Aquatic Resources held at University of Agriculture, Makurdi, Benue State, Nigeria.
- St. Aubin, D.T., and Lounsbury, V. (1990) Oil effects on manatees: Evaluating the risk. In: Geraci, J.R. and Aubin, D.T. (Eds) *Sea Mammals and Oil: Confronting the Risks*. Academic Press, San Diego: 241-251.
- UNEP/CMS. (2005) Invitation: UNEP and CMS Conserving Marine Mammals, 22 November 2005, a UNEP-CMS Side Event at the 8th Meeting of the Conference of the Parties to the Convention on Migratory Species, UNEP Headquarters, Nairobi, Kenya. [http://www.unep.org/regionalseas/Publications/Final Invitation.pdf](http://www.unep.org/regionalseas/Publications/Final%20Invitation.pdf), downloaded 10 May 2006.
- US Fish and Wildlife Service, (2000) Florida Manatee Recovery Plan, Third Revision. Atlanta: U.S.A. Fish and Wildlife Service Press, 2000.
- Van Lavieren, H. (2005) Joint action for protecting the West African manatee. *Sirennews* No.44, October, 2005. <http://www.sirenian.org/sirennews/44OCT2005.html>, downloaded 10 May 2006.

Effects of Raw Velvet Bean Seed Meal on Haematology and Serum Biochemical Parameters of Juvenile Catfish, *Clarias gariepinus*

¹J.B. Olasunkanmi, ²O.O. Bamidele, ²E.K. Ajani, ³I.E. Ezeaguand ⁴J.A. Adeyemi

¹Dept. of Fisheries and Aquaculture, Faculty of Agriculture, Federal University, Oye-Ekiti, Nigeria

²Dept. of Aquaculture and Fisheries, Faculty of Agriculture and Forestry, University of Ibadan, Ibadan, Nigeria

³Dept. of Medical Biochemistry, University of Nigeria, Nsukka, Enugu Campus, Nigeria

⁴Dept. of Biological Sciences, Faculty of Basic and Applied Sciences, Osun State University, Osogbo, Nigeria

E-mail: bunmi.olasunkanmi@gmail.com

Abstract

The physiological performance of farmed animals is largely influenced by their dietary intake. In this study, the physiological performance of juvenile African catfish (*Clarias gariepinus*) fed diets containing raw velvet bean (*Mucunautilis*) seed meals (VBSM) at different inclusion levels was evaluated. The treatments were raw VBSM at 0 (control), 10, 20 and 30% inclusion and the juveniles were fed for 84 days. Haematological parameters: haematocrit (PCV), red blood cells (RBC) count, white blood cells (WBC) count, lymphocytes count, neutrophils count, haemoglobin (Hb) concentration, mean cell hemoglobin (MCH), mean cell volume (MCV) and mean cell haemoglobin concentration (MCHC) and plasma biochemistry: total protein (TP), albumin, globulin and glucose levels were determined. The results show that there was no significant difference in the haematological parameters between the control and the groups fed with diets containing raw VBSM except WBC, lymphocytes and neutrophils count. The PCV values differed significantly in the fish fed raw VBSM at 30% inclusion. The plasma glucose, total protein, cholesterol, albumin and globulins levels decreased significantly in the fish fed with diets containing raw VBSM compared to the control. The inclusion of raw seeds of *Mucunautilis* in fish meal was not entirely beneficial to *C. gariepinus* suggesting that processing of the seeds may be required.

Keywords: African catfish, velvet bean, haematology, biochemistry, physiological performance

Introduction

The African catfish, *Clarias gariepinus* is a highly cultured fish species in West Africa, mostly for its high quality flesh, distinctive taste and the ease of cultivation (El-Shebly, 2006; Luckhoff, 2005). Since the feed intake plays important role in the physiological performance of fish (Wang *et al.*, 2014; Xu *et al.*, 2014), it is imperative that efforts are continually geared towards improving the dietary formulation of this important fish species for optimal growth and physiological performance.

With the increasing global demand for fish proteins, considerable attention must be given to aquaculture practices that would enhance increased production of cultivated fish species. One strategy of paramount importance to achieving this goal is the quality of the fish feed. Most catfish farmers, especially in the Nigeria, rely on imported fish pellets which have become

very expensive and may not even meet the dietary requirements for optimal growth and productivity. However, the country has abundant local plants, mainly legumes, (Abate *et al.*, 2012) whose extracts or seeds are rich in crude protein and so can be utilized to formulate cheap feeds affordable to the local farmers without compromising the physiological performance and nutritive quality of the cultured fish. The velvet bean (*Mucunautilis*) is a tropical legume native to Africa and the dried seed contains 25-35% crude protein (Olasunkanmi and Omitoyin, 2011; Vadivel *et al.*, 2011). Despite the local abundance of the plant, there are no studies on harnessing the rich biochemical profiles of the seeds in the formulation of dietary feeds for cultivated fish species. The use of haematological parameters for the assessment of physiological performance in cultured fish species has been widely

advocated (Adeyemiet *al.*, 2014). The analysis of these parameters is a valuable approach for assessing the health status of farmed animals as they can provide reliable information on metabolic disorders, deficiencies and chronic stress status before being present in a clinical setting. Apart from haematology, the plasma biochemistry has been widely used in monitoring the health status of cultivated fish species (Adeyemi and Adewale, 2013; Firatet *al.*, 2011). Other indices: glycogen levels, total protein, activities of plasma enzymes etc. have been used as biomarkers of the response of fish species to biotic and environmental stressors.

Therefore, the aims of this study were to determine the best inclusion levels of raw velvet bean seed meal (BVSM) that will enhance the physiological performance of fish maintained in formulated diets and to measure the secondary stresses associated with feeding fish with these diets. In this study, various hematological and biochemical parameters were measured to provide useful data about the physiological performance of juvenile African catfish (*Clarias gariepinus*) fed with various inclusion levels of raw VBSM for 84 days.

Materials and Methods

Juvenile catfish ($n=120$) of average weight, 6.60 ± 0.59 g, were obtained from a commercial fish hatchery located in Iyana-Offa, Oyo State, Nigeria (N07°26.177; E04° 00.369). The fish were divided into four groups of 30 fish each and allowed to acclimatize to laboratory conditions for 14 days. The experimental room temperature was set to 25°C and maintained at 14 h: 10 h light/dark cycles. The experiments were conducted in 38l plastic aquaria, filled with 20l of de-chlorinated tap water.

Raw seeds of velvet beans (*Mucunautilis*) were collected from International Livestock Research Institute (ILRI), Ibadan, de-hauled and milled into fine powder. Four iso-nitrogenous (CP 40%) and iso-caloric (ME 2900, kcal/kg) diets were formulated: Diet 1 without velvet bean served as control (0%), Diets 2, 3, 4, had the soybean component replaced by raw velvet bean at 10, 20 and 30% respectively. The treatments were randomly allotted to the tanks in three replicates. During acclimatization, the fish were fed Coppens® commercial fish pellets diet but at 5% of the body weight of prescribed diets

during the 84-day feeding trial. Water was replaced every 24 h by siphoning. The water quality parameters were monitored daily and mean values were: temperature $28.5 \pm 1^\circ\text{C}$; pH 6.8 ± 0.2 ; DO $6.4 \pm 0.5 \text{ mg.l}^{-1}$

Blood collection and hematological analysis

After 84 days, the fish were mildly anaesthetized with 50 mg.L⁻¹ benzocaine and 1 ml of blood was collected from each fish into EDTA heparinized bottle. The blood was collected through caudal puncture using a heparinized syringe. Hematocrit (percentage packed cell volume) was determined by the microhematocrit method. The red blood cells count, total leucocytes and leucocytes differential counts were done by the method of Dacie and Lewis (2001) using a hemocytometer after the blood had been diluted at 1: 200 with Dacie's fluid and stained with brilliant cresol blue. Mean cell hemoglobin (MCH), mean cell volume (MCV) and mean cell haemoglobin concentration (MCHC) were determined using the formulae given by Clark *et al.* (1979):

$$\text{MCV} = \text{PCV/RBC} \times 10,$$

$$\text{MCH} = \text{Hb/RBC} \times 10 \text{ and}$$

$$\text{MCHC} = (\text{Hb in } 100 \text{ mg blood/Hct}) \times 100.$$

Haemoglobin concentration was determined by spectrophotometry at 540 nm using the cyanmethalomoglobin method (Blaxhall and Daisley, 1973).

Plasma biochemical analyses

Plasma biochemistry parameters: glucose, total protein (TP), albumin, globulin and cholesterol levels were determined using commercially-available reagents that are compatible with Hitachi-912 portable automated chemical analyzer.

Statistical analyses

Data were checked for normality using the Shapiro-Wilk test. Since the data did not deviate significantly from normal distributions, parametric tests were performed. A two-way analysis of variance was performed with the factors being the experimental aquaria and the different dietary formulations. Since there was no significant effect of the experimental aquarium, the factor was eliminated from the

model and the data analyzed using a one-way analysis of variance test. Where significant differences were observed among the different treatment groups, Tukey's multiple comparison tests were performed. All statistics were performed using JMP version 9.0 software (SAS Inc. 2010). Data were expressed as mean $\pm$ standard error, and statistical significance was assumed at $p \leq 0.05$.

Results Hematological parameters

The haematological parameters are presented in Table 1. The group fed with 30% diet inclusion had a significantly higher PCV

compared to the control while the PCV of the groups fed with 10 and 20% diet inclusions were not different from the control. The total RBC count, Hb and MCHC were similar among the treatments but VBSM inclusion significantly increased the MCH and MCV values compared to the control. These values were highest at 30% diet inclusion. The total WBC count increased significantly among the groups in a dose-dependent pattern being highest in the fish fed at 30% inclusion of raw VBSM. Differential analysis of leucocytes showed that lymphocytes were most abundant in the fish while neutrophils were also present.

Table 1: Haematological profile of *C. gariepinus* fed velvet bean based diets

Parameter	Control	10%	20%	30%
PCV (%)	27.00 $\pm$ 0.58 ^a	26.33 $\pm$ 3.51 ^a	26.89 $\pm$ 3.79 ^a	30.33 $\pm$ 2.52 ^b
WBC($\times 10^3$ /mm)	1.83 $\pm$ 2.32 ^c	7.13 $\pm$ 9.53 ^a	5.63 $\pm$ 5.92 ^b	8.00 $\pm$ 3.61 ^a
RBC($\times 10^{12}$ /L)	3.53 $\pm$ 0.15 ^a	2.80 $\pm$ 0.17 ^a	2.37 $\pm$ 0.11 ^a	3.17 $\pm$ 0.68 ^a
Hb (g/L)	9.03 $\pm$ 0.15 ^a	7.90 $\pm$ 1.01 ^a	7.70 $\pm$ 1.30 ^a	10.00 $\pm$ 0.72 ^a
MCHC (g/L)	33.46 $\pm$ 3.45 ^a	32.06 $\pm$ 2.06 ^a	32.06 $\pm$ 1.74 ^a	33.00 $\pm$ 3.02 ^a
MCH (pg)	25.60 $\pm$ 1.39 ^b	28.37 $\pm$ 5.21 ^a	28.37 $\pm$ 3.82 ^a	32.40 $\pm$ 5.89 ^a
MCV (fl)	76.47 $\pm$ 3.55 ^c	88.76 $\pm$ 17.9 ^b	88.77 $\pm$ 11.09 ^b	98.03 $\pm$ 16.17 ^a
Lymphocytes (%)	75 $\pm$ 15.52 ^a	90.33 $\pm$ 10.0 ^b	100.00 ^b	100.00 ^b
Neutrophil (%)	18.33 $\pm$ 8.62 ^a	14.5 $\pm$ 9.19 ^a	0.00 ^c	0.00 ^c

Means with the same superscripts along the same row are not significantly different ($p > 0.05$)

Serum biochemical parameters

The biochemical analysis of the serum is shown in Table 2. The plasma glucose levels in the fish fed 10 and 20% raw VBSM was similar to the control while 30% inclusion showed significant reduction compared to the control. The total protein contents decreased significantly in fish fed diets with raw VBSM inclusion compared to

the control. The plasma cholesterol levels reduced in the groups that were fed raw VBSM compared to the control but this reduction was only significant with 30% inclusion. Similarly, the albumin and globulin levels decreased significantly in the groups fed diets with raw VBSM compared to the control.

Table 2: Plasma Biochemistry of *C. gariepinus* fed velvet bean based diets

Parameter	Control	10%	20%	30%
Glucose (g/L)	39.33 $\pm$ 9.24 ^a	39.00 $\pm$ 11.36 ^a	39.67 $\pm$ 11.36 ^a	32.67 $\pm$ 3.06 ^b
Total Protein (g/L)	129 $\pm$ 48.19 ^b	94.00 $\pm$ 24.64 ^a	40.67 $\pm$ 16.97 ^c	69.33 $\pm$ 1.15 ^d
Cholesterol(mol)	2.2 $\pm$ 0.78 ^a	0.90 $\pm$ 0.3 ^b	0.9a $\pm$ 0.57 ^b	2.17 $\pm$ 0.35 ^a
Globulin (g/L)	110 $\pm$ 45.56 ^a	77.66 $\pm$ 22.50 ^b	33.00 $\pm$ 19.09 ^c	53.33 $\pm$ 5.77 ^d
Albumin (g/L)	18.67 $\pm$ 2.52 ^b	16.00 $\pm$ 2.65 ^a	7.67 $\pm$ 2.12 ^a	15.67 $\pm$ 5.86 ^a
Glo-Alb. Ratio	5.77	4.81	3.02	3.98

Means with the same superscripts along the same row are not significantly different ($p > 0.05$).

Discussion

The results of this study provided some support, although limited, for the inclusion of raw VBSM in fish feed meal especially with regards to the PCV values. A high hematocrit level usually indicates good health status in fish as shown by values between 20 to 35% for healthy fish (Owolabi, 2011). The PCV values did not differ significantly between fish fed with 10 and 20% inclusion of raw VBSM compared to the control but increased significantly at 30% inclusion. This shows that the inclusion of this seed in fish meal has the potential to improve the PCV of fish especially when added in significant proportions.

The other hematological parameters did not support the inclusion of raw VBSM in fish diets. For example, the total RBC counts decreased, although marginally, in the fish fed diets with VBSM inclusion. The RBC is an important component of blood that functions in the transport of oxygen within the body. Studies have shown that a high RBC count is indicative of a strong oxygen-carrying capacity in fish and reflects the ability to carry out aerial respiration and high metabolic activities (Murad *et al.*, 1990; Murad and Houston, 1992). In the present study, the inclusion of raw VBSM in the fish meal did not improve the RBC counts. The WBC (leucocytes) counts have been widely used as biomarker for the assessment of immune status in fish. Generally, an organism will increase the rate of production of WBC in response to invasion by foreign bodies. The fish maintained on diets that included the raw VBSM had significantly higher WBC counts compared to the control thereby indicating that the inclusion produces stress in the fish. This may be in relation to the anti-nutritional factors contained in the raw velvet bean seeds (Nyirenda *et al.*, 2003). The differential leucocytes analyses showed a high lymphocytes count which supports the assertion that raw VBSM in the diet could be detrimental to fish. Also, lymphocytes and neutrophils were the only leucocytes present in this fish with the lymphocytes being more abundant. This agrees with previous studies which showed that the lymphocytes and neutrophils were the most abundant leucocytes present in *Clarias gariepinus* and which were

experimentally challenged with bacterial inoculums (Adeyemiet *et al.*, 2014).

The trends observed in plasma biochemical parameters did not support the inclusion of raw VBSM in fish diets. The plasma glucose and total protein levels have been widely used as indicators of physiological performance in fish (Firatet *et al.*, 2011). Glucose is the primary molecule involved in bioenergetics in animals. The decrease in plasma glucose levels indicates that VBSM inclusion in the diets is hardly beneficial and so the fish expends considerable amounts of energy to survive leading to reduction in the level of plasma glucose. Protein is another molecule involved in bioenergetics in animals, especially where the level of glucose is considerably low. The significant reduction in plasma total protein could mean that protein was being used as energy substrate in this fish even as poor digestibility of plant protein by fish can explain the low levels. The reduction in the level of plasma cholesterol is another indicator that diets with raw VBSM inclusion may be deleterious to *C. gariepinus*. The changes in cholesterol levels indicate stress in fish and the decrease in stressed animals can be a sign of damage to the hepato-pancreas (Svobodova *et al.*, 2006). The globulins and albumin are important plasma proteins that function in the transport of lipids and hormones and also as component of the immune system. Since the levels were significantly reduced in fish fed diets with raw VBSM inclusion, it means that the health status of the fish has been compromised. Usually, a healthy fish maintains a high level of plasma globulins and albumin (Kaleeswaran *et al.*, 2012).

In conclusion, the results of this study indicated that the inclusion of raw VBSM in formulating the diets has not been entirely beneficial to *C. gariepinus*. However, it has the potential to enhance the physiological performance of fish since marked improvement was found in the PCV values of fish fed diets with high percentage of VBSM inclusion. The observed reduction in haematological and plasma biochemical parameters could be due to the presence of anti-nutritional factors that would necessitate further processing of the velvet bean seed before inclusion in fish meal.

References

- Abate, T., Alene, A.D., Bergvinson, D., Shiferaw, B., Silim, S., Orr, A. and Asfaw, S. 2012. *Tropical Grain Legumes in Africa and South Asia: Knowledge and Opportunities*. International Crops Research Institute for the Semi-Arid Tropics. 112 pp.
- Adeyemi, J.A. and Adewale. O.O. 2013. The effects of exposure to multiple stressors of lead (Pb) and cypermethrin on biochemical profiles of African catfish, *Clarias gariepinus*. *Biokemistri* 25: 26-30.
- Adeyemi, J.A., Atere, T.G., Oyedara, O.O., Olabiyi, K.O. and Olaniyan, O.O. 2014. Hematological assessment of health status of African catfish *Clarias gariepinus* (Burchell 1822) experimentally challenged with *Escherichia coli* and *Vibrio fischeri*. *Comparative Clinical Pathology* 23: 1309-1313
- Blaxhall, P.C. and Daisley, K.W. 1973. Routine haematological methods for use with fish blood. *Journal of Fish Biology* 5: 771-781.
- Clark, S., Whitmore, D.H. and McMahon, R.F. 1979. Considerations of blood parameters of largemouth bass, *Micropterus salmoides*. *Journal of Fish Biology* 14: 147-158.
- Dacie, J.V. and Lewis, S.M. 2001. *Practical Haematology*, 9th edn. Churchill, Livingstone, 633pp.
- El-Shebly, A.A. 2006. Evaluation of growth performance, production and nutritive value of the African catfish, *Clarias gariepinus* cultured in earthen ponds. *Egyptian Journal of Aquatic Biology and Fisheries* 10: 55-67.
- Firat, O., Cogun, H.Y., Yuzeroglu, T.A., Gok, G., Firat, O., Kargin, F. and Kotemen, Y. 2011. A comparative study on the effects of a pesticide (cypermethrin) and two metals (copper, lead) to serum biochemistry of Nile tilapia, *Oreochromis niloticus*. *Fish Physiology and Biochemistry* 37: 657-666.
- Kaleeswaran, B., Ilavenil, S. and Ravikumar, S. 2012. Changes in biochemical, histological and specific immune parameters in *Catla catla* (Ham.) by *Cynodon dactylon* (L.). *Journal of King Saud University-Science* 24: 139-152.
- Khwanjai, H., Ward, F.J. and Pornchai, J., 1997. The effect of stocking density on yield, growth and mortality of African catfish (*Clarias gariepinus*, Burchell 1822) cultured in cages. *Aquaculture* 152: 67-76.
- Luckhoff, P.D. 2005. Application of the condition factor in the production of African sharptooth catfish, *Clarias gariepinus*. Unpublished M.Sc. Thesis, University of Stellenbosch, South Africa. 62pp.
- Murad, A. and A.H. Houston. 1992. Maturation of the goldfish (*Carassius auratus*) erythrocyte. *Comparative Biochemistry and Physiology* A102: 107-110.
- Murad, A., Houston, A.H. and Samson, L. 1990. Haematological response to reduced oxygen-carrying capacity, increased temperature and hypoxia in goldfish, *Carassius auratus* L. *Journal of Fish Biology* 36: 289-305.
- Nyirenda, D., Musukwa, M. and Jonsson, L.O. 2003. The effects of different processing methods of velvet beans (*Mucuna utilis*) on L-dopa content, proximate composition and broiler chicken performance. *Tropical and Subtropical Agroecosystems* 1: 253-260.
- Olasunkanmi, J.B. and Omitoyin, B.O. 2011. Growth response of *Clarias gariepinus* (Burchell 1822) juveniles to diets containing raw *Mucuna utilis* seed meal. *Journal of Aquaculture, Feed Science and Nutrition* 3: 17-19.
- Owolabi, O.D. 2011. Haematological and serum biochemical profile of the upside-down catfish, *Synodontis membranacea* Geoffroy Saint Hilaire from Jebba Lake, Nigeria. *Comparative Clinical Pathology* 20: 163-172.
- SAS, (2006). Institute Lac, SAS/STAT User's Guide: Version 6, Fourth Edition, Cary, NC. SAS Institute Inc. 2: 846.
- Svobodova, Z., Vykusova, B., Modra, H.,

- Jarkovsky, J. and Smutna, M. 2006. Haematological and biochemical profile of harvest-size carp during harvest and post-harvest storage. *Aquaculture Research* 37: 959-965.
- Vadivel, V., Pugalenth, M., Doss, A. and Parimelazhagan, T. 2011. Evaluation of velvet bean meal as an alternative protein ingredient for poultry feed. *Animal* 5: 67-73.
- Wang, A., Han, G., Lv, F., Yang, W., Huang, J. and Yin, X. 2014. Effects of dietary lipid levels on growth performance, apparent digestibility coefficients of nutrients, and blood characteristics of juvenile Crucian carp (*Carassius auratus gibelio*). *Turkish Journal of Fisheries and Aquatic Sciences* 14: 1-10.
- Xu, W., Gao, Z., Qi, Z., Qiu, M., Peng, J. and Shao, R. 2014. Effect of dietary *Chlorella* on the growth performance and physiological parameters of gibel carp, *Carassius auratus gibelio*. *Turkish Journal of Fisheries and Aquatic Sciences* 14: 53-57.

Potentials of Unripe Mature Pawpaw Fruit (*Carica papaya*) Meal as Alternative Dietary Carbohydrate Source for Catfish (*Clarias gariepinus*) Fingerlings

B. W. Obe, and O. L. Ajayi,

Department of Fisheries and Aquaculture Management,

Faculty of Agricultural Sciences,

Ekiti State University, P.M.B. 5363, Ado-Ekiti, Nigeria

Corresponding Author: E-mail address: bernadine.obe@eksu.edu.ng; +2348035746786

Abstract

Maize grains are the sources of energy supply in fish diets but the availability is now constrained by high cost due to stronger competition from the use as human foods, livestock feeds, and industrial raw materials. *Unripe mature pawpaw (Carica papaya) fruit meal (UMPFM) should be evaluated as an energy source to replace maize in fish diets without compromising fish growth and health. Ten fingerlings of Clarias gariepinus were randomly stocked into 10 tanks and subjected to five diet treatments formulated at 40% crude protein and with the UMPFM added at 0, 20, 40, 60 and 80% replacement, in two replicates. The fingerlings were fed for 70 days. The results show that fish fed with the diet at 40% replacement level had the best performance (specific growth rate of 2.073 ± 0.014 , feed conversion ratio of 1.427 ± 0.016 and protein efficiency ratio of 0.349 ± 0.002) while fish fed with the diet at 80% replacement level had the least performance (specific growth rate of 2.032 ± 0.036 , feed conversion ratio of 1.480 ± 0.057 and protein efficiency ratio of 0.334 ± 0.013). The cost of producing 1 kg of the experimental diets reduced as the replacement of UMPFM increased. Therefore, UMPFM which improved the growth performance and nutrient utilization, and reduced the cost of production could be considered as a potential replacement for maize in the diets of Clarias gariepinus fingerlings.*

Keywords: Unripe mature pawpaw fruit meal, *Clarias gariepinus*, fingerlings, growth performance.

Introduction

Fish is one of the most important and cheapest sources of animal protein and accounts for twenty percent of animal-derived protein in income-deficit countries (Delgado et al., 2003). Fish contains high levels of essential amino acids required by the body for maintenance of lean tissue (Fagbenro and Adeparusi, 2003). The most popular fish species that have proved desirable for culture in Nigeria are the Clariid fishes- *Clarias gariepinus*, *Heterobranchius* spp, 'Heteroclaris' spp (Adekoya et al., 2006) but the African catfish (*Clarias gariepinus*) remains the most sought-after species for research in aquaculture.

Feed is the most expensive cost item in semi-intensive and intensive fish culture (De Silva, 1993; Thompson et al., 2005) and maize grains are commonly used as a source of energy in fish diets. Unfortunately, the competition for maize in human foods, livestock feeds and as a raw material in industries continues to limit its supply and availability such that the price is very high in the market. Thus, the efforts to identify

locally available alternative sources of energy which will replace maize without compromising fish growth and health must receive proper attention.

Pawpaw (*Carica papaya*) originated in Central America, probably in the regions of southern Mexico and Costa Rica, and is now distributed throughout the tropics and subtropics where it is cultivated for the edible ripe fruits (Morton, 1987). The fruit is a 7-30 cm long, ovoid-oblong to spherical berry that weighs up to 9 kg with a central cavity containing many small black seeds. The immature fruit has a thin, smooth and green skin which matures and turns yellowish or orange when ripe. The skin is peeled to reveal the edible yellow to reddish flesh with the consistency of butter and has mild and pleasant flavour. The fresh pawpaw fruit is rich in fibre, vitamins (vitamin C, vitamin A, thiamine) and minerals (iron, calcium, and magnesium) (Manshardt et al., 1992; Fernandes et al., 2006). It is eaten for breakfast and dessert and in fruit salads; and used in making soft drinks, jam, marmalades, ice

cream flavours and syrup. Papaya fruit is highly appreciated worldwide for its flavor, nutritional qualities, digestive properties and serotonin content (Fernandes et al., 2006) as well as for its many medicinal and pharmacological properties (Morton, 1987; Mezhlumyan, 2003, Aravind et al., 2013).

The pawpaw fruit is common in Nigeria and floods the market during the harvest season resulting in glut and heavy post-harvest losses which reflect the poor state of development in the pawpaw value-chain. One way to minimize the volume of harvested fruits and the undesirable glut in the market will be to find alternative uses for the unripe fruits whose pulp has a proximate analysis of 13.63% crude protein, 10.66% moisture, 1.29% fat, 43.28% starch and 1.88% fiber (Oloyede, 2005) This nutrient composition would make unripe pawpaw fruits useful in nutrition. The crude protein content at 13.63% compared to 10% in maize suggests that the unripe pawpaw pulp can be a substitute for maize in the formulation of fish feeds. This form of utilization, as a feed ingredient, will reduce the waste of ripe fruits and reduce the competition for maize grains needed for human food, livestock feeds and raw material in food and beverages industries.

The objectives of this study are to:

- (i) determine the proximate composition of unripe mature pawpaw fruit meal
- (ii.) determine the effects of unripe mature pawpaw fruit meal on the growth and nutrient utilization of *Clarias gariepinus*.
- (iii.) determine the economic viability of using unripe mature pawpaw fruit meal for feeding *Clarias gariepinus*.

Materials and Methods

Ten (10) 30-litre plastic tanks with water level maintained at 20 litres were used for the experiment which was carried out in the Teaching and Research Farm, Ekiti State University, Ado-Ekiti. The underground borehole provided the water used for the experiment. 100 fingerlings of catfish (*Clarias gariepinus*) with the minimum mean weight of 4.29 g were purchased from the Federal Ministry of Agriculture, Ado Ekiti and allowed to acclimatize in the plastic tanks for 3 days. The fingerlings were randomly stocked at the rate of ten per tank. Each treatment was in duplicates and the experiment lasted for 70 days.

Feed formulation and preparation: Unripe mature pawpaw fruits (*Carica papaya*) were peeled, cut to remove the seeds, cut into flat slices and sun-dried. The sun-dried pawpaw slices were milled to obtain the unripe mature pawpaw fruit meal (UMPFM) used to replace maize in the diet at 0%, 20%, 40%, 60% and 80% inclusion levels and designated as Diets CTR, D2, D3, D4, and D5 respectively. The ingredients for each diet (Table 1) were mixed together thoroughly in a bowl and starch was added to act as a binder. The materials were processed into 2 mm size pellets using a pelleting machine. The pellets were sun-dried, packed in labeled cellophane bags and stored in a cool and dry place.

Growth experiment: The five diets were fed to the fish in the individual tanks at 5% of their total body weight daily. Feeding was done twice daily at 08.00-09.00 hours and 17.00-18.00 hours. The fish in each tank were weighed fortnightly and the feeding rate was adjusted with respect to body weight.

Table 1: The composition of formulated diets used for the experiment

Ingredients	Diet CTR	Diet D2	Diet D3	Diet D4	Diet D5
Replacement level	0%	20%	40%	60%	80%
Fish meal (72%)	31.76	31.31	30.86	30.44	29.99
Soyabean Meal (45%)	31.76	32.20	32.65	33.07	33.52
Yellow maize (10%)	28.49	22.79	17.09	11.40	5.70
UMPFM (12.08%)	-	5.70	11.40	17.09	22.79
Methionine	0.4	0.4	0.4	0.4	0.4
Mineral and vitamin premix	4.0	4.0	4.0	4.0	4.0
Vegetable oil	2.5	2.5	2.5	2.5	2.5
Starch	1.1	1.1	1.1	1.1	1.1
TOTAL	100.01%	100%	100%	100%	100%
Crude protein	40%	40%	40%	40%	39.99%

The wastes (uneaten feed and faeces) were siphoned out early in the morning every day. The physicochemical parameters of the water were measured fortnightly. The parameters measured immediately after water collection with a sampling bottle were dissolved oxygen using an oxygen meter, temperature using a mercury-in-glass thermometer and pH using a digital pH meter (Mettler Toledo 320).

Biological evaluation: Diet performance was determined as follows:

- Weight gain = Final weight of fish (w_2) - Initial weight (w_1)
- Specific Growth Rate (SGR) = $\frac{\ln \text{final } w - \ln \text{initial } w}{\text{Time period (Days)}} \times 100$
- Protein Efficiency Ratio (PER) = $\frac{\text{Fish weight gain (g)}}{\text{Protein consumed (g)}}$
- Feed Conversion Ratio (FCR) = $\frac{\text{Weight of feed (g)}}{\text{Fish weight gain (g)}}$

feed (g)

Fish weight gain (g)

Proximate analysis: The proximate analysis of the fish before and after the experiment was carried out using the methods described in AOAC (2005). The parameters determined were moisture content, crude protein, lipid, crude fibre, ash and carbohydrate contents.

Statistical analysis: The data obtained were subjected to statistical analysis (ANOVA) using SPSS version 15 and the differences between treatment means were separated using Duncan multiple range tests (Duncan, 1955).

Results Proximate analysis of unripe pawpaw fruit meal

The proximate composition of the UMPFM is presented in Table 2. The meal contained 64.12% nitrogen-free extract (carbohydrate), 12.08% crude protein, 1.25% lipid and 6.00% ash.

Table 2: The proximate composition of unripe mature pawpaw fruit meal

Crude protein	Lipid	Crude fibre	Ash content	Moisture	NFE
12.08%	1.25%	1.60%	6.00%	14.95%	64.12%

Nutrient utilization and growth of experimental fish

Table 3 shows the mean weight gain, the average daily weight gain, and the specific growth rate

of the experimental fish. The initial mean weight of fish was 4.29 g while the final mean weight was 18.02 g. The highest weight gain was in fish fed with diet D3 (14.02

Table 3: The performance evaluation of *Clarias gariepinus* fed with unripe mature pawpaw (*Carica papaya*) fruit meal.

Parameters	CTR (D1)	D2	D3	D4	D5
Initial weight (g)	4.29±0.01 ^a	4.29±0.01 ^a	4.29±0.01 ^a	4.27±0.01 ^a	4.29±0.02 ^a
Final weight(g)	17.85±0.26 ^a	17.96±0.21 ^a	18.31±0.15 ^a	18.22±0.39 ^a	17.78±0.54 ^a
Weight gain	13.56±0.25 ^a	13.67±1.21 ^a	14.02±0.16 ^a	13.95±0.37 ^a	13.49±0.52 ^a
Average daily weight gain	0.1937±0.004 ^a	0.1953±0.000 ^a	0.2003±0.002 ^a	0.1993±0.003 ^a	0.1927±0.008 ^a
Specific growth rate	2.0367±0.021 ^a	2.0455±0.015 ^a	2.0731±0.014 ^a	2.0727±0.033 ^a	2.0311±0.036 ^a
Protein efficiency ratio	0.335±0.007 ^a	0.342±0.004 ^a	0.349±0.002 ^a	0.348±0.011 ^a	0.334±0.013 ^a
Feed conversion ratio	1.476±0.026 ^a	1.463 ± 0.022 ^a	1.427±0.016 ^a	1.433±0.038 ^a	1.487±0.057 ^a

Mean and standard deviation along the same row and followed by the same superscripts are not significantly different ($p > 0.05$).

Cost of Experimental Diets

The cost analysis of the experimental diets is shown in Table 4. The feed with the

highest cost per kg feed is the control while D5 had the lowest cost per kg feed.

Table 4: The costs of formulated diets used for the experiment

Ingredients	CTR (₦)	D2 (₦)	D3 (₦)	D4 (₦)	D5 (₦)
Fish meal (72%)	177.86	175.34	172.82	170.46	167.94
Soya bean meal (45%)	50.82	51.52	52.24	52.91	53.63
Yellow maize (10%)	17.66	14.13	10.60	7.07	3.53
UMPFM (12.08%)	-	1.71	3.42	5.13	6.84
Methionine	4.0	4.0	4.0	4.0	4.0
Minerals and vitamin premix	40.0	40.0	40.0	40.0	40.0
Vegetable oil	25.0	25.0	25.0	25.0	25.0
Starch	0.8	0.8	0.8	0.8	0.8
TOTAL	316.14	312.50	308.88	305.37	301.74

Water quality parameters

Table 5 shows the water quality parameters measured during the period of the experiment. The temperature and dissolved oxygen ranged

between 25.39 ± 0.212 – 25.87 ± 0.594 °C and 5.23 ± 0.0007 – 5.34 ± 0.021 mg/litre respectively while the pH ranged between 6.84 ± 0.000 – 6.93 ± 0.000

Table 5: Water quality parameters recorded during the experimental period

Tanks	Temperature (°C)	DO ₂ (mg/ litre)	pH
CTR (D1)	25.74 ± 0.714^a	5.27 ± 0.007^a	6.87 ± 0.035^{ab}
D2	25.81 ± 0.735^a	5.23 ± 0.035^a	6.93 ± 0.000^a
D3	25.79 ± 0.792^a	5.28 ± 0.014^a	6.92 ± 0.035^a
D4	25.87 ± 0.594^a	5.23 ± 0.007^a	6.89 ± 0.028^{ab}
D5	25.39 ± 0.212^a	5.34 ± 0.021^a	6.84 ± 0.000^b

Mean and standard deviation along the same column and followed by the same superscripts are not significantly different ($p > 0.05$).

Proximate Composition of the Experimental Fish Carcass

The carcass composition of the experimental fish is given in Table 6. The crude protein content in all the fish fed the experimental diets increased compared to the initial protein content. The protein content was

highest in the fish fed with diet D4 (64.33 ± 0.59) while the fish fed with diet D5 contained the least protein at 56.25 ± 0.35 . The lipid content in fish fed with diet D5 was the highest (17.32 ± 1.22) while the fish fed the control diet had the lowest value (8.49 ± 0.16).

Table 6: The carcass composition of experimental fish

Parameter	Initial	Diet CTR	Diet D2	Diet D3	Diet D4	Diet D5
Crude protein	51.57 ± 0.276^e	63.90 ± 0.134^a	58.05 ± 0.424^c	62.13 ± 1.237^b	64.33 ± 0.594^a	56.25 ± 0.354^d
Lipid	11.66 ± 0.247^b	8.49 ± 0.143^c	16.44 ± 2.737^a	14.26 ± 1.853^{ab}	12.16 ± 0.566^b	17.32 ± 1.216^a
Ash	17.30 ± 0.085^a	15.19 ± 0.268^a	12.63 ± 1.534^c	12.39 ± 1.513^c	10.88 ± 1.245^c	12.92 ± 1.945^c
Moisture	13.93 ± 0.240^a	8.71 ± 0.481^b	9.79 ± 2.369^b	8.46 ± 0.785^b	9.18 ± 0.962^b	9.79 ± 1.464^b
N F E	5.55 ± 0.198^a	3.54 ± 0.014^a	3.11 ± 2.326^a	2.78 ± 0.792^a	3.45 ± 0.311^a	3.73 ± 1.344^a

NFE = Nitrogen-free extract

Means and standard deviation along the same row and followed by the same superscripts are not significantly different ($p > 0.05$).

Discussion

This study evaluated the potential of unripe mature pawpaw fruit meal (UMPFM) as a replacement for maize in the diet of *Clarias gariepinus* fingerlings. This is to complement previous studies that identified locally available feed resources as substitutes or replacement to the major conventional nutrient sources and feedstuffs such as maize, fish meal, soybean meal, groundnut cake etc. in fish feed formulations (Adeparusi and Olute, 2000; Okoye and Nnaji, 2004; Olaleye, 2015; Sashi, 2015). Oftentimes, the non-conventional feedstuffs would require upgrading through processing or fortification to improve their nutrient values, nutrient availability, and absorption by the test fish species. Maize has been of particular interest to many researchers because of its cost dictates or drives the market prices of some other feed ingredients, especially the energy and protein sources (Dairo, 2016). Many studies had successfully demonstrated the replacement of maize with other ingredients in livestock feeds. Sweet potato peel meal successfully replaced maize up to 75% replacement level in fish with better growth performance recorded in all the treatment fed the test ingredient than was recorded in the control diet that had 0% of the test ingredient (Olukunle, 2006). Oresegun and Alegbeleye (2002) and Abu *et al.* (2010) investigated the use of cassava peels and roots to replace maize in the fish diet with different levels of success. Okoye *et al.* (1994) also investigated the nutritive value of different parts of water hyacinth and concluded that the leaves and petioles could be potential feed ingredients in the fish diet.

The results of this study have shown that UMPFM can be a potential feed ingredient as a replacement for maize in enhancing the productivity of *Clarias gariepinus*. The acceptability of the fish to all the diets was good as attested to by the increase in body weight which reflected in general increase in weight gain from the first week till the end of the experiment at the 10th week. The best growth performance as indicated by the parameters measured and nutrient utilization were achieved in the fish fed at 40% replacement level of UMPFM (D3). Obe (2014) had obtained the best growth performance at 20% replacement level of maize with fermented sorghum waste in the diet of

hybrid catfish (*Heteroclaris*). The least growth performance and nutrient utilization recorded in the fish fed with 80% replacement level of UMPFM (D5) was probably a result of the reduced palatability of the diet which caused lower feed intake.

The better growth performances recorded in D2, D3, and D4 than the control (D1) indicate that UMPFM is a potential substitute for maize and can be added up to 60% inclusion level without adverse effects on the growth and nutrient utilization of *Clarias gariepinus* fingerlings. At the higher levels of substitution, however, reduced growth would set in, as observed in fish fed at 80% replacement level (D5). This differs from the results from Aderoluet *al.* (2009) and Agbabiaka *et al.* (2012) who indicated the best performances in the control diet when maize was replaced with processed cocoyam and tiger nut respectively in *Clarias gariepinus* diets with the performance reducing as the level of replacement increased. Pawpaw is rich in nutrients and minerals such as vitamin A, vitamin C, riboflavin, foliate, calcium, thiamin, iron, niacin and potassium (Manshardt, 1992; Fernandes *et al.*, 2006) which would also have positive effects on the fish growth performance. The protein content of UMPFM at 12.08% is lower than 13.63% obtained in the pulp of unripe mature pawpaw fruit (Oloyede, 2005) which may be due to differences in pawpaw variety, environmental conditions such as soil type and fertility level, method of production and harvesting time. Besides, the production of UMPFM involved slicing and sun-drying the pulp and milling into powder form during which some organic constituents, especially proteins, would have been denatured leading to the loss of nutritional value.

The cost of producing 1 kg feed in the experimental diets reduced as the level of replacement of maize with UPMF increased. Thus, the feeds involving 20-80% inclusion levels of UMPFM were less costly than the maize-based diet. This reduction in cost will invariably lead to lower production cost and thereby making fish farming more profitable. However, because of the lower performance in growth parameters and nutrient utilization, it is not advisable to use the diet with 80% inclusion level of UMPFM in feeding *Clarias gariepinus* fingerlings.

Conclusion

This study showed that maize can successfully be replaced up to 60% with unripe mature pawpaw fruit meal (UMPFM) in the diet of *Clarias gariepinus* compared to fish fed on maize as the sole energy source (the control diet), based on the growth performances and nutrient utilization parameters. The replacement has the potential of reducing the high competition for maize which has engendered the

rising costs without loss of productivity and nutrient utilization. The feeds formulated at 20-80% inclusion levels of UMPFM cost less than the maize-based diet. The diet with 80% inclusion level of UMPFM gave poor performance and would not be advisable for feeding fish. Therefore, the use of UMPFM to replace maize up to 60% as a source of carbohydrate in the diet of *Clarias gariepinus* should be given consideration.

References

- Abu, O. M. G., Gabriel, U. U. and Akinrotimi, O. A. (2010). Performance and survival of hybrid catfish (*Hetero X Clarias*) fed with whole cassava root meal as a replacement for maize *Journal of Tropical Agriculture Environment and Extension* 9: 176-183.
- Adekoya, B.B., Ayansawo, T.O., Idowu, A.A., Kudoro, O.A. and Salisu, A.A. (eds) (2006).
- Directory of Fish Hatcheries in Ogun State Agricultural Development Programme (OGADEP), Abeokuta. 18pp.
- Adeparusi, E.O. and Olute, B.W. (2000). Effects of methionine supplemented toasted lima bean (*Phaseolus lunatus*) diets on the growth of *Oreochromis niloticus*. *Journal of Applied Tropical Agriculture* 5(2); pp 113-117.
- Aderolu, A. Z; M.O. Lawaland M. O. Oladipupo (2009). Processed cocoyam tuber as a carbohydrate source in the diet of juvenile African catfish (*Clarias gariepinus*). *European Journal of Scientific Research* 35(3), 453-460
- Adewolu, M. A. and A. A. Adamson (2011). *Amaranthus spinosus* leaf meal as a potential dietary protein source in the practical diets for *Clarias gariepinus* (Burchell, 1822) fingerlings. *International Journal of Zoological Research*. 7 (2): 128-137
- Agbabiaka, L.A., Madubuike, C.U. and Anyanwu, C.N. (2012). Replacement value of tiger nut meal (*Cyperus esculentus*) with maize in catfish (*Clarias gariepinus*) diets. *Science Research Reporter* 2(2): 130-134
- A.O.A.C. (1990). Association of Official Analytical Chemists. Official Methods of Analysis, 15th edition. Washington D.C., United States of America. 1230pp.
- Aravind. G, Debjit Bhowmik, Duraivel. S, Harish. G (2013). Traditional and Medicinal Uses of *Carica papaya*. *Journal of Medicinal Plants Studies*. 1(1): 7-15
- Candolle, A. de. (1908). Origin of Cultivated Plants. International Scientific Series published by D. Appleton & Co. New York, N.Y. 492pp.
- Dairo, F. A. S. (2016). The Battle for Food and Feed: No Victor No Vanquished. 45th Inaugural Lecture, Ekiti State University, Ado-Ekiti. 80pp.
- Delgado, C. L.; N. Wada; M. W. Rosegrant; S. Meijer and M. Ahmed (2003): Fish to 2020, supply and demand in changing global markets. *World Fish Centre Technical Report* 62, 83pp.
- De Silva S.S. (1993): Supplementary feeding in semi-intensive aquaculture systems. In: New, M.B., Tacon, A.G.J. and Csavas, I. (Editors). Farm-Made Aquafeeds. Proceedings of the FAO/AADCP Regional Expert Consultation on Farm-Made Aquafeeds; 14-18th December 1992, Bangkok, Thailand. FAORAPA/AADCP, Bangkok, Thailand: 24-60.
- Duncan, D. B. (1955). *Multiple Range and Multiple F Test*. *Biometrics* 11: 1-42.
- Mezhlumyan, L.G.; Kasymova, T. D.; Yuldashhev, P. Kh. (2003). *Proteinases from Carica Papaya latex*. *Chemistry of Natural Compounds*. 39:223-228.
- Morton, J. F. (1987). *Papaya Carica papaya L*. In: *Fruits of Warm Climates*.

- Creative Resource Incorporated, Winterville, N.C.* pp336-346. http://www.hort.purdue.edu/newcrop/morton/papaya_ars.
- Fagbenro, O.A. and E.O. Adeparusi (2003). *Feedstuff and dietary substitution for farmed fish in Nigeria. Paper presented at Pan-African Fish and Fisheries Conference, Cotonou, Benin Republic.* 276pp
- Fernandes, F. A. N., Rodrigues, S., Gaspareto, O.C.P. and Oliveira, E.L. (2006). Optimization of osmotic dehydration of papaya followed by air-drying. *Food Research International*, 39(4): 492-498.
- Manshardt, R. M. (1992). Papaya. In: Hammerschlag, F.A. and Litz, R.E. (eds). *Biotechnology of Perennial Fruit Crops*, Vol. 21. CAB International, Wallingford, UK: 489-511.
- Obe, B.W. (2014). Growth performance and nutrient utilization of catfish hybrid (*Heterobranchus bidorsalis* × *Clarias gariepinus*) fed fermented sorghum (*Sorghum bicolor*) waste meal diets. *International Journal of Applied Science and Technology*. 4(3): 130-136.
- Okoye, F. C., Daddy, F. and Ilesanmi, B. D. (1994). The Nutritive Value of Water Hyacinth (*Eichhornia crassipes*) and its Utilisation in Fish Feed. 7pp. http://aquaticcommons.org/965/1/WH_065-070.pdf
- Okoye, F. C. and Nnaji, J. C. (2004). Effects of substituting fishmeal with grasshopper meal on the growth and food utilization of the Nile Tilapia, *Oreochromis niloticus* fingerlings. <http://aquaticcommons.org/3987/1/30.pdf>.
- Olaleye I.G (2015). Effects of grasshopper meal in the diet of *Clarias gariepinus* fingerlings. *Journal of Aquac Res and Development* 6: 321.
- Oloyede, O.I. (2005). Chemical profile of unripe pulp of *Carica papaya*. *Pakistan Journal of Nutrition*, 4(6): 379-381.
- Olukunle, O. (2006). Nutritive potential of sweet potato peel meal and root replacement value for maize in diets of Africa catfish (*Clarias gariepinus*) advanced fry *Journal of Food Technology* 4(4): 289-293.
- Oresegun, A. and Alegbeleye, W. O. (2002). Serum and tissue thiocyanate concentration in tilapia (*Oreochromis niloticus*) fed cassava peel based diets supplemented with DL-methionine. *Journal of Aquaculture in the Tropics* 17(2): 93-100.
- Sashi, B. M. (2015). Utilization of water hyacinth (*Eichhornia crassipes*) meal as partial fish protein replacement in the diet of *Cyprinus carpio* fry. *Euro. J. Exp. Bio.* 5(5):31-36.
- Thompson K.R., Muzinic, L.A., Engler, L.S. and Webster, C.D., (2005): Evaluation of practical diets containing different protein levels, with or without fish meal, for juvenile Australian red claw crayfish (*Cherax quadricarinatus*). *Aquaculture*. 244 (1-4): 241-249.

Comparative Assessment of Value Addition Techniques used by Rice Farmers in Edu and Patigi Local Government Areas of Kwara State, Nigeria

¹F.O.Oladipo, ¹A.K.Daudu, ¹R.O.Orire, ³A.O.Adekunmi and ¹A.L.Onasanya,

¹Department of Agricultural Extension and Rural Development,
University of Ilorin, Ilorin, Nigeria

²Department of Agricultural Economics and Extension,
Kwara State University, Malete, Nigeria

³Department of Agricultural Economics and Extension Services,
Ekiti State University, Ado-Ekiti, Nigeria

E-mail: felixoladipo5@gmail.com

Abstract

This study compared the use of value addition techniques by rice farmers in Edu and Patigi Local Government Areas of Kwara State, Nigeria. A purposive sampling technique was employed to select 120 rice farmers as respondents to well-structured questionnaire and interview schedule and descriptive and inferential statistics were used to analyze the responses. The results show that the mean ages of the rice farmers at 48.5 and 49.3 years in Edu and Patigi respectively. Majority of the respondents in Edu (86.7%) and Patigi (98.3%) were males and with 36.7 and 46.7% of the rice farmers respectively without formal education. Most (64.2%) of the rice farmers in Patigi used improved technology and only (42.1%) of rice farmers in Edu. The rice farmers in Edu and Patigi used value addition techniques but the order of importance of the various stages in rice value addition initiatives was not the same. Most of the respondents in Edu (71.3%) and Patigi (61.7%) sourced their information through extension services and the constraints the rice farmers face include insufficient capital and poor government supports. Since more rice farmers in Patigi were using improved technologies than their counterparts in Edu, the study recommended that the extension agents should intensify more efforts in the training and retraining of rice farmers on the effective use of improved value addition techniques.

Keywords: Comparative, Assessment, Value Addition Techniques, Rice Farmers

Introduction Rice (*Oryza sativa* L) is one of the most extensively cultivated arable crops in the world. It grows and completes the production cycle within 13 to 20 weeks depending on the species, biotechnology effect, climate and edaphic factors. Rice does best in waterlogged clayey soils though with irrigation and under controlled environment production, it can be produced on different types of soil including mountain tops (Ugwuet al., 2014).

Rice is grown on approximately 3.7 million hectares (ha) of land in Nigeria, covering 10.6 percent of the 35 million hectares (ha) of land under cultivation in any year. About 77% of the area cultivated to rice is rain-fed with 47 and 30% under lowland and upland ecologies (Bayou Farms and Industries Limited, 2009). Domestic rice production has increased over the past three decades in response to favourable government policies of input subsidies and ban on rice imports that ensured higher produce

prices which made Nigeria the largest rice producer in West Africa (Osungbade, 2004, WARDA, 2005), but the output level cannot meet the national requirements. The demand for rice is double the rate of population growth which has necessitated increased imports that constitute huge drains on the scarce foreign exchange.

Rice is one of the crops targeted for accelerated production to ensure household food security. The primary output from the rice fields is paddy obtained after harvesting, threshing and winnowing. The paddy would subsequently need to be processed in order to obtain consumable product. Rice processing entails two distinct operations: parboiling and milling. Parboiling rice paddy requires soaking paddy in hot or cold water in a drum, followed by a rapid exposure of the soaked paddy to steam and a gradual drying for at least one day (Lancon, et al., 2003). The purpose of the operation is to respond to consumer preferences

while it also has a positive effect on the grain milling and nutritional properties. Rice milling consists of removing the husk (shell) from grains after parboiling. Traditionally, rice processors removed shell from their grains by hand pounding but this practice has been replaced with machines in mills where such services are being rendered (Osungade, 2004). The final product is usually of poor quality which may relate to the biophysical properties of the varieties grown but the major problem is the appearance and the cleanliness of the grains delivered to the market (Lancon, *et al.*, 2003). The low quality of locally-produced rice arising from poor processing and packaging has increased the preference of urban dwellers for imported rice. With adequate processing, the locally-produced rice can compete favourably with imported ones and add market value to the product with its intact nutrients compared to the imported rice which takes five years after production before being consumed in Africa and would have lost its nutrients (WARDA, 2005).

Value addition during rice processing with a view to improving the quality can be used to improve the quality and acceptability of the produce of Nigerian rice farmers. The value addition activities and strategies will in one way or the other contribute to the maximization of profit or utility derived from rice. This study was designed to assess the value addition techniques used by rice farmers and identify the constraints that affect their adoption in Edu and Patigi Local Government Areas of Kwara State, Nigeria.

Methodology

The study was carried out in Edu and Patigi Local Government Areas (LGAs) of

Kwara State, Nigeria. Kwara State covers an area of approximately 32,000 square kilometers and it shares boundary with Niger, Oyo, Osun, Kogi States and the Republic of Benin. Edu and Patigi LGAs are in Kwara Central Senatorial District and inhabited by Nupe people who exhibit a linguistic repertoire of the Yoruba dialect but are not fluent in Yoruba Language. They are farmers, aquatic sellers, fishers, transporters and traders. The population for the study comprised of all rice farmers in Edu and Patigi LGAs of Kwara State, Nigeria. Purposive sampling technique was used to select 120 respondents from Edu and Patigi LGAs located closely to the south bank of River Niger. Descriptive statistical tools such as frequency counts, mean, charts and percentages were used while the inferential tool of the Pearson Product Moment Correlation (PPMC) was used to make deduction from the study.

Results and Discussion

The socio-economic characteristics of the respondents are shown in Figs 1-7. The results in Fig. 1 show that the mean age of the rice farmers in Edu was 48.5 years and 49.3 years in Patigi. This suggests that an average rice farmer in Patigi is older than the counterpart in Edu. The respondents of less than or equal to 30 years of age were 15.0 and 18.3% in Edu and Patigi respectively. Fig. 2 shows that there were male and female rice farmers in the study areas but overwhelming majority of the respondents in Edu (86.7%) and Patigi (98.3%) were males thereby confirming the dominance of male in the production of rice.

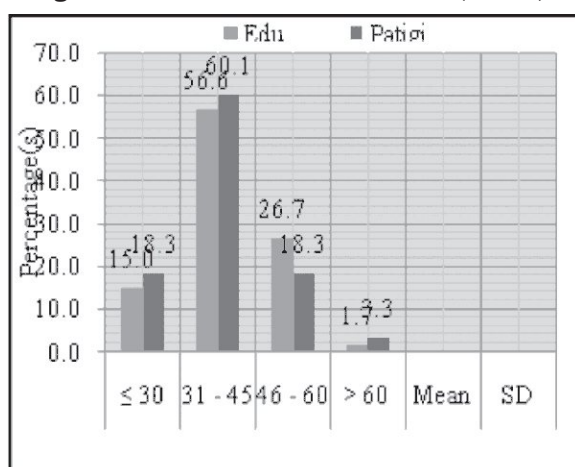


Fig. 1: Age of the respondents

Source: Field survey, 2016

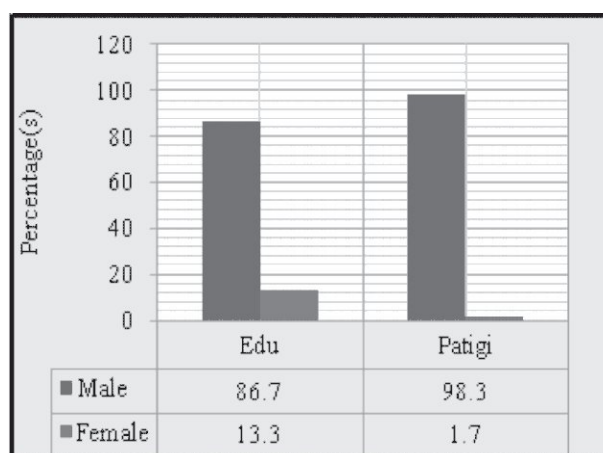


Fig. 2: Gender of the respondents

Fig. 3 shows that majority of the respondents in Edu (88.3%) and Patigi (86.7%) were married and would have family responsibilities that they must attend to physically, socially and economically. The engagement in rice farming

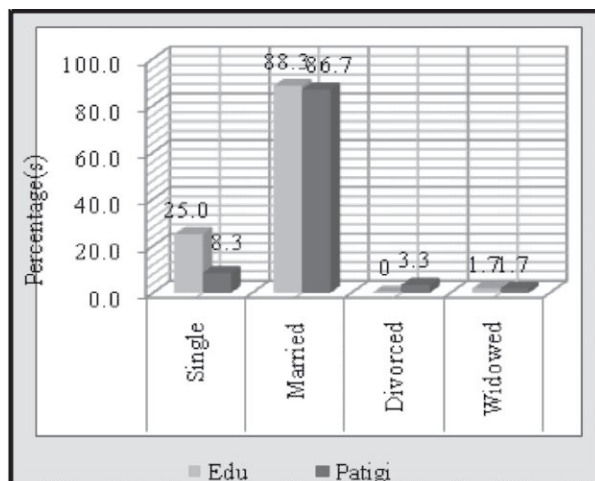


Fig. 3: Marital status of the respondents

Source: Field survey, 2016

The mean farm size for Edu was 5.20 ha while that of Patigi was 8.53 ha (Fig. 5). This suggests that rice farmers in Patigi cultivate larger farm lands than their counterparts in Edu. Fig.6 shows that about 65.0 and 78.3% of respondents in Edu and Patigi respectively belong to one form of cooperative group or the

as a source of income or to feed their families even as their marital status would be the catalyst to the commitment to rice farming since their integrity is at stake. Fig. 4 show that about 36.7 and 46.7% of the rice farmers in Edu and Patigi respectively had no formal education.

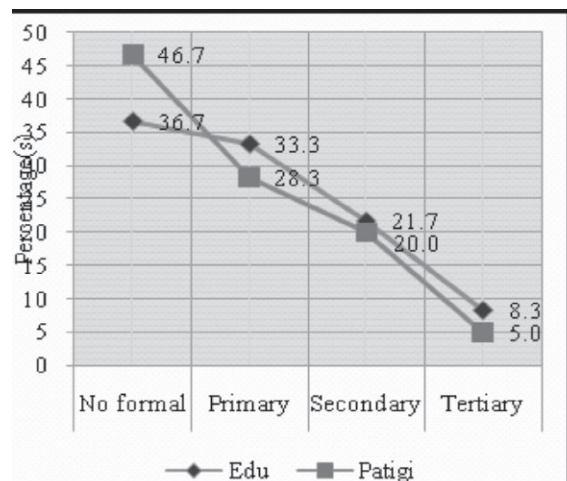


Fig. 4: Educational level of the respondents

other. However, the implication of this is that more rice farmers in Patigi would enjoy support from their cooperative societies. Also, majority 85.0 and 88.3% of respondents in Edu and Patigi respectively had contact with extension agents and this confirmed the high presence of extension agents.

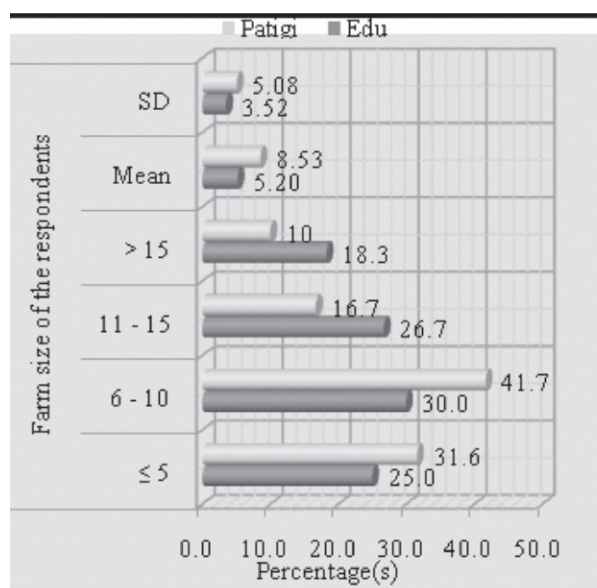


Fig. 5: Farm size of respondents

Source: Field survey, 2016

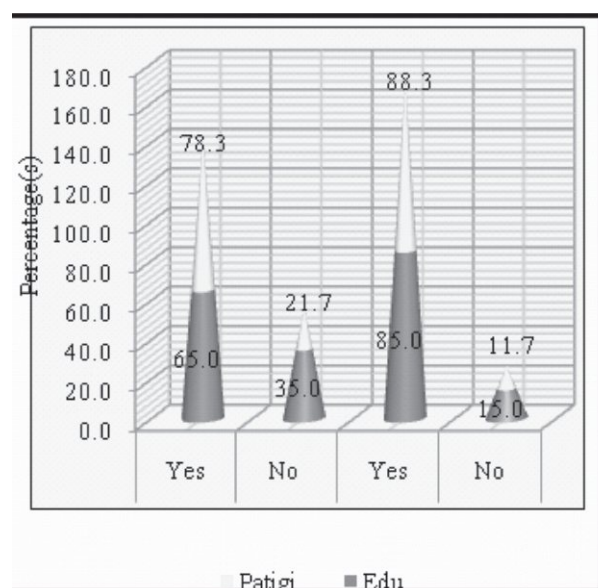


Fig. 6: Membership of coop. and extension contact

The results in Fig. 7 show that most (60%) of respondents in Edu and only 36.7% in Patigi earn at least ₦200,000 per annum, some 20.0% in Edu and 21.7% in Patigi earn ₦200,001-400,000 per annum while only in Patigido some

respondents (8.3%) earn above ₦800,000 per annum. This implies that rice farmers in Edu earn less compared to their counterparts in Patigi which may be due to the larger rice farmland cultivated.

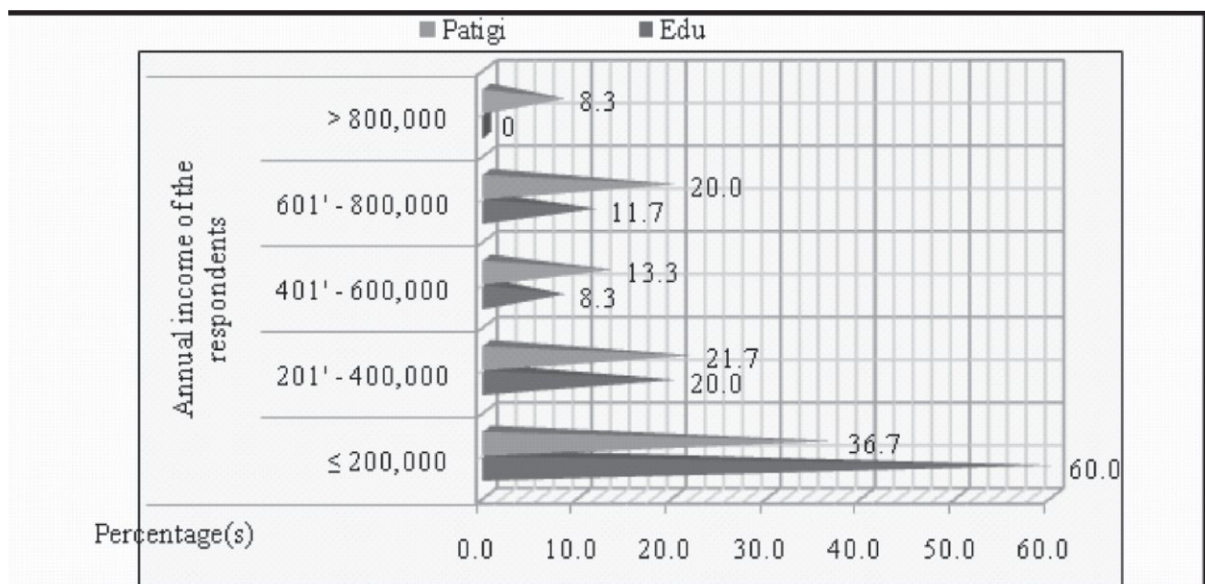


Fig. 7: Distribution of the respondents according to annual income in Naira

Source: Field survey, 2016

Available technology that affects value addition in rice business

Fig. 8 shows that most (64.2%) of the rice farmers in Patigi used the improved technology as against 42.1% in Edu which would no doubt affect the income and livelihood of the farmers. Use of technology is measured against the cost associated with it viz-a-viz the benefit (Ugwuet al., 2014). More than half (52.4%) of the rice farmers in Edu used the intermediate technology (i.e they combined both crude method and the modern together) while only

23.3% of rice farmers in Patigido did so. This suggests that rice farmers do not want to leave the old ways of farming and they also want to embrace the modern technology and this leads to a situation where they combine both technologies. However, very few (5.5% and 12.5%) of rice farmers in Edu and Patigi respectively still used local technology to produce rice.

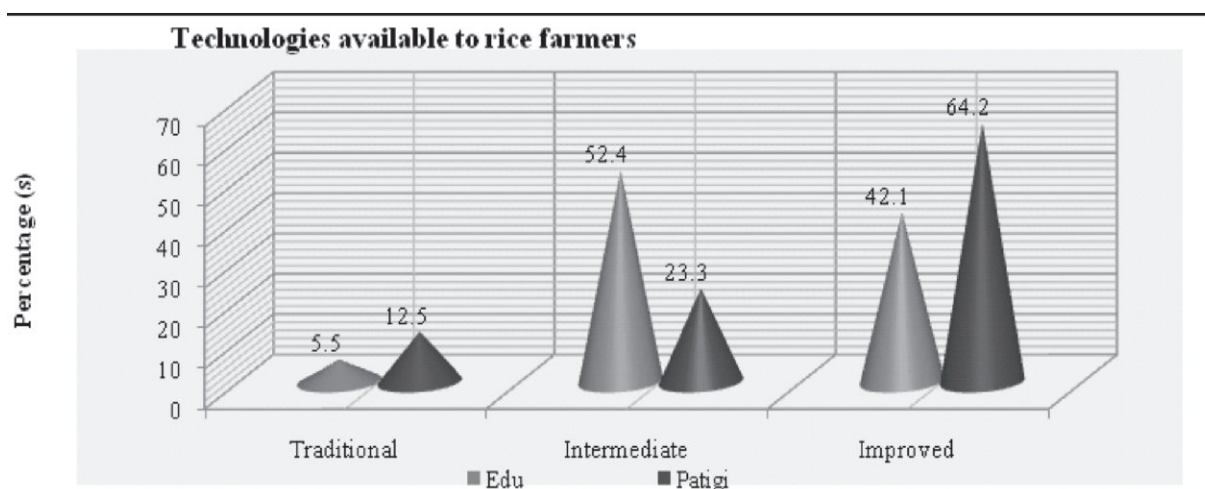


Fig. 8: Technologies available to rice farmers in Edu and Patigi

Source: Field survey, 2016

Value addition techniques

The results in Table 1 show the various steps in rice value addition techniques as ranked according to the order importance to the respondents using mean scores and standard deviation. In Edu, drying was ranked 1st (2.942 ± 0.298) followed by milling (2.500 ± 0.781), parboiling as 3rd (1.883 ± 0.700), de-husking 4th (1.733 ± 0.742), de-stoning 5th (1.717 ± 0.676), gleaning 6th (1.642 ± 0.515), packaging by machine 7th (1.583 ± 0.602), advertisement of the product 8th (1.317 ± 0.594), labelling 9th (1.317 ± 0.467), mechanical harvesting 10th (1.242 ± 0.467) and

coating ranked 11th (1.217 ± 0.434). In Patigi, parboiling ranked 1st (2.836 ± 0.530), drying of seeds 2nd (2.774 ± 0.158), de-husking 3rd (2.611 ± 0.215), milling by hand/machine 4th (2.442 ± 0.452), gleaning 5th (1.766 ± 0.452), separation from stone or de-stoning 6th (1.717 ± 0.676), packaging 7th (1.613 ± 0.534), advertisement of the product 8th (1.464 ± 0.434), mechanical harvesting 9th (1.331 ± 0.901), labelling 10th (1.248 ± 0.281) and coating was ranked 11th (1.126 ± 0.334). However, the order of importance of the various steps in rice value addition initiative used by the respondents was not the same..

Table 1: Value Addition Initiative used by the Respondents

Improved Techniques used by Rice farmers	Edu Mean $\pm$ SD	Ranking	Patigi Mean $\pm$ SD	Ranking
Mechanical Harvesting	1.242 ± 0.467	10 th	1.331 ± 0.901	9 th
Drying	2.942 ± 0.298	1 st	2.774 ± 0.158	2 nd
De-husking	1.733 ± 0.742	4 th	2.611 ± 0.215	3 rd
Separation of Stones	1.717 ± 0.676	5 th	1.717 ± 0.676	6 th
Parboiling	1.883 ± 0.700	3 rd	2.836 ± 0.530	1 st
Milling	2.500 ± 0.781	2 nd	2.442 ± 0.452	4 th
Coating	1.217 ± 0.434	11 th	1.126 ± 0.334	11 th
Gleaning	1.642 ± 0.515	6 th	1.766 ± 0.452	5 th
Packaging	1.583 ± 0.602	7 th	1.613 ± 0.534	7 th
Labelling	1.317 ± 0.467	9 th	1.248 ± 0.281	10 th
Advertisement	1.317 ± 0.594	8 th	1.464 ± 0.434	8 th

Source: Field survey, 2016

Source of information on rice value addition techniques

Most of the respondents (71.3 and 61.7% in Edu and Patigi respectively) sourced information through extension services delivery and this confirms a high level of awareness among the rice farmers in the study area (Fig. 9). However, about 8.3% of the rice farmers in Edu

and 18.3% in Patigi sourced value addition initiative from cooperative societies, 12.1% in Edu and 13.3% in Patigi sourced from family/friends and neighbours while only 1.0% in Edu and 1.7% in Patigi sourced information from broadcast media (Television).

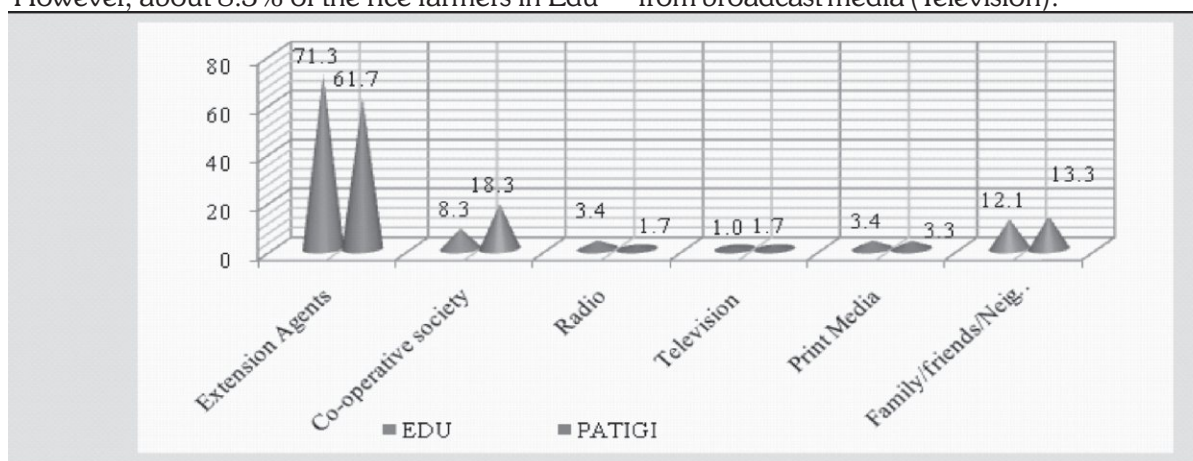


Fig. 9: Sources of information on rice value addition initiatives
Source: Field survey, 2016

Constraints to rice value addition initiative

Table 2 shows the constraints facing the respondents in adding value to rice. The high cost of labor was a very serious constraint faced by rice farmers in the study area as it ranked 1st with a mean of 3.633. Majority of the rice farmers complained about the high rate of the cost of production. The lack of government incentives was rated the 2nd and with a mean of 2.842, pest invasion was the 3rd based on the ranking and has a mean of 2.817. The others were insufficient fund as the 4th (2.683), inadequate input supply as the 5th (2.233), inadequate infrastructure as 6th (1.908), theft (or pilfering) as 7th (1.900), loss of energy (1.875), natural hazards (1.867), transportation (1.842), lack of manpower (1.800), lack of improved technologies (1.783), lack of training (1.758), ignorance (1.725) and weather (1.642).

Table 3 shows the results of relationship between the socio-economic characteristics of the respondents and the value addition initiatives used. In Edu, the correlation analysis show that age ($r=0.131$), farm size ($r=0.174$) were positive and not significant while education ($r=0.367$) was positive and significant at $P \geq 0.01$ and extension ($r = -0.114$) was negative and not significant. In Patigi, the correlation analysis of the value addition techniques with age ($r=0.148$) and education ($r=0.127$) were positive but not significant while farm size ($r=0.452$) and extension ($r=0.217$) were positive and significant at $P \geq 0.01$ and $P \geq 0.05$ respectively. The positive relationship simply that the independent variables would enhance the use of rice value addition.

Table 2: Constraints faced by Rice farmers in using value addition techniques

Perceived constraints	Very severe	Severe	Less severe	Not severe	Mean $\pm$ SD	Ranking
Insufficient fund	72(60.0)	39(32.5)	8(6.7)	1(0.8)	2.683 $\pm$ 0.961	4 th
Ignorance	67(55.8)	24(20.0)	12(10.0)	17(4.2)	1.725 $\pm$ 0.733	14 th
Loss of energy	28(23.3)	58(48.3)	25(20.8)	9(7.5)	1.875 $\pm$ 0.992	8 th
Transportation	66(55.0)	38(31.7)	13(10.8)	3(2.5)	1.842 $\pm$ 0.710	10 th
Pest invasion	56(46.7)	50(41.7)	11(9.2)	3(2.5)	2.817 $\pm$ 0.917	3 rd
Weather	65(54.2)	12(10.0)	19(15.8)	24(20.0)	1.642 $\pm$ 0.591	15 th
Theft	29(24.2)	61(50.8)	15(12.5)	15(12.5)	1.900 $\pm$ 1.854	7 th
Inadequate infrastructure	86(71.7)	24(20.0)	7(5.8)	3(2.5)	1.908 $\pm$ 0.594	6 th
High cost of labour	38(31.7)	69(57.5)	11(9.2)	2(1.7)	3.633 $\pm$ 0.798	1 st
Lack of manpower	34(28.3)	33(27.5)	45(37.5)	8(6.7)	1.800 $\pm$ 0.603	11 th
Lack of training	58(48.3)	22(18.3)	20(16.7)	20(16.7)	1.758 $\pm$ 0.608	13 th
Natural hazards	53(44.2)	43(35.8)	17(14.2)	7(5.8)	1.867 $\pm$ 1.061	9 th
Lack of government incentives	66(35.0)	49(40.8)	4(3.3)	1(0.8)	2.842 $\pm$ 0.859	2 nd
Lack of improved technologies	60(50.0)	44(36.7)	14(11.7)	2(1.7)	1.783 $\pm$ 0.712	12 th
Inadequate input Supply	75(62.5)	35(29.2)	9(7.5)	1(0.8)	2.233 $\pm$ 0.932	5 th

Source: Field survey, 2016

Table 3: Results of correlation analysis showing the relationship between some selected socioeconomic characteristics and the value addition techniques used by rice farmers

Variables	Edu			Patigi		
	r-value	p-value	Decision	r-value	p-value	Decision
Age	0.131	0.318	Not Significant	0.148	0.529	Not Significant
Farm size	0.174	0.183	Not significant	0.452**	0	Significant
Education	0.367**	0.004	Significant	0.127	0.334	Not Significant
Extension	-0.114	0.325	Not significant	0.217*	0.016	Significant

Source: Field survey (2016)

*, ** Correlation is significant at the 0.01 and 0.01 level (2-tailed)

Conclusion and Recommendations

This study has shown that there are more rice farmers in Patigi LGA using improved technologies to produce rice than their counterparts in Edu LGA and this has contributed largely to the income and total well-being of the rice farmers in Patigi than in Edu. Also, the low level of literacy among the rice farmers in the study areas could account for low usage of improved value addition initiatives. However, the major constraints facing the rice farmers in the study area are high cost of labour,

financial problem, lack of government incentives and pest invasion. It was, therefore, recommended that the extension agents should intensify more efforts in training and retraining of rice farmers on the effective use of improved value addition techniques so as to increase rice production. Also, cooperative societies should reach out to rice farmers on the best value addition techniques which are in vogue as almost every rice farmers belongs to one cooperative or the other.

References

- Bayou Farms and Industries Limited (2009). Rice Value Chain Development Plan, Kaduna Rice Industry Supply Chain Development Programme, submitted to MSME Nigeria, April 2009
- Lancon, F., Erenstien, O., Akande, S.O., Titilola, S.O.; Akpokodje, G. and Ogundele, O.O. (2003). Rice Processing in Nigeria: A Survey. WARDA, Abidjan.
- Matanmi, B.M., Adesiji, G.B., Owawusi, W.O. and Oladipo, F.O. (2011). Perceived factors limiting rice production in Patigi Local Government Area of Kwara State, Nigeria. *Journal of Agriculture and Social Research* 11 (2):
- Ugwu J N ,Ugwu M N and Chitor C C(2014):Assessment of value addition in rice production and processing in Adani in Uzouwanilocal government area of Enugu State, Nigeria. *International Journal for Agricultural Sciences and Veterinary Medicine* 2(4)pp 53 -68
- Osungade, A.O. (2004). Impact of Government Policies on Rice Production in Nigeria. Unpublished M.Sc. Thesis, University of Ilorin, Ilorin, Nigeria.
- WARDA (2005) Africa Rice Centre at a Glance. West Africa Rice Development Association, Cotonou.

Effects of Dressing Methods on the Meat Quality of Commercially-available Rabbits

S.S. Fagbuaro and S.O.K. Fajemilehin

Department of Animal Production and Health Sciences

Faculty of Agricultural Sciences,

Ekiti State University, Ado-Ekiti, Nigeria

E-mail: dipofajemilehin@yahoo.com

Abstract

The aim of the study was to investigate the effects of singeing, scalding and skinning on the meat quality characteristics of matured commercially-available rabbits in Ekiti-State, Nigeria. The experiment was carried out at the Teaching and Research Farm, Ekiti State University, Ado-Ekiti between July and September, 2012. Twenty four matured rabbits with average weight of 2.11 ± 0.56 kg were used for the study. The rabbits were fed concentrate diet containing 20.13% crude protein and 2540 kcal ME.kg⁻¹ and randomly allocated to scalding, singeing and skinning before slaughtering. The following parameters were determined: thermal shortening, temperature, pH, cooking yield, cooking loss, drip loss, water holding capacity, proximate analysis, raw meat visual colour and sensory evaluations. The results show that dressed weight, thermal shortening, drip loss, internal temperature and pH were significantly ($P < 0.05$) different with the singed showing higher values. The water holding capacity was highest in the scalded carcass while the dressing methods did not significantly ($P > 0.05$) differ on cooking loss. The proximate analysis showed that the moisture content was lowest in singed carcass while the skinned carcass had the least fat content. The result of sensory evaluation shows the lowest score for skinned carcass in terms of colour and the highest in the scalded carcass. The flavour was least in scalded and best in the singed carcass. The least tenderness and juiciness values were obtained in the singed carcass. The overall acceptability shows that irrespective of the dressing methods, rabbit meat was equally acceptable. Singeing as a processing method is preferred to other methods because it gave the highest values in most of the parameters investigated.

Key words: Rabbits, scalding, singeing, skinning, carcass, acceptability

Introduction

Rabbit meat is highly digestible, tasty, low-caloried and can satisfy the animal protein intake of man at low cost and without putting the consumer at risk of vascular diseases. However, in almost all markets in Nigeria today, rabbit meat unlike poultry meat, mutton, beef, chevon and pork, is not available for sale and this similar scenario operates in the home front. Meat processing industries in most parts of the world, including Europe, are gradually expanding and improving the availability of rabbit meat in a large variety of processed ready-meat in order to meet the demands of consumers (Dallezotte, 2002).

Meat will remain an acceptable food item if it is nutritionally valuable and organoleptically satisfactory. In order to ensure this, proper attention must be paid to the ante- and post-mortem factors to which the animals are exposed. These factors have been widely

reported to affect the quality of meat derived from such animals (Omojola and Adesehinwa, 2006 and Bovera *et al.*, 2010). Ante-mortem factors, animals' health conditions and stress the animals were subjected to during transportation, management, feeding, handling, etc, are under the control of the experimenter. However, post-mortem factors which include carcass processing and handling, biochemical changes that occur in meat during post-slaughter storage and distribution (Keith *et al.*, 2002) are not. The post-mortem conditions, therefore, require sufficient understanding to assist in the determination of the best processing technique that will enhance the eating quality needed for rabbit meat market to grow and become economically-viable and in assurance of consistent meat quality (Okubanjo *et al.*, 2008).

The present study is therefore aimed at investigating the effects of singeing, scalding and skinning on meat quality characteristics of rabbit.

Materials and Methods

Twenty four matured commercially-available rabbits obtained from a reputable commercial farm in Ekiti state, Nigeria with an average weight of 2.11 ± 0.56 kg were used for this study. The rabbits were fed a concentrate diet containing 20.13 % crude protein and 2540 kcal of metabolisable energy.kg⁻¹ for twenty eight (28) days. At the end of the 28th day, the animals were randomly allocated to the three dressing methods namely: scalding, singeing and skinning. Singeing is the processing method whereby the fur on a carcass is burnt off with

naked flame of fire made from wood. Scalding requires plunging of whole carcass into hot water which boiled at 65-70°C for few seconds in a container for the base of the fur to become softer for easy removal with a scraper. Skinning entails complete removal of the pelt from a carcass with a sharp knife. Each treatment composed of eight rabbits. The rabbits were slaughtered in batches of three. The carcasses were washed and eviscerated and the bled weight, blood loss and dressed weights obtained. Percentage blood loss and dressing percentage were calculated with the methods outlined by Omojola (2007).

Thermal shortening

The thermal shortening of the meat was recorded using the formula proposed by Omojola and Akinsehinwa (2006) as follows:

$$\text{Thermal shortening} = \frac{\text{Initial meat length} - \text{Final meat length} \times 100}{\text{Initial meat length}}$$

Temperature and pH

Immediately after dressing and at thirty minutes interval thereafter, (0, 30, 60, 90, 120, 150, 180, 210 and 240 minutes post-mortem), the internal temperature was measured at a depth of 1 cm at

the longissimus dorsi. For pH measurement, 10 g of meat sample obtained from the right thigh was ground and homogenized in 100 ml of distilled water and the pH taken with the MINISI pH meter, model 800

Cooking yield

This was determined using the formula proposed by Okubanio (1997) as stated below:

$$\text{Cooking yield} = \frac{\text{Wt of cooked meat} \times 100}{\text{Wt of raw meat}}$$

Cooking loss This was determined using the method proposed by Omojola and Akinsehinwa (2006) as follows:

$$\text{Cooking loss} = \frac{(\text{Weight of sample before cooking} - \text{Weight after cooking} \times 100)}{\text{Weight before cooking}}$$

Drip loss

This was determined following the procedures of Insausti *et al.* (2001)

$$\text{Drip loss} = \frac{\text{Final weight of meat} \times 100}{\text{Initial weight of meat}}$$

Water holding capacity

This was determined with the method described by Suzuki *et al.* (1991) as follows:

$$\text{WHC} = \frac{100 - (Aw - Am) \times 9.47 \times 100}{Wm \times Mc}$$

where Aw = Area of water released by meat samples (cm²) Am = Area of meat sample (cm²)

Wm = Weight of meat sample (g)

Mc = Moisture content of meat sample (%)

9.47 = a constant factor

Proximate composition of meat

The proximate composition of the meat was determined following the procedures of AOAC (2000).

Raw meat visual colour

This was determined following the procedures of AMSA (1995).

Sensory evaluations

A panel of eight trained individuals was used for sensory evaluation. The panelists were male (n=4) and female (n=4) and ranged in age from 21-25 years. These panelists were randomly allocated to the three differently processed rabbits which constituted the treatments. The panelists were made to rate each of the 4 replicates of the meat samples separately. Equal bite size from each treatment was coded and served in an odourless plastic container. Each sample was evaluated independent of the other. The panelist rated the sample on a 9-point hedonic scale for colour, flavour, tenderness, juiciness and overall acceptability.

Statistical analysis

All data generated were subjected to analysis of variance and where statistical significance difference was observed, the means

were compared using the Duncan's Multiple Range (DMRT) Test. The SPSS Computer software package was used for all statistical analysis SPSS (1989).

Results and Discussion

Data on the different meat qualities of scalded, singed and skinned rabbit carcasses and other information are shown in Table 1. The result shows significant ($p < 0.05$) differences between the scalded and the singed. The blood loss in scalded rabbit was significantly ($p < 0.05$) lower than the singed and skinned carcass while blood loss% in the scalded and skinned were significantly ($p < 0.05$) lower than the singed carcass. The dressed weight in the three treatments were significantly ($p < 0.05$) different with the singed carcass showing superiority over the two other methods. The dressing percentage significantly ($p < 0.05$) increased from 51.61 % observed in the skinned rabbit to 54.48 and 56.17% in scalded and singed rabbit carcass respectively. The superior dressing percentage of the scalded and singed carcasses over the skinned can be attributed to the added weight of the skin retained in the two carcasses as observed by Omojola and Akinsehinwa (2006) and Okubanjo (1997).

Table 1. Meat quality characteristics of rabbit meat as influenced by dressing methods

Parameters	Scalding	Singeing	Skinning
Live weight (kg)	2.20±0.02	2.21±0.02	2.23±0.02
Bled weight (kg)	2.15±0.01 ^a	2.17±0.01 ^b	2.16±0.01 ^{ab}
Blood loss (g)	47.07±0.91 ^a	49.88±0.91 ^b	50.67±0.91 ^b
Blood loss (%)	2.27±0.02 ^b	2.13±0.02 ^a	2.31±0.02 ^b
Dressed weight (kg)	1.19±0.01 ^b	1.26±0.01 ^c	1.14±0.01 ^a
Dressing percentage	54.48±1.11 ^b	56.17±1.11 ^b	51.61±1.11 ^a
Thermal Shortening (%)	40.63±0.55 ^b	44.03±0.55 ^c	38.38±0.55 ^a
Cooking Yield (%)	64.87±0.47 ^b	63.17±0.47 ^a	65.70±0.47 ^b
Cooking Loss (%)	30.63±1.86	31.08±1.86	28.51±1.86
Drip Loss (%)	5.81±0.25 ^b	7.16±0.25 ^c	4.61±0.25 ^a
Water Holding Capacity	68.05±1.50 ^c	41.97±1.50 ^a	62.20±1.50 ^b

a,b,c means with different superscript along the same rows differ ($p < 0.05$) significantly

The thermal shortening of the three treatments differed significantly ($p < 0.05$) with the singed rabbits showing superiority over the two others. The superiority can be attributed to its higher internal temperature because thermal shortening, particularly during the first few hours post-mortem, is temperature dependent in relation to the calcium released from the sarcoplasmic reticulum (Hertman, 1993).

Theoretically, when a meat sample is cooked, it emits water thus resulting in the reduction of the original weight of the meat sample. More water loss was expected to occur in the singed and scalded carcasses because of the addition of initial heat applied during processing to heat applied during the final cooking. The heat caused the muscle structure to puncture leading to drain of juices and consequent reduction in

the final weight of the meat sample. Although, cooking loss was observed to be numerically higher in meat from singed carcasses and lowest in meat of skinned carcasses, the dressing methods did not affect the variable significantly ($p > 0.05$). This was in agreement with the report of Awosanya and Okubanjo (1993) who reported no significant difference in cooking losses of meat samples from carcasses skinned, scalded and singed. The result is also in close agreement with the findings of Omojola and Akinsehinwa (2006) who reported cooking losses of $29.69 \pm 3.09\%$, $29.35 \pm 3.21\%$ and $27.69 \pm 3.12\%$ respectively for meats from singed, scalded and skinned carcasses of New Zealand rabbits. However, the results of this study differ from the findings of Omojola *et al.* (2012) who reported significant differences in the cooking losses of meat samples from singed carcasses ($26.71 \pm 0.01\%$), scalded carcasses ($24.92 \pm 0.01\%$) and skinned carcasses ($19.86 \pm 0.01\%$) of goats. The result was equally at variance with the reports of Fisher *et al.* (2000) who reported cooking losses of 26.8% and 26.7% for scalded barrows and gilts and Ukah *et al.* (2006) who reported cooking losses ranging from 20.88% to 26.10% for leg cut, shoulder cut, rib, loin and BSF in scalded meat of grass cutters.

It has been widely established that the basis of drip is intracellular water which is capable of being lost from the muscle fibre post-mortem. This loss is known to be driven by stress prior to slaughter, pH and calcium induced shrinkage of myofibrils during rigour development (Offer and Night, 1998), permeability of the cell membrane to water and the extent of protein denaturation and muscle shortening due to heat (Silveira, 1997). The method of dressing employed in this study affected the percentage drip loss significantly ($p < 0.05$). While the drip loss was highest in the singed carcass with a value of 7.16 ± 0.25 , it was least in the skinned carcass (4.61 ± 0.25). It is pertinent to know that the highest drip loss obtained in meat samples from singed carcass was most probably as a result of heat applied by naked flame from firewood during processing which stimulated rigor causing the muscles to shrink than in others processed under lower temperatures thereby losing the most fluid. The results obtained for meat samples from singed ($7.16 \pm 0.25\%$), scalded ($5.81 \pm 0.25\%$) and

skinned ($4.61 \pm 0.25\%$) carcasses in this study is comparable with the values of $6.82 \pm 0.01\%$, $5.57 \pm 0.01\%$ and $4.30 \pm 0.01\%$ reported by Omojola *et al.* (2012) for singed, scalded and skinned carcasses respectively. It is also comparable with the value of 5.48% reported for scalded carcass by Silveira (1997) as well as the values of $7.15 \pm 0.01\%$, $5.65 \pm 0.02\%$ and $4.64 \pm 0.42\%$ for singed, scalded and skinned carcasses of Rabbits respectively by Omojola and Akinsehinwa (2006).

Water holding capacity is the ability of meat samples to retain its naturally occurring water during application of any external force such as cutting, grinding or processing (Dennis, 2002). The result on Table 1 showed significant ($p < 0.05$) differences among the three treatments in water holding capacity. The capacity of the meat samples to hold water was superior in meat sample from scalded carcass by 5.85 % and 26.06 % in meat samples from skinned and singed carcasses respectively because the heat applied on it was not capable of denaturing the proteins. There was a considerable decrease in water holding capacity of meat during heating as obtained in the result of meat from singed carcass as a result of loss of fluid due to contraction of myofibrillar network by heat acting as a denaturing factor for protein. The meat sample from skinned carcass was able to hold on to intrinsic water because no heat of any sort was applied that could have denatured the proteins to cause any considerable lowering of the variable. The results obtained in this study on water holding capacity were in line with the reports of previous workers (Omojola and Akinsehinwa, 2006; Omojola *et al.*, 2012 and Ukah *et al.*, 2006).

Table 2 shows the result of changes in internal temperature of dressed rabbit carcasses (time post-mortem) as influenced by dressing methods. The result of this study revealed that internal temperature of singed carcasses was highest being 46.0 ± 0.21 , followed by that of scalded carcass (32.5 ± 0.21), and least in skinned carcass (30.5 ± 0.21) for two hours of the four hours during which the temperature was taken. The trend of temperature decline in the carcasses was such that it was gradual until after two hours when they evened out. This result agreed with the findings of Omojola and Akinsehinwa (2006) who reported that the temperature evened out as the time post-

mortem increased for skinned, singed and scalded rabbit carcasses. In the present study, initial internal temperature of 30.5 ± 0.21 , 46 ± 0.21 and 32.5 ± 0.21 were obtained for internal temperature of skinned, singed and scalded rabbit carcasses taken at *Logissimus dorsi* muscle at 0 hour post-mortem. The internal temperature of $46 \pm 0.21^\circ\text{C}$ achieved at

a depth of 1 cm in this study during singeing was well below the internal temperature of 58 to 60°C needed to cook meat to a rare state with most glycolytic enzymes inactivated (Forest *et al.*, 1975). At the temperature achieved during singeing in this report, the activities of glycolytic enzymes were intact (Marsh, 1954).

Table 2: Changes in internal temperature of dressed rabbit carcasses (time post-mortem) as influenced by dressing methods

T (mins)	Skinning	Singeing	Scalding
0	30.50 ± 0.21^a	46.00 ± 0.21^b	32.50 ± 0.21^b
30			
60	30.10 ± 0.18	32.50 ± 0.21	30.90 ± 0.23
90	30.40 ± 0.23	31.60 ± 0.18	30.20 ± 0.20
120	30.10 ± 0.20	30.30 ± 0.20	27.90 ± 0.19
150	27.80 ± 0.19	28.00 ± 0.19	27.60 ± 0.17
180	27.60 ± 0.17	27.70 ± 0.17	27.40 ± 0.16
210	27.40 ± 0.16	27.50 ± 0.16	26.50 ± 0.24
240	26.50 ± 0.24	26.80 ± 0.24	26.40 ± 0.22
	26.40 ± 0.22	26.70 ± 0.22	

a,b,c means with different superscript along the same rows differ ($p < 0.05$) significantly

Table 3 shows the result of changes in pH of dressed rabbit carcasses (time post-mortem) as influenced by dressing methods. Initial pH at 0 h post-mortem was highest in the singed followed by the scalded and least in the skinned carcass. Although the observed differences were not significantly ($p > 0.05$) different, it is worth of note that a slight increase in pH will affect most of the meat attributes. The results of pH obtained in this study were in agreement with the findings of previous workers (Monin *et al.*, 1995; Marchiori *et al.*, 2003; Omojola and Akinsehinwa, 2006;

Okubanjo *et al.*, 2003 and Bovera *et al.*, 2012). The higher pH values of the singed and scalded rabbit carcasses at 0 h post-mortem could be due to modification of electric charges of acid groups, separation of peptide chain and production of new components or could be attributed to the fission of protein chain at labile linkages involving inidazole, -SH and OH groups, followed by hydrogen bonding between carboxyl and amino groups in accordance with the reasoning of Omojola and Akinsehinwa (2006).

Table 3: Changes in pH of dressed rabbit carcasses (time post-mortem) as influenced by dressing methods

T (min)	Skinning	Singeing	Scalding
0	6.05 ± 0.22	6.30 ± 0.22	6.00 ± 0.22
30	6.42 ± 0.24	6.29 ± 0.24	5.91 ± 0.24
60	6.42 ± 0.16	6.29 ± 0.16	5.94 ± 0.16
90	6.32 ± 0.18	6.31 ± 0.18	5.93 ± 0.18
120	6.31 ± 0.20	6.31 ± 0.20	5.93 ± 0.20
150	6.22 ± 0.25	6.32 ± 0.25	5.80 ± 0.25
180	6.20 ± 0.23	6.41 ± 0.23	5.80 ± 0.23
210	6.22 ± 0.19	6.10 ± 0.19	5.80 ± 0.19
240	6.00 ± 0.26	6.00 ± 0.26	5.76 ± 0.26

Means with no superscript along the same rows are statistically similar ($p > 0.05$)

Proximate analysis

Table 4 shows the means for proximate analysis of the differently processed carcasses. The lowest moisture ($p < 0.05$) content was found in the singed carcass. This is expected because as the carcass was flamed off over burning firewood, some water will be lost resulting in shrinkage of the carcass (Omojola and Akinsehinwa, 2006). The crude protein and the ash contents were not significantly ($p > 0.05$) affected by the processing methods. However, a slight increase in ash content was noticed in the

singed carcass. This might have occurred probably because the carcasses were not properly washed after flaming off the hair. The fat content was lowest ($p < 0.05$) in the skinned carcass compared to the scalded and the singed. This is most probably because a number of adipose tissues naturally lay beneath the animals' skins and when these animals are processed by skinning, a lot of these tissues go with the skin. However, there was no significant ($p > 0.05$) difference in the fat contents of the carcasses of singed and scalded treatments.

Table 4: Proximate analysis of rabbit meat as influenced by the dressing methods (g/100 g)

Parameters	Scalding	Singeing	Skinning
Moisture content (%)	73.99 $\pm$ 1.19 ^a	70.98 $\pm$ 1.28 ^b	71.44 $\pm$ 0.38 ^{ab}
Crude Protein content (%)	20.58 $\pm$ 0.41 ^a	22.31 $\pm$ 0.41 ^b	22.93 $\pm$ 0.41 ^c
Fat content (%)	3.53 $\pm$ 0.07 ^b	3.64 $\pm$ 0.07 ^b	2.52 $\pm$ 0.07 ^a
Ash content (%)	1.87 $\pm$ 0.03 ^a	3.03 $\pm$ 0.03 ^b	3.06 $\pm$ 0.03 ^b
Carbohydrate content (%)	0.03 $\pm$ 0.04 ^a	0.04 $\pm$ 0.04 ^b	0.05 $\pm$ 0.04 ^c

Means with no superscript along the same rows are statistically similar ($p > 0.05$)

Table 5: Organoleptic characteristics of rabbit meat as influenced by the dressing methods

Parameters	Scalding	Singeing	Skinning
Colour	6.30 $\pm$ 0.02 ^b	6.00 $\pm$ 0.03 ^c	5.20 $\pm$ 0.01 ^a
Flavor	6.30 $\pm$ 0.04 ^b	6.35 $\pm$ 0.02 ^b	5.63 $\pm$ 0.03 ^a
Tenderness	6.50 $\pm$ 0.01 ^b	4.70 $\pm$ 0.01 ^a	6.91 $\pm$ 0.0 ^c
Juiciness	6.70 $\pm$ 0.03 ^b	5.51 $\pm$ 0.03 ^a	6.86 $\pm$ 0.04 ^c
Overall acceptability	5.99 $\pm$ 0.03	6.05 $\pm$ 0.03	6.00 $\pm$ 0.01

Sensory evaluation

The result of sensory evaluation indicates a lower ($p < 0.05$) score for skinned rabbit meat in terms of colour followed by scalded and least in singed carcass. The implication is that the meat from the skinned rabbit will be less acceptable since meat colour is the first criterion consumers would use to judge meat quality and acceptability (Comforth, 1994). The flavour rating was least ($p < 0.05$) in the skinned carcass while there was no significant ($p > 0.05$) difference between the scalded and singed rabbit carcasses. This could be attributed to the contribution of the skin which was intact in the scalded and singed carcasses unlike in the

skinned carcass where it has been removed. The panelists gave the least tenderness value ($p < 0.05$) to the meat obtained from singed rabbit carcass. The rapid development of heat-induced contraction and rigid setting of various muscle fibres especially during singeing operation could have accounted for the meat toughness (Wheeler and Koohmarie, 1994). There were significant ($p < 0.05$) differences in the juiciness score of meat from the three dressing methods. The least value obtained in the singed carcass could be attributed to the slightly higher cooking loss and lower water holding capacity obtained from the same treatment.

References

- AMSA, 1995. Research Guidelines for Cookery, Sensory Evaluation and Instrumental Measurements of fresh meat. National Livestock and Meat Board. Chicago, IL, USA.
- AOAC, 2000. Official Methods of Analytical Chemists. 15th Edn. Washington DC
- Awosanya, B. and Okubanjo. A.O. (1993). Effect of skinning, scalding or singeing on the physical characteristics of rabbit carcasses. *Nig. Food Jour.* 11: 147 – 152
- Bovera, C., Di Meo, S., Nizza, G. Piccolo, A. and Nizza, A. 2008. Effect of different raising techniques on in vivo performance and carcass and meat traits of Ischia grey rabbit. *Asian-Australian Journal of Animal Science* 21(9): 1361-1366.
- Bovera, F., Lestingi, A., Iannaccone, F., Tateo, A., Nizza, A., 2012. Use of dietary mannanoligosaccharides during rabbit fattening period: Effects on growth performance, feed nutrient digestibility, carcass traits, and meat quality. *Journal of Animal Science* 90 (11): 3858-3866
- Cornforth, I. 1994. Colour: Its basis and importance. In: Pearson, A.M. and Dutsin, T.R. (Ed). *Quality Attributes and their Measurements in Meat, Poultry and Fish Products. Advances in Meat Research Series.* Blackie Academic and Professional, Glasgow: 33-77
- Dallezotte, A. 2002. Perception of rabbit meat quality and major factors influencing the rabbit carcass and meat quality. *Livestock Products Science* 75: 11-32..
- Forest, J.C., Aberle, E.D., Hedrick, H.B., Judge, M.D. and Merkel, R.A. 1975. Palatability and cookery of meat. In: Forest J.C., E.D. Aberle, H.B. Hedric, M.D. Judge and R.A. Merkel (Eds.). *Principles of Meat Science.* WH Freeman and Co San Francisco: 288-305.
- Hertman, C., Olson, U. and Tomberg, E. 1993. The influence of high temperature type of muscle and electrical stimulation on the course of rigor, ageing and tenderness of beef muscle. *Meat Science* 35: 119-141.
- Keith, E., Belk, J.A, Scanga, G.C. and Grandin, T. 2002. The relationship between good handling/stunning and meat quality in beef, pork and lamb. American Meat Institute Foundation; Animal Handling and Stunning Conference 21-22 USA: 1-19.
- Marsh, B.B., 1954. Rigor mortis in beef. *Journal of Science, Food and Agriculture* 5: 70-75.
- Monin, G., Talmant, A., Aillery, P. and Collas, G. 1995. Effects of carcass weight and meat quality of pigs dehaired by scalding or singeing post-mortem. *Meat Science* 39: 247-254
- Marchiori, A.F. and deFelicio, P.E. 2003. Quality of wild boar meat and commercial *Pork Science Agriculture (Piracicaba, Braz)* 60(1): 1-10
- Offer, G. and Night, P. 1998. The structural basis of water holding and drip losses development in meat Part 2: In: Lawrie, R.A. (ed) *Development in Meat Science* Elsevier, London. *Applied Science* 4: 173-243
- Okubanjo, A. 1997. Meat characteristics of singed and conventionally dressed chevon carcasses. *Journal of Food Science* 34: 494-197.
- Okubanjo A.O., Omojola, A.B., Ogunsola O.O., Adewumi, M.K., Ajiboro, O.G., Alabi, G.F. and Babayemi, O.J. 2003. Meat characteristics of Bunaji, Gudali and Keteku Cattle. *Tropical Animal Products Investment* 6: 185-193
- Omojola, A.B. and Adesehinwa, A.O.K. 2006. Meat characteristics of scalded, singed and conventionally-dressed rabbit carcasses. *WJ Zoology: International Digital Organization for Scientific Information.* 1(1): 24-29
- Omojola, A.B. 2007. Effect of delayed bleeding on carcass and eating qualities of rabbit meat. *Pakistan Journal of Nutrition* 6(5):

- 438-442.
- Omojola, A.B., Apata, E.S. and Fagbuaro S.S. 2012. Comparison of skinning versus scalding and singeing: Effect on temperature, pH and meat quality in goats. *Journal of Animal Science Advances* 2(9): 740-748
- Silveira, E.T.F. 1997. Tecnicas de abate esues efeitos na qualidade decarne suina. Campinas Tese (Dou torado) Universidade Estadualde Campinas pp 247.
- SPSS., 1989. Statistical Package for Social Sciences. New York, Cary.
- Ukah, O.G, Omojola, A.B, Ogunsola, O.O, Okubango, A.O. 2006. Carcass and meat characteristics of grasscutter (*Thryonomys Swinderianus*) *Tropical Journal of Animal Science* 9(1): 31-38.
- Wheeler, T.L. and Koohmarie, M. 1994. Pre-and post-rigour changes in tenderness of ovine longissimus muscle. *Journal of Animal Science* 72: 1232-1238

Evaluation of Improved Hot Pepper Cultivars (*Capsicum* spp) in Ekiti State, Southwestern Nigeria

¹A.K. Oluleye, ²A. Omotayo, ³C. Ribeiro and ⁴A.A. Fajinmi

¹Department of Soil Science and Land Resources Management, Federal University, Oye-Ekiti, Nigeria

²Institute of Food Security Environmental Resources and Agricultural Research (IFSERAR) Federal University of Agriculture, Abeokuta, Nigeria

³EMBRAPA Vegetables, Brazil

⁴Department of Crop Science and Horticulture, Federal University, Oye-Ekiti, Nigeria
E-mail: anthony.oluleye@fuoye.edu.ng

Abstract

The agronomic features of nine (9) hot pepper (*Capsicum annum*) varieties obtained from EMBRAPA, Brazil (3); NIHORT, Ibadan (4) and local landraces (2) were evaluated in 2013 at the Teaching and Research Farm, Federal University, Oye-Ekiti, Nigeria. The experiment was laid out as a factorial split-plot design with fertilizer as main plot and the varieties as sub-plots in three replicates. Growth indices: plant height, stem girth and number of leaves; yield and fruit parameters: fruit length, fruit girth and pericarp thickness were measured. The agro-economic indicators calculated were incremental yield, net returns and benefit-cost ratio. The varieties differed significantly ($P < 0.05$) in the growth and fruit parameters. Two varieties (Z106 and Z107) from Brazil gave significantly ($P < 0.05$) higher yields than the local varieties (F104 and F105) and those developed in NIHORT. The profitability of Z106 was the highest followed by Z107 while F104 gave the least due to the low yield recorded as a result of severe disease infection. The study shows that Z106 and Z107 varieties could be adopted for profitable pepper production in Ekiti State.

Keywords: Pepper cultivars, 'Atarodo', cost of production, growth indices, economic analysis

Introduction

Peppers (*Capsicum* spp) are widely cultivated in Nigeria, especially in the savannah agro-ecological zones during the rainy season and in the dry season under irrigation. The popularity is on account of the spicy nature and high nutritional value as pepper supplies large portions of vitamins A and C and minerals in many Nigerian diets. Kelley and Boyhan (2009) had emphasized this high nutritional value as one medium green bell pepper would provide up to 8% of the recommended daily allowance of vitamin A, 180% of vitamin C, 20% of calcium (Ca), 2% of iron (Fe) and substantial amounts of vitamin A and B. *Capsicum annum* and *Capsicum frutescens* L. are the two pepper species cultivated commonly in Nigeria and other parts of humid to semi-arid tropics where the fruits have widespread use in the culinary, pharmaceutical and beverage industries (Aliyu, 2000).

The average national productivity for

Nigeria was 3.85 tons (t).hectare (ha)⁻¹ in 2009 (FMARD, 2010) which is low compared to the world average capsicum pepper fruit yield at 13.4 t.ha⁻¹ (FAO, 2013). This low productivity on the predominant smallholder farms conforms with reports that pepper yield in the developing countries is probably 10-30% of yield obtained in developed countries due to the local low-yielding varieties being grown, unfavourable weather conditions and production constraints which include the problems of pests and diseases, low soil fertility and poor weed management (Galanihe *et al.*, 2004; Grubben and El-Tahir, 2004; Idowu-agida *et al.*, 2010; Idowu-agida and Ajayi, 2011).

Capsicum suffers from a myriad of pests and diseases. The most important pests are mites, thrips, aphids, white flies and caterpillars (*Heliothis* spp, *Spodoptera* spp). The pepper fruit fly (*Coratitia capitata*) feeds on the fruit flesh leaving the skin. Scale insects and mealy bugs occur mainly on the stems of older plants

while the other insects are cutworm, aphids, grasshoppers, leaf miner, seed corn maggots, and pepper weevils (Green *et al.*, 1991; AVRDC, 2004; Agrios, 2005; Fajimi, 2010). Bacterial wilt is a very serious disease as the infected pepper plants show wilting and death of the growing point and upper leaves. The virus diseases transmitted by aphids, white flies and thrips or by mechanical means and fungal diseases (anthracnose or fruit rot caused by *Colletotrichum gleosporioides* and blight caused by *Phytophthora* spp) cause extensive losses (Fokunang *et al.*, 2001; Grubben and El-Tahir, 2004).

The use of integrated pest management technologies involving many biological products and natural enemies to produce healthy crops with minimal chemical residues is the rule in the developed countries but less applicable in Nigeria. Besides, the chemicals for spraying to control diseases and pests are beyond the reach of the resources-poor farmers. The major step in the control is to identify and use local varieties that have broad general field tolerance to the most important pests and diseases as those with absolute resistance are rarely available (Grubben and El-Tahir, 2004). Attention would be paid to assessing the performance of hot pepper varieties in the production season. EMBRAPA, Brazil and the National Horticultural Research Institute (NIHORT), Ibadan, Nigeria with mandates for vegetable improvement have developed some cultivars of pepper which can be evaluated for performance. The objective of this study was to compare the agro-economic performances of pepper cultivars from Brazil and the local landraces developed by NIHORT with the view to making recommendations on the best varieties for the adoption under the conditions of Ekiti State, Nigeria.

Materials and Methods

Nine (9) cultivars of hot pepper consisting of three developed at EMBRAPA, Brazil: Z106, Z107 and Z108; four from the National Horticultural Research Institute, Ibadan: NHVI-RBig, NHVI-RHBig, NHVI-RC and NHVI-RL; and two local varieties: F104 and F105 were used for the study. The seeds were

obtained from the institutions while selected naturally-ripened fruits of local 'Atarodo' pepper varieties were macerated to extract the seeds which were air-dried, bulked and packaged. The seeds were sown in 10-litre trays filled with 1:1 mixture of topsoil and compost to 1.5 cm depth and covered with soil. Watering was done daily and the seedlings were nursed in a 7×4×3 m growth chamber for about six weeks. The seedlings were transplanted to the prepared field at the Teaching and Research Farm (7°48'N and 5°29'E, 530 m above sea level) of Federal University, Oye-Ekiti, Nigeria on the 8th of March 2013. The site is predominantly forest with hydromorphic soil and the land use pattern that showed cultivation of cassava/maize, vegetables, yam in many cycles for a period of 15 years and without history of fertilizer use.

Surface (0-15 cm) soil samples were randomly collected from the plot area, bulked for a composite sample, air-dried and sieved (<2 mm). The sample was analyzed for soil physical and chemical properties using standard laboratory procedures described in Udo *et al.* (2009): particle size distribution using the hydrometer method, soil pH (1:1 soil/water) with a glass electrode pH meter, organic matter by dichromate oxidation, extraction of exchangeable cations with neutral normal ammonium acetate and determination of Na, K and Ca with flame photometer while the Mg was read on an Atomic Absorption Spectrophotometer; exchangeable acidity extraction with 0.01M KCl and titration with 0.01M NaOH; total N by the macro-Kjeldahl method; and available P extraction with Bray P-1 extractant and the molybdenum blue colour read on a spectrophotometer.

The trial was laid out in a split-plot design with three replications. The main plot was the fertilizer treatment (0 and 100 kg ha⁻¹ of NPK 20-10-10) and the sub-plots were the varieties. The size of each plot measured 2×3 m and separated by 1 m path. These seedlings were transplanted at 0.6×0.5 m. The fertilizer was applied in two splits at 4 and 12 weeks after transplanting by banding while manual weeding operations were carried out as necessary. Plants were monitored weekly for disease symptom expression and evaluated for disease incidence and disease

severity. Data were collected on plant height, stem girth and number of leaves weekly. Ripe fruits were harvested twice weekly to determine yield. plant^{-1} and yield. ha^{-1} while fruit parameters: fruit length and girth, pericarp thickness, number of seed.fruit⁻¹ and seed weight were measured. Data were subjected to Analysis of Variance (ANOVA) using Statistical Analysis System (SAS) and the means were separated using Least Significant Difference (LSD). Correlation analysis was carried out between number of leaves and fruit yield. plant^{-1} and yield. ha^{-1} .

Gross margin analysis model was used to determine the profitability of each cultivar based on estimated input cost and total revenue. The inputs were valued at farm gate prices at the time of production while the labour cost component consisted of nursery management, land preparations, transplanting, weeding and application of fertilizer and pesticides.

Results

The physical and chemical characteristics of the soil are shown in Table 1. The soil was a neutral($\text{pH}=7.0$) clay loam with total N (2.10 g.kg^{-1}) and available P(34.61 mg.kg^{-1}). The exchangeable bases were abundant in the order: Ca (21.50)> Mg (1.57)> K (0.67)>Na (0.08)

cmol.kg^{-1})

The nature of pepper plant height development over the period of observation is shown in Fig. 1. Plant height increased with time and at 2 WAT, F104 and NHVI-RL produced the tallest plants which differed significantly from Z106. The trend in plant height was $\text{Z106}>\text{F105}>\text{Z107}>\text{Z108}$. At 3 and 4 WAT, F104, NHVI-RL and Z106 gave plants which were significantly taller than Z107 and Z108 while F104 gave the highest value at 5 WAT which differed from F105, NHVI-RH, Z107 and Z108. The tallest plants were from Z106 which did not differ from F104 and NHVI-RC at 6 WAT but Z107 and Z108 were the shortest. NHVI-RL and Z106 were tallest followed by F104 and NHVI-RC at 7 WAT. Fig 2 shows the stem girth of pepper cultivars with time (in weeks). F104 gave the best stem girth over 2-4 WAT during which it was significantly different from Z106, NHVI-RB, Z107 and Z108. The trend was the same at 5 WAT but the varieties were not significantly different. At 6 WAT, F104 and NHVI-RL gave the highest values which differed only from Z107. At 7 WAT, NHVI-RL produced the thickest plants which did not differ from the other varieties.

Table 1: Characteristics of the soil in the experimental site

Properties	Values
pH (H_2O) (1:1)	7.0
Organic matter (g.kg^{-1})	46.03
Total N (g.kg^{-1})	2.10
Available P (mg.kg^{-1})	34.61
Exchangeable cations (cmol.kg^{-1})	
Calcium, Ca	21.50
Magnesium, Mg	1.57
Potassium, K	0.67
Sodium, Na	0.08
Exch. Acidity	0.00
Effective CEC	4.47
Particle size (g.kg^{-1})	
Sand	560
Silt	210
Clay	220
Textural Class	Clay loam

The number of leaves produced with time is shown in Fig.3. At 2 WAT, F104 produced higher number of leaves than the other varieties with Z108 least. At 3 WAT, the highest number of leaves was produced by F104 and NHVI-RL while the Z107 and Z108 produced the least. At 4 and 5 WAT, F104 and NHVI-RL produced the highest number of leaves while Z108, NHVI-RH and Z106 produced the least. At 6 WAT, NHVI-RL and F104 produced the highest number of leaves which differed from Z108, NHVI-RH and F105 but Z106, Z107 and NHVI-RB were not different. At 7 WAT, NHVI-RL produced the greater number of leaves than F104 and Z106 while the least were produced by NHVI-RC, Z108 and NHVI-RB.

Fruit yield per plant, fruit length and stem girth, pericarp thickness, seed number and weight in the varieties are shown in Table 2. The parameters significantly differed among the varieties. The highest fruit yield at 235.2 g.plant⁻¹ produced by Z106 was significantly different from other varieties. NHVI-RB, NHVI-RC and

NHVI-RL gave similar values and were superior to NHVI-RH while F105 was better than F104 at 52.2g.plant⁻¹. The fruit girth was highest in NHVI-RB which did not differ from NHVI-RC and Z107 while Z104 and Z106 were least. Fruit length was highest in Z106 which was similar to Z104. The pericarp thickness was not different among the varieties. The number and weight of seeds per fruit were least in F104 and Z106 to the highest values in F105.

The ripe fruit yields of the different pepper varieties at 0 and 100 kg.ha⁻¹ are shown in Fig.4. The varieties differed significantly ($P < 0.05$) at 0 and 100 kg.ha⁻¹ of NPK fertilizer application. At the 0 kg.ha⁻¹ rate, Z106 produced the highest yield followed by NHVI-RB, NHVI-RH and Z107 while the least were F104, F105, NHVI-RC and Z108. The pattern was the same at 100 kg.ha⁻¹ NPK fertilizer application for Z106 which gave the highest yield but was followed by Z107, NHVI-RC and F105. The effect of fertilizer increased fruit yield slightly in NHVI-RH and NHVI-RL but decreased in NHVI-RB.

Table 2: Fruit yield characteristics in nine varieties of hot pepper

Accession Number	FY/PT(g)	FG(cm)	FL(cm)	PTH(cm)	SN	SW(g)
NHVI-RBig	93.0	7.0	5.3	0.20	73	1.3
NHVI-RHBig	72.0	8.9	4.6	0.20	68	1.4
NHVI-RC	91.8	8.6	5.3	0.20	71	1.3
NHVI-RL	89.4	7.2	5.3	0.19	67	1.4
F104	52.2	5.8	5.5	0.19	57	1.0
F105	76.2	7.5	4.7	0.20	82	1.7
Z106	235.2	4.0	6.2	0.20	57	1.1
Z107	157.2	8.6	3.9	0.20	72	1.4
Z108	77.4	6.9	3.6	0.20	66	1.4
LSD (5%)	6.7	0.9	0.7	0.01	7.5	0.7

FY/PT= Fruit yield per plant, FG= Fruit girth, FL=Fruit length, PTH= Pericarp thickness, SN= Seed number, SW= Seed weight

The pooled average pepper yields of the varieties over the treatments and replicates are presented in Table 3. The highest (7,839 kg.ha⁻¹) fruit yield was obtained from Z106 cultivar followed by Z107 (5,239 kg.ha⁻¹) while the least was obtained from F104 (1,739 kg.ha⁻¹). NHVI-RB produced 3099 kg.ha⁻¹ which was slightly higher than NHVI-RC (3059 kg.ha⁻¹) and NHVI-RL (2979 kg.ha⁻¹).

The correlation coefficients of the relationships between plant growth parameters and yield attributes are shown in Table 3. Plant height had significant correlations with stem girth and number of leaves. The fruit yield correlated significantly with only yield.plant⁻¹ while fruit girth with number of seeds and number of seeds with seed weight showed significant correlations.

Table 3: Correlation matrix of the relationships between crop growth parameters and fruit yield of hot pepper cultivars

SG	PH Y/ha	LN	Y/p	F girth	F length	P thick	S no	S wt
Stem girth-	0.57**	-0.68**	-0.32	-0.03	0.03	-0.04	-0.12	-0.01
Plant height -	0.63**	-0.13	-0.37	0.36	-0.09	-0.32	-0.28	0.03
Leaf number	-0.16	-0.19	0.18		-0.17	-0.21	-0.19	-0.03
Yield/plant	-0.22	-0.19	-0.04		0.06	-0.02	0.49*	
Fruit girth	-0.22	0.06	0.46*		-0.02	0.07		
Fruit length	-	-0.08	-0.2		-0.25	0.07		
Pericarp thickness				-	-0.05	0.07	-0.09	
Seed number				-	0.65**	0.21		
Seed weight					-	0.12		
Yield/ha	-							

*, ** = Significant at 5 and 1% respectively.

All the varieties were susceptible to viral diseases and Cercospora leaf spot but with varied degrees of disease severity. The local accessions of the three *Capsicum annum* cultivars (rhombus fruit shaped, 'RODO' responded poorly with high disease incidence and severity compared with the exotic accessions.

The average cost of pepper production for the pepper varieties is presented in Table 4. It has assumed the same costs for all the items especially seed, fertilization and harvesting.

Table 5 shows the economics of producing the pepper varieties. The average price of fresh pepper fruits was ₦400.kg⁻¹ used to calculate the revenue which gave Z106 the highest gross returns (₦3,135,600/ha), net returns (₦2,923,800/ha) and benefit cost ratio 13.8:1. The highest profit (₦13.8) for every ₦1.00 invested was recorded by planting Z106 followed by Z108 with ₦8.8 benefit from the ₦1.00 investment. The benefit-cost ratio was least for F104 at ₦2.2 for every ₦ spent in producing the variety

Table 4: Average cost of production of pepper during the season

Variable	N/ha
Nursery	6,000
Land preparation	20,000
Transplanting	30,500
Weeding	75,600
Fertilizer application	10,200
Insecticide	11,500
Harvesting	40,000
Fertilizer	8,000
Seed	10,000
TOTAL	211,800

Source: Field Data, 2013

Table 5: Economic production of rhombus fruit shaped pepper cultivar

Accessions Number	Yield kg/ha	Gross returns/ha	Cost of production/ha	Net returns N/ha	Benefit to cost ratio
NHVI-RL	2979	1,191,000	211,800	979,800	4.6
F104	1739	695,600	211,800	483,800	2.2
F105	2539	1,015,600	211,800	803,800	3.7
NHVI-RC	3059	1,223,600	211,800	800,000	3.7
NHVI-RH	2399	959,600	211,800	747,800	3.5
Z107	5239	2,095,600	211,800	1,883,800	8.8
NHVI-RB	3099	1,239,600	211,800	1,027,800	4.8
Z108	2579	1,031,600	211,800	819,800	3.8
Z106	7839	3,135,600	211,800	2,923,800	13.8

Farm gate price of pepper was N400/kg

Source: Field Data, 2013

Discussion

The soil in the experimental site was high in total N, available P and exchangeable K when compared with 1.0 g kg^{-1} , $8\text{-}15 \text{ mg kg}^{-1}$ and $0.18\text{-}0.2 \text{ cmol kg}^{-1}$ critical levels respectively established for the soils in Nigeria (Adepetu *et al.*, 2014). Also, the soil organic matter content was high considering that the established critical level beyond which most arable crops would not respond to fertilizer is 20 g kg^{-1} . This high fertility status is due to the nature of the soil. It is located in the valley bottom and benefitted from sediments eroded from the upper parts of the topography as well as the effects of seasonal hydromorphic conditions. The clay loam texture, also a result of the soil formation process, is suitable for pepper production.

Although the experiment involved fertilizer main plots, the means of the 9 pepper varieties were presented for growth parameters. All the pepper varieties showed increase in the growth parameters as the plants aged. The local varieties F104 and NHVI-RL produced the tallest plants initially (2-4 WAT) after which Z106 and NHVI-RL became prominent. F104 and NHVI-RL produced plants with the highest stem girth and number of leaves throughout the period of observation. The development indicates the early vegetativeness of some local pepper varieties and agrees with Idowu-Agida *et al.* (2010) that local varieties of pepper had greater values for stem height and girth compared to some improved pepper cultivars. The varieties that gave the least values for the growth parameters were Z107 and Z108.

The fruit yield, plant^{-1} , fruit length and fruit girth, pericarp thickness, seed number and weight were significantly different among the varieties. The exotic variety Z106 gave the highest fruit yield, plant^{-1} and was followed by Z107 which differed from three out of the NIHORT varieties (NHVI-RB, NHVI-RC and NHVI-RL) that gave similar values while F104 produced the least yield. The pattern of performance in fruit yield, plant^{-1} was the same with the yield, ha^{-1} which showed that the initial vegetative growth advantage of F104 and NHVI-RL did not reflect in greater fruit production. The low yield of F104 and F105 could be due to the severity of viral infection, anthracnose and cercospora leaf spot diseases. Fokunang *et al.* (2000) and AVRDC (2004) had noted the negative correlation between disease traits and yield on various crops. Also, Fajinmi (2013) observed that the growth and yields of pepper genotypes grown in Nigeria are hindered by the high incidence and severity of diseases, especially those caused by viral infections due to the tropical vegetation that supports many alternative hosts and the rapid multiplication of insect vectors that transmit the virus.

The varieties differed in fruit yield at 0 and 100 kg ha^{-1} NPK 20-10-10 treatments. The highest yields of Z106, Z107, NHVI-RB and NHVI-RH at 0 kg ha^{-1} are indicators of the potentials of these varieties. Only Z106 and Z107 still showed the high yields at 100 kg ha^{-1} NPK but included NHVI-RC and F105. The yields indicate the highest responses to the NPK fertilizer in F104, F105, NHVI-RC and Z107;

medium in Z106 and Z108; and low in NHVI-RL, NHVI-RH and NHVI-RB. The responses are not expected in this soil whose total N, available P and exchangeable K contents exceed the established critical levels for the soils in Nigeria (Adepetu *et al.*, 2014) which emphasize the need to conduct systematic studies to determine the nutrient and fertilizer needs of pepper based on soil test correlation and calibration in various pepper growing zones.

With regard to economic performance, Z106 and Z107 gave the highest revenue, net returns and benefit cost ratio while Z108 was not different from some of the local varieties in terms of low profits on account of poor yields. The lowest yields recorded, especially in F104, could be attributed to severity of disease infections. Thus, Z106 (Pimenta BRS Mari) and Z107 (Pimenta Moema) which out-yielded the NIHORT and local varieties (F104 and F105) are considered better suited for cultivation and should be promoted among farmers in Ekiti State, Nigeria. However, further research should be conducted on the adaptability of the exotic pepper varieties, including Z108 (Pimenta BRS Seriema) to the agro-ecological environment in Southwestern Nigeria and especially for resistance/tolerance to the viral, fungal and bacterial diseases identified during the field trial. This is particularly important because the exotic varieties are usually grown under cover and controlled environment in greenhouses.

Conclusions

Considering the yield response and the cost of production, Z106 (Pimenta BRS Mari) cultivar was considered better suited for

cultivation. Results showed that the two of the Rhombus shaped varieties introduced, Z106 (Pimenta BRS Mari) and Z107 (Pimenta Moema) significantly ($P < 0.05$) out-yielded the local varieties (F104 and F105). The result also revealed that the profitability of Z106 has the highest (BCR 13.8:1) profit, followed by Z107 (BCR 8.8:1), with the least (BCR 2.2:1) recorded in F104. The low yields recorded in F104 could be attributed to disease infestation. The study recommends that for profitable production Z106 and Z107 varieties could be adopted.

Based on the results so far, Z106 and Z107 are being promoted among farmers in Ekiti State, Nigeria. It is recommended that further research be conducted to adapt the exotic varieties of pepper to the environment in Southwestern Nigeria for resistance to viral and bacterial diseases which were much evident on the field during the trials. This is particularly important because the varieties introduced from Brazil are usually grown under greenhouse conditions and disease infestation is closely controlled. Since pepper production takes place in open field conditions in Nigeria, efforts should be made to minimize disease infestation through further adaptation and breeding for resistance to diseases.

Acknowledgement

This study was financed by the Africa-Brazil Agricultural Innovation Marketplace Project, within the framework of a grant to the Federal University, Oye-Ekiti (Ref. Project ID No 154). We thank EMBRAPA Brazil (Brazilian Enterprise for Agricultural Research) for outstanding collaboration.

References

- Adepetu, J.A., Adetunji, M.T. and Ige, V.I. (2014). Soil Fertility and Crop Nutrition. Jumak Publishers, Ring Road, Ibadan. 560pp
- Agrios, G.N. (2005). Plant Pathology (5th Ed.). Elsevier Academic Press, Burlington
- Aliyu, L. (2000). Effect of organic and mineral fertilizer on growth, yield and composition of pepper (*Capsicum annum*. L). *Journal of Biological and Agricultural Research* 18: 29-36.
- AVRDC. (2004). Development of high-yielding, disease-resistant chilli peppers. In: *AVRDC Progress Report 2003*. Asian Vegetable Research and Development Centre, Publication Number 04-599. Shanhu, Taiwan: 41-46
- Fajimi, A.A. (2010). Agro-ecological incidence and severity of pepper veinal mottle virus, genus Potyvirus, family potyviridae, on cultivated pepper (*Capsicum annum*) in Nigeria. 21st International Conference on Virus and Other Graft Transmissible

- Diseases of Fruit Crops: 314-322
- Fajinmi A.A. (2013). Pepper veinal mottle virus, a potyvirus of pepper under tropical conditions. *International Journal of Vegetable Science* 19: 2150-2156
- FAO. (2013). Production Year Book, Food and Agricultural Organization of the United Nations, Rome, Italy. 15pp.
- FMARD. (2010). Report of the 2009 Agricultural Production Survey. Federal Ministry of Agriculture and Rural Development Abuja, 86pp.
- Fokunang, C.N., Ikotun, T., Dixon, A.G.O. and Akem, C.N. 2000. Field reaction of cassava genotypes to anthracnose, bacterial blight, cassava mosaic disease and their effects on yield. *African Crop Science Journal* 8 (2): 179-186
- Galanihe, L.D., Priyantha, M.G.D.L., Yapa, D.R., Bandara, H.M.S. and Ranasinghe, J.A.D.A.R. 2004. Insect pest and disease incidences of exotic hybrids chilli pepper varieties grown in the low country dry zone of Sri Lanka. *Annals of Sri Lanka* 6:99-106.
- Green, S.K. and Kim, J.S. (1991). Characteristics and control of virus infecting Pepper: A literature review, Asian vegetable research and development centre. Technical Bulletin, 18: 60pp
- Grubben, G.J.H. and El-Tahir, I.M. (2004). Capsicum species, In: Grubben, G.J.H. and Denton, O.A. (Editors). *Plant Resources of Tropical Africa 2. Vegetables*. PROTA Foundation, Wageningen, Netherlands/Backhuys Publishers, Leiden, Netherlands/CTA, Wageningen Netherlands: 154-164.
- Idowu-Agida, O.O., Nwaguma, E.I. and Adeoye, I.B. (2010). Cost of wet and dry season pepper production in Ibadan, Southwestern Nigeria. *Agriculture and Biology Journal of North America*. ISSN Print: 2151-7525.
- Kelly, W.T and Boyhan, G. 2009. Commercial Pepper Production Handbook. The University of Georgia Cooperative Extension Bulletin 1309. 56pp
- Udo, E.J., Ibia, T.O., Ogunwale, J.O., Ano, A.O. and Esu, I.E. (2009). Manual of Soil, Plant and Water Analysis. Sibon Books Ltd, Lagos. 183pp.

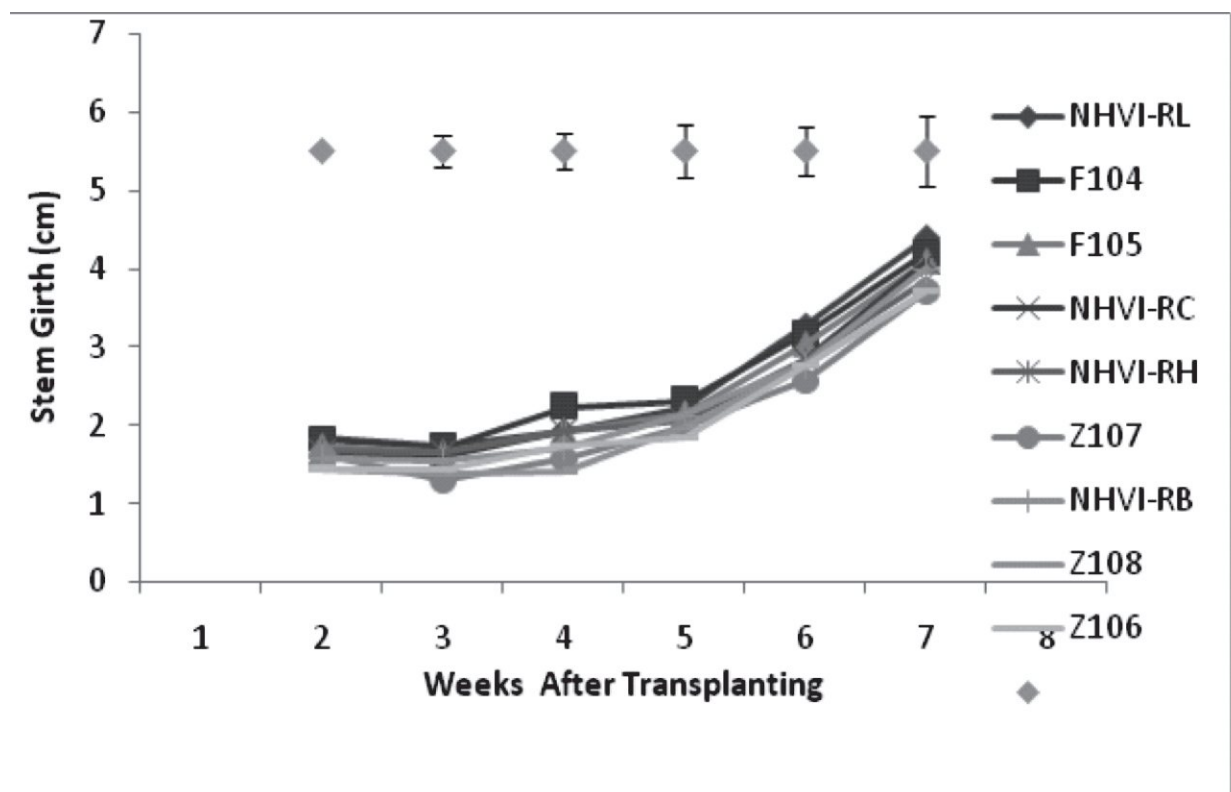


Fig 1: Stem girth development over weeks of 'atarodo' varieties

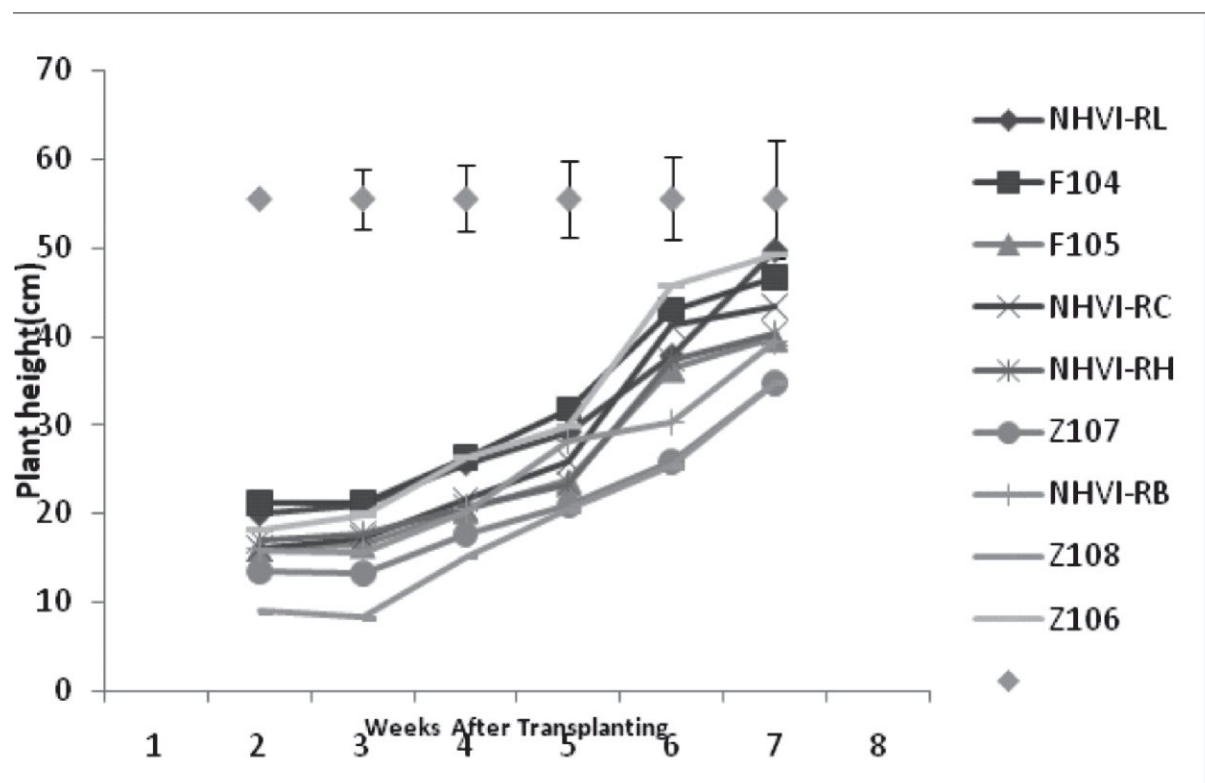


Fig. 2: Plant height development over weeks of 'atarodo' varieties

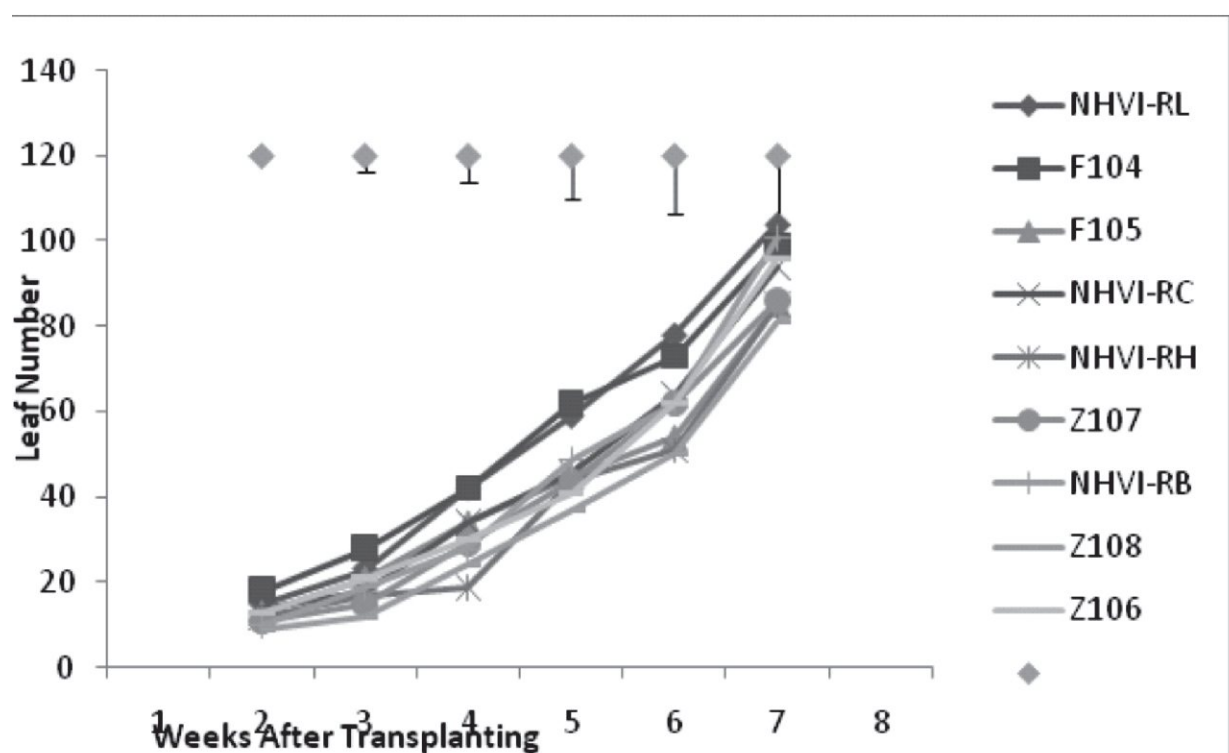
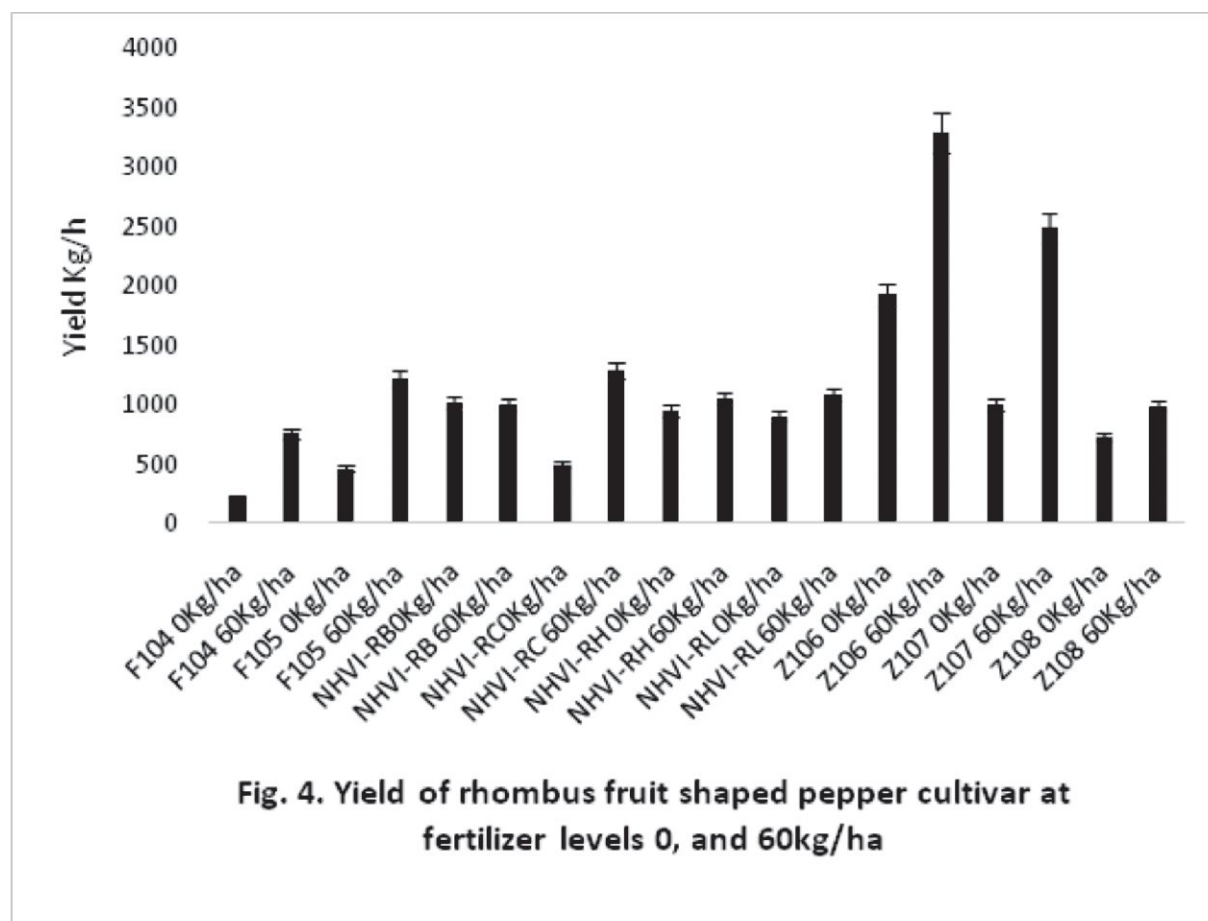


Fig 3: Leaf number development over weeks of 'atarodo' varieties



Response of Broiler Chicken Fed Diets Containing *Tithoniadiversifolia* Leaf Meal Supplemented with Polyzyme

T.A. Oluwasola,

Department of Animal Production and Health Sciences,

Faculty of Agricultural Sciences,

Ekiti State University, Nigeria

E-mail: oluwasolaademola1@gmail.com

Abstract

The high costs of conventional feed stuffs and the desire to reduce the food-feed competition have tilted research efforts towards identifying and using alternative vegetable protein sources as poultry feed ingredients. The effect of replacing soyabean with *Tithoniadiversifolia* leaf meal (TDLM) at 0, 5, 10, 15 and 20% inclusion and supplemented with polyzyme in the formulated diets designated as T1, T2, T3, T4 and T5 respectively evaluated on the growth performance, carcass characteristics and haematology of broiler chickens in a 56-day feeding trial. 150 day-old chicks were randomly allotted to the diet treatments at 30 chicks each, divided into three replicates and fed for 56 days. The birds were weighed weekly and the following parameters were measured on selected birds and at the end of the starter (28 days) and finisher phases (56 days): live and dressed weights, carcass characteristics; weights of internal organs and cut parts and the haematological and blood serum characteristics. Diet T1 gave the highest average daily feed intake, average daily weight gain, final live weight, feed conversion ratio and protein efficiency ratio while Diet T5 gave the least values in both phases. The carcass and eviscerated weights were highest in birds fed Diet T1 and followed by Diet T2. In the starter phase, Diet T2 gave highest cut parts (head, neck, drumstick and shank) but the wing and thigh did not differ from Diet T1. Diet T1 gave the highest value for chest only while Diet T2 was best for neck, thigh and shank at the finisher phase. The haematological indices and serum parameters were significantly ($p < 0.05$) affected by the diet treatments with Diet T2 giving the highest values.

Keywords: Additive, *Tithoniadiversifolia*, polyzyme supplementation

Introduction

Mexican sunflower (*Tithoniadiversifolia*) leaf meal can be a valuable source of dietary energy and protein in feeding livestock. However, previous studies showed that the limitation to its use is associated with the high contents of fibre and non-starch polysaccharides as cell wall components (Oladejo *et al.*, 2006). The limitation to the use of most cereal by-products and leaf meals in monogastric diets is because their gastro-intestinal tracts are not adequately equipped to handle fibrous feed materials (Choct, *et al.*, 1996). Thus, monogastric animals, especially poultry, have limited utilization of leaf meals due to the fibre content (Dairo, 1997; Esonuet *et al.*, 2002; Agbede and Aletor, 2003).

The nutritional challenges posed by the fibrous nature can be addressed by the use of fibrolytic enzymes because broilers do not produce the endogenous enzymes that can effectively hydrolyse cell wall and other fibre components of their feed (Buchanan *et al.*, 2007). This is more so, as the reliance on the

proventriculus and the microbial activities in the hind gut (Leeson and Summers, (2001) for hydrolysis of dietary fibre cannot make available all nutrients in the fibrous component to the birds. The use of hexogenous enzymes has enhanced growth performance and production indices such as hen day production in broiler and laying chickens (Ojewola *et al.*, 2003; Fasuyiet *et al.*, 2007; Oluwasola *et al.*, 2007). These enzymes are mostly of fungi and bacteria origin and include xylanases, cellulases (P-1, 4-glucanases) (Zanella *et al.*, 2004; Leslie *et al.*, 2007), mannanases and pectinases. There are branded hexogenous enzymes such as Roxazyme G, Ronozyme P and Bromzyme which were equally effective in the enhancement of growth performance through improved digestibility and hence utilization of the nutrients locked up in the fibrous feed ingredients (Jackson *et al.*, 2004). This experiment, therefore, was designed to investigate the growth performance and haematological indices of broiler chickens when fed diets containing TDLM supplemented with polyzyme,

a fibrolytic enzyme.

Materials and Methods

Tithoniadiversifolia leaves were harvested before the flowering stage at the Teaching and Research Farm, Ekiti State University, Ado-Ekiti, air-dried and milled to produce *Tithoniadiversifolia* leaf meal (TDLM). Broiler starter diets were prepared in which TDLM protein were used to replace soybean meal protein at 0, 5, 10, 15 and 20% inclusion and designated as diets T1, T2, T3, T4 and T5 respectively (Table 1). Polyzyme (400 g/ton of feed) was added to diets T2-T5. The dietary treatments were arranged in a completely randomized design (CRD) feeding trial during the starter and finisher phases.

One hundred and fifty (150) day-old broiler chicks were brooded at the Poultry Unit in the Teaching and Research Farm, Ekiti State University, Ado-Ekiti. The chicks were randomly assigned to the five treatment diets at 30 each and divided into three (3) replicates. The initial live weights of the birds were taken. All necessary routine medications were administered to the birds and they were fed the experimental diets *ad libitum* and water was given generously. Weight gained was taken on weekly basis. At the end of the feeding trial, all the birds were starved overnight and one chick per replicate was selected, weighed and slaughtered by severing the head with a sharp surgical knife. The blood was collected into bijoux bottles containing little quantity of ethylene diamine tetracetic acid powder (EDTA). Blood samples were also collected without EDTA in another set of bijoux bottles for serum analysis. The birds were dressed, weighed and eviscerated. The internal organs: pancreas, heart, spleen and gizzard were removed, weighed and the carcasses cut into parts: thigh, drumstick, shank, chest, back, neck, wing and head and weighed. The haematological parameters: packed cell volume (PCV), haemoglobin concentration (Hbc), red blood cell (RBC) and white blood cell (WBC) were determined by the methods outlined by Sastry (2004). The blood serum was analyzed for total protein (TP), albumin (ALB) globulin (GLB), aspartate amino transaminase (AST) and alanine amino transaminase (ALT).

Statistical analysis

All the data collected on performance indices, carcass characteristics, relative organ measured, serum and haematological indices were subjected to analysis of variance and means separated with Duncan Multiple Range

Test using the General Linear Model as described by SAS (1987).

Results

Table 2 shows the growth performance of broiler starter chicks fed the diet treatments. The average daily feed intake (ADFI) was highest in the birds fed diet T1 (control) but which did not differ significantly from T2, T3 and T4 while T5 was least. The average daily weight gain (ADWG) differed significantly among the treatment diets. The birds fed diet T1 had the highest value which did not differ from T2 and followed by T4 while T3 and T5 gave the least. Diets T1 and T2 had the highest and similar feed conversion ratio (FCR) but poor in T3-T5. The protein efficiency ratio (PER) was highest and similar in birds fed diets T1, T2 and T4 and low in T3 and T5 which did not differ significantly.

Table 3 shows the carcass characteristics of the birds. The highest mean final live weight (FLW) was obtained in birds fed diet T1 and followed by diet T2 and T4 which were similar while T3 and T5 gave the least. The carcass and eviscerated weights were also highest in diet T1 and followed by diet T2 while diets T3-T5 had lower and similar values. The weights of the cut parts expressed as percentage of the carcass weight showed that the head was similar in diets T2 and T5 but significantly higher than the birds fed diets T1 and T3. Diet T2 gave the highest value for neck while the proportion of the wing was higher in the birds fed diets T1 and T2. Only diet T4 gave a significantly lower proportion of the thigh, diet T2 gave the highest shank and drumstick whereas diet T1 gave the highest value for the chest. The internal organs: spleen, lungs and heart were significantly higher in birds fed diet T1 while the liver was highest in diet T4 but least in diet T1. The gizzard in diet T5 was significantly higher than diets T2 and T3 while the biggest proventriculus was found in diet T5 but smallest in diet T3. The birds fed diet T2 had the largest intestine but least in the birds fed diet T1.

Table 4 shows the haematology and some serum indices of broiler starter chickens fed the treatment diets. The PCV was highest in birds fed diet T2 while T3 and T4 gave the least but similar values. The Hbc in birds fed diets T2, T3 and T5 was similar and significantly higher than in diets T1 and T4. The RBC count was least in birds fed diet T4 but similar with the other diets while the WBC count was highest in diet T2 and

least in diet T3. The MCHC was similar but significantly higher in birds fed diets T3 and T4 while diet T2 gave the least. The MCV was similar in birds fed diets T2, T4 and T5 was similar while MCH was least in diet T1. The serum total protein was highest in diet T2 which had the least albumin content. The cholesterol level was similar and higher in birds fed diets T1 and T2. The AST was highest in diet T1 but least in birds fed diets T2 and T3 while ALT activity was similar and higher for broilers on diet T1 and T2.

The growth performances of broiler finishers fed the dietary treatments are shown in Table 5. There were significant differences in the ADFI and ADWG with birds fed diet T1 and T2 giving similar but significantly ($p < 0.05$) higher values and least in diets T4 and T5. The FCR and PER were highest in diet T1 and T2 while diet T4 had the least values.

The carcass characteristics of finisher broilers are shown in Table 6. The birds fed diet T1 were heaviest in live, carcass and eviscerated weights followed by diet T2; diets T3 and T4 were similar while diet T5 gave the least weight. The cut parts expressed as percentage of the carcass weight showed that the birds on diet T3 and T4 had the biggest heads followed by diet T2 and T5. The proportion of the neck was higher in diet T2 while the wing was not different among the diets. The thigh was highest in diet T2 followed by diets T1, T3 and T5 which were similar and higher than in birds fed diet T4. The drumstick and back were highest in birds fed diets T4 and T5 respectively but the chest was highest in diet T1 followed by diets T2, T4 and T5 with similar values. The diets T2 and T4 had the highest values for the shank and were followed by diets T1 and T3. The internal organs increased with TDLM inclusion for liver, lungs, gizzard, proventriculus and the intestine but not the spleen and heart. The diets T1 and T2 had similar values for the liver while diet T5 had the highest for lungs and gizzard. The proventriculus was highest with diets T2 and T5 while diets T2 and T4 produced the highest values for intestine.

Table 7 shows the haematological indices and serum chemistry of broiler finisher fed diets containing levels of TDLM inclusion and polyzyme. There were significant differences ($p < 0.05$) in the PCV, Hbc, RBC and WBC among the various diet treatments. Broilers fed diets T1, T2 and T4 had the highest ($p < 0.05$)

but similar PCV. Diets T2 and T5 had the highest Hbc and RBC which differed significantly from other treatment diets while WBC were higher and similar in diets T2 and T3. The MCV and cholesterol were highest in diet T1; total protein, albumin and globulin were highest in diet T2 while diet T4 produced the highest AST and ALT activities.

Discussion

The ADFI in broiler starter chickens was similar for the different levels of TDLM inclusion with polyzyme except the decrease at 20% (diet T5). The pattern in broiler finisher was somewhat similar with the only difference being that there was a decrease in birds fed diet T4 and T5. It shows that the enzyme was able to effectively solubilize the fibre component of the TDLM and thereby increased the ability of the birds to consume as much feed as in diet T1 despite the anti-nutrient factors contained in the TDLM (Oladejo *et al.*, 2006). The low ADFI in diet T4 and T5 might be due to the higher fibre content and possibly palatability issues. With the action of the enzyme, the nutrients locked up in the TDLM became available for utilization by the birds which resulted in corresponding ADWG for the birds (Choctet *et al.* 1996; Iji, 1999; Buchaman *et al.*, 2007). The ADWG of birds fed diet T2 was similar to diet T1 but as TDLM increased, the tannin and other anti-nutrient factors decreased the utilization of TDLM. The tannin content could have an astringent property on the taste of the birds thereby decreasing the feed intake and weight gain. The presence of carbohydrate and non-starch polysaccharides might be another factor in the reduced utilization as enunciated by Iji (1999) because *Tithonia diversifolia* contains fibre fractions that inhibited digestion and utilization of the nutrients. These observations agree with the reports of Odunsi *et al.*, 1999; Togun *et al.*, 2006). The FCR and PER were best in the birds fed diet T1 and T2 in a pattern similar to ADWG in both starter and finisher phases. This is expected since these parameters are derivatives of the feed intake and weight gain.

The FLW, carcass and eviscerated weights, cut parts and internal organs of the birds at the starter and finisher phases were best in the birds fed diet T1 and followed by diet T2. Although the values obtained in birds fed diets T2 and T4 were somewhat similar, no clear explanation can

be given for this observation. However, TDLM appeared to attain optimum inclusion level at 5% (diet T2) which corroborates the finding of Odunsiet *et al.* (1999), Farinuet *et al.* (2005), Togunet *et al.* (2006). The cut parts did not strictly follow a definite pattern as indicated by Dunnington and Siegel (1995) that the enzymes influenced the growth of some organs more than others. The proportion of the gizzard relative to the carcass weight increased to a maximum in diet T5 and was significantly different from the other treatments because the birds had to work more on the fibrous diet which caused better development of the gizzard muscle and size.

The PVC, Hbc, RBC and WBC decreased as the TDLM inclusion increased in the birds which did not suffer any serious health

hazard. However, the WBC values indicated that the birds might have been exposed to infections but which were subclinical as no outbreak of diseases was recorded during the study. The serum indices: total protein, albumin and globulin were best for the birds fed diets T2. The serum enzyme activity (AST) was highest in birds fed diets T4 and T5 while ALT was least for these dietary treatments implying that the quality of the ingredients in the diet T2 appeared adequate for the broiler chickens. The calculated MCHC, MCH and MCV values are within the range reported by Jain (1993) and indicated that the birds were not anaemic. The results show that TDLM can be conveniently included in the diets of broiler chickens at optimum dietary level of 5% with the fibrolytic enzyme, polyzyme.

References

- Agbede, J.O. and Aletor, V.A. (2003). Evaluation of fish meal replaced with leaf protein concentrate from gliricidia in diets for broiler chicks: Effect on performance, muscle growth, haematology and serum. *International Journal of Poultry Science* 2: 242-250
- Buchanan, N.P., Kimbler, L.B., Parsons, A.S., Seidel, G.E., Bryan, W.B., Felton, E.E.D. and Moritz, J.S. (2007). The effects of non-starch polysaccharide enzyme addition and dietary energy restriction on performance and carcass quality of organic broiler chickens. *Journal of Applied Poultry Research* 16 (1): 1-12.
- Choct, M., Hughes, R.J., Wang, J., Bedford, M.R., Morgan, A.J. and Annison, G. (1996) Increased small intestinal fermentation is partly responsible for the anti-nutritive activity of non-starch polysaccharides in chickens. *British Poultry Science* 37: 609-621
- Dairo, F.A.S. (1997). Evaluation of water hyacinth (*Eichhornia crassipes*) as feed ingredient and yolk colouring agent in layers' diet. *Nigerian Journal of Animal Production* 24(1): 42-45.
- Dunnington, E. A and Siegel. P.B (1995). Enzyme activities and organ development in newly hatched chicks selected for high or low eight week body weight. *Poult. Sc.* 74; 761 -770.
- Esonu, B.O., Iheukwumera, E.L., Emenalom, O.O., Uchogbu, M.C. and Etuk, E. (2002). Performance, nutrient utilization and organ characteristics of broiler finishers fed *Microdesmis puberula* leaf meal. *Livestock Research for Rural Development* <http://www.cipar.org.c/lrd/6/esonl46htm>
- Farinu, G.O., Ojebiyi, O.O., Akinlade, J.A. and Laogun, I.A.O. (2005). Effect of graded levels of wild sunflower meal (WSFM) on performance of pullet chicks and growing pullets. *Proceedings 10th Annual Conference of ASAN*, Ado-Ekiti, Nigeria: 217-219
- Fasuyi, A.O. (2007). Effects of graded levels of fluted pumpkin (*Telfairia occidentalis*) leaf meal on the nutrition, biochemistry and haematology of broiler finisher. *Agricultural Science Research Journal* 1: 5-12.
- Iji, P.A. (1999). The impact of cereal non-starch polysaccharides on intestinal development and functions in broiler chickens. *World Poultry Science Journal* 55(4): 375-387
- Jackson, M.E., Geronian, K., Knox, A., McNab, J. and McCartney, E. (2004). A dose-response study with the feed enzyme beta-mannanase in broilers provided with corn-soybean meal based diets in the absence of antibiotic growth promoters. *Poultry Science* 83: 1992-1996.
- Jain, N.C. (1993) *Essentials of Veterinary Haematology*. Lea & Febiger. Philadelphia: 56- 70
- Leeson, S. and Summers, J.D. (2001).

- Digestion and nutrient availability. In *Scott's Nutrition of the Chicken*. Univ. Books, Guelph, Ontario, Canada: 5
- Leslie, M.A., Moran, E.T. Jr. and Bedford M.R. (2007). The effect of phytase and glucanase on the digestible energy of corn and soybean meal fed to broilers. *Poultry Science* 86: 2350-2357
- Odetokun, B.Y. (2001). Influence of Roxazyme G Supplementation on the Replacement Value of Wheat Offals or Rice Bran for Maize in Broiler Chick Diets. M. Agric. Tech. Thesis, Federal University of Technology Akure. 88pp
- Odunsi, A.A., Farinu, G.O., Akinola, J.O. and Togun, V.A. (1999). Growth, carcass characteristics and body composition of broiler chickens fed wild sunflower (*Tithoniadiversifolia*) forage meal. *Tropical Animal Production* 2: 205-211
- Ojewola, G.S., Oguike, M.A., Akomas, S.C., Likita, T. Onyiro, O. and Wokocha, C. (2003). Comparison of the supplemental effects of roxazyme-g enzyme in palm kernel meal and brewers dried grain based diets fed to male turkey poults. *Nigerian Agricultural Journal* 34: 116-124
- Oladejo, J.A., Sanusi, W.A., Ojedapo, I.O. Iwe, A.O. and Adesanya, L.O. (2006). Comparative analysis of poultry feed production using alternative and conventional ingredients in Ibadan metropolis. *Proceedings 31st Annual Conference of the Nigerian Society of Animal Science (NSAP)* Kano, Nigeria.
- Oluwasola, T.A., Agbede, J.O., Dairo, F.A.S., Olowu, O.P.A. and Aletor, V.A. (2007). Replacement value of *Panicum maximum* (Guinea grass) for maize in the diets for broiler chicks with or without Roxazyme-G and Ronozyme-P supplementation. *Research in Agricultural Science* 1(2): 39-44
- SAS Institute (1987). SAS/STAT User's Guild. SAS Institute Inc, Cary, NC, USA.
- Satsry, G. A (2014). Veterinar Clinic Pathology CBS Publishers and Distributors, 45961/1-A, 11, DryaGanj, New Delhi – 110002 (India).
- Togun, V.A., Farinu, G.O. and Olabanji, R.O. (2006). Feeding graded levels of wild sunflower (*Tithoniadiversifolia*Hemsl. A. Gray) meal in replacement of maize at pre-pubertal age, negatively impacts on growth and morphometric characteristics of the genitalia of Anak 2000 broiler cocks at their pubertal age in Nigeria. *World Applied Sciences Journal* 1 (2):115-118.
- Zanella, I., Sakomura, N.K., Rosa, A.P., Figueiredo, A.N. and Magon, L. (2004). Enzyme supplementation on digestibility of corn-soybean diets for broiler chicks. *ArsVeterinaria* 20: 144-150.