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General Information

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EDITORIAL

Designing strategies to cultivate research culture requires tact. Adopting a project action plan matrix would help a business-like approach that would enable higher education institutions to be better managers. The special Feature is a compendium to guide strategy development and project management in higher education institution.

It is our hope that this issue would be a great reference resource material.

Professor Monioluwa O. Olaniyi

Editor-in-Chief

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IMPACT OF SOCIO-CULTURAL ELEMENTS ON INSTRUCTIONAL MATERIALS DESIGN FOR ODL

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Abstract

Indigenous teaching systems in Africa which were pervasively informal, equipped learners with the social and occupational skills to grapple with the challenges of their socio-cultural and natural environment. This was however disrupted by the invasion of the continent by colonialists who introduced Africans to formal learning systems meant for purposes of assimilation, evolution and education' depending on their imperialist interests. The accompanying curriculum and instructional modes of the colonial learning systems were foreign; they made learning terse and left the learners tense. Although instructional materials remain core in the sustenance of the informality and delivery of Open and Distance Learning (ODL) programmes, a gap still exists in the efficacy and quality of such materials in new ODL institutions in Africa. This paper will examine the socio-cultural elements of language, presentational and dramatic arts and folklore and their usages in the design of print and other formats of instructional materials in ODL programmes. With a review of relevant literature, bibliographic and archival materials, the writer examines and critically analyzes some print course materials of the National Open University of Nigeria (NOUN) to assess the level of cultural friendliness or otherwise of the textual- and non-textual inputs. The study reveals among other things that the nuances of the learners' historical cum cultural peculiarities have been largely neglected in the course materials examined. Following these findings, the researcher recommends the exploration of socio-cultural elements in enhancing instructional materials for ODL programmes where their potentials have not been properly articulated in the continent. Increased use of indigenous cultural elements in the texts and accompanying graphics, illustrations, animation, etc. for instructional materials design may not only reverse the apparent negative results of colonial learning systems if fully explored, but would also equip the graduates of such institutions with the necessary skills to face the challenges of sustainable development of their society.

Keywords: **Impact, instructional resources development, indigenous socio-cultural elements, ODL**

Learning is defined by psychologists as a "change in behaviour, more or less permanent in nature, which is the result of experience and reinforced practice" (Encyclopedia Americana 1988: 116). Indigenous modes of learning in Africa have goals, structures, contents and methods tailored to meet the needs and future challenges of the various communities. The modes involve the bringing up of the young by the older members of the society. Indigenous learning takes place when the experience of the society is transmitted from generation to generation. As Mwalimu Nyerere put it,

The purpose of education, whether informal or formal, is to transmit from one generation to the next the accumulated wisdom and knowledge of the society, and their active participation in its maintenance or development. (Nyerere, 1982,17)

The hallmark of the indigenous forms of learning in Africa is the informality. The process of teaching and learning takes place from day-to-day experience and last from the cradle to the grave. Yet the learning modes prepare the learners to meet the challenges of their immediate environment which they impart upon daily and uniquely, even beyond their lifetime.[1]

The curriculum is designed with emphasis on the living conditions of the people; their view of the universe, God, relationship between the Supreme Being and mankind as well as relationships between various groups of people. More importantly, the learning forms have a lot to do with the natural environment on which the survival and well-being of the society depends and determines its mode of production. It is furthermore functional in the sense that it is primarily aimed at helping children in particular and adults learn and master the necessary social and occupational skills which enable them to effectively cope with their socio-cultural and natural environment. In other words, it is inward oriented as opposed to the outward directed western colonial forms of education which came with the European conquest of Africa in the 19th Century.

The foreign learning and teaching systems were aimed at transplanting foreign world views and life styles on the conquered Africans. The objective of education in this case was not geared to help Africans live in harmony with their environment; it was rather to establish and perpetuate the master-slave status quo between the colonizer and colonized. <

The French and Portuguese called their westernization efforts assimilation, the Belgians
evolution while the British, being more polite, labeled it as education (Rodney, 1985
cited in Garba Diallo, 2003) These foreigners introduced very formal modes of learning and teaching which disrupted the indigenous modes and left the learners in distraught state. Africans
had to cope with having schools located in sacrosanct places away from the homes and cope
with all that came along with formality. Formal learning and teaching modes are not part of indigenous African socio-cultural lifestyle.
Culture[2] is the embodiment of the people, it is also about the things they share and do together

, language, family structure, how and when they plant, how they die, and what they hold to be
sacred. Indeed virtually everything the people hold in common is a part of their culture. Elements that make up culture include norms, values, beliefs, technology, etc. While values are abstract ideals, norms are definite principles or rules which people are expected to observe. So, elements of culture of a people include how they dress, their marriage custom and family life, their patterns of work, religious ceremonies, leisure pursuits, goods they create - and which become meaningful to them - bows, arrows, computers, books, dwellings, etc.(CSS *101,* 15) Human groups or communities enjoy the fraternity of those with whom they share similar elements of culture.

Research into the experiences of individual learners has stressed how important this dimension of enjoyment of the mode of learning in line with their cultural peculiarities and relationship can be in fostering personal transformation. (Lunneborg, 1994, 1997)

There is no doubt that Africa, as the African Ministerial Council on Science and

Technology
noted recently, has "a relatively rich body of indigenous knowledge and related technologies ... embodied in the cultural and ecological diversities of the continent ...used by the African people for thousands of years to solve specific developmental and environmental problems.

(NEPAD document)

Indigenous teaching and learning in Africa starts from the cradle and ends in the grave. The knowledge and skills acquired are however, not only used while alive but even beyond the grave. Nigeria is a country with over 170 million people who speak over 250 ethnic dialects with diverse cultural backgrounds and larger population of rural dwellers. "Unity in Diversity" is a popular slogan an attempt to keep all these people united under one Federal Republic. Three major tribes and languages - Hausa, Igbo and Yoruba are prominent with a plethora of other minorities in multi-cultural diversity.

The nuances of the learners' socio-cultural peculiarities have been largely neglected in the existing materials published in African ODL institutions. Their art, myth and languages have mnemonic qualities which are useful for purpose of giving clear instructions.

Without joining issues in the dialectics of where the boundaries now lie between learner support and course design and development, this writer like M. Thorpe (2002) takes the position that learner support is "that which happens after the course materials have been made." This is to distance all possible distractions from our focus here which is on the impact of socio-cultural elements in course material design.

Yet we should not lose sight of the fact that socio-cultural elements are also components of learner support when viewed against the background of Tait's (2000, 291) definition of learner support as "the range of services both for individuals and for students in groups which complement the course materials or learning resources that are uniform for all learners and which are often perceived as the major offering of institutions using ODL." Later,Tait (2015, p.2) proposing three primary functions of student support (cognitive,affective and systemic) aptly asserts “These functions are both essential and interdependent....the three core functions are truly inter-related.”

Again, like Thorpe (2002), although her subject matter is on the place of online interaction, the question of whether the impact of socio-cultural elements is in the purview of course design is contentious. The import of this will suffice presently. Some of her deductions hold sway for some print course materials of the National Open University of Nigeria (NOUN) which we examine in this paper.

The concept of Science, Technology and Society (STS) encourages reform in science education across the globe. Emphasis has shifted from integrated science to STS by UNESCO and other stakeholders in science education. The concept emphasizes context. The goal is to achieve the teaching and learning of science in the concept of human experience.

For design of course materials, R.K Lowe (1989) hit the right cord when he asserts that
"illustrations can be seen as far more than icing on the instructional cake. They can take the role of a full partner with text in the explanatory process."

This foregrounds our examination of the NOUN print course material in the Faculty of Sciences - *PHY* 131: *Hazards in Laboratory and Laboratory Safety.* Giving example of "the consequences of unplanned dumping of industrial chemical wastes that affected small children of an elementary school" (97) with the disposal of toxic chemicals in Love Canal is quite remote. A much more local example such as the celebrated Koko toxic waste dumping, would have been more culturally-friendly.

Also, the illustrations demonstrating positions of safety with photographs of Indians on several pages of the book[3] would have been more culturally friendly with Nigerian faces.

According to Lowe, for enhanced benefits to be reaped from the combination of text and
illustration, "careful analysis of the subject matter is necessary." A careful analysis of another
NOUN print course material in the School

of Business and Human Resources Management, *TSM 106: The Cultural Heritage* would have been more culturally friendly[4] with full colour of the illustration photographs of celebrants during festivals in the examples used. *Also* other tourist sites exemplified in the course such as, the famous Durbar (8,53), the dyeing pits in Kano (55), the Afromosia laxiflora tree - the tree from which the charcoal for making fire that could smelt iron ore is made- (92), actual charcoal preparation (93), the Isundunrin Domed Furnace (95) and the aerial view of Sukur total landscape would be more culturally friendly with colour photographs. In fact Tourism course materials including others such as *TSMJ01: Understanding Tourism,* which features colourless illustrations on pages 2, 12, 21 and 36 among others, would be more culturally impactful with full colour photographs.

Festival performance texts employ multiple media for their messages (Gbenoba, 2006, 131).
Marshall McLuhan (1964) earlier stated that the media remain expressive extensions of man's
senses and functions, adding that they affect man's relationships with his environment. Fundamental progress or retrogression, as the case may be, is therefore made as we employ these media of speech, writing, printing, filming, etc to convey our message.

African indigenous festival performances including the popular *Eyo* festival in Lagos convey
messages through acting and other paraphernalia of stage - dancing, poetry rendition, and singing with the attendant musicality, sculptural as well as other presentational arts. The presentation of the aspects that could be arrested in print through digitalized technology may be used to enhance instructional materials for ODL and reduce the shortcomings of cold print format.

Although the potentials of indigenous African cultural elements of presentational arts as a
medium of instruction may not be exhaustively exploitable in the print course material format, the musicality of the written word with the ingenious combination of linguistic, stylistic and semantic aphorisms - with appropriate interplay of literary devices displayed in reader-friendly graphics and instructionally enhancing colours would go a long way in making our print instructional materials better. This would still leave; if not even open up further, the great potentials of these same cultural elements (of indigenous presentational arts) for the design of other non-print formats including the web interactive.

Therefore, just as the print format of NOUN course material *GST 201: Nigeria People and*
Culture which is about Nigerians, would do well if spiced with the popular folk songs and folktales of the people being described, a rendition of the instrumental version of their indigenous songs should be used as interlude or background music in any web and non-web instructional material of the same course. Same goes for similar materials as the *TSM 106* highlighted earlier.

The song accompaniment for GST 101 demonstration compact disc would be better enhanced with the use of an instrumental rendition of *"Alo alo* O, *alo, alo, alo"* after the presenter's instruction to the learner to 'Listen carefully to the following passage!'

Just as Lowe rightly concludes, "like most text examples, illustrations are likely to be far more effective if, rather than simply being presented, they are set in context whereby students explore the concepts and relationship they embody." The NOUN is probably poised to address these challenges as seen in some of its recently printed course materials. *BED* 111: *Introduction to Keyboarding* is printed with colour illustrations. If produced without colour illustrations, the material might not have adequately instructed the learners who are expected to practise with computers which feature colour pop ups on the monitors. The 133-page course material is features colour illustrations throughout for higher instructional fidelity which could also benefit other print course materials when the university extends it to go round. The use of more indigenous cultural elements in the texts and accompanying graphics, illustrations, animation, oral narrative techniques and so on for instructional materials design a not only reverse the apparent negative impact of colonial

education, it would also restore the values that the indigenous learning modes lost to the colonial epoch.

The language element of culture signifies at various levels the main of which are - iconic, indexical, symbolic and aesthetic. The graphical representation signifies the medium of expression among others. Some content words, no matter the medium, however, have indexical functions. Then, according to Ricouer,

Symbols occur when language produces signs of composite degree in which the meaning, not satisfied with designating some one thing, designates another meaning attainable only and through the first intentionality. (1970, 16)

This means any word used (especially creatively) is denotatively and connotatively signifying. That is why Viti Elgar aptly asserts that the "Linguistic symbol is a sign of double signification" as he identifies the symbolic functions as: for unification, revelation of reality and adaptation of reality. (1979, 17)

Language at the aesthetic level is no less significant for the design of instructional materials for ODL. Pierrie Guiraud situates the function of aesthetic signification two antithetical modes of experience - the logical and the affective (1975,66) while Adedotun Ogundeji much later situates it as the rhetoric and poetic. (1989;75). The four levels of signification inherent in linguistic medium examined so far, (more with the polyglot continent) taken with the myriad of indigenous cultural elements available, larger space exists for possible exploration by the instructional material designer for ODL courses in Africa.

It is exigent therefore that the design of instructional materials be enhanced through further exploration of socio-cultural elements. This is with the aim to reduce, if not totally eliminate, the harsh formality which alienates the learner and makes learning a monumental task in African ODL institutions. Increased use of indigenous socio-cultural elements in the texts and accompanying graphics, illustrations, animation and oral narrative techniques among others, for instructional materials design for their programmes may not only reverse the apparent negative results of colonial learning systems but would also equip the graduates of such institutions with the necessary skills to face the challenges of sustainable development of their society.

Notes

1. This is because the indigenous Africans continue to exert great influence on the living members of the community as dead ancestors. Indigenous festivals in Africa especially ritual festivals are laden with the invoking the spirit of the ancestors who participate at various stages particularly at the initiation stages. According to the Ugandan poet Okot p'Bitek (1986) "Man has a boundle of duties which are expected from him by society, as well as a boundle of rights and privileges that the society owes him. In African belief, even death does not free him. If he had been an important member of society while he lived his ghost continues to be revered and fed; he, in turn, is expected to guide and protect living." *(Song of Lawino and Song of Ocol)*
2. Suppose that A and B are sitting together and B is telling a story about the origin of the people that A and B consider themselves to be. This story is one that is known by all of B's generation. What is told to A by B is culture. Suppose also that B has thought about this story and has some different ideas about the elements of the story but B has never told this to anyone else. So long as B keeps this to herself, it is not a part of the culture of people of A and B. Therefore culture is said to be shared and learned. The consensual element simply means that many share it and agree to its meaning and importance." *(CSS 101, 15)*
3. See pages 101, 102,116, 117, 118 and 119 i.e. Figures 6.1, 6.2, 6.4, 6.5 a and b and 6.6 demonstrating the cleaning of the victim's mouth, adjustment of the chin and head, recovery position, artificial respiration a and b and heart massaging respectively in *PHY 131.*

The popular *Eyo* Festival of the people of Lagos given as example is reputed for its colorfulness. Beliefs are associated with religion-those things we hold to be true. Beliefs and values blend. Our national ideologies are also beliefs. Christians believe that the world was created in seven days by God while the average American believes that man evolved from other forms of life over a very long period. - Both are belief systems (involving certain assumptions about what is and how things have come to be), that shapes the lives of the true believers. They shape their lives by supporting their notions of what is important, what is real and how we are to believe at all times.

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OPEN EDUCATIONAL RESOURCES (OERS) DEVELOPMENT IN NIGERIA: PREDICTING TASK TECHNOLOGY FIT (TTF) IMPACT ON FACULTY USAGE, SATISFACTION AND PERFORMANCE

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Abstract

Open educational resources (OER) are gaining grounds globally. However, different regions face different obstacles to OER adoption, policies and experiences. Unfortunately, Africa has continued to trail behind the rest of the world in the adoption of OERs. A number of factors have been adduced from literature ranging from lack of awareness; absence of policies, infrastructural deficits among others with total absence of literature on the fit of the existing technologies being used and how these technologies fit affects utilization, satisfaction and performance impacts. This work adopted the TUSPEM model as a theoretical framework to assess the causal relationship among five constructs of Task Technology Fit, social norms, utilization, satisfaction and performance impacts. Through a quantitative research approach, snowballing sampling was adopted to identify 123 respondents from a Nigerian University. Smart PLS was used to analyse the dataset. Although the results had strong support for relationships between TTF, satisfaction, the result showed a stronger relationship from post usage satisfaction to performance than TTF to performance. It implies that in a voluntary usage environment, TTF and user satisfaction is critical if performance using any information system is to be achieved.

Keywords: *Task Technology fit, OER, user satisfaction, utilization, performance, information system etc.*

Introduction

The public outcry on the falling standard of education especially in Africa is alarming. While huge chunks of budget projections are directed towards improving the standard of education, little effort is made geared towards improving access to quality content. As reported by (Ngugi, 2011; Nyandara, 2012), educational institutions rely on printed resources which are usually (a) expensive (b) old and out-dated text books/course materials (c) non-interactive or lack of multimedia quality (d) almost impossible to share with wider group of readers etc.

Developed countries of the world are today faced with serious social challenges of coping with the influx of migrants from poorer countries who may be searching for greener pastures including access to sound education for their children. The shot fall in the number and quality of content especially in developing countries poses a big threat to the quality of education offered by educational institutions Jimes et al (2013). Today, the concept of open educational resources addresses most of these challenges. OER are considered as freely and openly available digitized learning resources that can be adapted, modified, and re-used for teaching, learning, and research (OECD, 2007). The idea of Open Educational Resources (OER) was muted in a forum on the impact of open courseware for higher education in developing countries in 2002 hosted by UNESCO in Paris, France by United Nations Educational, Scientific and Cultural Organization (UNESCO) in a Forum (UNESCO, 2002). OER has been defined as teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use and repurposing by others OER Africa (2017).

Past research show that OER increases access to quality materials and heavy reduction in the cost of purchasing materials Hilton III et al. (2014). In a study that focused on tertiary education in the US, Allen & Student PIRGs (2010) analyzed the cost of OER by focusing on ten US college courses which were available in that subject area. It was concluded that on the average, 80% annual savings of the cost of material was achieved using OER.

With a total of 1.4 billion resources at the end of 2017, the growth of OERs tracked by the number of creative commons licenses is unprecedented. In 2015, Africa continent trailed behind the rest of the world with only 2% contribution OER Africa (2017). Fortunately, efforts by the OER movement and other initiatives targeted at sensitizing African institutions is yielding fruits as Africa overtook the Arab world with 7% as against 6% creative commons (2019).

In order to further entrenched OER, a number of searching techniques (web tools) and evaluation tools have been designed to find and evaluate OERs namely CC Search, OER Commons, OER Africa, Google Power Searching OER Africa (2017). Additionally, on successful identification of appropriate OERs, some tools exist (hosted at OER Commons, OER Quality Evaluation, UKOER Synthesis and Evaluation etc.) in the determination of fit for purpose and an evaluation system comprising rubrics aimed at addressing issues of quality of open learning resources.

OERs are being put to use through (a) developing an online platform that supports faculty to create, locate and customize curriculum in open content. (b) The creation of African Storybook Initiative where children stories are translated into different African languages as well as (c) the creation of free and adaptable textbooks OER Africa (2017).

In a survey by Hoosen (2012) for Common Wealth of Learning (COL) and UNESCO on OER across continents of the world, African countries except South Africa reported that lack of awareness of OER, lack of skills for the development OERs, lack of infrastructural facilities, lack of funds to undertake the production of OER, digital illiteracy, absence of OER policy etc.

Consideration of the fit perspective remain critical as research has shown that not less than 80 percent of tools developed for organizational usage ought to fit the organizational operations while 20 percent of the application can be customized if the standard rule of thumb for customization is anything to go by (Strong and Volkoff, 2010,

Foster 2001). However, there has been little or no known research that has focused on understanding the fit phenomenon in predicting faculty's performance impacts on OERs despites it theoretical and practical needs.

Hence, this study addresses the research question: how fit are these tools and how does fit predict faculty's usage and performance impacts of OERs? Since theory serves as a guide for data collection and analysis (Walsham, 2006), part of the technology utilization, satisfaction and performance (TUSPEM) model was adopted as the theoretical framework in order to understand fit that predicts usage, satisfaction and performance.

The Technology Utilization, Satisfaction and Performance Model (TUSPEM)

The widespread adoption of software applications has necessitated the urgency for a deeper understanding of fit, usage, performance and other dependent variables. Since the advent of information and communication technologies, there have been several theories aimed at formulating principles guiding its operations.

While several theories focuses on pre-adoption studies Davis et al (1989), others concentrate on satisfaction-based studies DeLone and McLean (2002) with the aim of exploring satisfaction derived from usage of ICTs. Several others concentrate on performance based evaluations with a view to assessing/interpreting the impacts of ICTs on individual and organizational performance.

The TUSPEM model as a hybridization of the technology-to-performance model (Goodhue and Thompson, 1995) and other information systems models is hinged on a tripartite dimensions predicting performance impacts of technologies and information systems namely the task technology fit dimension, the utilization pre-cursors dimension as well as the satisfaction dimension. The fit dimension presupposes that for a technology to perform any given task satisfactorily, it must first and foremost suit that given task. As noted by Eden et al 2010, an evaluation of how well a specific technology is suited for the performance of a given task has motivational effects on the users. It agrees that task characteristics, technology characteristics and individual characteristics are major determinants of task technology fit which in turns affect performance. The satisfaction dimension views satisfaction from the post usage perspective. It proposes that users' satisfaction of an information system/technology is a product of usage. The utilization dimension focuses on the pre-cursors or determinants of information system utilization which includes users' attitude to using, computer self-efficacy, perceived usefulness and ease of use, social norms, habit and IT support.

TUSPEM combined constructs such as ease of use and perceived usefulness from technology acceptance model (TAM), satisfaction from DeLone and McLean (2002), usage, TTF, user habit, attitude and performance from Goodhue and Thompson (1995), and computer self-efficacy from Compeau and Higgins (1995), Eden et al (2010); Aguirre-Urreta, 2011).

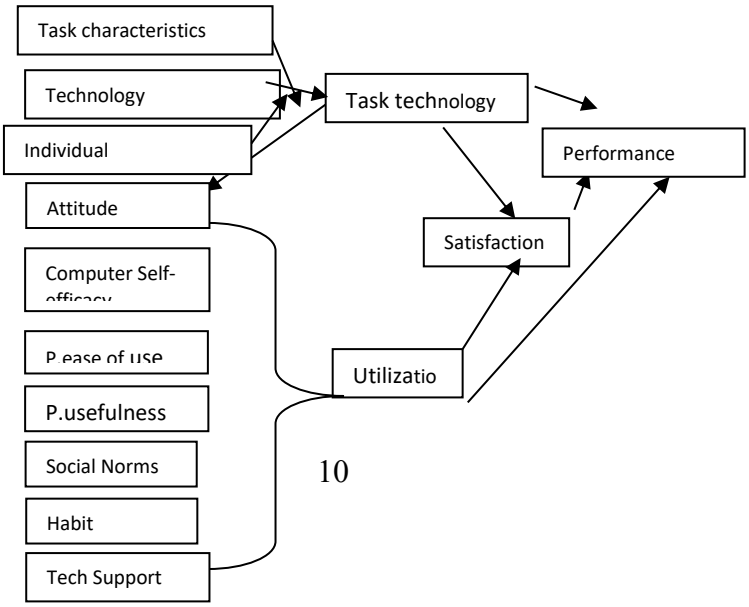

Figure 1: The Technology Utilization, Satisfaction and Performance Model (TUSPEM)
Source: author

The Research Model and Hypotheses

The Task-Technology Fit Construct

Prior to the advent of computers, several operations were driven through manual operations. Today, the advent of computer systems have resulted to the computerization of tasks required to drive processes both at individual and organizational levels. The capability for any specific technology to handle a given task requirement is what is regarded as task-technology fit. Fit changes with the technology Iversen & Eierman (2018). TTF is seen to be higher when the functionality of a technology and the user's requirements are similar. Additionally, TTF is lower if the functionality of the technology is less adequate in meeting the needs of the user. Individuals have a greater tendency to utilize technology if the capabilities of the technology fit the needs of the individual.

In their study Dishaw et al (2013) found that Word/email and Google Docs were perceived to have a better Task-Technology Fit than Twiki or Office Live with no perceived difference in fit between Word/email and Google Docs or between Twiki and Office Live.

Building upon the work of Dishaw et al (2013), Iversen & Eierman (2018) conducted an investigation on collaborative writing and editing tools and the factors that impact on TTF and technology acceptances using 162 students from College of Business at a Midwestern US university. Students in three semesters were subjected to the same tool (MS Word/email, Google Docs, and Office Live/Office 365). The study speculated that students are eager to interact with new tools than with older tools. They perceive that the old technology no longer fits the task as well and thus it performs lower on outcome measures. It was also observed that even though the Word/email technology did not change during the time of the study, its scores went down, possibly due to users' experience with newer technologies more suited to the task.

Task characteristics, technology characteristics and individual characteristics have been identified to be determinants of TTF (Goodhue and Thompson 1985, Dishaw et al 1999). However, findings have confirmed that users' evaluation of TTF on performance can be sufficiently determined on performance without necessarily assessing its determinants McGill et al (2008).

The casual relationship between TTF and performance has been investigated in IS literature with mixed findings. TTF has been reported to having a positive and motivational impact on job performances Eden et al (2010). Parameswaran & Kishore (2017) opined that reduced task effort improves task performance through flow cognitive elaboration as a moderating factor. Staples and Seddon (2004) also reported strong support for the influence of TTF on the performance impact using library management systems. On the contrary, Luarn (2009) found moderate support for the linkage that TTF will positively affect the performance of employees to collaborate. Thus the hypothesis is stated thus:

H_1: TTF has a positive relationship on faculty's performance using OER tools

H_2: TTF has a positive relationship with satisfaction

H_3: TTF has a positive relationship with utilization

Social Norms

One key precursor of utilization according to the TPC model (Goodhue & Thompson, 1995) is social norm. In organizational settings, it is incumbent on the employer to provide the tools needed by the employee to carry out assigned tasks. Depending on existing organizational policies/interest, users are expected to produce expected outcomes using available tools. Results from literature shows mixed findings.

In the corporate context, educational institutions for example, results from

literature shows mixed findings on the relationship social norms and LMS utilization (Venkatesh & Davis, 2000) found that in a mandatory usage environment and when experience is at its early stages, social norms directly impacted on users' intention to use an application. In the eLearning domain, McGill et al (2011) found that social norms affected usage only when the lecturers feel that students expect them to use LMS. Van Raaij & Schepers (2008) on the other opined that social norms relates with users intention indirectly through perceived usefulness. Thus, the hypothesis is stated thus:

H_4: Social norms have a positive relationship with lecturers' utilization of OER tools.

System Utilization

There has been a plethora of intention to use based research in the IS field without much recourse to investigating actual usage and how this construct result to users satisfaction and eventual performance. While Davis et al (1989) and other TAM-based researchers identified perceived ease of use and perceived usefulness as external variables resulting to intention to use and actual usage predictions, the TUSPEM model considers precursors of utilization to include computer self-efficacy, social norms, affect towards use, users habit, perceived usefulness, perceived ease of use and ICT support. However, since this research is not interested in the entire precursors of utilization as modelled by both TPC and TUSPEM models, we model the precursors using a critical precursor social norm (McGill et al 2011; Staples & Seddon, 2004) to ensure that utilization is sufficiently well explained in a mandatory usage context to test the relationship between utilization and OER performance impacts.

Being a key component of several models, findings from researches in the field have been characterized by mixed findings depending on the tools, system and context. On lecturers' use of learning management system (LMS), McGill et al (2011) found a significant relationship between lecturers LMS utilization and performance impacts. Contrarily, while testing the TPC model among university librarians and students users of productivity software, Staples and Seddon (2004) results did not support the relationship between users' level of utilization and performance. Thus, the hypothesis:

H_5: Utilization has a positive relationship with performance

H_6: Utilization has a positive relationship with user satisfaction

User Satisfaction

This model views satisfaction as a post usage experience as it affects performance. It postulate that increased satisfaction with an information system results to increased individual and organizational performance.

In investigating users experience and satisfaction with enterprise resource planning systems (ERP) using qualitative content analysis method, Liere-Netheler et al (2017) found that aspects of task and the type of technology used affects job satisfaction. The causal relationship between task characteristics and job satisfaction was used by Morris & Venkatesh (2010) with the job characteristics model JCM as the theoretical foundation during an ERP system implementation. Questionnaires were used before and after the implementation, to further determine the validity of the influence, it was confirmed that all the five job characteristics had an influence on job satisfaction. Conversely, while Pim Baas (2010) found employee satisfaction as not being consistently found to be related with task-technology fit, Luarn (2009) found moderate support between TTF and utilization directly. Hence, the hypotheses are stated thus:

H_7: User satisfaction has a positive relationship with performance

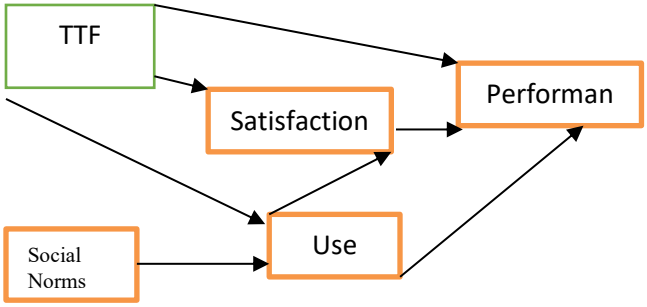

Figure 2: The Research Model

Methodology

Design

The study adopted an offline survey with a view to empirically validating the theoretical model. Based on the theoretical framework, structured test items are adapted bearing in mind that the research model has two exogenous constructs (TTF and social norms) and three endogenous construct (use, satisfaction and performance).
The methodology used is the structural equation modelling. Structural equation modelling is a second generation multivariate technique used to analyse or test theoretical relationships among the variables in a model.

Sampling

In order to ensure that the views collected through the survey is representative of the Lecturers familiar with OERs operations, snowballing method was used. This approach is suitable in identified respondents through referrals.

Of the 150 selected across the schools for the study, 123 respondents participated actively in the study by returning the questionnaires. In calculating the minimum sample size required using PLS, the endogenous construct with the most paths leading to it was considered.
In calculating the minimum sample size required using PLS, the endogenous construct with the most paths leading to it was considered (Performance with three precursors leading into it). According to Chin (1998), the minimum sample size must be 10 times the number of paths leading to the construct with the most endogenous variables. Hence, the sample size in this study is considered adequate for the PLS analysis.

Development of the Instrument

The first section of the instrumentation used four ordinal scales for the collection of basic demographic information namely age (between 30 -70), gender (male or female), education (Bachelors, Masters and Doctorate), and years of experience with OERs (1-10 years).
The second section of the instrument adopted the direct measurement of the variables under study. To guarantee content validity, the items used were adapted from existing validated scales from previous related studies. The twenty-nine test items were modified to suit the context. All the items were modelled with reflective indicators and measured on a 7 point Likert scale with the end points being "strongly disagree" and "strongly agree".
The diagram below shows the coding used and the number of test items used in the measurement of each of the constructs used in the study.

Social Norms	SN	SN1…..SN4
Performance Outcome	PERF	PERF1…PERF7
Satisfaction	SAT	SAT1….SAT5
Task Technology Fit	TTF	TTF1….TTF8

Utilization	USE	USE1….USE5

Table 1: Showing Construct Codes

Validity and Reliability

The work considered both the outer model and inner models for analysis. The measurement model represents the relationship between the indicators and the LVs. The outer model assessed the model in terms of: Uni-dimensionality, internal consistency reliability, indicator reliability, convergent validity and discriminant validity as discussed under measures above since our model is a reflective model.

Survey Protocol

The survey was conducted in a Nigerian University. Members of the faculty who participated in OER workshop on course material development using OER tools organized by OER Africa in collaboration with the National Open University of Nigeria (NOUN) took part in the survey at the end of the workshop. In addition, faculty members familiar with OER whose courses were selected for 'OERization' also participated in the survey.

Completion of the questionnaire was voluntary and all responses anonymous. The questionnaire and completion process were pilot tested by some members of staff of the OER unit in NOUN and slight changes were made in order to further simplify some items.

Collection of data

A one-week period was given to the faculty to enable them enough time to respond to the instrument. The data was collected by the researcher and recorded in excel (csv) format. Discrepant cases in the spreadsheet were assigned -1 for computation. Storage of the data was done in both internal and external disk drives to avoid any lost of data after collection.

Results

A total of 123 Lecturers (Male (71), Female (52)) from the rank of Assistant Lecturer to Full Professor participated in the survey with ages ranging from 30 to 70 years. The participants had varying years of experience in OERs.

4.1 The Measurement Model

Assessment of the outer model comprised of uni-dimensionality, internal consistency reliability, convergent validity and discriminant validity.

4.1.1 Uni-dimensionality: Out of the 29 items used, twenty two loaded significantly on the latent variables. Three items from social norms (SN1, SN3 and SN4) and four items from utilization (USE1, 3, 4 and 5) failed to meet the threshold as recommended by Gefen and Straub (2005) and were consequently eliminated for purification purposes. Hence there was high evidence of uni-dimensionality with the other constructs indicator loadings used in the model as all items loaded above the upper threshold.

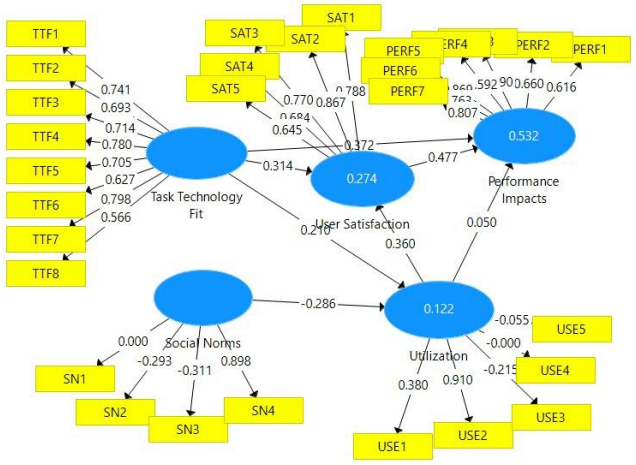

Figure 3: Showing indicators validity and reliability measures

4.1.2 Composite reliability (CR): For determination of the extent to which measured items within the same construct were related to each other, composite reliability measurement criteria were used in this study to assess internal consistency reliability. All constructs in the model exceeded the minimum threshold of 0.6 (Nunally and Berstein, 1994) and 0.70 (Hair et al, 2006) except utilization that had 0.51 as shown in table 2 below. Hence, there was also sufficient evidence of internal consistency reliability among the items of the variables in the model.

4.1.3 Convergent reliability was assessed using average variance extracted (AVE). All constructs met the threshold of AVE greater than 0.50 (Hair et al. 2006) social norms and utilization as shown in table 2 below.

4.1.4 Discriminant Validity: From the squared AVE values shown in the table below, there was evidence of discriminant validity. Each of the constructs shared more variance with its assigned indicators than with any other variables within the column under it. As a test for discriminant validity, the diagonal elements must be higher than any other corresponding row or column entry Barclay et al (1995). Consequently, all items loaded highest on their targeted constructs as showed in table 2 below:

Construct	CR	No of items	AVE	Rho-A	1	2	3	4	5
Perf	0.89	8	0.54	0.86	0.74				
Social Norm	0.03	4	0.23	0.23	-0.01	0.50			
TTF	0.89	7	0.50	0.88	0.57	0.01	0.71		
Satisfaction	0.86	5	0.57	0.86	0.64	0.15	0.39	0.76	
Utilization	0.21	5	0.20	0.21	0.33	0.23	0.20	0.42	0.45

Table 2: Showing outer model

The Structural Model

Ability of the model to explain the variance in the dependent model and the statistical significance of the estimated model coefficient are the assessors of the inner model.

The Predictive Ability of the Model

The predictive power of the model for the dataset is represented by the R^2 value on the endogenous variables as shown in figure …below which indicates that 53% of performance impact, 27% of user satisfaction and 12% of utilization were predicted by the factors contained in this model.

Construct	R Square Value
Performance Impact	0.532
User Satisfaction	0.274
Task Technology Fit	-
Utilization	0.22

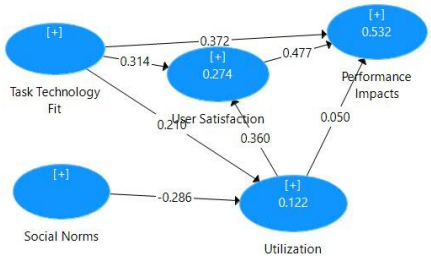

Figure 4: Showing the Structural equation modelling (SEM)

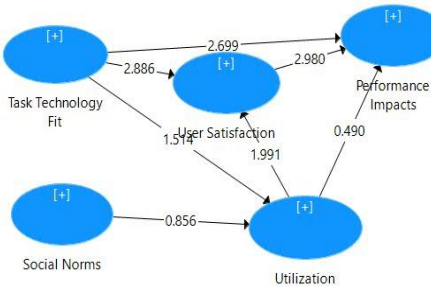

Figure 5: Bootstrapped result

The detailed R square values derived from the SEM calculation are showed in table 3 below:

Table 3: R square Values

The statistical significance of the estimated model coefficients/ Hypotheses Testing

The second aspect of the inner model examines the path coefficients of the latent variables used in the model. The table 4 below shows the path coefficient, t-values and r-values.

Hypothesis	Paths	Path Coefficients	t-value	R-values	Support for H_1 ?
H_1	TTF to performance	0.37	2.63	0.01	Yes
H_2	TTF to Satisfaction	0.31	2.78	0.00	Yes
H_3	TTF to Utilization	0.21	1.52	0.13	No
H_4	Social Norm to Utilization	0.29	0.85	0.40	No
H_5	Utilization to Performance	0.05	0.50	0.62	No
H_6	Utilization to Satisfaction	0.36	2.01	0.00	Yes
H_7	User Satisfaction to Performance	0.48	2.93	0.00	Yes

Table 4: Path Coefficients

Discussion on Findings

With a 53% predictive power of the research model used, it is implied that the model is suitable for research especially in the eLearning domain. From the figure 3 above, 53% of performance impacts is explained by TTF, utilization and satisfaction, 27% of Lecturers satisfaction is explained by TTF and utilization, and 12% of utilization is explained by TTF and social norms constructs. It also implies that the model predicts 53% of the dependent variable (performance). By implication, 47%, 73% and 88% of performance, satisfaction and utilization respectively would be explained by other variables not included in this researched model.

While TTF contributed about 37% in determining performance impacts, the relationship in this study was found to be

positive with a t-value of 2.63 at a 0.01 significance level and was supported. This finding is consistent with the work of Parameswaran & Kishore (2017) which opined that reduced task effort improves task performance through flow cognitive elaboration as a moderating factor. TTF has earlier been reported to having a positive and motivational impact on job performances Eden et al (2010). Staples and Seddon (2004) also reported strong support for the influence of TTF on the performance impact using library management systems. By implication, members of the faculty's performance would be increased with an increase in the fit of OER tools available for discharging their functions.

The hypothesized relationship between TTF and user satisfaction (H_2) was significant and was therefore supported with a t-value of 2.63 at 0.00 significance level. This finding agrees with Liere-Netheler et al (2017) that found that aspects of task and the type of technology used affects job satisfaction. Morris & Venkatesh (2010) also supported the causal relationship between task characteristics and job satisfaction using the JCM model as the theoretical foundation during an ERP system implementation.

The relationship between TTF and utilization (H_3) as hypothesized was not supported at with a t-value of 1.52 at 0.13 level of significance. This finding is supported by earlier works of Staples and Seddon (2004) while testing the TPC model among university librarians and students' users of productivity software which did not support the relationship between users' level of utilization and performance.

The causal relationship between usage and performance was not supported. This finding agrees with Staples and Seddon (2004). While testing the TPC model, they did not find any relationship between level of utilization and performance. Equally, as contained in the McGill et al (2011) that pointed out that utilization may not be influenced by system quality and information quality (Liveri, 2005; Landrum et al 2008). It was also concluded that level of utilization may not influence performance (Wu and Wang, 2006; McGill et al 2003, 2009, 2011). In fact, according to Seddon (1997), the causal relationship between utilization and individual performance proposed by DeLone and McLean may not exist.

Equally, the hypothesized relationship between usage and satisfaction (H_6) vis-a-vis user satisfaction and performance (H_7) were supported with 2.01 and 2.93 t-values at 0.00 and 0.00 levels of significance respectively. This association was supported by the findings of Lee, Kim and Lee (1995). This work therefore supports the suggestion that satisfaction is a product of usage. By implication, increased in performance/production is achieved when users are satisfied using any system.

The causal relationship between social norms and utilization (H_4) was not supported. Scholars in the information system field have been involved in testing effects of social norms (presence) with different variables and context. Van Raaij & Schepers (2008) also supported that social norms relates with users intention indirectly through perceived usefulness. On the other hand, the relationship between social norms and performance expectancy has been tested in the e-commerce context (Ogonowski et al. 2014) and microblogging context (Yan and Huang 2014).

These findings also suggest that in order to have maximum performance from Lecturers, the technology must not only fit the e-assessment task, their satisfaction while using such system is equally crucial. It implies that educational institutions and organizations should aimed at providing adequate training of staff to enable them fully utilize and appreciate the functionalities and capabilities of the various technologies in their work places.

Conclusion

The result of this study is different from those obtained from the TPC model by Goodhue and Thompson (1995), Staples and Seddon (2004), McGill et al (2008, 2011). While their results found more explanatory power from the task technology fit than from the utilization angle, this research found more

explanatory power from satisfaction 48% compared to the 37% obtained from the TTF construct in this study. In the optional usage context, post usage satisfaction is the most critical factor in determining performance.

The results showed that TTF had a direct impact on faculty's performance impacts using OER tools. This implies that the better the fit of the technology to the task and the better the effect on their task performance. Contrarily, poor TTF results to dissatisfaction with the system, frustrations and eventual abandonment of information systems. It implies that for organizations to adopt OERs, adequate training and retraining of faculty members must be carried out on existing tools with the view to determining fit, satisfaction and usage perceptions to avoid waste of financial and material resources.

It is believed that this research has contributed towards the establishment of the linkage between technology utilization, satisfaction and performance impact in a mandatory IS usage environment. Most of the studies along this dimension have focused on predicting performance only from the TTF and utilization angles. This study however has expanded the scope to include satisfaction as well, as a predictor of performance impact. It therefore means that for performance impacts of an IS to be determined especially in the e-learning domain, the technology must not only fit the task and be used, it should also satisfy the user for better performance.

Another important dimension is the post utilization study of the influence of IS usage on satisfaction. Usage influences satisfaction instead of the pre-usage approach of satisfaction stimulating usage in information systems studies.

Recommendations for Future Research

Considering the effect of social norms in mandatory and compulsory usage environment context, further research should explore it effect on usage using other test items as only one of the four test items used in this model was appropriate for the construct. Further work should formulate test items with higher unidimensional and internal consistency reliability criteria.

The relationship between the precursors of utilization such as affect towards use, social norms, users' habit, computer self-efficacy, perceived usefulness and ease of use and other related constructs should be explored to provide deeper understanding of utilization in different context using different technologies.

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PHYTOCHEMICAL ANALYSIS AND ACUTE TOXICITY STUDIES ON *AGBO IBA PONTO* SOLD IN LAGOS METROPOLIS

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Abstract

The presence of young ladies hawking local herbal mixtures along the streets has become common in Lagos metropolis. Artisans and traders purchase these herbal mixtures popularly called *Agbo* and use as curative agent for various ailments. The present study has been carried out to determine the oral acute toxicity of the herbal mixture for typhoid fever, *Agbo iba ponto*, as well as the phytochemical analysis of samples of this mixture from three different areas in Lagos metropolis. The acute toxicity study was done in two phases. Single doses of 10 mg/kg, 100 mg/kg and 1000 mg/kg body weight respectively were administered to three groups of three mice each in the first phase. For the second phase, single doses of 1250 mg/kg, 2500 mg/kg and 5000 mg/kg body weight respectively administered to three groups of one mouse each and the animals were observed for 24 hours. Qualitative and quantitative phytochemical screening carried out using standard methods showed the presence of saponins, tannins, phenols, phlobatanins, terpernoids, steroids, cardiac glycosides and alkaloids. The results showed saponins as the most prominent phytoconsituent with values ranging between 35.00 ± 0.37 and 37.45 ±0.37 mg/100 g while the least values were from the terpernoids (15.93 ± 0.23 to 17.41 mg/100 g). In the acute toxicity study although the highest dose used (5000 mg/kg bwt) caused drowsiness in the experimental animals, no mortality was observed in the experimental animals. The result of this study revealed a wealth of phytoconstituents in this herbal mixture, although dosage above 5000 mg/kg body weight, it may be considered to be nontoxic for oral intake.

Key words: *Agbo iba ponto*, acute toxicity, phytochemicals, Typhoid fever

Introduction:

Typhoid fever (enteric fever) caused by the bacterium *Salmonella enteric serovar typhi* is a common disease in the tropics and subtropics (Adabara *et al*., 2012). The disease is systemic, and is often contracted by ingestion of food or water that is contaminated with the pathogen usually from a feco-oral source. Adabara *et al*. (2012) in their study reported a prevalence rate of 45.0% for typhoid fever in Minna, Nigeria similar to the 46.0% prevalence rate earlier reported in, Nepal India (Bhatta *et al.,*2005). In tropical countries including Nigeria where the disease is often encountered, they account for several cases of morbidities and mortalities (Ibekwe *et al.,* 2008). The causative organism of this disease, *Salmonella typhi,* has rapidly gained resistance to antibiotics (Butt *et al*., 2013) and some people have resorted to the use of herbal remedies.

Herbal remedies are medications prepared from plants materials (Shiel, 2018). These plant materials include seeds, berries, roots, leaves, bark or flowers (Kamatenesi *et al.,*2011). Over seventy five percent of the world population use of one herbal remedy or the other and this trend is gradual but surely on the increase (Oreagba *et al.,* 2011). Ogunsola and Egbewale (2018) attributed this increase in the use of herbal remedies to their relative affordability, acclaimed efficacy and perceived safety by users. The presence of young ladies hawking locally prepared herbal mixtures along the streets has become a common sight in Lagos metropolis. Artisans and traders purchase these herbal mixtures popularly called *Agbo* (a Yoruba word that describes a concoction of plant parts – bark, root, trunk, leaves – steeped or boiled in alcohol or water, which is used to cure various ailments). Oral interview of the hawkers revealed various forms of these locally prepared remedies. The most common of these locally prepared herbal mixtures include; *Agbo jedi-jedi* (hemorrhoids herbal medicine), *Agbo iba* (Malaria fever herbal medicine), *Agbo iba ponto* (Typhoid fever herbal medicine). Oral interview of the hawkers of these locally prepared herbal remedies show variations in the constituents and mode of preparation of the remedy for a particular ailment.

With the increased patronage of these herbal mixtures, the need to determine of the phytochemical constituents of these herbal mixtures and to carry out an acute toxicity test on these herbal mixtures becomes a necessity. It is for these reasons that phytochemical screening as well as acute toxicity studies on *Agbo iba ponto* from various localities in Lagos metropolis has been carried out in this study.

Materials and Methods

Sample Collection

In accordance with the method of Akande *et al*. (2012), this study was undertaken to identify a number of herbal remedies used in the treatment of some common diseases in Nigeria among hawkers of these remedies. They were interviewed for possible information on the constituents and mode of preparation of the typhoid remedy, *Agbo iba ponto*. Samples of the remedy were purchased from three areas, Surulere, Mushin and Ikorodu, in Lagos Metropolis.

Phytochemical screening

Qualitative tests

The methods used by Akande *et al.,* (2012) were used for all the qualitative phytochemical analysis except for the test of terpenoids where the method of Sheel *et al*., 2014 was employed.

Quantitative Tests

Determination of Total Tannins

A quantity of 0.5 g of the concentrated sample was dispersed in 50 ml of distilled water and shaken. The mixture was left undisturbed for 30 minutes at 28°C and filtered through Whatman No. 1 filter paper. A measured volume (2 ml) of the filtrate was dispersed into a 50 ml volumetric flask and 2.5 ml of 10% Na_2CO_3solution was added. The content of each flask was made up to 50 ml with distilled water and incubated at 28°C for 90 minutes. Absorbance was read at 260

nm using the reagent blank. Tannic acid was used for the calibration curve (Salau *et al*.2013).

Total Flavonoid content estimation

An aliquot of 1 ml of sample was added to 4 ml of water which was left to stand for 5 minutes.0.3 ml of 5% Sodium nitrite and 0.3 ml of 10% $AlCl_3$ were added to the mixture and later incubated for 6 minutes at room temperature. Then, 2 ml of NaOH was added to the incubated mixture and the volume was increased to 10 ml with distilled H_2O. The absorbance was measured at 510 nm. Quercetin was used as a standard against a blank. (Aletan and Kwazo,2019)

Estimation of Saponins

A quantity of 1 g of the concentrated sample was treated with 25 ml of 20 % Ethanol and this mixture was heated in a water bath for 2 h with continuous stirring at about 55°C. The residue from the mixture was added to 50 ml of 20 % ethanol. The combined extracts were reduced to 40 ml over water bath at about 90 °C. The concentrate was transferred into a 250 ml separatory funnel and 20 ml of diethyl ether was added and shaken vigorously. The aqueous layer was recovered while the ether layer was discarded. Thereafter, 60 ml of n-butanol was added. The combined n- butanol extracts were washed twice with 10 ml of 5% aqueous sodium chloride. The remaining solution was heated in a water bath at 90 °C for 30 minutes. After evaporation the samples were dried in the oven to a constant weight (Aletan and Kwazo, 2019)

Estimation of Steroid content

The method of Aletan and Kwazo 2019 was modified for this estimation. An aliquot of 2 ml taken from the concentrated sample prepared in 50 ml of distilled water and shaken for 1 hour was transferred into a 10 ml volumetric flask. Sulphuric acid (4N, 2ml) and iron (III) chloride (0.5% w/v, 2 ml), were added, followed by potassium hexacyanoferrate (III) solution (0.5% w/v, 0.5 ml). The mixture was heated in a water-bath maintained at 70 ± 2° C for 30 minutes with occasional shaking and diluted to the mark with distilled water. The absorbance was measured at 780 nm against the reagent blank.

Estimation of Total Phenolic Compound

A quantity of 0.5g of the concentrated sample was weighed and dissolved in 50 ml of water. A portion of 0.5 ml was added to 0.1ml of Folin C [Folin- Ciocalteu] reagent. It was mixed and incubated at room temperature for 15 minutes. After which 2.5 ml of sodium carbonate solution [7.5% w/v of Na_2CO_3] was added and further incubated for another 30 minutes at room temperature. The absorbance of the solution was measured at 760 nm with the use of Gallic acid as standard. The concentration of total phenol was expressed as Gallic acid equivalent (GAE) (mg/g of dry mass) which is a commonly used reference value.

Determination of Alkaloids

This was determined using the method of Harborne (1973). H_2SO_4 reacts with alkaloids in the presence of formaldehyde to form a coloured complex which is read spectophotometrically at 565nm. Exactly 1ml of the sample was pipetted into a clean and dried test tube. Therafter,5ml of 60% sulphuric acid was added into the test tube, which was allowed to stand for 5mins. 5ml of 0.5% formaldehyde in 60% sulphuric acid was also added. This was mixed properly and allowed to stand for 3hrs. Absorbance was read at 565nm (Aja *et al.,* 2017)

Determination of Terpenoids

An aliquot of 1ml of each sample was pipetted into a test tube and 1ml of 5% phosphomolydic acid was added. Gradually, 1ml of sulphuric acid was also added. It was allowed to stand for 30mins and then 2mls of ethanol was added. Absorbance was read at 700nm (Aja *et al.,* 2017).

Determination of Cyanogenic Glycosides

Cyanogenic glycosides react to alkaline picrate under boiling temperature to produce a colour that is read spectrophotometerically at 490 nm. A measured quantity (1ml) of sample was pipetted into a test tube and 4ml of alkaline picrate solution was added. The

mixture was boiled for 5mins and was allowed to cool. Absorbance reading was taken at 490nm (Aja *et al*., 2017).

Determination of Phlobatannins

The concentrated sample (0.5 g) was weighed into a 50 ml beaker and 20 ml of 50% methanol was added, covered with paraffin and placed in a water bath set at 80°C for 1 hour. The mixture was properly shaken to ensure uniform mixing after which it was filtered through a Whatman No. 1 filter paper into a 50 ml volumetric flask, rinsed with aqueous methanol and then made up to the marked level with distilled water. A quantity of 1 ml of this extract was pipetted into a 50 ml volumetric flask, 20 ml of distilled water, 2.5 ml of Folin-Dennis reagent, and 10 ml of 17% sodium carbonate were added to the solution in the 50-ml flask. This mixture was homogenized thoroughly for 20 minutes and absorbance read at a wavelength of 550 nm (Salau *et al.,* 2013)

Determination of Acute Toxicity

Experimental Animals

Healthy young nulliparous and non-pregnant female albino mice with an average weight of 25g were obtained from College of Medicine, University of Lagos, Idi Araba, Lagos Nigeria. The animals were marked for individual identification, and kept under standard condition in plastic cages for 7 days prior to treatment to allow for acclimatisation. Commercially available rodent pellet was given and drinking water was always available.

Acute Toxicity Studies

This was divided into two phases. During first phase of the experiment, Single doses of 10mg/ kg, 100 mg/kg and 1000 mg/kg body weight respectively were administered orally to three groups of three mice each. A second phase of the experiment was carried out based on the result of the first phase. Single doses of 1250 mg/kg, 2500 mg/kg and 5000 mg/kg body weight respectively were administered orally to three groups of one mouse each. These were done using oral gavage after having deprived the animals of food for 12 hours. The animals were observed for behavioral changes, symptoms of toxicity and mortality after treatment in the first thirty minutes, four hours then for 24 hours and up to 14 days after administration (Gad, 2014).

Statistical analysis

All the determinations were carried out in triplicates. The results were expressed as mean ± standard deviation. The data were analyzed for statistical significance by Analysis of Variance (ANOVA)(Microsoft Office Excel 2019) using the statistical tool, post hoc test was done using the Bonferroni Procedure . Data were considered significant at $p \leq 0.05$.

Results

Phytochemical screening

The results of the phytochemical screening of samples of *Agbo iba ponto* from three localities in Lagos are presented in the Tables 1 and 2. Table 1 shows the results of the qualitative screening of *Agbo iba ponto* samples, while the results of quantitative analysis are presented in Tables 2. All the phytoconstitents screened for except flavonoids were present in all the sample. Saponins were shown to be the most prominent phytoconstituents among the phytochemicals studied with values ranging from 37.45 ± 0.37 mg/100g in samples from Ikorodu to 35.00 ± 0.37 mg/100g in samples from Mushin. Terpenoids were the least present phytoconstituents with values ranging from 17.41 ± 0.46 mg/100g in samples from Ikorodu to 15.93 ± 0.23 mg/100g in samples from Surulere. Flavonoids were present only in the samples from Ikorodu. The results of the quantitative analysis of the samples of *Agbo iba ponto* are presented in Tables 2.

Table 1: Results of the qualitative screening of *Agbo iba ponto* from three locations in Lagos Metropolis.

Phytochemicals	Surulere	Mushin	Ikorodu
Saponins	+	+	+
Tannins	+	+	+
Phenols	+	+	+
Phlobatannins	+	+	+
Flavonoids	-	-	+
Terpernoids	+	+	+
Steroids	+	+	+
Cardiac glycosides	+	+	+
Alkaloids	+	+	+

+ indicates presence

- indicates absence

Table 2: The results of quantitative analysis of the phytoconstituents of *Agbo iba ponto* from three locations in Lagos

Phytochemicals	Surulere	Mushin	Ikorodu
Saponins (mg/100g)	36.01 ± 0.37	35.00 ± 0.37	37.45 ± 0.37
Tannins (mg/100g)	18.54 ± 0.19	19.08 ± 0.08	19.71 ± 0.16
Phenols (mg/100g)	32.04 ± 0.16	29.55 ± 0.28	30.53 ± 0.22
Phlobatannins (mg/100g)	21.71 ± 0.11	19.95 ± 0.18[b]	20.02 ± 0.29[b]
Flavonoids (mg/100g)	ND	ND	19.03 ± 0.45
Terpernoids (mg/100g)	15.93 ± 0.23[b]	16.96 ± 0.40[b]	17.41 ± 0.46[b]
Steroids (mg/100g)	20.51 ± 0.25	19.69 ± 0.25[b]	21.37 ± 0.19[b]
Cardiac glycosides (mg/100g)	27.08 ± 0.23[b]	26.51 ± 0.23[b]	27.72 ± 0.23[b]
Alkaloids(mg/100g)	18.28 ± 0.32	17.44 ± 0.12	19.83 ± 0.37

ND- Not detected

Values are means ± standard deviation

[b] indicates no significant differences between groups ($p \leq 0.05$)

Acute Toxicity studies

Oral administration of Agbo *Iba ponto* at 10 mg/kg, 100 mg/kg and 1000 mg/kg body weight respectively did not produce any clinical signs of toxicity or mortality in the experimental animals thus the need for the second phase of the experiment. In the second phase single doses of 1250 mg/kg 2500 mg/kg body weight did not produce any clinical signs of toxicity or deaths in the experimental animals. At a dose of 5000 mg/kg body weight, however, the animals showed signs of drowsiness within the first one hour of administration but became normal after a short nap. No mortality was recorded in the experimental animal within 24hours and up to 14 days post administration.

Table 3: Results of acute toxicity studies on *Agbo iba ponto*

Phases/Groups	Dose (mg/kg bwt)	Mortality	Behaivoural Changes
Phase 1			
Group 1	10	$0/3$	Nil
Group 2	100	$0/3$	Nil
Group 3	1000	$0/3$	Nil
Phase 2			
Group 1	1250	$0/1$	Nil
Group 2	2500	$0/1$	Nil
Group 3	5000	$0/1$	Scratching, Weakness and Drowsiness

Key: $Mortality/Number\ of\ animals\ used$

Discussions

This study was undertaken to determine the phytochemical components and acute toxicity study of locally prepared herbal mixture for typhoid fever, *Agbo iba ponto.* The result of the qualitative screening revealed the presence of saponins, tannins, phenols, phlobatannins, terpernoids, steroids, cardiac glycosides and alkaloids in all the samples studied, while flavonoids was found only in the samples from Ikorodu. These were unlike the results of Akande *et al.* (2012) which had no presence of phlobatannins and cardiac glycosides. From the oral interview of some of the hawkers, this may not be unexpected as constituents and recipes of *Agbo* were seen to vary with hawkers. However, some of the hawkers were reluctant to give out their recipes due to their oath of secrecy.

In the quantitative analysis, saponins were the most prominent phytoconstituents in all the samples studied. This is similar to the observation of Akande *et al*. (2012) who were of the opinion that the high levels of saponins in the samples may act as anti-nutrients. They also noted that oral administration of haemolytic saponins to mammals in large doses is toxic and can result in death due to a massive release of erythrocyte debris and reduced oxygen-carrying capacity of the blood. However, saponins have been known to have antidiarrhoeal, anticancer and anthelmintic properties (Tiwari *et al.,* 2011). Higher levels of phenols were also found in the sample compared to the other phytoconsitituents. According to Dia and Mumper (2010) the presence of phenolic compounds indicates antimicrobial activity in plants. Furthermore, Rasool *et al.* (2010) attributed the effectiveness of the herb *Prunella vulgaris* in the treatment of typhoid fever and other bacterial infections to its high phenolic content. Appreciable amounts of cardiac glycosides, steroids, tannins, phlobatannins and alkaloids were also found in the samples and most of these are known to have activity against pathogens (Ghosh *et al*., 2010) and therefore may aid the antimicrobial activities ascribed to *Agbo iba ponto* by the hawkers. Tannins, for example, are known to exhibit antimicrobial activity against some pathogenic bacteria (Maisetta *et al.,* 2019) .Terpernoids had the least presence among the phytochemicals determined. Terpernoids have found industrial applications in the formulation of medicinal compounds such as the anticancer drug, taxol (Croteau *et al.*, 2006), the antimalarial agent, artemisin (Paddon *et al.,* 2013) and are antimicrobial in nature (Gupta and Birdi, 2017). Although the mode of microbial action of terpernoids is not clearly defined, Termentzi *et al.* (2012) ascribed it to the disruption of the microbial membranes.

According to Gupta and Birdi (2017) the major limitations in the use of plant extracts for clinical applications include their complex composition, extract instability and toxicity risks. Generally, safety studies on herbal medicines are usually done by performing acute and sub-acute toxicity tests using laboratory animals (Fennel *et al*., 2004).

In this study acute toxicity effects were observed soon after a single dose administration (within 24hours) and mice are the most frequently selected rodent species for acute toxicity testing (Gad, 2014). The choice of routes of administration depends on the intended clinical route. Since *Agbo iba ponto* is usually taken orally, oral administration was employed in this study. The administration of a single dosage of up to 2500 mg/kg body weight of herbal mixture did not reveal any signs of toxicity or mortality in the animal during the entire observation period. However, an increase to the maximum allowed dosage of 5000mg/kg body weight (OECD,2001) produced a short period of weakness and drowsiness but did not lead to mortality of the animal. No mortality was recorded in the experimental animals up to 7days after administration. Therefore the LD_{50} (the dosage which kills 50% of the animals) of this herbal mixture may be considered to be more than 5000mg/kg body weight. According to the classification of Teke and Kuete (2014) any compound with oral LD_{50} of 5000mg/kg or more should be considered as practically nontoxic. However, there is need to carry out subacute toxicity studies on this herbal mixture to ascertain the effect of repeated intake at lower dosage over a period of time.

Conclusion

In conclusion, the qualitative and quantitative analysis of *Agbo iba ponto* has shown the presence of an appreciable wealth of phytochemical constituents in this mixture. An acute toxicity study has shown that a single dose of 5000 mg/kg though led to weakness and drowsiness in mice did not cause death. The results of this study therefore suggested that *Agbo iba ponto* is relatively nontoxic up to 5000 mg/kg body weight.

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PROFITABILITY AND MARKETING EFFICIENCY OF TRADITIONAL PALM OIL PRODUCTION TECHNOLOGY IN OVIA NORTH EAST LOCAL GOVERNMENT AREA, EDO STATE, NIGERIA

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Abstract
This profitability analysis of palm oil production was conducted in Ovia North East Local Government Area, Edo State, Nigeria specifically to determine the socioeconomic characteristics, enterprise statistics, cost and return and the constraints to palm oil production in the study area. Information required for the study were generated using primary source of data. Structured questionnaire were used to generate the required data for the study. Data required were collected from forty (40) palm oil producers in the study area. Data collected were coded and analysed using quantitative and qualitative analysis.
The study established that palm oil production in the study area was not gender specific. The marital status analysis also established that majority of palm oil producers in the study area were married. The result also established that palm oil producers in the study area were young, literacy level was high, household size was large and were well experienced ion palm oil production. Profitability analysis determined established that palm oil production in the study area was profitable with a return on investment of 0.93. The result also established that palm oil producers were 93% efficient in the use of resources. The major constraints to palm oil production in the study area were established to lack of credit facilities, lack of capital, complexity of production, bad feeder roads, poor production equipment, seasonal availability of fresh fruit bunches and inadequate improved equipment.
Since the study established that palm oil production in the study area was profitable, it was recommended that, sensitization of the profitability of palm oil production should be carried out. It was also recommended that non-governmental organizations, government and financial institutions should assist palm oil producers in the area to provide funds in form of soft loan, credit facilities and needed capital so as to improve their financial base and increase their production capability. It was also recommended that the Edo State government and policy makers in agriculture should put into consideration measures that will facilitate opening of the feeder roads. Since the study established that poor production equipment and inadequate improved equipment were also identified as a constraint, government – private sector participation in the provision of improved production equipment was recommended.
Keywords: *Palm oil, production, marketing, efficiency, profitability and fresh fruit bunch (FFB)*

Introduction

Agriculture is an important sector of the economy. It is the only sector that provides the basic necessities to man. The role of agriculture in the economy has been documented as the largest employer of labour, absorbing about 75 percent of the teaming population, with up to 60 percent of the rural population being linked directly or indirectly in agriculture. This is the only sector that contributes about 48 percent of the nation's Gross Domestic Product (GDP) and more than 25 percent of the foreign exchange earnings (Kaine and Ume, 2017, Ume and Kaine, 2017, *Hina et al*., 2015 and CBN, 2013). The authors opined that agricultural sector is essential in ensuring food security, economic growth and development, poverty reduction and industrial transformation. Hina *et al.,* (2015) on the other hand added that there is a strong forward and backward linkage between agriculture and other sectors of the economy.

Palm oil is oil extracted from fleshy mesocarp of the palm fruits. The oil has been reported to be an important ingredient in the diet of many Nigerians (Elijah *et al.,* 2014). It has been documented that palm oil provides the largest source of edible oil in the world. This account for 38.5 million tonnes or 25% of the global edible oil and fat produced (MPOC, 2007). Akangbe *et al.,* 2011, Ekine and Onu, (2008) and Omereji, (2005) established that household and industrial demand for palm oil is on the increase and had been estimated that an average of two liters of palm oil used and consumed weekly for cooking by every Nigerian households out of five households. Palm oil is important in production of soap, margarine, candle, wax, lipstick and polish bases in a condense form, confectionary among others (Embrandiri *et al.,* 2011and Aghalino, 2000). Adeniyi et al., (2014) reported that palm wine is another important produce of oil palm that it is popular and generally accepted in some parts of Nigeria. The authors also opined that the produce is economically viable and can compete favourably with palm oil in terms of return. It is not certain that palm oil producers in the study area were able to break-even and maximize profit. It is against this background that the work was carried out specifically to determine the socioeconomic characteristics, enterprise statistics, cost and return as well as the constraints to palm oil production in the study area.

Methodology

This study was carried out in Ovia North East Local Government Area (LGA), Edo State, Nigeria. Ovia North East LGA has a total population of one hundred and fifty-five thousand, three hundred and forty-four (155,344) people comprising of eighty thousand four hundred and (80,433) male and seventy-four thousand, nine hundred eleven (74,911) female (NPC, 2006). The projected population figure in the study area at a growth rate of 3.2% in the year 2017 was recorded as two hundred and twenty-two thousand and eighteen (222,018) people with one hundred and fourteen thousand, nine hundred and fifty-five (114,955) males while the female projected population was recorded as one hundred and seven thousand and sixty-three (107,063). Farming is the major economic activity of the inhabitants of the LGA. Small and medium scale enterprise existed in the area too. The climatic and edaphic factors of the area favoured the production of crops and livestock. Multi stage random sampling procedure was used to select forty (40) palm oil producers that were used for the study. The first stage involved the selection of communities. Five (5) communities were selected and used for the study. The second stage involved the selection of palm oil producers. Eight (8) palm oil producers were randomly selected giving a total sample size of forty (40) palm oil producers that were used for the study. Primary data was used to collect the information required for the study using structured questionnaire and interview schedule. Data collected were coded and analyzed using qualitative and quantitative techniques. Descriptive statistics was used to analyze the socioeconomic characteristic and constraints to palm oil production while gross margin analysis was used to determine the profitability of palm oil production in the study area.

Gross Margin (GM) is the difference between total revenue (TR) and Total Variable Cost (TVC). Net revenue (profit) margin is the difference between Gross Margin and depreciation. Gross Margin and net profit is expressed:

GM = TR - TVC

TC = TVC + TFC

NPM = GM – Depreciation
Where
GM = Gross Margin
TR = Total Revenue (₦)
VC = Variable Cost (₦)
NPM = Net Profit Margin

Marketing efficiency (ME) was used in this study to know how palm oil producers in the study area were efficient in the use scarce resources. This was obtained by dividing the value of output with the value of input and expressed as ratio. A higher efficiency ratio indicated that the producers were more efficient. Marketing efficiency was expressed as:

$$ME = \frac{\text{Output of processed fish}}{\text{Input used in processing}} x \frac{100}{1}$$

$$ME = \frac{\text{Value of output}}{\text{Value of input}} x \frac{100}{1}$$

$$ME = \frac{\text{Value added by marketin}}{\text{Cost of marketing services}} x \frac{100}{1}$$

Result and Discussions

The socio-economic characteristics of palm oil producers in the study area was determined and presented in Table 1. The analysis indicated that both male and female were involved in palm oil production in the study area. The result showed that majority – twenty-one (50.50%) of the traditional palm oil producers in the study area were female. The analysis of the marital status indicated that nineteen (47.50%) of palm oil producers were married, twelve (12) (20.00%) were single while six (6) (15.00%) and three (3) (7.50%) were divorced and widow(er) respectively. The result of the age determined indicated that twenty-two (55.00%) were within the economic active age range of 40 – 49. This implied that palm oil producers in the study area were relatively young. Household size analysis determined indicated a large household size with a range of 9 – 11 persons (27) (67.50%). Number of years of schooling determined showed that literacy level of the producers was high. A further analysis of the oil palm production experience indicated that the oil palm producers in the study area were well experienced with majority nineteen (19) (47.50%) having a production experience range of 9 -13 years.

Table 1: Socio-economic characteristics of palm oil producers (n=40)

Variables	Frequencies	Percentage (%)
Gender		
Female	21	50.50
Male	19	47.50
Marital Status		
Single	12	30.00
Married	19	47.50
Divorced	06	15.00
Widow(er)	03	7.50
Age		
30 – 39	12	30.00
40 – 49	22	55.00
50 – 59	06	15.00
60 and above	01	2.50
Household size		
6 – 8	13	32.50
9 – 11	27	67.50
Years of Schooling		
11 – 15	16	40.00
16 – 21	15	37.50
22 – 26	09	22.50
Production Experience		
< 4	02	5.00
4 – 8	16	40.00
9 – 13	19	47.50
14 – 18	03	7.50

Source: Computed from Field Survey, 2018

Enterprises statistics of palm oil producers

The enterprise statistics of palm oil producers in the study area was determined and presented in Table 2. The result indicated that majority, twenty-nine (29) (72.50%) of the palm oil producers in the study financed their palm oil business enterprise through personal savings. A detailed analysis of the source of finance determined showed that eight (8) (20.00%) and three (3) (7.50%) obtained their finance through loan and assistance from friends and relatives respectively. A further analysis of the enterprise statistics of the palm oil producer in the study area revealed that twenty-four (24) (60%) sourced their fresh fruit bunch (FFB) at the farm gate, nine (9) (22.50%) travelled to other communities within the Local Government Area (LGA) to source for FFB while seven (7) (17.50%) travelled outside the LGA to obtain the FFB used for production of oil palm. The result also indicated that majority, eighteen (45.00%)of the palm oil producers were low income earners with an average income range of ₦201,000.00 – ₦300,000.00 ($574.29 - $857.14) per annual.

Table 2: Enterprises statistics of palm oil producers (n=40)

Variable	Frequency	Percentage
Source of finance		
Personal savings	29	72.50
Loan	08	20.00
Assistance from friends and relative	03	7.50
Status of palm oil producers		
Full time	27	67.50
Part time	13	32.50
Cosmopolitans		
Farm gate	24	60.00
Travelled to other communities Within the L.G.A	09	22.50
Travelled to other communities Outside the L.G.A	07	17.50
Income level (Naira)		
Below N100,000	07	17.50
N101,000-200,000	09	22.50
N201,000-300,000	18	45.00
Above N300,000	06	15.00

Source: Computed from Field Survey, 2018

Cost and Return Analysis

Profitability of palm oil production was determined and presented in Table 3. The result revealed that total cost of production was ₦2, 523,985.00 while the total variable cost was ₦2, 519,400.00. A further analysis of the total cost of production revealed that the variable cost item formed the major cost component. This result is in line with that observed by Ibekwe (2008) who revealed that variable cost formed the larger cost components of total cost of processing palm oil The result of the net profit was positive with a net value of ₦2, 343,215.00. This indicated that palm oil production is profitable. Alufohu and Ahamadu (2012) asserted that palm oil processing was a profitable venture in their studies on economics of fresh fruit bunches (FFB). The authors recorded a return on investment of 66%. This was however lower than that 0.93 or 93% observed in this study. Adejei – Nsiah *et al* (2012) also confirmed that palm oil processing is profitable obtaining a positive benefit – cost ratio (BCR) of 1.26. A similar result was also obtained by Olagunju (2008) with a BCR of 1.29. The authors opined that palm oil processing was profitable. These results were inconsonance with that obtained in this study that revealed palm oil processing was profitable. Further analysis revealed that return on investment was 0.93. This implied that for every one naira (₦1.00) invested in palm oil production, there is a return of 0.93 naira. This also implied that palm oil production in the study area was profitable.

Table 3: Profitability analysis of Palm Oil processing technologies

Variable	Value (₦)
Revenue	4,867,200.00
Production (labour cost)	340,600.00
FFB cost	2,056,600.00
Cost of Water	122,200.00
Total Variable Cost (TVC)	2,519,400.00
Depreciated Cost	4,585.00
Total Cost (TC)	2,523,985.00
Gross Margin (GM)	2,347,800.00
Net Profit (NP)	2,343,215.00
Return on Investment	0.93

Source: Computed from Field Survey, 2018
*FFB = Fresh Fruit Bunch

Marketing Efficiency of palm oil producers

The Marketing Efficiency of palm oil producers in the study area was determined and the result presented and the result showed a marketing efficiency of 93%. This implied that the palm oil producers in the study area were 93% in the use of resources and were7% inefficient. The 7% inefficiency observed in this study could be attributed to some factors that are beyond the control of the palm oil producers.

$$ME = \frac{\text{Output of processed fish}}{\text{Input used in processing}}$$

$$ME = \frac{2343215.00}{2519400} x \frac{100}{1}$$

$$= 93\%$$

Palm oil production Constraints

Palm oil producers in the study area were confronted with a number of problems that tended to reduce ability to improve their production activities, reduce their level of participation and consequently retard expansion in investment in palm oil production business. The major constraints as indicated by the respondents were presented in Table 4. The result revealed that majority – thirty six (90%) and thirty-five (87%) of the palm oil processors identified bad feeder road and poor production equipment respectively as one of the major challenges to palm oil production. A detailed analysis of the constraints to palm oil production showed that about twenty-four (60.00%) of the palm oil producers reported lack credit facilities as a challenge to palm oil production in the study area. Complexity of production (18) (45.00%), lack of capital (12) (30%), seasonal availability of FFB (24) (60.00%) and inadequate improved equipment (18) (45.00%) were also reported to be among the constraints to palm oil production in the study area.

Table 4: Production Constraints

Variables	Frequency	Percentage (%)
Lack of credit facilities	24	60.00
Complexity of production	18	45.00
Lack of capital	12	30.00
Bad feeder roads	36	90.00
Poor production equipment	35	87.50
Seasonal availability of FFB	24	60.00
Inadequate improved equipment	18	45.00

Source: Computed from Field Survey, 2018
*Multiple responses by respondents.

Conclusion and Recommendation

Though the study established that palm oil production in the study area was not gender specific, majority of palm oil producers in the study area were females. The marital status analysis also established that majority of them were married. The result also established that palm oil producers in the study area were in their economic active age. Literacy level was established to be high, household size was large and the result of the production experience established that palm oil producers in the area were well experienced. Profitability analysis determined established that palm oil production in the study area was profitable with a return on investment of 0.93. The major constraints to palm oil production in the study area were established to lack of credit facilities, lack of capital, complexity of production, bad feeder roads, poor production equipment, seasonal availability of fresh fruit bunches and inadequate improved equipment.

Since the study established that palm oil production in the study area was profitable, it was recommended that, sensitization of the profitability of palm oil production should be carried out. It was also recommended that non-governmental organizations, government and financial institutions should assist palm oil producers in the area to provide funds in form of soft loan, credit facilities and needed capital so as to improve their financial base and increase their production capability. It was also recommended that the Edo State government and policy makers in agriculture should put into consideration measures that will facilitate opening of the feeder roads. Since the study established that poor production equipment and inadequate improved equipment were also identified as a constraint, government – private sector participation in the provision of improved production equipment was recommended.

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PERFORMANCE AND HAEMATOLOGICAL PARAMETERS OF YANKASA SHEEP FED *Ficus sycomorus* SUBSTITUTING GROUNDNUT CAKE

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ABSTRACT

The effect of replacing groundnut cake (GNC) with *Ficus sycomorus* foliage on the performance of Yankasa rams. Sixteen (16) Yankasa rams weighing on the average 14.25 ±0.2kg were divided into four groups with four animals per group. Each group was randomly assigned to the four dietary treatments in a completely randomized design (CRD). The diets compared were 0%, 5%, 10%, 15% *ficus sycomorus* levels of inclusion designated as T_1, T_2, T_3, and T_4 respectively. Result indicates significant ($P<0.05$) differences in all the parameters studied for chemical composition of the experimental diets. T_1 had the highest values for dry matter (DM), Cellulose, acid detergent fibre (ADF) and neutral detergent fibre (NDF) respectively). The body weight gain, dry matter intake (DMI) and metabolic mass were higher for T_3= than other treatment groups. The nutrients digestibility investigated were significantly affected ($P<0.05$) with the substitution rate. Dry matter (DM) and the fibre fraction digestibility were generally low. Nitrogen intake and Nitrogen retained as % Nitrogen intake were not significantly affected ($p>0.05$) by the substitution rate. The results show no significant effect ($p>0$, 05) on the haematological parameters except for the white blood cell differentials (Lymphocytes, Neutrophils and Monocytes) which show significant difference ($p<0.05$) among treatment groups. Serum metabolites results were significantly not affect by the substitution rate except for urea, protein, globulin and alkaline Phosphatase which showed significant difference ($p>0.05$) amongst treatment. From the results, it can be concluded that F. sycomorus can used to substitute groundnut cake, though decrease in fibre digestibility should be taken into consideration. The best level of substitution 10% *F. sycomorus*.

Keywords: Browse, *ficus sycomorus*i, sheep, haematology, Digestibility and performance

INTRODUCTION

Small ruminants form an integral part of the livestock economy in Nigeria. The arid and semi-arid areas are home to over 80% of small ruminants and their sustenance is reducing due to dependence on natural pastures (Kosgey *et al.,* 2008). They support 46-58% of pastoral households and play a significant role in the food chain and overall livelihoods of rural households, where they are largely the property of women and their children (Lebbie, 2004).

Dry season feeding of ruminants in most tropical areas has always been a problem for farmers since little good pasture exists during this period. At this time, the performances of these animals are seriously impaired. One possible way to alleviate this problem and maintain production in the tropics is to feed them with crop residues and browse plants. These feed resources are not consumed by man but can be converted by ruminants into animal products desirable as human food. This therefore reduces total cost of animal production without a decrease in productivity and also maintains efficient feed utilization.

The multipurpose tree *Ficus sycomorus* is available in many parts of Nigeria. *F. sycomorus* tress grows best on drainage lines, streams, rivers, springs or dams (Bekele *et al.,* (1993); Belete *et al.,* 2016). The fruits of these trees are used for wild animals and birds (Belete *et al.,* 2016). *F.sycomorus* leaf and petioles are well accepted by West African Dwarf lambs and led to higher levels of apparent digestibility than the other tree species (Anugwa and Okori, 1987; Kassa and Mekasha, 2014). Feeding Ficus fodder to lambs is actively encouraged in Nigeria.

This MPT leaf (*F. sycomorus*) have been reported to have high nutritive value (Orwa *et al*., 2009). Njidda and Ikhimioya (2010) reported 95.6% DM, 14.90% CP, and 32.5% CF, 3% EE, 18% ash, 54.80% NDF, 33.4% ADF, 12.60 % ADL and 4.49 ME (MJ/kg DM) while Nkafamiya (2010) reported that the leaf of *F. sycomorus* has 14.12% moisture, 10.24% ash, 3% lipids, 31.52% CF, and 17.95% CP. *F. sycomorus* plant is known to have some pharmacological activities (Salvador *et al.,* 2012; Higa *et al*., 1987; Salvador *et al*., 2012; Yan *et al*., 2014), antioxidant (Sheikha *et al*., 2015a and 2015b, Afaf *et al*., 2015), antimicrobial (Sheikha *et al*., 2015a and 2015b, Afaf *et al*., 2015) and cytotoxic activity (Sheikha *et al*., 2015b). The study was therefore design to evaluate the effects of substituting groundnut cake with *F. sycomorus* leaf on performance haematological profile of Yankasa sheep.

MATERIALS AND METHODS

Location of the study

The research was conducted was conducted at the Kaduna State University Teaching and Research Farm, Kafanchan campus, Jema'a local Government area of Kaduna state, Nigeria. The area is located within latitude $9^0$34'N and longitude $8^0$17'E. The vegetation of the area is Guinea Savannah and the area is designated as koppen's Aw climate with two distinct seasons, a wet season in summer and a dry season in winter. Rainfall occurs between the months of April to October with a peak in August. The mean annual rainfall is about 1800 mm and the mean monthly temperature is 25^0C, while the relative humidity is about 63^0, Ishaya and Abaje (2008).

Animals and treatments

Sixteen clinically healthy Sheep (rams) about 5 months old with 14.25±0.2 kg mean initial body weight (BW), were randomly assigned to one of four dietary treatments in a completely randomized design for a period of 77 days. The dietary treatments compared were: T_1 received diet containing 0% *Ficus sycomorus*, T_2 5% *F. sycomorus*, T_3 10% *F. sycomorus* and T_4 fed diet containing 15% *F. sycomorus* as shown in Table 1. The diets were offered twice daily (08.00 and 15.00 hours) respectively in two equal portions.

Metabolism trial

At the end of the feeding trial 12 rams, equally representing the four dietary treatments were selected at random and transferred to the metabolism cages for the metabolism trial. Animals were allowed to adjust to metabolism crates for 3 days prior to the start of the experiment, and were then offered the experimental diets for 10 days followed by 4 days of total collection of feed, faeces, and urine. Animals were offered the experimental diets. Total feces and urine voided were collected in plastic buckets; urine buckets contained 10 ml of conc.

H_2SO_4. Faeces were weighed and urine volume measured and weighed prior to taking a 10% aliquot, and compositing for each animal.

Haematological and Biological assay
The Rams were bled through jugular vein and 10 ml of blood collected. 3ml of the blood samples was collected into plastic tube containing EDTA for haematological studies. The remaining 7ml of blood samples was deposited in anticoagulant free plastic tube and allowed to clot at room temperature within 3 hours of collection. The serum samples were stored at -20^{0}C for biochemical studies Total erythrocytic count and total leukocytic counts were determined with the aid of Haemocytometer (Neubaur counting chamber) and Hb concentration wad determined by Sahl's (acid haematin) method (Bengamin 1978). Mean corpuscular Haemoglobin Concentration (MCHC), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Volume (MCV) values were calculated (Jain, 1986) Serum Aspartate Aminotransferase, serum Alanine Aminotransferase and Alkaline Phospatase were analyzed spectrophotometric linked reaction method (Henry *et al*., 1960). Total protein by the Biuret method according to the procedure of Oser (1976), Albumin by Bromocresol green (BCG) method, serum glucose, creatinine and bilirubin by Peters *et al.,* 1982), Sodium ion and potassium ions by flame photometric method. Other biochemical analysis was done using the method describe by (Ogunsami *et al*., 2002).

Chemical Analysis
Samples of the experimental diets were collected and oven dry at 60°C for 96 h, ground separately to pass through a 1 mm sieve in a Wiley mill and sampled for chemical analysis using the standard methods of (AOAC) (2002). Fiber fraction analysis was by the methods of Van Soest *et al*. (1991). Hemicellulose and cellulose were estimated as differences between neutral detergent fiber (NDF) and acid detergent fiber (ADF) and ADF and lignin, respectively.

Statistical Analysis
Feed intake, digestibility, body weight gain and carcass parameters were subjected to analysis of variance (ANOVA) using the general linear model procedure in SAS soft ware (V9) (SAS, 2002). The association between nutrient intake, digestibility and body weight gain was tested using correlation analysis. Treatment means were separated using least significant difference (LSD). The model employed was: $Yij= \mu + ti + bj + eij$,
Where; Yij = Response variable
μ = Overall mean ti = Treatment effect
bj = Block effect (initial body weight)
eij = Random error

RESULTS

Chemical composition of the diets
The results of the chemical composition of the experimental diets is shown in Table 2. There was significant effect ($p<0.05$) for all the parameters studied for the chemical composition. The DM, cellulose, ADF, NDF were observe to be high for diet T_1. The CP content was highest in T_2 (5%) *F. sycomorus*. The NDF values were moderate in all the treatment likewise the ADF but the ADL was high for all the treatment groups.

Performance characteristics
Dry matter Intakes of the diets were greater ($P < 0.05$) for T_2 than the other treatment groups likewise the weight gain and metabolic mass ($P < 0.05$). Intakes of DM (Kg day^{-1}) relative to the control and the treatments receiving *F. sycomorus.* Diet had effect ($p<0.05$) on feed: gain ratio (Table 3).

Apparent nutrient digestibility
The nutrient digestibilities were generally low for all the nutrients with more adverse effects on the fibre fractions. The CP and EE had low to moderate digestibility with higher values in T_3. Animals on diet T_3 were observed to have better digestibility ($p < 0.05$) values compare to other treatment groups (Table 4)

N use efficiency
N intake and retention were greater ($P < 0.05$) for the T_2 diets than for the control diet. Urinary, absorbed, retained and N absorbed

as percent N intake was greater ($P < 0.05$) for T_2 than the other treatment groups (Table 5).

Hematological indices

Whereas Hb concentration, MCV, PCV, Lymphocytes and Neutrophils were higher ($P < 0.05$) for T_4, other hematological parameters were similar ($P > 0.05$) among the diets (Table 6).

Biochemical profiles

Except for urea N, Total protein and alkaline phosphate (ALP concentrations which were affected ($P < 0.05$) by dietary treatments, other indices of serum biochemistry showed no ($P > 0.05$) difference (Table 7).

DISCUSSION

The chemical composition of the experimental diets is shown in Table 2. The dry matter (DM) content of experimental diets was observe to be high (897.30 to 915.10 g Kg^{-1} DM) for all the dietary treatments. The DM content of the diets may be attributed to the high DM content of *F. sycomorus* leaf meal. This was similar with the findings of Njidda *et al.* (2010) and Achi *et al*. (2018) who reported DM content of 956.00 and 895.60 g Kg^{-1} DM for *F. sycomorus*. The CP content of the diets in this study was observe to increase with increase in the level of CP. Njidda *et al.* (2010) and Njidda *et al.* (2013c) reported that browse plants such as *Ficus polita, Ficus thonningii and Khaya senegalensis* had above 13% CP content which is an indicator that most tropical browse species are high in CP content and can be used to supplement poor roughage to increase productivity for ruminant livestock in tropical region. The *F. sycomorus* leaf meal used in this study had lower (172.26 g Kg^{-1} DM) crude fibre (CF) content compared to the 325.00 g Kg-1 DM reported by Njidda *et al*. (2011) and 181.90 g Kg-1 DM reported by Achi *et al.* (2018). One of the characteristics of most browse leaves is that they have relatively high CF value which could be attributed to the high cell-wall constituents usually present in the leaf meal as this is indicated in the high fibre content of the diets.

The NDF, ADF and ADL values of the experimental diets were higher than earlier reports on the tropical forage species (Njidda 2008, Njidda *et al.* 2012a; Njidda *et al.* 2012b and Njidda *et al.* 2016). Difference in compositions may be due to variation in age, environmental and soil conditions and climatic factors. Although the NDF was slightly higher than the recommended value of 20–35% for effective ruminal degradation (Norton 1994; Bakshi and Wadhwa 2004; Njidda *et al.* 2013b), it was lower than 60% value at which feed intake is depressed (Meissner *et al*., 1991).

PERFORMANCE AND INTAKE OF YANKASA SHEEP FED *F. sycomorus* LEAF MEAL

The effect of feeding varying inclusion levels of *F. sycomorus* leaf meal substituting groundnut cake on feed intake and weight gain of Yankasa rams is shown in Table 4. The DMI was significantly ($P<0.05$) different across treatments. Animals fed diets T_3 (10% inclusion of *F. sycomorus* had significantly ($P<0.05$) higher DMI (3.25 kg day^{-1}) while those on 5% inclusion level had the lowest (2.26 kg day^{-1}). The high DM intake observe in T_3 was probably due to better balace between energy and protein as more organic matter was consumed from the leaves. Lawan *et al.* (2008) also reported that supplements containing more degradable protein enhance complete utilization of structural carbohydrates in the ingested forage. Final weight and total weight gain was significantly ($P<0.05$) influenced by the levels of *Ficus sycomorus* in the diet. Animals fed diets T_3 FSLM at 10% inclusion level had highest (8.62 kg) weight gain, respectively. While those on 5% inclusion levels recorded the least values statistically.

Final weight and total weight gain was significantly ($P<0.05$) influenced by the levels of *Ficus sycomorus* in the diet. Animals fed diet T_3 FSLM at 10% inclusion level had highest (22.97 and 8.62 kg) final and total weight gain, respectively. While lower values were obtained for those on 0, 5 and 15% levels of *F. sycomorus* levels of inclusion. The ADG varied from 0.03 to 0.10 kg day^{-1} with T_2 having the lowest (0.03 kg day^{-1}) ADG, suggesting a low efficiency in utilization of the experimental diet. Almost all literature on the use of shrub and tree fodders to supplement either natural grasses or crop residues have shown positive

responses with respect to the productivity of cattle, sheep and goats (Norton, 1998)
However, among the supplemented group, sheep in T_3 performed significantly better ($P<0.05$) than sheep in T_2 and T_4. Inclusion of *F.sycomorus* also significantly increased ($P<0.001$) FCE and FBW of sheep on diet T_3 compared to other treatment groups. Adebowale *et al.* (1991) reported that low degree of digestion coupled with low passage rate through the alimentary tract limit net energy availability for production. Though the inclusion of *F. sycomorus* (T_2-T_4) sheep did significantly ($P>0.01$) differ in these parameters. Supplementation of MPT to small ruminants improved growth performance as documented earlier (Reed *et al.*, 1990; Njidda and Ikhimioya 2010; Kassa and Mekasha., 2014). It has been reported that fodder trees would be good protein supplements for ruminants, provided that they are degraded adequately in the rumen to make the protein available to the animal and non-toxic (Leng, 1997). Anugwa and Okori (1987) reported that, West African dwarf lambs gained 71 g/day over a 14-day period when fed a sole diet of *F. elasticoides* foliage. However, the *F. sycomorus* leaf, in the present showed positive body weight change, possibly due to sufficient supply of protein. Generally, supplementation with MPTs like *F. sycomorus* leaf, BW gain of sheep at 10% level of inclusion, probably either by providing nutrient available for absorption or by enhancing microbial protein synthesis. Though there has not been exhaustive study conducted on *F. sycomorus* in Nigeria on one hand and Yankasa sheep on the other.

NUTRIENTS DIGESTIBILITY

The lower DM digestion coefficients observed for all the treatments could be due to the relatively higher fiber fraction contained in the diets. However, among supplemented group, the apparent digestibility coefficient of CP and EE were significantly higher ($P<0.01$) for T_3 compared to T_2 and T_4. The digestibility coefficient of CP was significantly higher ($P < 0.001$) for T_3 followed by T_3, T_4. The finding is in agreement with McDonald *et al., (*2002) who reported that higher CP intake is associated with better CP digestibility. There is no statistically significant difference ($p<0.05$) between, T_2 and T_4 in CP digestibility. The DM digestibility of the supplemented group in the present study is comparable with 75.8-80% reported by Tegbe *et al.,* (2005) in West African dwarf goats fed basal diet of *Panicum maximum a*nd supplemented with *M. indica, F. thonningii, G. sepium* leaf and concentrate. Similarly, dry matter digestibility (DMD), which is related to nutrient composition, varied widely among tree and shrub species. Anugwa and Okori (1987) also reported that the fresh Ficus leaf and petioles were well accepted by West African dwarf lambs and led to higher levels of apparent digestibility than the other tree species, ranging from 70.1% for crude fibre (CF) to 81.8% for crude protein. Ahn *et al.,* (1989) and Njidda (2013a) have shown that drying of MPT leaf decreases tannin content and showed increase in digestibility of protein from 64-84%. McSweeny *et al.* (2001) also reported that tannins could reduce fibre digestion by complexing with lignocelluloses and preventing microbial attachment and degradation, or by directly inhibiting cellulotic microorganisms, or both. A low level of CP (less than 80 g kg^{-1} DM) is shown to depress digestibility (T_2), as it is not sufficient to meet the needs of the rumen bacteria (Norton, 1998). Lignification of the plant cell wall decreases the digestibility of plant material in the rumen. Bakshi and Wadhwa, (2004) also reported that high NDF and ADL depress DM intake DM digestibility.

NITROGEN UTILIZATION

The nitrogen utilization trial showed a significant ($P<0.05$) effect among dietary treatments. Nitrogen (N) intake and Urinary N of sheep on T_2 (16.38 and 1.25 g/day) were significantly ($P>0.05$) higher than the other treatment groups. Yankasa rams receiving *F. sycomorus* inclusion in their diets had higher N retention compared to the control group receiving 0% *F. sycomorus.* Abdu *et al.* (2012) had similar observation when F. sycomorus was included in Yankasa rams diets. The urinary N output was significantly ($P<0.05$) influenced by the dietary treatment groups, with sheep on T_2 (1.25 g/day) being the highest output and T_3 (0.58 g/day) being the lowest. Nitrogen balance (g/day) was

significant (P<0.05) among the dietary treatments. The findings of an increased N balance in Yankasa rams is consistent with the findings of Silva *et al.* (2004) who reported higher level of N retention in sheep fed forage based diets but also observed an increased DMI and CP intake (g kg^{-1} $W^{0.75}$) in ram lambs. These authors suggest a higher utilization of recycled N as a mechanism for the improved N balance. N retention is considered a better criterion for measuring protein quality tha digestibility. N retention is associated with the amount of N used for protein deposition and biological value isa measure of protein quality (Silva *et al.,* 2004; Wildeus *et al.*, 2007). The browse forage offered gave a positive N balance. This demonstrated that the browse forages were efficiently used as fermentable N source for microbial growth in the rumen. The values for the N balance were higher than the values (1.50 to 7.69 g day^{-1}) reported by Wampana *et al.* (2008) who fed agro-industrial by-product and also higher than the values (0.59 to 8.11 g day^{-1}) reported by Njidda *et al.* (2018) who fed *Daniellia oliveri* foliage.

HAEMATOLOGY SERUM CHEMISTRY

The result of the haemoglobin (Hb) value shows that sheep had higher values than other breeds but the value obtained in this study fall within the normal range (9,80 to 12.90 g/dl) reported for sheep (Baneejee, 2007 and Njidda *et al.,* 2014). The observed suggest the oxygen carrying capacity of the blood was higher in the experimental animals. Generally, increase in the Hb concentration is associated with greater ability to resist disease infection and low level is an indication of disease infection and poor nutrition (Cheesbrough, 2004; Tambuwal *et al*., 2002; Njidda *et al.,* 2014). The values of MCV, MCHC and MCH significantly increased and are very important in the diagnosis of anemia and also serve a useful index of the capacity of the bone marrow to produce red blood cells (Awodi *et al*., 2005). The increased in MCV, MCHC and MCH are greatly influenced by age and sex (Egbe–Nwiyi, 2000).

The packed cell volume (PCV) obtained in the present study (11.15 to 15.50%) was lower than the normal range (28.47 to 30.25%) reported for sheep (Rusuff *et al*. 1954; Bianca 1955; Baneejee, 2007; Njidda *et al.,* 2014). A decreased PCV generally means red blood cell loss from any variety of reasons like cell destruction, blood loss, and failure of bone marrow production. The RBC values obtained in this study were within the normal values reported by (Campbell *et al*., 2003) but lower than the values reported by Njidda *et al*. (2014). The difference may be due to age, sex breed or nutrition. RBC is a signal of the health status of the animals. The low RBC counts may be associated iron deficiency, internal bleeding, some types of anemia or some vitamin deficiency. The white blood cell differentials (Neutrophils and monocytes) levels are comparable among treatments groups. There was significant influence (p>0.05) of diet on lymphocyte count. The value for lymphocytes was higher for T_4 than the other treatment groups. The lymphocytes constituted majority of the WBC counts and the cells increased with age in early life in both sexes of sheep and goats (Egbe-Nwiyi *et al*., 2000). The high lymphocyte counts in the animals in this study are favoured by the findings of (Milson *et al*., 1960) and (Wilkins and Hodges, 1962) and it might be attributed to stress and immune response to the environment (Cole, 1986). The urea level in the study falls within the range (4.4 to 8.9 mmol/L) reported by Njidda *et al.* (2014) and 8 to 20 mg/dl reported by (Banejee, 2007) in matured domestic animals and 5.28 mg/dl for free ranging desert big-horn sheep. High level of serum urea has been attributed to excessive tissues protein catabolism associated with protein deficiency (Oduye and Adedevon (1976).

Serum biochemical indices is used to determine the level of heart attack, liver damage and to evaluate protein quality and amino acid requirements in animals as reported by (Harper *et al*. 1979). The values of serum electrolyte of sodium, potassium and chloride ranged from 122.00 to 129.0 mmol/L, 4.00 to 4.83 mmol/L and 98.50 to 105.00 mmol/L respectively. The values obtained in this study are above the normal range reported by Baneejee (2007; Njidda *et al.* 2014). The electrolytes are known to regulate osmotic pressure, maintain membrane potentials and acid base balance and transmit nerves impulses sodium and

potassium deficiency affect the tubes of kidney resulting in inability to concentrate urine (Latimer *et al*., 2004). The result of hydrogen carbonate ions reveals that there is breed and sex difference with Balami rams having higher values than other breeds.

Blood metabolites were used to monitor nutrient status and associated muscle mass (creatinine). Differences in N utilization among treatment groups were apparently not of sufficient magnitude to be reflected in blood urea-N concentrations (Kohn *et al*., 2005). Horton and Burgher (1992) observed higher blood urea-N concentrations in growing Katahdin lambs

The creatinine values in the present study were within normal range and differ ($P<0.05$) among treatments. High creatinine is indicative of poor protein and amino acid metabolism that can lead to impaired renal function and cardiac infarction (Gray and Howarra, 1980). Increased creatinine has been associated with tannin toxicosis in cattle consuming tannin-rich oak fodder (Garg *et al*, 1992).

The glucose levels was observe to decrease with increase in the level of *F. sycomorus.* This follow the same pattern with energy content of the diets. Serum glucose is an indicator of cito metabolism in high energy diets (Coles, 1986). When glucose is lower than the normal range is an indication of hypoglycemia while higher levels are indication of hyperglycemia (Olorunnisomo, 2012). The values for total protein concentration obtained were within the range (55.0 to 94.0 g/L) reported by Njidda *et al.* (2014). Kamalu *et al*. (1988) and Duke (1955) that plasma protein help to transport calcium and phosphorus and other substances in the blood by attachment to the albumin. The albumin level in this study shows that Yankasa sheep had lower compared to the reports of Njidda *et al.* (2014). A reading of albumin less than the normal physical value of albumin usually indicates hypoalbuminemia (Altman, 1979). The result of the ALT and ALP were higher in the rams than in ewes while for AST the result is in consistent. Contrary to the results obtained for the lambs, all the aminotransferases (AST and ALP) clearly shows that there is a significant influence ($P<0.05$) of these parameters on the experimental animals. AST level is helpful for the diagnosis and following of cases of myocardial infarction, hepatocellular disease and skeletal muscle disorders. In trauma or in diseases affecting skeletal muscle, after a renal infarct and in various haemolytic conditions (Alex and LaVerne, 1983). The concentration of Serum Alanine Aminotransferase in tissues is not nearly as great as for Serum Aspartate Aminoferase. It is present in moderately high concentration in liver, but is low in cardiac and skeletal muscles and in other tissues. Their uses for clinical purpose are primarily for the diagnosis of liver diseases (DeRitis *et al*., 1972) and resolve some ambiguous increase in serum Alanine Aminotransfase in cases of suspected myocardial infarction (Aach *et al*., 1981). When both enzymes (i.e. Alanine Aminotransferase and Aspartate Aminotransferase) are elevated in serum, the liver is the primary source of the enzymes (liver ischemia because of congestive heart failure or other sources of liver cell injury) (DeRitis *et al*., 1972). If the serum Aspartate Aminotransferase is elevated while the serum Alanine Aminotransferase remains within normal limit in case of suspected myocardial infarction, the results are compatible with myocardial infarction (Alex and LaVerne, 1983).

CONCLUSIONS

Weight gain of rams fed 10% level of inclusion of *F. sycomorus* was higher than the other treatment groups which signify efficient energy and protein utilization at tissue level. Dry matter intake (Kg $BW^{0.75}$) was similar among T_1 to T_3 dietary treatments, but rams had a higher apparent digestibility of most feed fractions compared to T_1 and utilized available N more efficiently than T_1. Both the haematological and serum metabolites are within range except the PCV that is low.

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Table 1: Composition of the experimental diet (%)

	Treatment s			
Ingredient	**T_1**	**T_2**	**T_3**	**T_4**
Ficus sycomorus	0	5	10	15
Groundnut cake	20	15	10	5
Rice bran	19	19	19	19
Sorghum Stover	10	10	10	10
Sorghum offal	10	10	10	10
Maize offal	20	20	20	20
Wheat offal	20	20	20	20
Bone meal	0.5	0.5	0,5	0.5
Salt	0.5	0.5	0.5	0.5
Total	**100**	**100**	**100**	**100**
Calculate ME/MJ	**10.61**	**10.06**	**9.51**	**9.00**
Calculate CP	**16.92**	**16.55**	**15.33**	**15.01**

*ME = Metabolizable energy, CP = Crude protein

Table 2: Chemical composition of the experimental died (g kg^{-1} DM)

	TREATMENTS					
Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**SEM**	**FSL**
Dry mater	915.10^{a}	902.30^{b}	897.30^{b}	899.30^{b}	0.24	901.12
Crude fibre	286.90^{a}	221.90^{c}	266.30^{ab}	241.30^{bc}	1.65	172.60
Crude protein	78.40^{c}	102.40^{a}	84.90^{c}	95.10^{b}	0.65	180.20
Cellulose	266.10^{a}	209.30^{b}	257.20^{ab}	225.00^{ab}	0.30	197.10
Hemicelluloses	95.00	96.80	89.20	99.90	1.87	64.90
Ether extract	12.40^{c}	42.40^{a}	28.40^{b}	31.10^{b}	0.37	29.60
Acid Detergent Fibre	361.10^{a}	306.10^{d}	346.40^{b}	324.90^{c}	0.41	283.30
Acid Detergent Lignin	102.90^{c}	113.40^{ab}	106.40_{ab}	115.90^{a}	0.39	86.2
Neutral Detergent Fibre	456.10^{a}	402.90^{d}	435.60^{b}	424.80^{c}	2.39	348.20
Ash	21.10^{d}	116.30^{a}	70.20^{c}	82.90^{b}	0.28	8.35

a, b, c, d means with different super script within the same row are significantly different ($P<0.05$).

Table 3: Performance and nutrient intake of Yankasa sheep fed *ficus* *sycomorus*

	Treatments				
Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**SEM**
Initial body weight (kg)	14.25	14.25	14.25	14.25	NAS
Final body weight(kg)	20.87^{b}	17.40^{d}	22.97^{a}	19.72^{c}	0.76
Weight gain(kg)	6.60^{b}	3.15^{d}	8.62^{a}	5.47^{c}	1.02
Average Daily Gain (kg day^{-1})	0.07^{b}	0.03^{d}	0.10^{a}	0.06^{b}	0.002
Dry matter intake (kg day^{-1})	2.56^{b}	2.26^{c}	3.25^{a}	2.35^{c}	0.57

Dry matter intake (kg $W^{0.75}$)	2.02	2.05	2.42	1.89	0.86
Metabolic mass (kg $w^{0.75}$)	15.65^{b}	13.05^{d}	17.22^{a}	14.79^{c}	0.32
Feed conversion ratio	0.42^{b}	0.79^{a}	0.42^{b}	0.47^{b}	0.04

a, b, c, d means with different super script within the same row are significantly different (P<0.05).

Table 4: Effect of *ficus sycomorus* supplementation on nutrient digestibility of Yankasa sheep (g kg^{-1} DM)

	Treatments				
Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**SEM**
Dry matter	28.90^{a}	10.40^{bc}	06.40^{c}	14.50^{b}	0.22
Crude fibre	02.10^{d}	86.50^{b}	146.80^{a}	48.10^{c}	0.95
Crude protein	89.23^{c}	235.40^{a}	765.60^{a}	237.60^{b}	0.40
Ether extract	161.30^{b}	625.00^{a}	764.00^{a}	588.40^{a}	8.52
Cellulose	91.70^{b}	164.40^{a}	70.70^{b}	149.40^{a}	0.93
Hemicellulose	95.80^{b}	83.60^{b}	48.20^{c}	136.20^{a}	1.30
Acid Detergent Fibre	15.30^{c}	87.50^{a}	64.90^{b}	61.50^{b}	042
Acid Detergent Lignin	06.80^{b}	08.80^{b}	23.50^{b}	169.20^{a}	1.23
Neutral Detergent Fibre	13.50^{c}	45.20^{b}	61.50^{a}	15.10^{c}	0.33

a, b, c, d means with different super script within the same row are significantly (P<0.05).

Table 5: Nitrogen balance of Yankasa breed of sheep fed *ficus sycomorus* g day^{-1}

	Treatment s				
Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**SEM**
Nitrogen intake	12.54^{d}	16.38^{a}	13.58^{c}	15.22^{b}	1,02
Nitrogen in faeces	0.93^{a}	0.50^{b}	0.78^{ab}	0.59^{b}	0.12
Nitrogen in urine	0.74^{ab}	1.25^{a}	0.58^{c}	1.03^{ab}	0.13
Nitrogen absorbed	11.61^{c}	15.88^{a}	12.75^{bc}	14.63^{ab}	0.94
Nitrogen retained	10.87^{c}	14.63^{a}	12.22^{bc}	13.60^{ab}	0.89
Nitrogen balance ($BW^{0.75}$)	5.98^{ab}	7.48^{a}	6.53^{a}	7.08^{a}	1.23
Total Nitrogen	1.67	1.75	1.36	1.62	0.92
Percent as N intake					
Faeces N	7.41^{a}	3.05^{b}	4.27^{b}	3.87^{b}	2.02
Urine N	5.90^{c}	7.63^{a}	5.74^{c}	6.76^{b}	0.37
Absorbed	92.50^{b}	96.74^{a}	93.88^{ab}	96.13^{a}	1.27
Retained	86.66	89.31	90.31	89.35	4.08

a, b, c, d means with different super script within the same row are significantly differently (P<0.05).

Table 6: Effects of *ficus sycomorus* on the haematological parameters of yankasa sheep.

	Treatment s				
Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**SEM**
Hb (g/.dl)	8.10±1.52	9.50±1.52	9.10±1.52	10.80±1.52	1.52
MCH (pg)	27.55^{a} ±0.39	13.05^{a} ±0.39	11.60^{a} ±0.39	13.50^{b} ±0.39	0.39
MCHC(g/dl)	26.55^{a} ±0.53	18.05^{c} ±0.53	23.35^{b} ±0.53	15.55^{b} ±0.53	0.53
MVC(fi)	17.30±2.34	15.30±2.34	18.10±2.24	18.00±2.34	2.34
PVC (%)	12.80±2.08	14.55±2.08	11.15±2.08	15.50±2.08	2.08
RBC ($\times 10^2$ /1)	3.88±087	3.88±0.87	2.62±0.87	3.458±0.87	0.87
Lymphocyte (%)	28.80^{b} ±1.16	19.15^{c} ±1.16	16.35^{d} ±1.16	48.55^{a} ±1.16	1.16
Neutrophils (%)	11.20^{b} ±0.23	9.20^{b} ±0.23	10.10^{c} ±0.23	16.50^{a} ±0.23	0.23
Monocytes (%)	14.78^{b} ±1.02	13.60^{b} ±1.02	17.60^{a} ±1.02	13.60^{b} ±1.02	1.02

*abcd means with difference super script within the same row are significantly different (P<0.05). **Note**: Hb = hemoglobin, PCV = packed cell volume, RBC = Red blood cell, WBC = white blood cell.

Table 7: Blood chemistry of yankasa bread of sheep fed *ficus syncomorous*

	Treatments				
Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**SEM**
Urea (mmol/L)	4.81^{b}±0.66	6.50a±0.66	5.60ab±0.66	5.60ab±0.66	0.66
Sodium (mmol/L)	129.00±15.85	127.00±15.85	122.00±15.85	124.50±15.85	15.86
Potassium (mmol/L)	4.83±0.97	4.00±0.97	4.83±0.97	4.83±0.97	0.97
Chlorine (mmol/L)	98.50±4.74	101.00±4.74	105.00±4.74	103.00±4.74	4.74
Glucose (mmol/L	5.70±1.14	4.81±1.14	4.50±1.14	3.53±1.14	12.35
Creatinine (mmo/L)	88.50±12.35	97.00±12.35	86.50±12.35	96.00±12.35	12.35
Total Protein (g/L)	66.00^{ab} ±4.92	69.00^{ab} ±4.92	63.50^{b} ±4.92	75.50^{b}±4.92	4.92
HCO^{-3} (mmol/L)	29.00±6.59	28.50±6.29	28.50±6.29	29.50±6.59	6.59
Globulin (g/L)	44.00^{a} ±3.19	33.00^{b} ±3.19	33.50^{b} ±3.19	47.00^{a} ±3.19	3.19
Albumin (g/L)	53.00±9.24	42.00±9.24	37.00±9.24	49.00±9.24	9.24
AST (IU/L)	12.50±2.23	14.00±2.23	13.00±2.23	11.00±2.23	2.23
ALP (IU/L)	29.00^{ab} ±4.85	25.00^{a} ±4.85	25.00^{b} ±4.85	39.00^{a} ±4.85	4.85
ALT (IU/L)	32.0± 1.72	17.0± 0.47d	39.0± 0.62	38.0± 0.78	2.35

a,b,c means with different super scrip within the same row are significantly different ($p>0.05$).
AST= Aspartate Aminotransferase; ALT= Alanine Aminotransferase; ALP= Alkaline Phosphate

PARAMETRIC AND NON-PARAMETRIC SUITABILITY EVALUATIONS OF RICE SOILS DERIVED FROM ASU RIVER GROUP PARENT MATERIALS IN OHAOZARA, SOUTHEASTERN NIGERIA

Obasi S.N

Abstract

The study was carried out in Ohaozara Southern Ebonyi State in Southeastern Nigeria and aimed at using parametric and non – parametric suitability evaluation to study the rice soils under Asu River Group parent material. Study area was identified in a rice soil of about 120 hectares used by FGN/IFAD Value Chain Development program (VCDP). Three profile pits were dug on a transect line of about 100 – 200m apart for suitability evaluation study. When the factor ratings for land use requirement for rice was considered; climate, soil physical conditions and wetness were optimum S1(95%) and moderately suitable S2(85%) while fertility and toxicity parameters made the soil marginally suitable S3(60%). Parametric and non – parametric suitability evaluation revealed that the soils were mostly marginally suitable both potentially and currently. Major limitations of the investigated soils bother on fertility and Al toxicity.

Keywords: Soil Suitability, Parametric and Non-Parametric Evaluations, Asu River Group, Parent Material.

Introduction

Soil is one of the most important natural resources and proper understanding of its properties is necessary for judicious, beneficial and optimal use on sustainable basis (Jagdish, *et al*, 2009. Soil suitability is the categorization of soils into groups at varying levels of generalization according to their morphological, physical, chemical, and mineralogical properties. The soils are intensively utilized in Nigeria without proper management practices to replenish soils fertility due to lack of crop suitability maps. This has led to soil degradation and reduced agricultural productivity (Ekwoanya and Ojanuga, 2002).

Land evaluation can tell farmers how suitable their land is in terms of soil limitations, to specified land use and management practices. Land suitability evaluation is the process of making predictions of land performance over time based on specific types of uses. These predictions are then used as a guide in strategic land use decision making. The process of land suitability classification is the assessment and categorized of specific areas of land in terms of their suitability for defined uses (Food and Agricultural Organization, 1976). This assessment is always carried out separately for each category of land use (Iha, 2009).

The most important soil characteristics in land evaluation include drainage, texture, soil depth, nutrient retention (pH, cation exchange capacity), alkalinity, erosion hazard, and flood/inundation. Soil attribute is important for the overall performance of land and play a preponderant role in checking land quality, and has been used extensively by several authors to monitor land degradation (Senjobi , 2007; Senjobi and Ogunkunle, 2011).

In the views of Esu (2004), studying soil in detail through processes of soil characterization and land evaluation for various land utilization types is one of the strategies for achieving food security as well as sustainable environment. However, despite the importance of land evaluation on sustainable management of land and for enhanced crop production, specific soil suitability studies; such as suitability assessment for rice production have not been properly documented; and available ones show locations and ecological bias (Aondoakaa and Agbakwuru, 2012). More so, some of the studies available provide holistic approach on land evaluation and are not crop specific (Rossiter, 1996; George, 1997; Adeleye, 2002; Soil Survey Staff, 2003).

Eze (2014), noted that Aguilar and Ortiz (1992) used the FAO Framework, in combination with the parametric Riquier index to define the suitability classes (S1, S2, S3, N1 and N2) for land capability. However, in a recent study, Udoh *et al*, (2011), used the parametric and the non-parametric methods to evaluate the suitability of the eight pedons for rice and cocoa cultivation in soils developed from alluvial deposit; in which five land quality groups were used for the study and only a member of each of the five land quality groups was used in the calculation, because of the strong correlation among members of the same group (Ogunkunle, 1993). The five land quality groups were climate (c), soil physical characteristic (s), wetness (w), fertility status (f) and toxicity (t).

This study attempts to use parametric and non – parametric evaluation procedures to investigate the suitability of rice soils within the Asu River group parent materials in Ohaozara, Southeastern Nigeria.

The Study Area

Location

The study area is located near Umunaga – Uburu in Ohaozara Local Government Area of Ebonyi State Southeastern Nigeria, with the Latitude of 6º 010899′ N and Longitude of 7º 777467′ E. The study area falls within the tropical rainforest zone of the southeastern Nigeria and experiences rainfall between March - November with highest intensities occurring between June-September while about three months of dry season occur from December - February. The area lies within the humid tropics with Ustic moisture regime. This concept is one of moisture that is limited but is present at a time when conditions are suitable for plant growth. The soil in moisture control section in ustic moisture regime is dry in some or all parts for 90 or more cumulative days in normal year (Soil Survey Staff, 2003). This location receives a mean annual rainfall of between 2250 mm in the South and 1500 mm in the northern part of the zone, average annual temperature of

about 27ºC with relative humidity of 85% (Nwakpu, 2003).

Geology and Geomorphology

The Asu River Group is a major stratigraphic unit in the study area, consisting of dark micaceous shale, fine grained and calcareous sandstone bodies. Asu-River group geological formation is lower cretaceous, consisting of Eze-Aku shale formation and Nkporo formation made up of shales, sandstones and siltstones. The sediments later became folded given rise to two major structural features, the Abakalili anticlinorium and related Afikpo synclinorium (Esu, 2004; Ukaegbu and Akpabio 2009).

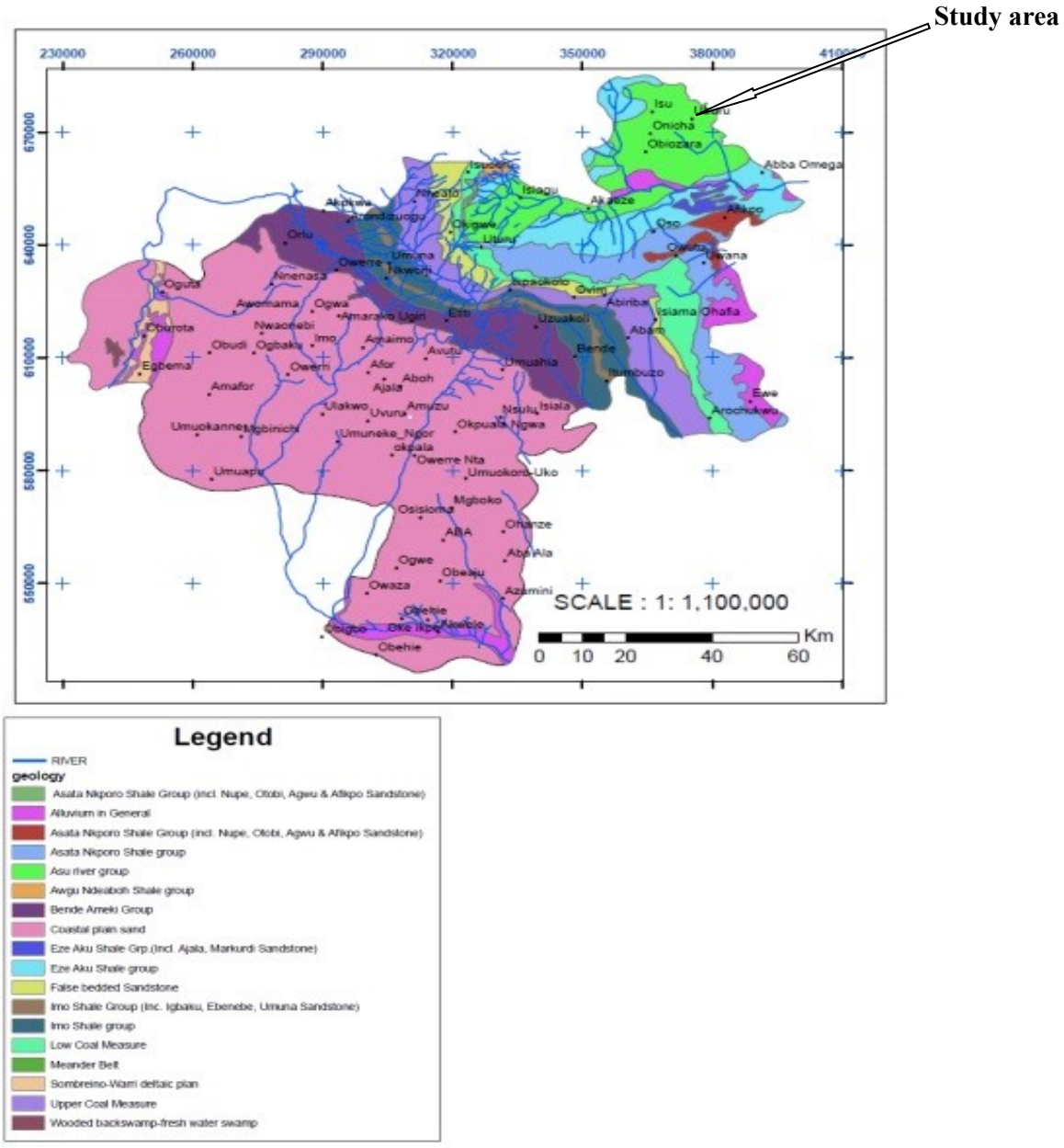

Fig 1: Geological Map of Old Imo State Showing the study area, Ahukaemere *et al.,* 2015

Field Work

Reconnaissance study was carried out and the study area identified near Umunaga in Ogbuoma autonomous Community Uburu in Ohaozara Local Government Area of Ebonyi State. The study area was in a FGN/IFAD/ Value Chain Development Programme (VCDP) site having about 120 Hectares of Land. The study area has been subjected to rice farming over the years due

its prevalent lowland nature. Three profile pits were dug at an appreciable interval of 100 – 200 m apart within the study area.

Laboratory Analysis
Soil samples were air dried, pulverized, and sieved through a 2 mm sieve mesh. The properties analyzed include particle size distribution determined by hydrometer method (Gee and Bauder, 1986). Soil pH was determined in a 1:1 soil/water ratio using digital pH meter and conductivity meter respectively. Exchangeable acidity was determined by the 1N KCl method. Exchangeable bases; Calcium (Ca), Magnesium (Mg), Potassium (K), and Sodium (Na) were determined using NH4OAc saturation method (IITA, 1979). Ca and Mg in solution were determined using Atomic Absorption Spectrophotometer, while K and Na were determined using Flame Emission Photometer. Organic carbon was determined by Walkley and Black dichromate wet oxidation method (Nelson and Sommers,1982). Total nitrogen was determined by micro-kjeldahl technique (Bremner and Mulvaney, 1982). The Effective Cation Exchange Capacity (ECEC) was determined summation method, while the available phosphorus was extracted by Bray II method (Olsen and Sommers 1982). Base saturation was calculated as the sum of all base forming cations, divided by cation exchange capacity and multiplied by 100.

Evaluation procedure
The non-parametric method as well as the parametric method were used to evaluate the suitability for rice soils of Ohaozara in Southeastern Nigeria.
Non-parametric method (FAO, 1976), pedons was placed in suitability classes by matching their land characteristics with the agronomic requirements of rice (Table 1).
By parametric method (Ogunkunle, 1993) each limiting characteristic was rated as using Table 1. The index of productivity (IP) (actual and potential) was calculated using the equation**:**

IP= A x √(B/100 x C/100 x D/100xE/100).
Where A is the overall lowest characteristic rating and B, C, D and E are the lowest characteristic ratings of each land quality group (Udoh *et al.*, 2011). Five land quality groups was used for this study and only a member of each of the five land quality groups was used in the calculation because (Ogunkunle, 1993) noted that there exists a strong correlation among members of the same group. For example, texture and structure in group "s". The five land quality groups were climate (c), soil physical characteristic (s), wetness (w), fertility status (f) and toxicity (t) (Table 1).

Table 1: Factor ratings of land use requirements for wetland rice

Land Qualities Factor Ratings	Land Characteristics	Units %	S1 100-85	S2 84-60	S3 59-40	N1 39-20	N2 19-0
Climate (c)							
	Annual Rainfall	Mm	>1400	1200-1400	950-1100	850-900	<850
	Solar radiation	Cal.cm-2.day-1	>300	300-200	200-100	<100	any
Growing Periods							
	LPG+	Days	120-180	70-120	<70	<70	<70
Soil physical Condition							
	Soil Depth	Cm	> 20	10-20	5-10	<5	any
	Clay	%	40-25	25-15	15-5	≤5	any
Wetness (w)							
	drainage	-	1-3	1-3	3	any	any
	S.W.D	Cm	10-20	20-40	40-60	>60; <10	any
	F.D	Months	4	3-4	2-3	<2;>4	any
	G.W.T	Cm	0-15	15-30	30-60	>60	any

Fertility Status (f)							
	pH	-	5.5-7.5	5.2-5.5	≤5.2;≥8.2	≤5.2;≥8.2	Any
	Total N	%	> 0.2	0.1-0.2	0.05-0.1	<0.05	any
	Organic C	%	2-3	1-2	3-4	>4;<1	any
	P (Bray)	mg.kg-1	> 20	15-20	10-15	<10	any
	P (Olsen)	mg.kg-1	> 10	7.5-10	5-7.5	<5	any
	K	cmol.kg-1	> 0.2	0.1-0.2	<0.1	<0.1	any
	Ca	cmol.kg-1	10-15	5-10	1-5	<1; >5	Any
	Mg	cmol.kg-1	2-5	1-2	<1	<1;>5	Any
	CEC	cmol.kg-1	>16	10-16	5-10	<5	any
	- Base saturation	%	>50	35-50	<35	<35	any
Toxicity (t)							
	Active- Fe	%	<0.75	0.75-1.0	1-1.25	<1.25	any

Ogunkunle, 1993
Key: S.W. D= Surface Water Depth, F. D= Flooding Duration, G. W. T= Ground Water Table, 1= Imperfect, 2= Moderate; Poor, 3= Good, 4= Very Poor, LPG= Length of Growing Periods

Potential Index of Productivity (IPp): In computing the IPp, properties that are not easily altered like cation exchange capacity, base saturation, pH and organic matter were used as part of the "f" group while the easily altered chemical properties like exchangeable K, Ca, available P, Mg:K ratio were not part of the calculation (Ogunkunle, 1993).

Current Index of Productivity (IPc): In this case, both the easily altered chemical properties like exchangeable K, Ca, available P and Mg:K as well as those used for IPp were used for the calculation of the IPc.

Result and Discussion

The land qualities /land characteristics of Ohaozara were as shown in Table 2. The climatic data indicated that rainfall within the study area was 1800 mm. The table of factor ratings of land requirements for rice (Table 1) shows that temperature was optimum having 95%. Also mean annual temperature and relative humidity also scored 85 and 95% respectively.

Table 2: Land qualities/characteristics of Ohaozara soils

Land Qualities/Land Characteristics	Units %	Pedon 1	Pedon 2	Pedon 3
Climate				
Annual Rainfall	Mm	1800	1800	1800
Mean Temperature	^{o}C	26 – 28	26 – 28	26 – 28
Relative Humidity	%	80	80	80
Soil Physical Condition				
Soil Depth	Cm	110	124	126
Clay	%	22.76	25.76	26.76
Wetness (w)				
Drainage	-	1	1	1
S.W.D	Cm	10	10	10
F.D	Months	3	3	3
G.W.T	Cm	18	15	15
Fertility Status (f)				
pH	-	5.25	5.16	5.14
Total N	%	0.068	0.055	0.044
Organic C	%	0.715	0.571	0.468
P (Olsen)	mg.kg-1	27.68	24.18	20.3
K	cmol.kg-1	0.152	0.079	0.077

Ca	cmol.kg-1	1.79	1.14	1.25
Mg	cmol.kg-1	0.91	0.82	0.82
ECEC	cmol.kg-1	3.713	3.313	3.293
- Base saturation	%	78.65	66.5	66.9
Toxicity				
Al. Saturation	%	44.75	36.6	48.1

S.W. D= Surface Water Depth, F. D= Flooding Duration, G. W. T= Ground Water Table,
1= Imperfect, 2= Moderate; Poor, 3= Good, 4= Very Poor, LPG= Length of Growing Periods

Table 3: Suitability Class Scores of Studied Soil

Land Qualities/Land Characteristics	Pedon 1	Pedon 2	Pedon 3
Climate			
Annual Rainfall	S1 (95)	S1(95)	S1(95)
Mean Temperature	S2 (85)	S2(85)	S2(85)
Relative Humidity	S1 (95)	S1(95)	S1(95)
Soil Physical Condition			
Soil Depth	S1 (95)	S1(95)	S1(95)
Clay	S2(85)	S1 (95)	S1(95)
Wetness (w)			
drainage	S1 (95)	S1(95)	S1(95)
S.W.D	S1 (95)	S1(95)	S1(95)
F.D	S2 (85)	S2(85)	S2(85)
G.W.T	S2(85)	S1(95)	S1(95)
Fertility Status (f)			
pH	S2(85)	S2(85)	S2(85)
Total N	S3(60)	S3(60)	S3(60)
Organic C	S3(60)	S3(60)	S3(60)
P (Olsen)	S1 (95)	S1(95)	S1(95)
K	S2(85)	S3(60)	S3(60)
Ca	S3(60)	S3(60)	S3(60)
Mg	S3(60)	S3(60)	S3(60)
ECEC	S3(60)	S3(60)	S3(60)
- Base saturation	S1 (95)	S1(95)	S1(95)
Toxicity			
Al. Saturation	S3(60)	S2(85)	S3(60)

N = Nitrogen, C= carbon, Ca = Calcium K = Potassium, Mg = Magnesium, P = Phosphorus, Fe = Iron, Al = Aluminum, ECEC = Effective cation exchange capacity

Soil physical condition of the study area revealed that pedons 1, 2 and 3 had depth of 110, 124 and 125 cm respectively. The depths recorded were as result of high water table that did not allow further depth determination down the profile. These depths were very good for rice cultivation. All investigated profile pits scored 95% which was highly suitable for rice production. Clay recorded 22.76, 25.76 and 26.76% in pedons 1, 2 and 3 respectively. This clay content was not the optimum clay needed for the rice plant as it scored 85% in the suitability class score which indicated moderately suitable clay content.

There is the possibility that as the water table goes down; the clay concentration at the subsoil will increase. The lower clay content of the upper layer may further indicate the degree of leaching the soil has undergone. This is evident of Ultisols, formed by the mineral weathering, translocations of clays to accumulate in an argillic or kandic horizon and leaching of base forming cations from the profile (Bray and Weil, 1999). Idoga and Azagaku, 2005)

noted that increase in clay with depth may be the result of eluviations, illuviation processes as well as contribution of the underlying geology through weathering. According to Malgwi *et al*., (2000), lower clay content of the surface horizon could also be due to sorting of soil materials by biological and or agricultural activities, clay migration or surface erosion by runoff or combination of these.

Wetness parameters were as recorded in table 2; drainage indicated imperfectly drained, surface water depth was >10cm in the heavily flooded period while flood duration lasts about three months.

The fertility status of the investigated soils was as shown in table 2. Soil pH recorded 5.25, 5.16 and 5.14 in pedons 1, 2 and 3 respectively. The soils of the studied area are generally slightly acidic. The acidic nature of the soils may be due to high intensity rainfall in the area, which leaches basic cations down the profile. Enwezor *et al.,* (1998), stated that leaching of Ca and Mg is largely responsible for acidity development in soils. Also, it may be due to Al saturation of the exchange complex. Acidity (Low pH) of the soils may also be due to the effects of cultivation, erosion and leaching of nutrients or a combination of these. However, soil acidity in the investigated soil was moderately suitable as it scored 85% in the suitability class score as shown in table 3.

Organic carbon, total nitrogen, Ca, Mg and ECEC were all marginally suitable in the investigated rice soil scoring S3 (60%) in the suitability class score as shown in table 3. In all pedons, organic matter contents decreased with soil depth having means below the critical level. The low values of organic matter would encourage a rapid leaching of cations such Ca and Mg into the subsoils from the surface. Thus, the soils are very low in ECEC (<4.0 cmol kg-1) and low in total N. This agrees with Hassan (2010) who advocated that any soil which has <4cmol (+) kg-1 ECEC is less productive since soils from all pedons possessed low ECEC <4.0cmol (+) kg-1. According to Chikezie *et al.* (2009) and Eze (2014), the environment of eastern Nigeria is characterized by high temperature and relative humidity conditions that favour rapid decomposition and mineralization of organic matter. Therefore, organic matter content has to be substantially increased through effective crop residue management. Base Saturation was however optimum as it scored S1 (95%) in the suitability class scores while Al saturation was relatively high, posing a slight toxicity challenge to the rice crops grown in the area. Al saturation toxicity made the soil moderately suitable S2 (85%) in pedon 2 and marginally suitable S3 (60%) in pedons 1 and 3 as revealed by the suitability class score in table 3

Table 4: Suitability Aggregate scores and suitability classification

Pedons	Parametric Potential	Current	Non-Parametric Potential	Current
1	S3(36.42)	S3(31.32)	S3ft	S3ft
2	S2(55.42)	S3(48.45)	S3f	S3f
3	S3(35.00)	N1(24.70)	S3ft	S3ft

Aggregate suitability class score: 100-75 = S1; 74 – 50 = S2; 49 – 25 = S3; 24 – 15 = N1; 14 – 0 = N2
f = Fertility limitation; t = toxicity; w = wetness (water table) limitation

The suitability aggregate scores and suitability classification of the studied soils were represented in Table 4. This reveals the potential and current suitability status of the studied soils using parametric and non-parametric suitability evaluation procedures. Parametrically; pedons 1 and 3 were potentially marginally suitable scoring S3 (36.42) and S3 (35.00) respectively, while pedon 2 was potentially moderately suitable scoring S2 (55.42). Also, parametrically currently, pedons 1 and 2 were marginally suitable scoring S3 (31.32) and S3 (48.45) respectively while pedon 3 was currently not suitable N1(24.7). The non suitability nature of the soil can improve using appropriate agronomic and soil management practices.

Non – parametrically; all investigated soils were all marginally suitable both potentially and currently. The key limitations of the investigated soils bother on fertility and toxicity for pedons 1 and 3 while pedon 2 had a limiting fertility challenge.

Conclusion

Climate, Soil physical condition and wetness properties were optimum and sub optimum in their suitability status while fertility and toxicity parameters were moderately and marginally suitable in the studied soils. Parametric and non – parametric suitability evaluation revealed that the soils were mostly marginally suitable both potentially and currently. Major limitations of the investigated soils bother on fertility and Al toxicity.

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CORRELATES OF AQUACULTURE BUSINESS DECISION AND PROFITABILITY STATUS OF SELECTED FIRMS IN KADUNA, NIGERIA

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Abstract

This study examined the variables that can influence business decisions towards profitability of fish farming in Kaduna State, Nigeria. The study mapped the socioeconomic characteristics of farmers, fish farm characteristics, constraints to fish farm productivity and rate of profitability. Simple random sampling technique was used to select seventy-five respondents drawn from list of Agricultural Development Programme contact farmers in three Local Governments Areas (Chikun, Igabi and Kaduna North). A well-structured questionnaire was used to obtain primary data. Data analysis was done using descriptive statistics, gross margin, net farm income analysis and profitability ratios. Results showed that majority of the respondents (74.7%) were married. About 45.3 percent of farmers are within the age of 31-40 years. About 50.7 percent had about 5 years experience in fish farming. About 69.3 percent went through tertiary education. About 40 percent of the fish farmers have household size of 4 – 6. A large proportion (42.70%) of the fish farmers are civil servant. About 42.7 percent of fish farmers' objective was to make profit. Majority (66.7%) of fish farmers source their fingerling from breeders. About 68 percent started fish farms with their own personal savings and majority (70.7%) indicate that they have stable market for culture Clarias species of fishes. Pond construction and feed cost accounted 19.57% and 14.12% of fixed and variable inputs of the total cost, respectively. Gross margin of fish farmers was N743, 219.16 with a Net Farm Income of N8, 190.36. The profitability ratio gave a benefit-cost ratio of 1.05, rate of return of 0.05, gross revenue ratio of 1.37, expense structure ratio of 1.89 and operating ratio of 0.36. Constraints encountered by the farmers includes; inadequate and high cost of feed, lack of personnel management problems, poaching, scarcity of fingerling, high cost of fuel inconsistent and input procurement.

Keywords: Fish Farm, Aquaculture, Profitability, Constraints

Introduction

Man's transition from extractive economic expeditions to cultured entrepreneurship remains significant contribution to economic advancement and development, especially in the wake of declining supplies from natural reservoirs, caused by sudden but gradual weather/climatic changes, alongside human induced ecological unfriendly activities (UNFCCC, 2018). Start-ups may be more effective in exploiting new technologies and introducing radical innovations, which can help address some of the major challenges of our times [such as climate change]" (Breschi *et al*., 2018). Therefore, the emergence of aquaculture epitomized the novelty of human creativity in achieving fish supply adequacy, transiting from the conventional fisheries captures in the wild to an intensive fisheries culturing. This form of aquatic agricultural practice has contributed remarkably to the global fisheries production to meet up with daily consumption ever since the relative static harvest of fishery in the late 1980s. Aquaculture fishery contributes about 47% to the global fish supply chain in 2016, and it first value share is estimated at 232 billion USD (FAO, 2018).

Aquaculture fishery was introduced in sub-Saharan Africa in the 1940s having as main objectives to improve nutrition in rural areas, generate additional income, diversify activities to reduce risk of crop failure and create employment. Nigeria experience of aquaculture was in the 1940s, it is obviously viewed as the strategic means of attaining self- sufficiency in fisheries production and a catalyst for improving socio-economic welfare. Nigeria remains the largest aquaculture fish producer in the sub-Saharan Africa accounting for 54% of the total fish production in the sub-region. The country's aquaculture focus is mainly on fresh-water fishes, with catfish species accounting for 64% of the country's aquaculture production in 2015(FAO 2017). Nigeria fish trade deficit increased from 350 thousand tonnes to nearly 2 million tonnes between 2000 and 2011 before declining to 940 thousand tonnes in 2013. Fish production grew from 26000 tonnes in 1980 to over 1 million tonnes in 2015 aquaculture quota increased from 2% in 1980 to over 30% in 2015 (FAO,2015). However capture fisheries is still the main source of production. The fish demand projections by FAO shows that in the early 2020s demand will raised to 600000 tonnes higher than the mid - 2010s levels due to income and population growth in the country, and that aquaculture fisheries would require to grow at 22% per year from mid- 2010s to early 2020, to bridge demand-supply gap. The Nigerian fisheries statistics report further affirms the deficit fishery production gap, the report in 2016 puts fisheries demand to be 3.32 million metric tonnes, with domestic output of 1.12 million tonnes leaving about 2.22 million tonnes as deficit. This clearly reveals the country's sub-optimal fisheries production level thus, making fish import inevitable. The deficit in fisheries production portends an excellent opportunity for substantial investment in aquaculture fisheries, in order to reverse the import fisheries trend, which has gulp 1.2 billion USD in 2013 according to FAO (2017).

Investment decision is prompted by the profitability projections and risk (uncertainty) forecast about the intended business undertake or startups, likewise aquaculture fisheries. Avalanche of studies reveals aquaculture fisheries as a profitable business venture in Nigeria (Ugwumba,et al., 2010; Ihere, et.al., 2014; Cynthia Jeh Mkong *et al.* 2018). It is ironic that, such a profitable agro- business sector output remains sub-optimal, relative to the country's fishery demand. According to FAO (2017), the contribution of aquaculture fishery to fishery production in Nigeria stood at 31%. The National Bureau of Statistic (NBS, 2017), indicated that out of 5.79 million tonnes of fish production between (2010-2015) in Nigeria, artisanal and industrial fishing contributes 69% and 4% respectively, while aquaculture stood at 27%. Although the profitability profile of aquaculture fishery business outlook is positive based on studies (Adewuyi et al., 2010, Ekanem et al., 2012, Thompson *et al*., 2014, and Omobepade et al., 2015), but the margin of profitability is also of paramount interest to a prospective fish farmer, and it is key determinant that can influences the allocation of resources to the business (Cynthia Jeh Mkong *et al.* 2018). Profit margin of fish farming perhaps might be one of the major constraints affecting the aquaculture fisheries supply chain as the best alternative of meeting Nigeria fishery self-sufficiency level. Therefore it is

imperative to examine the incidences of constraints and profitability of aquaculture firms, which is the focus of this study, while the study objective is to identify, analyze aquaculture fishery firm characteristics and assess the impact of constraints on profitability. Aquaculture potential or prospects in meeting fish supply-demand need is certainly not in doubt but mitigating the constraints elements for a better profit margin is imperative, and being a capital intensive business it requires a skilled managerial capacity for operational efficiency/effectiveness and competiveness for it profit realization motive as a private business. Constraints may vary subject to the country's ecological regions but could be broadly viewed or classified into spectrums: economic, technical and effective policies and good institutional framework. The economic spectrum of the constraint highlights the challenges of sourcing for both operating and investment capital at low cost for the business financial sustainability and expansion or transiting from subsistence level to commercial level, while technical category of constraints boarders on skilled knowledge gap in fish production, processing, marketing and cost effective. The latter focused on governmental policies/strategies towards enhancing the sector through; extension services, research and financial intermediation or subsidies and physical infrastructure provision.

In a similar study on measuring profitability in small scale aquaculture enterprises in south west Nigeria, Samson and Adeoye (2012) and Yemi and Deji (2012) analyses the economics of fish farming to determine the possibility of making money generally from the business by performing enterprise budget analysis and simple profit/loss calculation to determine the profitability of the system. The result showed that fish farming in south west Nigeria was viable since BRC (benefit cost ratio) was greater than one but not profitable enough with the rate of returns at 1.05 implying that for every one naira invested N1.05 would be gained and that only 25% of the firms operated profitably. The study survey reveals; high price of fish feeds and high mortality of stocked fish, as the most serious constraints believed to have contracted the profit margin although the margin was not indicated. Also in another related study by Cynthia, Ernest and Stephanie, (2018)., on determinant of profitability of fish farming in Cameroon showed that profitability was significantly affected by price of fingerlings, where a unit increase in it price will lead to 13% decrease in the net profit ($p<0.01$) while price of feed showed a positive relationship with net profit ($p<0.1$), a unit increase in price of feed will lead to 0.94% increase in net profit, cost of labour was significant at 1% ($p<0.01$), indicating that a unit increase in labour cost will lead to a 0.49% increase in net profit from marine fishing but contrary to *a priori* expectation and that cost of transportation and years of experience had no significant effect on profit. The study concluded that fish farming in Cameroon is profitable, it levels of profitability is being determined by price of feed, price of fingerling and cost of labour.

Materials and Methods

The study was conducted in the metropolis of Kaduna (a City in North Western Nigeria) capital of Kaduna State. Kaduna State is comprised of 23 Local Government Areas with a total land area of about 46,053 km^2 and an estimated population of 6,066,562. Kaduna State is mostly populated by Hausa, Gwari, Katab and Banjjuu ethnic communities. The State is bordered by Sokoto, Katsina, and Kano States to the North, Bauchi to the East, Plateau to the East and South, Niger to the West and Abuja (FCT) to the South. Local Government Areas (LGAs) selected in Kaduna metropolis for the study includes: Chikun, Igabi and Kaduna North.

Sampling Technique and Data Collection Method:

The simple random sampling technique was used to select 75 respondents from the list of Agricultural Development Project (ADP) contact farmers in the study areas. Twenty-five (25) fish farmers were selected at random from Chikun, Igabi and Kaduna North LGAs. The data for the study were collected between March 2018 and August 2018, through well – structured questionnaire.

Data Analysis Technique:
In order to estimate the cost and returns in this study, the following formulae are used;
Net farm Income (NFI): Net farm Income (NFI) is the Total Revenue less the Total cost of maintenance (addition of fixed cost and variable cost).
$NFI = TR - TC, Where, TR = Total\ revenue\ and\ TC = Total\ cost$
Gross margin (GM): This is computed by subtracting Total variable cost from Total revenue.
$GM = TR - TVC, Where, TR = Total\ revenue\ and\ TVC = Total\ variable\ cost$
Depreciation (DEP): is the ratio of Cost of the fixed farm items less Salvage value to Useful life of the fixed items.
$DEP = \frac{C-S}{N}$,$Where, C = Cost\ of\ the\ fixed\ item, S = Salvage\ value\ and\ N = useful\ life\ of\ the\ fixed\ item$s.

Profitability ratio in fish production
In order to estimate the profitability ratios in this study, the following formulae are used;
Benefit Cost Ratio (BCR): is the ratio of Total Revenue to Total Cost.
$BCR = \frac{TR}{TC}$, $Where, TR = Total\ Revenue\ and\ TC = Total\ cost$
Rate of Return (ROR): is the ratio of Net Farm Income to Total Cost.
$ROR = \frac{NFI}{TC}, Where, NFI = Net\ farm\ Income\ and\ TC = Total\ cost$
Rate of Return (ROR): is the ratio of Total Fixed Cost to Total Variable Cost.
$ESR = \frac{TFC}{TVC}$, $Where, TFC = Total\ fixed\ cost\ and\ TVC = Total\ variable\ cost$
Gross Revenue Returns (GRR): is the ratio of Total Cost to Total Revenue.
$GRR = \frac{TC}{TR}$, $Where, TFE = Total\ farm\ expenses\ (TC) and\ TR = Total\ revenue\ (TR)$
Net Profit Margin (NPM): is the ratio of Total Farm Income to Total Revenue.
$NPM = \frac{NFI}{TR}$, $NFI = \ Total\ farm\ income\ and\ TR = Total\ revenue$

Results and Discussion

Socio-economic Characteristics of Fish Farmers
Table 1 presents the result of the descriptive analysis of the socio economic characteristics of the sampled farmers in the study area. The results show that majority (45.3%) of farmers are within the age of 31-40 years. However, few (16.0%) of the farmers are less than 30 years in age. This suggested that youths that are in their productive ages are mostly involved in fish farming in the study area. The finding on age agrees with the work of EI-Naggar et al. (2010) and Olasunkanmi (2012) reported that the age bracket 31-50 years is usually made up of innovative, motivated and adaptive individuals. By implication, most of these farmers are still in their active age and therefore, have the tendency to be more productive in fish farming in the study area. Among all the famers, about 74.7% of the farmers are males while 25.3% are females. This literally means males are more involved in fish farming than the females in the study area. This study buttress Oparinde and Ojo (2012) who reported that, it is a prior expectation to have more male in aquaculture than female. Ideba et al. (2013) consented to this finding that male dominated the production aspect of aquaculture than female.

This may be due to the fact that fish farming is a herculean task which makes males to be more involved. Also, 74.7% of the farmers are married, 20.0% are single while the remaining 5.3% are in other categories. These findings reinforce the report of Agbebi (2011) where it was established that a high percentage of married individuals in a community is an indication that they are permanent settlers in the area hence a cheaper family labor.

The farming experience revealed that majority (50.7%) of the fish farmer s had 1-5 years of experience in fish farming business, while 40 % of fish farmers had 6-15 years of experience, then 9.3% of the fish

farmers had 16-20 years of experience. The implication of this finding is that high percentage of the fish farmers in the study area are experienced which encourages increased production and innovation adoption. This is in agreement with that of Akinrotimi et al. (2010) in survey of brackish water aquaculture status in Rivers state.

In the household size of the selected fish farmers, about 40.0% of them have their household size between 4-6 members and on the other extreme 9.3% have it to be more than 10 members. The large household size in the study area could be an advantage in providing family labor. The finding supports the preponderance of large family sizes among the poor in rural areas Kainga and Adeyemo (2012). Based on educational qualification, majority (69.3%) of the farmers has tertiary education and this is followed by secondary education with about 25.3% and primary education with 5.3%. This implies that majority of the fish farmers are educated. Good education is believed to enhance innovation as well as enhance proper documentation in farm business (Olasunkanmi *et al*., 2.012). A large proportion (42.70%) of the fish farmers are Civil servant, 25.3% are traders, 18.24% are core farmers, 6.70% are into Crop/ Livestock farming and just about 1.30% are artisanal fisher men. This means that fish farming does not prevent the selected respondents from getting involved in other means of earning. Further more, about 42.7% indicate profit making as their fish farm goal while 9.30% is for consumption and the remaining 48.0% are for both profit and consumption

Table 1: Socio-Economic Characteristics

Items	Characteristics	Frequency	Percentage
1	**Age (Years)**		
	Less than 30	12	16
	31 to 40	34	45.3
	41 to 50	15	20
	Above 51	14	18.7
2	**Gender**		
	Male	56	74.7
	Female	19	25.3
3	**Marital Status**		
	Single	15	20
	Married	56	74.7
	Other	4	5.3
4	**Year of experience**		
	1 to 5	38	50.7
	6 to 10	19	25.3
	11 to 15	11	14.7
	16 to 20	7	9.3
5	**Household status**		
	1 to 3	26	34.7
	4 to 6	30	40
	7 to 9	12	16
	10 and above	7	9.3
6	**Educational Status**		
	No Formal Education	0	0
	Primary School	4	5.3
	Secondary School	19	25.3
	Tertiary	52	69.3
7	**Other Occupation**		
	Civil servant	32	42.7
	Trading	19	25.3

	Crop/ Livestock farming	5	6.7
	Artisanal fishing	1	1.3
	Farming	18	24
8	**Goal of Production**		
	Profit	32	42.7
	Consumption	7	9.3
	Both	36	48

Note: N=75 fish firms respondent

Fish Farm Characteristics

The results in Table 2 show that majority (64.0%) of the farmers practice fish farming on less than 0.25hacters of land. 42.7% of the fish farmers acquired their land through purchase. Majority (66.7%) of the fish farmers obtained their fingerlings from other farms while 29.3% obtained theirs through on-farm breeding. Adewuyi *et.al*., (2010) reported that 90.3% of fish farmers in Ogun State obtained their fingerlings from farm gate. Majority (62.67%) of the respondents obtained their broodstock from on-farm, 36% obtained theirs from other pond owners, only 1.33% collected from rivers/streams. Opiyo and Charo-Karisa (2012) affirmed that although Kenya fish farmers has a number of fish hatcheries, some fish farmers still obtain fish seed from recruits in their ponds after harvest. According to respondent, those sourced from hatchery are more likely to be healthier and disease free. This is supported by Obande and Solomon (2000) who observed that fingerlings sourced from hatcheries, have high rate of growth and may be diseased free.

Majority (68%) of the respondents sourced their fund from personal savings while family and friends account for 17.35% of sources of fund while very few (5.3%) obtained bank loan. 65.3% of the respondents obtained credit facility of between N100, 000.00 and N500, 000.00, while 6.7% obtained above N500, 000.0 and majority (70.7%) farmer indicate that they have stable market. This is similar to Ekanem *et al*., (2012) and Adewuyi *et al*., (2010) who said majority of fish farmers in Cross River and Ogun State sourced capital from personal savings. The inability of fish farmers to assess bank and Government loans might be connected to its high rate of interest, stringent conditions and inability to provide collateral.

The results further indicate that majority (81.3%) of the of the respondents cultured mud/catfish, 18.2% cultured Heteroclarias, 7.3% cultured tilapia fish while 1.8% cultured Heterobranchus. According to the respondents, majority cultured mud/catfish because of its high preference/marketability, resistant to harsh environmental condition and can survival even in running and stagnant water. This finding is in agreement with FAO's position (2000) that catfishes have a market value of two to three times that of tilapia. Okwu and Achenje (2011) also showed that in Nigeria, Catfish is cultured by a large number of farmers because of its good marketability, resistance to harsh environmental conditions and survival in diverse water conditions.

Table 2: Farm characteristics

Item	Farm characteristics	Frequency	Percentage
1	**Size of farm**		
	Less than 0.25 ha	48	64
	0.26 to 0.5ha	18	24
	0.51 to 0.75 ha	5	6.7
	Above 0.76 ha	4	5.3
2	**Method of land Acquisition**		
	Inherited	19	25.3
	Leased	24	32
	Purchased	32	42.7
3	**What sources are of fingerling**		
	Collection from the wild	0	0
	Purchased from the other farms	50	66.7
	On – farm breeding	22	29.3
	Others (Specify)	3	4
4	**Sources of brood stock**		
	Collection from the wild	1	1.33
	Purchased from the other farms	27	36
	On – farm breeding	47	62.67
5	**Source of finance**		
	Own saving	51	68
	Bank Loan	4	5.3
	Cooperatives	7	9.3
	Family & Friends	13	17.3
6	**Obtained credit facilities**		
	N50, 000 - N100, 000	21	42.7
	N100, 000 - N500, 000	49	65.3
	>N500, 000	5	6.7
7	**Stable market**		
	Yes	53	70.7
	No	22	29.3
8	**Species of fish cultured**		
	Clarias	61	81.3
	Tilapia	5	6.7
	Heterotis	0	0
	Carp	2	2.7
	Clarias and Tilapia	6	8.0
	Clarias and Carp	1	1.3

Note: N= 75 fish farm respondents

Cost and Return of Fish Farming in the Study Area

The variable cost inputs in Table 3, reveals the cost of feed accounted for the largest proportion (14.12%) of the variable cost of fish farming in the study area. This is followed by cost of fingerlings (9.27%). This shows that large amount of money was spent by fish farmers in the study area for purchase of feeds and fingerlings. This is in line with Olawumi et al., (2010) who discovered that labour cost, cost of fingerlings and feed constituted the lion

share of aquaculture production in Ogun State. Okwu and Acheneje (2011) disclosed that the cost of feed and fingerlings accounted for over 50 percent of expenditure for fish farming in Benue State. The fixed cost of production (63.83%) consists of pond construction (19.57%), farmhouse (12.65%), borehole (17.12%), tanks (9.17%), pond equipment (1.08%) such as net, water heater, vibrators etc. The higher value of fixed cost may be due to high cost of construction materials like cements used in constructing a high standard fishpond and farmhouse in the study area.

Furthermore, the results of the respondent in a season presented in Table 3 reveals that, on average, total cost (TC) of N1, 151, 525.64 is recorded by all the fish farmers in the study area while the average total revenue (TR) of about N1, 159, 716.00 was recorded. The average Gross Margin (GM) recorded was N743, 219.16 with a Net Farm Income (NFI) of N8, 190.36. GM and NFI are a good measure of profitability; therefore, the positive value of GM and NFI indicates that fish farming in study area is profitable business in the study area. Furthermore, the results show that fixed cost was more pronounced than variable cost given the average values of N735, 028.80 (63.83% of Total Cost) for fixed cost and N416, 496.84 (36.17% of Total Cost) for variable cost. These depicts that higher amount of money that is spent on fish farming are majorly on procurement of Tank, Pipe Networks, equipment and others equipment or materials.

Table 3: Average Cost and Return of Fish Farming Per Quantity of Fish Harvested

Items (in a cropping season)	Amount (N)	% of Total Cost
A) Variable inputs		
Feed	162,568.12	14.12
Aerators	58,680.00	5.10
Transport Cost	10,260.00	0.89
Drugs	9,172.00	0.80
Labour (Hired)	61,840.00	5.37
Lime	6,887.20	0.60
Fertilizer	289.52	0.03
Fingerling	106,800.00	9.27
Total Variable Cost (TVC)	**416,496.84**	36.17
B) Fixed inputs		
Tank	105,606.67	9.17
Pipe Networks	22,166.80	1.92
Equipment (nets. Scale etc.)	12,407.33	1.08
Borehole/or Well	197,120.00	17.12
Generator/NEPA Charge	26,746.67	2.32
Pond construction	225,306.67	19.57
Farm house	145,674.67	12.65
Total Fixed Cost (TFC)	**735,028.80**	63.83
Total Cost (TC)	**1,151,525.64**	
Total Revenue (TR)	**1,159,716.00**	
Net Farm Income (NFI)	**8,190.36**	
Gross Margin (GM)	**743,219.16**	

Profitability of Fish Farming in the Study Area

The estimation of profitability ratio in Table 4 shows that the Benefit Cost Ratio (BCR) is more than unity (one). Specifically, the ratio is 1.05 implying that the fish farmers get 1.05kobo from every N1.00 spent on the fish farming business. This further confirms that the farming business in the

study area is profitable. Similarly, the rate of returns, 0.05 implies that 5kobo is realized for every N1.00 devoted by the farmers and a gross revenue ratio of 1.89 indicates that for every one naira return to fish farm enterprise, N89 kobo was spent. These parameters shows that aquaculture in the study area was profitable. This result is similar to the work of Okwu and Acheneje (2011) that discovered that fish farming is profitable in Benue State. The value of operating ratio was 0.36 which implies that about 36% of the total cost of production was made up of fixed cost. This implies that the business is worthwhile since increase in the production with variable cost would increase the total revenue leaving the fixed cost unchanged. Though, the results shows a positive business venture just similar to what Yemi and Deji (2012) observed in the South West Nigeria. The margin of profit might not induce high traffic for investors and practicing farmers ought to be cautious of risk that might reduce the relatively low rate of returns on investment.

Table 4: Profitability ratios

Ratios	Value
Benefit Cost Ratio (BCR)	1.05
Rate of Return (ROR)	0.05
Expense Structure Ratio (ESR)	1.89
Gross Revenue Ratio (GRR)	1.37
Operating Ratio	0.36

Incidence of Constraints Faced by Fish Farmers in the Study Area

The distribution of the constraints in Table 7 was influenced by incidences pattern admitted by the respondents towards fish production in Kaduna State. Majority of the respondents (25.33%) indicate that inadequate and high cost of feed was the main constraints in the study area. This was followed by lack of personnel (18.67%), management problems (16%) and poaching (14.67%). Other constraints are scarcity of fingerling (9.33%), high cost of fuel (9.33%), inconsistent (NEPA) (4%) and input procurement (2.67%). The prevalent incidences are different event across sub-Saharan Africa, as noted in Cameroun by Cynthia, et al (2018), the high cost of fish feeding can be injurious to investment design as it constitutes a threat to profitability and risk to investment in general.

Table 7: Percentage distribution of fish farm production constraints in Kaduna state

Item	Constraints	Frequency (N)	Percentage (%)
1	Inadequate and high cost of fish feed	19	25.33
2	Lack of technical personnel	14	18.67
3	Management Problem	12	16.00
4	Poaching	11	14.67
5	Scarcity of fingerlings	7	9.33
6	High cost of fuel	7	9.33
7	Inconsistent (NEPA)	3	4.00
8	Input Procurement	2	2.67

Conclusion:

Aquaculture business decision correlates and profitability status of selected firms in Kaduna, State, Nigeria revealed that even though labour cost, cost of fingerlings and feed constituted the lion share of aquaculture production, the positive value of Gross Margin and Net Farm Income indicates that fish farming in study area is profitable business in the study area. It can also be concluded that aquaculture production was profitable in the study area considering the fact that the farmers were able to cover their operating expenses. Even though the fish farming is profitable, the margin or ratio of profitability (rate of return) is a pertinent issue that requires concerted action towards enhancing its profitability in view of attaining the country's objective of self-sufficiency in fish production. Prospective investors in the state should therefore capitalize

on this highly viable sub-sector of economy should capitalize to increase fish production in the study area as well as increase the economic profile of the state. The production constraints must be address through a deliberate governmental policy particularly the cost of feeds, fingerlings. Farmers in the study area should learn how to formulate quality feeds from locally available feed ingredients so as to reduce the pressure on total cost of production. Government should subsidize feed and other inputs so as to increase fish production in the study area. Government should as a matter of necessity provide capital for fish farmers in the study area in form of soft loan, as this formed the highest problem confronting the success of aquaculture in the study area. Small-scale farmers should organize themselves into fish cooperatives to promote their access to credit facilities, exchange of idea, control of price and technical information among members. However, Government should show more loyalty to the enactment of agricultural credit scheme for coherent service implementation.

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PARTICIPATION OF RURAL WOMEN IN AGRICULTURAL PRODUCTION IN KOGI STATE, NIGERIA

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Abstract
In Nigeria traditional setting, more than 60% of the Agricultural production is carried out by women. They are responsible for a large proportion of women resources for economic activities in rural area. This percentage is progressively increasing as women get more involved in agricultural production while their male counterparts move into off- farm employments and the youths migrate to urban areas. This paper discusses the contributions of women in agricultural production in Kogi State Nigeria. Results indicate that rural women in Kogi State are highly involved in all aspects of food production including processing, storage and marketing. The paper further reveals that earnings from the agricultural products are directed towards the family upkeep. Recommendations are made to improve the productive output of rural women.

Key words: Participation, Rural women, Agriculture, Production, Food crops.

Introduction

Agricultural development in Nigeria and other developing countries aims at increasing Agricultural output, ensuring food security for the country as well as improving the quality of life of those involved in agriculture. The government has introduced a number of policy measures to improve the performance of the agricultural sector. These include: effective devolution of power to state and local government for agricultural development activities, reduction of import tariffs on agricultural inputs and machinery and provision of incentive for agricultural exports (Ajala 2010). This is to enable agricultural sector carry out its four major work roles of self-sufficiency in basic food commodities, increased production of agricultural raw materials to meet the requirements of industries; increased rural employment (Okundayo et al 2012). To achieve these functions, one needs to consider the contributions of the farmers in general and women farmers in particular, who are the main actors in the agricultural production.

In Nigeria, rural women farmers play significant role in food production and security. They are actively involved in carrying out agricultural activities and produce about 60-80% of agricultural food in the country (Buckland and Mogan 2011 and Onjobi 2013). They direct their earnings to meet the need of their families. The rural women combine their roles as wives, mothers, housekeepers with their invaluable functions as farmers, farm labourers among others (Ogorogie and Suleiton 2013). They work longer hours at home and in farms utilising labour intensive and crude farm implements with little to show for their efforts in terms of ouput and income. These rural women work relentlessly to increase their productivity with little recognition by their communities (Njoku 2014).

In Kogi state it has been observed that women farmers undertake most food production, processing, storage and marketing their household. Mostly they depend on farming as the only source of income and livelihoods. These rural women who mostly bear the brunt of the high food demand pressure have impressively ventured into more intensive agricultural production activities. However, they always have different production objectives than men, more limited access to resources, less education, and more challenges in their time and energy because of their many responsibilities as home makers, farmers, marketers among others. The responsibility for getting food for the families lies on the women (Onweye 2012). Thus, it is not an exaggeration to say that rural women in Kogi state are the back-bone of the rural and urban food systems and so are increasingly significant with regard to food security (UNDP 2009).

The contributions of these rural women in recent times have increased. This is as result of the movement of their male counterpart into off- farm employment, emergency of more female headed households, increases population with corresponding high demand on agricultural food production (Barden and Edmon 2012). Moreover, the traditional methods of food production have become much inadequate to cope with the current food. Needs of the families. Therefore, any step to increase agricultural production should take cognizance of the great roles played by these rural women in food production, processing, storage and marketing, and should also consider ways of helping them improve, increased and sustain their agricultural production with increased income.

The objectives of the study were to determine the contributions of rural women farmers in various agricultural sectors with a view to identify their production challenges and recommending ways of improving and increasing their productivity and income.

Materials and methods

A thematic survey of rural women farmers in Bassa from Eastern and Kogi from Western agricultural zones of Kogi state Agricultural Development project (ADP) was carried out in March 2016. Six women groups in each of the two zones were visited. A total of 240 randomly selected women farmers were interviewed in the two zones respectively. Information on farming activities carried out and challenges encountered were obtained utilizing the participatory rural appraisal (PRA) method and a check list questionnaire.

Results and Discussion

The results indicate that the rural women farmers in Kogi state were actively involved in agricultural production: They grow food crops, tree crops and keep livestock and poultry.They process, store and market their agricultural products. They produce for family utilization and for sale.

It was however observed that research and extension are not adequately gender sensitive to these study areas as they do not cover the production, processing and storage activities for which these rural women were responsible. As a result of that, the rural women farmers are still having challenges in production, processing, and storage and marketing (Table 1).

The challenges or felt needs of the rural women farmers in Kogi state are as shown in Table 1

Table 1: Production challenges of Kogi State rural women farmers

S/NO	CHALLENGES
1.	Lack of access to lands and high cost of labour
2.	Predicaments in marketing surplus crops especially during time of planting
3.	Heavy demands of women's time emanating from lack of time and labour – technologies saving
4.	Lack of security, especially against bad harvest and crop failure
5.	Food wastage and spoilage at various stages of harvest, processing, storage and marketing due lack of adequate storage and preservation facilities.
6.	Lack of incentives and full control over returns from their activities, poor market, infrastructure and low prices of these goods
7.	In adequate extension services, resources and inputs for improved food production
8.	Lack of social amenities like portable water, electricity, health facilities
9.	Lack of mobility in rural areas and improper function of the Extension Agent (EA) in rural areas.
10.	Lack of appropriate and suitable to technologies for the crops produced by women farmers.
11.	Unavailability of credit facilities
12.	Lack of education

Source: Field survey 2016

Rural women farmers still utilize low yielding and unimproved planting materials which are susceptible to pests and diseases, primitive and labour intensive farm implements, traditional farming practices, which have adversely affected agricultural production. Even after production, there are lots of losses and wastages of agricultural production due to lack of improved and efficient processing, storage, preservation methods and facilities (Sanglo and Hart 2008 and Nelson 2011). There is a constraint of marketing food crop in time of plenty and constraint of transportation which has resulted in low price of agricultural products.

Inspite of the production challenges identified in table 1, rural women in Kogi state have make significant contributions in various sub-sectors of agriculture such as food crop production, tree crop production, livestock production, cash crops, fishery production, forestry and environmental management, post-harvest and marketing activities. Women constitute the majority of small holder farmers, provide most of the labour and manage many farms on a daily basis. Their contributions have assisted to increase agricultural production in the state in the last decade.

Food Crop Production: The rural women have contributed significantly so much in food crop production. They participate in agronomic practices of almost all the food crop production activities such as land preparation, planting, weeding, fertilizer application, pests control and harvesting.

Apart from yam, the rest of the other food crops are grown mostly by these rural women. The crops are grown basically for family consumption but excesses are sold to boost family income. They also engage in dry season vegetable production.

Livestock production: The rural women in the state raised small ruminants like sheep, goats, and rabbits, and also kept local birds. Cassava peelings and other by products of small-scale food production, combined with household wastes were important feed for their livestock. The women had a more integrated and holistic approach to crop and livestock, time and resource they use. Owning a few animals can be attractive, efficient subsidiary enterprise complementing crop production. Therefore, these animals were usually kept as a means of raising money for the family needs. However, the animals could be used by the family occasionally during festivals

Fishery production: Rural women contributed a lot in fish production. They handle and finance fishery businesses. They are mostly engaged in a host of post-harvest and non-fisheries activities such as harvesting of crabs, snails etc., for the existence and survival of their families. Women have the exclusive role of sorting, grading, salting smoking and marketing fishes. They performed the exhausting function such as collection of wood for smoking the fishes and for preservation.

Forestry and Environmental Management: Rural women in the state were the main collectors of fire wood, and at times also helped in collecting fodder and grasses for their livestock. It was observed that their constant need to these resources has caused wide spread degradation of forest areas. However, recently in Kogi state, the rural women were involved in planting trees around the houses. The rural women also gather the forest products such as vegetables, mushrooms. larvae of edible insects, snails, crab etc. to augment family meals.

Post Harvest Activities: The rural women are mostly responsible for processing, preservation, utilization and storage of food crop, tree crops, animals, fishes etc. They have contributed much in the processing of cassava, cocoyam, and maize into various food forms for family consumption and for sale. They processed and stored palm oil, palm kennel and also help in the processing of cashew for sale. They store seeds and planting materials for future uses. They embarked on poverty alleviation activities, income generation and agricultural business to help improve the standard of living of their households.

Marketing Activities: The rural women in the state were actively engaged in the marketing of agricultural products. While almost all of them marketed the produce from their farms, some others travelled to the neighbouring states and village markets to purchase some agricultural produce which they sold in the urban towns like Lokoja, Idoh, Ankpa among others.

Conclusion

If rural women farmers' opportunities, productivity, and earning potentials are well expanded and enhanced especially in the areas of food production, processing storage, utilization and marketing, there is bound to be a corresponding improvement in the well being of the members of the households in Kogi state.

This will subsequently, bring about increased agricultural production, better economic performance, poverty alleviation, overall better family condition and standard of living.

Recommendations

Since there is urgent need to increase and sustain agricultural production to meet up the demand of the ever increasing population, the productivity of rural women farmers must be elevated.

The following recommendations are made for improvement.

1. The rural women should be given full empowerment to enable them have access to land, have control over returns from their activities and products, have access to resources such as education, knowledge and skill, time, mobility and energy. They should be provided with the social amenities such as good roads, potable water, electricity, health facilities among others.
2. Research and extension should identity and understand the roles of rural women farmers in the farming systems and find ways of generating appropriate and sustainable technologies for these gender specific activities. This could be done by carrying out gender analysis to understand the gender

roles in farming systems of Kogi state, analyse information about men's and women's activities, resources challenges and benefits.

3. Appropriate technologies which will increase and improve the women's productivity, income and living standard should be made accessible to them. The technologies that are appropriate for the activities, farming objectives, and production conditions of the rural women farmers should be developed.
4. They should also be provided with adequate processing storage and preservation facilities for proper handling of the crops to prevent wastage and losses incurred during post-harvest activities.
5. The Government should provide policies that favour high prices for the crops grown by these rural women. This can be made possible by removing the activities of intermediaries providing subsidies to prices of agricultural products, providing security to the crops and animals produced by rural women by paying compensation to the women when there are crop failures and natural disaster.
6. Government should also make credit facilities more easily available and accessible to the rural women farmers to enable them improve their productivity and enhance their earning potentials.

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FUEL QUALITY ANALYSIS OF COAL DEPOSIT SAMPLE OBTAINED FROM CHIKILA, GUYUK LOCAL GOVERNMENT, ADAMAWA STATE.

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Abstract

This work examined some physicochemical parameters of fuels in coal deposits found in Chikila village of Guyuk Local Government Area of Adamawa State. The major elements determined were: Carbon, Hydrogen, Nitrogen, Oxygen, and Sulphur while some of properties examined include; moisture content, ash content, volatile matter, fixed carbon, pH and calorific value. The averages are: Moisture content 8.09%, ash content 17.55%, volatile matter 32.67%, fixed carbon 40.975%, pH 5.92 and calorific value 5536.09 Kcal/kg. the coal ash contains heavy metals in form of oxides of; Fe_2O_3, CaO, MgO, Na_2O, K_2O, SO_3, MnO, V_2O_5, Cr_2O_3, CuO, ZnO, BaO and NiO, with average compositions of 69.71%, 2.06%, 17.99%, 1.89%, 3.50%, 0.75%, 0.91%, 0.40%, 2.20%, 0.092%, 0.10%, 0.035%, 0.074% and 0.0%**.** The proximate analysis showed that Chikila coal values for moisture and ash are high while the volatile matter, fixed carbon and calorific values are moderate. The ultimate analysis of Chikila coal has higher value of oxygen, nitrogen and less Sulphur. Based on the result of the proximate, coal-ash, calorific value, elemental and ultimate analysis of Chikila coal, it can be concluded that it is high quality source of fuel with less environmental side effects.

KEY WORDS; Calorific value, Ultimate analysis, Proximate analysis, Moisture content and Ash content

INTRODUCTION

The industrial growth and development of a developing country like Nigeria depends on the availability of raw materials resources, exploration and utilization. Most raw materials for industrial development are derived from natural resources (Usman, 2013).

Coal is an organic, combustible sedimentary rock that also contains minerals and inorganic Material, within the organic matter. The compressed organic matter lay down in typically saline inland sea basins or swamps millions of years ago, is interspersed with finely weathered rock material, known as shale (Mahesh *et al* 2016). The heaviest metals accumulate in coal and shale strata because their densities and electronic charge mean they tend to concentrate in depositional environments. Coal and coal shale therefore, concentrate and accumulates heavy metals, amongst other elements, most of which are bio-toxic and some of which are also radioactive (Mahesh *et al* 2016).

This research work is to assess the physicochemical properties and elemental composition of coal mineral for the study area. The specific objectives are;

(i). To carry out proximate analysis of the volatile matter, pH, moisture content and ash content of different samples of coal from the study area; and

(ii). To carry out ultimate analysis and X-ray fluorescence (XRF)

Nigeria is endowed with millions of tons of coals. The knowledge of the quantity of the various constituents of coal will give an idea on how the coal should be processed to enable the utilization within a safe environment. The successful conversion of these coals to smokeless fuel will provide the means to utilize them in national development. The availability of cheap smokeless fuel will reduce the use of fire wood and stem deforestation.

MATERIALS AND METHODS

Sample Collection

Samples were collected in Chikila, Upper Benue Trough that lies within longitude 11^0 50' East to 11^0 56' East and latitude 9^0 52' North to 9^0 52' North within top sheet 174 North-East (N.E). It covers a total area of about 7.10km^2. Chikila of Guyuk local government Area, N.E. Nigeria. It can be accessed by roads, which are the major roads linking Numan and Guyuk. This research work will be restricted only to the coal deposits mineral found in the vicinity of Guyuk Local Government Area Chikila villages of Adamawa State.

Sampling and Sample Preparation

Samples of coal were collected using the stratification method described by Samuel and Maina (2010) as follows; five samples per location at several regular meters intervals apart were taken with consideration of possibilities of variations in sample constituents. Pieces of coal were chiseled from the deposit. About 600 g each of the representative samples from the five locations were collected and labeled C_1, C_2, C_3, C_4, and C_5. The samples were ground using pestle and mortar and sieved through a 150 µm mesh to obtain a consistent particle size. Smaller quantities of the representative samples were obtained by repeated cutting and matching methods (Obaje *et al.,* 2018).

PROXIMATE ANALYSIS OF COAL

Determination of Moisture Content

The moisture content of coal samples preserved in polythene bags (Krumins *et al.,* 2017), determined by adopting the method described by Usman, (2013) as follows; an empty crucible was weighed with its lid to obtain W1, 20 g of coal was weighed together with the crucible and this was recorded W2. The unit was then heated at 120°C for 2hrs, after which it was cooled in the desiccator before it was weighed again to obtain W3. Triple determinations were carried out and the average was calculated using the formula below:

The percentage moisture content (M %) = $\frac{WB-WA}{W2-W1} X \frac{100\%}{1}$

Where; W1 = weight of empty crucible and lid

W2 = weight of crucible and sample before drying

W3 = weight of crucible and sample after drying

Then, W2 – W1 = WB (weight of the sample after drying)

W3 – W1 = WA (weight of the sample after drying)

Determination of Ash content

Coal sample (20 g) was weighed into a crucible and heated in a muffle furnace. The residue was dissolved in aqua regia (HNO_3 and HCl in ratio 3:1), to remove organic substances from the sample. Care was taken to ensure that volatile elements such as mercury, arsenic and even lead were not removed in the ashing process (Nkafamiya *et al.,* 2017).

Determination of Fixed Carbon

Determination of fixed carbon contents was calculated based on the modified Dulong's formula, i.e. Seyler's formulae (Ryemshak and Jauro, 2013):

$$\% \text{ Carbon} = 0.59 \left[\frac{Q}{2.3} - \frac{1.1 \times VM}{3}\right] + 43.4$$

Where Q is the gross calorific value (MJ/Kg) and VM is the percentage of volatile matter

Determination of pH Values of Coal

Coal sample (5g) was soaked in 100cm^3 of distilled water at room temperature and allowed to stay overnight, after which the pH was taken using the pH meter (phywe pH meter model 18 195.04) (Tiza, 2010).

Determination of the Calorific Value of Coal

The calorific value of coal was carried out using the bomb calorimeter (6400 Parr isoperibol). The finely powdered sample of coal (sieved through the 90µm mesh) was weighed (1g) and pressed into pellets and placed into a bomb calorimeter. The machine was run for 8 minutes.

ULTIMATE ANALYSIS

The ultimate analysis includes the determination of the amount of carbon, hydrogen, oxygen, nitrogen and sulphur. All these except sulphur were determined by measuring the weight percent (wt. %) and were calculated using the empirical formula given below:

$$\% C = 0.97c + 0.7 (Vm + 0.1A) – M (0.6 – 0.01M)$$

$$\% H_2 = 0.036c + 0.086 (Vm – 0.1A) – 0.0035M^2 (1 - 0.02M)$$

$$\% N_2 = 2.10 – 0.020Vm$$

Where C = % of fixed carbon

A = % of ash

Vm = % of volatile matter

M = % of moisture (Ritz and Klika, 2010).

Determination of Sulphur was carried out using carbon/Sulphur analyzer (CS2000). Coal sample (0.25g) was accurately weighed into the analyzer's sample compartment. The machine was then operated at 1335^0C.

Elemental Analysis of Coal Ash Using X-ray Fluorescence Spectroscopy (XRF)

X-ray fluorescence method was adopted for the determination of the coal ash elemental oxides as reported by Magili, *et al*. (2014) as follows; 2.0g of coal ash mixed with 0.4g stearic acid which acts as a binder so as not to allow the sample to disperse or scatter and pressed with a hydraulic press. This fused tablet was X-rayed and counted to determine the major and minor elements present in the ash sample.

Statistical Analysis of Data

The mean values of the five main coal samples from Chikila village were calculated and their standard deviations determined using the equation:

$$S.D = \frac{\sum_{i=1}^{n} xi - \sum_{i=1}^{n} xi^2}{n-1}$$

Where S.D = Standard Deviation

n-1 = Degree of freedom

xi = mean

The results of the standard deviation were used to ascertain the student's t-test for the purpose of comparing some standard values and also to express some level of confidence in the significant of the comparison at 95% confidence Interval:

$$C.I = x \pm \frac{ts}{\sqrt{N}}$$

Where C.I = Confidence Interval

X = Mean

S = Standard Deviation

N = Degree of Freedom

The value of t was obtained from the equation:

$$t = \frac{(\bar{x} - \mu)\sqrt{n}}{s}$$

Where $\bar{x}$ = experimentally determined mean

μ = population mean

S = standard deviation

n = number of data set (Mendham *et al.,* 2000)

RESULTS

Moisture Content of Coal Samples

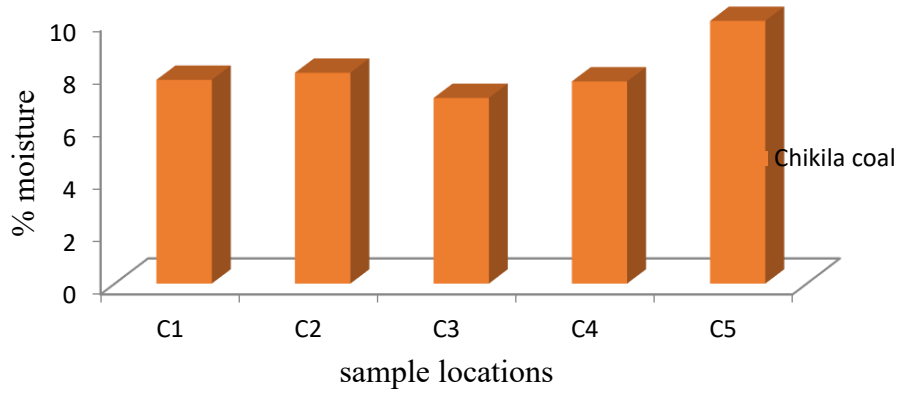

Figure 1: Moisture Content of Chikila Coal at Different Locations

The result of moisture content of the coal sample in figure 1 above shows that sample C_5 retains the highest moisture contents while sample C_3 has the lowest value. All the samples except C5 contain less than 10 % of moisture.

Ash Content of Chikila Coal Samples

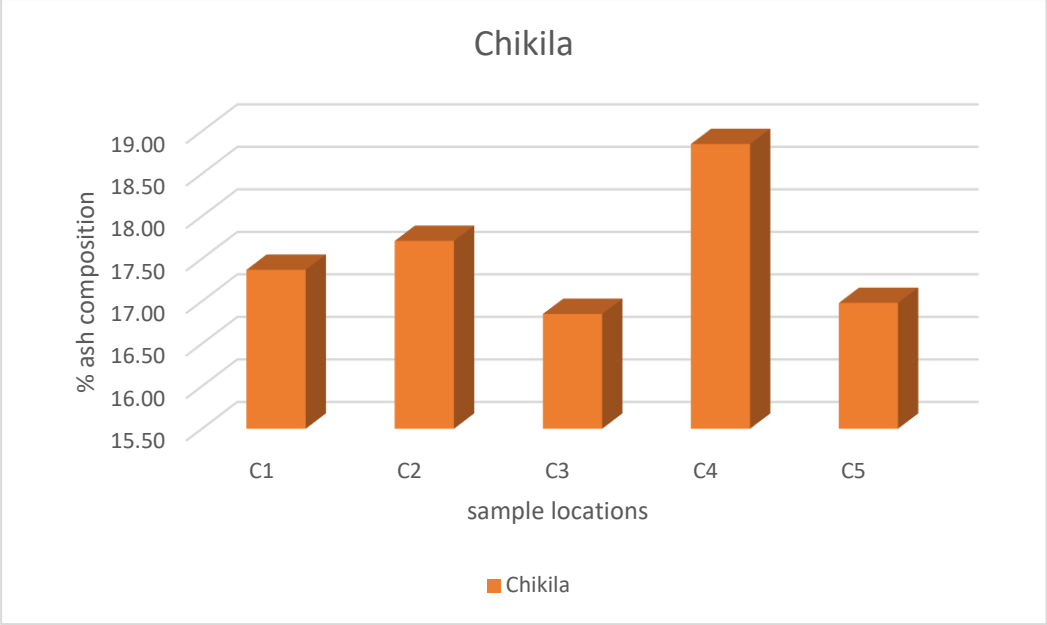

Figure 2: Ash Content of Sample Coal at Different Locations

The result of dry ashing process of five coal samples from the study area is shown in figure 2 above. Sample C_4 has the highest ash content of 18.85%, while samples C_5, C_1 and C_2 have lower ash content ranging from 16.98 to 17.71%. Sample C_3 has the lowest ash content of 16.85%.

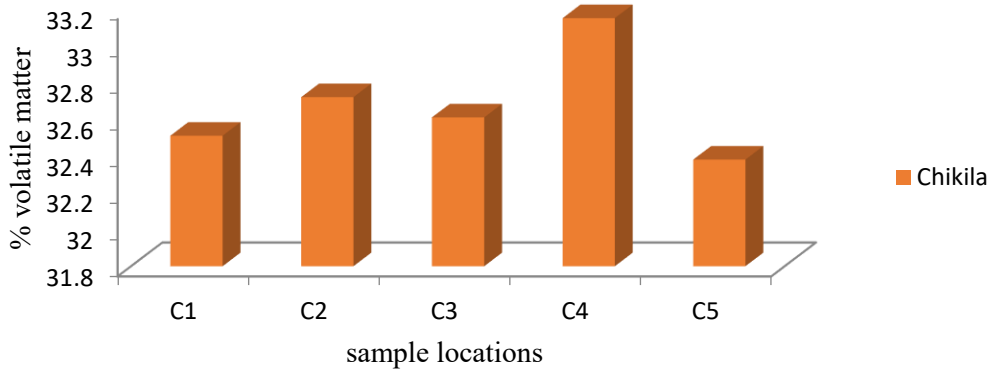

Figure 3: Volatile Matter of Coal at Different Locations

The result of volatile matter of Chikila village coal samples is shown in Figure 3. Sample C_4 has the highest volatile matter (33.2 %) while sample C_5 has the lowest volatile matter (32.4 %). The result also showed that, sample C_2 is next in percentage value with 32.8 % total volatile matter, C_3 contained 32.7 % and C_1 has 32.6 % of volatile matter.

Calorific Values of Coal Samples

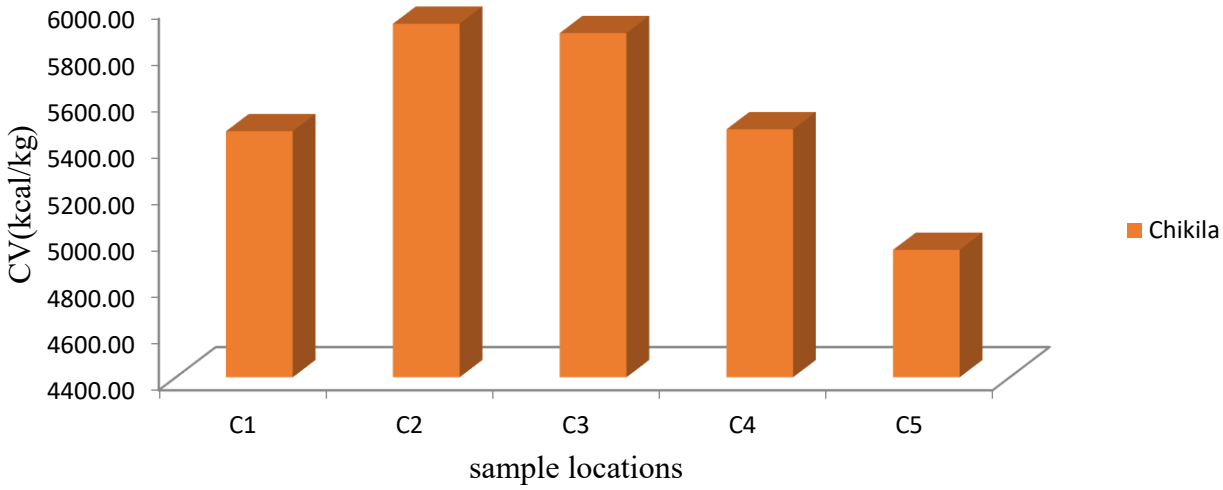

Figure 3: Calorific Values of Coal at Different Locations

Figure 3 shows clear view of calorific value of coal which is the suitability of heat capacity retention and generation of viable coal to produce heat and light. It indicated that sample C_2 has the highest calorific value of 6000 Kcal/Kg while C_5 recorded the lowest calorific value of 5200. Other calorific values are those presented by sample C_3 5800 Kcal/Kg whereas samples C_1 and C_4 has the same calorific value of 5600 Kcal/Kg.

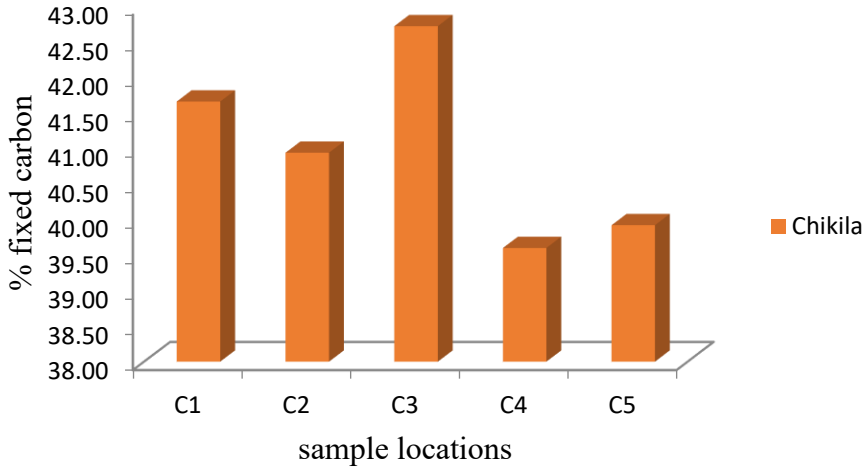

Figure 4: Fixed Carbon Values of Chikila Coal at Different Location

Sample C_3 has the highest fixed carbon content of 43 % while sample C_4 has the lowest fixed carbon content of 39.50 % as shown in figure 4 above. Sample C_1 has a total of 42 % fixed carbon value exceeding sample C_2 and C_5 which have 41 and 40 % fixed carbon respectively.

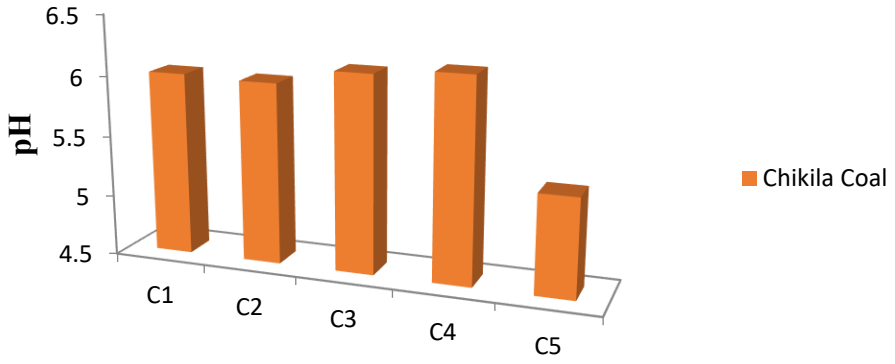

Figure 5: pH Values of Chikila Coal at Different Location

pH levels of coal samples using pH meter as shown in Figure 5, revealed that sample C_4 has the highest pH of 6.3 and C_5 has the lowest pH of 5. Other pH values are for C_1 6.05, C_2 6.0 and C_3 6.10.

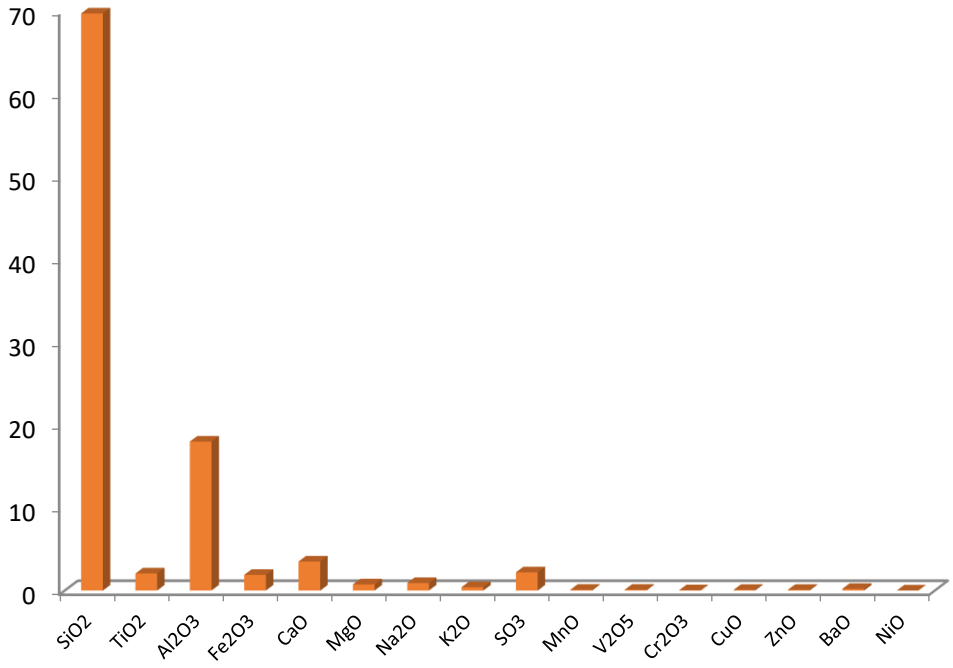

Figure 6: Average Percentage Mineral Compositions in Coal Samples

The result of X-ray Fluorescence analysis as indicated in figures 6 of Guyuk coal has shown that the coal contains heavy metals in form of compounds or oxides of; Fe_2O_3, CaO, MgO, Na_2O, K_2O, SO_3, MnO, V_2O_5, Cr_2O_3, CuO, ZnO, BaO and NiO, with average compositions of 70 %, 2.06%, 17.99%, 1.89%, 3.50%, 0.75%, 0.91%, 0.40%, 2.20%, 0.092%, 0.10%, 0.035%, 0.074% and 0.0% for coal samples from Chikila village.

DISCUSSIONS

Moisture Content of Chikila Coal Samples

Generally, High moisture content would result in a decrease plant capacity and an increase in operating cost and it also affects calorific value and concentration of other constituents (Chittatosh *et al.*, 2013). Due to the fact that when coal burns, the moisture in coal evaporates taking away some heat of combustion which is not available for use vis-à-vis the amount of moisture determines how much of heating is to be done to dry coal before it is burned in the boiler (Chittatosh *et al.*, 2013).

Ash Content of Chikila Coal Samples

Since typical range for coal ash is 5 to 40% (Nasirudeen and Jauro, 2011), a high ash percentage reduces handling and burning capacity, increases handling costs, affects combustion efficiency and boiler efficiency and Causes clinkering and slagging (Nwoko, *et al*, 2016). Thus, all the coal samples are very good for making coke for heating in industries. Since low ash content is an essential requirement for making coals. In addition to the rich ability for coke making, Chikila village coal will influence slag volume and composition in blast furnace with poor in coke making as stated by (Ryemshak and Jauro, 2013).

Volatile Matter of Chikila Coal Samples

Since the typical range for volatile matter is 20 to 35% (Andrés and Juan 2013), therefore, the high volatile matter obtained in Chikila coal will proportionately increase flame length, help in easier ignition of the coal, set minimum limit on the furnace height and volume, influence secondary air requirement and distribution aspects and influence secondary oil support.

Calorific Values of Chikila Coal at Different Locations

the coal samples have high potentials in coke formations and heat generation capability. Since coal is the primary fuel for producing electricity in industries, therefore, the calorific value of coal has a profound influence on the day to day working and economics of the power plant. Power plant coals have a general calorific value in the range of 2700 kJ/kg to 9500 kJ/kg (Mahapatra, 2016). Therefore, Chikila coal has a very suitable calorific value for utilization in power plants. The calorific value is also related to the fixed carbon contents in terms of heat generation capacity (Ayhan, 2003).

Fixed Carbon Content of Coal Samples at Different Locations

The values of percentage carbon content (40 to 43) of Chikila coal indicate that the coal will be suitable for generation of electricity and also show that the coal type is sub-bituminous. Sub-bituminous coal has carbon content percentage range of 35 to 45 (Brian and Marty, 2008). Sub-bituminous coal contain low Calorific value compare to Anthracite and Bituminous coal. It is a clean source of fuel which is valued above lignite coal which contains high pollutants (Chibuisi and Maduabuchi, 2017). Another quality of the coal sample under study is effective coke formation due to its relative carbon content since this parameter is responsible for coke formation as reported by (Nasirudeen and Jauro, 2011).

pH of Coal from Chikila

The distribution of pH in Chikila coal which ranges from 5 pH to 6.3 pH is an indication that the coal contains low acidic oxide. This reality is possible due to the very low sulphur content (0.88 %) in the coal as revealed earlier in this work (see Figure 6). Another study on bimodal pH distribution in coal shows that pH is controlled by iron disulfide and calcareous minerals found in coal-bearing rock (Charles, *et al*, 2004). These acidic enhancers and neutralizers are readily reactive as such contribute to the bimodal pH distribution in coal. Going by this, it is also evident that the near neutral values observed in all the coal samples as presented above, could be attributed to the presence of substantive amount of carbonate buffering (Charles, *et al,* 2004).

Ultimate Analysis of Sample Coal

The ultimate analysis of five major elements found were; Carbon, hydrogen, oxygen, nitrogen and sulphur. The percentage composition of sulphur is small, 0.88%. The ultimate carbon composition of the coal sample is 60.2%, Hydrogen, 4.1% whereas Oxygen and nitrogen have 8.1% and 1.4% respectively. Since the cause of acid mine drainage is sulphide mineral (Sangita and Bably, 2010 and Clark, *et al* 2018), the outflow of acidic water or acid mine drainage from Chikila coal will be of a lesser concern due the low sulphur content of Chikila coal. This implies that the

depletion of the buffer ability of streams located close to the coal mining site will be very minimal as presented by (James and Kevin, 2000). Notwithstanding, the sulphur can still affect clinkering and slagging tendencies, corrodes chimney and other equipment such as air heaters and economisers and limit exit flue gas temperature. This side effect is also observed in other equipment use in oil industries (Alexander, *et al*, 2015).

Conclusion

This work significantly contributes to the exploration of fuels in Nigeria based on the result of the Proximate (high calorific value). Result of Coal-ash element shows that the heavy metal levels are also low whereas, the Ultimate analysis of the coal shows a high Carbon content; this confers that the coal obtained from Chikila is of good quality for power and heat generation. Also, due to the low sulphur and ash content of the coal, the mining and utilization of the coal will pois no harm to the environment, underground and surface water as well safe for life existence within the proximity of the mining site.

Recommendations

1. The coal deposits found in Chikila village will have a tremendous importance due to its high energy capacity. The Government and other firms should put some effort to utilize the deposits of this coal for heat and energy generation. This will help substitute the shortage of power supply and possibly, provide the energy needed to explore the vast amount of minerals such as limestone deposit located in the same vicinity.
2. Further geological studies of Chikila in Guyuk Local Government Area coal should be made to determining the extent and size of the coal deposit.

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CONCEPTUAL FRAMEWORK OF UNDERLYING FACTORS LIMITING ERADICATION OF HIDDEN HUNGER IN DEVELOPING COUNTRIES

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Abstract

Background: Hidden hunger (HH) is a global public health problem. There is interplay of several underlying factors limiting HH in developing countries**.**

Objective: This paper aims at conceptualising the interplay of these underlying factors limiting HH in developing countries.
Methodology: A mixed method was used. A goggle search was done to extract data from literature on underlying factors of HH using the following term "corruption," "nutrition knowledge," "war," " agricultural food production," "food choices and handling," "caring practices," "refugees," "food scarcity," "prevalence of micronutrient deficiencies", "malnutrition", and "country populations" to construct a conceptual framework. Out of 34 Low Income and 47 Lower Middle, 20 countries each were randomly selected from World Bank Country Classification. Secondary data were collected from Global Hunger Index (GHI) 2015), Food Insecurity Experience Scale (FIES) 2018, Corruption Perceptions Index (CPI) 2018 and World Population Review, 2019. Data was analysed using descriptive statistics and presented as means, standard deviation and percentages.
Result: Regional mean GHI was world (11.6%), Africa (19.5%), Asia (13.1%). Mean CPI, GHI and population for developing countries were 29.1, 40.7 million and 25.9. Mean FIES was world (9.1%), Africa (24.9%), Asia (6.8%). Conceptualised frame work showed that the major underlying causes of hidden hunger were nutrition knowledge, war, corruption, low agricultural productivity and over population culminating in HH.
Conclusion: Policies discouraging the underlying risk factors of hidden hunger and that promoting adequate micronutrients supply for vulnerable groups in developing countries are very important.

Key words: hidden hunger, micronutrient deficiencies, underlying factors, developing countries

Word count: 239

1.0 Introduction

Hidden hunger also called micronutrient deficiency is a global public health problem in developing countries especially Sub-Saharan Africa (SSA) and Asia (Sight and Life, 2013; UNHCR, 2013)). Globally, about 2 billion people lack key micronutrients like iron and vitamin A (Development Initiatives, 2017). One in three people in the world suffer from hidden hunger [2]. Nigeria, South Sudan and Somalia are countries cited as experiencing food insecurity and malnutrition from famine and droughts. In these countries, it is estimated that about 38 million people are severely food insecured, approximately 2 million children under five have severe acute malnutrition and 5 million people have moderate acute malnutrition (Development Initiatives, 2017).

Sustainable development Goals (SDGs) Targets 1 and 2 aim at no poverty and zero hunger and these are some of the risk factors of hidden hunger. Hunger has been reported to influence life expectancy in war-torn Sub-Saharan African countries (Uchendu, 2018). There are about 1 million Rohingya refugees from Myanmar many of whom are suffering from acute food insecurity, poor health, and injuries caused by violence (Hammond, 2018). Nigeria has approximately 7 million persons internally displaced displaced persons (IDPs) (Lenshie and Yenda, 2016) while about 200, 000 Nigerians are refugees in Chad, Niger and Cameroun (WFP, 2018). Chad has 1 million IDPs, Niger 1.2 milion, Cameroon 50, 000 and Ghana, 150, 000 (Lenchie 2016). Food shortage in Nigerian IDP camps has resulted in chronic hunger, and acute malnutrition (Adedibu, 2017). SDG Target 2.1 says "By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round." (FAO, IFAD, UNICEF, WFP and WHO, 2018). It has been suggested that hunger and displacement must be understood and treated as political problems (Hammond, 2018). It has been reported that food shortage in Nigerian IDPs' camps have resulted in chronic hunger, and acute malnutrition (Adedibu, 2017).

Micronutrient deficiencies are silent epidemics of vitamin and mineral deficiencies affecting people of all genders and ages, as well as certain risk groups (Tulchinsky, 2010). The most vulnerable are pre-school children, pregnant and lactating mothers and adolescents. In Nigeria, hidden hunger is a serious problem, with 29.5 % of children under-five estimated to be vitamin A deficient (HarvestPlus, 2012). Hidden hunger is a chronic lack of vitamins and minerals that often has no visible warning signs, so that people who suffer from it may not even be aware of it. It is as a result of inadequate intake of micronutrient dense staples and low food diversity. Other studies have also shown that micronutrient deficiency and worm infections are intertwined and co-exist among low-income population (Al-Mekhlafi et al. 2008; Khor and Zalilah, 2008). An association has been found between nutrition knowledge and food intake indicating that knowledge is an important factor in explaining variations in food choice (Wardle et al, 2000).

Poverty combined with other socioeconomic and political problems create the bulk of food insecurity around the world (FAO, 2011). Income poverty (due to unemployment, low wages, or lack of education) can lead to household food insecurity, inadequate care, "unhealthy household environment, and lack of health services (Black et al. 2008). People of low socioeconomic status are most vulnerable to food insecurity since purchasing power serves as a main determinant of the ability-to-afford nutritional food sources. Households that cannot attain nutritious foods due to income poverty are most associated with the inadequate diet and disease that leads to malnutrition (**Wieser** et al. 2013). Poverty, hunger, and gross food insecurity are ravaging the masses not because of lack of resources in some cases, but due to the absence of a 'messiah' or a true patriot or selfless advisors and managers of national resources and tax payers' money (Uchendu, 2013). Corrupt practices have been reported to be negatively influencing food security and life expectancy in developing countries (Uchendu and Abolarin, 2015). This is an indication that if positive effort is not made to stop this trend, SDG target 2.1 which aims at eradicating hunger by 2030 might not be achieved (FAO, IFAD, UNICEF, WFP and WHO, 2018).

The prevalence of undernourishment is used to monitor hunger while the prevalence of severe food insecurity is measured using the Food Insecurity Experience Scale (FIES) which was introduced in 2017. FIES provides an estimate of the proportion of the population experiencing serious challenges of obtaining safe, nutritious and sufficient food (FAO, IFAD, UNICEF, WFP and WHO, 2018). The aim of this study therefore is to describe underlying risk factors responsible for persistent increase in hidden hunger in developing countries.

Materials and methods

Inclusion criteria

Countries were excluded if they do not have complete relevant data (CPI, FIES, POP, GHI) available. Global hunger Index (GHI) 2015 and Corruption Perceptions Index 2018 had records for 104 and 180 countries, respectively. Only developing countries that had complete data and a population of at least 1 million were included in the study resulting in 40 countries selected.

Sample collection

A mixed method was used in collecting the data. A systematic review of relevant databases was searched from the earliest record until November 2019. Comprehensive search terms included: global prevalence of micronutrient deficiencies, malnutrition, country populations, corrupt practices, refugees, social amenities, food security, food scarcity, food availability, war incidences in SSA, agricultural productivity in developing countries and nutrition knowledge among women. A conceptualised framework was constructed. List of developing countries were collected from World Bank Country Classification, 2019. Developing countries were randomly selected from Low Income (LEs) ($995 or Less) and Lower Middle (LMEs) ($996 to $3,895) Economies. Out of 34 LEs and 47 LMEs, 20 countries each were randomly selected. Secondary data were also collected from Global Hunger Index (GHI) 2015, Food Insecurity Experience Scale (FIES) 2018, Corruption Perceptions Index (CPI), 2018 and World Population Review, 2018. 2019. Out of 104 and 180 countries in GHI and CPI. Countries were arranged according to their CPIs in chronological order.

Statistical analyses

Data was analysed using descriptive statistics and presented in tables as means, standard deviation and percentages.

Result

Figure 1 shows the conceptual framework of the major underlying factors limiting hidden hunger in developing countries. It reveals the major underlying factors as low agricultural food production, war, corruption, and over population and poor nutrition education/knowledge among women and children. The underlying factors had either direct or indirect influences on HH but the overall effect was micronutrient insecurity. This conceptual framework will guide the discussion.

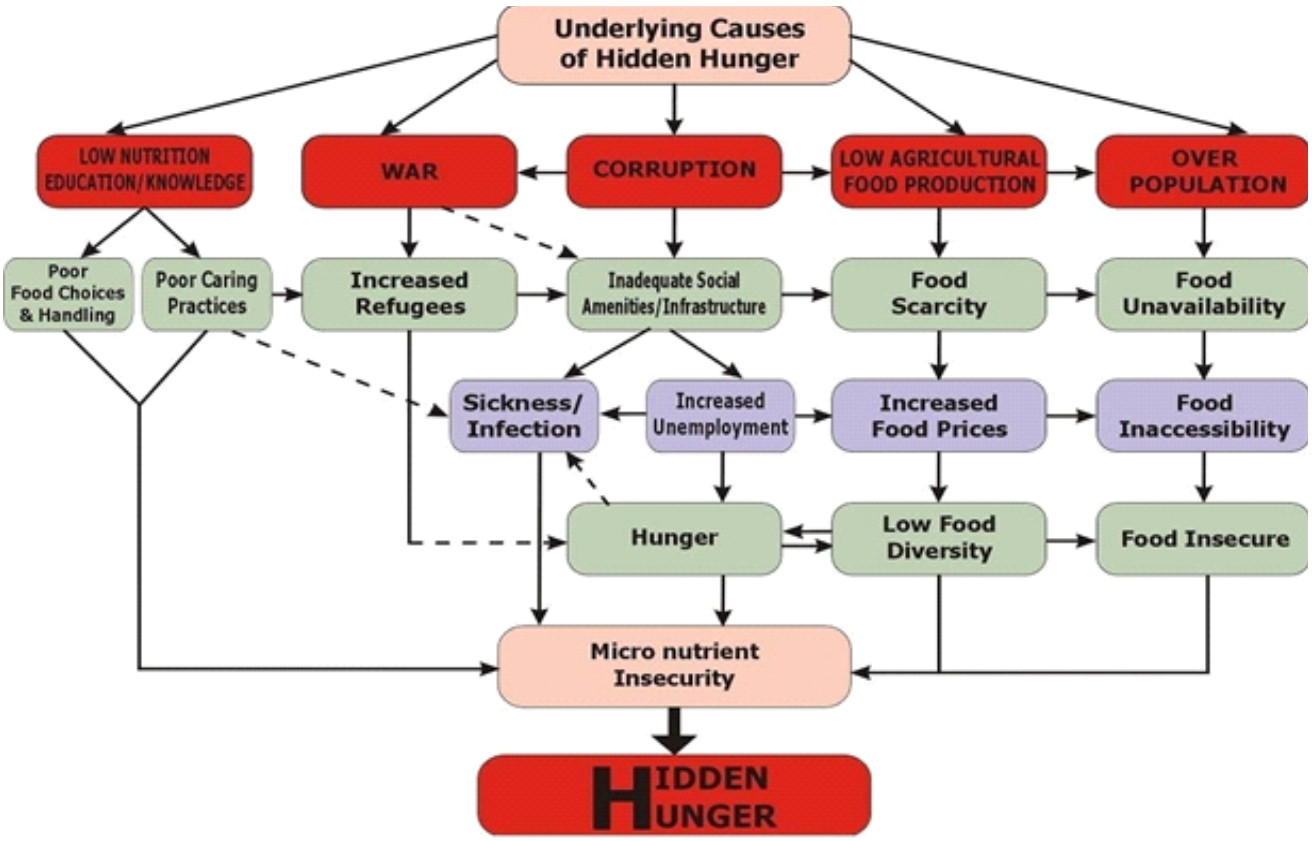

Figure 1: Conceptual framework of risk factors limiting the eradication of hidden hunger in developing countries

Table 1 shows the mean corruption perceptions index 2018 of selected developing countries to be 29.1, GHI 2015 (25.9) and population (40.3 million).

Table 1: Developing countries' corruption perceptions index 2018 and their population

S/N	Country	CPI Score[a] 2018/100	GHI 2015[b]	Population (≈million)[c]
1	Morocco	43	9.5	36.6
2	Lesotho	41	23.5	2.3
3	Burkina Faso	41	31.8	20.3
4	Ghana	41	15.5	30.1
5	Benin	40	21.8	11.8
6	Gambia	37	21.5	2.2
7	Mongolia	37	14.7	3.2
8	Philippines	36	20.1	108.1
9	Tanzania	36	28.7	60.9
10	Côte d´Ivoire	35	26.3	21.1
11	Zambia	35	41.1	18.1
12	Ethiopia	34	33.9	110.1
13	Niger	34	34.5	23.1
14	Pakistan	33	33.9	204.8
15	Vietnam	33	14.7	97.4
16	Liberia	32	30.8	4.9
17	Mali	32	29.6	19.7
18	Sierra-Leone	30	38.9	7.9
19	Togo	30	23.0	8.2
20	Bolivia	29	16.9	11.4

21	Honduras	29	13.4	8.6
22	Myanmar	29	23.5	54.3
23	Paraguay	29	10.5	6.8
24	Equatorial Guinea	28	28.8	1.4
25	Kenya	27	24.0	52.2
26	Nigeria	27	32.8	200.9
27	Bangladesh	26	27.3	168.1
28	Uganda	26	27.6	45.7
29	Cameroon	25	24.2	25.3
30	Madagascar	25	36.3	26.9
31	Nicaragua	25	13.6	6.0
32	Mozambique	23	32.5	31.4
33	Uzbekistan	23	13.3	32.8
34	Zimbabwe	22	30.8	17.2
35	Democratic Republic of Congo	20	26.6	86.7
36	Haiti	20	37.3	11.2
37	Angola	19	32.6	31.8
38	Chad	19	46.9	15.8
39	Congo, Rep.	19	26.6	5.5
40	Yemen	14	34.2	29.6
	Mean[d]	**29.1±7.69**	**25.9±9.13**	**40.7±51.43**

[a]Transparency International Corruption Perceptions Index, 2018: Score 0 -100; The high the cleaner

[b]Global Hunger Index, 2015;

[c]World Population Review, 2019

[d]Developing countries without complete data and population <1 million were excluded.

Table 2 reveals the mean regional CPI scores of the world. The average CPI scores for Asia Pacific, Eastern Europe & Central Asia, Middle East & North Africa and Sub-Saharan Africa regions were 44 %, 35%, 39 % and 32 %.

Table 2: Mean regional CPI scores of the world

		CPI Scores 2018/100*				
S/N	**Region**	**Average**	**Top**	**Score**	**Bottom**	**score**
3	Asia Pacific	44	New Zealand	87	North Korea	14
4	Eastern Europe & Central Asia	35	Georgia	58	Turkmenistan	20
5	Middle East & North Africa	39	United Arab Emirates	70	North Korea	14
6	Sub-Saharan Africa	32	Seychelles	66	Somalia	10

*Scale of zero (highly corrupt) to 100 (very clean)

Source: Transparency International 2019

Table 3 shows the regional prevalence of hunger (GHI) in the world from 2005 - 2017. The mean prevalence of hunger indices were world (11.6), Africa (19.5) and Asia (13.1).

Table 3: Global prevalence of undernourished people (GHI) in regions of the world 2005 - 2017

		Undernourishment (years)[a]						
S/N	**Region**	**2005**	**2010**	**2012**	**2014**	**2016**	**2017**	**Mean**
1	World	14.5	11.8	11.3	10.7	10.8	10.9	11.6±1.44
2	Africa	21.2	19.1	18.6	18.3	19.7	20.4	19.5±1.10
3	Asia	17.3	13.6	12.9	12.0	11.5	11.4	13.1±2.21
4	Latin America and the Caribbean	9.1	6.8	6.4	6.2	6.1	6.1	6.7±1.16

5	Oceania	5.5	5.2	5.4	5.9	6.6	7.0	5.9±0.72
6	Northern America and Europe	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5
Source: [a]FAO, IFAD, UNICEF, WFP and WHO (2018); [b]Population Reference Bureau, (2019) *billion, Population mid-2018 (millions)								

Table 4 shows the prevalence of severe food insecurity, measured with the food insecurity experience (FIES) scale, 2014–2017 in developing countries as world (9.1 %), Africa (24.9 %) and Asia (6.8 %).

Table 4: Global prevalence of severe food insecurity, measured with the food insecurity experience scale, 2014–2017

		Food Insecurity Experience Scale (FIES) by year				
S/N	**Region**	**2014**	**2015**	**2016**	**2017**	**Mean**
1	World	8.9	8.4	8.9	10.2	9.1±0.77
2	Africa	22.3	22.4	25.4	29.8	24.9±3.52
3	Asia	7.3	6.6	6.5	6.9	6.8±0.35
4	Latin America	7.6	6.3	7.6	9.8	7.8±1.45
5	Northern America and Europe	1.5	1.5	1.2	1.4	1.4±0.14
Source: FAO, IFAD, UNICEF, WFP and WHO. (2018).						

Discussion

Corruption, war, over population, low agricultural food production and low agricultural food production might be underlying risk factors limiting the eradication of hidden hunger in developing countries (Figure 1). Developing countries are densely populated (40.7 million), have the highest mean corrupt practices tendencies below 30 % (29.1) and very high hunger people (25.9). Sub-Sahara African countries have the highest corrupt perceptions index (32.0 %), Africa has the highest undernourished people (19.5 %) followed by Asia (13.1 %) when compared with the rest of the regions while the highest most food insecure people is in Africa only (24.9 %). The prevalence of food insecurity in Africa is four times that of Asia and twice the world prevalence. Even though the level of undernourishment in Asia has reduced and remained stable, that of Africa starting increasing again from 2016. This is an emergency trend and needs critical action to check met it. Hidden hunger is precipitated by underlying factors such as corruption, war, over population, low agricultural food production and low agricultural food production. These underlying risk factors either have direct or indirect influence on hidden hunger and they are also interlinked (Figure 1).

Corruption is described as the dishonest and fraudulent practices by officials in power or position of authority. It is an abuse of entrusted power for personal gain (Transparency International, 2018).

From the conceptual framework, corruption leads to unavailability of adequate social amenities/infrastructures. Absence of social amenities/infrastructures in turn precipitates sickness, infection and increased unemployment. For example, lack of portable water will lead to infection and sickness and if there is no money to pay for hospital bills due to unemployment, this might result to increased morbidity and mortality. Corrupt practices have been reported to negatively influence food security and life expectancy in developing countries (Uchendu and Abolarin, 2016). Unemployment in the presence of increased food prices results in hunger and prolonged hunger gives rise to micronutrient insecurity among the vulnerable groups.

Many African countries are over-populated with a mean population of 41.7 million. The three most populous countries were Bangladesh (156.6 million), Nigeria (173.6

million), and Pakistan (190.7 million) (Table 1). Developing countries are highly populated but with very high mean CPI index less than 30 %. Poverty, hunger, and gross food insecurity are ravaging the masses not because of lack of resources in some cases, but due to the absence of a 'messiah' or a true patriot or selfless advisors and managers of national resources and tax payers' money (Uchendu, 2013).

There is an increasing incidences of war, conflicts and unrest in many developing countries especially Sub-Sahara Africa. War and conflicts forcefully displaces people from their residences or homes and makes them refugees incapable of helping themselves. There are about 1 million Rohingya refugees from Myanmar many of whom are suffering from acute food insecurity, poor health, and injuries caused by violence (Hammond, 2018). Nigeria has approximately 7 million persons internally displaced (Lenshie and Yenda, 2016) while about 200, 000 Nigerians are refugees in Chad, Niger and Cameroun (WFP, 2018). Chronic hunger threatens the lives of forcibly displaced persons. Hunger has been reported to influence life expectancy in war-torn Sub-Saharan African countries (Uchendu, 2018). The prevalence of undernourished people (PoU) in the world has stabilized except in Africa where the PoU started increasing again from 2016 (19.7 %) to 2017 (20.4 %). This might be attributed to the underlying factors that limit eradication of hidden hunger (Figure 1). War results in forced migration via increased number of refugees and internally displaced persons (IDPs) who live in camps with no shelter, food, portable water and clean environment. Children and women especially pregnant women and lactating mothers in IDP camps face prolonged hunger and malnutrition. Hunger has been reported to influence life expectancy in war-torn Sub-Saharan African countries (Uchendu, 2018). It has been suggested that hunger and displacement must be understood and treated as political problems (Hammond, 2018).

Low agricultural food production leads to inadequate supply of food which is an indicator of hunger and it affects the whole population both adults and children. This in turn causes food scarcity resulting in increased food prices, low food diversity and undernourishment. Low food diversity affects the quality of food consumed. Food scarcity results in food unavailability, food inaccessibility and eventually food insecurity due to low food diversity ultimately leading to hidden hunger. Most developing countries do not embark on mechanized agriculture to produce enough food for their population.

Low nutrition knowledge gives rise to poor food choices, poor food handling and poor caring practices. Poor food choices would result in low food diversity while poor food handling could lead to degradation and destruction of micronutrients during processing. Low food diversity and degradation of micronutrients have a direct relationship with hidden hunger. Adequate nutritional knowledge is required to make the right food choices by mothers and care-givers. In the presence of low agricultural food production, good nutritional knowledge is necessary to be able to combine the available and affordable food to get quality meal. Good nutritional knowledge will provide the citizens with the information necessary to choose healthy foods which will eventually lead to an improvement in dietary intake. Also, good nutritional knowledge will give accurate information about what the people should be eating and the implications to their health if they eat the `wrong' foods, and this will make them change their diets appropriately. An association has been found between nutrition knowledge and food intake indicating that knowledge is an important factor in explaining variations in food choice (Wardle et al, 2000). Women who had better knowledge of nutrition also exhibited better dietary behaviour, thus underlying the importance of nutrition education for improving dietary behaviour (25). Global nutrition education is very important among children, adolescents, and adults to eradicate hidden hunger.

Conclusion

The underlying primary socio-economic factors for persistent increase in hidden hunger in developing countries include corruption, over population, incessant war, low agricultural food production, and low nutrition knowledge among mothers and care-givers. The region of Africa still has the highest corrupt practices, undernourished people and severe food insecurity. Implementation and monitoring

of policies geared at reducing the underlying risk factor of hidden hunger in developing countries is very important. Hidden hunger policies face the challenges of implementation and monitoring.

Ethics statement
The datasets used in this study were obtained from [21-25]. Full review of this study from an institutional review board was not sought as the datasets were anonymous and they are available for public use with no identifiable information on the survey participants.

Conflict of interest: The author declares no conflict of interest.

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PHYTOCHEMICAL AND MINERAL CONSTITUENTS OF SUCCESSIVE EXTRACTS OF *LUFFA CYLINDRICA* (M.J ROEM) LEAVES

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Abstract

Objective: The present study aimed to assess the phytochemical constituents present in successive leaf extracts of *Luffa cylindrica* and the mineral and vitamin constituents of the dried powdered leaves.

Methods: The extracts of the powdered leaves of *L. cylindrica* were obtained using n-hexane, ethylacetate, methanol and distilled water in succession by maceration method and were tested for the presence of tannins, alkaloids, terpenes, flavonoids, anthraquinones, cardiac glycosides, saponins and phlobatannins using standard methods for phytochemical screening. The micro, macro minerals and vitamins content in the powdered leaves were also determined.

Result: The results showed the presence of tannins, alkaloids, terpenes, flavonoids, cardiac glycosides and saponins in the extracts of the selected solvents (from non-polar to polar) used in succession. The dried powdered leaves of *L. cylindrica* contained potassium (9.80 ± 0.97mg/100g), sodium (0.32 ± 0.12mg/100g), phosphorus (6.17 ± 0.41mg/100g), calcium (0.42 ± 0.97mg/100g), magnesium (0.12 ± 0.01mg/100g), zinc (7.67 ± 0.02mg/100g), chromium (0.70 ± 0.01mg/100g), vitamins C (6.92 ± 0.03mg/100g) and E (0.11 ± 0.01mg/100g).

Conclusion: The selective solubility of the phytochemicals is probably responsible for conferring a wide range of therapeutic and pharmacological activities attributed to the leaves of *L. cylindrica* suggesting the relevance of the solvent as a decisive factor for confirming the presence of a phytoconstituent which could serve as a benchmark for drug development from bioactive principle(s) of plant origin with biological activities. The data on the mineral and vitamin constituents detected in the leaves of the plant suggest that the plant could serve as a source of dietary supplement for boosting the immune system. The data also justify the medicinal uses of the *Luffa cylindrica* in folklore medicine of Nigeria and some other countries for the treatment of different ailments.

Introduction

In folk medicine practice in Nigeria and other African countries, medicinal plants are used locally to treat a myriad of ailments such as jaundice, diabetes, gastrointestinal disorders, hepatitis and malaria. This is because medicinal plants contain bioactive chemical constituents possessing therapeutic properties (Ray *et al*., 2004; Negi *et al*., 2011). The identification of the bioactive principles in medicinal plants play a strategic role in the phytochemical investigation of plant extracts and is so essential with regards to their potential pharmacological effects (Pascual *et al*., 2002). Therefor assessment of both organic and inorganic constituents in medicinal plants can be relevant in the efficacy of the medicinal plants in treating various diseases as well as provide an in-depth understanding of their pharmacological actions. *Luffa cylindrica,* (Family *Curcubitaceace*) sponge gourd as it is commonly called is a source of food and medicinal plant used as a therapeutic in traditional medicine in Nigeria and some other countries like China and Indian. Decoctions of the leaves, stems, roots seeds and fruits are used locally to treat fever, malaria, jaundice, tumors, leprosy, wounds, bleeding from bowels or bladders and also to alleviate pain and inflammation (Pal and Manoj, 2011; Azeez *et al*., 2013; Khan *et al*., 2013a). Earlier studies had reported the phytoconstituents present in the extracts of *L. cylindrica* leaves using a single solvent (Salman *et al*., 2013**,** Sharma *et al*., 2014**,** Etim *et al*., 2018; Saliu *et al*., 2019) but information on the screening of bioactive principles in successive extracts of the *L. cylindrica* leaves using solvents of varying polarities in succession is yet to be reported. The present study therefore aimed at investigating the phytochemicals in successive leaf extracts of *L. cylindica* using n-hexane, ethylacetate, methanol and water solvents in succession.

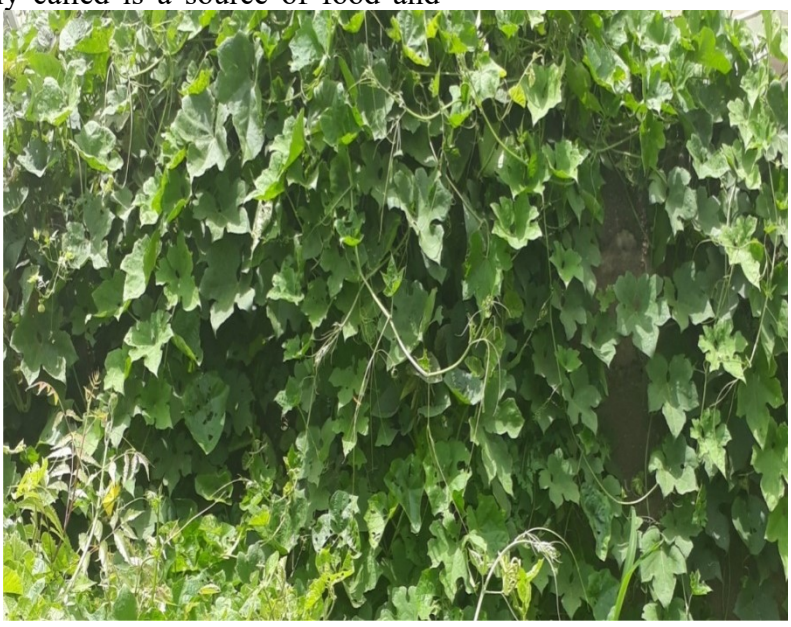

Figure 1: Leaves of *Luffa cylindrica*
Source: Zulle Farm, Suleja, Niger State

Materials and Methods

Collection of plant material and authentication

Leaves of *Luffa cylindrica* (Fig. 1) were collected from Zulle Farms, Suleja, Niger State, Nigeria in the month of July, 2015 around10 a.m and authenticated at the National Institute for Pharmaceutical Research and Development, (NIPRD), Abuja, where a voucher specimen (NIPRD/H/6650) was deposited at the herbarium of the institute.

Preparation of successive extracts

The leaves were washed with water to remove dirt and air-dried to a constant weight for three weeks. Leaves were milled into powder with mechanical blender (Mazeda Mill, MT 4100, Japan). 100 g of the dried leaf powder was extracted firstly using n-hexane followed by ethylacetate,

methanol and distilled water in succession by maceration method. Each extract obtained following successive extraction was filtered using Whatman No 1 filter paper, concentrated in a rotary evaporator (RE-300B model, product of Henan Touch Science, China) except the aqueous extract and subsequently dried to a semisolid mass using water bath at 45ºC. The yield of each extract thus obtained was recorded and stored in a refrigerator at 4^0C till further use.

Phytochemical analysis

Qualitative phytochemical screening viz. saponins, tannins, flavonoids, cardaic glycosides, phenolics, phlobatannins, terpenes, alkaloids, anthraquinones was carried out for each successive extract using standard methods described by Harbone (1973); Trease and Evans (1989) and Sofowora (1993). The quantification was carried out for saponins (Brunner, 1984), alkaloids (Henry, 1973), flavonoids, tannins, terpenes, phenolics and phlobatannins (El-Olemy *et al*., 1984).

Mineral analysis

Mineral evaluation such as calcium, potassium, magnesium, sodium and phosphorus were carried out on the powdered leaves of *Luffa cylindrica* using the multiple-nutrient wet acid digestion method described by AOAC (1980). The minerals were quantified by Flame photometric method on Jenway Digital Flame Photometer (PFP7 Model) using filters corresponding to each mineral element. Determination of trace elements Cd, Cr, and Zn was carried out with Atomic Absorption Spectrophotometer (AAS) Buck 211 Model.

Results

Table 1 depicts the yield obtained from each successive extracts of the leaves of *Luffa cylindrica* using hexane, ethylacetate, methanol and water. The aqueous extract gave the highest yield followed by methanol, hexane and ethylacetate. The qualitative and quantitative secondary metabolites evaluations of the various successive extracts are presented in **Table 2**. The phytochemical tests employed detected the presence of alkaloids in all the successive (aqueous, methanolic, ethylacetate and hexane) extracts, terpenes in methanolic, ethylacetate and hexane extracts alone, saponins and phenolics were present only in the aqueous and methanolic successive extracts, cardaic glycosides in aqueous, methanolic and hexane extracts, flavonoids were present in methanolic and ethylacetate extracts while tannins was present only in the methanolic extract. Prominent among these secondary metabolites is terpenes, found to be (44.86 ±19.4 mg/g) in hexane, (22.45 ± 0.03 mg/g) in ethylacetate and (17.45 ± 2.16 mg/g) in methanolic successive extracts while cardaic glycosides had the lowest concentration (0.05 ± 0.01 mg/g) among the respective successive extracts. Alkaloids, flavonoids, tannins, phenolics, saponins varied in concentrations among the respective successive extracts.

The mineral and vitamin analyses of *L. cylindrica* powdered leaves showed elements like K (9.80 ± 0.97 mg/g), P (6.17 ± 0.41 mg/g), Ca (0.42 ± 0.01 mg/g) Na (0.32 ± 0.12 mg/g), Zn (7.62 ± 0.02 mg/g) and Mg (0.12 ± 0.01 mg/g) (**Table 3**). The leaves also contain minute amounts of Cr (0.70 ± 0.01 mg/g). Vitamin C (6.92 ± 0.03 mg/g) and Vitamin E (0.11 ± 0.01 mg/g) were also found to be present in the powdered leaves in considerable amount

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Table 1: Yield and colour of successive extract of *Luffa cylindrica* leaves

Organic solvent used	weight of sample (g)	Extraction time (hours)	Yield (g)	colour of sample
n-hexane	100	14	5.2	Dark brown
Ethylacetate	95	12	3.8	Dark brown
Methanol	91	10	5.6	Black
Aqueous	86	10	9.2	Dark green

Table 2: Secondary metabolites of successive leaves extracts of *Luffa cylindrica*

Secondary Metabolites	Composition (mg/g)			
	Aqueous Extract	**Methanolic Extract**	**Ethylacetate Extract**	**Hexane Extract**
Saponins	1.32 ± 0.18	0.90 ± 0.03	-	-
Tannins	-	3.58 ± 0.90	-	-
Anthraquinones	-	-	-	-
Terpenes	-	17.45 ± 0.18	22.45 ± 0.03	44.86 ± 19.4
Phenolics	7.79 ± 0.22	9.16 ± 0.12	-	-
Flavonoids	-	7.45 ± 0.49	26.07 ± 0.18	-
Alkaloids	0.10 ± 0.01	11.35 ± 0.04	18.24 ± 0.02	13.28 ± 0.01
Phlobatannins	-	-	-	-
Cardaic Glycosides	0.06 ± 0.01	0.05 ± 0.01	-	0.05 ± 0.02

- **absent**

Values are means ± SEM of three replicates

Table 3: Mineral/vitamin constituents present in powdered leaf of *L. cylindrica*

Mineral/Vitamin Constituents	Composition (mg/100g)
Calcium	0.42 ± 0.01
Potassium	9.80 ± 0.97
Phosphorus	6.17 ± 0.41
Magnesium	0.12 ± 0.01
Sodium	0.32 ± 0.12
Zinc	7.67 ± 0.02
Chromium	0.70 ± 0.01
Cadmium	-
Vitamin C	6.92 ± 0.03
Vitamin E	0.11 ± 0.01

- **absent**

Values are means ± SEM of three replicates

Discussion

The secondary metabolites, mineral and vitamin constituents identified in *L. cylindrica* leaves in this present study could be responsible for the medicinal use of the plant in the folk medicine of some countries like Nigeria as well as the biological activities scientifically attributed to the plant. Alkaloids are one of the secondary metabolites in plants majorly used as basic active ingredients in pharmaceutical drugs to kill or relief pains. Flavonoids are also important bioactive compounds which exhibit a wide range of biological activities among which are antioxidant, anti-inflammatory and antimicrobial activities (Ayoola *et al*., 2008; Panche *et al*., 2016).

Flavonoids have been reported to be capable of inhibiting the synthesis of prostaglandin, a metabolite that mediates pain and fever (Manthey, 2000). In addition, flavonoids, saponins and triterpenes are reported to also possess analgesic property (Borgi *et al*., 2008; Biswas *et al*., 2009) thus, justifying the use of *L. cylindrica* leaves in the treatment of pain and enteric fever in folk medicine. Saliu *et al*. (2019) further established the analgesic and antipyretic activities of *L. cylindrica* leaves in animals. Tannins are capable of precipitating proteins and therefore they possess astringent properties, promote wounds healing and inflamed mucous membrane. Plants containing tannins are used for healing of wounds, varicose ulcers, hemorrhoids, frost- bite and

burns (Ibrahim and Fagbohun, 2012; Kigigha *et al*., 2015) therefore the use of *L. cylindrica* leaves for the treatment of inflammation and wounds in folk medicine maybe attributed to presence of tannins and flavonoids. In addition, Khah *et al*. (2013b) have also established the anti-inflammatory activities of *L. cylindrica* leaves in experimental animals. Saponins constitute a group of triterpenes which are bioactive compounds generally known to be produced by plants for defense against pathogens and herbivorous animals. Apart from their role in plant defense, saponins are of pharmacological importance having the ability to inhibit DNA replication in cancerous cell thus act as anti-tumor and anti-cancer agents. Similarly, flavonoids are also reported to be potent against cancer cells (Ravishankar *et al*., 2013). In view of this, several studies establishing the anti-cancer activity of *L. cylindrica* containing saponins and flavonoids are well documented in literature (Abdel-Salam *et al.,* 2018; Garai *et al*., 2018; Abdel-Salam *et al*., 2019).

Tannins, saponins, phenolics, alkaloids and flavonoids have been suggested to be involved in anti bacterial and anti-viral activities. Bulbul *et al*. (2011); Mankilik and Mikailu (2014) reported the anti-microbial activities of *L. cylindrica* leaves against *Staphylococcus species*, *Salmonella typhii*, *Escherichia coli,* and *Aspergillus species*. This is evident for the traditional use of the plant to treat microbial related diseases such as leprosy, skin diseases etc. due to the presence of tannins, saponins, phenolics, alkaloids and flavonoids in the plant. The macro minerals content of the powdered leaves of *L. cylindrica* from this study is lower but the micro minerals content is higher than ones reported by Ogunyemi *et al*. (2020) in the seed of the plant obtained from South-Western region of Nigeria suggesting that the trace minerals maybe predominantly present in the leaves than the seed. From this study, the plant leaves contained 0.42 mg/100g of calcium which is lower than calcium content (2.12 mg/100g) in the plant seed reported by Ogunyemi *et al.* (2020). The phosphorus content of the powdered leaves was 6.17 mg/100g as against 30.63 mg/100g of phosphorus obtained from the seed of *L. cylindrica*. The leaves also contained a smaller amount of magnesium with a value of 0.12 mg/100g than the seed which contained 28.93 mg/100g. Calcium, magnesium and phosphorus are minerals that plays key role in bone mineralization and teeth development. Calcium is important for optimal bone health, assists in transmission of nerve impulses, necessary for muscle contraction and blood clotting. Magnesium like calcium assists in the proper function of nerves, muscles and many other parts of the body. Magnesium also acts as an antacid for heartburn by neutralizing stomach acids and is also helpful as a laxative for constipation as it moves stool through the intestine. Phosphorus is involved in energy production, storage and cell signaling via phosphorylation reactions, and regulation of normal acid-base balance (homeostasis) by acting as one of the body's most important buffers (Knochel, 2006).

The concentration of potassium was 9.80 mg/100g, which is lower to 13.86 mg/100g of potassium concentration recorded in the seed of the plant. Potassium is an important element that acts as a vasodilator, strengthening the elasticity of the blood vessels and thus lowers the risk of developing cardiovascular disease. Sodium whose concentration (0.32mg/100g) in the leaf of *L. cylindrica* in this study is smaller to the value reported in the seed (8.18 mg/100g) of same plant is required in the body for regulating blood pressure and blood volume. It also helps in the proper functioning of the muscles and nerves in the body. Though the calcium, magnesium, phosphorus and sodium contents present in *L. cylindrica* leaves were lower to the recommended daily allowance (Ca-800 to 1200mg, K- 1600mg, Mg- 400mg, Na-2000mg, P-700mg/day), it still suggests that the plant may be good as a therapy for mineral-deficiency related diseases like osteoporosis, clogged arteries and hereditary heart disease. These macro minerals (calcium, potassium, magnesium, phosphorus and sodium) are not only the minerals that promote the proper function of the body, trace minerals like zinc, iron and chromium also plays significant physiological role in the body. *L. cylindrica* powdered leaves contained 7.67 mg/100g and 0.70 mg/100g of zinc and chromium respectively which were higher than the concentrations (3.42 mg/100g and 0.25

mg/100g for zinc and chromium respectively) accounted for by Ogunyemi *et al*. (2020) in the seed of *L. cylindrica.* The content of zinc (7.67 mg/100g) in *L. cylindrica* leaves is close to the recommended daily allowance (8mg/day for women and 11mg/day for men) implying that the leaf of *L. cylindrica* is a good source of zinc. Zinc stimulates the production of sex hormones thus promote fertility. It also promotes wound healing inferring the use of *L. cylindrica* as a choice in folk medicine for the treatment of wounds. Zinc also plays a major role as a regulator of gene expression by binding to transcription factor to activate gene expression (Cousins, 1994; Dalton *et al*., 1997; Cousins *et al*., 2003). Chromium (Cr^{3+}) as an essential trace mineral assists the body cells in the uptake of glucose by enhancing their sensitivity to insulin response. The chromium perhaps act in conjunction with other phytoconstituents to promote the anti-hyperglycemic effect exhibited by *L. cylindrica* as the anti-diabetic activity of the plant have been established (Balakrishnan and Sharma, 2013; Akther *et al*., 2014). Cr^{3+} also help lower cholesterol levels such as triglyceride, total cholesterol, low density lipoproteins (bad cholesterol) and increase the level of high density lipoproteins (good cholesterol) which reduces the risk of developing cardiovascular diseases. Calcium, magnesium, and zinc generally are components of some antioxidant enzymes acting as co-factor in enhancing their activities against free radicals that causes damage to biological membranes by oxidative stress. Many other enzymes also depend on some of these minerals for their catalytic action as their removal could results in loss of the enzymes activity. Vitamins are part of organic molecules required in the body though in small quantity for proper functioning of the body. Vitamins like Vitamin C and Vitamin E can act as antioxidants that helps prevent aging, damage to cells, tissues, proteins and DNA induced by free radicals. Vitamin E most often referred as α-tocopherol act on free radicals by donating electrons to them to form a radical tocopherol which can spontaneously be converted back to non-radical tocopherol using other non-enzymatic antioxidants like vitamin C. The presence of vitamin C and E and other phenolic compounds like flavonoids and saponins further supports the earlier report of Saliu *et al.* (2020) on *L. cylindrica* as having free radical and reactive oxygen species scavenging property. Earlier studies on preliminary screening of secondary metabolites have documented the presence of these secondary metabolites identified in the successive leaf extracts of *L. cylindrica* employing a single solvent (Khan *et al*., 2013; Etim *et al*., 2018; Saliu *et al*., 2019). However, in this study, the phytochemical test of successive leaf extracts of *L. cylindrica* obtained by using n-hexane, ethylacetate, methanol and water as the solvents for extraction infers the presence of different active ingredients having selective solubility in successive solvents of varying polarities used in succession thus suggesting the important role of the solvent as a decisive factor (Koruthu *et al*., 2011). This could be guide for isolating bioactive ingredients of plant origin with biological activities for the purpose of drug development.

Conclusion

The nature of solubility of the phytochemicals is probably responsible in conferring a wide spectrum of therapeutic and pharmacological activities attributed to the leaves of *L. cylindrica* suggesting the relevance of the solvent as a decisive factor for confirming the presence of a phytoconstituent which could serve as a benchmark for drug development from bioactive principle(s) of plant origin with biological activities. The data on the mineral and vitamin constituents detected in the leaves of the plant suggest that the plant could serve as a source of dietary supplement for boosting the immune system. The data also justify the medicinal uses of the *Luffa cylindrica* in folklore medicine of Nigeria and some other countries in treating different ailments.

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