JOURNAL OF AGRICULTURE

AND

AGRICULTURAL TECHNOLOGY

Vol. 11(1) April, 2020

ISSN: 1597 – 5460

A Publication of School of Agriculture and Agricultural Technology
Federal University of Technology Minna

EDITORIAL

The Editorial Board is happy to release Volume 11(1) of our reputable Journal.

.

Editor-in-Chief

Prof. Job N Nmadu

Table of Contents

ASSESSMENT OF SUSTAINABLE LAND MANAGEMENT PRACTICES AMONG FOOD CROP FARMERS IN NIGER STATE AND FEDERAL CAPITAL TERRITORY, ABUJA, NIGERIA

Samuel[1*], Y. J., Baba[1], K. M., Tanko[1], L. and Umar[2], I. S.
[1]Dept. of Agricultural Economics and Farm Management, Fed. University of Tech., Minna, Nigeria.
[2]Dept. of Agricultural Extension and Rural Development, Fed. University of Tech., Minna, Nigeria.
*Corresponding author's Email: jednajoe@gmail.com
Phone number: 08032212837

ABSTRACT
The study assessed the use of sustainable land management practices among food crop farmers in Niger State and Federal Capital Territory, Nigeria. Multistage sampling procedure was used to select a total of 350 farmers and primary data were collected using questionnaire. Descriptive statistics and multivariate probit regression model were used to analyze the data. The results reveled that the sustainable practices mostly undertaken by the farmers under agronomic practice was sole cropping (81.43%), the most undertaken cultivation practice was ridge tillage (92.00%), structural and mechanical erosion control practice mostly carried out was construction of ridges across field slopes (23.14%), and soil management practices (fertilizer application (93.43%) were the structural and mechanical erosion control practice mostly carried out. The results of multivariate probit showed that the significant determinants of land management practices among the farmers include membership of farmers' association (p≤0.10), source of information (p≤0.01), years spent in school, age (p≤0.01), days unable to go to work or farm (p≤0.01), years of farming experience (p≤0.05), distance from home to nearest market (p≤0.01), rainfall sufficiency for crop production (p≤0.05), adequacy of soil fertility (p≤0.05), tenancy security of farm land (p≤0.10) and access to extension (p≤0.01). It was recommended that more sustainable land management practices should be adopted by the farmers.

KEYWORDS: Land, Sustainable practices, Farmers, Niger, FCT

INTRODUCTION
Degradation of land is a serious problem worldwide. It has caused poverty and general under employment because of its devastating effects on agricultural production in developing and underdeveloped nations (Chabela *et al.*, 2014). According to Nkoya *et al.* (2016), land degradation affects about 30% (about 2 billion hectares) of total global land area and about three million people reside on degraded lands. The annual global cost of using land management practices on degraded lands is about 300 billion USD (FAO, 2013). Sub-Saharan Africa constitutes the largest share (22%) of the total global cost of land degradation (FAO, 2014).

Babalola and Olayemi (2013) also reported that settlements in southern part of Nigeria have had more than 10% of their land area destroyed by degradation and still exposed to possibility of destruction on more productive land area soon. Ademola *et al.* (2020) revealed that about 15% and 18% of agricultural land in Niger State and FCT is degraded even though government and development agencies such as Food and Agricultural Organiation (FAO) as well as nongovernmental organizations have done much within and outside Nigeria on sensitization and creation of awareness to educate people in urban and rural areas to control land degradation. This is because areas where land degradation occurs are yet to witness significant change due to inappropriate policy formulation and implementation, misallocation of resources, insufficient monitoring and evaluation concerning control of land degradation and its negative impact (Sale *et al.*, 2018).

Udoh (2002) and Feder (2005) suggested that Land Management Practices (LMPs) aimed at reducing the menace of land degradation for the benefit of small-scale farmers will be more interesting if differences in farmers' area of production is considered while formulating the LMP policies and this could enhance farmers' productive capacity of land since the destruction of land can be controlled using sustainability practices.

Curtailing land degradation through sustainability practices becomes possible through the combination of suitable livelihood strategies which are achievable given available household assets to the small-scale farmers (Samatar, 2015). It therefore becomes pertinent to carry out research on sustainable land management practices among food crops farmers in Niger State and Federal Capital Territory, Abuja, Nigeria. The objectives of this study were to identify the sustainable land management practices adopted by the farmers and to analyze the factors influencing their choice of land management practices in the study areas.

The destroyed natural environment can be reclaimed through implementation of suggestions of this research on sustainability practices. It is envisaged that more agricultural output is likely to be realized through implementation of findings of this research as degradation will be controlled. Contribution of the findings of this research towards documentation on the subject matter in the study area would guide stakeholders and policy makers in further policy making on livelihood combination and sustainability practices to control land degradation and guarantee economic and environmental efficiency. The research will also add to the existing literature which serves as a guide to aid further research on the subject matter.

METHODOLOGY

The Study Area: The study was conducted in Niger State and the Federal Capital Territory (FCT), Abuja, Nigeria. Niger State lies between Latitudes 8°20′N and 11°30′N and Longitudes 3°30′E and 7°20′E (Ojo *et al.*, 2009). It has land area of 76,363km^2. Niger State lies in the Guinea Savannah vegetation zone of the country with favorable climatic conditions for crop and livestock production. The topography is predominantly plain lands with interrupted undulations, and the soil ranges from sandy to clay loam (Niger State Agriculture and Mechanization Development Authority (NAMDA, 2014). The population of Niger State according to 2006 population census was 3,950,249 which could have increased at an annual population growth rate of 3.8% to give a projected value of 6,666,293 at the end of 2018. About 85% of the population of Niger State are crop farmers who sometimes combine this with rearing of livestock such as local poultry, ducks, sheep and goats which are marketed in order to supplement revenue from the cultivation of crops such as yam, rice, maize, cassava, melon and millet (NAMDA, 2014).
FCT, Abuja on the other hand lies on Latitudes 8°23′N and 9°20′N and Longitudes 6°45′E and 7°39′E. It has six Area Councils with projected population of 6,424,262 by 2018 according to United Nations Population Commission (UNDP), (2014). FCT-Abuja has a land mass of approximately 7,315km^2 of which the actual city occupies 273.3km^2. It is situated within the Guinea Savanna region with moderate climatic conditions. The natural resources available in the area are marble, tin, clay, mica, and tantalite (Tsue *et al.*, 2014).

Sampling Procedure and Sample Size

Multi-stage sampling procedure was used to select respondents for this study. Following Abu (2019), the proportionate sample allocation technique specified in equation (1) was adopted to select a total of 282 food crop farmers from Niger State while 68 were selected from FCT giving a total of 350 farmers for the study.

$$S_h = \frac{n \times Nh}{NT} \quad (1)$$

S_h =Number of household heads to be selected,
n= Total number of household heads for the survey,
N_h= Farming households in each selected Sub-Cells, and
N_T= Sum of the farming households in the selected sub-Cells

Method of Data Collection

Primary data were collected from the respondents through the use of questionnaire with the assistant of trained enumerators. The sampling unit was the farm households in the study area. Household heads were visited at

farms and home and multiple visits were made in some cases. Information were collected on parcel and plot levels including land tenure, cropping patterns and crop production use of labor and other crop production inputs.

Analytical Tools

Descriptive and inferential statistics such as frequency distribution, percentage, mean and multivariate probit regression model (inferential statistics) were used to analyze the data collected. Multivariate probit regression model was used to examine the determinants of adoption of land management practices and the model is presented in equation (2) following Green, (2000) and Mugisha and Alobo (2012).

$Yi^*= \beta \boldsymbol{X}i + Ei$ (2)

Where;

Yi^* = Latent variables that index the land management options on a given plot, that is, LMP (i.e.,Stuctural and Mechanical Erosion Control Practice (SMECP), Agronomic Practice (AP), Soil Management Practice (SMP) and Cultivation Practice (CP)),

Xi = Vectors of independent variables,

β = vector of parameter to be estimated and

Ei= stochastic term error.

The explicit form of the model is as follows in equation (3);

$$Y_i = \alpha + \beta S_i + \beta H_i + \beta F_i + \beta P_i + \beta N_i + \beta R_i + \beta I_i + \beta L_i \quad (3)$$

Where;

Yi = Latent variables that index the land management options on a given plot i.e., LMP (i.e. SMECP, AP, SMP and CP);

S_i, H_i, F_i, P_i, N_i, R_i, I_i, and LS_i are the determinants of adoption of land management practices (Independent variables, Xs)

S_i=Social capital variables

S_1 = Farmers' participation in government agricultural program (number)

S_2=Access to adult education program, (1 for access, 0 otherwise)

S_3= Association membership of farmers (1 for membership, 0 otherwise)

S_4=Access to information (number)

H_i= Human capital variables

H_1= Education of the household head (years),

H_2= Age of farmer (years),

H_3= Health status (number of days unable to go to work or farm),

H_4= Farming experience (years), and

H_5 =Family labour (man-days).

F_i = Financial capital variables

F_1= Amount of credit (₦),

F_2= Savings (₦),

F_3 = Amount of pension (₦),

F_4 = Income (₦), and

F_5 = Access to insurance (1 for access, 0 otherwise).

P_i=Physical capital variables

P_1= Value of Physical assets (₦)

P_2=Access to good road (yes=1, No=0), and

P_3 =Distance from home to market (km).

N_i= Natural capital variable

N_1= Size of farmland (ha),

N_2 = access to wildlife (1 for access, 0 otherwise),

N_3 = Rain fall sufficiency for crop production (1 for sufficient, 0 otherwise), and

N_4 = Adequacy of soil fertility (1 for adequacy, 0 otherwise).

R_i = Parcel- level factors

R_1= Percentage of cultivated farm land over borrowed land (ha),

R_2=Topography of farmland (sloppy farm land=1, 0 otherwise), and

R_3= Tenancy security of farmland (owned land=1, 0 otherwise).

I_i =Institutional factor

I_1= Extension contact (number), and

I_2= Access to new crop varieties from research institutes (1 for yes, 0 for no).

L_i=Livelihood Strategies

LS_1=Staple crop/off-farm income, (1 for participation and 0 for non-participation),

LS_2=Staple crop/wages and salary, (1 for participation and 0 for non-participation),

LS_3 = Staple, fruit and vegetable crops and livestock production and off-farm income, (1 for participation and 0 for non-participation), and

LS_4 = staple crop, fruit, vegetables and tree crops, livestock production and off-farm income. (1 for participation and 0 for non-participation). The staple crops in consideration are cereals, legumes and tuber crops.

RESULTS AND DISCUSSION

Sustainable land management practices of the respondents: Descriptive statistics of sustainable land management practices undertaken is shown in Table 1. The results show the pooled sample of respondents that undertook agronomic practices; sole cropping (81.43%), crop rotation (68.86%) and mixed cropping (68.45%) were the major agronomic

practices undertaken by the smallholder farmers. Strip cropping (2.00%), agroforestry (2.57%) and bush fallowing (2.57%) were the least undertaken agronomic practices. This could be due to efforts to either control erosion or for nitrogen fixation among food crop producers. The practice of sole cropping, crop rotation, and mixed cropping in pooled could be attributed to the condition of cultivable lands which determines the crop grown and quest to achieve increase in yield. Result of agronomic practice shows that crop rotation, multiple cropping, mixed cropping, and sole cropping were carried out more among respondents in Niger State than in FCT. While strip cropping, leguminous cropping, cover cropping, agro forestry, bush fallowing and shifting cultivation were carried out more among respondents in FCT. This agrees with report of Abdullazeez *et al.* (2013) who reported that crop rotation, mixed cropping and sole cropping were the agronomic practice mostly carryout among small scale farmers in the study area. The possible reason for carrying out primary tillage, ridge tillage and zero tillage could be that most small scale-farmers utilized primitive tools which are suitable for ridge tillage. They also carryout zero tillage practice because it is cheaper considering the reality that it allows cultivation of large farm size within a short period. In the same vein, possible access to tractors through agricultural programmes maybe among reasons why they chose primary tillage more among other tillage practices. The result is in agreement with finding of Oyeneke and Mmagu (2017) who reported that small holder farmers mostly carryout primary, ridge and zero tillage practice among other sustainability practices.

Result on structural and mechanical erosion control practices (SMECP) showed that construction of ridges across field slopes (23.140, contour bunds (2.86%) and land grading (4.29%) were the most undertaken among food crop producers. This may be because arable lands available to farmers were water lodged or prone to erosion which must be sustained to achieve growing of crops. Land grading could be due to sloppy nature of farm land to control erosion and grow crops with minimal losses. The choice of those practices was the same in Niger State and FCT separately. Erosion control measures were undertaken more among respondents in FCT than Niger State. The undertaken measures of structural and mechanical erosion control practices were land grading, construction of ridges across field slopes and contour bunds. This finding is in contrast with Frank *et el.* (2010) who reported that terraces, wind breaks and construction of ditches were the major structural and mechanical erosion control practices undertaken in Uganda and this could be ascribed to the regional difference in research areas.

Result on soil management practice (SMP) in Table 1 showed use of fertilizer (93.43%), mulching (56.29%) and composting (33.43%) as the most utilized practices. The least carried out practices were application of farm yard manure and green manure as reported by 22.57% of the respondents respectively. The practice of composting and mulching is usually done by farmers whose cultivable land requires nutrient replenishment to achieve more crop yield but could not afford fertilizers, while that of fertilizer application could be due to interventions by government and nongovernmental organizations towards making fertilizer accessible by the farmers. Fertilizer application was the most practiced soil management measure among respondents in Niger State while composting, organic/farm yard manure, mulching and green manure were carried out more among food crop farmers in FCT. The report of Amusa *et al.* (2015) concurs with this finding that mulching, composting and use of fertilizer are among the frequently practiced soil management measures among farmers

Determinants of Land Management Practices (LMP): Results of multivariate probit regression model is shown in Table 2. The significant determinants of land management practices include membership of farmers' association ($p \leq 0.10$), source of information ($p \leq 0.01$), years spent in school, age ($p \leq 0.01$), days unable to go to work or farm ($p \leq 0.01$), years of farming experience ($p \leq 0.05$), distance from home to nearest market ($p \leq 0.01$), rainfall sufficiency for crop production ($p \leq 0.05$), adequacy of soil fertility ($p \leq 0.05$), tenancy security of farm land ($p \leq 0.10$) and access to extension ($p \leq 0.01$) accordingly.

Coefficient for farmer's association signifies that as farmers belong to more associations

which serves as source of information, the more their likelihood to carryout agronomic practices. This could be due to the fact that farmers obtain important information from associations on farming activities which could be useful in production. This agrees with stated *a priori* expectation. Information that farmers easily accept are disseminated by other family members or members of association who they rely on and thus acceptance of such idea is easy among them.

The result also indicated that the more the years farmers spent in school, the more likely they are to participate in agronomic practices. This could be because a farmer who has spent more years in school is expected to have acquired more education as well as easy understanding of new farm technologies. Such a farmer will likely choose to adopt new farm practices such as the sustainable land management practices which could reduce the number chosen and carried out.

Also, the older the farmer, the more the likelihood to carryout agronomic practice. Age of farmer is synonymous to experience which play a role in decision making. Important decisions are most times taken based on age which could include more participation in agronomic practice. The finding is in agreement with stated *a priori* expectation. The results concur with the findings of Muvendo *et al.* (2016), who reported that, level of education, farming experience, access to information as well as distance to nearest market influences the adoption of sustainable agricultural practices in Zimbabwe.

Days unable to go to work or farm were also a significant determinant of land management practice. Good health status contributes to productivity of individual. A farmer whose health status is good would be more productive than the one with threatened health. Generally, good health status would allow a productive person to carryout production many days and times compare to an ill-heath individual. The more days one is unable to go to work or farm, the less his participation in agronomic practice. Experience is a good quality in general life endeavor. Experience guides during decision making among farmers. Also, the more the farming experience of the farmer, the less the likelihood to carryout agronomic practice because of age and farming experience. These contribute to level at which farmers take decision on choice of new farm technology. This disagrees with the *a priori* expectation but is in line with the finding of Ndem (2015) who reported that the older the farmer, the more the days he is unable to go to farm but have farming experience which guides during number of practices carried out on farm.

The coefficient for cultivation practice shows that participation in government agricultural programmes was significant at 1%. The implication is that increase in access to government agricultural programmes could lead to increase the likelihood continuous participation in cultivation practices. This is in line with the stated *a priori* expectation. Agricultural programmes are organized by government on agricultural policies most times to teach farmers about new technologies, and to help them produce more output. This goes further to improve the well-being of the farmer and to make food available for the nation. Similarly, soil management practice was also influenced by participation in government agricultural programme implying that, the more the farmers participate in government agricultural programmes, the more the soil management practices undertaken by the farmer. This could be because government agricultural programme towards increasing farmer's output may include making fertilizer available, training on composting and use of organic manure among others to increase output. Thus, participation in such programmes may increase farmers participation in soil management activities.

Source of information was significant at 1% which implies that increase in access to information leads to increases the likelihood of the farmers involving in cultivation practice. In addition, more sources of information increase awareness of farmers which lead to acceptance of new practices on the farm. This agrees with *a priori* expectation. In line with the findings of this study, Balalola and Olayemi (2013) revealed that community-based organization and source of information of farmers positively determined the choice of sustainability practices.

The coefficient for percentage of owned land over borrowed land was also significant at 5%.

Increase in percentage of owned land over borrowed land will lead food crop producers to carryout less cultivation practice. On the other hand, an individual with secured tenancy (i.e., the percentage of own land over borrowed land is more) is relatively tenancy secured could put the land to use for nonagricultural purposes where cultivation will not be needed. Tenancy security and access to new crop variety from research institute were both significant at 10% in line with stated *a priori* expectation. Tenancy security allows owners to exercise right including choice of enterprise to practice and as such, cultivation practice will also increase in order to grow crops in the interest of the farmer. Due to tenancy security, cultivation could be carried out to grow biennial or perennial crops. Mugagga *et al*. (2013) also reported that long term conservation technique could be hindered by tenure insecurity among farmers.

Coefficient for source of information was significant at 1% and also concurs with *a priori* expectation. Sources of information mostly available to farmers include farmer's association, extension agents, Radio, neighbors/family members and Television among others. New technologies are disseminated through these media to the farmers. In some instances, trainings are carried out to enable participants to grasp the new concept. Increase in access to source of information will increase the likelihood of farmers carryout the soil management practice. The more farmers are exposed to sources of information, the more they become aware of good management practices including soil management practice.

The older the farmer the more likelihood to participate in sustainable land management practice. This is due to the fact that older farmers are more experienced and they may have carried out land management practices in the past. More so, older farmers may pay more attention to soil management practices such as composting, mulching, manuring than younger ones since those are relatively traditional methods close to rural dwellers.

The distance from home to all season road was significant at 5%. The implication is the more the distance from home of the farmer to all season road could increase the likelihood of the farmer carrying out soil management practices. This also applies to distance from home to the nearest market which was significant at 1%. Soil management inputs and contacts on soil management consultants are accessed in urban areas, this implies that the less the distance from homes of the farmer to the nearest market, the more the likelihood of such farmer to carryout soil management practice to control degradation. This disagrees with the started *apriori* expectation. Results on age, savings, farming experience and source of information agrees with results of Muvendo *et al.* (2016).

Access to wild life was significant at 1% and negatively signed and this is at variance with the started *a priori* expectation while tenancy security was significant at 1% but positively signed. It implies that as farmers have more access to wild life which serves as source of food and income, the less the likelihood to carryout soil management practices. This is because wildlife access serves as a means of meeting needs for food and income to individual. Wildlife comprises wild plants and animals which serve as food and medicine. In addition, it may decrease the level of soil management practice as farmer's attention maybe diverted to wildlife as livelihood.

Access to extension service and access to new crop varieties were significant at 1% each in line with stated *a priori* expectation. The coefficient for extension contact implies that increase in access to extension service will increase the likelihood of the farmers to invest in soil management practice. Farmers who have less access to extension service are most likely not to accept new farm technologies because extension officers who are farmer's friends are also major source through which farmers are convinced about new technologies. Muzan *et al.* (2012) revealed that institutional factors such as access to extension determine choice of sustainability practices by small farm households in Sub-Sahara Africa. While, the more the access by farmers to new crop varieties from research institutes, the more the likelihood of the farmer to remain in carrying out soil management practice. New crops varieties accessed by farmers could be a factor of encouragement to carry out soil management measures.

Coefficients for livelihood strategies one, two and four were significant. This implies that

increase in participation on each livelihood strategy will increase the likelihood of the farmers to remain participatory in land management practices because as each livelihood activity is carried out, more income could be generated which may be invested in the chosen land management practices. This is in line with stated *a priori* expectations. The result conforms the report of Misganaw *et al*. (2019) who reported that participation of farmers on different livelihoods enable them to invest in sustainability practices.

Covariance for determinants of land management practices of food crop producers: Coefficients of CP/AP was significant at 1%, SMP/AP significant at 5%, SMECP/AP significant at 1%, SMP/CP significant at 1%, SMECP/SMP significant at 1% respectively as shown in Table 3. positively signed sustainability practices are complements, while negatively signed are substitutes.

Coefficient for CP/AP implies that increase in cultivation practice will increase the likelihood of the farmers to carryout agronomic practices. This also means CP and AP complement each other. In addition, as CP is carried out more nutrients from organic materials which decomposes add nutrients to the soil. This is among reasons why AP such as leguminous planting which adds nitrogen to soil is carried out. Each time cultivation is carried out then planting will take place. Cultivation practice and Agronomic Practice are complements.

Soil management practices and agronomic practices (SMP/AP) were significant and positively signed. It implies that increase in soil management practice will increase probability carrying out agronomic practice. Farmers must not manage nutrient of soil if idea of growing crops is not conceived. Cover cropping and leguminous plants are measures of soil management since they fix Nitrogen to soil. Composting, manuring and fertilizer application among other soil management practices serve the same function with agronomic practice. It therefore means that SMP/AP are complements to each other as both are measures to retain soil nutrients as crops are grown as well.

Soil and mechanical erosion control practice and agronomic practice (SMECP/AP) was significant and negative, implying that increase in soil and mechanical erosion control practice will decrease the likelihood of the farmer to remain in carrying out agronomic practice. Agronomic practice such as legumes and cover crops also control erosion as SMECP, therefore, agronomic practice could replace structural and mechanical erosion control practice as substitute.

Soil management practice and cultivation practice, that is, SMP/CP or TP was also significant and positively signed. The implication is that increase in soil management practice will increase the probability of farmers engaging in cultivation practice or tillage practice to grow crops. Also, SMP/TP or CP are complements because SMP restores soil nutrient as TP, they are complements to each other.

Structural and Mechanical Erosion Control Practice and Soil Management Practice were significant at 1% and negatively signed implying that, SMECP and SMP were not complementarities but substitutes because as SMECP is carried out (use of legumes and cover cropping to control erosion), then soil management is also achieved.

Table 1: Distribution of farmers according to sustainable land management practices

Sustainable land management practices	Niger State (n=282) Frequency	FCT (n=68) Frequency	Pooled (n=350) Frequency
Agronomic practice (AP)			
Sole cropping	233 (82.6)1st	52 (76.47) 1st	285 (81.43) 1st
Crop rotation	209 (74.11) 3rd	37 (54.41) 3rd	246 (70.28) 2nd
Multiple cropping	109 (38.65)	19 (27.94)	128 (36.57)
Strip cropping	4 (1.41)	3 (4.41)	7 (2.00)
Cover cropping	70 (24.82)	38 (55.88) 2nd	108 (30.85)
Legume planting	97 (34.39)	37 (54.4)	134 (38.29)
Mixed cropping	212 (75.1) 2nd	28 (41.17)	240 (68.45) 3rd

Agro-forestry	6 (2.12)	3 (4.4)	9 (2.57)
Bush fallowing	5 (1.77)	4 (5.8)	9 (2.57)
Shifting cultivation	23 (8.15)	10 (14.70)	33 (9.42)
Cultivation Practice (CP)			
Ridge tillage	276 (97.87) 1st	46(67.64) 2nd	322 (92.00) 1st
Primary tillage	143 (50.70) 2nd	63(92.64) 1st	206(58.85) 2nd
Conventional tillage	12 (4.25)	22 (32.35)	34(9.71)
Minimum tillage	12 (4.25)	23 (33.82)	35(10.00)
Zero tillage	121 (42.90) 3rd	29 (42.64) 3rd	150(42.86) 3rd
Mold tillage	42 (14.89)	21 (30.88)	63(18.00)
Structural and mechanical erosion control practice			
Construction of ridges across field slope	63 (22.34) 1st	18 (26.47) 1st	81 (23.14) 1st
Landing grading	9 (3.19) 2nd	6 (8.82) 2nd	15 (4.29) 2nd
Contour bunds	8 (2.83) 3rd	2 (2.94) 3rd	10 (2.85) 3rd
Soil Management Practices			
Fertilizer application	273 (96.80) 1st	54 (79.41) 2nd	327 (93.43) 1st
Mulching	135 (47.87) 2nd	62 (91.17) 1st	197 (56.28) 2nd
Composting	74 (26.24) 3rd	43 (63.23) 3rd	117 (33.43)
Organic manure/farm yard	62 (21.98)	17 (25.00)	79 (22.57) 3rd
Green manure	43 (15.24)	36 (52.94)	79 (22.56)

Source: Field survey, 2018. (Figures in parentheses are percentages)

* Multiple responses were recorded

Table 3: Covariance of multivariate probit analysis for determinants of LMP of food crop producers

Variables of **interaction**	**Coeff.**	**Z-value**
Cultivation Practice (CP) and Agronomic Practice (AP)	0.4751981	3.18***
Soil Management Practice (SMP) and Agronomic Practice (AP)	0.3630378	2.73**
Structural and Mechanical Erosion Practice (SMECP) and Agronomic Practice (AP)	-0.802759	-5.45***
Soil Management Practice (SMP) and Cultivation Practice (CP)	0.352837	3.10***
Structural and Mechanical Erosion Practice (SMECP) and Cultivation Practice (CP)	-0.6138417	-4.10
Structural and Mechanical Erosion Practice (SMECP) and Soil Management Practice (SMP)	-0.1730288	-1.61***

***: 1% level of significance, **: 5% level of significance, * : 10% level of significance
AP = Agronomic practice, CP = Cultivation practice, SMP = Soil management practice, SMECP = Soil and mechanical erosion control practice.

Table 2: Determinants of land management practices

Variables	AP Coeff/ (Z-value)	CP Coeff/.(Z-value)	SMP Coeff./(Z-value)	SMECP Coeff./(Z-value)
Participation in gov't Agric program	0.0030(0.04)	0.2104(2.67)***	0.0813851(1.66)*	-0.2004(-3.17)***
Access to adult education program	0.1824(0.74)	-0.0606(-0.24)	0.3333(0.104)	0.0779(0.35)
Membership of farmer's association	0.4190(1.82)*	-0.1037(-0.44)	0.1504(0.425)	0.4050(1.73)*
Source of information	0.8545(7.26)***	0.6675(7.71)***	0.2104(3.00)***	0.0764(0.89)
Years spent in school	0.0507(2.41)**	-0.0343(-1.64)	-0.0077(0.660)	0.6445(3.30)***
Age	0.0452(2.91)***	0.0007(0.05)	-0.0497(-3.88)***	-0.0265(-1.97)**
Days unable to go to work or farm	-0.0150(-4.23)***	-0.0045(-1.08)	0.0045(0.136)	0.0050(1.40)
Years of farming experience	-0.0402(-2.48)**	-0.0086(-0.59)	0.0324(2,71)***	0.0131(0.99)
Family labour	-0.0038(-1.48)	0.0013(0.52)	0.0031(0.161)	0.0024(1.01)
Amount of credit	-1.32e-06(-0.77)	1.28e-06(0.72)	2.24e-05(0.139)	6.18e-07(-0.35)
Savings	8.29e-07(0.95)	-7.97e-07 (-0.81)	1.62e-06(2.09)**	3.48e-07(0.44)
Pension	4.85e-05(0.00)	-1.12e-6(-0.97)	-20.93e-04(0.977)	07.32e-06(1.06)
Income	2.19e-07(-0.59)	-9.88e-08(-0.31)	1.90e-07(0.466)	1.67e-07(0.51)
Access to insurance	0.6982(1.15)	4.413455(0.01)	4.8362(0.980)	-4.5456(-0.01)
Physical assets	9.64e-07(0.03)	5.93e-07(-0.03)	4.96e-07(0.692)	8.97e-08(0.80)
Distance from home to all season road	-0.0249(-0.74)	-0.0333(-0.96)	0.06421(2.23)**	0.3792(1.09)
Distance from home to nearest market	-0.0682(-2.70)***	-0.1755(-4.90)***	-0.0633(-2.69)***	-0.0862(3.93)***
Farm size	0.07615(1.51)	0.0278(0.70)	0.0051(0.868)	-0.0197(-0.51)
Access to wildlife	0.3968(1.62)	-0.0598(-0.25)	-0.7524(-3.41)***	-0.2216(-1.04)
Sufficiency of rainfall	-0.7798(-2.21)**	-0.1455(-0.50)	0.2678(0.281)	-0.6853(-2.61)***
Adequacy of soil fertility	0.5585(2.27)**	-0.3803(-1.62)	-0.1885(0.342)	0.0752(0 .35)
Percentage of owned land over borrowed land	-0.1308(-0.75)	-0.3733(-1.99)**	-0.4485(0.770)	0.2133(1.31)
Topography of farmland	0.1283(0.48)	0.2932(1.17)	0.3234(0.133)	0.2301(1.00)
Tenancy security of farm land	-0.4587(-1.91)*	0.2823(1.79)*	0.5702(2.86)***	-0.3430(-1.61)
Access to extension	0.06746(2.93)***	-0.0117(-0.62)	0.4053(2.66)***	-0.0172(-0.92)
Access to new crop varieties from research institution	-0.3269(-1.26)	0.4610(1.70)*	0.6007(2.73)***	0.2049(1.00)
Livelihood strategy 1	-0.2039(-0.43)	0.5292(1.00)	0.3541(0.922)	0.8267(1.79)*
Livelihood strategy 2	-0.5094(-0.87)	0.3013(0.43)	-0.3038(0.512)	1.2371(2.26)**
Livelihood strategy 3	-0.2135(-0.43)	0.6874(1.27)	-0.0086(0.981)	0.6775(1.43)
Livelihood strategy 4	-0.6144(-1.12)	0.0039(0.01)	-0.2164(0.615)	1.2371(2.31)**
Constant	-1.0330(-1.31)	-0.4266(-0.50)	-0.1175(0.855)	-1.7599(-2.36)

AP=Agronomic practice, CP=Cultivation practice, SMP=Soil management practice, SMECP=Soil and mechanical erosion control practice

Source: Author's Field survey (2018). ***= 1% level of significance. ** = 5%level of significance and * =10%level of significance

CONCLUSION AND RECOMMENDATIONS

Fertilizer application in (Soil Management Practice), sole cropping (Agronomic Practice), ridge tillage (Tillage/Cultivation Practice), and construction of ridges across field slopes (Soil and Mechanical Erosion Control Practice) were the sustainable land management practices mostly carried out among the respondents Livelihood strategy one, two, three and four, household assets, institutional factors and parcel level factors affected choice of sustainability practices among food crop producers. Thus, the study recommended that; sustainable land management practices such as strip cropping, agro forestry, conventional tillage, minimum tillage, green manure, bush fallowing, and shifting cultivation, construction of ridges across field slopes, wind breaks and ditches should be practiced among respondents. The farmers should use of organic material as source of fertilizer due to its availability and affordability to control degradation of land.

REFERENCES:

Abdullazeez, M., Omotesho, K. F., Olabisi, F. & Adekunle, D. (2013). Assessment of land management practices on food crops production among small scale farmers in Kwara State, Nigeria. *International Journal of Agricultural Mnagement and Development*. 4(2): 106-116.

Abu, O. (2019). Technical efficiency of maize and sorghurm producers in Niger and Kaduna States. An Unpublished PhD Thesis Submitted to Post Graduate School, Federal University of Technology, Minna, Niger State, Nigeria. Pp48-145.

Ademola, A., Adenle, B., & Chinwe, I. (2020). Socio-archetypes of land degradation in the Nigerian Guinea Savanna. *Highlights for Sustainable Land Management*. Pp 2-16.

Amusa, T. A., Enete, A. A., &Okon, V. E. (2015). Willingness to pay for agronomic soil conservation practices among crop-based farmers in Ekiti State, Nigeria. *Trends in Agricultural Economics.* 8(1):1-4.

Babalola, D. A. &Olayemi, J. K. (2013). Determinants of farmer's preference for sustainable land management practices for maize and cassava production in Ogun State, Nigeria. Invited Paper at the 4th International Conference of African Association of Agricultural Economists, September 22-25, 2013, Hammament, Tunisia. Pp8-14.

Babalola, D. A. &Olayemi, J. K. (2013). Determinants of farmer's preference for sustainable land management practices for maize and cassava production in Ogun State, Nigeria. Invited Paper at the 4th International Conference of African Association of Agricultural Economists, September 22-25, 2013, Hammament, Tunisia. Pp8-14.

Chabela, K., Chambers, R., and Conway, T, (2014). Vulnerability, coping and policy, *International Department of Soil Science*, Bulletin, 20(2): 1-8

Conrad, M., Simon, G., Nkululeko, M., Torisayi, P., Kizito, M., & Pauline, C. (2016). The adoption of portfolio of sustainable agricultural practices by smallholder farmers in Zambabwe. *5th International Conference of African Association of Agricultural Economist*, September 23rd-26th. Addis Ababa, Ethiopia.

Feder, G. (2005). The acquisition of information and the adoption of new Technology, *American Journal of Agricultural Economics*, 66:312-320.

Food and Agricultural Organization (2013). " Food and agricultural commodity production Country by commodity "Ritrieved on February 3, 2014 from *http://Foostat.fao.org/ste/339/default.*

Food and Agricultural Organization (2014). World food security index. F.A.O Paper. So/I Rome, Italy.

Green, Z. (2000). Hybrid Corn: *An Exploration in Economics of Technological Change*, *Econometric* 25: 501-510.

Misganaw, T. A., Atsushi, T., Enyew, A., Nigussie, H., Zerihum, N., Zemen. A., Asres, E., Dessalegn, M., &Daregot, B., (2019). Explorating drivers of livelihood diversification and its effects on adoption of sustainable land management practices in the Upper Blue Nile Basin. *Ethiopian Journal of Sustainability. 11:3-10.*

Mugaga, F. &Buyanza, M. (2013).). Land tenure and soil conservation practices on the slopes of MtElgon National Park, Eastern Uganda. *Journal of Geography and Regional Planning*. 6(7):2-4.

Mugashi, J. &Alobo, S. (2012). Determinants of land management practices in the agricultural High Lands of Ugadanda: A Case of Kabale District in Western Uganda. Department of Agribusiness and Environmental Sciences, *Makerere University Uganda, 4(4) :6-12.*

Muvendo, C., Gwara, S., Mfpofu, N.,Pedzisa, T., Mazvimavi, K., &Chivenge, P. (2016). The adoption of a portfolio of sustainable agricultural practices by smallholder farmers in Zimbabwe. Invited paper presented at 5th International Conference of African Association of Agricultural Economist. September 23rd-26th, 2016.Addis Ababa, Ethiopia. Pp 1-4.

Muzan, W., Gats, W. &Muvhunzi, S. (2012). The impact of technology adoption on small holder agricultural productivity in Sub-Saharan Africa. *Journal of Sustainable Development.* 5(8):69-71.

Niger State Agricultural and Mechanization Development Authority (NAMDA), (2014). Impact Study. Final report Pp26.

Nkoya, E., Mirzabaev, A., Von, B., &Joanchin, A. (2016). Economics of land degradation and improvement. *A Global Assessment For Development* . Center for development research, University of Bonn. ISBN 978-3-319.

Ojo, M.A., Mohammed, U.S., Ojo, A.O., &Olaleye, R.S., (2009). Return to scale and determinants of farm level technical inefficiency among small scale yam based farmers in Niger State: Implication for food security. *International Journal of Agricultural Economics and Rural Development. 3:47-58.*

Onyeneke, R.U. &Mmagu, C. J. (2017). Effects of livelihood strategies on sustainable land management practices among food crop producers in Imo State, Nigeria. *Journal of Agriculture* 20:1:18-20.

Sale, F.A., Adeh, H. &Edibo, E. (2018). Effects of potting mixtures on germination, growth and lield of Ginger in Anyigba. *International Journal of Forestry and Horticulture* 4:2:7-13.

Samatar, M. (2015). Determinants of livelihood strategies of agro-pastoral households of Jig-Jag Districts, Somalia Region State. Published M.SC Thesis Submitted to Haramaya University, Ethiopia. Pp 28-29.

Samuel, A. (2010). *Land Management Practices and their Effects on Food Crop Yields in Ghana*. 3rd African Association of Agricultural Economist (AAAE) and 4th Agricultural Economist of South Africa (AEASA), Cape Town, South Africa. 19th-23rd, 2010.

Tsue, P., Chukwuemeka, O. and Noble, J. N. (2014). Effects of arable land tenure and use of environmental sustainability among crop farmers in FCT, Abuja, Nigeria. *Journalm of Agriculture*. 5(8):6-15.

Udoh, Y. (2002). A capital assets framework for analyzing household livelihoods strategies: *Implications For Policy Development Review* 17:315-342.

EFFECTS OF SOME NATURAL PRESERVATIVES ON THE NUTRIENT COMPOSITION AND SHELF LIFE OF SMOKED TILAPIA SPECIES *(Oreocromis niloticus*)

***Orire A. M.[1], Musa, Y[2]. and Haruna, M. A[3]**
[1]Dept. of Water Resources, Aquaculture and Fisheries Tech., Federal University of Technology, Minna, Nigeria
[2,3]Department of Fisheries and Aquaculture, Federal University Dutse, Jigawa State, Nigeria
*Corresponding author: abdullahiorire@gmail.com

ABSTRACT
The effects of some natural preservatives on the nutrient composition and shelf life of smoked tilapia species (Oreocromis niloticus) was evaluated. Three natural preservatives Syzygium aromaticum, Myristica fragrans and Piper guineense were used in their powdery form at (10%) inclusion rate to coat tilapia species before smoking. The smoked treated tilapia fish samples were stored for 8 weeks and analyzed for nutrient and shelf life parameters using standard methods. Results of the nutrient composition showed significant differences (P<0.05) in nutrient retention among treatments throughout the storage period. The clove treated smoked tilapia species lost 2.41% crude protein, nutmeg treated smoked tilapia lost 1.70%, black pepper treated smoked tilapia was reduced by 9.03% while control had a significant (P<0.05) loss of 22.8% of its crude protein value. Clove treated smoked tilapia recorded highest lipid value (57.72%) while the control has lowest lipid percentage (31.70%). The ash content was significantly higher (P<0.05) for nutmeg treated smoked tilapia (93.5%) while the control gave an increment of (27.62%). The clove and nutmeg treated smoked tilapia species had moisture increment by (87.75%) and (89.07%) respectively while the control has the lowest moisture increment (53.88%). The nitrogen free extract (NFE) was significantly low for nutmeg treated smoked tilapia (49.16%) while the control had the highest value (61.72%). The result indicated that nutmeg treated smoked tilapia gave a high nutrients retention followed by clove treated smoked tilapia. All treatments including the control did not develop insect attack during the study period which is a function of good shelf life. Therefore, it is recommended that, for better nutrient retention of preserved smoked tilapia species and extended shelf life, Myristica fragrans can be used.

Key words: fish, preservation, natural, tilapia, smoked

INTRODUCTION

Preservation techniques are needed to prevent fish spoilage and lengthen shelf life. They are designed to inhibit the activity of spoilage bacteria and the metabolic changes that result in the loss of fish quality. Spoilage bacteria are the specific bacteria that produce the unpleasant odours and flavours associated with spoiled fish. Fish normally host many bacteria that are not spoilage bacteria, and most of the bacteria present on spoiled fish played no role in the spoilage. To flourish, bacteria need the right temperature, sufficient water and oxygen, and surroundings that are not too acidic. Preservation techniques work by interrupting one or more of these needs (Ananou *et al*., 2007). Fish is a major source of protein and its harvesting, handling, processing and distribution provide livelihood for millions of people. Freshwater fish processing should assure best market quality, assure health safety of products, apply the most appropriate processing method and reduce wastes to the barest possible extent (Al-jufaili and Opara, 2006). Al-jufaili and Opara (2006) also reported high incidence of fish losses as a major impediment to the realization of government approach towards increasing the contribution of the sector to the overall national economy.

Oreochromis niloticus is the second largest fish species cultured worldwide (FAO, 2000). The cultivation of tilapia is becoming more and more popular due to its higher growth rate, higher fecundity, ease of manipulation, good consumer acceptance, and ability to grow under suboptimal nutritional problems and response to adverse environmental conditions such as low oxygen and high ammonia levels in the water (Nazrul *et al*., 2011).

Natural preservatives are vegetable products used for flavoring, seasoning and imparting aroma in food (FAO, 2005). Cloves are the aromatic flower buds of a tree of family Myrtaceae. They are native to the Maluku Islands (or Moluccas) in Indonesia and are commonly used as a spice. It is locally called kanunfari. Cloves are available throughout the year due to different harvest seasons in different countries (Merr and Perry, 2011). Nutmeg is the seed or ground spice of several species of the genus Myristica. *Myristica fragrans* is native to Indonesia. It is also a commercial source of an essential oil and nutmeg butter. Locally, called gyadankanshi. The California nutmeg, *Torreya californica*, has a seed of similar appearance, but is not closely related to *Myristica fragans*, and is not used as a spice (Remany, 2004). West African black pepper, *Piper guineense*. They are known as Guinea cubeb, Benin pepper and Ashanti pepper. Locally, they are called uziza, iyere, sasema, kale, masoro, etc. in different parts of West and Central Africa which they are native to. West African black pepper seeds and leaves are widely used in West Africa for culinary and medicinal purposes because of its aromatic

flavour and medicinal properties. The root is also used for medicinal preparations (Katzer, 2015).

The inclusion of artificial preservatives in fish processing is a major concern to healthy fish food. This research evaluated the nutrient composition and shelf life of smoked tilapia fish preserved with selected natural preservatives.

METHODOLOGY

Study Area

The study was conducted in the fish processing unit of the Department of Fisheries and Aquaculture, Faculty of Agriculture, Federal University Dutse, Jigawa State, Nigeria located on latitude 11° 70' North and longitude 9° 33' East and Altitude of 431m above sea level (Elevation-map, 2019).

Experimental design

A complete randomized design (CRD) was adopted where four (4) treatments were used; tilapia species (*Oreochromis niloticus*) was seasoned with the three selected natural spices (*Syzygium aromaticum* (Treatment A), *Myristica fragrans* (Treatment B), *Piper guineense* (Treatment C) at 10% body weight while Treatment D was the control with no preservative except brimming. The spices were ground into powdery form and was used in coating the fish inside-out before smoking. The treatments were in replicates, and each replicate has three fish, making it twelve (12) tilapia species per treatment, the processe0.d tilapia was preserved for eight weeks for insect infestation study, nutrients analysis at both initial and final carcass analysis.

Collection and preparation of *Syzygium aromaticum* (nut meg), *Myristica fragrans* (clove), *Piper guineense spices* (black pepper)

The *Syzygium aromaticum*, *Myristica fragrans*, *Piper guineense* were purchased from Shuwari market, Kiyawa, Jigawa State, Nigeria. They were ground to fine powder with a grinding machine, packaged in air tight bag and stored at room temperature for later use.

Experimental fish

Forty-eight (48) *Oreocromis niloticus* juvenile of total weight of 2.4kg and mean weight of 49.71g were purchased from Warwade dam, Dutse, Jigawa State, Nigeria. The samples were transported to the Teaching and Research Fish Farm of the Department of Fisheries and Aquaculture, Federal University Dutse, Jigawa State in plastic robber with ice. Identification of *Oreochromis niloticus* was done using fish identification guide by Olaosebikan and Raji (1998).

Preparation of the fresh fish sample

The fish was descaled using a sharp knife to scrape the scales toward the head until all are removed. After descaling, the fish was cut along its mid ventral side, and the visceral organs were removed and washed. The weight of the fish was then obtained. The fishes were then washed with clean freshwater with two litres of freshwater in plastic bowl. The cleaned fish was then brined in10% salt concentration in a one litre of freshwater for twenty minutes. This was done for all treatments. This was followed by application of selected preservatives at 10% inclusion rate per the weight of the fish. The treated fishes were then spread in the sun for 20 minutes for pre-drying process.

Fish smoking

The modified drum kiln was used for the smoking process. It was made from a 400 L drum with 90 cm length and 58 cm diameter. The drum was cut open midway. The base was used as the combustion chamber with a firebox of 22 × 22 cm^2. The fish samples were then placed on the mesh in the for about 5 hours. The burning wood was adjusted continuously to maintain the required temperature (33°C) in the chamber during the smoking period. After smoking, the total weight of 469.6g was recorded for the all treatments, with average weight of 9.78g per fish. TA weight was 154.4g, TB (97.1g), TC (127.2g) while the control TD was 90.9g respectively.

Cooling and Packaging

After this process, the fire was lowered, the fish uncovered and left to cool for 1 hour. Then, the products were unloaded and were hygienically packaged in sealed labelled polythene material and thereafter stored in a deep freezer at -18°C for further laboratory analyses.

Determination of proximate composition of smoke tilapia species

Proximate compositions (crude protein, crude lipid, ash, moisture, and nitrogen free extracts) of smoke tilapia treated with selected natural preservatives was conducted using the methods described by AOAC, (2006).

Insects infestation examination

The fish samples were sampled fortnightly and examined for insect attack for the period of 8 weeks of the experiment.

Statistical Analysis

The data obtained from the parameters evaluated were subjected to one-way analysis of variance (ANOVA). The differences between the means were determined using Turkey at 95% confidence level with Minitab release version 14 statistical tool.

Results

The dried weight of fish indicated significant water loss including scale and visceral loss (80.32%) which indicates a good dry matter (Table 1).

Table 1: Weight loss of processed fish

Fresh weight of fish(g)	Dressed weight(g)	Weight after smoking(g)	Total weight loss(g)	%weight loss
2385.7	1591.13	469.6	1916.1	80.32

Table 2: Nutrient composition (dry weight basis) of Tilapia species preserved with natural spices for 8 weeks

Proximate compositions (%)	Treatments							
	A		B		C		D	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Crude protein	61.39±0.01^{b}	59.91±0.01^{ab}	58.69±0.01^{ab}	57.69±0.01^{b}	60.49±0.01^{ab}	55.03±0.01^{c}	69.79±0.01^{a}	53.96±0.01^{c}
Crude lipid	6.19± 0.01^{c}	10.72±0.01^{b}	5.69± 0.01^{c}	13.52±0.01^{a}	4.39± 0.01^{d}	11.21±0.01^{b}	3.89± 0.01^{d}	12.27±0.01^{a}
Ash	7.29± 0.01^{c}	10.11± 0.01^{b}	9.39± 0.01^{ab}	10.04±0.01^{b}	8.49± 0.01^{ab}	14.32±0.01^{d}	3.59± 0.01^{d}	13.00±0.01^{a}
Moisture	5.59± 0.01^{c}	7.76± 0.01^{b}	7.59± 0.01^{b}	8.65± 0.01^{a}	6.19± 0.01^{c}	6.95±0.01^{ab}	4.79± 0.01^{d}	8.89± 0.01^{a}
NFE	19.49±0.01^{a}	10.63± 0.01^{c}	18.59±0.01^{bc}	9.14±0.01^{bc}	20.39± 0.01^{a}	11.69±0.01^{c}	17.79±0.01^{b}	10.98±0.01^{c}

Data along the row/column with different superscripts are significantly different ($p<0.05$)

Nutrient composition of tilapia species preserved with natural preservatives

Table 2 shows results on nutrient compositions of smoked tilapia treated with natural preservatives. The crude protein for the initial carcass analysis ranged from 69.79% (treatment D) to 58.69% (treatment B) with significant differences across the treatment while the final carcass analysis also showed a significant difference ($p<0.05$) among final treatments with highest crude protein value of 59.91% (Treatment A) and lowest value for Treatment D (53.96%). Within the treatment, treatment A, had reduction in crude protein content from 61.39% to 59.91% (2.41%), treatment B from 58.69% to 57.69% (1.70%), treatment C from 60.49% to 55.03% (9.03%) while treatment D gave reduction from 69.69% to 53.96% (22.68%) respectively with significant differences ($p<0.05$).The initial crude lipid values for the carcass was significantly high ($p<0.05$) for treatment A (6.19%) and significantly low ($p<0.05$) for treatment C (4.39%) and D (3.89%) with no significant difference ($p>0.05$) between the two. While the treatment B was significantly high in lipid for final carcass analysis (13.52%) and low for treatment A (10.11%). Within treatment levels, treatment A had lipid increment from 6.19% to 10.72% (73.18%), treatment B 5.69% to 13.52% (42.09%), treatment C 4.39% to 11.21% (39.16%) while treatment D had increase from 3.89% to 12.27% (31.70%) respectively.

The ash content of the treatments for the initial and final carcass analysis were also significantly different ($p<0.05$). The ash values ranged from 9.39% for treatment B to 3.59% for treatment D for the initial carcass values while it ranged from 14.32% for treatment C to 10.04% for treatment B. The ash content was significantly varied within treatments. Treatment A increased from 7.29% to 10.11% (72.11%), treatment B from 9.39% to 10.04% (93.33%), treatment C from 8.49% to 14.32% (52.29%) while treatment D varied from 3.59% to 13.00% (27.62%) respectively.

Similarly, the moisture content was significantly different ($p<0.05$) among treatments for both initial and final carcass values. Treatment B had highest moisture content (7.59%) while treatment D had a low moisture value (4.79%) for the initial carcass value. However, the moisture values were highest for treatment D (8.89%) and lowest for treatment D (6.95%). The moisture content within treatments also showed variation. Treatment A increased from 5.59% to 7.76% (72.04%), treatment B from 7.59% to 8.65% (87.75%), treatment C from 6.19% to 6.95% (87.07%) while treatment D increased in its moisture content from 4.79% to 8.89% (53.88%) respectively.

The Nitrogen Free Extract (NFE) also showed significant difference ($p<0.05$) for the treatments. Treatment C gave a significantly high ($p<0.05$) NFE value while treatment D gave a significantly low ($p<0.05$) value (17.79%) for the initial carcass values while treatment D gave a significantly high value (10.98%) while treatment B gave a low value (9.14%). The nitrogen free extract was also varied within treatments, treatment A reduced from 19.49% to 10.63% (54.54%), treatment B from 18.59% to 9.14% (49.16%), treatment C from 20.39% to 11.69% (57.33%) while treatment D was lowered to 10.98% from 17.79% (61.72%) (Table 2).

Insects infestation

The result shows that, for the period of two months (from 11th July, 2019 to 22nd of August, 2019), there was not any insects attack recorded for the all treatments, the fish samples were checked fortnightly for insect/weevil infestation and the fishes were in good condition.

Discussion

Protein content in the processed fish increased with decreasing moisture agreeing with Kumolu-Johnson (2010) that protein nitrogen may not have been lost during drying resulting in increase in protein concentrations as the moisture reduced. High protein value (69.79%) was obtained from initial fish carcass of control, and lowest protein of (55.03%) was obtained from final black pepper. The crude protein (CP) of the *Oreocromis niloticus* recorded for both initial and final in this study was high (61.39%) than the value (47.69%) recorded by (Olapade *et al*., 2013) and (Idah and Nwankwo, 2013) who reported high value of (39.20).The variation of Crude Protein level in this study could be due to the temperature and time, because as temperature and time for smoking increase the protein content increase (Olapade *et al*., 2013).

Increase in fat content could be due to dehydration caused by processing heat during heat which led to concentration of lipids (Chukwu and Shaba, 2009; Holma and Maalekuu, 2013). Aberoumad and Pourshafi (2010) concluded that the lower the percentage of water, the greater the lipid content. However, the highest lipid was from obtained the final carcass of nutmeg treated fish (13.52%), and the lowest value was obtained (3.89%) from initial carcass analysis of control, the lipid obtained from final (13.52%) was higher than the value reported by (Idah and Nwankwo, 2013) which was (7.95%) and (Olapade *et al*., 2013) (10.21%) , but were higher than initially control.

Increased ash values of smoked fish may be a result of concentration of salts in the flesh due to dehydration caused by heat (Kiini-Kabari *et al.*, 2011; Islam *et al.*, 2012; Aberoumad, 2014). High ash content is consistent with bony fish such as tilapia species (Devi and Sarojnalini, 2012). High ash content was observed in nutmeg treated fish with value of (14.32%) on final carcass, and lowest was (3.59%) in control (initial), the final and initial value are higher than those reported (Olapade *et al*., 2013) (1.53%) and (Idah and Nwankwo, 2013) (0.8%) respectively.

The fresh fish sample indicated a high content of moisture as compared to smoked tilapia species fish samples, the results can be attributed to the loss of water during the process of either smoking (Ande *et al.*, 2012). On the other hand, it is a known fact that most of the fresh fish body is made up of water hence the higher content of moisture in fresh fish sample. Indeed, moisture is vital for ensuring good palatability of fish. However, it must be watched carefully to ensure that it does not increase too much as it can create a conducive environment for microbial growth (Mphande and Chama, 2015). However, findings from this study are in line with that of Ande*et al. (*2012) who concluded that there is a great loss of water during the smoking process. According to Shehu *et al.* (2013), during smoking, approximately one-quarters and one thirds of moisture is lost, which means that both processes are responsible for the lower moisture values indicated in this study. High moisture from (8.89%) in control carcass on final and lower value observe from (4.79%) in control on initial carcass analysis, the value obtained lower than that reported (Idah and Nwankwo, 2013) (35.5%) and (Olapade *et al*., 2013) (1.53%) (38.36%).High Nitrogen free extract of (20.39%) was obtained in black pepper carcass of initial and lower value observed from (9.14%) in nutmeg on final carcass analysis. Finding from the study was higher than the values (0.32%) obtained by (Idah and Nwankwo, 2013).

CONCLUSION AND RECOMMENDATION

The study revealed that natural preservatives have effects on the preservation of tilapia for the eight (8) weeks of study for all the treatments. Nutmeg treated smoked tilapia lost the least crude protein value (1.7%) compared to other natural preservatives used in the study and thus recommended for fish preservation.

REFERENCES

Aberoumad, A. (2014). *Nutrient composition analysis of fish fillets affected by different cooking methods. International Food Research Journal 21* (5)*: 1989- 1991.*

Aberoumad, A. and Pourshafi, K. (2010). *Chemical and proximate composition of different fish species obtained from Iran. World Journal and Marine Sciences 2(3): 237-239.*

Al-Jufaili, M S, and Opara, L U., (2006) *Status of fisheries post-harvest industry in the Sultanate of Oman: Part 1. Handling and marketing system of fresh fish. Journal of fisheries international* 1 (2-4): 44-49b.

Ananou1 S, Maqueda1 M, Martínez-Bueno1 M and Valdivia1 E (2007). "Biopreservation, an ecological approach to improve the safety and shelf-life of foods" In: A. Méndez-Vilas (Ed.) *Communicating Current Research and Educational Topics and Trends in Applied Microbiology*, Formatex. ISBN 978- 84-611-9423-0.

AndeSesugh, LekeLuter, EnejiIshaq and Yakubu Sunday (2012*). Proximate analysis of smoked and unsmoked fish (cat and tilapia) in Ombi River Lafia Nasarawa State*

Nigeria. *Elixir Food Science* 53 11801-11803.

AOAC (2006). *Official Methods of Analysis Associations of Analytical Chemists. Wastington D.C*, 69-88.

Chukwu, O. and Shaba, I. (2009). *Effects of drying methods on proximate compositions of catfish (Clarias gariepinus). World Journal of Agricultural Sciences 5: 114-116.*

Devi, W. S. and Sarojnalini, C. (2012). Impact of different cooking methods on proximate and mineral composition of Amblypharyngodon mola of Manipur. *International Journal of Advanced Biological Research 2(4): 641-645*.

FAO (2000). Aquaculture production: quantities, Datasate for fishstat Plus Version 2.3, 78Pp.

FAO, (2005). Post-harvest changes in fish. In: FAO Fisheries and Aquaculture Department, Food and Agriculture Organization, Rome, Italy. http://www.fao.org/fishery/topic/12320/en

Holma, A. K. and Maalekuu, B. K. (2013). Effect of traditional fish processing methods on the proximate composition of red fish stored under ambient room conditions. *American Journal of Food and Nutrition* 3(3): 73-82.

Idah, P. A. and Nwankwo, I. (2013). Effects of smoke-drying temperatures and time on physical and nutritional quality parameters of Tilapia (*Oreochromis niloticus*). *International Journal of Fisheries and Aquaculture* 5(3): 29-34.

Islam, M. J., Hossain, M. S. and Mian, S. (2012). Nutritive value of dried and heat processed Mola fish *(Amblypharyngodon mola)* products. *International Journal of Natural Sciences 2(2): 43-48.*

Katzer, Gernot. (2015) "Cubeb pepper (Piper cubeba, cubebs)" . *Gernot Katzer's Spice Pages* Retrieved 26 May 2015. https://en.wikipedia.org/wiki/Piper_uineense

Kiin-Kabari, D. B; Barimalaa, I. S.; Achinewhu, S. C; Adeniji, T. A. (2011). Effects of extracts from three indigenous spices on the chemical stability of smoke-dried catfish *(Clarias lazera)* during storage. *African journal of food, Agriculture, Nutrition and Development Volume* 11 No. 6

Kumolu-Johnson, N. F., Aladetohun, C. A. and Ndimele, A. (2010). The effect of smoking on the nutrient composition of the African cat fish (*Clarias gariepinus) African Journal of Biotechnology 9: 73 -76.*

Merr L. & Perry L. M. (2011) *Syzygium aromaticum* Germplasm *Resources Information Network (GRIN) Agricultural Research Service (ARS), United States Department of Agriculture (USDA).* Retrieved June 9,2011

Mphande J. and Chama L. (2015). Preservation Methods and Storage Period Affect the Mineral and Moisture Composition of Freshwater Fish Species. *International Journal of Food Science and Nutrition Engineering* 2015,5(3):147-153DOI: 10.5923/j.food.20150503.06.

Nazrul, K. M. S., Mamun, A. A., Sarker, B. S. and Tonny, U. S. (2011). Morphological variability of the 11th generation strain of Nile tilapia, (*Oreochromis niloticus)* and traditional genetically improved farmed tilapia. *Journal of Bangladesh Agriculture University*,9: 345-9.

Olapade, O. A., Taiwo, I. O. and Agbato, D.A. (2013). Effect of Traditional smoking Method on Nutritive Values and organoleptic Properties of *Sarotherodon galilaeus and Oreochromis niloticus*. Department of Animal Science and Fisheries, University of Port Harcourt, Rivers State, Nigeria. Federal University of Agriculture, Abeokuta, Nigeria.

Olaosebikan, B.D and Raji, A. (1998). *Field Guide to Nigerian Fresh Water Fishes. Federal College of Fresh Water Fisheries Technology (FCFFT) New-Bussa, Niger State, Nigeria.*

Shehu, L. Akintola, Ayodele Brown, Abubakar Bakare, Oluwafemi, D. Osowo, Beatrice, O. Bello., (2013). Effects of Hot Smoking and Sun Drying Processes on Nutritional Composition of Giant Tiger Shrimp (*Penaeus monodon, Fabricius, 1798). Pol. Journal of Food Nutrition Sci*ence, 2013, Vol. 63, No. 4, pp. 227-237 DOI: 10.2478/v10222-012-0093-1 http://journal.pan.olsztyn.pl

QUALITY ASSESSMENT OF CHEESE FROM COW MILK SUPPLEMENTED WITH TIGERNUT MILK AND COCONUT MILK

Oni[1] O.K., Ojo[2] M. O., Folake[1,3]-Idowu Adebayo., Adepeju[1] A.B. and Oyinloye[1] A.M.
[1]Department of Food Science and Technology, Federal University Oye Ekiti, Nigeria
[2]Department of Food Science and Technology, Federal University of Technology, Minna, Nigeria
[3]Food Quality and Design Group, Wageningen University, the Netherlands
***Corresponding E-mail: kunle.oni@fuoye.edu.ng 08069336753**

ABSTRACT
Cow milk was supplemented with tigernut milk and coconut milk in the percentage ratio of 25:25:50; 25:50:25; 50:25:25; 75:25:0; 75:0:25 for cow milk-tigernut milk-coconut milk respectively (v/v) to produce cheese. The shelf life and sensory attributes of the cheese samples were examined. The samples were analyzed using standard methods. The percentage yield of the cheese samples ranged from 13.43 to 17.33%. An increase in the percentage inclusion of tigernut milk resulted to an increase in percentage yield while an increase in coconut milk results in a lower yield. The total titratable acidity decreased significantly ($p<0.05$) with decrease in percentage cow milk in the blend with the values ranging from 0.30 to 0.23%. The moisture content increased significantly ($p<0.05$) from 53.18% to 59.66% with increase in coconut milk. The protein content differed significantly ($p<0.05$) with values ranging from 18.77 to 14.59%. The fat content ranged from 21.49 to 12.90% with an increase in coconut milk. The total ash content ranged between 3.03 and 1.47% while the carbohydrate content ranged from 10.72 to 2.81%. Significant ($p<0.05$) difference was observed in the fungal and bacterial counts at different levels of storage period. Sample $C_{25}S_{50}N_{25}$ and $C_{75}S_{25}N_{0}$ showed the highest number of both bacterial and fungal counts respectively. There was significant ($p<0.05$) difference in color, texture, aroma and overall acceptability of the samples. The taste shows no significant difference. The study recommended that tigernut milk and coconut milk could be used either alone or as a mix to supplement cow milk. However, 25% supplementation proved to be the best blend based on consumer general acceptability.

Keywords: Cheese, cow milk, tigernut milk, coconut milk, supplementation

INTRODUCTION

Milk is a major constituent of the diet and is considered essential to the welfare of a community (Marimuthu *et al*., 2013). It is a perishable commodity and also an excellent medium for microbial growth (Ogunlade *et al*., 2017). In Nigeria, milk production is mainly produced by the Fulani. Fulani women do process the surplus fresh milk into unripened cheese called "warankasi" or "wara" due to lack of refrigeration facilities (Omotosho *et al*., 2011).

Tigernut (*Cyperus esculentus*) are often used in various ways in traditional Nigerian cuisine. Tigernut milk has great potentials to supplement cow milk; it contains high quality protein and essential amino acids, essential minerals, vitamins, unsaturated fatty acids, soluble and insoluble dietary fibres, and isoflavones whose presence in everyday diet is very important. Unlike cow milk, tigernut contains no cholesterol and can be consumed by lactose intolerant individuals. (Hussein *et al*., 2016).

Coconut (*Cocos nucifers*) milk is the liquid that comes from the grated meat of a brown coconut. Coconut milk contains approximately 3% protein, 17% - 24% fat,2% carbohydrate, many vitamins, minerals and electrolytes, including potassium, calcium and chloride as well as cholesterol free (Balogun *et al*., 2016). Coconut milk is being used by confectionaries, bakeries, biscuits and ice cream Industries worldwide to enhance flavor and taste of various products (Adejuyiyan *et al*., 2014).

According to Balogun *et al*. (2016), cheese is a dairy product made by coagulating either whole milk, part-skim (low fat) milk, skim milk, or cream by removing much of the liquid portion while retaining the coagulum and the entrapped milk solids. It is an excellent source of protein, fats and minerals such as calcium, iron and phosphorus, vitamins and essential amino acids, thus making it an important food in the diet of both old and young people (Oladipo and Jadesimi,2013).

'Warankashi' is processed by coagulating pasteurized milk at a specific temperature, pH and processing time with an appropriate coagulant. The preferred coagulant comes from Sodom apple leaf extract (*Calotropis procera*) because the cheese made with this coagulant has a sweeter flavour and a higher protein content compared to the cheese made with the other coagulants (Omotosho *et al*., 2011).The coagulated milk is poured

into a small basket or strainer in order to drain and to give the cheese the desired shape and size (Adetunji and Salawu, 2008). So many types of cheeses are produced based on their different characteristics and method of productions. Their styles, textures and flavours depend on the origin of the milk (including the animal's diet), whether they have been pasteurized or not, the butterfat content, the bacteria and the mold, the processing and aging. Herbs, spices or wood smoke may be used as flavouring agents (Fankhauser and David, 2007)

The manufacture of soft cheese (*wara*) is widespread in developing Africa countries and was thought to have originated in the Northern region of Nigeria due to the traditional cattle rearer (*Fulani*) access to fresh milk from cattle rearer. However, many factors such as shortage of good quality milk, poor processing and preservation methods, poor hygiene practices, poor packaging and storage facilities have contributed to poor utilization and availability in areas where it might have been useful in alleviating protein and other nutritional deficiency (Omotosho *et al*., 2011). This often leads to importation of milk and milk products such as cheese which may adversely affect the nutrition and the socio-economic well-being of people especially low income earners and rural dwellers. Thus, there is a need to find alternatives making the use of plant milk supplementations a research field.

Coconut utilization in Nigeria is very low as it is mainly eaten as a snack or shredded and fried to make a coconut candy. Coconut oil is still being used however, the milk is under-utilized in the country (Balogun *et al*., 2016). Blend of cow milk, tigernut milk and coconut milk for the production of cheese will not only give a food product of improved quality but also a product which can be consumed by lactose intolerant individual, people with low fertility and more so consumer who intend to improve his immune system and prevent cardio- vascular diseases, inflammatory, diabetes and cancer.

Little research attention and inconsistency in research findings have been major challenges on the production and blending ratio of cow milk to vegetable sourced milk such as tigernut milk, coconut milk, soy milk and Bambara nut milk. Therefore, this study is to evaluate the chemical composition and sensory qualities of West African soft cheese 'warankashi' produced from blends of cow milk, tigernut milk and coconut milk, documenting its keeping quality and also increase the utilization of blends of plant milk for the production of good quality cheese product.

MATERIALS AND METHODS

Material Collection and Preparation

Sodom apple leaves (*Calotropis procera*) and fresh cow milk were obtained from a nomadic settlement located within Ikole Ekiti, Nigeria. The fresh cow milk was collected from a cow aseptically, packaged in a sterile white container, and placed in a cooler containing ice crystal. The tiger nut and coconut were purchased from King's Market, Ikole Ekiti, Nigeria and processed using the method described by Belewu and Belewu (2007) and Balogun *et al*. (2016) respectively.

Production of Cheese (Warankashi)

The portion of the sieved milk for warankashi production from the cow, tigernut and coconut were measured. The variation in the measurement was done according to the method described by Balogun *et al*. (2016) with modifications. Cheese samples were produced using 1000ml as standard with formulation by partial substitution of cow milk with coconut milk and tigernut milk at varying proportions as presented in Table 1.

ANALYSIS

The proximate compositions were carried out on the cheese samples using the AOAC (2010) method. The percentage yield and total titratable acidity were carried out using methods described by Balogun *et al*. (2016), AOAC (2006) and AOAC (1996) respectively.

The method described by Adegoke (2004) was used for microbiological analysis. The analysis was repeated for three days of the studies to determine the effect of storage on the spoilage organisms of the samples.

Sensory Evaluation

1. Instrument for Data Collection: The samples were coded and validated questionnaire made up of quality evaluation for flavor, texture, color and overall acceptability was used. Quality ratings were based on a 9-point descriptive hedonic scale with 9 (like extremely) being the highest score and 1(dislike very much) the least score (Ihekoronye and Ngoddy, 1985).

2. Panel of Judges: The population was made up of ten (10) students of Food Science and Technology, Federal

University Oye Ekiti, Ekiti State, Nigeria. The purposive sampling technique was adopted in the selection of the panel of judges because the students have better knowledge of food than other students and would therefore give better interpretation on what would be required from them.

Statistical Analysis

Means were compared using test of significant difference (Steel and Torrie, 1980). Test of significant ($P<0.05$) difference among the treatments were determined by Analysis of Variance (ANOVA) as described by Steel *et al*. (1997).

RESULTS AND DISCUSSION

Proximate composition of cheese produced from cow-tigernut-coconut milk blends

The result of proximate composition is presented in Table 2. There were significant ($p<0.05$) differences in all the parameters (Moisture, Protein, Fat, Ash and Carbohydrate) evaluated. This difference could be attributed to the addition of coconut milk and tigernut milk at different levels and the resultant difference in the proportion of cow milk present in the samples. The moisture content of cheese (*warakanshi)* samples ranged from 53.92% to 56.66% with samples $C_{75}T_0CC_{25}$ having the lowest value while sample $C_{25}T_{25}CC_{50}$ had the highest value. This result shows that the blending of cow-tigernut-coconut milk significantly ($p<0.05$) influenced the moisture content of cheese (*warankashi)* products. The moisture content increases with addition of vegetable sourced milk. This can be further proved from samples with lowest moisture content having zero percent in either coconut milk, tigernut milk or both as observed in samples $C_{75}T_0CC_{25}$, $C_{75}T_{25}CC_0$; and C_{100}. The result agrees with the findings of Balogun *et al. (*2016) who reported increase in moisture content as the level of coconut increases.

The protein content ranged from 14.59% to 18.77% with sample $C_{25}T_{25}CC_{50}$ having the lowest value while $C_{75}T_{25}CC_0$ have the highest value. The lowest protein content value in sample $C_{25}T_{25}CC_{50}$ may be attributed to the high amount of coconut milk in the blend since coconut milk contains the least amount of protein of all the three milk used,. This result agreed with the findings of Balogun *et al.* (2016) who reported that sample with 75:25% of cow-coconut cheese has the highest protein content. Hussein *et al.* (2016) also reported increase in the crude protein as the proportion of tigernut milk is increased in the blend for the cow- tigernut cheese production. The differences in the findings may be due to many factors such as differences in the species of tigernut used, the maturity and nutrient composition of the tigernut and coconut as well as the amount of protein available in the milk after the extraction process.

The fat content value ranged from 12.90% to 21.49% with sample $C_{75}T_{25}CC_0$ having the lowest value while sample $C_{25}T_{25}CC_{50}$ have the highest value respectively. The fat content of the samples can be seen to be dependent on the proportion of cow milk and coconut milk in the samples. This is in agreement with Balogun *et al.* (2016) who reported that the fat content increases with increase in the coconut milk as a result of the high fat content of the milk.

The ash content ranged from 1.47 to 3.03% with sample $C_{25}T_{25}CC_{50}$ having the lowest value while sample $C_{75}T_{25}CC_0$ had the highest value. Thus it can be deduced that increase in the percentage cow milk (i.e. above 50%) leads to increase in the ash content. This is supported by the findings of Balogun *et al.* (2016) who reported decreased in the ash content of cheese with addition of coconut milk. The increased in ash content with the addition of 25% of tigernut implies that it is a good source of minerals.

No value at all for crude fiber. Total carbohydrate content of the cheese samples ranged from 2.81 to 10.72% with sample $C_{25}T_{25}CC_{50}$ having the lowest value while sample $C_{75}T_{25}CC_0$ had the highest value. The result indicates that the total carbohydrate content is dependent on the tigernut milk.

Percentage yield and total titratable acidity of cow-tigernut-coconut cheese

The percentage yield and titratable acidity of the samples are presented in Table 3. The percentage yield ranged from 13.43% ($C_{25}T_{25}CC_{50}$) to 17.33% ($C_{25}T_{50}CC_{25}$).The variations may be attributed to the nutrient composition of the blends, the nature and specie of the food materials and the quantities of the materials used in the production. The highest yield was recorded in sample $C_{25}T_{50}CC_{25}$ and this was in agreement with the findings of Adedokun *et al.* (2013) who reported an increase in percentage yield of cheese as bambara milk inclusion is increased in the blends. The relatively low value of the percentage yield in the cheese produced from the higher proportion of cow milk may be due to the specie of the animal, age, sex,

feeding habits and type of feeds given to the animal as well as the time and season of milking.

It can be deduced from the findings that the percentage yield may depend on the available protein for curdling by enzyme. Thus, it can be said that increase in the amount of protein rich materials used in supplementations in the production of cheese will lead to increase in the percentage yield of the cheese as observed in this research and also the findings of Adedokun *et al.* (2013). Balogun *et al.* (2016) also reported that percentage yield decreases with increase in the percentage coconut milk in the blend. However as reported by Balogun *et al.* (2016) the principles of cheese making involves the removal of water from milk with a consequent six to ten-fold concentration of protein, fat, minerals and vitamins by the formation of protein coagulum which further shrinks to expel whey. Therefore, the decline in the percentage yield of the cheese sample $C_{25}T_{25}CC_{50}$ can be attributed to the high proportion of the coconut milk which is also in agreement with the findings of Balogun *et al.* (2016).

The total titratable acidity (TTA) was found to be between 0.23% and 0.30% for sample $C_{25}T_{50}CC_{25}$ and $C_{75}T_{25}CC_0$ respectively. The significant ($p<0.05$) differences between the samples can be attributed to the differences in the ratio of the cow milk in the blend as the samples with 25 percent cow milk as observed in samples with $C_{25}T_{50}CC_{25}$ and $C_{25}T_{25}CC_{50}$ have lower titratable acidity compared to samples with cow milk of 50 percent and above. This is supported by the findings of Abdel *et al.* (2012) who reported that cheese samples produced from cow milk has higher titratable acidity than those produced from goat milk or the mixtures of both milk. Changes in pH and total titratable acidity depend on the impact of cheese ripening and condition of storage after the production.

Microbiological quality of cow-tigernut-coconut cheese

The resultof the bacteria count is presented in Table 4. The growth rate increased as the storage period increased with sample $C_{25}T_{50}CC_{25}$ having the highest bacteria growth throughout the storage period. This may be due to the highest ratio of the tigernut milk used in the blend as tigernut milk contains high amount of nutrients than enhance microbial growth (Dauda, 2017). Moreover, the increase in the number of microorganism in the samples may partially result from the curdling and partially from the retention of these microorganisms in the curd as the whey is run off couple with other factors such as environmental factors, milking unit operations, storage condition, the differences in the pH and titratable acidity of the cheese products may attribute to proliferation of microorganisms in the product.

It can be deduced from the finding that cheese produced from blends of cow milk with tigernut milk or other milk from plant sources get spoilt easily and thus preservation methods such as drying, frying, refrigeration and use of chemicals can be employed to maintain the quality and enhance the shelf life of the product.

There was significant ($p<0.05$) difference in the total fungal count of the cheese samples with increase in storage period (Table 5). The increase could be attributed to addition of tigernut milk

and coconut milk in the sample. The control sample C_{100} has a value of 1.67 which is low compared to sample $C_{75}T_{25}CC_0$ which has a greater value of 100. Sample $C_{75}T_{25}CC_0$ shows increase in spoilage over the storage period while also having the highest number of fungal growth on a daily basis. Decrease in fungal growth with increase in coconut milk was observed as sample $C_{50}T_{25}CC_{25}$ showed a steady value of having the least number of growths during the storage periods.

Table 6 shows the colony forming unit per gram of the cheese sample with the control samples 100% cow milk cheese having a fungal count of 1.7×10^4, 7.3×10^5 and 9.3×10^5 cfu/g for the three days of storage these findings was in contrast with the findings of Dauda. (2017) who reported no fungal growth for storage at day one although this may be due to the difference in samples as the report was on fried cheese. The increase in the fungal count as the storage days increases is also in line with the findings of Dauda. (2017) who also reported that increase in the fungal growth could be due to favorable environmental condition and the acidity of the cheese samples at storage. Sample $C_{75}T_{25}CC_0$ has the highest fungal growth with values ranging from 1.0×10^6 cfu/g, 1.7×10^6 cfu/g and 1.7×10^6 cfu/g for the three days of storage respectively. However, growth was constant in days 2 and 3. The study showed that tigernut supplemented cheese is very prone to both bacterial and fungal spoilage and refrigeration temperature alone is not enough to maintain its quality and enhance its keeping period. Thus there is need for combined preservation methods to increase the shelf life, maintain the quality and enhance the safety and wholesomeness of the cheese product.

Sensory evaluation of cheese produced from blends of cow-tigernut-coconut milk

The mean sensory scores are shown in Table 7. There was no significant difference in the taste of all the six samples of cheese provided thus the taste was very palatable and acceptable by the consumers. There was significant ($p<0.05$) difference in colour, texture, aroma and overall acceptability aiming the samples. The sample with highest percentage of tigernut milk ($C_{25}T_{50}CC_{25}$) was rated lowest in colour with a value of 5.80. This could be attributed to the present of tigernut milk in the cheese analogue which may result in a slight brownish discoloration observed in the samples

The texture of the control sample (C_{100}) was rated highest (6.65) score. The result supports the findings of Balogun *et al.* (2016) who reported that 100% cow milk has the best texture.

In terms of aroma the sample $C_{75}T_{25}C_0$ had the highest (6.45) 6.45 score. Samples $C_{75}T_{25}C_0$ had the highest overall acceptability (7.00) while sample $C_{25}T_{25}CC_{50}$ had the least (5.40) value. This denotes that samples with coconut and tigernut milk supplements are generally accepted by the consumer and can be used for commercial production of cheese.

The result from this study shows increase in the yield, protein, moisture content, fat and ash content with increasing proportion of the coconut and tigernut milk at different levels in the blend formulation and this shows high possibility of using a milk analogue from a vegetable source such as coconut milk and tigernut milk in cheese production. The increase in yield of the supplemented cheese makes it economical and cost effective. The results of the microbiological evaluation showed that samples at day one of production with tigernut milk and coconut milk supplements have high bacteria and fungal count at day one thus very prone to spoilage. The result of consumer oriented test from this study shows that 75:25:0% cow-tigernut - coconut milk 'warankashi' was most accepted by the consumer. Therefore tigernut milk and coconut milk can be used alone and collectively to supplement cow milk up to 50 % without much adverse effect on the chemical properties, nutrients and acceptability of the final product. However 25% of supplementation proved to be the best blend based on consumer acceptability and hereby recommended.

Table 1: Blend formulation for the production of cow-tigernut-coconut cheese

Sample	Cow milk (%)	Tigernut milk (%)	Coconut milk (%)	Sodom Apple leaves (%)
C_{100}	100	0	0	15
$C_{75}T_0CC_{25}$	75	0	25	15
$C_{75}T_{25}CC_0$	75	25	0	15
$C_{50}T_{25}CC_{25}$	50	25	25	15
$C_{25}T_{50}CC_{25}$	25	50	25	15
$C_{25}T_{25}$ CC_{50}	25	25	50	15

Key: C_{100}: 100% cow milk; $C_{75}T_0CC_{25}$: (75% cowmilk+0% tigernut milk+25% coconut milk) $C_{75}T_{25}CC_0$: (75% cowmilk + 25% tigernut milk+0% coconut milk) $C_{50}T_{25}CC_{25}$: (50% cow milk + 25% tigernut milk + 25% coconut milk) $C_{25}T_{50}CC_{25}$: (25% cow milk +50% tigernut milk + 25% coconut milk) $C_{25}T_{25}CC_{50}$: (25% cow milk + 25% tigernut milk+ 50% coconut milk).

Table 2: Proximate composition of cow-tigernut-coconut cheese

Samples	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Carbohydrate (%)
C_{100}	$55.18^{c}\pm0.25$	$16.75^{b}\pm1.58$	$19.51^{b}\pm0.74$	$2.52^{c}\pm0.02$	$6.06^{bc}\pm1.06$
$C_{75}T_0$ CC_{25}	$53.92^{c}\pm0.81$	$17.25^{ab}\pm0.00$	$20.46^{ab}\pm0.53$	$2.72^{bc}\pm0.16$	$5.67^{c}\pm0.12$
$C_{75}T_{25}CC_0$	$54.59^{c}\pm0.01$	$18.77^{a}\pm0.16$	$12.90^{d}\pm0.22$	$3.03^{a}\pm0.14$	$10.72^{a}\pm0.06$
$C_{50}T_{25}CC_{25}$	$59.32^{a}\pm1.10$	$16.53^{b}\pm0.74$	$13.84^{d}\pm1.42$	$2.84^{ab}\pm0.17$	$7.49^{b}\pm0.91$
$C_{25}T_{50}CC_{25}$	$57.49^{b}\pm0.00$	$15.48^{bc}\pm0.43$	$15.71^{c}\pm0.01$	$1.92^{d}\pm0.15$	$9.42^{a}\pm0.29$
$C_{25}T_{25}CC_{50}$	$59.66^{a}\pm0.13$	$14.59^{c}\pm0.14$	$21.49^{a}\pm0.57$	$1.47^{e}\pm0.64$	$2.81^{d}\pm0.53$

Values are mean ± standard deviation .Means with same superscript across a columns are not significantly ($p<0.05$) different.

Key: C_{100}: 100% cow milk; $C_{75}T_0CC_{25}$: (75% cowmilk+0% tigernut milk+25% coconut milk) $C_{75}T_{25}CC_0$: (75% cowmilk + 25% tigernut milk+0% coconut milk) $C_{50}T_{25}CC_{25}$: (50% cow milk + 25% tigernut milk + 25% coconut milk) $C_{25}T_{50}CC_{25}$: (25% cow milk +50% tigernut milk + 25% coconut milk) $C_{25}T_{25}CC_{50}$: (25% cow milk + 25% tigernut milk+ 50% coconut milk).

Source: Data Analysis, 2019

Table 3: Percentage yield and total titratable acidity of cow-tigernut-Coconut cheese

Samples	Yield (%)	TTA (%)
C_{100}	14.32^{bc}±0.90	0.29^{a}±0.02
$C_{75}T_0CC_{25}$	15.33^{b}±1.53	0.27^{a}±0.02
$C_{75}T_{25}CC_0$	14.33^{bc}±0.61	0.30^{a}±0.02
$C_{50}T_{25}CC_{25}$	13.38^{c}±0.58	0.30^{a}±0.03
$C_{25}T_{50}CC_{25}$	17.33^{a}±0.83	0.23^{b}±0.01
$C_{25}T_{25}CC_{50}$	13.43^{c}±0.67	0.24^{b}±0.03

Values are mean ± standard deviation. Means with same superscript across a columns are not significantly ($p<0.05$) different.

Key: C_{100}: 100% cow milk; $C_{75}T_0CC_{25}$: (75% cowmilk+0% tigernut milk+25% coconut milk) $C_{75}T_{25}CC_0$: (75% cowmilk + 25% tigernut milk+0% coconut milk) $C_{50}T_{25}CC_{25}$: (50% cow milk + 25% tigernut milk + 25% coconut milk) $C_{25}T_{50}CC_{25}$: (25% cow milk +50% tigernut milk + 25% coconut milk) $C_{25}T_{25}CC_{50}$: (25% cow milk + 25% tigernut milk+ 50% coconut milk).

Source: Data Analysis, 2019

Table 4: Bacteria count of cow- tigernut-Coconut cheese during storage

	Storage period (days)		
Samples	1 (cfu/g)	2 (cfu/g)	3 (cfu/g)
C_{100}	83.33^{cd}±5.77	193.33^{c}±11.55	793.33^{ab}±17.10
$C_{75}T_0CC_{25}$	66.67^{d}±11.55	293.33^{bc}±83.27	733.35^{ab}±24.13
$C_{75}T_{25}CC_0$	125.33^{bc}±18.90	266.67^{bc}±130.13	786.67^{ab}±61.10
$C_{50}T_{25}CC_{25}$	133.33^{b}±23.09	353.33^{ab}±50.33	793.33^{a}±57.74
$C_{25}T_{50}CC_{25}$	180.00^{a}±20.00	450.00^{a}±86.60	840.00^{a}±69.28

Values are mean ± standard deviation. Means with same superscript across a columns are not significantly ($p<0.05$) different

Key: C_{100}: 100% cow milk; $C_{75}T_0CC_{25}$: (75% cowmilk+0% tigernut milk+25% coconut milk) $C_{75}T_{25}CC_0$: (75% cowmilk + 25% tigernut milk+0% coconut milk) $C_{50}T_{25}CC_{25}$: (50% cow milk + 25% tigernut milk + 25% coconut milk) $C_{25}T_{50}CC_{25}$: (25% cow milk +50% tigernut milk + 25% coconut milk) $C_{25}T_{25}CC_{50}$: (25% cow milk + 25% tigernut milk+ 50% coconut milk).

Source: Data Analysis, 2019

Table 5: Fungal count of cow-tigernut-coconut cheese during storage

	Storage period (Days)		
Samples	1 (cfu/g)	2 (cfu/g)	3 (cfu/g)
C_{100}	1.67^{c}±1.53	73.33^{b}±20.8	293.33^{c}±5.77
$C_{75}T_0\ CC_{25}$	12.00^{c}±2.00	76.67^{b}±15.82	106.67^{c}±11.55
$C_{75}T_{25}CC_0$	100.00^{a}±20.00	166.67^{a}±30.55	173.33^{a}±23.09
$C_{50}T_{25}CC_{25}$	10.00^{c}±2.00	16.00^{c}±5.29	20.00^{d}±2.00
$C_{25}T_{50}CC_{25}$	5.00^{c}±1.00	53.33^{b}±6.11	184.00±14.42
$C_{25}T_{25}CC_{50}$	43.33^{b}±5.77	80.00^{b}±20.00	133.33±11.54

Values are mean ± standard deviation Means with same superscript across a columns are not significantly ($p<0.05$) different

Key: C_{100}: 100% cow milk; $C_{75}T_0CC_{25}$: (75% cowmilk+0% tigernut milk+25% coconut milk) $C_{75}T_{25}CC_0$: (75% cowmilk + 25% tigernut milk+0% coconut milk) $C_{50}T_{25}CC_{25}$: (50% cow milk + 25% tigernut milk + 25% coconut milk) $C_{25}T_{50}CC_{25}$: (25% cow milk +50% tigernut milk + 25% coconut milk) $C_{25}T_{25}CC_{50}$: (25% cow milk + 25% tigernut milk+ 50% coconut milk).

Source: Data Analysis, 2019

Table 6: Colony forming of cow-tigernut-coconut cheese during storage

	Storage period (Days)		
Samples	1 (cfu/g)	2 (cfu/g)	3 (cfu/g)
C_{100}	1.7×10^4	7.3×10^5	9.3×10^5
$C_{75}T_0CC_{25}$	1.2×10^5	7.7×10^5	1.1×10^6
$C_{75}T_{25}CC_0$	1.0×10^6	1.7×10^6	1.7×10^6

$C_{50}T_{25}CC_{25}$	1.0 x 10^5	1.6 x10^5	2.0 x 10^5
$C_{25}T_{50}CC_{25}$	5.0 x 10^4	5.3 x10^5	8.4 x 10^5
$C_{25}T_{25}CC_{50}$	4.3 x 10^5	8.0 x 10^5	1.3 x 10^6

Values are mean ± standard deviation. Means with same superscript across a columns are not significantly ($p<0.05$) different

Key: C_{100}: 100% cow milk; $C_{75}T_0CC_{25}$: (75% cowmilk+0% tigernut milk+25% coconut milk) $C_{75}T_{25}CC_0$: (75% cowmilk + 25% tigernut milk+0% coconut milk) $C_{50}T_{25}CC_{25}$: (50% cow milk + 25% tigernut milk + 25% coconut milk) $C_{25}T_{50}CC_{25}$: (25% cow milk +50% tigernut milk + 25% coconut milk) $C_{25}T_{25}CC_{50}$: (25% cow milk + 25% tigernut milk+ 50% coconut milk).

Source: Data Analysis, 2019

Table 7: Sensory properties of cow-tigernut-coconut cheese

Samples	Colour	Texture	Taste	Aroma	Overall acceptability
C100	7.00a±1.41	6.65a±1.09	5.15a±1.90	5.40ab±1.85	6.10ab±1.86
C75T0 CC25	6.80ab±1.28	6.50ab±1.70	5.35a±2.13	5.20ab±1.96	6.30a±1.75
C75T25CC0	7.00a±1.56	6.50ab±1.61	6.05a±1.67	6.45a±1.99	7.00a±1.45
C50T25CC25	6.25ab±1.48	6.45ab±1.57	5.85a±1.95	6.00ab±1.89	6.10ab±1.77
C25T50CC25	5.80b±1.61	6.00ab±1.86	5.35a±2.16	5.50ab±1.85	5.75ab±1.83
C25T25CC50	5.95b±1.64	5.30b±2.72	4.80a±2.19	5.05b±2.16	5.40ab±1.85

Values are mean ± Standard deviation. Means with same superscript across a columns are not significantly ($p<0.05$) different.

Key: C_{100}: 100% cow milk; $C_{75}T_0CC_{25}$: (75% cowmilk+0% tigernut milk+25% coconut milk) $C_{75}T_{25}CC_0$: (75% cowmilk + 25% tigernut milk+0% coconut milk) $C_{50}T_{25}CC_{25}$: (50% cow milk + 25% tigernut milk + 25% coconut milk) $C_{25}T_{50}CC_{25}$: (25% cow milk +50% tigernut milk + 25% coconut milk) $C_{25}T_{25}CC_{50}$: (25% cow milk + 25% tigernut milk+ 50% coconut milk).

Source: Data Analysis, 2019

CONCLUSION

The result from this study shows increase in the yield, protein, moisture content, fat and ash content with increasing proportion of the coconut and tigernut milk at different levels in the blend formulation and this shows high possibility of using a milk analogue from a vegetable source such as coconut milk and tigernut milk in cheese production. The increase in yield of the supplemented cheese makes it economical and cost effective. The results of the microbiological evaluation showed that samples at day one of production with tigernut milk and coconut milk supplements have high bacteria and fungal count at day one thus very prone to spoilage. The result of consumer oriented test from this study shows that 75:25:0% cow-tigernut - coconut milk 'warankashi' was most accepted by the consumer. Therefore tigernut milk and coconut milk can be used alone and collectively to supplement cow milk up to 50 % without much adverse effect on the chemical properties, nutrients and acceptability of the final product. However 25% of supplementation proved to be the best blend based on consumer acceptability and hereby recommended.

REFERENCES

Abdel, M.E. Suleiman, R.A. Mohamed, A., Kamal,A. and Abdel, R. (2012). Production and Effect of Storage in the Chemical Composition of Mozzarella Cheese. *International Journal of Food Science and Nutrition Engineering***,** 2(3): 21-26.

Adedokun, I.I., Okorie, S.U., Onyeneke, E.N. and Anoruo, S.A. (2013). Evaluation of yield, sensory and chemicalcharacteristics of soft un-ripened cheese produced with partial incorporation of Bambaranut milk. *Academic Journal of Food Research* 1(1): 14-18.

Adegoke, G.O. (2004). Understanding Food Microbiology 2nd Edition Alleluia ventures Ltd. Pp 127-207.

Adejuyitan, J.A., Olanipekun, B.F. and Moyinwin, O.A. (2014). Production and Evaluation of Cheese-Like Product from the Blend of Soy Milk and Coconut Milk. *Archives of Applied Science Research*, 6(4): 263 – 266.

Adetunji, V.O. and Salawu, O.T. (2008). "West African soft cheese '*wara*' processed with *Calotropisprocera* and *Carica papaya*: A comparative assessment of nutritional values of *papaya*. A comparative assessment of nutritional values, *International Journal of Dairy Science*, 6(1): 58 – 65.

AOAC, (2010) Official Methods of Analysis *20th Edition Association of Analytical Chemists* Washington D.C. 46-80.

AOAC, (The Association of Official Analytical Chemist) (2006). *The Official Method Analysis of AOAC.* International, 18th edition. The Assoc. official Ana. Chem. Arlington, USA.

AOAC, (1996). Association of Official Analytical Chemists. *Official methods of analysis, 16th edition*. The Association, Washington, D.C, USA.

Balogun, M.A., Kolawole, F.L., Joseph, J. K., Adebisi, T.T. and Ogunleye, O.T. (2016). Effect of Fortification of Fresh Cow Milk with Coconut Milk on the Proximate Composition and Yield of Warankashi, a Traditional Cheese. *Croatian. Journal. Food Science. Technology.* 8(1): 1 – 5.

Belewu, M. A. and Belewu, K.Y. (2007). Comparative Physio-evaluation of Tiger-nut, tigernut and Coconut Milk Sources. *International Journal of Agricultural Biology.* 9: 785 – 787.

Dauda, A.O. (2017). Comparative Study of the Nutritional and Microbial Safety of Fried *"Wara"* (local cheese) widely hawked in Ilorin and Ogbomoso Towns in Nigeria *Annals. Food Science and Technology 18*(2): 22 – 26.

Fankhauser, D.B. (2007) .Fankhauser's Cheese page. http://biology.clc.uc.edu/fankhauser/cheese/cheese.html. Retrieved 2019 – 04 – 16.

Hussein, J.B., Suleiman, A.D., Ilesanmi, J.Y.O. and Sanusi, S.A. (2016). Chemical Composition and Sensory Qualities of West African Soft Cheese (*Warankashi*) Produced from Blends of Cow milk and Soy milk. *Nigerian Journal of Tropical Agriculture*, vol. 16, (79-89).

Ihekoronye, A.I. and Ngoddy, P.O. (1985). *Integrated Food Science and Technology for the Tropics.* 1st ed. Macmillian Publishers, London. Pp 115-130, 178-182, 372-375.

Marimuthu, M, Sankar, N, Sathish, A, Vivek. S and Mohan-Raj, N. (2013). Comparative study on physicochemical quality of raw milk samples collected from different villages of Karur district Tamilnadu, India. *International Journal of Pharmaceutical, Chemical and Biological sciences.* 3(3): 635-638.

Ogunlade, A.O, Oyetayo, V.O. and Ojokoh, A.O. (2017). Percentage Yield and Proximate Composition of Cheese Produced from Sheep Milk Using Different Coagulants. *International Journal of Microbiology and Biotechnology* 2(4): 171-175.

Oladipupo, I.C., and Jadesimi, P.D. (2012): Microbiological Analysis and Nutritional Evaluation of West African soft cheese (Wara) produced with different preservatives. *African Journal of Biotechnology*12 (2), 50-60.

Omotosho, O. E., Oboh, G. and Iweala, E. E. J. (2011). Comparative Effects of Local Coagulants on the Nutritive value, in vitro Multi-enzyme Protein Digestibility and Sensory Properties of Warankashi Cheese. *In International Journal of Dairy Science*, p. 1811-9743.

Steel, R.G.D. and Torrie, J.H. (1980): *Principles and Procedures of Statistics. A Biometric Approach.* 2nd ed. Auckland, New Zealand, McGraw–Hill Publishers.

Steel, R.G.D., Torrie, J.H. and Diekey, D.A. (1997): *Principles and Procedures of Statistics. A Biometric Approach*. 3nd ed. New York, McGraw–Hill Book Co. Publishers.

PERCEPTION OF THE USE OF SOCIAL MEDIA AMONG AGRICULTURAL RESEARCHERS IN IBADAN METROPOLIS

Kareem, A.T., Ugege, B.H., Ogunwale O.G., Ojo-fakuade A. A. and Oyewole O.O
Federal College of Forestry, Ibadan, Oyo State. P.M.B.5087
Correspondent Email: Kareemaminat82@gmail.com
Phone Number: 08052942900

Abstract
Research is about findings and discovery and social media offers a unique platform to present new content. The evolution of social media (SM) provides a visible solution to challenges. Perception of researchers on the use of social media for agricultural information in Ibadan Metropolis, Oyo State was therefore investigated. A Random sampling techniques was used to sample 112 researchers and questionnaire was used for data collection. Data were analyzed using descriptive statistics such as frequency counts, percentage, mean and inferential statistic; Pearson Product Moment Correlation (PPMC) was used to analyzed perception of media use at 0.05% level of significance. Results of analysis revealed that majority of the respondents were male (55.4 %) and are of middle age (66.1 %), majority (41.1 %) have BSc. Degree while few had Msc (37.5 %) with most of them married (75 %), and about (45.5 %) 6-10years of experience as researchers. The result further reveals that larger percentage of the respondent (75.9%) and majority 8(2.1%) regularly makes use of Facebook and Whatsapp respectively. The result of analysis further reveals that the level of perception of the researchers on the use of social media is high such that 67.0% strongly agreed that social media helps in getting information needed and provide reliable means of communication as well as saving time and energy. Also, the result reveals that there is significant relationship between perception of the respondents ($r = 0.199$, $p<0.05$) and the use of social media. It is therefore, recommended that every agricultural researcher should subscribe to and maintained multiple accounts of social media and also agricultural researchers should be encouraged to used social media network and collaborate with colleagues from institutes different from their own.
Keywords: Perception, Researcher, Use, Social media, Agricultural information

Introduction

In today's world social media is an ever-present facet of life that surrounds us. The advent of the internet in the 1990s has led to major developments in the world of communication hence the introduction of social networking sites (SNSs). The evolution of the internet has led to its usage as the best medium of communication whereby two-third (2/3) of the internet world's population visit social networking sites (SNSs) thus serving as communication and connection tools. These networking sites are referred to as social media (Boyd and Ellison, 2007). In contemporary society, there are many different social media network sites such as Facebook, Twitter, WhatsApp, Blackberry messenger, Badoo, Imo, Instagram, YouTube, 2go, Myspace, Gmail, yahoo goggle. The use of social media is rapidly spreading among different professionals, including Liberians, lawyers, doctors, marketers and researchers to mention a few. This is because it has different applications that enable fast connection and networking irrespective of the geographic location. As of January 2019, there were around 7.7 billion people in the world, of which 3.397 billion were active social media workers (Smith 2019).The evolution of social media (SM) provided a visible solution to challenges. . As a scientist, once you publish your research and you want to share it with as many colleagues and other people so that they may read This is premised on the fact that social media enables blogging, tagging, discussion, networking, and so on. Since past decade, social networking sites have become a mainstream cultural phenomenon (Boyd and Ellison, 2007), and Agricultural Researchers (ARAS) have caught a glimpse of the tremendous role social media can play in establishing connections, facilitating dissemination of agricultural research findings and exchange of information. Social media, has, therefore, become extremely popular because it allows people to connect in the online world to form a group, a forum and a community where ideas and information can be exchanged without any geographical barrier. CIARD (2009) emphasizes that social media is a shift on how people discover, read and share news, information and content; it supports the human need for social interaction with technology, broadcast media monologues into social media dialogues.

The role its play in sagricultural research cannot be overlooked. It allows researchers to get feedback on research outcomes at their fingertips. It proffers a fast platform for information dissemination. It has broken down the physical barriers in reaching one another and extended the mileage of exposure from one-to-one person, one-to-many-persons, and many-to-many-persons instant dialogues online.This medium has helps to transfer information to large audience at the same time, from the foregoing, one can say that social media plays the role of boosting communication

among a large number of people at the same time by making reports visible instantly.

In addition, it also helps to engage people and gather information to support and bring research reports together. It is a tool that brings experts and talents together for collaboration on research work, which they can carry out without meeting one another apart from exchanging ideas through social media network.This is believed to have the potential to change the face of agriculture in Nigeria and improve or increase the channel of gathering information among farmers because the ratio of agricultural extension officers is very low compare to the number of farmers that exist in the country (FMARD, 2011).

The Perception of the use of social media can be dependent on individual variations and the context it is used. Perception is the ability to see or become aware of something through the use of senses The way in which something is regarded, understood or interpreted is majorly dependent on the persons discretion. .. Relatedly, students nowadays use Google, Yahoo, Opera Mini, UC browser, and other search engine to search for lecture materials for project, assignment, general reading and use of concepts and construct for learning purpose. Although many studies have investigated the impact of social media among students. Hence, this study focuses study focuses on the Perception o f the use of social media among Agricultural Researchers.

METHODOLOGY.

Study Area

The study was carried out in Research institutes within Ibadan metropolis, Oyo state Nigeria. Ibadan is the capital of Oyo state and it is also the largest metropolitan geographical area. Ibadan consist of eleven (11) local government Areas. Ibadan is located in south western Nigeria in the South-eastern part of Oyo state about 120km east of the border with the Republic of Benin in the forest zone close to the boundary between the forest and the savanna. The city ranges elevation from 150m in the valley area, to 275m above sea level on the major North-South ridge which crosses the central part of the city. The city's total area is 1,190sq miter (3,080km^2). The city is naturally drained by four rivers with many tributaries: Ona Rivers in the North and West; Ogberi Rivers towards the East; Ogunpa Rivers flowing through the city and kudeti Rivers in the central part of the metropolis, Ogunpa Rivers, a third-order stream with a channel length of 12.76km and a catchment area of 54.92km^2. the climate is equatorial, notably with dry and wet season with relatively high humidity. The dry season last from November-March while the wet season starts from April and ends in October. Average daily temperature ranges between 25^{o}C (77.0^{0}F) and 35^{0}C (95.0^{0}F), almost throughout the year (Ibrahim, 2011) and on latitude 7^{0}W and longitude 9^{0}E of the equator and longitude 3^{0}W and 5^{0}S of the Greenwich Meridian.

Sampling Procedure and Sample size

Random sampling techniques was used in the selection of the respondents. Out of eight (8) Research Institutes in Ibadan which are: International Institute of Tropical Agriculture (IITA), Forestry Research Institute of Nigeria (FRIN), and Cocoa Research Institute of Nigeria (CRIN), Institute of Agricultural Research and Training (IART), National Horticultural Research Institute (NIHORT), National Cereals Research Institute (NCRI), National Animal Production Research Institute (NAPRI), and Nigerian Institute of Social and Economic Research (NISER).Three (3) Agricultural Research Institutes were randomly selected which are; National Horticultural Research Institute (NIHORT), Forestry Research Institute of Nigeria (FRIN), and Institute of Agricultural Research and Training (IART). Then, 30% of the total population of the researchers were randomly selected from each of the Research Institutes. A total number of 134 questionnaires were administered out of which 112 questionnaires were retrieved .

Analysis of data

Descriptive statistics (frequency distribution, percentages) and inferential statistic (PPMC) were used for data analysis.

Results and Discussion

Table 1: Socio-economic characteristics of respondents

Variables	Frequency	Percentage
Age		
21-40years	74	66.1
41-60years	34	30.4
Above 60years	4	3.6
Gender		
Male	62	55.4
Female	50	44.6
Marital status		
Single	22	19.6

Married	84	75.0
Divorced	5	4.5
Widow	1	0.9
Level of education		
ND	3	2.7
HND	19	17.0
Bsc.	46	41.1
Msc	42	37.5
PhD.	2	1.8
Years of experience		
1-5years	32	28.6
6-10years	51	45.5
11-15years	18	16.1
16-20years	5	4.5
Above 20years	6	5.4
Total	**112**	**100.0**

Source:Field Survey,2019

The result in Table 1 shows that 66.1% of the respondents were between the ages of 21-40years, 30.4% of them falls within the age category of 41-60years, about 3.6% were 60 years and above .This is an indication that majority of the researchers were in their active age. This result is in line with Akinbile (2007), who stated that population of between 21-40 years of age constitute the active work force.

In gender distribution of the respondents, the table reveals that 55.4% of the respondents are male while 44.6% of the respondents were female. This study revealed that most researchers in all the research institutes were mainly males. This is in line with Sokoya *et al,* (2012), who stated that agriculture is generally regarded in Africa as an occupation for men. The result also shows that majority (75.0%) of the respondents were married, 19.6% were single, 4.5% were divorced and 0.9% are widow. This indicates that most of the respondents were married which implies that they are matured and responsible, this is also in line with the findings of Akinbile, (2007), who stated that marriage confers responsibility.The table further reveals that about 41% of the respondents had BSc. Degree. FMRAD (2011) asserted that education is required as a basic prerequisite to sharpen extension agents' knowledge, skills and practices for effective delivery if food security will be achieved in Nigeria.

Table 2: Social media use by Researchers

Social media	Regularly	Occasionally	Never
Facebook	85(75.9)	25(22.3)	2(1.8)
WhatsApp	92(82.1)	15(22.3)	5(4.5)
Twitter	34(30.4)	48(42.9)	30(26.8)
YouTube	28(25.0)	57(50.9)	27(24.1)
BBM	22(19.6)	48(42.9)	42(37.5)
Yahoo Messenger	37(33.0)	41(36.6)	34(30.4)
MSN	14(12.5)	43(38.4)	55(49.1)
Google talk	26(23.2)	38(33.9)	48(42.9)
Conference call	29(25.9)	44(39.3)	39(34.8)
Instagram	36(32.1)	46(41.1)	30(26.8)
Imo	26(23.2)	52(46.4)	34(30.4)
Google plus	23(20.5)	40(35.7)	49(43.8)
Snapchat	15(13.4)	46(41.1)	51(45.5)
LinkedIn	18(16.1)	42(37.5)	52(46.4)

Source: Field Survey 2019 Percentages in parenthesis

The result in Table 2 reveals that WhatsApp ((82.1%) was regularly used as social media among the researchers, followed by Facebook (75.9%), YouTube (50.9%) was occasionally used, followed by Imo (46.4%), while MSN (49.1) was never used among agricultural researchers. This implies that WhatsApp is the most popular social media platform used among agricultural researchers in the study area compared to

the result of the finding of Christofides, Muise and Desmaraias (2008), who reveals that Facebook is the most popularly used social media in the world.

Table 3: Categorization of respondents based on their level of social media usage

Variable	Frequency	Percentage %
High	55	49.1
Low	57	50.9
Total	**112**	**100.0**

Source:Field survey 2019

The result in Table 3 shows the level of categorization that 50.9% of the respondents were low on the use of social media, while 49.1% of the respondents were high on the use of social media in the study area. This is an indication that most agricultural researcher use of social media is not fully utilized in the study

Table 4: Perception of the researchers on the use of social media

Perception statements	SA	A	U	D	SD
Social medial helps in getting information needed	75(67.0)	30(26.8)	3(2.7)	-	4(3.6)
Social media tools provide reliable means for communication	64(57.1)	37(33.0)	5(4.5)	5(4.5)	1(0.9)
The use of social media can save time and energy	57(50.9)	37(33.0)	10(8.9)	7(6.3)	1(0.9)
Age does not stop using social media	51(45.5)	42(37.5)	7(6.3)	7(6.3)	5(4.5)
Social media can be useful in other area of life than in research work	67(59.8)	37(33.0)	5(4.5)	3(2.7)	-
Social media encourages making of findings	61(54.5)	39(34.8)	10(8.9)	2(1.8)	-
Social media has more merit to demerit	37(33.0)	47(42.0)	14(12.5)	9(8.0)	5(4.5)
Social media is not a good idea in research work	32(28.6)	26(23.2)	16(14.3)	21(18.8)	17(15.2)
Social media training will helps the researchers to highest level	31(27.7)	44(39.3)	18(16.1)	10(8.9)	9(8.0)
Researchers can have more time for social media to get information needed	35(31.3)	15(10.2)	17(15.2)	10(8.9)	5(4.5)
Social media make easy access to information for researchers	51(45.5)	46(41.1)	9(8.0)	4(3.6)	2(1.8)
Social media is the best way of making findings among researchers	31(27.7)	42(37.5)	18(16.1)	13(11.6)	8(7.1)
Social media misuse can affect findings	39(34.8)	51(45.5)	11(9.8)	7(6.3)	4(3.6)
Researchers need training on the use of social media	34(30.4)	41(36.6)	12(10.7)	12(10.7)	13(11.6)
Social media enlighten you more about other things related to your research	40(35.7)	56(50.0)	13(11.6)	3(2.7)	-
Social media is a current way of how researchers get connected	48(42.9)	39(34.8)	11(9.8)	9(8.0)	5(4.5)

Source: Field survey 2019
Percentage in Parenthesis

The result in Table 4 shows the distribution of the respondents according to their perception on the use of social media. Researchers Strongly Agreed (67.0%) that social media helps in getting information needed, while 15.2% Strongly Disagreed that social media is not a good idea in research work. This implies that the perception of the respondents on the use of social media is high and if the advantages can be maximized for disseminating agricultural information, farmers will have access to information needed to boost production. This result collaborates that of Sokoya *et al.* (2012), who stated that disposition to the use of social media can affect its use for whatever purpose it is intended.

The result of analysis in Table 5 shows the level of categorization that 50.4% of the respondents had a high perception on the use of social media, while 49.6% of the respondents had low perception to social media usage. This implies that the perception of

researcher on the use of social media is high in the study area.

The result in Table 6 reveals that there is significant relationship between perception of the respondents (r = 0.199, p<0.05) p-value (0.035) and the use of social media. This implies that the researchers put a lot of value on the potentials of social media in facilitating the dissemination of information.

Conclusion and Recommendations

This study revealed that majority of the respondents were male and are of middle age, majority had BSc. qualification while few had MSc. Degree and most of them are married, also majority had 6-10 years of experience as researchers. larger percentage of the respondents regularly makes use of Facebook and Whatsapp respectively and most Agricultural researchers place a lot of value on the potentials of social media and consider it as a source of relevant information The perception of the researchers on the use of social media is high and if the advantages can be maximized for disseminating agricultural information, farmers will have quick access to information needed to boost their production.

References

Akinbile, L.A (2007). Social Impact of limestone Exploitation in Yewa North Local Government Area of Ogun State, *Nigeria.Pakistan Journal of Social Science*1:107 111.

Boyd, D. M., & Ellison, N. B. (2007). Social network sites: Definition, history, and scholarship. *Journal of Computer-Mediated Communication*, 13, 210-230.

Christofides, E., Muise, A. and Desmarais, S. (2008) "Information Disclosure and Control on Facebook: Are They Two Sides of the Same Coin or Two Different Processes?" CyberPsychology and Behaviour 12(2) 341-345

CIARD(Coherence Information for Agricultural Research and Development) (2009) "Using Social Media to Communicate Research Outputs." Version 0.1 October 2009

FMARD (2011): "Agricultural Transformation Agenda" Nigeria: Report on Agricultural Extension Transformation" Federal Ministry of Agriculture and Rural development, Abuja. Research Enugu: New Generation Books.

Ibrahim, A. (2011): Climate change mitigation adopted by cassava farmers in oyo state, Nigeria. Pp.2-9.

Sokoya, A.A, Onifade, F.N and Alabi, A.O. (2012) Establishing connection and Networking; The Role of Social Media in Agricultural Research in Nigeria. World Library and Information Congress.*http://conference.ifla.org/ifla*78 Retrieve 2nd October, 2017.

Smith, K. (2019). "123 Amazing social media statistics and facts," brandwatch, (https://www.brandwatch.com/blog/amazing-social-media-statistics-aSnd-facts/).

Table 5: Categorization of respondents based on their level of perception

Variable	Frequency f	percentage %
High	**58**	**50.4**
Low	**54**	**49.6**
Total	**112**	**100.0**

Source:Field survey 2019

Table 6: PPMC result on the perception of the respondents on the use of social media.

Variable	r-value	p-value	Decision
Perception and Use of social media	0.199	0.035	S

S= Significant at 0.05

QUALITY EVALUATION OF BREAD FROM WHEAT, COCOYAM AND ACHA COMPOSITE FLOUR BLEND

Oni[1], O.K., Ojo[2], M.O., Folake[1,3] Idowu Adebayo, Adepeju[1], A.B., Oyinloye[1], A.M. and Ibok[4], N.U.

[1]Department of Food Science and Technology, Federal University, Oye Ekiti, Nigeria
[2]Department of Food Science and Technology, Federal University of Technology, Minna, Nigeria
[3]Food Quality and Design Group, Wageningen University, the Netherlands
[4]Department of Food Science and Technology, Micheal Okpara University of Agriculture, Umudike, Nigeria
*Corresponding E-mail: kunle.oni@fuoye.edu.ng 08069336753

ABSTRACT

Composite flours were produced from wheat supplemented with acha and cocoyam flour at varying proportions (A=100:0:0; B=90:5:5; C=85:10:5; D=80:10:10; E= 75:15:10). Proximate, mineral composition and functional properties were analysed using standard methods. Bread loaves were prepared from the composite flours and the sensory attributes evaluated. Results obtained revealed supplementation had a significant ($p \leq 0.05$) effect on the proximate composition. Higher quantities of acha and cocoyam flour resulted in an increase in moisture, crude protein and ash content while there was a decrease in the crude fibre and carbohydrate content. Functional properties was significantly ($p \leq 0.05$) different among the flour blends with the exception of bulk density. Increase in iron and zinc in the flour blends was also observed as the supplementation increases. Bread loaves from C (85:10:5) were the most acceptable to the panellists.

Key words: Bread, Wheat, Cocoyam, Acha, Composite Flour

INTRODUCTION

The use of cereals, tubers with or without legumes and fibers as viable sources of functional composite flours keeps on increasing (Bamigbola *et al*., 2016; Awolu *et al.,* 2016). Bread is one of the most important staple foods and the second most widely consumed non-indigenous food products after rice in Nigeria. It isa low cost processed food consumed by people in every socio- economic class and is acceptable to both adults and children. Bread is a fermented confectionary product mainly made from wheat flour and a mixture of yeast, salt, sugar and water by unit operations involving mixing, kneading, proofing, shaping and baking. Wheat grains are relatively low in total protein and generally low in lysine and certain other amino acids, which could be supplemented by the use of acha (Dabels *et al*., 2016).

Cocoyam is nutritionally superior to other roots and tubers in terms of digestibility, crude protein and the following minerals (calcium, magnesium and phosphorus) content (Eze *et al*., 2015). This makes it suitable for potentially allergic infants (gluten allergy), persons with gastro intestine disorders, diabetes patient among others (Eze *et al*., 2015).

Acha, *Digitaria exilis*) is also known as Fundi, fonio, hungry rice, Fonio blanc and Petit mil (Ayo and Gidado, 2017), It is believed that acha may have nutraceutical properties, as it is used in some areas for managing diabetes (Jideani and Jideani, 2011). Acha is known to be easy to digest but does not sharply increase the blood sugar level. It is traditionally recommended for children, old people and for people suffering from diabetes or stomach diseases (Ayo and Gidado, 2017). It is commonly eaten as a porridge, couscous or non-alcoholic beverage (Glew *et al*., 2013).

The use of cocoyam and acha composite flour in the production of low cost and generally accepted food products would create an avenue to reduce over dependency of confectionary factories on wheat flour and also provide an alternative towards nutritionally richer and cheaper bread products. Moreover, it will provide essential phytochemicals in bread, ensure food security and improve the health of the consumers in addition to improving the purchasing power of the farmers. Therefore, this study was aimed at producing low-calorie, high-biological value dietary bread by producing protein rich gluten free bread using the composite flour comprising of wheat, cocoyam and acha.

METHODOLOGY

Source of materials and material preparations:

Hard wheat flour (Golden penny), bakers' yeast, butter, sugar table salt and cocoyam corms were purchased from King's market, Ikole Ekiti, Ekiti State, Nigeria. Acha seeds were purchased at the central market, Kaduna in Kaduna State. Wheat grains, cocoyam tubers and acha grains were processed into flour with slight modification to the method described by Agiriga (2014), Akinlua *et al*.(2018) and Olapade and Oluwole (2013) respectively. Wheat, acha and cocoyam flours were formulated in the proportion 100:0:0 (A), 90:5:5 (B), 85:10:5 (C), 80:10:10 (D) and 75:15:10 (E). Bread loaves were prepared using the straight dough method as described by Nwosu *et al*. (2014).

Analysis

Proximate, mineral compositions, and pasting properties were carried out on the samples using the

AOAC (2010) methods. The bulk density, water and oil absorption capacity, foam capacity and stability and least gelation concentration were determined using the method described by Onimawo and Akubor (2012). Swelling power was determined by the method described by Oladele and Aina (2007).

Sensory Evaluation

Sensory evaluation was carried out using the method as described by Ihekoronye and Ngoddy (1985). Twenty (20) trained sensory panelists consisting of members' students from the students of Food Science and Technology, Federal University Oye Ekiti, Ekiti State. The purposive sampling technique was adopted in the selection of the panel of judges because the students have better knowledge of food than other students and would therefore give better interpretation on what would be required of them. The samples were coded and validated questionnaire made up of quality evaluation for appearance, flavour, crust and crumb colour, texture and overall acceptability were used. Quality ratings were based on a 9-point descriptive hedonic scale with 9 (like extremely) being the highest score and 1(dislike very much) as the least score.

Statistical Analysis:

Means were compared using test of significant difference (Steel and Torrie, 1980). Test of significant ($P<0.05$) difference among the reatments were determined by Analysis of Variance (ANOVA) as described by Steel *et al*. (1997).

RESULTS AND DISCUSSION

The results of proximate composition of bread produced from wheat, cocoyam and acha composite flour blend is presented in Table 1. The moisture content ranged from 36.64 to 38.62% with sample A having the least value while sample E had the highest value. The moisture content of the breads produced from composite flour increased with increasing acha and cocoyam flours substitution into the wheat flour. This agrees with the report given by Ayo and Nkama (2004) who reported an increase in the moisture content of bread with increasing proportion of acha flour substituted into wheat flour. High moisture content in flours encourages the proliferation of micro-organisms and consequently microbial spoilage. However, bulky bread is desirable to hungry consumers because it is stomach filling and satisfying.

The crude protein content ranged from 11.29 to 14.32% with sample C having the least value while sample E had the highest value. This is in line with Olapade and Oluwole (2013) who reported an increase in the protein content of bread with increase in the proportion of acha flour substituted into wheat flour. The fat content ranged from 15.32 to 16.92% with sample E having the lowest value while sample C had the highest value. The sample with the highest acha content contains the least fat content. High fat content is not a desired attribute in flour as this could readily increase the oxidation rate thereby leading to rancid flavour and off-color. Tubers store energy in the form of starch rather than lipids. It is believed that increase in the quantity of cocoyam flour in the composite flour blends will amount to the reduction in fat contents of the blends which gives longer shelf life to the products. This study corresponds with Igbabul *et al*. (2014) who reported a decrease in the fat content of bread samples produced as the quantity of wheat flour reduces.

The crude fibre content ranged between 3.53% and 4.29% more non- digestible component therefore providing bulk for proper peristaltic action in the intestinal tract.

The ash content ranged from 1.76 to 2.71% with sample B having the least value while sample E had the highest ash content. This results obtained in this study are in line with values reported by Olapade and Oluwole (2013) and Igbabul *et al*. (2014) who reported that there was an increase in the ash content of the bread samples produced with increase in the proportion of acha flour substituted into wheat flour.

The carbohydrate content of the flour blend varied between 26.08% and 29.35% with sample A having the highest value while sample E had the least value. Carbohydrates are good sources of energy In this regard therefore these flour blends can be applicable where a high concentration of it is desirable This study. is in line with Olapade and Oluwole (2013) and Igbabul *et* al. (2014) who reported a decrease in the carbohydrate content of bread samples produced with decrease in the quantity of wheat flour substitution.

The results of functional properties of bread produced from the composite flour blends is presented in Table 2. The water absorption capacity (WAC) ranged from 150.50 to 172.45% with sample A having the lowest value while sample E had the highest value. Increase in WAC is useful in baked products, which requires hydration to improve paste handling

Table 1: Proximate Composition of Wheat, Cocoyam and Acha Composite Flour

Sample	Moisture content (%)	Fat content (%)	Crude fibre (%)	Crude protein (%)	Ash content(%)	Carbohydrate (%)
A	36.64 ± 0.25^{e}	16.64 ± 0.39^{b}	4.29 ± 0.11^{a}	11.29 ± 0.07^{e}	1.79 ± 0.21^{c}	29.35 ± 0.32^{d}
B	37.20 ± 0.05^{d}	16.50 ± 0.05^{c}	3.94 ± 0.02^{b}	12.12 ± 0.09^{d}	1.76 ± 0.02^{c}	28.48 ± 0.06^{c}
C	37.71 ± 0.08^{c}	16.44 ± 0.01^{d}	3.79 ± 0.01^{c}	12.74 ± 0.04^{c}	1.81 ± 0.10^{c}	25.95 ± 0.16^{a}
D	38.24 ± 0.11^{b}	16.42 ± 0.02^{a}	3.69 ± 0.01^{d}	13.48 ± 0.37^{b}	2.04 ± 0.55^{b}	26.13 ± 0.16^{b}
E	38.62 ± 0.09^{a}	15.32 ± 0.02^{e}	3.53 ± 0.01^{e}	14.32 ± 0.10^{a}	2.13 ± 0.09^{a}	26.08 ± 0.17^{e}

Values are mean ± standard deviation of triplicate determination. Means with same superscript within the same column are not significantly ($p<0.05$) different
Sample A (100% Wheat flour), sample B: (90% Wheat flour, 5% Cocoyam flour, 5% Acha flour), sample C (85% Wheat flour, 10% Cocoyam flour, 5% Acha flour), sample D (80% Wheat flour, 10% Cocoyam flour, 10% Acha flour), sample E (75% Wheat flour, 15% Cocoyam flour, 10% Acha flour)
characteristics.

High WAC is also useful in product bulking and consistency. High water absorption capacity may be as a result of the flours having more hydrophilic constituents such as polysaccharides. Also, protein has both hydrophilic and hydrophobic nature and therefore they can interact with water in food. The WAC increased with increasing quantity of cocoyam and acha flours in the blends. This work corresponds to Akonor *et al*. (2017) who reported that water absorption of composite flours of wheat and cocoyam increased significantly with increase in the quantity of cocoyam flour substituted into wheat flour.
The oil absorption capacity (OAC) varied between 140.00% and 146.50% with sample A having the lowest value while sample D had the highest value. The relatively higher values of the composite blends could be due to the variations in the presence of non-polar side chain, which might bind the hydrocarbon side chain of the oil among the flours. Similar findings were observed by Chandra *et al*. (2015). OAC of sample D suggests that it could be useful in food formulation where oil holding capacity is needed.

The bulk density of the flours ranged from 0.76to 0.79 g/ml with E having the least value while sample A and B had the highest bulk density. The slight variation in bulk density could be as a result of the variation in starch content, particle size and moisture content of the flours (Chandra et al 2015). Olapade and Oluwole (2013) reported a decrease in the bulk densities of wheat and acha composite flours with increase in the quantity of acha. Bulk density reflects the relative volume of packaging material required. The higher the bulk density, the denser the packaging material required.

The foaming capacities ranged from 11.04 to 11.51% with sample A having the lowest value while sample E had the highest value. Similar trend was observed by Mepba (2007) who reported the foaming capacities of wheat and plantain composite flour increasing with decrease in the quantity of wheat flour. Swelling capacity values ranged between 15.30% and

Table 2: Functional Properties of Wheat, Cocoyam and Acha Composite Flour

Samples	Bulk density (g/ml)	Water absorption (%)	Oil absorption capacity (%)	Foaming capacity (%)	Swelling capacity (%)	Foaming stability (%)
A	0.79±0.14^{a}	150.50±0.00	140.00±0.14^{e}	11.04±0.01^{c}	17.61±0.01^{a}	1.93±0.05^{e}
B	0.79±0.14^{a}	152.00±0.00	141.00β±0.00^{d}	11.16±0.02^{b}	15.80±0.01^{b}	2.29±0.01^{d}
C	0.78±0.00^{a}	160.00±0.07^{c}	144.45±0.00^{b}	11.20±0.14^{b}	15.60±0.03^{c}	2.49±0.00^{c}
D	0.77±0.07^{a}	165.35±0.00^{b}	146.50±0.14^{a}	11.21±0.00^{b}	15.50±0.00^{d}	2.64±0.03^{b}
E	0.76±0.14^{a}	172.45±0.00^{a}	144.10±0.07^{c}	11.51±0.07^{a}	15.30±0.03^{e}	2.84±0.00^{a}

Values are mean ± standard deviation of duplicate determination. Means with same superscript within the same column are not significantly ($p<0.05$) different
Sample A (100% Wheat flour), sample B: (90% Wheat flour, 5% Cocoyam flour, 5% Acha flour), sample C (85% Wheat flour, 10% Cocoyam flour, 5% Acha flour), sample D (80% Wheat flour, 10% Cocoyam flour, 10% Acha flour), sample E (75% Wheat flour, 15% Cocoyam flour, 10% Acha flour)

17.61% with sample E having the lowest value while sample A had the highest value. The swelling capacity decreased as the quantity of cocoyam flour and acha flour increased.

The results of mineral content of flours produced from wheat, cocoyam and acha composite flour blend is presented in Table 3. The sodium content of the composite flour varies from 8.91 to18.71 mg/100g with sample E having the least value while sample A had the highest value. The potassium content of the composite flour varies in value between 32.83 mg/100g and 50.75 mg/100g with sample A having the highest value while sample D had the least value. Onoja *et al*. (2011) reported a decrease in iron and potassium contents of composite flour blends with a corresponding increase in acha flour and decrease in wheat flour.
Calcium contents of the flour blends varied between 9.96 and 14.56 mg/100g with sample A having the least value while sample E had the highest value. Dabels *et al*. (2016) reported that there was an increase in calcium content of composite flour blends with a corresponding increase in plantain flour and decrease in wheat flour.
The iron content of the flour blends varied in value between 0.37 mg/100g and 0.61 mg/100g with sample A having the least value while sample E had the highest value. The iron content of the bread samples increased with increase in the proportion of acha flour and cocoyam flour. Ameh *et al*. (2013) reported a

similar increase in iron content of bread loaves with increase in the proportion of rice bran being substituted into wheat flour.

Zinc is one of the essential micronutrients given consideration in food product fortification needed for the immune system and the body to function appropriately. It is also involved in cell division, cell growth, and wound healing (Navarre, 2009). Zinc value ranged from 0.50 to 0.62 mg/100g

Table 3: Minerals Contents of Wheat, Cocoyam and Acha Composite Flour

Samples	Na (mg/100g)	K (mg/100g)	Ca (mg/100g)	Fe (mg/100g)	Zn (mg/100g)
A	18.71±0.01^{a}	50.75±0.21^{a}	14.56±0.04^{a}	0.37±0.00^{d}	0.50±0.00^{e}
B	13.00±0.00^{b}	39.08±0.04^{c}	12.72±0.01^{b}	0.43±0.00^{c}	0.55±0.01^{d}
C	10.61±0.01^{c}	36.61±0.01^{d}	10.28±0.01^{c}	0.50±0.00^{b}	0.56±0.00^{c}
D	10.43±0.04^{d}	32.83±1.06^{e}	10.23±0.01^{c}	0.55±0.01^{b}	0.59±0.01^{b}
E	8.91±0.01^{e}	41.05±0.71^{b}	9.96±0.01^{d}	0.61±0.00^{a}	0.62±0.01^{a}

Values are mean ± standard deviation of duplicate determination. Means with same superscript within the same column are not significantly ($p<0.05$) different
Sample A (100% Wheat flour), sample B: (90% Wheat flour, 5% Cocoyam flour, 5% Acha flour), sample C (85% Wheat flour, 10% Cocoyam flour, 5% Acha flour), sample D (80% Wheat flour, 10% Cocoyam flour, 10% Acha flour), sample E (75% Wheat flour, 15% Cocoyam flour, 10% Acha flour)

with sample A had the least value while sample E having the highest value. The zinc content increased with increase in the proportion of acha flour and cocoyam flour. Onoja *et al*. (2011) reported that there was an increase in zinc content of composite flour blends with a corresponding increase in acha flour and decrease in wheat flour. This implies that the composite flour samples could potentially be used to augment zinc status in aged people or those taking medications such as hormone replacements or diuretics. (Roberts-Nkrumah and Badrie, 2008)

The sensory scores of the bread produced from wheat, cocoyam and acha composite flour blend are shown in Table 4. There was no significant ($p<0.05$) difference among all the five samples in all the sensory parameters measured. Texture of the bread ranged from 7.07 – 7.47 with sample B having the highest score. Aroma ranged from 6.87 (B) –7.47 (E). While the appearance ranged from 6.93 -7.90 with sample E the lowest and A recorded the highest value. Sample C was the most acceptable in term of crust, crumb appearance and overall acceptability.

CONCLUSION

From this study, it may be inferred that composite flour of wheat with acha and cocoyam flour has shown good potential which could be beneficial as the protein and ash content were improved in addition to the functional properties of the flour having wide application in food products. Acha and cocoyam could be added to wheat to produce bread up to levels of 15 and 10 % respectively without significant adverse effects regarding the crust colour, crumb structure and appearance. However, composite flours with ratio of 85: 10:5 (wheat: acha: cocoyam) flours was the most accepted. Further study on the shelf life and antinutrients of the composite flours and bread required.

Table 4: Mean Sensory Scores of Bread Samples Produced from Wheat, Cocoyam and Acha Composite Flour

Samples	Texture	Aroma	Taste	Crumb	Crust	Appearance	Overall acceptability
A	7.27^{c}±0.80	7.27^{c}±1.03	7.33^{c}±1.45	7.20^{d}±1.15	7.73^{a}±1.10	7.90^{a}±0.12	7.27^{c}±1.44
B	7.07^{d}±0.88	6.87^{e}±1.06	7.07^{d}±1.22	6.40^{e}±1.35	6.67^{e}±1.72	7.77^{b}±0.08	7.13^{d}±1.64
C	7.33^{b}±0.72	7.33^{b}±0.82	8.07^{a}±0.46	7.67^{a}±0.82	7.67^{b}±0.72	7.73^{bc}±0.88	8.27^{a}±0.03
D	7.07^{d}±1.39	7.00^{d}±1.25	6.93^{e}±1.62	7.47^{b}±1.13	6.80^{d}±1.47	7.13^{bc}±0.25	8.00^{b}±0.54
E	7.47^{a}±0.99	7.47^{a}±1.25	8.00^{b}±1.69	7.33^{c}±0.82	7.07^{c}±1.10	6.93c^{d}±0.80	7.07^{e}±1.22

Values are mean ± standard deviation of duplicate determination. Means with same superscript within the same column are not significantly ($p<0.05$) different
Sample A (100% Wheat flour), sample B: (90% Wheat flour, 5% Cocoyam flour, 5% Acha flour), sample C (85% Wheat flour, 10% Cocoyam flour, 5% Acha flour), sample D (80% Wheat flour, 10% Cocoyam flour, 10% Acha flour), sample E (75% Wheat flour, 15% Cocoyam flour, 10% Acha flour)

REFERENCES

Agiriga, A. N.(2014). Effect of whole wheat flour on the quality of wheatbaked bread. Global *Journal of Food Science and Technology*, 2 (3): 127-133

Akinlua, O., Nupo, S. S., Akinlotan, J. V. and Sunmonu, N. (2018). Effect of Pretreatment on the Functional, Pasting and Baking Characteristics of Cocoyam Flour. *Journal of Scientific Research & Reports,*18(1): 1-7

Akonor, P. T., Buckman, E.S. and Tortoe, C. (2017). Evaluation of cocoyam- wheat composite flourin pastry products based on proximate composition,physicochemical, functional and sensory properties. *Journal of Culinary Science and Technology*, 16(1): 1-14.

Ameh, M. O., Gernah, D. I. and Igbabul, B. D. (2013). Physico-Chemical and sensory evaluation of wheat bread supplemented with stabilized undefatted rice bran. *Food and Nutrition Sciences*, 4(9): 43-48.

AOAC. (2010) Official Methods of Analysis. 18th Edition, Association of Official Analytical Chemists, Washington DC.

Awolu, O.O., Osemeke, R.O. and Ifesan, B.O. (2016). Antioxidant, functional and rheological properties of optimized composite flour consisting wheat and amaranth seed, brewers' spent grain and apple pomace. *Journal of Food Science and Technology*, 53(2):1151-1163.

Ayo, J. A. and Gidado, F. E. (2017). Physicochemical, Phytochemical and Sensory Evaluation of Acha-Carrot Flours Blend Biscuit. *Current Journal of Applied Science and Technology*, 25(5): 1-15

Bamigbola, Y.A., Awolu, O.O.and Oluwalana, I.B. (2016). The effect of plantain and tigernut flours substitution on the antioxidant, physiochemical and pasting properties of wheat- based composite flour. *Cogent Food Agriculture*, 2(1):15- 19

Chandra, S. , Singh, S. , and Kumari, D. (2015). Evaluation of functional properties of composite flours and sensorial attributes of composite flour biscuits. *Journal of Food Science and Technology*, 52(6), 3681–3688.

Dabels, N., Igbabul, B. D., Amove, J. and Iorliam B. (2016). Nutritional Composition, Physical and Sensory Properties of Cookies from Wheat, Acha and Mung Bean Composite Flours. International *Journal of Nutrition and Food Sciences*; 5(6): 401-406.

Eze, S. C., Ugwuoke, K. I., Ogbonna, P. E., Onah, R. N., Onyeonagu, C. C. and Onyeke, C. C. (2015). Evaluation of indigenous technologies of fresh cocoyam (*Colocasia esculenta(L.) Schott*) storage in Southeastern Nigeria. *African Journal of Agricultural Research*, 10(8), 737-741

Glew, R.H., Laabes, E.P, Presley, J. M., Schulze, J., Andrews, R., Wang, Y., Chang, Y and Chuang, L. (2013). Fatty acid, amino acid, mineral and antioxidant contents of acha (*Digitaria exilis*) grown on the Jos Plateau, Nigeria.*International Journal of Nutrition andMetabolism*, 5(1): 1-8.

Igbabul, B. D., Amove, J. and Okoh A. (2014). Quality Evaluation of Composite Bread Produced from Wheat, Defatted Soy and Banana Flours. *International Journal of Nutrition and Food Sciences*, 3(5): 471-476.

Ihekoronye, A.I. and Ngoddy, P.O. (1985). *Integrated Food Science and Technology for the Tropics.* 1st ed. Macmillian Publishers, London. Pp 115-130, 178-182, 372-375.

Jideani, I. A. and Jideani,V. A. (2011). Developments on the cereal grains Digitaria exilis (acha) and Digitaria iburua (iburu). *Journal of Food Science and Technology*, 48(3):251–259.

Mepba, H. D., Eboh, L. and Nwaojigwa, S. U. (2007). Chemical composition, functional and baking properties of wheat-plantain composite flours. *African Journal of food agriculture nutrition and development*, 7(1):1-22

Nwosu, J. N., Owuamanam, C. I., Omeire, G. C. and Eke, C. C. (2014). Quality parameters of bread produced from substitution of wheat flour with cassava flour using soybean as an improver. *American Journal of Research Communication*, 2(3):99-118. www.usa- journals.com, ISSN: 2325-4076.

Navarre, D. A. , Goyer, A. and Shakya, R. (2009). Nutritional value of potatoes : Vitamin, phytonutrient, and mineral content *Advances in potato chemistry and technology* (pp. 395–424). USA: USDA-ARS, Washinon State LInivers i', 24106 North Bunn Road, Prosser, WA, 99350.

Oladele, A. K. and Aina, J. O. (2007). Chemical composition and functional properties of flour produced from two varieties of tigernut (*Cyperus esculentus*). *African Journal of Biotechnology*, 6(1): 2473- 2476

Olapade, A. A. and Oluwole, O.B. (2013).Bread Making Potential of Composite Flour of Wheat-Acha (*Digitaria exilis* staph) Enriched with Cowpea (*Vigna unguiculata L. walp*) Flour.*Official Journal of Nigerian Institute of Food Science and Techonology*, 31(1): 6 –12

Onimawo, I. A. and Akubor, P. I. (2012). Food chemistry (Integrated approach with Biochemical background). 2nd edition. Joy printing pres. Ibadan, Nigeria.

OnojaU.S., Dibua U. M., Eze J.I. And OdoG.E. (2011).Physico-Chemical Properties, Energy, Mineral, Vitamin and Sensory Evaluation of Wheat-Based Bread

Supplemented with Legume, Root, Tuber and Plantain Flour. *Global Journal of Pure and Applied Sciences,*17(3): 319-327.

Roberts-Nkrumah L.B. and Badrie, N. (2008). Breadfruit consumption, cooking methods and cultivar preference among consumers in Trinidad, West Indies. *Food Quality Preference*, 16: 271-274.

Steel, R.G.D., Torrie, J.H. and Diekey, D.A. (1997): *Principles and Procedures of Statistics. A Biometric Approach*. 3nded. New York, McGraw –Hill Book Co. Publishers.

Steel, R.G.D. and Torrie, J.H. (1980): *Principles and Procedures of Statistics. A Biometric Approach.* 2nd ed. Auckland, New Zealand, McGraw –Hill. Publishers.

NUTRITIONAL EVALUATION OF COOKED T*amarindus indica* SEED MEAL AND PERFORMANCE OF C*larias gariepinus* FINGERLINGS

Orire, A.M[1]*., Chinenyem, F. S. [2]and Haruna, M.A.[3]
[1,2]Department of Water Resources, Aquaculture and Fisheries Technology,
Federal University of Technology Minna, Niger State, Nigeria
[3]Department of Fisheries and Aquaculture, Federal University Dutse, Jigawa State, Nigeria
*Corresponding author: abdul.orire@futminna.edu.ng; 07032552295

ABSTRACT
Attempt for alternate protein source from plant is desirable in aquaculture feed industry. This had necessitated the research into conducting a 56day feeding trial to evaluate the nutrient utilization and growth performance of *Clarias gariepinus* fingerlings mean weight 3.54±0.04g fed varying inclusion levels of cooked *Tamarindus indica* seed meal (CTM). Experimental diets were prepared at 40% crude protein at three inclusion levels (0%, 50% and 100%) as replacement for full fat soyabean meal. The weight gain, specific growth rate (SGR), feed conversion ratio (FCR), protein efficiency ratio (PER), apparent net protein utilization (ANPU) determined as growth indices were found significant ($p<0.05$) for the treatments. Among of the three diets, diet three (100% CTM) performed best after the control diet (0% CTM) with significant ($p<0.05$) growth parameters values. Body carcass compositions recorded significantly high ($p<0.05$) body lipid as inclusion level of CTM increased. Therefore, cooked *Tamarindus indica* seed meal can substitute for soyabean meal in the diet of *Clarias gariepinus* without adverse effect.

Key words: catfish, tamarindus, growth, alternative protein, plant protein, soyabean

INTRODUCTION

Nigeria's fish production sector is fast growing with constraints from dwindling resource supply from capture fisheries which hardly satisfies the demand of her teeming population. This gives rise to a need to increase fish production through aquaculture but this desire seems not to be met partly due to the high cost of commercial feed (Lovell, 1981).It is no news that the highest cost in fish farming goes to fish feed, thereby making feedstuff limited in supply and expensive (Fapounda and Fagbenro, 2006; Ridha, 2006 and FAO, 2011). Globally, soybean supplies over one-quarter of the fats and oils and two-thirds of the protein concentrates for animal feeds, and is three-quarters of the total world trade in high-protein meals (Peisker, 2001; Best, 2011). However, soybean, together with maize, has been a staple food of mankind since ancient times. In human diets, soybean has been used as a protein source for over 5,000 years (Peisker, 2001). A vast array of products can be derived from soybean and these are found nowadays in more than 20,000 items on the food shelves of supermarkets worldwide. Also, nutrition of high performing animals is unthinkable without soy products (Peisker, 2001). Therefore, there is intense competition between human and animals for soybean which necessitate the need to identify other protein-rich plant resources that could be used in animal diets. The world is becoming increasingly aware of the looming food scarcity, and hence the possibility of raising animals on unconventional but easily sourced and available feedstuffs in the tropics and subtropics deserves more attention (Belewu *et al.*, 2009). Worldwide, the growing scarcity of conventional animal feed has therefore motivated nutritionists to find alternative sources of protein for livestock. The need for alternative source of protein in fish feed has become an obvious challenge in the aquaculture sector; this has given rise to various researches on how this problem can be overcome. Other conventional plant protein cotton seed, groundnut cake, bambara nut meal (Orire *et al.*, 2015) poultry meat meal, silk worm pupae, dried brewers and some unconventional sources like soyabean waste meal (Orire and Ozoadibe, (2015), *Pakia biglobosa* seed meal (Orire and Muhammad (2014), and *Tamarindus indica* (El-Siddig *et al.*, 2006) have been reported. It has been established that plant sources contain anti-nutritional factors that could be toxic to animals and the need for processing of these plant protein sources before it is used in production Gatlin *et al*. (2007). This research therefore investigated into alternative plant protein source of *Tamarindus indica* to soyabean in the diet of *Clarias gariepinus.*

METHODOLOGY

Feedstuffs sourcing

Matured and dried pods of *Tamarindus indica* were bought from Kasuwan Gwari market in Minna, Niger State, Nigeria. The tamarind pods were soaked in water for 20 minutes while 500g seeds were removed and cooked for 1 hour at 100 ^{o}C. The cooked seeds were further washed of the seed coat and sun dried for 30 minutes. It was then milled to powder with the aid of a kitchen blending grinding machine (Ogbonna and Orire, 2015).

Feed formulation

Three experimental diets were formulated using the Pearson Square method at 40% crude protein. Diet 1

had 0% cooked tamarind; diet 2 contained cooked tamarind and soyabean at 50% each while diet 3 had 100% cooked tamarind. The feedstuffs and diets were analysed for proximate compositions according to the method of AOAC (2007) (Table 1) .

Table 1: Feed formulation and proximate composition of diets

Ingredients (%)	**Diet 1 (0% CTM)**	**Diet 2 (50% CTM:50% SM)**	**Diet 3 (100% CTM)**
Soyabean meal	78.20	35.90	0.00
Cooked *Tamarindus* seed meal (CTM)	0.00	35.90	57.40
Maize meal	7.90	14.20	28.60
Vitamin-mineral Premix	5.00	5.00	5.00
Shear Butter oil	9.00	9.00	9.00
	99.90	100.00	100.00
Proximate Composition (%)			
Moisture	4.5	2.17	4.03
Crude protein	40.60	40.25	40.00
Crude lipid	10.5	30.2	17.2
Crude fibre	0.5	1.9	7.15
Crude ash	4.5	1.99	1.97

CTM= cooked tamarind meal, SM= Soyabean meal

Experimental fish

The experimental fishes were obtained from Eco-Rehab Environmental Center, Kuje, Abuja, Nigeria, and were transported in a 50 litres plastic container to the laboratory of the Department of Water Resources, Aquaculture and Fisheries Technology, Federal University of Technology, Minna. Upon arrival at the laboratory, experimental fish samples were acclimatized for two weeks in one of the transitional ponds while they were sustained on maintenance ration once daily with commercial diet. At the commencement of the trial, fish were stocked in a randomized design at 20 fish per tank in triplicate.. The rearing tanks were subjected to continuous aeration by manual agitation of the water aided by the recirculatory system. The water was siphoned daily of faecal matters and uneaten feed to maintain water quality. The fishes were bulk weighed fortnightly with the aid of an electronic weighing balance (OHAUS, T2130).

Chemical analysis

The initial and final carcass were also analysed for their proximate compositions; crude protein, crude lipid, crude fibre, ash and moisture contents according to the method of AOAC (2007).

Fish growth and feed utilization estimation

Biological parameters evaluated were as according to Maynard *et al.* (1979) and Halver (1989) as described below:

Mean weight gain (g) = Mean final weigh – mean initial weight

Specific Growth Rate [SGR (%/day)] = $\frac{(\text{Log}_e W_2 - \text{Log}_e W_1)}{T_2 - T_1} \times 100$

Where, W_2 and W_1 represent final and initial weight, respectively, while T_2 and T_1 represent final and initial time, respectively.

Feed conversion ratio – Feed fed on dry matter/fish live weight gain (Brown, 1957)

Protein efficiency ratio (PER) =Mean weight gain per protein fed (Osborne *et al*., 1919).

Apparent Net Protein Utilization (ANPU) **(**%) = (P2 – P1) / Total protein consumed (g) x 100 Bender and Miller (1953), Miller and Bender (1955)

Where, P1=Initial carcass protein, P2=final carcass Protein intake (g) = Feed intake x crude protein of feed.

Percentage survival (%): no stocked/no left x 100

Statistical analysis

The data obtained were subjected to a one-way analysis of variance at 5% probability. The means were separated using Tukey's method while the growth curve was drawn with Microsoft excel office 2016. The statistical tool used was Minitab Release 14 (Pennsylvania, USA)

Results

The results of the 56 day feeding trial did not show significant differences ($p<0.05$) in the water quality indices among treatments. The water temperature, dissolved oxygen, pH and conductivity ranged from 24.4-27.9 °C, 4.0-6.0 mg/ l, 5.87 -7.47 and 254-325 mg/ I, respectively. However, the results on the growth parameters indicated significant differences ($p<0.05$) among treatments. Diet 1 (0% cooked tamarind meal & 100% soyabean meal) gave the

best weight gain (3.78 g) followed by diet 3 (100% cooked tamarind meal) with a value of 2.74 g while diet 2 gave the lowest weight gain (1.55g). Similar trends were observed in the specific growth rate, protein efficiency ratio and apparent net protein utilization. However, the feed conversion ratio was significantly low ($p<0.05$) for diet 1 while there was no significant difference ($p>0.05$) between diets 2 and 3. Diet 3 gave the highest survival percentage as against diets 2 and 3 which were significantly low (Table 2).

Table 2: Growth parameters for *Clarias gariepinus* fingerlings fed cooked *Tamarindus indica* meal for 56 days.

Growth Parameters	Diet 1 (0% CTM)	Diet 2 CTM/50% SM)	Diet 3 (100% SM)	Mean SD
Initial weight (g)	$3.64^{a}\pm0.35$	$3.51^{a}\pm0.16$	$3.78^{a}\pm0.18$	0.14
Final weight (g)	$7.41^{a}\pm1.67$	$5.04^{c}\pm0.83$	$6.52^{b}\pm0.40$	1.10
Mean weight gain(g)	$3.78^{a}\pm1.63$	$1.55^{c}\pm0.54$	$2.74^{b}\pm0.58$	1.07
Feed conversion ratio	$0.79^{a}\pm0.28$	$1.54^{b}\pm0.75$	$1.56^{b}\pm0.43$	0.52
Specific growth rate(%/day)	$1.25^{a}\pm0.39$	$0.64^{c}\pm0.28$	$0.97^{b}\pm0.28$	0.25
Protein efficiency ratio	$3.34^{a}\pm1.18$	$1.85^{c}\pm0.91$	$2.56^{b}\pm1.03$	1.05
Apparent net protein utilization (ANPU) (%)	$2.05^{a}\pm0.68$	$1.44^{c}\pm1.05$	$1.93^{b}\pm1.11$	0.97
Survival rate (%)	$33.33^{b}\pm0.00$	$36.67^{b}\pm14.14$	$80.00^{a}\pm18.85$	13.61

Data in the same row with different superscript letters are significantly different ($p<0.05$) from each other.
Mean in the same column with same letter are not significantly different ($p>0.05$)
CTM =cooked tamarind meal; SM = soyabean meal

Table 3: Proximate Composition of *Clarias gariepinus* fingerlings fed experimental diets for 56 days

Composition (%)	Initial	Final			
		Diet 1 (0% CTM)	Diet 2 CTM/50% SM)	Diet 3 (100% SM)	SD±
Moisture	$15.41^{a}\pm0.01$	$13.7^{b}\pm0.39$	$7.35^{c}\pm1.56$	$7.60^{c}\pm0.85$	1.04
Crude protein	$57.76^{b}\pm0.01$	$59.68^{b}\pm0.25$	$63.00^{a}\pm7.43$	$60.38^{b}\pm1.24$	4.35
Crude lipid	$12.26^{c}\pm0.01$	$13.25^{b}\pm0.78$	$14.00^{b}\pm2.12$	$15.45^{a}\pm0.21$	1.31
Crude ash	$14.53^{a}\pm0.01$	$13.62^{a}\pm0.28$	$4.55^{b}\pm0.78$	$5.75^{b}\pm1.34$	0.91

Mean in the same row with different letters are significantly different ($p<0.05$) from each other.
Figure 1 depicts the growth response of the test diets as *Clarias gariepinus* fingerings exhibited best growth curve on diet 1 followed by diet 3 while diet 2 gave the lowest response.

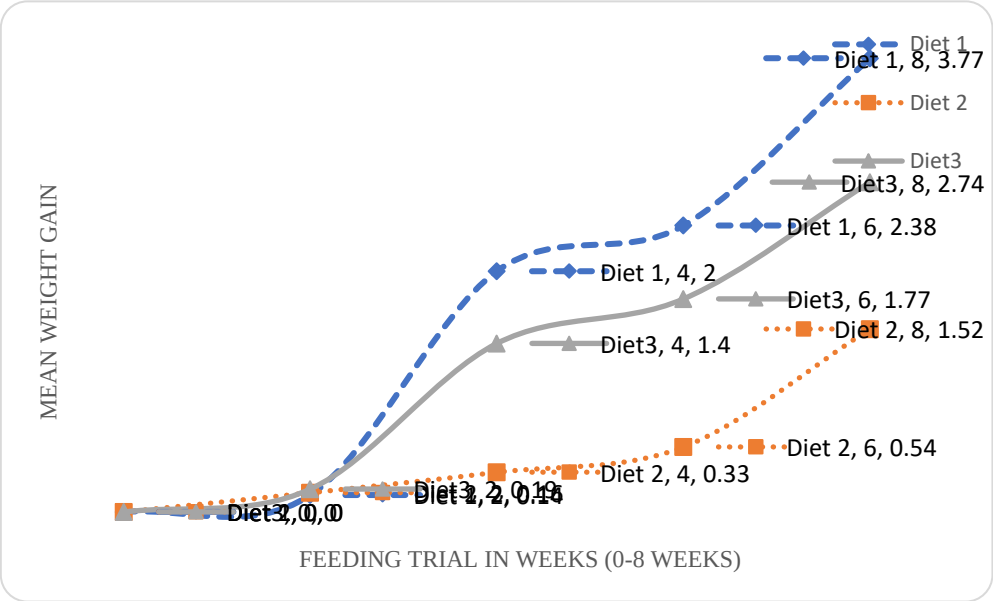

Figure 1. Growth response for *Clarias gariepinus* fingerlings fed experimental diets

The body compositions also exhibited significant differences ($p<0.05$) among treatments. The body moisture was significantly high ($p<0.05$) for diet 1 than diets 2 and 3 that are not significantly different ($p>0.05$) from each other. The body crude protein was significantly high ($p<0.05$) for fishes fed diet 2 while there were no significant differences ($p>0.05$) between diets 1 and 3. However, diets 3 was significantly high ($p<0.05$) in body crude lipid while there were no significant differences ($p>0.05$) between diets 1 and 2. Moreover, the body ash content was significantly high ($p<0.05$) for fishes fed diet 1 while there were no significant difference ($p>0.05$) between diets 2 and 3.

Discussion

The proximate composition of ingredients revealed soyabean meal having the highest Crude protein and Ash content value (Table 1). Cooked *Tamarindus* seed meal (CTM) had the highest value of crude lipid and crude fibre.It also showed the proximate composition of experimental diets, with diet 1 having the highest moisture content and subsequently reduced as the inclusion level of CTM increased indicating that moisture content reduces with increase in plant material. This finding agrees with Fagbenro (1999) and Francis *et a*l. (2001) who reported that anti-nutrients in plant protein sources may be reduced by processing to enhance its palatability and nutrient utilization for growth in fish. Cooked tamarindus seed meal was an acceptable source of protein in the diets for *Clarias gariepinus* fingerlings within the conditions of this experiment.

The ingredient was used at various inclusion levels in the experimental diet without adverse effect on the growth and survival rate as presented in the Table 2. The growth performance has been shown to vary among fish species and experimental conditions owing to the suitability of the inclusions of the diet (El-Sayed, 1999). The best performance was shown by fish fed diet 1 (0% inclusion of CTM) which is the control for the experiment, followed by diet 3 (100% inclusion of CTM) and the least performed was fish fed diet 2 (50% inclusion of CTM) (figure 1). A reduction in all the growth and nutrient utilization parameters measured was observed in the fish fed CTSM diet 2. This may be attributed to the presence of anti-nutritional factors from soyabean and tamarind (Azzaza *et al*., 2011; Akande, 2010; Reddy and Pierson, 1994; Aderibigbe *et al*., 1997 and Abo-state *et al*., 2009) where the authors reported that anti-nutrients render some major nutrients inactive, by the distortion of the digestive process or metabolic utilization of feed which exerts some effect contrary to optimum nutrition as observed in this study with respect to diet 2. Feed was better converted in diet 1 and protein efficiency was higher in diet 1 while diet 3 showed the fish effectively utilized the protein in the ingredients from the diets which also signified the digestibility of the test ingredient (Abo-sate *et al*., 2009 and Hajos *et al*., 1995).

There was a higher survival rate in diet 3 (100% inclusion of CTM) than the other experimental diets (soybean based-diets) which is in agreement with previous workers (El-Sayed, 1999; Francis *et al.*,2001) who reported that soybean meal does contain some anti-nutritional factors (such as trypsin, lectins, anti-vitamins, phytic acid, saponins and phytoestrogens) which could have been harmful to the fish, hence their survival rate of 33.33% and 36.67% for diets 1 and 2 respectively. The proximate composition of the whole body of the fish fed the experimental diet in this study agrees with Ogbonna and Orire (2015) and Orire *et al*. (2015) in nutrients utilization in terms of body fat which was inversely related to body moisture content.

CONCLUSION AND RECOMMENDATION

This study demonstrated that growth performance and nutrient utilization of this study gave an overall better result in diet 1 (100% soyabean meal) and diet 3 (100% cooked *Tamarindus indica* seed meal, while diet 2 (50% CTM) performed poorly. Therefore, cooked *Tamarindus indica* seed meal can be included in fish feed up to 100% as replacement for soyabean.

RECOMMENDATION

Further experiment should be conducted to establish best inclusion level of *Tamarindus indica* meal as replacement for soyabean meal in the diet of *Clarias gariepinus* fingerling.

REFERENCES

Abo-state H. A., Tahoun, A. M., and Hammouda, Y.A. (2009). Effect of replacement of soybean meal by DDGS combined with commercial phytase on Nile Tilapia. (*Oreochromis niloticus*) fingerlings Growth performance and feed utilization. *American European Journal of Agriculture and Environmental Science*, 5:437-479.

Aderibigbe, A.O., Jonson, C.O., Makkar H.P.S, Becker, K, and Foidl N. (1997). Chemical composition and effects of heat on organic matter- and nitrogen-degradability and some anti-nutritional components of Jatropha meal. *Animal Feed Science and Technology*, 65:223-243

Akande, K E: Doma, U. D., Agu, H.O. and Adamu, H.M. (2010). Major anti-nutrients in plant protein sources: their effect on nutrition. *Pakistan Journal of Nutrition*, 9 (8): 827-832

Association of Official Analytical Chemist (AOAC) (2007). Official methods of analysis (17thedn, AOAC), Gaithersburg, MD.

Azzaza, N.A.E., El-Nisr, N.A, Elsharkawy, E.E., and Elmotleb E.A.(2011). Chemical and Pathological Evaluation of *Jatropha curcas* Seed Meal Toxicity with or without heat and chemical treatment. *Australia Journal of Basic and Applied Science*, 5: 49-59.

Belewu, M.A., Muhammed, N.O., Ajayi, F.T. and Abdulgafar, D.T. (2009). Performance characteristics of goat fed Trichoderma-treated feather meal-rice husk mixture. *Animal Nutrition and Feed Technology*, 9:203–208.

Bender, A.E. and Miller, D.S. (1953). A brief method of estimating net protein value. *Biochemical Journal*, 53: vii.

Brown, M.E. (1957). Experimental Studies on growth. In: Hoar, W.S and D.J Randell (Eds.) Physiology of Fishes. *Academic Press New York*. 361-400 pp.

Best, P. (2011). World Feed Panorama: Expensive grain slows industry expansion. *Feed International*, Jan.–Feb. 2011:10–12.

El-Sayeed, A.F.M. (1999). Alternative Dietary Protein sources performed tilapia *Oreochromis* SPP. *Aquaculture*,179:149-168.

FAO (2012). The State of World Fisheries and Aquaculture Part I: *World Review of Fisheries and Aquacultur*e, Rome, Italy

Farris, D.G., Singh, U. (1990). Pigeon Pea. In: L. Nene *et al*. (eds). The Pigeon pea, Pantancheru AP, 502324. India. ICRISAT. p. 467.

Fagbenro, O. A. (1999). Comparative evaluation of heat processed winged bean (*Psophocarpus tetragonolobus*) meals as partial replacement for fishmeal in diets for African catfish (*Clarias gariepinus*). *Aquaculture*, 170:297-305.

Fapohunda, O. O. and Fagbenro, O. A. (2006). Biotechnical factors affecting tilapia culture systems in the savanna region of Nigeria. Proceedings of the south international symposium on Tilapiain aquaculture, Veracruz, Mexico.

Francis, G., Makkar, H.P.S. and Backer, K. (2001). Anti-nutritional factors present in derived alternate fish feed ingredients and their effects in fish. *Aquaculture*, 199.

Halver, J.E. (ed) (1989). Fish Nutrition, 2nd ed. Academic Press, New York, 875pp.

Hajos, G., Gelenser, E., Pusztai, A., Grant, G. and Sakhri, M. (1995). Biological effects and survival of trypsin inhibitors and agglutinin from Soybean in small intestine of the rat. *Journal of Agriculture and Food Chemistry*, 43: 165-170.

Lovell, R.I. (1981). Escalating feed costs requires more efficient fish feeding. *Aquaculture*, 75: 38- 42.

Maynard, L.A., J.K. Loosli, H.F. Hintz and R.G. Warner (1979). Animal Nutrition, 7th edition, pp: 13–4.McGraw Hill, New York

Miller, D.S and Bender, A.E. (1955). The Determination of the Net Protein Utilization by a Shortened Method. *British Journal of Nutrition*, 9:382 – 388.

Ogbonna, C.K. and A.M. Orire (2015). Growth and Composition of Catfish (*Clarias gariepinus*) Fingerlings fed Graded Inclusion Levels of Raw Locust Bean Meal (*Pakia biglobosa*) as Replacement for Fish Meal. Proceedings of the30th Annual Conference of Fisheries Society of Nigeria, ETF Lecture Theatre, Delta State University, Asaba, Delta State. 22nd -27th November, 2015 pp 273-276

Orire, A.M. and Muhammad, R. (2014). Growth Performance of *Clarias gariepinus* fingerlings fed graded Inclusion of Fermented Locust Bean *(Pakia biglobosa*) Proceeding of International Conference in Recent Advances in Agricultural, Biological and Environmental Sciences (AABES ,2014) edited by Prof. Dr. Md, Aminur Rahman, Prof. Dr. Rahim Ahmadi organized by International Institute of Chemical, Biological and Environmental Engineering held at Holiday Inn Dubai-Downtown Dubai, Al Rigga Road, Dubai-United Arab Emirates between 15-16th October,2014 pp 79-87.

Orire, A.M. and Ozoadibe, T.N. (2015). Evaluation of Growth Performance and Body Composition of *Clarias gariepinus* fed graded level inclusion of soybean waste. *Journal of Fisheries and Aquatic Science*, 10 (5):384-391.

Orire, A.M. Sadiku, S.O.E. and Gana, S.N. 2015. Evaluation of growth performance and body composition of *Clarias gariepinus* fingerlings fed graded level of bambara nut meal (*Vigna substrareana*). *Journal of Agriculture and Food Technology*, 5(3) 7-13.

Osborne, T., Mendel, L. and Ferry, E. (1919). A method for expressing Numerically the Growth Promoting Value of Proteins. *Journal of Biochemistry*, 37:223 – 229.

Peisker, M. (2001). Manufacturing of soy protein concentrate for animal nutrition. Cahiers options Méditerranéennes, 54:103–107

Reddy, N.R. and Pierson, M.D. (1994). Reduction in antinutritional and toxic components in plant foods by fermentation. *Food Resource International*, 27: 281-290

Ridha, M.T. (2006). Comparative study of growth performance of three strains of Nile tilapia, *Oreochromis niloticus*, L. at two stocking densities. *Aquaculture Resource*, 37: 172-179.

Robinson, E.H., Menghe, H.L. and Manning, B.B. (2001). A Practical Guide to Nutrition Feeds and Feeding of Catfish. Bulletin 1113. Office of Agricultural Communications, Division of Agriculture, Forestry and Veterinary Medicine, Mississippi State University, U.S.A. 39 p.