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Isiaka, B.T. (1998). Livestock rearing practices and problems in Lagos. In: Oduguwa O.O., Fanimo, A.O. and Osinowo, O.A (Eds). *Proceedings of the Silver Jubilee Anniversary Conference*, Nigerian Society for Animal Production, Gateway Hotel, Abeokuta, Nigeria. Pp. 223-225.

Stem, E., Mertz, G.A., Stryker, J.D. and Huppi, M. (1989). Changing animal disease patterns induced by the Greenhouse Effect. In: Smith, J. and Tirpack, D.A. (Eds.). *The Potential Effects of Global Change on the United States*. Appendix C, Agriculture, Volume 2. US Environmental Protection Agency, Washington, D.C., USA. Pp. 11-38.

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Original Research Article

Constraints to Pap Processing, and Safety Practices in Ndokwa West Local Government Area of Delta State, Nigeria

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Abstract

The constraints to pap processing, and safety practices in Ndokwa West Local Government Area of Delta State, Nigeria were examined. Five (5) respondents were randomly selected from each of ten (10) villages in the local government making a total of fifty (50) respondents that constituted the sample for this study. Data were collected through the use of a structured questionnaire. Data were analyzed with descriptive statistic, and presented as simple percentages and means. The socioeconomic characteristics of the respondents revealed that majority of the pap processors were females (90%) and had a mean age of 20 years. As much as 80% of the respondents had formal education. The result also showed that majority of the respondents carried out hygiene practices that are needed in pap processing. Inadequate training/education, laziness and lack of equipment (mean = 3.60, 3.04, 2.94 respectively) were the three most serious constraints faced by the pap processors. Also the majority of respondents agreed that the major benefits derived from pap were that is good for people with high blood pressure (mean=4.02), good for nursing mothers (mean=3.66), babies (mean=3.64), is a raw and natural (mean=3.54) among others. It was recommended that farmers should be trained on how to better process pap and should be encouraged to keep on practicing good hygiene in the study area.

Keywords: constraints, pap, processing, safety, practice

Introduction

Food processors are sometimes deficient in knowledge about critical cooking temperatures, storage temperatures, cross-contamination between raw and cooked food and personal hygiene (Jianu and Chis, 2012). Thus, insufficient knowledge about food hygiene and safety and inadequate use of modern processing techniques among food processors and sellers are primary causes of elevated risks of food-borne illnesses.

Pap, which is popularly known as *Ogi* or *Akamu* in Nigeria, is known to be one of the favourite foods consumed by several households in the country. It is produced from Guinea corn, maize, millet and sorghum. It is the starchy product obtained from these starchy grains after they have been soaked in water overnight, washed, ground, filtered and excess water pressed out of the starch. It can be prepared with hot water, and eaten with legumes such as cowpeas, or with foods produced from cowpeas, such as *Akara* (bean cake) and *Moi-moi* (bean pudding). It can as well be taken alone without combining with anything, or by adding milk and a sweetener like sugar or honey.

Pap processors, especially in rural Nigeria, are often uneducated and have little or no knowledge about safe handling of foods (Lues *et al*., 2006). Grace (2005) stated that ensuring food safety has been a major challenge in developing countries, given limitations in management systems and law enforcement as well as in individuals' knowledge and behavior. Food safety issues have been a worldwide problem for a long time now. Large population of people are affected by food-borne and health-related complications annually (Klimpel *et al.* (2019). This study was therefore undertaken to examine workplace hygiene practices, identify constraints to food safety, and identify the benefits of pap to people in Ndokwa West Local Government Area (LGA) of Delta State, Nigeria.

Methodology

The study was conducted in Ndokwa West Local Government Area of Delta State. Agriculture is the major occupation of the people. A simple random sampling technique was used to select ten (10) villages in Ndokwa West LGA namely, Abbi, Imam-Abbi, Ndemili, Oliogo, Utagba-uno, Isumpe, Etua-uno, Umusedeli, Umuseti and Umusadege, making a sample size of fifty (50) pap processors. The acceptance level for the distribution was mean point of 2.50 for the Likert scale. The instrument for data collection was a structured questionnaire combines with scheduled interviews. Data collected on the socioeconomic characteristics of the respondents, their hygiene practices, constraints faced, and benefits derived from the business were analyzed descriptively.

Results and Discussion

Socioeconomic characteristics of respondents

The result in Table 1 shows that majority of the respondents were females. The mean age of the respondents was 20 years, while 30% of them were married. As much as 80% of the respondents had formal education, while the average household size was 7 persons.

The implication is that a majority of the respondents had basic education, meaning they could read and write and, as such, capable of accessing and understanding good food safety practices.

Hygiene practices of pap processors

The result on hygiene practices (Table 2) revealed that 88% of the respondents washed their hands after using the restroom while 12% did not; about 70% of them covered their dustbins at all times while 30% did not. A little over half of them (52%) habitually kept a cleaning checklist, 94% separated fresh produce from ready-to-consume ones, and about 84% of them washed their hands after handling raw materials. It can be said, therefore, that most of the respondents carried out hygiene practices that are needed in pap processing in the study area. This is in consonant with a similar finding by Jeffrey and Maria (2013).

Table 1: Socioeconomic characteristics of respondents

Variable	Frequency	Percentage	*Mean/Mode
Gender			
Male	5	(10.0%)	
Female	45	(90.0%)	Female
Age			
21 – 30	6	(12.0%)	*20 years
31 – 40	25	(50.0%)	
41 - 50	15	(30.0%)	
51 – 60	2	(4.0%)	
60 and above	2	(4.0%)	
Marital status			
Single	5	(10.0%)	
Married	30	(60.0%)	Married
Divorced	5	(10.0%)	
Widowed	10	(20.0%)	
Level of Education			
No formal Education	10	(20.0%)	
Primary Education	13	(26.0%)	
Secondary Education	25	(50.0%)	Secondary
Tertiary	2	(4.0%)	Education
Household size			
1 – 4 persons	20	(40.0%)	
5 – 8 persons	27	(54.0%)	7 persons
Above 8	3	(6.0%)	

Source: Field Survey, 2022

Table 2: Hygiene practices of pap processors

Items	Yes	No	Total
Washing of hands after using the rest room	44 (88.0%)	6 (12.0%)	50 (100%)
Covering of dustbins at all times	35 (70.0%)	15 (30.0%)	50 (100%)
Checklist cleaning	26 (52.0%)	24 (48.0%)	50 (100%)
Separation of fresh produce from ready to consume pap	47 (44.0%)	3 (6.0%)	50 (100%)
Washing of hands after handling raw materials	42 (84.0%)	8 (16.0%)	50 (100%)

Source: Field Survey, 2022

Constraints to pap safety practices

The result in Table 3, shows that inadequate training/education (3.60), laziness (3.04) and lack of equipment (2.94) were the three most serious constraints faced by the pap processors. Others included, inadequacy of time (2.90), lack of raw materials (2.76), and inadequate water supply (1.60).

This implies that majority of the respondents in the study did not have access to training opportunities, perhaps from extension agents, and had probably become lazy, as a result. They also lacked modern processing equipment, lagged behind in terms of processing time, and had problems with accessing the required grains for pap processing. Lues *et al.* (2006), in their study on food safety and associated food handling practices in street food vending, stated that food processors are often uneducated and have little knowledge about safe handling of food.

Table 3: Constraints to pap safety practices

Items	SA	A	SD	D	Scores	Mean	Remark	Ranks
Inadequate training/education	35 (70.0%)	10 (20.0%)	5 (10.0%)	-	180	3.60	Accepted	1st
Inadequate water supply	-	3 (6.0%)	34 (68.0%)	13 (26.0%)	80	1.60	Accepted	6th
Lack of equipment	22 (44.0%)	12 (24.0%)	7 (14.0%)	9 (18.0%)	147	2.94	Accepted	3rd
Inadequacy of time	19 (38.0%)	14 (28.0%)	10 (20.0%)	7 (14.0%)	145	2.90	Accepted	4th
Laziness	24 (48.0%)	8 (16.0%)	14 (28.0%)	4 (8.0%)	152	3.04	Accepted	2nd
Lack of raw materials (grains)	34 (68.0%)	14 (28.0%)	-	-	138	2.76	Accepted	5th

Source: Field Survey, 2022

This implies that majority of the respondents in the study did not have access to training opportunities, perhaps from extension agents, and had probably become lazy, as a result. They also lacked modern processing equipment, lagged behind in terms of processing time, and had problems with accessing the required grains for pap processing. Lues *et al.* (2006), in their study on food safety and associated food handling practices in street food vending, stated that food processors are often uneducated and have little knowledge about safe handling of food.

Benefits of Pap

The result in Table 4 shows that the majority of respondents agreed that the major benefits derived from pap was that it is good for patients with high blood pressure (4.02), good for

Table 4: Respondents' opinions about the benefits of pap

Items	SA	A	SD	D	Scores	Mean	Remark	Rank
It is raw and natural.	34 (68.0%)	11 (22.0%)	3 (6.0%)	2 (4.0%)	177	3.54	Accepted	4th
It is nutritious compared to custard.	31 (62.0%)	14 (28.0%)	5 (10.0%)	-	176	3.52	Accepted	5th
Good for patient with high blood pressure.	33 (46.0%)	18 (36.0%)	6 (12.0%)	3 (6.0%)	201	4.02	Accepted	1st
It contains fibre.	25 (50.0%)	13 (26.0%)	2 (4.0%)	10 (20.0%)	153	3.06	Accepted	7th
Good for nursing mother.	33 (66.0%)	17 (34.0%)	-	-	183	3.66	Accepted	2nd
Good for babies.	38 (76.0%)	10 (20.0%)	-	2 (4.0%)	182	3.64	Accepted	3rd
Good for adults	25 (50.0%)	17 (34.0%)	5 (10.0%)	3 (6.0%)	164	3.28	Accepted	6th
Pap contains potassium.	20 (40.0%)	6 (12.0%)	11 (22.0%)	13 (26.0%)	133	2.66	Accepted	8th

Source: Field Survey, 2022

nursing mothers (3.66), and for babies (3.64). It is also believed to contain potassium (2.70), be good for nursing mothers (3.66), and to be raw and natural (3.54). Other benefits mentioned included the following: it is more nutritious than custard (3.52), is good for adults (3.28), contains fibre (3.06) and potassium (2.66). The implication is that pap is good for patients with high blood pressure, good for nursing mothers and is a nutritious food that is good for all categories of people to consume. This is in conformity with Nwokolo (2020) who stated that pap is rich in essential nutrients including folic acid, potassium and vitamins.

Conclusion

Pap processing in Nigeria is known to be very profitable venture as it can help to solve financial worries of families that are involved in it while making huge profit from it. The result from the findings revealed that majority of the respondents from the study area practiced good hygiene while carrying out their pap processing activities. Thus, Pap processors should at all times adhere to the safety practices of processing pap in order to avoid the pap being contaminated and harmful to human. Processed pap has numerous benefits to humans, especially to babies and patients with high blood pressure. It is recommended that more rural farmers should be trained on how to process pap and should be more encouraged to keep on practicing good hygiene.

References

Grace, D. (2015). Food safety in low and middle income countries. *International Journal of Environmental Research and Public Health* 12(9): 10490 – 10507.

Jeffrey A.G. and Maria N.G. (2013). Processing maize flour and corn meal. *Annals of the New York Academic of Sciences* 1312(1). DOI: 10.1111/nyas.12299.

Jianu, C. and Chis, C. (2012). Study on the hygiene knowledge of food handlers working in small and medium-sized companies in Western Romania. *Food Control* 26: 151 – 156.

Klimpel, T., Kuhu, J., Munster, D.D., Dorge, R.., Klapper and Kochman, J. (2019). *Parasites of Marine Fish and Cephalopods. A Practical Guide.* Pp. 149-155. Springer, Berlin.

Lues, J.F.R., Rasephel, M.R., Venter, P. and Therou, M.M. (2006). Assessing food safety and associated food handling practices in street food vending. *International Journal of Environmental Health Research* 16(5): 319-328.

Nwokolo, C. (2020). Eight confined health benefits of pap. https://web.facebook.com/healthguidengr/posts/3159480744132840/?_rdc=1&_rdr

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Iworh and Ovwigho, 2023

Original Research Article

Attitude and Willingness of Arable Farmers Toward Commercialization of Public Agricultural Extension Services in Delta North, Agricultural Zone Delta State, Nigeria

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Abstract

The study investigated the attitude and willingness of arable farmers towards commercialization of public extension services in Delta North Agricultural Zone of Delta State, Nigeria by specifically describe the socioeconomic characteristics of the arable farmers, examining farmers' willingness to pay for public extension services, and determining their attitude towards commercialization of public extension services in the study area. A simple random sampling technique was used to select the 224 respondents used for the study from a population of registered arable farmers. Primary data were collected using interview schedules, and analyzed by the use of Percentage, Mean, Pearson r, Chi Square test and Logistic Regression. Most of the respondents were within the 35 - 44-year age bracket, had arable farming (45.5%) as the most important income-generating activity, were males (51.8%), married (62.5%), and had one form of formal education or the other, (90.6%). Full-time farmers constituted only about a fifth (21.0%) of the respondents, while as much as 79.9% of the respondents had been farming for 6 years or more. Farmers with 4-6 persons per household (50.4%) were the most prevalent, while those who owned personal plots of farm (50.0%) were as much as those who did not (50.0%). As much as 73.7% of the respondents were willing to pay for public extension services. The farmers chose positive attitude statements toward the commercialization of public extension services (Grand Mean = 3.11) and disagreed with the negative attitude statements (Grand Mean = 2.73). There was a significant relationship between willingness to pay for public extension services and levels of education (X^2 = 148.55; p = 0.00), and a significant relationship between attitude to commercialization and household size (t = -2.568, p = 0.012). By these findings, it was recommended that the government should begin a gradual process of commercialization of public extension services in Delta north Agricultural Zone with a view to transferring the practice to the whole state.

Keywords: Attitude; Commercialization; public; extension; services; farmers

Introduction

Background of the Study

According to Asiabaka (2012) and Williams *et al.* (1984), agricultural extension as an out of school educational programme for farmers and their families. Extension services are provided by Organizations which assists farm people, through education, to improve farming methods and techniques, increase production efficiency and income, improve standards of living as well as social and educational status. Extension Organizations facilitate access of farmers, their families as well as relevant social groups, to knowledge, information, technologies and methods of improving yield with the ultimate aim of achieving agricultural development. These Organizations bring about a shift from traditional methods of production to new technological components (new varieties, improved cultural practices, chemical Fertilizers and pesticides), crops and new farming systems (Madukwe and Erie, 1999).

According to Swanson and Rajalahti (2010) the term extension was first used to describe adult education programmes Organized by the Oxford and Cambridge Universities in England in 1867. These educational programmes helped extend the work of the Universities beyond the institutions to the farmers. This term was formally adopted in the United States in conjunction with the Land Grant Universities that were originally established as teaching institutions during the early 20th century. The United Kingdom transferred the responsibility for agricultural extension activities to the Ministry of Agriculture. These activities were then referred to as advisory services. According to CTA (2011) and USAID (2011) extension and advisory services were designed to help farmers boost crops and livestock production, and enabled farmers to adopt new technologies for increased production and profitability.

Public agricultural extension describes the agricultural activities provided by government authorities including Ministries of Agriculture and Natural Resources, and the Agricultural Development Programme (ADP) in all states of the Federation. These public Organizations have predominantly dominated the extension services terrain in Nigeria for many years, and are supposed to have fostered a sustainable and dynamic approach to agricultural development (Agwu, *et al* 2008).

Akinsorotan (1998), Lele (1999), World Bank (2000) Omotosho and Oladele (2000), Kuponiyi *et al.* (2004), Adefarasin (2008) and Erie (2009) observed the increasing involvement of private companies in providing extension services in Nigeria. These companies like Shell Petroleum Development Company of Nigeria carry out their extension services as a part of their corporate social responsibilities, with little or no payment expected from benefiting farmers for services rendered.

The impact of public extension services is by no means impressive, with farmers and extension agents and agencies trading blames. Farmers are often blamed for not responding to extension delivery services, due to inherent stereotypes, poor levels of education, fear of adopting new technologies etc. The farmers, on the other hand, consider services rendered by the government extension agents as lacking effectiveness and efficiency. Many farmers have reported poor quality of services delivered, in terms of content, timeliness of input supply and their level of commitment to extension activities. High costs, irregular visits by extension workers and late supply of inputs such as fertilizers are among the many factors that hinder response of farmer to

public extension services (Agunga, 2017). Agbamu (2006) also asserted that the low ratio of 1: 300 extension agent to farmers in Nigeria was a main challenge of extension service delivery in Nigeria. Njoku (2003) affirmed that institutional inefficiencies in extension organizations were often the major reasons why farmers do not adopt farming innovations.

As noted by Rivera and Cary (2000), public agricultural extension delivery systems are under growing fiscal pressure arising from dwindling resource allocation by governments to extension services, and face bureaucratic bottle-necks associated with running public-sector-driven extension service. They emphasized that the situation calls for a paradigm shift to complete or partial privatization of extension services like in the Netherlands, New Zealand, Peru and in the UK. However, what is likely to be the attitude and willingness to pay for the services of public or private agricultural extension services by Nigerian farmers who, over the years, have been accustomed to not paying for such services?

Attitude is a psychological disposition to stimuli which usually results into feelings of like or hatred, pleasant or unpleasant, favourable or unfavourable, acceptable or unacceptable (Eagly and Chaiken, 1993; Ajzen, 1991; Ovwigho and Ifie, 2009). The study is therefore devoted to investigating the attitude and willingness of arable farmers to pay for public agricultural extension services.

Objectives of the Study

This study seeks, specifically, to (i) describe the socioeconomic characteristics of arable farmers in the study area, (ii) determine farmers' attitude towards commercialization of public extension services, and (iii) examine farmers' willingness to pay for public extension services.

Hypotheses

The following null hypotheses were tested in the course of the study:

Ho_1: There is no significant relationship between willingness to pay for public extension service and educational level of the arable farmers.

Ho_2: There is no significant relationship between attitude to pay for public extension services and socioeconomic characteristics of the arable farmers.

Methodology

Area of Study

This study was conducted in Delta North Agricultural Zone of Delta State, Nigeria. Delta North Agricultural Zone is one of the three agricultural zones in Delta State. The state is located in the Niger Delta area of Nigeria. Delta State is situated within longitudes 5.00'' and 6.45'' East and latitudes 5.00'' and 6.30'' North. Delta North is made up of nine Local Government Areas (LGAs) namely Oshimili South, Oshimili North, Aniocha South, Aniocha North, Ndokwa East, Ndokwa West, Ika South, Ika North East and Ukwani. According to the National Population Commission (2006) the population of Delta North Agricultural zone was approximately 1,236,840 persons.

Sampling Technique and Sample Size

The study was a survey research design. Simple random sampling done in stages was used to select blocks, cells and respondents. Registered arable farmers with the Delta Agricultural and Rural Development Agency, Asaba constituted the sampling frame. Thus the sampling frame was 448 arable farmers. The study was made up of nine (9) blocks. Fifty (50) percent each of the blocks and 50% of registered farmers were randomly selected to compose the sample. This gave a sample size of 224 arable farmers.

Method of Data Collection

Interview schedules were organized to collect data on socioeconomic characteristics, willingness to pay for extension services and attitude to commercialization of public extension services from the respondents, after subjecting the instrument to validity and reliability tests.

Measurement of Variables

Attitude to commercialization was measured with a 4 – Point Likert Type Scale. Positive and negative statements were constructed as used by Ovwigho and Ifie (2009).

Method of Data Analysis

The data obtained were analyzed by use of descriptive and inferential statistics. Objectives (i) and (iii) were achieved with frequency counts, percentages, means, modes and medians. Objectives (ii) was achieved by mean scores derived from the 4-point Likert type scale. Hypotheses one and two were achieved by the Chi Square test and multiple regression respectively.

Results and Discussion

Socioeconomic Characteristics of Respondents

The socioeconomic characteristics of the respondents are presented in Table 1. From the results, almost 60% of the respondents were within the 35 - 44-year age bracket (mean and mode = 41.1 and 40.0 years respectively). This means that the arable farmers were within the active and working ages, and therefore considered strong enough to withstand the physical strain of farming activities, and to have the mental capacity to learn new technologies.

The three most important primary income-generating activities were arable farming (45.5%), poultry farming (25.4%), and fish farming (25.0%), while casual labour (40.2%), motorcycle transportation (*Okada* riding) (31.3%), and hair plaiting/barbing were the three most important secondary income-generating vocations which provide income to farmers during the off season of primary production.

Among the respondents there were more males (51.8%) than females (48.2%). A majority of the respondents were married (62.5%), thus implying a good proportion of responsible farmers in the group, while 90.6% of the respondents had one form of formal education or the other, with most of them (60.7%) having secondary school certificates (WASSCE/SSCE). This is an indication that most of the farmers were moderately educated. As expected under conditions of economic distress, full time farmers constituted only about a fifth (21.0%) of the respondents, while part-time and seasonal farmers made up 55.4% and 23.7% respectively.

Table 1: Socioeconomic characteristics of the arable farmers (n=224)

Characteristics	Freq.	%	Mean/ Mode	Characteristics	Freq.	%	Mean/ Mode
Age				**Sex**			
20 – 34	8	3.6	40	Male	116	51.8	Male
35 - 44	134	59.8		Female	108	48.2	
45 – 54	24	10.7		**Land Ownership**			
55 – 64	38	17.0		Owned Land	112	50	
Above 65	20	8.9		On Lease	112	50	
Primary Income Generating Activities				**Secondary Income Generating Activities**			
Arable farming	102	45.5	Arable	Okada Riding	70	31.3	Causal
Poultry farming	57	25.4	Farming	Casual Labour	90	40.2	Labour
Fish Farming	56	25.0		Hair Plaiting/Barbing	35	15.6	
Sheep/Goat Production	9	4.1		Petty Trading	29	12.9	
Marital Status				**Household size**			
Single	70	31.3		1-3	67	29.9	
Married	140	62.5	Married	4-6	113	50.4	4-6
Divorced	12	5.4		7-9	32	14.3	
Widowed	2	.9		Above 10 years	48	21.4	
Level of Education				**Religion**			
No formal Education	21	9.4		Christianity	174	74.7	Christianity
Primary School	31	13.8	WASSC	Islam	28	12.5	
WASSCE/SSCE	136	60.7	E/SSCE	Traditional Religion	16	71	
Tertiary Institution	36	16.1		**Experience (years)**			
Farming Status				1-5 years	45	20.1	
Full time	47	21.0	Part	6-10 years	131	58.5	6-10 years
Part time	124	55.4	time	Above 10 years	48	21.4	
Seasonal Farming	53	23.7		None	6	2.7	

As much as 79.9% of the respondents had been farming for 6 or more years, with the bulk of them within the 6-10 years' experience bracket. Farmers with 4-6 persons per household (50.4%) were the most prevalent. This implies that the respondents had fairly large household sizes. Respondents who owned personal plots of farm (50.0%) were as much as those on leasehold plots of lands (50.0%).

Willingness to Pay for Public Extension Services

Results about the willingness of the farmers to pay for public agricultural extension services, presented in Table 2, indicate that most (73.7%) of the arable farmers were willing to pay for extension services while 26.3% were not willing to pay. Rivera (1992), Ameur (1994), Rivera (1996) and Qamar (2000) enumerated various advantages of commercialization of public extension services from various countries.

Table 2: Response on Willingness to Pay for Public Extension Services

Statement	Response	Frequency (Percentage)	Remarks
Are you willing to pay for Extension services	Yes	165 (73.7%)	Willing
	No	59 (26.3%)	

Attitude to Commercialization of Public Agricultural Extension Services

Attitude to commercialization of public agricultural extension services was measured by both negative and positive statements in order to remove bias.

Positive Attitude Measurement

In Table 3, the arable farmers showed a positive attitude to commercialization of public extension services in all the statements. The Grand Mean for positive attitude measurement was 3.11. The item with the highest rating was that payment for extension services would motivate them to adopt arable crop technology (3.24) while the item with the lowest rating was that commercialization of public extension services is possible in a regulated economy (mean =2.88).

In a similar study, Madukwe (1995) found that among the administrative issues suffered in the public extension system were irregular salary payment for the extension workers, and absence of incentives to motivate and boost the morale of extension agents. In views expressed by Omagbemi (1998) and Agwu and Chukwuone (2002), government's dwindling finances and budgets made the call for commercialization of public extension an important subject. They mentioned that the poor progress in raising economic and social well-being of the populace through public extension has led to calls for private sector involvement in the operation of extension services.

Table 3: Mean Response to Positive Attitude Measurement of Commercialization of Public Agricultural Extension Services

Statement	Mean	Standard Deviation	Remark
I consider agricultural extension services as an important item to be paid for by arable farmers.	3.21	0.81	Agreed
Payment for extension service will motivate me to adopt arable crop technologies	3.24	0.80	Agreed
Payments for public extension services will persuade me to attend meetings with extension agents.	3.22	0.74	Agreed
Payments for public extension services will make me self-fulfilled.	3.00	0.88	Agreed
Payments for public extension service will make public extension workers to be more dedicated.	3.24	0.84	Agreed
Commercialization will improve quality of public extension services.	3.16	0.74	Agreed
People value more what they pay for hence the need to pay for extension services.	3.08	0.85	Agreed
Anything Government or public should be paid for to enhance quality services delivery.	2.98	0.91	Agreed
Commercialization of public extension is possible in regulated economy.	2.89	0.87	Agreed
Government should continue to fund public extension services because of low income of farmers	3.11	0.91	Agreed
Grand Mean	**3.11**		

Negative Attitude Measurement

In Table 4 the respondents disagreed with all the negative attitude statements about commercialization of public extension services with a Grand Mean = 2.73. The highest mean score was that government cannot continue to fund public extension services because the income of farmers are low (mean= 2.93) while the lowest mean item was, payment for public extension will not make me to be self-fulfilled (mean=2.60).

The fact that the farmers disagreed with the bipolar negative statements about commercialization of public extension services confirmed the initial positive attitude. Swanson and Rajalahti (2010) stated that privatization of public extension services would help to increase farm productivity, reduce poverty and minimize food insecurity.

Table 4: Mean Response to Negative Attitude Measurement to Commercialization of Public Agricultural Extension Services

Statement	Mean	Standard Deviation	Remark
I do not consider agricultural extension services as an important item to be paid for by Arable farmers.	2.64	1.02	Disagreed
Payment for extension services is of no relevance in adopting arable crop technologies.	2.85	0.93	Disagreed
Payment for public extension services will not persuade me to attend meeting with extension agents	2.77	1.01	Disagreed
Payment for public extension services will not make me to be self-fulfilled	2.60	0.94	Disagreed
Payment for public extension services will not make public extension workers to be more dedicated	2.67	1.07	Disagreed
Commercialization will not improve quality of public extension services.	2.75	1.05	Disagreed
People do not value what they pay for hence there is no need to pay for extension	2.71	0.95	Disagreed
Anything government or public should not be paid for to enhance quality service delivery	2.66	0.99	Disagreed
Commercialization of public extension is possible in deregulated economy	2.71	0.96	Disagreed
Government cannot continue to fund public extension services because of low income of farmers	2.93	1.01	Disagreed
Grand Mean	**2.73**		

Actual Attitude Score

The actual attitude score of the arable farmers to commercialization of public agricultural extension services was 2.92. This was done by adding the negative and positive scores for each respondent on the items to arrive at a total and finding the average. In the alternative the Grand Means for positive and negative statements were added together and divided by 2 (3.11+ 2.729/2 = 2.92) to give the actual attitude score. Summarily the attitude of the farmers to commercialization of public agricultural extension system was positive. If the respondents were consistent in their responses, the scores from both negative and positive statements would have

been the same (Ovwigho and Ifie, 2009).The results showed that there was acquiescence responses in the positive statements.

Relationship between Willingness to Pay for Extension Services and Educational Levels

The data on relationship between willingness to pay for public agricultural extension services and levels of education was analyzed by the use of Chi square test and results were presented in Table 3.5. A significant relationship (X^2 = 148.55, p = 0.00) was found between willingness to pay for public extension services and levels of education. Education helps to influence individuals positively in acceptance of innovations. The higher the level of education the more positive attitude the arable farmers had towards commercialization of public agricultural extension services.

Table 5: Chi square results of the relationship between willingness to pay for public extension services and levels of education

	Levels of Education						
Willingness to Pay	**NF**	**PS**	**SSCE**	**NCE/ OND**	**B. DEG**	**POST DEG**	**Total**
Willing	1	0	54	38	41	31	165
Not willing	21	21	15	0	1	1	59
Total	22	21	69	38	42	32	224

X^2 = 148.55, p = 0.00; NF = No Formal Education; PS=Primary School Certificate; NCE = Nigerian Certificate in Education; OND = Ordinary National Diploma; B. DEG. = Bachelor's Degree; POST DEG = Postgraduate Degree

Relationship between Attitude and Socioeconomic Characteristics of Arable Farmers

The relationship between the attitude of arable farmers to commercialization of public agricultural extension services and their socioeconomic characteristics was tested by use of multiple regression (Table 6). An R^2 value of 0.095 was obtained. This showed an insignificant

Table 6: Results of multiple regression between attitude and socioeconomic characteristics of arable farmers

Socioeconomic Characteristics	**B**	**Std. Error**	**Beta**	**T**	**Sig**
Constant	3.173	.249		12.721	.000
Age	0.001	.005	.023	.226	.822
Primary Income	0.084	.049	.156	-1.710	.089
Secondary Income	0.073	.043	.145	1.693	.093
Sex	-0.070	.087	.071	-796	.427
Marital Status	-0.104	.077	.125	1.358	.177
Level of Education	-0.004	.008	.045	-490	.625
Farming Status	.0.053	.063	.074	-879	.381
Farming Experience	0.032	.035	.078	-922	.358
Household Size	-0.114	.044	.230	-2.558	.012
Religion	.-0.000	.058	.090	-1.039	.301
Land Ownership	-0.056	.065	.076	-866	.388
Model Summary	R ,309	$R^2$0.095	Adjusted R .025		

relationship between the dependent (attitude) and independent variables (socioeconomic characteristics (Table 6). However household size was significant (t= -2.568, p = 0.012). The more the household the more negative attitude the farmer displayed to public extension services. A large household could make a farmer develop a negative attitude to commercialization of public extension services.

Conclusion and Recommendation

Someday, extension advisory services would be commercialized. Any service that is rendered free is usually not valued by the beneficiaries. The government should begin a gradual process of commercializing public extension services since arable farmers have, in this study, indicated their willingness to pay for public extension services. This could make the farmers and government extension organizations to be more committed to the entire process of extension delivery.

References

Adefarasin, G.B. (2000). The Impact of Shell Petroleum Development Company (SPDC) Agricultural Extension Programme on Farmers in Oil Producing Area of Delta State, Unpublished M. Sc. Thesis, University of Ibadan.

Agbamu, J.U. (2006). *Essentials of Agricultural Communication in Nigeria* Lagos: Malhouse Press Limited.

Agunga, R. (2017). The Role of Agricultural Extension in Africa's Development. *International Journal of Agricultural Extension* 5(3): 17 - 29

Agunga, R. (2017). The Role of Agricultural Extension in Africa's Development. *International Journal of Agricultural Extension* 5(3): 17 - 29

Agwu, A.E. and Chukwuone, N.A. (2002), Cost sharing as an Alternative to Financing Agricultural Technology Transfer in Nigeria. A Research Proposal Submitted to the African Technology Policy Studies (ATPS) Network, Nairobi, Kenya.

Agwu, A.E., Dimalu, M.U. and Madukwe, M.C. (2008). Innovations system approaches to agricultural Development: Policy Implication for Agricultural Extension Delivery in Nigeria. *African Journal of Biotechnology* 11: 30 – 40.

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes* 50(2): 179-211.

Akinsorotan, A.O. (1998). Agricultural Compensation Activities of Farmers in Petroleum Mining Areas of Delta State, Nigeria. *JOSEN* 3(2): 15 – 21

Ameur, C. (1994). Agricultural Extension: a step beyond the next step, World Bank Technical Paper No. 247. The World Bank: Washington, DC.

Asiabaka, C.C. (2012). *Agricultural Extension: A Handbook for Development Practitioners*. Owerri: Hudson-Jude.

CTA (2011). Three steps towards modernization of agricultural. Spore No.108, p.8. Technical Centre for Agricultural and Rural Cooperation, Wageningen.

Eagly, A.H. and Chaiken, S. (1993). *The Psychology of Attitudes,* Orlando, FL: Harcourt Brace,

Erie, A.P. (2009). *A Conceptual Framework for the Privatization and Commercialization of Agricultural Extension Services: A Case Study of Edo State, Nigeria.* Benin City: Rudei Printers and Publishers, pp 1 & 2.

Kuponiyi, F.A, Ogunwale, A.B. and Oladosu, I.O. (2004). Private Participation in Agricultural Extension: The Case of the Nigeria Tobacco Company. Paper Presented at the 4th Annual Conference of the Agricultural Extension Society of Nigeria (AESON) held at Federal University of Agriculture Makurdi, Nigeria.

Lele, U. (1999). Rural Africa: Modernization Equity and Long Term Development. PMID: 17840932 DOI: 10.1126/science.211.4482.547

Madukwe, M.C. (1995), Agricultural Extension Systems and Strategies in Nigeria's Rural Development: In: Eboh, E.C.: Okoye, C.U and D. Ayichi (eds), *Rural Development in Nigeria Concepts, Processes and prospect* Auto- Century Publishing Company Limited, Enugu, Nigeria, pp. 265-273

Madukwe, M.C. and Erie, A.P. (1999). Privatization and Commercialization of Extension Service in Nigeria: Prospects and challenges. A paper presented at the 5th Annual Conference of the Agricultural Extension Society of Nigeria, held from April 12 – 15 1999 at University of Nigeria Nsukka

Njoku, J.E. (2003). Adoption of improved oil palm technologies in Imo State of Nigeria. Research Report Number 10, Winnock International, Argligation.

Omagbemi, O. (1998). Private Sector Involvement in Extension: The Shell Petroleum Development Company of Nigeria Limited example, Paper Presented at the 4th Annual National Conference of the Agricultural Extension Society of Nigeria held at Makurdi, Benue State, Nigeria

Omotosho, A and Oladele. O.I. (2000) Privatization of Agricultural Extension Service. A - Complementary Approach to Rural Development Strategy.in Nigeria. In: Olowola, A.S and Nwosu, A.C. (eds). Proceeding of the 6th Annual Conference of the Sociological Association of Nigeria.

Ovwigho, B.O. and Ifie, P.A. (2009). Attitude of Youth to Agricultural Development Programmes in Ughelli South Local Government Area of Delta, State, Nigeria. *Journal of Agricultural Extension*, 13(2): 67-75.

Qamar, M.K. (2000). Agricultural Extension at the Turn of the Millennium: Trends and challenges in *Human Resources in Agricultural and Rural Development*. Food and Agricultural Organization, Rome.

Rivera, W.M and Cary, J.W. (2000) Privatizing agricultural extensions. In: Swanson, B.E. Bentz, R.P. and Sofranko, A.J. (eds). *Improving Agricultural Extension: A Reference Manual:* Rome: Food and Agriculture Organization

Rivera, W.M. (1992). Decentralizing Agricultural Extension, Alternative Strategies. *International Journal of Lifelong Education* 16(5): 151-161.

Rivera, W.M. (1996). Agricultural Extension in Transition World; structural, financial and managerial strategies for improving agricultural extension. *Public administration and Development* 16: 151-161.

Swanson, B.E. and Rajalahti, R. (2010). *Strengthening Agricultural Extension and Advisory Services: Procedures for Assessing, Transforming and Evaluating Extension Systems*. Agriculture and Rural Development Discussion Paper No. 44, Washington, D.C: The World Bank

USAID (2011). Rural Extension and Advisory services. USAID Agriculture. United States Agency for International Development

Williams, S.K.T., Fenley, J.M. and Williams, C.E. (1984). *A Manual for Agricultural Extension Workers in Nigeria*. Ibadan: Les Shyraden

World Bank (2000). "Agricultural Extension, the next step" Policy and Research Washington, D.C.

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Original Research Article

Effects of Drying, as a Preservation Technique, on the Nutrient Contents of Three Meat Types (Beef, Chicken, and Chevon)

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Abstract

The principle of meat preservation is to create unfavourable conditions for the growth of micro-organisms which cause spoilage of fresh meat by making it lose its texture, flavour and nutritional value. This study aimed at evaluating the effects of oven-drying and sun-drying as preservation techniques on the nutrient contents of three meat types (beef, chicken, and chevon). Two kilogram (2kg) each of fresh beef, chicken and chevon were purchased from the market in Abraka, Nigeria, and prepared for drying. After preparation, the meat samples were oven-dried with an electric oven at a constant temperature of 60^0C, and another portion sun-dried with direct sun light between 9:00hrs and 15:00hrs daily for 5 days. Proximate analysis was carried out on the dried samples to determine their moisture content, crude protein (%), ether extract (%), crude fibre (%), ash content (%), and NFE or carbohydrate content (%). Sensory evaluation of the meat samples was also carried out to determine their tenderness, flavour, juiciness, and overall acceptability. All data obtained were subjected to two-way Analysis of Variance (ANOVA) at 5% level of significance, using the Statistical Package SPSS (23.0) software. Results from the study indicated that there was no significant ($p<0.05$) effect of drying on ash content, ether extract, and crude fibre, while there were increases in crude protein and carbohydrate contents of the dried meat products. Findings from the study also showed that while sun drying preserved the juiciness and tenderness of meat products, oven-drying increased the flavour and overall acceptability.

Keywords: Drying methods, proximate composition, meat types, acceptability, sensory evaluation.

Introduction

Background of the Study

The consumption of meat worldwide remains on a steady increase as it is one of the most preferred sources of animal protein for many people across the world. According to Heinz and

Hautzinger, (2007), annual per capita consumption of meat increased from 10kg in the 1960s to 26kg in 2000, and is expected to reach 37kg by 2030.

The definition of meat used in this work is based on Janus (1999), who defined meat as the flesh of an animal used for food. It is the consumed part of the muscle of domestic or other defined animals. This includes the muscles of the skeleton, tongue, diaphragm, heart, and oesophagus, with or without the accompanying and covering fat. Meat components include portions of bones, skin, nerves, and blood arteries that generally accompany muscles. However, the muscles on the lips, muzzle, and ears are not considered meat (Janus, 1999). According to Pal and Mahendra (2015), people in both developed and developing countries consume meat mostly derived from herbivorous animals such as cattle, buffaloes, goats, sheep, camels, and horses. Beef is one of the popular types of meat, which is used to prepare food recipes, across the globe. This meat is obtained from the cow, and is one of the much sought-after types of red meat (Davis and Lin, 2005).

Another popular meat that is consumed by people worldwide is chicken. Though a type of poultry, it is considered as a healthy meat and can be found as an indispensable ingredient in most of the regional cuisines of the world. Domesticated for thousands of years, distinguishable breeds of chicken have been present since the combined factors of geographical isolation and selection for desired characteristics (Heinrichs, 2007). Pork is another choice, as far as types of meat are concerned. Pork is derived from pigs and is classified as red meat. Sheep meat is also a staple food in some parts of the world and is consumed in many regions. Sheep meat is otherwise known as mutton [meat of mature sheep] or lamb [immature sheep]. This is also a type of red meat.

Meat is very susceptible to contamination by bacteria due to its almost neutral pH, high moisture content, and rich nutrients, making preservation of meat more difficult than most other foods. The principle of preservation is to create unfavourable conditions for microbial growth which may result in spoilage of meat thereby making it lose its texture, flavor, and nutritional value, making it unhealthy for human consumption.

Degradation, microbiological activity, enzymatic and chemical reactions, as well as physical changes, are all likely to occur unless adequate preservation measures are adopted. However, once meat has been contaminated with bacteria, their removal is difficult. There are numerous meat preservation techniques which include chilling/refrigeration, freezing, curing, smoking, thermal processing, canning, dehydration, irradiation, chemicals, and pressure processing which are used to preserve meat (Zhou *et al.* 2010).

The importance of meat in the evolution of humans, particularly in brain and intellectual development, cannot be overemphasized (Pereira and Vicente, 2013).

According to Pereira and Vicente (2013), meat contains high-quality proteins, a variety of fats, including omega-3 polyunsaturated fatty acids, zinc, iron, selenium, potassium, magnesium, sodium, vitamin A, B-complex vitamins, and folic acid, as well as zinc, iron, selenium, potassium, magnesium, sodium, vitamin A, B-complex vitamins, and folic acid. Its composition varies according to the breed, kind of feed consumed, climatic conditions, and meat cut, all of which have a significant impact on its nutritional and sensory qualities.

According to Ayanwale *et al.* (2007), dehydration or drying is arguably one of the oldest and most successful preservation techniques. Lewicki (2004) defines drying as the process in which water is removed from a food material by evaporation or sublimation. FAO (2001) reports that meat drying remains the most practicable means of preserving and storing meat in developing countries with warm climates and absence of a cold chain. The report however stated the open-air sun-drying process, which involves exposing pieces of meat to unprotected air and sunlight, has many disadvantages over oven-drying, as meat pieces can be exposed to dust, rain, and insects, all of which contribute to the meat's general acceptability or non-acceptability.

Drying in the open air is a typical practice in developing nations, and the effects must be investigated. This study was designed to evaluate effects of drying techniques (oven-drying and sun-drying) on the nutritional value of three types of meat pieces (beef, chicken, and chevon) with a view to recommending an appropriate meat-drying method for this environment.

Materials and Methods

Study area

This study was carried out in Abraka, a town in Delta State, Nigeria. Abraka lies approximately on latitude 5.79° N and 6.10° E. It is situated at the Eastern Bank of River Ethiope in Ethiope East Local Government Area of Delta State in the Niger Delta zone of Southern Nigeria. It is bounded to the North by Orhionwon Local Government Area of Edo State, and to the East and South by Ukwani Local Government Area and the Ughelli North Local Government Area respectively and lastly, the Ika Local Government Area bounds her western boundary. The region of Abraka has a total land area of 21.2 square kilometer (Akinbode and Ugbomeh, 2006)

The meat samples

Approximately 2kg each of fresh samples each of chicken meat, beef and chevon were purchased on the same day from the main market in Abraka in Nigeria. With the aid of an electronic weighing scale, 2kg of each of the meat types was shared into two equal portions of 1kg each, one of which was sun-dried while the other portion was oven-dried. Each 1kg portion was further divided into 4 approximately equal replicates of 0.25kg. The meat samples were thoroughly washed, parboiled for about 15 minutes and dipped into concentrated brine for 20 seconds. Thereafter, they were cut into small strips with the following approximate dimensions; 0.02 cm thickness, 5 cm wide and 8 cm long. These strips were weighed in bulk and dried using either of the two methods, that is, oven-drying and sun-drying to a constant weight of about 7-10% moisture content.

Oven-drying

Oven-drying was done using an electric oven at a constant temperature of 60°C till the samples attained constant weights. Portions of each sample were then ground with a mortal and a pestle after drying, and stored in an air-tight bottle for proximate and functional analyses. Both the raw and the dried samples were analyzed.

Sun-drying

Sun-drying was carried out by placing the meat samples on a wire gauze and put directly in the hot humid tropical sun. The sun-drying was done between 9:00 hours and 15:00 hours daily. The

average daily temperature during this period was 33°C and relative humidity was 67%. Sun-drying lasted for 5 days.

Proximate analysis

Samples (2g per replicate) of the ground meat were subjected to proximate analysis to determine moisture, crude protein, crude fibre, ether extract, ash and nitrogen-free extract contents in line with AOAC (2010) methods.

Sensory evaluation

The color, appearance, aroma, texture, and general acceptability of fresh and dried meat samples were assessed using a 5-point descriptive hedonic scale (5 = great and 1 = poor) as defined by Ihenkoronye and Ngoddy (1985). The evaluation was conducted by a panel of ten untrained judges made up of students from the department who were chosen at random. The order in which the meat samples were presented to the judges was randomized, and the meat samples were coded in order to conceal their identities.

Statistical analysis

All data obtained from the three meat types and two drying methods were subjected to the two-way Analysis of Variance (ANOVA) at 5% level of significance using the Statistical Package SPSS (23.0) software.

Results

The result of proximate composition of chicken meat using different drying method is presented in table 1 above. The result reveal that moisture content (24.32 ± 0.21%) of sun-dried chicken meat was significantly ($p<0.05$) higher when compared with the chicken meat dried using oven (8.64 ± 1.51). On the other hand, the crude protein (15.36 ± 0.87) and nitrogen free extract (60.55 ± 3.28) of oven-dried chicken meat was significantly higher ($p<0.05$) than that of sun-dried chicken meat. In the same vein, crude fibre (3.86 ± 0.66) of oven-dried chicken meat was significantly ($p<0.05$) higher than sun-dried chicken meat. However, there was no significant ($p<0.05$) difference in the percentage ether extract and ash content of meat dried with oven and sun.

Table 1: Effect of drying method on the proximate composition of chicken meat

Proximate parameters	Oven-dried	Sun-dried
Moisture content (%)	8.64 ± 1.51^{b}	24.32 ± 0.21^{a}
Crude protein (%)	15.36 ± 0.87^{a}	12.55 ± 1.77^{b}
Ether extract (%)	7.39 ± 0.02	6.86 ± 0.06
Crude fibre (%)	3.86 ± 0.66^{a}	2.05 ± 0.34^{b}
Ash (%)	3.52 ± 0.70	2.78 ± 0.58
NFE (%)	60.55 ± 3.28^{a}	51.36 ± 1.62^{b}

Values are means ± standard Deviations of triplicate determinations. Values are presented as Mean ± SD. Values on the same row with different superscript differ significantly ($P<0.05$).

Table 2 presents the result of the proximate composition of beef dried with different drying method (oven and sun). From the result obtained, it was observed that sun-dried beef with mean value (20.05 ± 2.56%) had higher ($p<0.05$) moisture content than beef dried with oven (16.79 ± 2.54%). Results from this experiment further indicates that there was no significant difference ($p<0.05$) between the oven-dried and sun-drying method for proximate parameters: crude fibre, crude protein, ether extract, ash content and nitrogen free extract. However, the crude protein mean value (10.82 ± 1.19%) was slightly higher in oven-dried beef when compared to sun-dried beef (9.78 ± 0.37%), although this difference was not statistically significant ($p<0.05$).

Table 2: Effect of drying method on the proximate composition of beef

Proximate parameters	Oven-dried	Sun-dried
Moisture content (%)	16.79 ± 2.54^{b}	20.05 ± 2.56^{a}
Crude protein (%)	10.82 ± 1.19^{a}	9.78 ± 0.37^{a}
Ether extract (%)	8.69 ± 0.04	9.23 ± 0.53
Crude fibre (%)	3.92 ± 0.36	4.39 ± 1.15
Ash (%)	2.55 ± 0.51	2.47 ± 0.95
NFE (%)	58.13 ± 3.51	54.11 ± 1.85

Values are means ± standard Deviations of triplicate determinations. Values are presented as Mean ± SD. Values on the same row with different superscript differ significantly ($P<0.05$).

Table 3 present the result showing different drying method (oven drying and sun drying) on the proximate composition of chevon meat. The result shows that % moisture content (22.92 ± 2.72), crude protein (13.55 ± 0.75), and crude fibre (5.45 ± 0.53) of sun-dried chevon were significantly ($p<0.05$) higher than the mean value obtained for moisture content (8.64 ± 1.51), crude protein (9.64 ± 0.79), and the crude fibre content (3.02 ± 0.42) of oven-dried chevon respectively.

There was no significant ($p>0.05$) difference in the % ash content obtained for chevon dried using oven and sun drying method. The ether extract of oven dried chevon (9.32 ± 0.07) and nitrogen free extract (63.57 ± 3.06) were significantly ($p<0.05$) higher in mean value than ether extract (6.87 ± 0.03) and nitrogen free extract (49.66 ± 2.45) obtained from sun dried chevon.

Table 3: Effect of drying method on the proximate composition of chevon

Proximate parameters	Oven-dried	Sun-dried
Moisture content (%)	8.64 ± 1.51^{b}	22.92 ± 2.72^{a}
Crude protein (%)	9.64 ± 0.79^{b}	13.55 ± 0.75^{a}
Ether extract (%)	9.32 ± 0.07^{a}	6.87 ± 0.03^{b}
Crude fibre (%)	3.02 ± 0.42^{b}	5.45 ± 0.53^{a}
Ash (%)	3.99 ± 0.60	2.84 ± 0.86
NFE (%)	63.57 ± 3.06^{a}	49.66 ± 2.45^{b}

Values are means ± standard Deviations of triplicate determinations. Values are presented as Mean ± SD. Values on the same row with different superscript differ significantly ($P<0.05$).

The result of sensory evaluation of the different meat types (beef, chevon, and chicken) is presented in Table 4. Beef meat had the highest mean ($p<0.05$) (6.13 ± 0.97) for tenderness, followed by chicken (4.38 ± 1.05) while chevon (3.50 ± 0.80) had the least tenderness. Chicken

on the other hand had higher ($p<0.05$) flavour (8.38 ± 0.26) compared to chevon (7.50 ± 0.50) and beef (4.88 ± 0.64). Juiciness was significantly ($p<0.05$) lower in chicken (3.50 ± 0.71) when compared to chevon (5.75 ± 0.65) and beef (5.25 ± 0.37). However, there was no statistically significant ($p>0.05$) difference in juiciness between chevon (5.75 ± 0.65) and beef (5.25 ± 0.37).

Table 4: Effect of sensory evaluation of different meat type (beef, chevon, and chicken)

Sensory Evaluation	Beef	Chevon	Chicken
Tenderness	6.13 ± 0.97^{a}	3.50 ± 0.80^{c}	4.38 ± 1.05^{b}
Flavour	4.88 ± 0.64^{c}	7.50 ± 0.50^{b}	8.38 ± 0.26^{a}
Juiciness	5.25 ± 0.37^{a}	5.75 ± 0.65^{a}	3.50 ± 0.71^{b}
Overall acceptability	5.63 ± 0.49^{b}	7.25 ± 0.45^{a}	7.17 ± 0.48^{a}

Values are means ± standard Deviations of triplicate determinations. Values are presented as Mean ± SD. Values on the same row with different superscript differ significantly ($P<0.05$).

Chevon and chicken were generally more acceptable ($p>0.05$) compared to beef which was the least ($p<0.05$) acceptable (5.63 ± 0.49).

The result of the effect of drying methods (oven dried and sun dried) on the quality of meat type is presented in Table 5. Oven drying had better effect ($p<0.05$) on flavour (7.92 ± 0.34) and overall acceptability (7.60 ± 0.37) compared to sun drying (5.92 ± 0.65 and 5.83 ± 0.34 respectively). However, tenderness (6.00 ± 0.39) and juiciness obtained for sun drying method were significantly ($p<0.05$) higher than the mean values (3.33 ± 0.95 and 4.08 ± 0.69 respectively) obtained for oven dried meat samples.

Table 5: Effect of drying method on sensory evaluation of different meat types

Sensory Evaluation	Oven Dried	Sun Dried
Tenderness	3.33 ± 0.95^{b}	6.00 ± 0.39^{a}
Flavour	7.92 ± 0.34^{a}	5.92 ± 0.65^{b}
Juiciness	4.08 ± 0.69^{b}	5.58 ± 0.19^{a}
Overall acceptability	7.60 ± 0.37^{a}	5.83 ± 0.34^{b}

Values are means ± standard Deviations of triplicate determinations. Values are presented as Mean ± SD. Values on the same row with different superscript differ significantly ($P<0.05$).

Table 6 presents the interaction effect between drying methods (oven drying and sun drying) and meat type on the sensory attributes of the meat. The result shows that oven-dried beef was the most tender ($p<0.05$) (6.75 ± 1.93) relative to chevon (1.50 ± 0.29) and chicken (1.75 ± 0.48).

Chicken shows higher ($p<0.05$) tenderness (7.00 ± 0.57) for sun drying compared to beef and chevon. The mean values obtained for sun-dried beef and chevon (5.50 ± 0.65 and 5.50 ± 0.50 respectively) were not significantly ($p>0.05$) different.

The flavour value obtained was not significantly ($p>0.05$) different in chevon (8.75 ± 0.25) and chicken (8.50 ± 0.29) using oven dry method but significantly ($p>0.05$) higher than the flavour value obtained for beef (6.50 ± 0.29). The flavour obtained using sun dry was higher in chicken

(8.25 ± 0.48) followed by chevon (6.25 ± 0.25) with beef having the least mean value (3.25 ± 0.25).

Table 6: Interaction effect of drying methods (oven drying and sun drying) on sensory evaluation of different meat type (beef, chevon, and chicken)

Sensory Evaluation	Beef	Chevon	Chicken
Tenderness			
Oven dried	6.75 ± 1.93^{a}	1.50 ± 0.29^{b}	1.75 ± 0.48^{b}
Sun dried	5.50 ± 0.65^{b}	5.50 ± 0.50^{b}	7.00 ± 0.57^{a}
Flavour			
Oven dried	6.50 ± 0.29^{b}	8.75 ± 0.25^{a}	8.50 ± 0.29^{a}
Sun dried	3.25 ± 0.25^{c}	6.25 ± 0.25^{b}	8.25 ± 0.48^{a}
Juiciness			
Oven dried	5.25 ± 0.25^{a}	5.25 ± 1.31^{a}	1.75 ± 0.48^{b}
Sun dried	5.25 ± 0.25^{b}	6.25 ± 0.25^{a}	5.25 ± 0.25^{b}
Overall acceptability			
Oven dried	6.50 ± 0.29^{b}	8.25 ± 0.47^{a}	8.50 ± 0.50^{a}
Sun dried	4.75 ± 0.75^{b}	6.25 ± 0.25^{a}	6.50 ± 0.29^{a}

Values are means ± standard Deviations of triplicate determinations. Values are presented as Mean ± SD. Values on the same row with different superscript differ significantly ($P<0.05$).

The juiciness value obtained using oven drying was higher ($p<0.05$) in beef (5.25 ± 0.75) and chevon (5.25 ± 1.31) but was lower in chicken (1.75 ± 0.48) respectively. There was no significant ($p>0.05$) difference in the juiciness mean value obtained in beef (5.25 ± 0.25) and chicken (5.25 ± 0.25) when sun dried as shown in the table above.

The results obtained further showed there were no significant ($p>0.05$) differences in overall acceptability between oven-dried and sun-dried chevon (8.25 ± 0.47; 6.25 ± 0.25 respectively) and oven-dried and sun-dried chicken (8.50 ± 0.50 and 6.50 ± 0.29 respectively). However, overall acceptability was significantly ($p<0.05$) lower in oven-dried (6.50 ± 0.29) and sun-dried (4.75 ± 0.75) beef when compared to chevon and chicken.

Discussion

The important role of meat as a major contributor of high-quality protein, B-vitamins and mineral contents in human nutrition cannot be overemphasized. However, the intrinsic properties of fresh meat such as high moisture content, make it highly perishable thereby requiring some form of preservation to avoid deterioration and spoilage (Mishra *et al.* 2013).

Among the numerous preservation techniques available, reports by FAO (2001) indicate that drying is the most practical and effective technique for preserving and storing meat especially in developing counties with warm climates. Although drying is an age-long preservation technique to extend the shelf life of meat, it is a fact that this method considerably affects the nutrient quality of meat (Adak *et al.* 2017).

Results on the proximate composition of chicken meat shows that moisture content of sun-dried chicken meat was higher when compared to oven-dried chicken meat. This was the same for beef and chevon. This shows that sun-drying as a method of meat preservation, especially in a hot but

humid tropical environment like in southern Nigeria, is not as efficient as oven-drying (Thiagarajan, 2008). With an average humidity of about 70%, sun-drying cannot but be slow. Findings of this study was also in line with Chahbani *et al.* (2018) which reported that oven dried products have better rehydration property, lower water activity, and better microbial quality when compared to the conventional sun-dried products.

Arising from the lower moisture contents of the oven-dried chicken and chevon, percent protein and fibre, increased. The same was, however, not true for beef, probably because of differences in the muscle structures of the different species from which the meat samples were derived. This was similar to the result obtained by Adeyi *et al.* (2015) who recorded a significant increase in crude protein content of *kilishi* with drying.

Ether extract, which is the fat component of the meat, was unaffected by drying method for chicken and beef. However, oven-dried chevon was significantly higher ($p<0.05$) ether extract than sun-dried chevon. This is in line with the findings of Lee *et al.* (2003), who recorded an increase in ether extract of dried meat products compared to fresh meat. According to Adeyi *et al.* (2015), percentage increase in ether extract content of dried meat products makes it have high energy values in human nutrition and also enhances its flavour.

The percentage ash content of these meats (beef, chicken, and chevon) showed no significant ($p>0.05$) differences. Chukwu and Imobidoh (2009) stated that the use of condiments in dehydrated meat products caused an increase in the ash content of the products. Since condiments were not used in the drying process of the meat products in this study, this may explain the non-significant difference in ash content.

Furthermore, findings from this study revealed that the percentage nitrogen free extract (NFE) or carbohydrate content in oven-dried chicken and chevon was significantly ($p<0.05$) higher than sun-dried chicken and chevon. Although there was percentage increase in NFE content in oven-dried and sun-dried beef, it was not statistically ($p>0.05$) significant.

The observed percentage increase in NFE/carbohydrate content in this study conforms with the findings of Ayanwale *et al.* (2007) that dried meat samples had higher carbohydrate and energy levels than fresh meat samples. This could be due to the higher water absorption capacity of fresh meat samples of chicken, beef, and chevon which usually results in greater starch swelling.

Results of the sensory evaluation of the meat samples for tenderness, flavour, juiciness, and overall acceptability, irrespective of drying method, revealed that beef had the highest mean for tenderness, while chevon was the least tender. However, chicken had more flavour (8.38 ± 0.26) compared to chevon (7.50 ± 0.50) and beef (4.88 ± 0.64). Juiciness was least in chicken (3.50 ± 0.71) compared to chevon (5.75 ± 0.65) and beef (5.25 ± 0.37). More so, chevon (7.25 ± 0.45) and chicken (7.17 ± 0.48) had higher overall acceptability value compared to beef which had a considerably lower acceptability value (5.63 ± 0.49).

Generally, oven drying had better flavour and overall acceptability values (7.92 ± 0.34 and 7.60 ± 0.37 respectively) compared to sun drying (5.92 ± 0.65) and (5.83 ± 0.34). This is in contrast to the findings of Zhang *et al.* (2006) who stated that oven-drying of meat products leads to overheating, scorching and development of off flavour.

However, the tenderness (6.00 ± 0.39) and juiciness (5.58 ± 0.19) obtained for sun drying method were significantly ($p<0.05$) higher than those (3.33 ± 0.95 and 4.08 ± 0.69 respectively) obtained for oven drying of the meat types.

Conclusion

From the results obtained in this study, it could be seen that drying is an effective preservation technique for meat products. Both oven drying and sun drying can prolong the shelf-life of the meat products by significantly reducing the moisture content. Although there was generally no significant effect of drying methods on ash content, ether extract, and crude fibre, the study showed an increase in crude protein content in oven-dried meat products.

This study further concludes that dried meat products are a better source of carbohydrate than fresh meat. In addition, the study concludes that sun drying preservation technique maintains the juiciness and tenderness of meat products. Conversely, the flavour and overall acceptability of meat products were preserved with oven-drying.

References

Adak, N. Heybeli, N. and Ertekin, N. (2017). Infrared drying of strawberry. *Food Chemistry* 219: 109–116.

Adeyi, A.M., Osunde, Z.D., Ogunjirin, O.A., Awu, J.I. and Ibrahim, A. (2015). Effect of drying on nutritional quality of dried meat (kilishi). *Journal of Agricultural Engineering* 23(1): 14-34.

Akinbode, A. and Ugbomeh, B.A. (2006). Abraka Region, Occasional Publications, Department of Geography and Regional Planning, Delta State University, Abraka, 79.

AOAC (2010). *Official Methods of Analysis*. 17th Edn., Association of Official Analytical Chemists,Washington, D.C.

Ayanwale, B.A., Ocheme, O.B. and Oloyede, O.O. (2007). The effect of sun-drying and oven-drying on the nutritive value of meat pieces in hot humid environment. *Pakistan Journal of Nutrition* 6(4): 370-374.

Chahbani, A., Fakhfakh, N., Balti, M.A., Mabrouk, M., El-Hatmi, H., Zouari, N., and Kechaou, N. (2018). Microwave drying effects on drying kinetics, bioactive compounds and antioxidant activity of green peas (*Pisum sativum* L.). *Food Bioscience* 25: 32–38

Chukwu, O. and Imodiboh, L.I. (2009). Influence of storage conditions on shelf life of dried beef product (Kilishi). *World Journal of Agricultural Sciences* 5: 34-39.

Davis, C. and Lin, B. (2005). Factors Affecting U.S. Beef Consumption. LDP-M-135-02. Economic Research Service/USDA

FAO. (2001). Improved meat drying in Asia and Pacific, FAO Rome.

Heinrichs, C. (2007). *How to Raise Chickens: Everything You Need to Know.* Voyageur Press, St. Paul, MN. 192 pages.

Heinz, G. and Hautzinger, P. (2007). *Meat Processing Technology. For Small-to Medium Scale Producers*. Food and Agriculture Organization of the United Nations Regional Ounce for Asia and the Pacific.

Ihenkoronye, A.I. and Ngoddy, P.O. (1985). *Integrated Food Science and Technology for the Tropics*. McMillan Education, Ltd; London and Oxford, pp: 334-337.

Janus, S.F. (1999). *Meat Science*. Prentice Hall, Ltd., 27.

Lee, S.O, Min, J.S, Kim, I.S. and Lee, M. (2003). Physical evaluation of popped cereal snacks with spent hen meat. *Meat Science* 64: 383-390.

Lewicki, P.P. (2004). Drying. In: Jensen, W.K, Devine, C. and Dikeman, M. (Eds.). *Encyclopaedia of Meat Sciences*, Vol-1. Elsevier Ltd. pp. 402–411.

Mishra, B.P., Chauhan, G., Mendiratta, S.K., Sharma, B.D., Desai, B.A. and Rath, P.K. (2013). Development and quality evaluation of dehydrated chicken meat rings using spent hen meat and different extenders. *Journal of Food Science and Technology* 52(4): 2121–2129.

Pal, M. and Mahendra, R. (2015). *Sanitation in Food Establishments*. First Edition, LAMBERT Academic Publishing, Saarbruchen, Germany.

Pereira, P.M. and Vicente, A.F. (2013) Meat nutritional composition and nutritive role in the human diet. *Meat Science* 9: 586-592.

Thiagarajan, I.V. (2008). Combined microwave - convection drying and textural characteristics of beef jerky. M.Sc. Thesis. University of Saskatchewan Saskatoon, SK. University of Georgia. Athens.

Zhang M, Tang, J., Mujumdar, A.S. and Wang, S. (2006). Trends in oven-related drying of fruits and vegetables. *Trends in Food Science and Technology* 17: 524-534.

Zhou, G.H., Xu, X.L. and Liu, Y. (2010). Preservation technologies for fresh meat – A review. *Meat Science* 86: 119–128

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Original Research Article

The Nutritional Effect of Cassava Leaf Meal on Broiler Starter Chickens

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Abstract

The nutritional effect of cassava leaf meal on broiler starter chickens was investigated. The cassava leaf meal (CLM) was used to formulate five broiler starter diets at 0%, 2.5%, 5.0%, 7.5% and 10% inclusion levels partly replacing soya bean meal in the diet. The diets were represented as T_1 (0%), T_2 (2.5%). T_3 (5.0%), T_4 (7.5%) and T_5 (10%) respectively. Seventy five (75) three-day-old broiler starter chickens were divided into five treatment groups of fifteen (15) birds each in a completely randomized design (CRD). Each treatment group was further divided into three replicates of five birds per replicate and each of the groups was assigned to one of the treatment broiler starter diet and fed for 28 days. Data were collected on body weight changes, feed intake and feed conversion ratio. Economic parameters determined were cost/kg weight gain, cost of total feed consumed and gross margin. The results indicated that performance of chicks in T4 and T5 (7.5% and 10%) inclusion levels of cassava leaf meal decreased significantly ($P<0.05$) compared to the control (T1) for average final weight, average weight changes and average daily weight gain. Feed intake at 10% CLM (T5) was significantly decreased compared to T1 (the control) and T3 (5% CLM). The feed conversion ratio revealed that T1, T2, T3 and T5 representing 0%, 2.5%, 5% and 10% CLM inclusion levels were statistically similar ($P>0.05$). T_1 (0%), followed by T_2 (2.5%), then T_3 (5%) revealed higher revenue earnings and a better gross margin as a result of heavier average weight changes and better feed conversion ratio. The haematological indices showed that the haemoglobin, packed cell volume and red blood cell increased as the dietary levels of cassava leaf meal increased with T5 increasing significantly ($P<0.05$) compared to the control. The white blood cell increased significantly ($P<0.05$) at T5 compared to the rest of the treatments. Biochemical indices showed that total protein increased progressively as the dietary inclusion level increased. Cholesterol, serum alkaline phosphatase, and Serum alanine transaminase were significantly increased ($P<0.05$) at T5 compared to the control. It was therefore concluded that cassava leaf meal could serve as a protein source to replace soya bean meal in the diet of broiler finishers at a level not exceeding 2.5% to reduce cost of production and earn higher revenue.

Keywords: Nutritional effect, cassava leaf, broiler starter, cost and returns, haematology, serum indices

Introduction

It is very obvious that the population of Nigeria is increasing daily and this has doubled the demand for food and dietary protein needs. Poultry products are among the most common and available protein sources that enable us to meet the protein needs of the people in Nigeria. With the growth of the population, meeting the animal protein requirements of the masses requires doubling output from our poultry industry. The expansion of the poultry industry over the years has been militated against by high cost of energy and protein source ingredients such as maize, groundnut cake and soya bean required to feed the industry. Protein is a dietary essential required in the body of animals for growth, reproduction, metabolic and biochemical processes et cetera. High cost of protein ingredients needed for formulating feed for poultry has increased the operating cost of the industry and consequently leading to high cost of poultry products that most consumers are unable to buy in order to meet their protein delights. Therefore it becomes necessary to research into alternative poultry feed sources that are available, cheap and not competing with human or industrial demands that can partly or wholly replace soya bean meal in the diet of broilers as a protein source. Cassava leaf meal appears to hold some potential as a protein source on account of its being rich in protein but low in sulfur-containing amino acids (Gomez and Valdivieso, 1985, Phuc *et al*., 2000).

Abu *et al*. (2015) reported that cassava leaf meal contains 25.37% crude protein, 11.17% ether extract, 8.47% ash, 10.63% crude fibre and 73.00% total carbohydrate and concluded that soya bean meal and maize respectively, could be replaced by up to 20% inclusion of cassava leaf meal and 20% cassava peelings in the diets of both broiler starter and finisher rations without any deleterious effect on growth and carcass yield of broilers. Similarly, Iheukwumere *et al.* (2008) reported the chemical composition of cassava leaf meal to be 25.30% DM, 25.10% crude protein, 11.40% crude fiber, 12.70% ether extract, 46.10% nitrogen free extract and 9.10% ash, and capped it up that cassava leaf meal at 5% inclusion level could be used in broiler finisher ration without any deleterious effect. The cassava plant has been known to yield about 10 – 30 t/ha of leaves that have been wasted or used as manure (Bokanga, 1994).

Despite the huge nutritional quality of cassava leaf meal, it contains some phytochemicals and anti-nutrients. It has been reported that cassava leaf meal contains 26.03-38.33 mg/100mg alkaloids, 48.07-58.94 mg/100g flavonoids, 1.58-1.65 mg/100g saponins, 0.49-0.57 mg/100g cyanogenic glycosides and 0.45-0.71 mg/100g tannin. The anti-nutrients composition were oxalate 29.32-35.77 mg/100g, phytate 1.95-2.17 mg/100g, cyanide 31.48-35.77 mg/100g, and trypsin inhibitor in the range of 0.48-0.72 mg/100g (Ogbuji and David-Chukwu, 2016).

This research therefore, was to evaluate the nutritional effect of feeding graded levels of cassava leaf meal to broiler starter chicks.

Materials and Methods

This experiment was carried out at the Poultry unit of Teaching and Research farm, Imo State University Owerri, which is located within the South-Eastern agro-ecological zone of Nigeria. Owerri lies on latitude $5^0$29”N and longitude $7^0$20”E. It is almost 91m above sea level with annual rainfall, temperature and relative humidity ranging from 1500mm-2200mm, 20.0-27.50 ^{0}C and 75-90% respectively (Accuweather, 2022). The cassava leaf used for this experiment were harvested from the cassava section of Imo Victory Cooperative Farms, Ezioha, Eziama-

Obiato in Mbaitoli L.G.A of Imo state. The leaves were chopped for faster and effective drying on a mat floor. The chopped leaves were sun-dried for three (3) days until they became crispy while still retaining the greenish coloration. The leaves were turned regularly to prevent uneven drying and possible decay of the leaf. The dried leaves were then milled using a hammer mill to produce cassava leaf meal (CLM). A sample of the leaf meal was taken to the laboratory for proximate and phytochemical analysis according to AOAC (2010).

The cassava leaf meal (CLM) was then used to formulate five broiler chicken starter diets at 0%, 2.5%, 5.0%, 7.5% and 10% inclusion levels partly replacing soya bean meal in the diet. The experimental diets and their calculated nutrient contents are presented in Table 1.

Table 1: Ingredients and calculated nutrient composition of the experimental broiler starter diets

Ingredients	**T1 0% CLM**	**T2 2.5% CLM**	**T3 5% CLM**	**T4 7.5% CLM**	**T5 10% CLM**
Maize	48.00	48.00	48.00	48.00	48.00
Soya bean meal	16.00	13.50	11.00	8.50	6.00
Cassava leaf meal	0.00	2.50	5.00	7.50	10.00
Groundnut cake	15.00	15.00	15.00	15.00	15.00
Fish meal	2.00	2.00	2.00	2.00	2.00
Blood meal	2.00	2.00	2.00	2.00	2.00
Palm kernel cake	8.00	8.00	8.00	8.00	8.00
Wheat offal	4.00	4.00	4.00	4.00	4.00
Bone meal	4.00	4.00	4.00	4.00	4.00
Salt	0.25	0.25	0.25	0.25	0.25
Vitamin premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Calculated Nutrient Composition					
Crude protein	23.00	23.42	23.13	22.87	22.59
ME(Kcal/Kg)	2798.27	2736.76	2735.59	2734.43	2733.25
Calcium	1.60	1.60	1.59	1.58	1.58
Phosphorus	1.14	1.13	1.11	1.10	1.08
Lysine	1.07	1.04	1.04	1.02	1.00
Methionine	0.54	0.53	0.51	0.50	0.48
Ash	3.45	3.50	3.45	3.55	3.58
Crude fibre	4.24	4.92	5.60	6.28	6.89
Lipid	4.78	4.69	4.60	4.52	4.43

Seventy-five day old broiler chicks were purchased from a certified poultry vendor in Owerri. The chicks were brooded together for three days to stabilize them. Thereafter, the chicks were randomly divided into five treatment groups of fifteen (15) birds each in a Completely Randomized Design (CRD). Each treatment group was further divided into three replicates of five birds per replicate and kept in a deep litter compartment of 1m x 0.5m. Brooding continued in the various compartments while the experimental trial went on. Each of the groups was assigned to one of the treatment broiler starter diet. Water and feed were given *ad libitum*. The necessary routine vaccinations and medications were given as and when due. The trial lasted for 28 days. The birds were weighed at the beginning of the trial to obtain their initial body weights.

Thereafter, the weighing was done on weekly basis. Daily feed intake was determined, daily, by subtracting the weight of the leftover feed from the weight of the initial feed given. Data were collected on feed intake and body weight changes. Also feed conversion ratio was calculated by dividing the average daily feed intake by average daily weight gain.

Data collected were subjected to analysis of variance using the SPSS Software (2012). Where analysis of variance indicated significant treatment effects, means were separated using Duncan New Multiple Range Test (DNMRT) (SPSS, 2012). Economic parameters determined were average weight changes, average daily weight gain, average daily feed intake, cost/kg weight gain, and cost of total feed consumed. Cost of production (₦) = Cost/Kg weight gain multiplied by average weight changes. Price/Kg meat (₦) = Price of selling one Kg of meat. Revenue (₦) = Price/Kg meat multiplied by the average weight changes. Gross margin (gain/ profit) = Revenue minus cost of production.

Haematological and serum indices studies

At the last day of the feeding trial, three birds per treatment were randomly selected to determine their haematological and serum indices. 5ml blood samples were collected from the wing vein of each of the birds using a syringe and needle, and placed in the specimen bottles with EDTA (Ethylene Diamine Tetra Acetate) for haematological studies. Blood was analysed within three hours of collection for haemoglobin (HB), packed cell volume (PCV), red blood cells (RBC), mean cell volume (MCV), mean cell haemoglobin (MCH), mean cell haemoglobin concentration (MCHC), and white blood cells (WBC). Another 5ml of blood was collected and placed in the specimen bottles without EDTA for serum biochemical analysis. Parameters analysed were urea, total protein, creatinine, cholesterol, serum electrolytes and liver enzymes. The methods outlined by Ochie and Kolhatkar (2000) were used for the haematological and serum indices analyses.

Results

Proximate analyses of cassava leaf meal in this study revealed that it contained 33.25% crude protein, 33.79% crude fibre, 10.40% lipids, 7.03% ash, 8.23% nitrogen free extract and a metabolizable energy of 2373.14 Kcal/kg. The results of the performance characteristics of broiler starter birds fed cassava leaf meal are shown in Table 2. The results show that the average final weight, average daily weight changes, average daily weight gain, average daily feed intake and feed conversion ratio were affected by the dietary treatment ($P<0.05$).

Table 2: Performance characteristics of broiler starter chicks offered dietary cassava leaf meal as a protein source

Parameters	T1 0% CLM	T2 2.5% CLM	T3 5% CLM	T4 7.5% CLM	T5 10% CLM	SEM
Average initial weight (g)	174.07	173.61	173.85	173.11	173.85	5.57
Average final weight (g)	1018.93^{a}	931.13^{ab}	898.87^{ab}	779.67^{b}	800.93^{b}	41.43
Average weight changes (g)	844.86^{a}	757.52^{ab}	725.02^{ab}	606.56^{b}	627.08^{b}	39.80
Average daily weight gain (g)	30.17^{a}	27.05^{ab}	25.89^{ab}	21.66^{b}	22.40^{b}	1.40
Average daily feed intake (g)	63.33^{a}	58.73^{ab}	62.68^{a}	62.00^{ab}	56.42^{b}	1.55
Feed Conversion ratio (g)	2.10^{b}	2.17^{b}	2.42^{ab}	2.86^{a}	2.52^{ab}	0.17

a,b,c: means within the same row with different superscripts are significantly different ($p<0.05$)

T4 and T5 (7.5% and 10% inclusion levels of cassava leaf meal respectively) were significantly decreased (P<0.05) compared to the control (T1) for average final weight, average weight changes and average daily weight gain. Feed intake at 10% dietary level (T5) was significantly decreased compared to T1 (control) and T3 (5% inclusion level). The feed conversion ratio shows that T1, T2, T3 and T5, representing 0%, 2.5%, 5% and 10% inclusion levels respectively, were statistically similar (P>0.05).

Data on the cost and returns of broiler starter chicks offered dietary cassava leaf meal are shown in Tables 3. Feed cost was highest at T1 due to the high cost of soya bean meal, decreasing gradually as the cassava leaf meal was increased. Cost per Kg weight gain was lowest at T1 due to high feed conversion ratio or low value for feed conversion ratio. This means that it cost less to produce one Kg of meat. T4 (7.5% CLM) had a high mean cost/Kg weight gain due to poor feed conversion ratio or high value for feed conversion ratio. This means that it cost more to produce one Kg of meat which is uneconomical. Cost of feed consumed was lowest at 10% inclusion level T5 (10% CLM) and highest at 0% inclusion level (T1). The revenue or sales from the product and gross margin were highest at T1 (0% CLM inclusion level).

Table 3: Cost and returns on broiler starter chicks offered dietary cassava leaf meal as a protein source

Parameters	T1 0% CLM	T2 2.5% CLM	T3 5% CLM	T4 7.5% CLM	T5 10% CLM
Feed cost (₦)	450.00	438.75	427.5	416.25	405.00
Cost/kg weight gain (₦)	936	956.5	1034.6	1223.8	1024.7
Cost of feed consumed (₦)	790.79	724.58	750.13	738.22	642.58
Price/Kg meat (₦)	2500	2500	2500	2500	2500
Revenue (₦)	2112.18	1893.83	1812.60	1508.05	1567.73
Gross margin (₦)	1321.39	1169.25	1062.47	769.83	925.15

Note: Selling price per kg meat is ₦ 2500

The haematological characteristics of broiler finisher birds offered cassava leaf meal are presented in Table 4. There was a remarkably significant treatment effect (P<0.05) for all the

Table 4: Haematological indices of broiler starter chicks offered cassava leaf meal as a protein source

Parameters	T1 0% CLM	T2 2.5% CLM	T3 5% CLM	T4 7.5% CLM	T5 10% CLM	SEM
Packed cell volume (PCV)	36.63^{c}	36.53^{c}	37.00^{bc}	37.50^{b}	38.13^{a}	0.14
Haemoglobin (Hb)	12.21^{c}	12.18^{c}	12.33^{bc}	12.47^{b}	12.71^{a}	0.05
Red blood cells (RBC)	4.27^{b}	4.31^{b}	4.30^{b}	4.36^{b}	4.49^{a}	0.03
Mean cell volume (MCV)	81.80^{b}	81.87^{ab}	81.77^{b}	82.27^{ab}	82.37^{a}	0.14
Mean cell haemoglobin (MCH)	27.40^{b}	27.67^{b}	27.60^{b}	27.93^{b}	28.50^{a}	0.15
MCHC	32.43^{b}	32.39^{b}	32.44^{b}	32.46^{b}	32.90^{a}	0.10
White blood cell (WBC)	18.33^{b}	21.67^{b}	18.33^{b}	19.67^{b}	26.67^{a}	1.15
Neutrophil	51.33^{c}	55.00^{bc}	56.33^{bc}	61.33^{b}	70.33^{a}	2.17
Lymphocyte	24.00^{c}	27.00^{bc}	28.33^{bc}	31.00^{ab}	$34,33^{a}$	1.58
Monocyte	4.00	3.00	3.67	2.67	4.00	0.43
Eosinophil	2.00	2.00	2.00	1.00	2.67	0.44
Basophyl	0.00	0.00	0.00	0.00	0.00	0.00

a,b,c: means within the same row with different superscripts are significantly different (p<0.05)

parameters studied except for Monocytes, Eosinophils and Basophils. Mean PVC, Hb, RBC, MCV, MCH, MCHC, WBC and Neutrphils in T1 (0% CLM), T2 (2.5% CLM) and T3 (5.0% CLM) were statistically similar (P>0.05), but significantly lower than those of T5 (10% CLM) (P<0.05).

Mean values for T4 and T5 were similar (P>0.05) only for MCV and Lymphocytes.

The biochemical indices of broiler starter birds offered cassava leaf meal are presented in Table 5. Total protein and globulin increased significantly (P<0.05) as the inclusion level of cassava leaf meal increased. T5 (10%) inclusion level was significantly increased (P< 0.05) compared to the rest treatment.

Table 5: Biochemical Indices of broiler starter chicks offered Cassava leaf meal

Parameters	T1 0% CLM	T2 2.5% CLM	T3 5% CLM	T4 7.5% CLM	T5 10% CLM	SEM
Total Protein	2.13^{d}	2.97^{c}	3.40^{bc}	3.77^{b}	4. 67^{a}	0.14
Globulin	2.60^{c}	2.73^{bc}	2.93^{bc}	3.13^{b}	3.67^{a}	0.13
Albumin	1.57	1.53	1.87	1.70	1.80	0.14
Creatinine	0.23^{c}	0.26^{bc}	0.40^{a}	0.34^{ab}	0.36^{ab}	0.03
Urea	3.67^{bc}	2.33^{c}	4.43^{ab}	5.70^{a}	5.40^{ab}	0.47
Total Cholesterol	69.67^{c}	74.67^{bc}	84.00^{ab}	76.00^{bc}	90.00^{a}	3.34
AST	65.00^{b}	68.67^{ab}	75.33^{ab}	74.67^{ab}	83.33^{a}	4.39
ALT	2.53^{ab}	2.13^{b}	3.10^{ab}	3.97^{a}	3. 97^{a}	0.37
ALP	811.33^{b}	642.67^{c}	826.67^{ab}	791.00^{b}	934.67^{a}	31.47

a,b,c: means within the same row with different superscripts are significantly different (p<0.05); ALP indicates serum alkaline phosphatase; AST indicates Serum aspartate transaminase; ALT indicates Serum alanine transaminase.

Blood creatinine at T3 (5%) inclusion level of cassava leaf meal was significantly increased compared to T1 (0%) and T2 (2.5%). Serum urea increased significantly (P< 0.05) as the inclusion level of cassava leaf meal increased. Serum urea for T3 (5%), T4 (7.5%) and T5 (10%) were statistically similar (P>0.05) but significantly higher than those of birds in T1 (0%) and T2 (2.5%). Serum total cholesterol increased (P<0.05) as the inclusion level of cassava leaf meal increased. Feeding 10% CLM significantly (P<0.05) increased total cholesterol compared to the control, T2 (2.5% CLM) and T4 (7.5% CLM). Serum liver enzymes, AST, ALT and ALP showed significant treatment effect. Serum AST in T1, T2, T3 and T4 were statistically similar (P>0.05), just as T2, T3 and T4 were similar (P>0.05) statistically. It revealed that AST was significantly higher in birds fed 10% CLM (T5) compared to birds on the control diet (T1 (0% CLM)). Serum ALT showed statistical similarity in T1 (0%), T3 (5%), T4 (7.5%) and T5 (10%). T2 (2.5%) was significantly lower (P<0.05) compared to T4 and T5. Serum ALP recorded in T5 was also statistically (P<0.05) higher than that observed in T2.

Discussion

Performance characteristics

The average weight changes, daily weight gain and feed conversion ratio were significantly different (P<0.05). The average final weight, average weight changes, and average daily weight gain were highest in birds which were fed the 2.5% CLM diet (T_2), and started declining

significantly (P<0.05) compared to the control. The decline in weight gain could be attributed to a higher intake of tannin, phytate and oxalate resulting in nutrient imbalance and poor feed conversion ratio which is a pointer to poor efficiency of feed utilization. This implies that there was poor digestion and utilization of the nutrients especially proteins, possibly as a result of amino acid imbalance.

The values for feed conversion ratio obtained in this study were lower than the values 2.29-3.24 and 2.74-3.38 reported by Esiegwu (2021) for broiler starters offered nutritional supplement of fluted pumpkin leaf meal, and Fasuyi and Nonyerem (2007) for broiler starters offered *Telfairia occidentalis* leaf meal as protein supplement respectively, but similar to the values of 2.06-2.80 reported by Onu (2012) for starter broilers offered aqueous extract of *Telfairia occidentalis* leaf extract. The values were higher than the reference value 1.7 to 2 for broilers (Ghosh, 2015). The cassava leaf meal dietary treatment performed best at T_2 (2.5%) inclusion levels for feed conversion ratio and other parameters investigated. The depression in performance at 10% inclusion level of cassava leaf meal agrees with the general observation that at high leaf meal inclusion levels in poultry diets, growth is depressed (D'Mellow and Acomovic, 1989). This also agrees with Ravindra *et al*. (1986) who evaluated cassava leaf meal as a substitute for coconut and reported that broiler performance was depressed at higher levels of inclusion but gives satisfactory results at lower levels of inclusion.

Costs and returns of the broiler starter chicks fed varying levels of cassava leaf meal

The high cost of feed in T_1 was due to the high cost of soya bean meal, and this is what we want to minimize being one of the objectives of this research. Cost per kg weight gain was lowest at T1 compared to other treatment as a result of better feed conversion ratio which means that it cost less to produce one kg meat. T4 had the highest cost per kg weight gain due to poor feed conversion. Broilers on the control diet, T_1 (0%) had the highest value for cost of feed consumed due to high cost per kg of feed, whereas those on the 10% CLM diet, T_5 had the lowest value for cost of feed due reduced cost per kg of cassava leaf meal. T_1 (0%), followed by T_2 (2.5%), then T_3 (5%) revealed a higher revenue earnings and a better gross margin as a result of heavier average weight changes and better feed conversion ratios.

The cassava leaf meal did not show excellence in performance above soya bean meal and so produced lesser weight gain than the soya bean group, that is, the control, T_1 (0%). That is why despite the reduction in the costs of feed consumed as a result of using the cassava leaf meal in the treatment groups, the revenue and gross margin remained low compared to the control. The target of every producer is to produce heavier birds and make high profit. Cassava leaf meal did not compare favorably with soya bean meal in producing heavier broilers, and hence reduction in revenue and profit.

Haematological characteristics of the broiler starter chickens

The haemoglobin (Hb) increased significantly (P<0.05) with increase in the dietary levels of the cassava leaf meal. This is an indication that it can support high oxygen-carrying capacity by the blood in chickens by being able to increase the haemoglobin. This implies that there was likely to be adequacy of oxygen in the body tissues, effective functioning of the tissues and maintenance of healthy cells. Haemoglobin is primarily responsible for transport of oxygen to the body's tissues. The values were within the range 12.77-13.00 reported by Esiegwu and Obih

(2022) for broilers offered nutritional supplement of comfrey leaf extract and higher than the values 9.60-9.89 reported by Oguntoye *et al*. (2018) for broiler chickens fed varying levels of DL-methionine and inorganic sulphur. However, the values were within normal reference range 7.0-13 reported by Banerjee (2013). Reduction in the concentration of haemoglobin suggested the presence of toxic factors such as haemaglutinin, which can have an adverse effect on blood formation (Oyawoye and Ogunkunle, 1998; Oguntoye *et al*., 2018).

The packed cell volume (PCV) increased significantly ($P<0.05$) with increased dietary levels of cassava leaf meal. PCV is the volume percent of red blood cells in circulating blood (Purves *et al*., 2003). The increase in PCV was an indication that the dietary treatment of cassava leaf meal have the capacity to increase the red blood cells, thereby increasing oxygen supply to the tissues and thus strengthening the immune system and maintaining a healthy and intact body system. Healthy tissues result from healthy body cell growth which culminates in healthy body systems and invariably a healthy chicken or animal. A decrease in PCV below the normal range is a pointer to liver and kidney diseases, malnutrition of vitamin B12, and folic acid deficiencies (Demoranville and Best, 2013). Kepeme *et al*. (2011) reported that when the PCV values are below the normal range, the chickens become anaemic. The PCV values obtained in this study were higher than the values 30.9-33.41% for broiler finishers offered supplementary *Telfairia occidentalis* (pumpkin) leaf extract (Alabi *et al*., 2017) but close to 37.67- 41.33 for broiler finisher chickens offered comfrey leaf extract by Esiegwu and Obih (2022). The values from this work fall within the normal reference range 25-45% (Banerjee, 2013), 22-35% (Jain, 1989) and 30-33% or 35-45% for male chickens (Swenson, 1977).

The red blood cells (RBC) increased significantly with dietary inclusion of cassava leaf meal. Red blood cells function to transport oxygen from the lungs to the tissues and take CO_2 back to the lungs to be exhaled. The increase in value of red blood cell implies that the cassava leaf meal was able to keep the health and immune system of the animals intact. Red blood cells in the circulating blood transport adequate oxygen and nutrient to the cells and remove gaseous waste products out of the body, thus purifying the tissues and nourishing them healthily. The values for the RBC were within the normal reference range of 7-12 as reported by Banerjee (2013), Jain (1989), and Swenson (1977). Low values for Hb and RBC are good indicators of emerging anaemia (Mohammed and Oloyede, 2009). Esiegwu and Obih (2022) reported that normal values for RBC, PCV and Hb mean adequacy of amino acid and iron metabolism and utilization for haeme and normal haemoglobin synthesis.

The mean cell volume (MCV), mean cell haemoglobin (MCH) and mean cell haemoglobin concenteration (MCHC) increased significantly ($P<0.05$) with increase in dietary inclusion of cassava leaf meal. This implies that the dietary intake of cassava leaf meal provided adequate amino acids and iron for haemoglobin synthesis. It was reported that a low level of mean cell haemoglobin is an indication of anaemia (Aster, 2004). Similarly, PCV, Hb, and MCH have been reported as the major indices for evaluating circulatory erythrocytes and are significant in the diagnosis of anaemia and for the bone marrow's capacity to produce red blood cells in mammals (Chineke *et al*., 2006). The MCHC values were within the normal reference values of 26.0-35.0% reported by Banerjee (2013). The MCH values also fell within the standard reference values (25-27pg) reported by Swenson (2004). The mean cell volume (MCV) were within the range 81.60-89.10fl reported by Wikivet (2013). This implies that the production of red blood cells by the bone marrow was adequate and the chickens were in good health.

The white blood cells, the neutrophil and the lymphocyte increased ($P<0.05$) as the dietary inclusion of the cassava leaf meal increased. A rise in the number of white blood cells is a strong indicator of toxicity of diet or poor detoxification process, which leads to increase in production of white blood cell to fight foreign substances in the body (Oguntoye *et al*., 2018). Similarly, Esiegwu and Obih (2022) reported that the white blood cells and the differentials are good indicators of toxin, and rises in the presence of infection. Eosinophils increase in allergy and in parasitic infections, and neutrophils are walls of defense against bacteria in the tissues. Their numbers increase when acute infection is present (Barnerjee, 2013). Valencia (2012) reported that a high WBC could be caused by infection, immune system disorder or stress.

Similarly, it has been reported that white blood cell differentials rise in number in the event of infections to engulf bacteria (monocyte and neutrophil), to detoxify the body system (eosinophil), to prevent clotting and stasis of blood and lymph (basophil) and to form antibodies against antigens (lymphocytes) (Banerjee, 2013). White blood cells were within the normal reference range of $9\text{-}31x10^3/mm^3$ (Banerjee, 2013). The cassava leaf meal did not impact negatively or cause any deleterious effect on the blood of the animals since the WBC values were within the normal range. The monocyte, eosinophil and basophil did not show any detrimental effect ($P>0.05$) on the blood of the chickens.

Serum biochemical indices of the broiler starter chickens

Total protein and globulin increased significantly ($P<0.05$) as the dietary cassava leaf meal were increased. The increase in total protein as the dietary cassava leaf meal increased was a pointer to effective amino acid metabolism and utilization. Decreased serum protein concentration has been reported as an indication of alteration to normal metabolism due to interference in protein utilization (Bolu and Balogun, 2009). There was adequate supply and improved utilization of dietary proteins from feeding cassava leaf meal.

Urea is one of the blood indices used to measure protein quality. Esiegwu (2017) reported that the higher the urea quantity, the lower the protein quality. That means, urea quantity is inversely proportional to protein quality. The serum urea of the treatment groups was statistically similar ($P>0.05$) to the control. The non-significant differences relative to the control was a pointer to good protein quality as a result of proper amino acid metabolism and utilization (Esiegwu, 2021). The values for urea was lower than the value 5.60-6.30 and 9.38-10.50 reported by Esiegwu (2021) and Oguntoye *et al*. (2018). Serum creatinine is also used to evaluate protein quality in the blood. Ogunbode *et al*. (2016) reported that increase in blood creatinine could be as a result of excess breakdown of blood proteins. Yuengang *et al*. (2008) in the same vein added that excess blood creatinine is from muscle when wasting occurs and creatinine phosphate is catabolized. That means the animal is surviving at the expense of body reserve, which can lead to weight loss. The values from this trial were lower than 0.92-1.0 mg/dl and 54.00-62.00 mg/100ml reported by Oguntoye *et al*. (2018) and Esiegwu (2021) respectively. The values were also lower than the 0.90-2.0 mg/dl for normal broiler chicken reported by Okorie *et al.* (2011).

Serum cholesterol increased significantly with the dietary inclusion of cassava leaf meal. The values were, nevertheless, still below the range 157.93-173.94 mg/dl reported by Oguntoye *et al*. (2018). The rise in cholesterol level implies that fat is not being adequately mobilized, metabolized and utilized. The liver enzyme, serum alkaline phosphotase (ALP) and Serum aspartate transaminase (AST) increased significantly with the inclusion of cassava leaf meal at 10% dietary level compared to the control. Serum alanine transaminase (ALT) increased significantly ($P<0.05$) but was comparable to the control. The liver enzymes activities are used

for checking toxicity and monitoring protein quality (Ukpabi *et al*., 2015). The increase in ALP and AST at 10% dietary levels may suggest that from this point the protein quality may be challenged.

Conclusion

The result of the trial showed that cassava leaf meal contains nutrients which can be of value in animal nutrition especially proteins, fat and carbohydrates.

It also revealed that cassava leaf meal could serve as a protein source for broiler starter chickens, replacing soya bean in the ration at a level not exceeding 2.5%. It is economical and cost effective to use cassava leaf meal at this level.

The study also revealed that cassava leaf meal did not compare favorably with soya bean meal in producing heavier birds.

The trial also revealed that cassava leaf meal causes depression in performance of broilers at inclusion levels of 7.5% and above.

The study showed that cassava leaf meal had no deleterious effect on the haematological and serum biochemical indices of broiler finisher chickens at the current inclusion levels of this study.

It was therefore concluded that cassava leaf meal could serve as a protein source to replace soya bean meal in the diet of broiler starter at a level not exceeding 2.5% in order to earn higher revenue.

Recommendation

It was therefore, recommended that cassava leaf meal could serve as a protein source in broiler starter ration at not more than 2.5% inclusion level.

References

Abu, O.A., Olaleru, I.F., Oke, T.D., Adepegba, V.A. and Usman, B. (2015). Performance of broiler chickens fed diets containing cassava peel and leaf meals as a replacement for maize and soya bean meal. *International Journal of Science and Technology* 4(4): 169-173.

Accuweather (2022). Weather for Owerri, Nigeria. Available at http:www.accuweather.com/en/ng/owerri/253317/weather-forecast/253317 Retrieved on November 15, 2022.

Alabi, O., Ayoola, M. and Akinoso, O. (2017). Performance characteristics and physiological response of broiler chicken at finisher stage to oral supplementation with fluted pumpkin, (*Telfairia occidentalis)* leaf extract. *Journal of Central European Agriculture* 18(3): 646 – 656.

AOAC. (2010). *Official Methods of Analysis*, 19th edition, Association of Official Analytical Chemists.Washington D.C., USA.

Aster, J.C. (2004). Anaemia of diminished erythropoiesis. In. Kumar, V., Abbas, A.K., Fausto, N., Robbins, S.L. and Cotran, R.S. (eds.) *Pathologic Basis of Disease* (7th ed.). Sanders Co. Philadelphia. Pp. 638-649.

Banerjee, G.C. (2013). *A Textbook of Animal Husbandry*. Oxford and IBH publishing company. Pvt Ltd.

Bokanga, M. (1994). Processing of cassava leaf for human consumption. *Acta Horticulturae* 375: 203-208.
DOI: https://doi.org/10.17660/ActaHortic.1994.375.18

Bolu, S.A. and Balogun, O.O. (2009). Effects of improved (addition of anti microbials and anti-oxidants) locally produced natural vitamin premix on performance, haematology and some serum constituents of broiler chickens. *Nig. J. Anim. Prod*. 36(2): 246 – 255.

Chineke, C.A., Ologun, A.G. and Ikeobi, C.O.N (2006). Haematological parameters in rabbit breeds and crosses in humid tropics. *Pakistan Journal of Biological Science* 9(11): 2102-2016.

D'Mellow, J.P.F. and Acomovic, T. (1989). *Leuceana Leucocephala* in poultry nutrition. A review. *Animal Feed Science and Technology* 25: 1-28.

Demoranville, V.E. and Best, M.A. (2013). Heamatocrit. *Encyclopaedia of Surgery. A guide for Patients and Caregivers*. Available at enwikipedia.org/wiki/haematology.

Esiegwu, A.C. (2017). Effect of fermented sorghum seed meal on the performance, carcass characteristics and blood profile of broiler finisher chicken. *Nigerian Journal of Animal Production* 44(3): 300-308.

Esiegwu, A.C. (2019). The supplementary effect of Moringa oleifera leaf water on performance and blood indices of finisher broiler. *Direct Research Journal of Medicine and Animal Science* 4(4): 27–32.

Esiegwu, A.C. (2021). Growth performance, haematological and serum biochemical indices of broiler starter chickens offered nutritional supplement of fluted pumpkin (*Telfairia occidentalis*) leaf extract. *Journal of Agriculture and Food Environment* 8(3): 10-19.

Esiegwu, A.C. and Obih, T.K.O. (2022). Growth performance, serum indices and histopathology of finisher broiler chickens offered nutritional supplement of comfrey (*Symphytum officnale* L) leaf extract. *Asian Research Journal of Agriculture* 15(4): 254-265.

Fasuyi, A.O. and Nonyerem, A.D. (2007). Biochemical, nutritional and haematological implications of *Telfaina occidentalis* leaf meal as protein supplement in broiler starter diet. *African Journal of Biotechnology* 6(8): 1055-1063.

Ghosh, N. (2015). *Poultry Science and Practice*. *A Textbook*. CBS Publishers and Distributors PVT Ltd.

Gomez, G. and Valdivieso, M. (1985). Cassava foliage chemical composition, cyanide elimination. *Journal of the Science of Food and Agriculture* 36(6):433-441.

Iheukwumere, F.C., Ndubuisi, E.C., Mazi, E.A. and Onyekwere, M.U. (2008). Performance, nutrient utilization and organ characteristics of broilers fed cassava leaf meal diet (*Manihot esculenta* Crantz). *Pakistan Journal of Nutrition* 7(1): 13 – 16.

Jain, N.C. (1989). *Veterinary Hematology*, 4th edition, Lea and Febiger, Philadelphia, USA.

Kepeme, E.V., Elaluu, V., Koofreh, M.E. and Udensis, O. (2011). Phytochemisty and haematology potential of ethanol seed, leaf and pulp extracts of carioca papaya (inn). *Pakistan Journal of Biological Sciences* 14: 408-411.

Mohammed, N.O and Oloyede, O.B. (2009). Growth performance of broiler chicks fed *Aspergillius niger*-fermented *Terminalia catappa* seed meal based diets. *Global Journal of Biotechnology and Biochemistry* 4(2): 179–183.

Ochie, J. and Kolhatkar, A. (2000). *Medical Laboratory Science. Theory and Practice*. Tata McGraw-Hill Company Limited, New Delhi.

Ogbuji, C.A., and David-Chukwu, N.P. (2016). Phytochemical, antinutrient and mineral composition of leaf extracts of some cassava varieties. *Journal of Environmental Science and Technology* 10(1): 05-08.

Ogunbode, A.A., Okeniyi, G., Fatola, O.S.G., Ogunjimi, B.A. and Folarin, M.O. (2016). Haematology and serum indices of weaner pigs fed raw Pride of Barbados (*Caesalpina pulcherrima*) Seed Meal. *Nigerian Journal of Animal Science* 18(2): 408-416.

Oguntoye, M.A., Idowu, O.M.O., Sogunle, O.M., Akintunde, A.R. and Danladi, Y. (2018). Haematology and serum biochemistry of finisher broiler chickens fed maize-cassava diet supplemented with methionine and inorganic sulphure. *Nigerian Journal of Animal Science* 20(1): 152- 162.

Okorie, K.C., Nkwocha, G.A. and Ndubuisi, E.C. (2011). Implications of feeding varying dietary levels of cassava leaf meal on finisher broiler: Performance, carcass, haematological and serological profiles. *Global Research Journal of Science* 1: 58-66.

Onu, P.N. (2012). Effect of aqueous extract of *Tefairia occidentalis* leaf on the performance and haematological indices of starter broilers. *International Scholarly Research Network* 2012: 1–4.

Oyawoye, E.O. and Ogunkunle, M. (1998). Physiology and biochemical effect of raw jack beans on chicken. Proceeding of 23rd Annual conference of Nigerian Society of Animal Production. Gateway Hotels Abeokuta, Nigeria. Pp 141-142.

Phuc, B.H.N., Ogle, B. and Lindberg, J.E. (2000). Effect of replacing soya bean protein with cassava leaf meal in cassava root meal based diets for growing pigs on digestibility and nutrient retention. *Animal Feed Science and Technology* 83: 223-235.

Purves, W.K., Sadava, D., Onans, G.H. and Heller, H.C. (2003). *Life: The Science of Biology*. (7th edition) Sunderland, Mass Associates, 954.

Ravindran, V., Rajaderan, P.E., Goonewardene L.A. and Rajaguru, A.S.B. (1986). Effect of feeding cassava leaf meal on the growth of rabbit *Agricultural Wastes* 17(3): 217-224.

SPSS (2012) Statistical Package for Social Sciences, Version 21, IBM Corporation, USA.

Swenson, M.J. (1977). *Duke's Physiology of Domestic Animals*. 9th edition. CBS Publishers and Distributors, PVT ltd, India, pp. 14-35.

Ukpabi, U.H., Mbachu, C.I. and Nwazue, B. (2015). Effect of inclusion of different levels of raw *Adenanthera pavonina* seed meal (RAPSM) on haematology and blood biochemistry of finisher broiler. *Nigerian Journal of Animal Science* 17(1): 28-36.

Valencia, H. (2012). White blood cell count. Healthline Reference library. Healthline Networks, Inc. San Francisco, California.

Wikivet (2013). Haematology. Available at en.wikipedia/wiki/haematology. Accessed on 15th August 2022.

Yuengang, Z., Chengium, W. and Chengium, T. (2008). Simultaneous creatinine and uric acid in human urine by high performance liquid chromatography. *Analytical Science* 24: 1589 – 1592.

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Original Research Article

Rumen Fermentation Characteristics and Microbial Counts of West African Dwarf Goats Fed Cassava Peel-based Ration Supplemented with Enzymes

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Abstract

The study was conducted to evaluate rumen fermentation characteristics and microbial counts of West African Dwarf (WAD) goats fed cassava peel-based rations supplemented with three different fibrolytic enzymes. A total of 48 WAD goats, weighing approximately 6.55±0.09, were procured and quarantined for 21 days after which they were randomly allocated to eight treatment groups, based on a 2 x 4 factorial experimental in a completely randomized design. The two factors were sex (buck and doe) and experimental diet (D1, D2, D3 and D4). All the treatment diets had equal composition of feed ingredients except for type of enzyme added. D1 contained no enzyme (control); D2 contained protease, phytase xylanase and mannanase; D3 had beta-glucanase, cellulase and xylanase); and D4 had beta-glucanase, cellulase and xylanase). The feeding trial lasted for 90 days. Data were collected on rumen fermentation characteristics and microbial counts. The results showed that experimental diet had significant effects ($P<0.05$) on the values of total volatile fatty acids (TVFAs), bacterial and fungal counts with goats on D4 having the highest TVFAs (89.13 mM/100ml), and bacterial (6.13 x 10^6 cfu/ml) and fungal (0.66 x (11.93kg) counts. The study concluded that feeding goats with cassava peel-based rations supplemented with feed enzymes resulted in improved rumen ecology, with bucks performing better than does. Diet 4 [containing beta-glucanase (6,157 U/g), cellulase (2,222 U/g) and xylanase (23,222 U/g)] gave the best results followed by Diet 3 (containing beta-glucanase, cellulase and xylanase) and then Diet 2 (containing protease, phytase, xylanae, mannanase and amylase). The least result was obtained from Diet 1 (the control diet containing no enzyme).

Keywords: cassava peels, elephant grass, fibrolytic enzyme, rumen fermentation, rumen microbial counts

Introduction

Ruminants are efficient animals that can subsist on forages which are high in plant fibre, one of the most abundant organic resources in nature (Pérez-Barbería, 2020). This is possible because ruminants have evolved a digestive system that relies entirely on a symbiotic relationship with micro-organisms, and most of their energy comes from the end-products of microbial digestion, enabling them to make use of the plant cell wall, which is something that no other vertebrate can do to such an extent (Pérez-Barbería, 2020). However, the seasonality in the quantity and quality of these forages is a challenge to the productivity of ruminants. In the tropics, forages dry up during the dry season with consequential low nutritive value, leading to a marked decrease in voluntary intake and digestibility of the forages. This has led to intensive search for alternative feedstuff and ways of improving the quality of available low-quality feed resources through supplementation and/or fortification (Ojebiyi *et al.*, 2009).

Research has shown that supplementing ruminant diets with fiber-degrading enzymes improves feed utilization and animal performance, and also increases the range of feedstuff that can be used. This increases flexibility in feed formulation by reducing or removing the constraint on the inclusion limit of poorly digested ingredients (Ravindran, 2013) with consequences on rumen ecology. However, research data on rumen fermentation characteristics and microbial counts of West African Dwarf (WAD) goats fed cassava peel-based rations supplemented with different locally available fibrolytic enzymes is scanty, thus justifying this study. The study was therefore designed to evaluate the rumen fermentation characteristics and microbial counts of WAD goats fed cassava peel-based rations supplemented with three different fibrolytic enzymes.

Materials and Methods

Experimental site, experimental design, and the animals

The study was conducted at the Teaching and Research Farm of the Department of Animal Science, Faculty of Agriculture, Delta State University, Abraka, Nigeria (5.78^0N and 6.10^0E). The experimental design was a 2 x 4 factorial experiment in a completely randomized design. The two factors were sex (buck and doe) and experimental diet (4 levels). Forty-eight (48) WAD goats, weighing 6.55±0.09 on the average were procured and quarantined for 21 days after which they were randomly allocated to 8 treatment groups based on the 2 x 4 factorial design. The feeding trial lasted for 90 days.

Experimental ration: collection and preparation

Three exogenous enzymes were obtained from a feed supplement company. Cassava peels were gathered from cassava processing plants in Abraka, washed thoroughly to remove all traces of sand, and sun-dried for 5 days to constant weight. Elephant grass (*Pennisetum purpurem*) was harvested from the surroundings and sun-dried to constant weight for 5 days. Other components of the ration were procured from local feed dealers. The cassava peels and elephant grass were ground coarsely in a hammer mill and, thereafter, measured out with other feed ingredients, in accordance with their various inclusion rates. The resultant mixture was ground in a hammer mill, thoroughly mixed for 30 minutes and converted into 8mm diameter and 20mm length pellets. The gross composition of the experimental diets is presented in Table 1.

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

Feed ingredients	Treatments			
	D1	**D2**	**D3**	**D4**
Cassava peels	35.000	35.000	35.000	35.000
Elephant grass	20.000	20.000	20.000	20.000
Rice bran	13.500	13.465	13.465	13.465
Palm kernel meal	15.000	15.000	15.000	15.000
Soybean meal (SBM)	3.000	3.000	3.000	3.000
Urea	1.500	1.500	1.500	1.500
Limestone	5.000	5.000	5.000	5.000
Salt	1,000	1.000	1.000	1.000
Premix	1.000	1.000	1.000	1.000
Molasses	5.000	5.000	5.000	5.000
Exogenous enzyme	0.000	0.035	0.035	0.035
Total (%)	100.000	100.000	100.000	100.000

D1 = control diet (without enzyme);
D2 = experimental diet with enzyme product containing protease (1000 U/g), phytase (5000 U/g), xylanase (2000 U/g) and mannanase (10 U/g) and amylase (1000 U/g)
D3 = experimental diet with enzyme product containing beta-glucanase, cellulase and xylanase
D4 = experimental diet with enzyme product containing beta-glucanase (6,157 U/g), cellulase (2,222 U/g) and xylanase (23,222 U/g)

Determination of rumen fermentation characteristics and microbial counts

At the end of the feeding trial, before feeding in the morning, 20ml of rumen fluid was collected from the rumen of 24 goats (three per treatment group, that is one per replicate) using a stomach tube into sample bottles as described by Wanapat and Khampa (2007). The rumen pH was determined immediately using a pH meter (3150 model, Jenway, UK). After collection, the rumen fluid collected was made free of coarse particles by filtration with a four-layered cheese cloth and divided into three. One part was acidified with 1ml of a 5% (v/v) orthophosphoric acid solution and stored frozen at -20^{o}C till required for analysis of volatile fatty acids concentrations. Total volatile fatty acids distillate concentration was determined by titration of sample with 0.1N NaOH solution expressed as volatile fatty acid content. The method is a modified protocol that replaced conventional titration with potentiometric titration system. The concentration of NaOH solution was matched with volatile fatty acid content in the samples for all the samples (Siedlecka *et al.*, 2008). A second portion was used for the determination of rumen ammonia nitrogen as described by Lanyasunya *et al*. (2008). The last portion was fixed with 10% formalin solution (1:9 v/v, rumen fluid: 10% formalin) for measuring microbial population by total direct count of bacteria, protozoa and fungal zoospores (Galyean, 1989).

Statistical analysis

Data obtained from the study were statistically analyzed using the general linear model procedure for two-way analysis of variance (ANOVA) adopted by IBM SPSS Statistics for windows (IBM, 2017) according to the following model:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \epsilon_{ijk}$$

Where:

Y_{ijk} = dependent variable (parameter under analysis),

μ = population mean,

α_i = main effect of factor A (experimental diet),

β_j = main effect of factor B (sex),

$(\alpha\beta)_{ij}$ = interaction effect of both factors,

ϵ_{ijk} = experimental or residual error.

Duncan's multiple range test in the same statistical package was used to separate significantly different means at 5% level of significance.

Results

Rumen fermentation characteristics of experimental animals

The effects of experimental diet and sex on the rumen fermentation characteristics of WAD goats are presented in Table 2. The results showed that diet had significant effects ($P<0.05$) on values of ammonia nitrogen (NH_3-N), total volatile fatty acids (TVFA), acetic acid and propionic acid with goats on Diet 4 (D4) having the highest values.

Table 2: Main effect of diet and sex on rumen fermentation characteristics of the WAD goats

	Experimental diets						Sex			
Parameters	**D1**	**D2**	**D3**	**D4**	**±SEM**	**Sig**	**Buck**	**Doe**	**±SEM**	**Sig**
Rumen pH	6.48	6.55	6.55	6.44	0.06	0.422	6.49	6.52	0.04	0.633
Ammonia-Nitrogen (mg/100ml)	7.24^{b}	7.61^{ab}	7.47^{ab}	7.79^{a}	0.14	0.075	7.61	7.45	0.10	0.254
Total volatile fatty acids (mM/100ml)	67.99^{c}	74.09^{b}	83.89^{a}	89.13^{a}	1.84	0.000	80.07	77.48	1.30	0.179
Acetic acid (mM/100ml)	37.86^{c}	43.26^{b}	47.60^{a}	48.83^{a}	1.43	0.000	44.01	44.76	1.01	0.606
Propionic acid (mM/100ml)	17.96^{c}	18.17^{c}	22.42^{b}	25.48^{a}	0.78	0.000	21.79	20.23	0.55	0.062
Butyric acid (mM/100ml)	11.40	11.24	11.82	12.13	0.31	0.204	12.33^{a}	10.96^{b}	0.22	0.000

Note: Values are presented as means ± standard error; ^{abcd} Within each of the factors (diet or sex) means in the same row with different superscript differ significantly ($P<0.05$).

The pH values showed no definite trend. The value for butyric acid varied significantly ($P<0.05$) with sex, with bucks (12.33mM/100m) having the higher values than does (10.96 mM/100m).

The interaction effect of diet and sex on rumen fermentation characteristics of WAD goats is in Table 3. Diet and sex had no interaction effect on the rumen fermentation characteristics of WAD goats.

Table 3: Interaction effect of experimental diet and sex on serum fermentation characteristics of the WAD goats

	D1		D2		D3		D4			
Parameters	**Buck**	**Doe**	**Buck**	**Doe**	**Buck**	**Doe**	**Buck**	**Doe**	**±SEM**	**Sig**
Rumen pH	6.47	6.48	6.52	6.59	6.56	6.55	6.41	6.46	0.08	0.949
Ammonia-Nitrogen (mg/100ml)	7.50	6.98	7.82	7.40	7.34	7.60	7.78	7.80	0..20	0.201
Total volatile fatty acids (mM/100ml)	71.63	64.36	73.98	74.20	84.06	83.71	90.61	87.65	2.60	0.482
Acetic acid (mM/100ml)	37.95	37.77	42.05	44.46	47.34	47.85	48.69	48.97	2.02	0.923
Propionic acid (mM/100ml)	20.11	15.81	18.09	18.26	22.60	22.24	26.35	24.61	1.10	0.247
Butyric acid (mM/100ml)	11.97	10.83	12.14	10.33	12.22	11.41	13.00	11.26	0.44	0.620

Note: Values are presented as means ± standard error.

Rumen microbial counts of experimental animals

The main effects of diet and sex on rumen microbial counts of WAD goats are shown in Table 4. The results show that diet and sex had significant effects (P<0.05) on bacterial and fungi counts but had no significant effect (P>0.05) on protozoa counts. The bacterial counts increased significantly (P>0.05) from D1 to D4 with goats on D4 having the highest bacterial count (6.13 x 10^6 cfu/m), and goats on D1 having the lowest (3.63x 10^6 cfu/m). The fungal populations also increase significantly (P<0.05) from D1 to D4, with goats on D4 having the highest value of 0.66 x 10^6 cfu/ml. Rumen microbial counts did not vary significantly (P>0.05) with sex.

Table 4: Main effect of experimental diet and sex on rumen microbial counts of WAD goats fed the experimental diets

	Experimental diets						Sex			
Parameters	**D1 (Control)**	**D2**	**D3**	**D4**	**±SEM**	**Sig**	**Buck**	**Doe**	**±SEM**	**Sig**
Bacterial (x10^6 cfu/m)	3.63^d	4.52^c	5.97^b	6.13^a	0.12	0.000	4.95	4.70	0.08	0.052
Fungi (x10^6 cfu/ml)	0.29^d	0.46^c	0.53^b	0.66^a	0.03	0.000	0.49	0.48	0.02	0.567
Protozoa (protozoa/ml)	169.23	171.44	172.51	178.95	3.09	0.182	173.59	172.47	2.18	0.722

Note: Values are presented as means ± standard error; ^{abcd} Within each of the factors (diet or sex) means in the same row with different superscript differ significantly (P<0.05).

There was no significant (P>0.05) interaction effect of diet and sex on rumen microbial counts as shown in Table 5.

Table 5: Interaction effect of experimental diet and sex on rumen microbial counts of WAD goats

	D1 (Control)		D2		D3		D4			
Parameters	**Buck**	**Doe**	**Buck**	**Doe**	**Buck**	**Doe**	**Buck**	**Doe**	**±SEM**	**Sig**
Bacterial (x 10^6 cfu/m)	3.57	3.69	4.78	4.36	5.31	4.64	6.14	6.12	0.17	0.106
Fungi (x 10^6 cfu/ml)	0.33	0.25	0.45	0.47	0.53	0.53	0.66	0.66	0.04	0.575
Protozoa (protozoa/ml)	167.37	171.08	168.72	174.17	174.61	170.41	183.67	174.23	4.37	0.316

Note: Values are presented as means ± standard error.

Discussion

Rumen fermentation characteristics of the experimental animals

The pH values (6.44 to 6.55) all fell within the range of 6.00-7.20 reported by Chathurvedi *et al.* (2015) as suitable for the growth and activities of microbes. They were comparable to the range of 6.48 to 7.14 reported by Ajagbe *et al.* (2020) for WAD goats fed cassava peels-poultry manure concentrate supplements, and 6.23 to 6.44 reported by Adebayo *et al.* (2017) for WAD goats fed enzyme-supplemented total mixed rations in the dry season. The pH level in the rumen is affected by the level of volatile fatty acids (VFA) in the rumen. Consequently the higher the amount of VFAs produced in the rumen the lower the level pH in the rumen fluid of goats (McDonald *et al.*, 2002). The observed pH values showed no definite trend. The ammonia nitrogen values obtained in this study (7.24 to 7.79mg/100ml) were all within the optimum levels (5.00 to 20mg/100ml) reported by Zareian *et al.* (2013) as suitable for ruminal bacteria activities and 6.90 to 7.29mg/100ml reported Adebayo *et al*. (2017). This is an indication that the protein contents in the diets formulated in this study were adequate, and the feed was normally and properly degraded under optimum pH levels. The VFA values (67.99 to 89.13mM/100ml) obtained increased from D1 to D4, and were within the range of 52.70mM/100ml to

86.23mM/100ml reported by Adebayo *et al*. (2017). However, only the values recorded in D3 which had an enzyme product containing beta-glucanase, cellulase and xylanase (83.89mM) and D4 which contained beta-glucanase, cellulase and xylanase (89.13mM) had VFA concentrations of 80mM to 160mM reported by Ismartoyo *et al.* (2022). Normal VFA concentration in the rumen is associated with optimum growth of rumen microbes (Ismartoyo *et al*., 2022). VFA production is generally affected by the type and amount of plant materials ingested, as well as the rumen pH. High-roughage diets result in increased proportion of acetate whereas herbage with high levels of water-soluble carbohydrates or concentrate-based diets result in increased proportion of propionate (Annison *et al.*, 2002). This was evident in this study as acetic acid values were higher across the treatments than propionic acid values, as the diets were high in fibre. Acetic acid (37.86 to 48.83mM/100ml) and propionic acid (17.96 to 25.48mM/100ml) increased significantly ($P<0.05$) from D1 to D4. This shows that the diet given to the WAD goats were properly degraded by them with the best degradation occurring in WAD goats that were fed diets supplemented with D4, followed by those fed D3 and D2 in that order.

Rumen microbial counts of the experimental animals

The bacterial counts recorded in this study were 3.62×10^6 cfu/ml (D1), 4.57×10^6 cfu/ml (D2), 4.97×10^6 cfu/ml (D3) and 6.13×10^6 cfu/ml (D4), thus indicating that the values increased progressively and significantly ($P>0.05$) from D1 to D4. This means that the supplementation of the diets with exogenous enzyme increased fibre digestion thus providing energy and protein for the multiplication and growth of bacteria. An increase in bacterial population increases, further, fibre degradation with consequential increase in microbial protein made available to the animal. Bacterial count in the rumen is dependent on rumen pH and ammonia concentration, and both are a function of the diet (Adebayo *et al*., 2017). Rumen bacteria are the principal agents for fermenting plant cell wall carbohydrates hence they constitute the largest proportion of microorganism in the rumen in relation to fungi and protozoa (Adebayo *et al*., 2017). The fungal populations recorded in this study increased significantly ($P<0.05$) from D1 (control, no enzyme) to D4 (enzyme product containing beta-glucanase, cellulase and xylanase). Ruminal fungal populations are favored by the consumption of fibrous forage that are mainly highly lignified, and play an essential role in fiber digestion due to the production of filamentous rhizoids which invade plant tissues, and their efficient enzymatic activities (Denman *et al.*, 2008). This physical action on plant cell walls can facilitate access to more digestible tissues and help release polysaccharides, which are linked to lignin, increasing the pool of digestible energy for the rumen microflora (Pitta *et al.*, 2010).

Conclusion

The results of this study show that the feed challenge in goat farming can be addressed by feeding cassava peel-based rations supplemented with exogenous fibrolytic enzymes to improve rumen ecology and animal performance with the best results obtained from the addition of a mixture of beta-glucanase (6,157 U/g), cellulase (2,222 U/g) and xylanase (23,222 U/g) to forage-based feeds containing cassava peels at a rate of 0.35g/kg DM. Good results can also be obtained from any locally available enzyme products containing beta

glucanese, cellulase and xylanase or product containing protease (1000 U/g), phytase (5000 U/g), xylanase (2000 U/g) and mannanase (10 U/g) and amylase (1000 U/g).

References

Adebayo, K.O., Aderinboye, R.Y., Isah, O.A. and Onwuka, C.F.I. (2017). Rumen fermentation characteristics of West African Dwarf goats fed enzyme supplemented total mixed ration in the dry season. *Animal Research International* 14(3): 2867-2875.

Ajagbe, A.D., Okpe, A.A., Abdulhamid, A.A. and Abalaka, E.O. (2020). Rumen Parameters of West African Dwarf (WAD) Goats Fed Cassava Peels- Poultry Manure Concentrate Supplements. *International Journal of Environment, Agriculture and Biotechnology* 5(5): 1245 – 1249.

Annison, E.F., lindsay, D.B. and Nolan, J.V. (2002). Digestion and metabolism. In: Freer, M. and Dove, H. (Eds.). *Sheep Nutrition*. CABI, Wallingford, UK. Pages 95 – 118.

Chathurvedi, I., Duta, T.K., Sharma, A. (2015). Effect of combined herbal feed additives on methane, total gas production and rumen fermentation. *Bioinformation* 11: 261–266. doi: 10.6026/97320630011261. eCollection 2015.

Denman, S.E., Nicholson, M.J., Brookman, J.L., Theodorou, M.K. and McSweeney, C.S. (2008). Detection and monitoring of anaerobic rumen fungi using an ARISA method. *Letters in Applied Microbiology* 47: 492-499.

Galyean, M. (1989). Laboratory procedure in animal nutrition research. Department of Animal and Life Science, New Mexico State University, USA.

IBM (2017). *IBM SPSS Statistics for Windows*, version 25. IBM Corp. Armonk, New York.

Ismartoyo, I., Islamiyati, R., Muhummad Rusdy, M. and Mushandri, M. (2022). Characteristics of Rumen Fermentation of Goat Fed Four Different Diets. *Newest Updates in Agriculture and Veterinary Science* 1: 9-16. DOI: 10.9734/bpi/nuavs/v1/3143A.

Lanyasunya, T.P., Wang, H., Kariuki, S.T., Mukisira, E.A., Abdulrazak, S.A., Kibitok, N.K. and Ondiek, J.O. (2008). The potential of *Commelina benghalensis* as a forage for ruminants. *Animal Feed Science and Technology* 144(3): 185 – 195.

McDonald, P., Edward, R.A., Greenhalgh, J.F.D. and Morgan, C.A. (2002). *Animal Nutrition.* (6th Ed.) Prentice Hall, United Kingdom. Pp. 235-240.

Ojebiyi, O.O., Emiola, I.A., Rafiu, T.A., Hamzat, R.A.H. and Ademowa, I.O. (2009). Growth, haematological and serum biochemical responses of broiler chickens fed graded levels of kola (*Cola acuminata*) husk meal. *Tropical Journal of Animal Science* 2: 110-11.

Pérez-Barbería, F.J. (2020). The ruminant: Life history and digestive physiology of a symbiotic animal. In: Santiago García-Yuste (Author). *Sustainable and Environmentally Friendly Dairy Farms.* Pp. 19-45. Springer, New York. DOI: 10.1007/978-3-030-46060-0_2.

Pitta, D.W., Pinchak, E., Dowd, S.E., Osterstock, J., Gontcharova, V., Youn, E., Dorton, K., Yoon, I., Min, B.R., Fulford, J.D., Wickersham, T.A. and Malinowski, D.P. (2010). Rumen bacterial diversity dynamics associated with changing from bermudagrass hay to grazed winter wheat diets. *Microbial Ecology* 59: 511-522.

Ravindran, I.V. (2013). Feed enzymes: The science, practice, and metabolic realities. *Journal of Applied Poultry Research* 22: 628–636. http://dx.doi.org/ 10.3382/japr.2013-00739.

Siedlecka, E.M., Kumirska, J., Ossowski, T., Glamowski, P., Golebiowski, M., Gajdus, J., Kaczynski, Z. and Stepnowski, P. (2008). Determination of volatile fatty acids in environmental aqueous samples. *Polish Journal of Environmental Studies* 17(3): 351 – 356.

Wanapat, M. and Khampa, S. (2007). Effect of levels of supplementation of Concentrate containing high levels of cassava chip on rumen ecology, microbial N supply and digestibility of nutrients in beef cattle. *Asian-Australian Journal of Animal Science* 20(1): 75-81.

Zareian, M., Ebrahimpour, A., Mohamed, A.K.S. and Saari, N. (2013). Modeling of glutamic acid production by *Lactobacillus plantarum* MNZ. *Electronic Journal of Biotechnology* 16(4): 5482-5497. doi:10.2225/vol16-issue4-fulltext-10.

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Original Research Article

Capacity Building Needs and Measures for Developing Resilient Cassava Farmers in a Fragile Economy

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Abstract

The study was conducted in Delta State, Nigeria, and guided by two research questions. The ex-post factor research design and a descriptive survey research method were adopted on a 4-point scale to solicit the opinion of respondents on the capacity-building needs and intervention measures that are capable of strengthening cassava farmers' resilience. The population of the study was 2,423 registered cassava farmers in 364 clusters in Delta State. A multi-stage sampling technique was employed to sample 191 cassava farmer clusters for the study. A self-developed 9 and 14-item structured questionnaires were used for data collection and were validated by 3 experts. The validated instruments were pre-tested to ascertain their internal consistency using the Split-half method which yielded reliability coefficient of 0.85 and 0.91 for the two questionnaires. Data collected were analyzed descriptively, and presented as means and standard deviations. The results of the study identified understanding conflict management and resolution, understanding early warning signs, and building resilient farm structures and livelihoods among others as the capacity-building needs for developing resilience. Furthermore, the study identified mustering of political will to enforce microeconomic policy in promoting sustained cassava production, and deliberate financial support to cassava farmers among others as the measures capable of building resilient Cassava farmers in a fragile economy. The study recommended among others that cassava farmers' capacity should be built regularly and the Nigerian government should make provisions for improved cassava variety and other farm inputs supplies to farmers.

Keywords: Capacity-Building, Cassava farmers, Developing Resilience, Resilient, Fragile Economy

Introduction

In modern times, world leaders are making every available sustainable effort in solving the food crisis amidst challenges facing the availability, access, and utilization of food. Despite these efforts, Nigerian farmers', particularly cassava farmers' livelihoods are still economically

threatened. Cassava farmers are not only faced with external obstacles such as land grabbling, inter- and intra-community clashes, farmers-herders clashes, insurgencies, transport hikes, oil spillage, Covid-19 and climate-related changes not limited to flooding, drought, and bush burning, but are also exposed to economic shocks orchestrated by the fragility of the Nigerian economy (Oladunmi, 2019; Ikeoji and Agbidi 2021; UNFSS, 2021; Agbidi and Imobighe, 2022; FAO, 2022).

A fragile economy is regarded as a state of vulnerability to exposure to economic shocks. This is often characterized by poverty, insecurity (kidnapping, rape, farmers-herders clashes), deprivations to fundamental rights to ownership and control over farmland, land disputes, divided political will, youth agitations, food price hikes, fuel scarcity, power failures and declining economy (Gatto *et al*., 2021; Ikeoji and Agbidi 2021; Agbidi *et al*., 2022; Haken *et al*., 2022). Fragility breeds vulnerability to exposure to shocks and this accounts for Nigeria being ranked the 16th most fragile country in the world according to the 2022 Fragile State Index report (Haken *et al*., 2022). The relative impact of this fragility is on cassava farmers as it is the major food crop cultivated by most farm families in Nigeria.

Cassava is a popular staple food valued by many mostly in the southern part of Nigeria and the crop is grown across many family households (IITA, 2021). Some studies widely hold that cassava farmers are poor in finance and land as the majority often operate subsistence farming while a few engage in marketing the product (Anikwe and Ikenanyia, 2018; Ibe and Isiwu, 2021; Oyekola *et al*., 2021). With better-informed cassava farmers, emerging issues to avert food insecurity can be confronted with new thinking habits as reflected in quality agricultural education (Agbidi *et al*., 2021). These habits will help cassava farmers develop measures to tackle unexpected threats to their livelihoods amidst a fragile economy.

Thus, building resilient cassava farmers would help in mitigating these external obstacles and economic fragility on their livelihood activities. Developing resilience is conceptualized as the capacity of farmers to recover quickly from shocks and intricacies during food production (Mallappa and Babu, 2022). To be resilient is simply the ability to withstand shocks. An adaptable and transformable resilient capacity building is best adapted to the local environment (Meuwissen *et al*., 2019). Resilient measures can be developed by building the capacity of cassava farmers and ensuring that intervention actions are put in place to checkmate economic shocks. These measures are actions needed as support in strengthening the cassava farmers' resilience. These actions may include among others financial support, adequate and timely provision of improved cassava varieties, assurance of farmland and lives, and political willingness to stop farmers-herders clashes, insurgencies, and kidnapping (Ikeoji and Agbidi, 2021; Oyekola *et al*., 2021; Agbidi and Imobighe, 2022; FAO, 2022). More so, resilient farmers are better prepared to withstand shocks (Ikeoji and Agbidi, 2021; Kumar and Babu, 2021; FAO, 2022).

Furthermore, building cassava farmers' resilience can prepare them psychologically to resist economic shocks that may affect their production and equip them with innovative approaches to improve and increase their productive capacity. Notwithstanding, capacity building should be designed to meet the felt needs of the cassava farmers who often operate in clusters (Ikeoji and Agbidi 2021). More so, cassava farmers' resilience must be developed to enable them to withstand the symptoms of a fragile economy.

Emanating from the symptoms of Nigeria's fragile economy, emerging issues are brewing because of the importance of cassava to food security leading to numerous studies. Several studies have examined the production and challenges facing cassava farmers (Ekeleme *et al*., 2016; FAO, 2018a; Ikuemonisan *et al*., 2018; Ikeoji and Agbidi 2021; Oyekola *et al*., 2021) while some studies investigated the contributions of cassava to food security (Oyekola *et al*., 2021; Kennedy *et al*., 2019; Otekunrin and Sawicka, 2019; FAO, 2018b; Ikuemonisan *et al*., 2018; Ekeleme *et al*., 2016;), and government intervention and measures to assist cassava farmers (Ikeoji and Agbidi 2021; Oyekola *et al*., 2021; Inegbedion *et al*., 2020; Otekunrin and Sawicka, 2019; FAO, 2018b; Ikuemonisan *et al*., 2018). Some other studies examined cassava farmers' resilience (Gatto *et al*., 2021; Ikeoji and Agbidi 2021; Mallappa and Babu, 2021). Despite these several studies, non in a single context examined the capacity-building needs and measures for developing resilient cassava farmers in a fragile economy.

Furthermore, the increasing demand for cassava products both for domestic and industrial usage calls for concern. It seems cassava farmers cannot meet the demand for the product by the consumers owing largely to the fragility of the Nigerian economy as occasioned by economic threats to their livelihoods. It is, therefore, this concern that necessitated the study to develop a framework for building cassava farmers' resilience amidst a fragile economy.

Purpose of the Study

The major purpose of this study is to develop resilient capacity-building measures for cassava farmers amidst the fragility of the Nigerian economy. Specifically, the study seeks to:

i. identify the resilience capacity-building needs of cassava farmers in a fragile economy; and

ii. determine the measures capable of building resilient cassava farmers in a fragile economy.

Research Questions

i. What are the resilient capacity-building needs of cassava farmers in a fragile economy?

ii. What are the measures capable of building resilient cassava farmers in a fragile economy?

Methodology

The study was performed in Delta State located in the Niger Delta Area of Nigeria with the dominance of cassava as a major crop cultivated in its 25 Local Government Areas. An *ex-post-facto* design and a descriptive survey research method were adopted for the study to solicit the views of cassava farmers within the area of study. This technique was considered appropriate for the study because pre-existing variables about cassava farmers' vulnerability to the fragility of Nigeria's economy had already occurred, and so cannot be manipulated as data are collected through structured questionnaires.

The study population consisted of 2,423 registered cassava farmers in Delta State's 364 clusters (Delta State Ministry of Agriculture and Natural Resources, 2020). Slovin's sample size formula was adopted to select 191 cassava farmers' clusters. Thereafter, one cassava farmer, representing

7.88% of the total population of registered cassava farmers in Delta State, was randomly selected per cluster. The instruments for data collection titled "Resilient Capacity Building Needs in a Fragile Economy (RCBNFE)'' and "Measures Capable of Building Resilient Cassava farmers in a Fragile Economy (MCBRCFFE)'' contained 9 and 14 structured items that were self-developed from the reviewed literature for the study. The items on each question were assigned a Likert scale-type response option of Strongly Agree (4-point) to Strongly Disagree (1-point). The instrument for data collection was face and content validated by two experts from the Department of Vocational Education (Agricultural Education Unit) and one from the Department of Guidance and Counselling (Test and Measurement Unit) all from Delta State University, Abraka. The experts went through the instruments to confirm that they encompassed the correct items that were needed.

The reliability of the validated instruments was established by pre-testing them on 30 cassava farmers from Edo State. The internal consistency of the instruments was determined using the Split-half technique by splitting each section of the instruments into odd and even number groups. Each group's scores were gathered and computed using Statistical Package for Social Sciences (SPSS) version 26 and analyzed employing the split-half reliability tool correlated with the Spearman Rank Order Correlation Coefficient to obtain a reliability coefficient of the half test. The reliability of the entire test was then calculated using the Spearman-Brown coefficient which yielded reliability coefficients of 0.85 and 0.91 for RCBNFE and MCBRCFFE respectively.

One hundred and ninety-one copies of the questionnaire were personally administered and retrieved by the researcher with the aid of two programme personnel from the Ministry of Agriculture and Natural Resources to the cassava farmers' cluster leaders during a one-day flag-off of the Cassava Development Programme held at the Cenotaph – Asaba, Delta State organized for cassava farmers within the State. Out of the 191 questionnaire copies distributed, only 180 copies were retrieved indicating a 94.24% return rate. Collated data were analyzed using descriptive statistics, and any Mean ($\bar{x}$) score greater or equal to 2.50 was regarded as *Agreed* and any Mean score less than 2.50 as *Disagreed* for each item remark.

Results

Research Question 1: What are the resilient capacity-building needs of cassava farmers in a fragile economy?

Table 1: Cassava farmers' responses on resilient capacity-building needs in a fragile economy (n=180).

S/N	Items	Mean ($\bar{x}$)	SD	Decision
	Build my resilient capacity on:			
1	reduction of post-harvest loss or waste	2.99	0.89	Agree
2	team work/collaborations among cassava stakeholders	3.31	0.66	Agree
3	decision-making skills amid threats	3.30	0.63	Agree
4	innovative approaches in risk management	3.34	0.61	Agree
5	disaster-risk management-control skills	3.12	0.87	Agree
6	building resilient farm structures-livelihoods	3.35	0.59	Agree
7	understanding early warning signs	3.42	0.52	Agree
8	information sourcing-management	2.97	0.93	Agree
9	understanding conflict management-resolution	3.49	0.50	Agree

Table 1 presents the Mean ($\bar{x}$) scores of the respondents on the resilient capacity-building needs of cassava farmers in a fragile economy with all the items ranging from 2.97 – 3.49. These values are above the benchmark of 2.50, signifying agreement that all the items are the capacity-building needs for developing resilient cassava farmers in a fragile economy, particularly in the areas of understanding conflict management and resolution, understanding early warning signs, building resilient farm structures and livelihoods, innovative approaches in risk management among others. The values of the Standard Deviation (0.50 – 0.93) showed that the cassava farmers' responses did not deviate widely from the Mean ($\bar{x}$) but were close to one (1) in their opinions on the capacity building needed for developing resilience in a fragile economy.

Research Question 2: What are the measures capable of building resilient cassava farmers in a fragile economy?

Table 2: Responses on measures capable of building resilient cassava farmers in a fragile economy (n = 180).

S/N	Items	Mean	SD	Decision
1	Develop rapid multiplication-resistant varieties of cassava against climatic shocks	3.51	0.50	Agree
2	Sustain-fund cassava research development activities in schools	3.38	0.63	Agree
3	Deliberate financial support to cassava farmers	3.52	0.50	Agree
4	Strengthen cassava farmers-extension agents-research institute linkages	3.48	0.54	Agree
5	Prompt distribution of resistant cassava varieties to enhance the availability of planting materials	3.51	0.50	Agree
6	Value chain development of cassava production at the cluster level	3.48	0.50	Agree
7	Enhance cluster-level processing technology in cassava farming communities	3.51	0.51	Agree
8	Muster political will to enforce microeconomic policy to promote sustained cassava production	3.56	0.50	Agree
9	Deliberate enforcement of law order at the community level	3.48	0.52	Agree
10	Consent effort to support smart technology in cassava production	3.53	0.50	Agree
11	Invest in rural infrastructures at the farming community level	3.51	0.50	Agree
12	Mitigate measures against perennial flooding through dredging of rivers and creeks	3.50	0.50	Agree
13	Enforce social protection measures	3.48	0.52	Agree
14	Enforce anti-grazing laws at the community level	3.51	0.50	Agree

Table 2 describes the Mean scores of the respondents on the measures capable of building resilient cassava farmers in a fragile economy. All the responses ranged from 3.38 – 3.56. These values are above the benchmark of 2.50, indicating that the respondents agreed that all the items were the measures capable of building resilient cassava farmers in a fragile economy, particularly in terms of mustering of political will to enforce microeconomic policy in promoting sustained cassava production, deliberate financial support to cassava farmers, developing rapid multiplication-resistant varieties of cassava against climatic shocks, prompt distribution of

resistant cassava varieties to enhance the availability of planting materials, enhancing cluster level processing technology in cassava farming communities among others. The Standard Deviations ranged from 0.50 – 0.63 indicating that cassava farmers' responses were not far apart from the Mean but close to one another in their opinions on the measures capable of building resilient cassava farmers in a fragile economy.

Discussion

Resilient Capacity Building Needs of Cassava farmers in A Fragile Economy

The result of the study in Table 1 shows that in a fragile economy, cassava farmers need resilient capacity-building in the area of understanding conflict management and resolution, recognizing early warning signs, building resilient farm structures and livelihoods, employing innovative approaches in risk management, teamwork and collaborations, developing decision-making skills amid threats, among others. This finding aligns with an earlier study by Yaseen *et al*. (2015) which reported that the basic reason for capacity building and training is to ensure individual and organizational change. This is also in line with Ikeoji and Agbidi (2021) that capacity-building in resilience gives credence to the centrality of Agricultural education to sustainable development. This implies that applying the right capacity-building measures is capable of empowering and facilitating cassava farmers' resilience against economic fragility. Climatic shocks, food shortages, food price hikes, conflicts, clashes, and other factors are capable of weakening the capacity of cassava farmers to increase production. Therefore, resilient capacity building in the identified areas is vital to strengthening cassava farmers in a fragile economy.

Measures Capable of Building Resilient Cassava farmers in A Fragile Economy

The result in Table 2 identified the measures capable of building resilient cassava farmers in a fragile economy. These measures include mustering of political will to enforce microeconomic policy in promoting sustained cassava production, deliberate financial support to cassava farmers, developing rapid multiplication of resistant varieties of cassava against climatic shocks, prompt distribution of resistant cassava varieties to enhance the availability of planting materials, enhancing cluster level processing technology in cassava farming communities among others. This finding agrees with Oyekola *et al*. (2021) that financial support, farm equipment supplies, and the provision of the new variety of cassava were the major interventions carried out by the Nigerian government. Intervention measures have the potential to strengthen vulnerable cassava farmers to be productive despite obstacles. Interventions are necessary measures geared toward strengthening cassava farmers against economic threats to livelihood (Ikeoji and Agbidi 2021; Oyekola *et al*., 2021; Ekeleme *et al*., 2018; Ikuemonisan *et al*., 2018).

Conclusion/Recommendation

In developing resilient cassava farmers in Nigeria, capacity-building is a necessary embodiment and key element of Agricultural education for achieving food security in a fragile economy. In doing this, intervention measures are also vital in creating assurances for the farmers against unwanted circumstances. Therefore, understanding, managing and resolving conflict, identifying early warning signs, building resilient farm structures, and collaborations among others are the resilient capacities needed by cassava farmers to make them capable of withstanding vulnerability to economic fragility. Likewise, measures such as mustering of political will to enforce microeconomic policy in promoting sustained cassava production, deliberate financial support to cassava farmers, developing rapid multiplication of resistant varieties of cassava against climatic shocks, prompt distribution of resistant cassava varieties to enhance the availability of planting materials, enhancing cluster level processing technology in cassava

farming communities among others are capable of sustaining and supporting productive capabilities of cassava farmers in a fragile economy.

Having identified the capacity-building needs and intervention measures capable of strengthening cassava farmers against fragility in the Nigerian economy, it is recommended that, cassava farmers' capacity should be built regularly to meet emerging challenges in the future. The government of Nigeria and research institutions should develop, multiply and distribute improved varieties of cassava that can withstand extreme climatic and anthropomorphic shocks such as floods, bush burning, and drought. The gap between cassava farmers, extension agents and research institutions should be bridged to enhance communication. Since farmers are constantly faced with challenges, the government of Nigeria should implement policies that socially support farmers facing economic threats to their livelihoods. The government of Nigeria should also provide cluster cassava-processing facilities to farming communities to aid farmers during periods of economic fragility.

References

Agbidi, S.S. and Imobighe, U.M. (2022). Stakeholders' perception, knowledge and attitude toward the goal to end poverty. *International Journal of Scientific Development and Research* 7(12): 613-620. http://www.ijsdr.org/papers/IJSDR2212093.

Agbidi, S.S., Ideh, V., Imobighe, U.M. and Emefia, I. (2022). Impediments faced in teaching agricultural trade-based curriculum amid the covid-19 era and sustainable resilient measures in Delta State. Nigeria. *Innovations* 70: 1307-1316.

Agbidi, S.S., Iyeke, A.P. and Ikeoji, C.N. (2021). Imperatives of agricultural education stakeholders towards zero hunger in Delta State. Nigeria. *Journal of Agricultural Education Teachers' Association of Nigeria* 5(1): 33-43.

Anikwe, M.A.N and Ikenanyia, E.E. (2018). Ecophysiology and production principles of Cassava (*Manihot Species*) in Southeastern Nigeria. *Intech Open*. https://www.intechopen.intechopen.com/chapter/5703

Ekeleme, F., Hauser, S., Atser, G., Dixon, A., Weller, S., Olorunmaiye, P., Usman, H., Olojede, A. and Chikoye, D. (2016). Weed management in cassava in Africa: Challenges and opportunities. *Outlooks on Pest Management* 27(5): 208–212.

FAO (2018a). *Guidelines on Defining Rural Areas and Compiling Indicators for Development Policy*. United Nations Organization. Food and Agriculture Organization, Rome, Italy. http://www.fao.org/3/ca6392en/ ca6392en.pdf.

FAO (2018b). *Food Outlook - Biannual Report on Global Food Markets – November 2018.* Food and Agriculture Organization, Rome, Italy, p. 104. http://www.fao.org/3/ca2320en/CA2 320EN.pdf.

FAO (2022). The future of food and agriculture. FAO Regional office for Near East and North Africa. Food and Agriculture Organization, Rome, Italy. https://www.fao.org>perspectives.

Gatto, M., Naziri, D., San Pedro, J. and Bene, C. (2021). Crop resistance and household resilience - the case of cassava and sweet potato during Super-typhoon Ompongin Philippines. *International Journal of Disaster Risk Reduction* 6(27): 1102392. Doi:10.1016/j.ijdrr2021.102392.

Haken, N., Woodburn, D., Gallo-Carelli, J., Cooper, A., Moglen, S., Faborode, J., Asfaw, Y. and Wilson, W. (2022). Fragile States Index 2022 Annual Report.

Ibe, V.S.O. and Isiwu, E.D. (2021). Awareness level and utilization of modern technologies in cassava production by farmers in Ebonyi State. Nigeria. *Journal of Agricultural Education Teachers' Association of Nigeria* 5(1): 205-212.

IITA (2021). *Cassava: Production*. International Institute of Tropical Agriculture, Ibadan, Nigeria. https://www.iita.org/cropsnew/cassava/

Ikeoji, C.N. and Agbidi, S.S. (2022). Improving extension agents and cassava farmers' attitude and resilience to end poverty in a pandemic era. *Proceedings of the 34th Annual Conference of Farm Management Association of Nigeria (FAMAN),* pp. 920-927.

Ikuemonisan, E.S., Mafimisebi, T.E., Ajibefun, I. and Adenegan, K. (2018). Cassava production in Nigeria: trends, instability and decomposition analysis (1970 – 2018). *Heliyon* 6(10): e05089. Doi.org/10.1016/j.heliyon.2020.e05089.

Inegbedion, H.E., Inegbedion, E.E., Obadiaru, E.D., Asaleye, A.J., Ayeni, A. and Aremu, C. (2020). Cassava attractiveness in Nigeria: a policy improvement approach. *Journal of Agribusiness in Developing and Emerging Economies* 10(2): 157–175.

Kennedy, G., Raneri, J., Stoian, D., Attwood, S., Burgos, G., Ceballos, H., Ekesa, B., Johnson, V., Low, J.W. and Talsma, E.F. (2019). Roots, tubers and bananas: contributions to food security. In Ferranti, P., Anderson, J.R. and Berry, E.M. (Eds.). *Encyclopedia of Food Security and Sustainability*, *3*, 231–256. Elsevier. https://doi.org/10.1016/B978-0-08-100596-5.21537-0.

Mallappa, V.K.H. and Babu, S.C. (2021). Building a resilient food systems: challenges and a way forward. In: Mallappa, V.K.H. and Shirur, M. (Eds.). *Climate Change and Resilient Food Systems: Issues, Challenges and Way Forward.* Springer, Singapore, pp. 1-34. https://doi.org/10.10071978-981-33-4538-6-1

Meuwissen, M.P.M., Feindt, P.H., Spiegela, A., Termeer, C.J.A.M., Mathijs, E., de Meya, Y., Finger, R., Balmann, A., Wauters, E., Urquhart, J., Vigani, M., Zawalińska, K., Herrera, H., Nicholas-Davies, P., Hansson, H., Paasa, W., Slijper, T., Coopmans, I., Vroege, W., … Reidsma, P. (2019). A framework to assess the resilience of farming systems. *Agricultural Systems* 17(2): 1-10. https://doi.org/10.1016/j.agsy.2019.102656.

Oladunmi, S. (2019). External shocks and Business cycle fluctuations in oil-exporting small open economies: The case of Nigeria. *CBN Journal of Applied Statistics* 10(2): 39-71. Doi:10.33429/cjas.10219.2/6.

Otekunrin, O.A. and Sawicka, B. (2019). Cassava, a 21st century staple crop: how can Nigeria harness its enormous trade potentials. *Acta Agriculturae Slovenica* 3(8): 194–202.

Oyekola, I.A., Oye, A.J., Samuel, F., Oyeyipo, O.A., Iwelumor, K., and Rasak, B. (2021). Social, economic and ecological factors influencing cassava farming in Nigeria rural context. *International Journal of Social Sciences* 10(04): 295–303. Doi:10.468852/2249-6637.04.2021.2.

United Nations Food Systems Summit (2021). Action track 5-building resilience to vulnerabilities, shocks and stress: Synthesis report potential game changing and systematic solutions. An initial compilation. February 19th 2021. Un.org/sites/un2.un.org/files/2021/04/unfss_at5-synthesis_propositions_round 1.pdf

Yaseen, M., Hassan, S., Tunio, M.T., Ameen, M. and Abbas, S. (2015). Role of capacity building and training for sustainable livelihood of farming community in Pakistan. *European Academic Research* 3(3): 3085 – 3096.