https://dx.doi.org/10.4314/dujopas.v11i2c.16
ISSN (Print): 2476-8316
ISSN (Online): 2635-3490

Dutse Journal of Pure and Applied Sciences (DUJOPAS), *Vol. 11 No. 2c June 2025*

Effect of Processing of Sweet Potato Peel on its Composition, Nutrient Inhibitor Components and Growth Metrics by Broiler Finisher Chickens

[1]Abdullahi, I., [2]Idachaba, C. U., [2]Joseph, I., [2]Adeniyi, A. K. and [2]Kurdor, P.N.

[1]National Animal Production Research Institute,
Shika Zaria,
Nigeria.

[2]Department of Animal Production,
Faculty of Agriculture,
University of Jos,
Nigeria

Email: udagbenei@unijos.edu.ng

Abstract

The study examined the effect of processing of sweet potato peel meal (SSPPM) on its composition, nutrient inhibitor components and growth metrics by broiler finisher chickens. SSPPM was soaked in separate containers for 6, 12, 18 and 24 hours with the drain and replacement of fresh water every 6 hours. Proximate composition and lowering of anti-nutrients were best at 24 hours of soaking duration. Thus, SSPPM at 24-hours of soaking was used in a feeding trial with broiler finisher chickens. One hundred and fifty 6-week old finisher broiler chickens of Arbor Acres strain were allocated to five groups, each had three replicates having ten chickens per replicate, in a completely randomized design. The trial lasted for a period of three weeks. Broilers allotted to the control group did not have SSPPM in their diet while it was included at 2.5, 5.0, 7.5, and 10.0% in diets of chickens in T_2, T_3, T_4 and T_5 respectively. Results showed that final weight, weight gain, feed intake and feed to gain ratio were significantly ($P<0.05$) poor at 10.0% level of dietary SSPPM. Final weight decreased by 11.42% at 10.0% inclusion of SSPPM. Enzyme supplementation in the diets did not seem to improve feed utilization at higher inclusion of SSPPM (10.0%). The study concluded that SSPPM could be processed by soaking for 24 hours and included in broiler diets up to 7.5% with 0.1% enzyme supplementation without negative effect on productive parameters.

Keywords: Broiler, Sweet potato, Utilization, Performance, Enzyme

**Author for Correspondence*

INTRODUCTION

The demand for poultry products in Nigeria has been on the rise due to population growth, urbanization, and changing dietary habits (Iliya *et al.,* 2022). Poultry farming has become a popular business venture for many Nigerians, especially in rural areas, due to its relatively low start-up costs and high returns on investment. However, the poultry industry in Nigeria faces several challenges, including disease outbreaks, lack of access to quality feed and veterinary services, inadequate infrastructure, and poor market access (Oyadeyi *et al.,* 2022). These challenges have hindered the growth and development of the industry.

The use of alternative feed ingredients in poultry nutrition is gaining attention due to the cost of conventional feedstuffs as reported by Idachaba *et al.* (2019). Sweet Potato Peel (*Ipomea botata*) has been used in poultry diet by some animal nutritionists (Njidda *et al*., 2017; Iliya *et al.,* 2022). Their reports show varied outcomes mostly due to different methods deployed in processing sweet potato peel for dietary incorporation. Report by Iliya *et al.* (2022) showed that inclusion of sweet potato peel at levels below 10% in broiler diet had no detrimental effects on growth performance, feed conversion ratio and meat quality. Njidda *et al*. (2017) stated that processed sweet potato peel can be included in poultry diet up to 20% without negative effects on the chickens. Auta *et al.* (2024) fed raw sweet potato peel meal to broiler chickens and found that it can replace maize up to 10% in broiler diet. Sweet potato peel contains anti-nutrients that can inhibit digestion and utilization of feed especially by simple stomach animals. There is a need for effective processing of sweet potato meal to lower anti-nutrients to tolerable levels for non-ruminant animals. Abdullahi *et al.* (2019) asserted that soaking, boiling, autoclaving, fermentation are among some effective methods that can lower anti-nutrients in alternative feedstuffs. Thus, this study employed various durations of soaking (6, 12, 18 and 24 hours) of sweet potato peels to determine the effect on proximate, lowering of anti-nutrients and growth metrics of finishing broilers.

While previous studies (Njidda *et al*., 2017; Iliya *et al.,* 2022) have examined the use of sweet potato peels in poultry nutrition, there is limited information on how different soaking durations specifically affect its nutrient composition, anti-nutrient content, and subsequent growth performance in broiler finisher chickens. Most existing research either used a single processing method or did not comprehensively evaluate the relationship between processing time and nutritional quality. Therefore, this study is novel in its approach by systematically assessing the impact of graded soaking times (6, 12, 18, and 24 hours) on the chemical composition, anti-nutrient reduction, and broiler performance metrics. The findings aim to provide practical recommendations for optimizing sweet potato peel processing for use as a cost-effective feed ingredient for poultry production in Nigeria.

MATERIALS AND METHODS

Trial Location

The trial was conducted at the Poultry Unit within the Department of Animal Production, Teaching and Research Farm, University of Jos, located in Jos, Plateau State. Ambient temperatures within the facility varied seasonally, ranging from 21°C to 25°C. The wet period in Jos is between April and November with annual rainfall between 1200 – 1500mm (FCF, 2019).

Source of Test Ingredient (Sweet Potato Peel)
Sweet potatoes peel was obtained from a cluster of traders within faringada market, Jos Plateau State, after which they were processed for dietary inclusion.

Processing Methods on the Test Ingredient
Sweet potato was processed by soaking at varied durations i.e. 6, 12, 18 and 24 hours.

Soaking Method
Four liters of water were distributed into four separate bowls, each having an eight-liter capacity. Next, 400 grams of raw sweet potato peels were added to each bowl and allowed to soak for predetermined durations of 6, 12, 18, and 24 hours. For the samples subjected to soaking for 12, 18, and 24 hours, the water was drained and refreshed at six-hour intervals. Following the soaking process, the test ingredient was drained, air-dried, ground, packaged, and labeled. They were then transported to the Biochemistry Laboratory at the National Veterinary Research Institute, Vom, Plateau State, where the proximate composition was determined following the procedures outlined by A.O. A.C. (2005). Additionally, the anti-nutritional factors in both the raw and soaked sweet potato peel meal (SSPPM) were analyzed using the methodologies described by Cooke and Maduagwu (1978).

Source of Broiler Chickens
Arbor Acres strain broiler chickens were procured from a commercial hatchery in Ibadan, located in southwestern Nigeria.

Source of Exogenous Enzyme Enerzyme™
Enerzyme™ was acquired from commercial feed mill in Jos North LGA, Plateau State. This product comprises a proprietary blend of digestive enzymes, including cellulase, xylanase, beta-glucanase, amylase, protease, lipase, phytase, and pectinase.

Methods of Determination of Anti-nutrients in Raw and Soaked Sweet Potato Peel Meal (SSPPM)

Determination of Tannic acid in Raw and SSPPM
Tannin content was quantified using the method of Earp *et al.* (1981). A 10-gram sample was first defatted and then extracted with a solvent mixture containing 5% ethyl ether in ethanol. This procedure utilizes a vanillin-HCl assay, which is based on the acid-catalyzed addition of vanillin to flavonols, their polymers, and other phenolic compounds, including dihydrochalcones and flavones. The absorbance of the reaction products was measured at 500 nm using a spectrophotometer.

Determination of Oxalate in Raw and SSPPM
The oxalate content in SSPPM was determined using the method of Munro and Bassir (1969). Initially, 2 g of the powdered sample were weighed into a 250 mL flask, to which 190 mL of distilled water and 10 mL of 6 M hydrochloric acid were added. The mixture was subsequently heated in a boiling water bath for one hour, cooled, and then transferred to a 250 mL volumetric flask where it was diluted to volume.

Next, four drops of methyl red indicator were introduced, followed by the gradual addition of concentrated ammonia until the solution acquired a faint yellow hue. The mixture was then reheated to 100°C, allowed to cool, and filtered to eliminate any precipitate containing ferrous

ions. The filtrate was boiled again and 10 mL of a 5% calcium chloride solution was added under constant stirring; the sample was then left to stand at room temperature overnight.
Afterwards, the mixture was filtered through Whatman No. 40 filter paper. The collected precipitate was washed several times with distilled water, transferred to a beaker, and dissolved in 5 mL of 25% sulfuric acid. The resulting solution was maintained at 80°C and titrated against a 0.5% potassium permanganate solution until a persistent pink coloration was observed for approximately one minute. A blank sample was run concurrently, and the oxalate content was subsequently calculated using the conversion: 1 mL of potassium permanganate corresponds to 2.24 mg of oxalate.

Determination of Saponin in Raw and SSPPM

The saponin content in SSPPM was determined according to the AOAC (2005) method using a gravimetric approach with a Soxhlet extractor and two distinct organic solvents. Initially, a 2 g sample was weighed into a thimble and placed in the Soxhlet extraction chamber, which was connected to a round-bottom flask fitted with a condenser. Acetone was added to the flask to extract lipids and interfering pigments. The extraction was conducted for 3 hours on a hotplate, during which the solvent was continuously recycled and distilled off.
For the subsequent extraction, the apparatus was reconfigured by transferring the sample thimble to a Soxhlet system with a pre-weighed round-bottom flask. A 5% methanol solution was added, and the saponin was extracted for another 3 hours under heating. After complete distillation of the solvent, the flask was reweighed; the increase in weight corresponded to the saponin extracted.

$$\%\ \text{Saponin} = \frac{\text{mass of saponins}}{\text{mass of sample}} \times 100$$

Experimental Design and Management of Chickens

A total of 150 broiler finisher chickens of the Arbor Acres strain were utilized in this experiment. The chickens were allocated to five treatment groups in a completely randomized design, with each treatment group having three replications of 10 chickens per replicate. The chickens were housed in a deep litter system, with feed and water provided *ad libitum*. Standard management practices for broiler chickens were strictly practiced. Parameters measured were: initial weight, final weight, weight gain and feed intake. Feed conversion ratio and feed cost per kilogram gain were calculated while mortality was recorded as it occurred.

Experimental Diets

The processing duration of 24 hours soaking, which yielded the best results in terms of proximate composition and reduction of anti-nutritional factors, was utilized in the formulation of the experimental diets. The control treatment did not include SSPPM (Soaked and Sun-dried Processed Plant Material). Diets for chickens in treatments T2, T3, T4, and T5 contained 2.5%, 5.0%, 7.5%, and 10.0% SSPPM, respectively. Additionally, diets for chickens in treatments T2, T3, T4, and T5 were supplemented with an enzyme at the manufacturer's recommended dosage of 100g per ton of feed. The compositions of the experimental broiler finisher diets are detailed in Table 1.

Table 1: Broiler Finisher Diets Containing Varied Levels of SSPPM Based Diets with Enzyme Supplementation (6-9 weeks)

	Inclusion Levels of SSPPM (%)				
Ingredients (%)	**0.0**	**2.5**	**5.0**	**7.5**	**10.0**
Maize	50.0	48.8	47.5	46.3	45.0
GNC	21.9	20.5	20.0	20.0	18.7
Full fat soya	10.0	10.0	10.0	10.0	10.0
Guinea corn	12.0	7.3	8.0	9.0	9.4
Maize offal	1.0	7.2	6.4	6.4	7.7
SSPPM	0.0	1.2	2.5	3.8	5.0
Bone meal	2.9	2.9	2.9	2.9	2.9
Limestone	1.0	1.0	1.0	1.0	1.0
Salt	0.3	0.2	0.2	0.2	0.2
Vitamin premix	0.3	0.2	0.2	0.2	0.2
Lysine	0.3	0.2	0.2	0.2	0.2
Methionine	0.2	0.2	0.2	0.2	0.2
Enerzyme™	0.0	0.1	0.1	0.1	0.1
Total	100.0	100.0	100.0	100.0	100.0
Calculated analysis					
ME (Kcal/Kg)	3038.0	3029.0	3024.0	3020.0	3017.0
Crude Protein (%)	20.00	19.9	19.8	19.8	18.7
Ether Extract (%)	5.4	5.4	5.4	5.4	5.3
Crude Fibre (%)	3.3	3.8	3.8	3.8	3.9
Calcium (%)	1.2	1.2	1.2	1.2	1.2
Available Phosphorus (%)	0.5	0.5	0.5	0.5	0.5
Lysine (%)	1.2	1.2	1.2	1.2	1.2
Met+ Cys (%)	0.8	0.8	0.7	0.7	0.7

SSPPM= Soaked Sweet Potato Peel Meal %= percent, Kcal/Kg= kilocalorie per kilogram, ₦/kg= Naira per kilogram.

Data analysis

The experimental data were analyzed using the General Linear Model Procedure of SAS (2001). To identify significant differences among treatment means, Duncan's Multiple Range Test (1955) was employed.

RESULTS

Proximate Composition of Raw and Processed SSPPM

The proximate composition of raw and variously processed SSPPM is detailed in Table 2 below. A numerical increase in the dry matter content of processed SSPPM was observed, peaking at 24 hours of processing. The lowest value was recorded in the unprocessed peel. This indicates that extended soaking duration mitigated the effects of anti-nutrients by enhancing the dry matter content of the test ingredient. However, soaking durations did not significantly affect the crude protein content of SSPPM.

Table 2: Chemical Composition of Raw and Processed SSPPM

	Processing Durations of SSPPM (Hours)				
Parameters(%)	Raw	6 hours	12 hours	18 hours	24 hours
Dry Matter	92.0	93.1	93.4	93.6	93.8
Crude Protein	6.09	6.10	6.11	6.12	6.12
Ether Extract	5.99	5.99	5.99	5.99	5.99
Crude Fibre	11.58	11.56	10.01	9.68	9.46
Ash	3.50	3.40	3.40	3.40	3.40
Nitrogen Free Extract	82.23	82.35	82.40	82.43	82.45

Anti-nutritional Factors in Raw and Processed SSPPM

Table 3 below presents the chemical composition of raw and processed SSPPM. The anti-nutrients investigated (tannin, saponin, oxalate and phytate) were found in the unprocessed sweet potato peel. Soaking durations had effect on reduction of the tannin concentration in SSPPM with 24 hours soaking showing the highest percentage reduction (6.0%).

Table 3: Anti-nutritional Factors in Raw and Processed SSPPM

	Processing Durations of SSPPM (Hours)								
Parameters	Raw	6hrs	%Red	12hrs	%Red	18hrs	%Red	24hrs	%Red
Tannin(mg/100)	1.82	1.82	0.0	1.79	1.65	1.75	3.85	1.71	6.0
Phytic acid(mg/100)	0.08	0.08	0.0	0.08	0.0	0.08	0.0	0.08	0.0
Saponins(mg/100)	10.52	10.52	0.0	10.52	0.0	10.51	0.1	10.51	0.1
Oxalate (mg/100)	0.22	0.20	9.1	0.19	13.6	0.15	31.8	0.10	54.5

% = Percentage, hrs = Hours

Growth Metrics of Broiler Finisher Chickens Fed SSPPM Based Diets with Enzyme Supplementation (6-9 weeks)

Table 4 presents the growth metrics of broilers fed SSPPM based diets with enzyme supplementation. Chickens fed the control diet and SSPPM-based diets (0.0 to 7.5%) exhibited significantly (P<0.05) better finishing weight and weight gain in contrast to those fed the 10.0% SSPPM-based diet.

Table 4: Growth Metrics of Broiler Finisher Chickens Fed SSPPM Based Diets with Enzyme Supplementation (6-9 weeks)

		Inclusion Levels of SSPPM (%)				
Parameters	**0.00**	**2.5**	**5.0**	**7.5**	**10.0**	**SEM**
Initial weight (g/bird)	1025.0^{b}	1145.0^{a}	1040.0^{b}	1000.0^{b}	1055.0^{a}	37.7
Final weight (g/bird)	2168.3^{a}	2203.9^{a}	2259.0^{a}	2103.9^{a}	2001.8^{b}	52.6
Weight gain (g/bird)	1143.3^{ab}	1058.9^{b}	1219.0^{a}	1103.9^{b}	946.8^{c}	55.9
Feed intake (g/bird)	2586.1^{a}	2582.2^{a}	2670.4^{a}	2592.2^{a}	2980.5^{b}	46.5
FCR	2.26^{a}	2.44^{a}	2.19^{a}	2.34^{a}	3.15^{b}	0.1
Feed cost/kg gain(₦/kg)	1589.2	1676.9	1619.0	1608.8	2048.50	71.9
Mortality (%)	10.0	10.0	20.0	10.0	0.00	N/A

SEM= Standard error of mean g/bird= gram per bird, FCR= Feed conversion ratio, %= Percent, ₦/kg= Naira per kilogram, SSPPM= Soaked Sweet Potatoes Peel Meal

DISCUSSION

Proximate Composition of Raw and Processed SSPPM

The crude fiber content of SSPPM decreased with longer soaking durations, consistent with Idachaba *et al.* (2019), who reported a reduction in crude fiber levels of raw sorghum grains from 2.96% to 2.79% due to soaking. Ether extract and crude protein contents between raw and differently soaked SSPPM remained unaffected by soaking durations. This contrasts with findings from other studies, such as Kikafunda *et al.* (2006), which noted that soaking influenced the ether extract and crude fiber contents of sorghum, millet, and maize by-products.

The percentage ash content was highest in raw SSPPM compared to various soaking durations. This observation aligns with Abdullahi *et al.* (2019), who noted that soaking durations did not affect the proximate composition of sweet potato peel. The slight reduction in percentage ash was related to the leaching of soluble components into the soaking water. The percentage of nitrogen-free extract was lowest in the unprocessed sweet potato peel compared to the processed form.

Anti-nutritional Factors in Raw and Processed SSPPM

The decrease in the concentration of tannin through soaking was also observed in reports by Forsido *et al*. (2020). This might be due to water solubility of tannins mainly concentrated in the seed coat of grains which can be easily leached out during soaking (Afolayan and Afolayan, 2008). Phytate concentration showed no difference in the raw and different processing durations of SSPPM. This is inconsistent with the assertion by Olika *et al*. (2019) who stressed that there was a reduction in the concentration of phytic acid in soaked sweet potato peel. Phytic acid may lower bioavailability of minerals and digestibility of proteins and carbohydrates, by inhibiting the normal activity of digestive enzymes like pepsin, trypsin, and amylase (Idachaba *et al*., 2019).

There was a decrease in the concentration of saponin as the soaking duration of SSPPM increased. This was similar to the report of Kikafunda *et al.* (2006) who stressed that saponin concentration decreased from 3.6mg/100g to 2.92mg/100g in the raw yam peel flour at 18 hours of soaking. High levels of consumption of saponins in food results to haemolysis of red blood cells due to saponin's ability to lyse erythrocytes (Yisa and Daniel, 2022).

The concentration of oxalate decreased across various soaking durations, with the lowest concentration observed at 24 hours of soaking. Yisa and Daniel (2022) had similar observation as the authors reported that the oxalate concentration in unprocessed sweet potato peel was lowered by 80.47% at 24 hours soaking duration. This may be attributed to the leaching of oxalate compounds into the water in the course of soaking.

Growth Metrics of Broiler Finisher Chickens Fed SSPPM Based Diets with Enzyme Supplementation (6-9 weeks)

The suboptimal final weight and weight gain in chickens fed the 10.0% SSPPM-based diet were attributed to the inefficient utilization of the diet at that inclusion level. Apparently, the supplementation of enzymes did not improve weight gain at 10.0% SSPPM as the chickens had the poorest result. Idachaba *et al.* (2019) reported that fibrous diets could lower nutrient utilization in chickens due to absence of endogenous fibrolytic enzymes.

Although weight gain was lower in chickens fed 10.0% SSPPM based diet, feed intake was greater ($P<0.05$) than other groups. In order for the chickens fed 10.0% SSPPM based diet to compensate for nutrient requirements, they increased feed consumption significantly. This could also be the reason for the poor feed to gain ratio observed by chickens in that group. Mishra (2017) had contrary report in which feed conversion ratio did not decline in chickens fed 10.0%

The highest feed cost per gain was observed in chickens fed 10.0% SSPPM based diet. This was attributed to the increased feed intake and poor performance indices. The highest mortality was recorded among chickens fed diet which contained 5.0% SSPPM, while those fed 0.0, 2.5 and 7.5% SSPPM diets had fewer mortality. No mortality was recorded among those fed 10.0% SSPPM based diet. Post mortem investigation did not show that mortality occurred from the test ingredient. It was suggested to have resulted from cold stress as there was adverse weather condition during the early phase of the trial.

CONCLUSION

Soaking sweet potato peel for durations of 6, 12, 18, and 24 hours effectively lowered the crude fiber fraction and certain inhibitors to feed utilization (tannin, saponin, and oxalate). Soaking sweet potato peels had remarkable results on improving the crude protein and lowering of crude fibre levels of SSPPM, with 24 hours showing the best result. Similarly, 24 hours soaking of SSPPM had the best outcome in reduction of anti-nutrients compared to others. At levels below 10.0% inclusion level of SSPPM, the best results in growth performance indices were obtained. Thus, final weight decreased by 11.42% at 10.0% inclusion of SSPPM. Enzyme supplementation in the diets did not seem to improve feed utilization at higher inclusion of SSPPM (10.0%). The study concluded that SSPPM could be processed by soaking for 24 hours and included in broiler diets up to 7.5% with 0.1% enzyme supplementation without negative effect on productive parameters.

REFERENCES

Abdullahi, I., Omage, J.J., Abeke, F.O., Onimisi, P.A., Idachaba, C.U. & Alhabib, I.K. (2019). Nutrient Digestibility and Haematological Parameters of Broiler Finisher Chickens Fed Diets Containing Differently Processed *Balanite aegyptiaca* Fruit Meal Based Diets. *Nigerian Journal of Animal Science and Technology*, 2 (3), 73 – 82.

Adeniji, A. A. and Jimoh A. (2007). Effects of Replacing Maize with Enzyme- Supplemented Bovine Rumen Content in the Diets of Pullet Chicks. *International Journal of Poultry Science*, 6 (11): 814-817.

Afolayan, M.O. and M. Afolayan, (2008). Nigeria Oriented Poultry Feed Formulation Software Requirements. *Journal of Applied Sciences Research,* 4(11): 1596-1602.

Ani, A.O., Ugwuowo, L.C. and Omeje, O.D. (2009). The effect of graded level of raw Bambara nut (Vigna subterranean (L) Verdc) waste and supplementary enzyme on the conformational characteristics of broilers finishers. *Nigerian Society for Animal Production*, 34: 48.

Association of Official Analytical Chemist Official Methods of Analysis, AOAC, (2005), 7th Edn., Washington DC., USA.

Auta, Y., Muhammad, A., Sani, I. and Jama'A, Nasir. (2024). Growth Performance of Broiler Chickens Fed Dietary Levels of Sweet Potato Peel Meal as Replacement for Maize. *Nigerian Journal of Agriculture and Agricultural Technology.* 4. 241-246.

Cooke, R. D., and E. N. Maduagwu. 1978. The effects of simple processing on the cyanide content of cassava chips. *Journal of Food Technology* 13:299-306.

Duncan, D. B. (1955). Multiple range and multiple T-test biometrics. SAS User's Guide. Version SAS Institue. Inc. Cary, NC.

Duru, S. (1955). Processing of feed ingredients for improved animal nutrition. Journal of Animal Feed Science and Technology, 23(2): 112-120.

Earp, C.F., Akinghala, J.O., Ring, S.H. and Rooney, L.W. (1981). Evaluation of several methods to determine tannin in sorghum with varying kernel characteristics. *Cereal Chemistry* 58: 234-238.

FCF. (2019). Federal College of Forestry, weather report, Jos, Plateau, Nigeria.

Forsido, S. F., Hordofa, A. A., Ayelign, A., Belachew, T., and Hensel, O. (2020). Effects of fermentation and malt addition on the physicochemical properties of cereal based complementary foods in Ethiopia. *Heliyon, 6(7),* 1–8.

González-Alvarado, J. M., E. Jiménez-Moreno, D. G. Valencia, R. Lázaro, G. G. Mateos. (2008). Effects of fiber source and heat processing of the cereal on the development and pH of the gastrointestinal tract of broilers fed diets based on corn or rice. *Poult. Sci. 87*:1779-1795.

Idachaba, C.U., Duru, S., Omage, J.J., Onimisi, P.A. & Abdullahi, I. (2019). Effect of Feed Grade Acidifier, Phytase or their Combined Supplementation on Growth Performance and

Phytate Utilization by Broiler Chickens. *Nigerian Journal of Animal Science and Technology*, 2 (3), 55 – 64.

Iliya, B., Egbo, M.L. and Abubakar, M. (2022). Response of Broiler Chickens to Diets Containing Graded Levels of Spent Sorghum Residues. *Proceedings of the 47th Annual Conference, Nigerian Society for Animal Production. Held 13th-17th March, 2022 at Federal College of Forestry, Jos.* pp. 1062-1067.

Kikafunda, J. K., Abenakyo, L., and Lukwago, F. B. (2006). Nutritional and sensory properties of high energy/nutrient dense composite flour porridges from germinated maize and roasted beans for child-weaning in developing countries: *A case for Uganda. Ecology of Food and Nutrition, 45(4)*, 279–294.

Mishra, N. (2017). Utilization of waste defatted rice bran in formulation of functional cookies and its effect on physiochemical characteristic of cookies. *International Journal of Advance Science and Research*, 2(5), 64-68.

Munro A. & Bassir D. (1969). Oxalate in Nigerian vegetables. *West African journal of biological and applied chemistry*, 12: 14-18.

Njidda, A. A., Olafadehan, A. O. and Alkali, A. H. (2017). Potential nutritive value of selected leguminous browse forage. *Iranian Journal of Applied Animal Science.* 7 (4): 567-575.

Olika, E., Abera, S., and Fikre, A. (2019). Physicochemical properties and effect of processing methods on mineral composition and anti-nutritional factors of improved chickpea (Cicer arietinum L.) varieties grown in Ethiopia. *International Journal of Food Science*, 1–7.

Oyadeyi, O. and Temidayo, A. (2022). Financial Development and the Current Account in Nigeria. *IOSR Journal of Economics and Finance* 13: 65–74.

SAS (2001).Statistical Analysis System Institute, User's Guide. 6th Edition. North Carolina, USA.

Yisa, A. G. and Daniel, C. (2022). Proximate and Phytochemical Compositions of Differently Processed Sweet Potato (*Ipomoea batatas*) Peel Meal. *Proceedings of the 47th Annual Conference, Nigerian Society for Animal Production. Held 13th-17th March, 2022 at Federal College of Forestry, Jos.* pp. 1062-1067.