THE PROXIMATE COMPOSITIONS OF DRIED GROUNDNUT SHELL (*Arachis hypogea*) MEAL SUPPLEMENTED WITH HEMICELLULASE FED TO ROSS 308 BROILER CHICKENS

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Abstract

Categorization of the chemical composition of animal feed for principal nutrients is one of the most dynamic considerations in the field of animal nutrition. In this study, the proximate constituents, of dried groundnut shell meal and the experimental diets in the Northern Guinea savanna of Nigeria were evaluated. A total of 90 one-day old ROSS 308 broiler chickens were allotted to five dietary treatments having three replicates of 6 birds each in a completely randomized. The study was designed to evaluate the proximate compositions of dried groundnut shell meal (DGSM). The collected samples of DGSM were processed and analyzed using standard analytical procedures and the data obtained were subjected to analysis of variance (ANOVA). The result for the proximate composition showed the moisture contents (7%), dry matter (93%), ash (4.2%), crude fibre (37.8%), crude protein (7.5%), ether extract (1.31%), carbohydrate (49.19%) and calorie value of 2129.68kcal/kg. Birds were fed 5 treatments (T); T1 (0% DGSM), T2 (5% DGSM), T3 (10% DGSM), T4 (15% DGSM) and T5 (20% DGSM). Dry matter, moisture, energy and ash were not significantly different (P>0.05) across all the treatments. Crude protein in T4 (21.54%) was significantly lower (P<0.05) than in T1 (25.27%), T2 (23.94%), T3 (24.62%) and T5 (24.96%). Ether extract increased significantly (P<0.05) in T5 (5.50%) while carbohydrate (Nitrogen Free Extract) decreased significantly (P<0.05) in the same treatment, T5 (47.98%). The control diet, T1 (6.22%) and T2 (6.84%) had significantly higher crude fibre (P<0.05) than T3 (7.92%), T4 (7.73%) and T5 (7.99%). The results showed that dried groundnut shell meal contained essential and valuable nutrients that were within the normal range for broiler chickens, which are beneficial to broiler diets. Utilisation of DGSM also addressed a waste disposal problem by helping in spinning waste into a treasure.

Keywords: *Dried groundnut shell meal, ROSS 308 broiler chickens, Feed analysis, Alternative feed, Hemicellulase*

Introduction

Feeding is the major constraint to livestock production especially in sub-Sahara Africa. Most countries in the tropics do not have enough feed resources to sustain high level of livestock production; therefore, development of rations based on readily available resources is imperative (Aregheore and Ikhatua, 1999). A study by Iyeghe-Erakpotobor et al. (2002) revealed that, due to the increase in human population and consequent high cost and demand for conventional feedstuffs, it has become increasingly necessary to alternate these feedstuffs with other feed resources so as to reduce the competition between man and livestock. Aside from cost, its quality and balanced mix of nutrients directly affect the growth, health, and productivity of birds regardless of their genetic potential (Zampiga *et al.*, 2021). Therefore, feed must contain essential nutrients like carbohydrates, proteins and amino acids, fats, vitamins, and minerals in their proper proportions to meet the physiological needs of the birds (broiler or layer) at different stages of their growth (NRC, 1994).

Most poultry farmers in Nigeria depend on commercial feeds for their poultry farms, but with the recent increase in feed prices, farmers are struggling to cope (Abdulrahman *et al.*, 2022). On the other hand, manufacturers are affected by the scarcity of macro ingredients, like maize and soybeans, which made them fail to meet the required standards for poultry feeds. Hence, there is a need for alternative feeding materials that are cheap and can meet the nutrient requirements of birds.

The search for alternative feed materials or non-conventional, locally available agricultural by-products, such as cottonseed meal, cocoyam peel meal, dried cabbage meal and groundnut husk meal, is important for economic sustainability and can potentially reduce the heavy burden of feed costs on farmers and keep the environment clean (Ilaboya and Imouokhome, 2023). Groundnut (*Arachis hypogaea*) is produced in large quantities in Nigeria. However, apart from oil, the by-products of peanut contain many other functional compounds like proteins, fibers, polyphenols, antioxidants, vitamins and minerals which can be added as a functional ingredient into many processed foods (Zhao *et al.,* 2012). The husk is the fibrous outer shell of peanuts, a by-product of groundnut processing which is usually discarded after consumption of its seed. Large quantities of the groundnut husks are discarded and burnt, which pollute the environment (Ogbe and George, 2012). However, in recent times, studies have shown that it contains some nutritional potential and can serve as a feed ingredient.

Groundnut shell meal (GSM) is high in fiber and has moderate levels of essential minerals, making it a viable alternative for partially replacing conventional feed ingredients like maize and wheat bran in broiler diets (Alaba *et al.*, 2015). Therefore, this study was designed to evaluate the proximate compositions of dried groundnut shell meal fed to ROSS 308 broiler chickens. This is to raise awareness among poultry farmers and feed manufacturers about the nutrients that are inherent in this agricultural by-product that can serve as a useful tool for nutritionists to formulate balanced diets for broiler chickens.

Materials and Methods

Sample preparation of fresh samples of dried groundnut shell was collected from Gwarimpa community, Abuja. The samples were brought to the Department of Animal Science and Animal Technology unit, Faculty of Agriculture and Agricultural Technology Teaching and Research Farm, Benson Idahosa University, Benin City, Edo State.

Experimental Diets

Samples of dried groundnut shell were washed with clean water to remove dirt and other contaminants. The samples were sun-dried, ground into powder, and stored in an air-tight container for analysis. The grounded shell meal was then incorporated in graded levels at the expense of maize in the experimental diets as follows: Diet one was the control (0% DGSM), diets 2, 3, 4, and 5 had 5%, 10%, 15%, and 20% DGSM, respectively. The gross compositions of the experimental diets are presented in Table 1.

Management of Birds and Experimental Layout

Ninety (90) day-old Ross 308 strain chicks were randomly divided into five (5) groups of eighteen (18) birds each and replicated three (3) times with six (6) chicks per replicate in a completely randomized design. The experiment lasted forty-six (46) days, during which a light source was provided and Tungsten filament as a source of heat. Drugs, vaccinations, and other routine management practices were strictly followed according to the manufacturers and veterinary recommendations.

Laboratory Analysis

Laboratory analysis was carried out to determine the proximate composition of the dried groundnut shell samples. The proximate composition, which included dry matter, moisture, crude protein, ether extract, ash and carbohydrate was determined in triplicate according to standard procedure (AOAC, 1990).

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Crude Fibre determination

A sample weighing two grams, which was free of moisture and fat, was subjected to digestion with acid (1.25% H_2SO_4) and alkali (NaOH) for 30 minutes. The contents were then dried in a hot air oven at 100°C until a constant weight was achieved. The dried residue was ignited in a muffle furnace at 550°C for 20 minutes. The loss in weight during this process was reported as crude fibre.

Crude fibre = Loss in weight on ignition × 100 Weight of sample

Ether Extract

Ether extract was obtained by performing extraction with petroleum ether (PE) using Soxhlet system, which operates within a boiling point range of 40–60°C. The extraction process involved using 25 ml of PE and 1g of the dried sample. The process lasted for 3 to 4 hours. After extraction, the petroleum ether was evaporated at 105˚C. The percentage of crude fat (ether extract) was determined by deducting the weight of the residue from the dry weight of the sample.

Ether extract = $\frac{W2 - W1}{W3} \times 100$

Where W1 = weight of empty flask; W2 = Weight of flask + fat; W3 = weight of sample taken.

Crude Protein determination

Dried groundnut shell samples were digested with a catalyst composed of mercuric sulfate (H_gSO_4) and potassium sulfate (K_2SO_4) using concentrated sulfuric acid until the mixture became clear. After digestion, the material was cooled and diluted with distilled water. An aliquot of the solution was then transferred to a Kjeldahl distillation apparatus for distillation, using a 40% sodium hydroxide (NaOH) solution and zinc dust. The ammonia generated during this process was captured using a 2% boric acid solution that contained an indicator. The resulting distillate was titrated to a light pink color using 0.1 N sulfuric acid. The percentage of Nitrogen was calculated using the following formula;

Nitrogen %= ml 0.1 N H_2SO_4 x $\frac{0.0014}{W1 \times 10} \times 250 \times 100$

Where Conversion factor = 100/N (N% in fruit products).

Moisture Content determination

The 5gm of the sample was placed in a hot air oven at 80˚C up to constant weight, and the moisture percentage was recorded.

Moisture % = $\frac{\text{Weight of fresh sample} - \text{Weight of the dried sample}}{\text{Weight of fresh sample}}$ x 100

Ash content determination

The 10-gram sample was placed in a crucible and kept in a muffle furnace at 550°C for 6 hours, then desiccated and weighed.

Ash % = $\frac{\text{Weight of sample after ashing}}{\text{Total weight of the sample}}$ x 100

Statistical Analysis

The proximate composition, which includes moisture, crude protein, crude fat, ash, and carbohydrate, was determined in triplicate according to standard procedure (AOAC, 1990). Samples of the experimental diets containing varied levels of DGSM were analyzed for proximate compositions. Samples of dried groundnut shell meal were also analyzed for proximate compositions. The collected data were analyzed using SAS (2012) statistical software. Means were separated using the least significant difference.

Table 1. Gross composition of broiler finisher diet

Ingredients	T1 (control)	T2 (5%DGSM)	T3 (10%DGSM)	T4 (15%DGSM)	T5 (20%DGSM)
Maize	55.10	52.34	49.59	46.85	44.08
DGSM	0.00	2.76	5.51	8.25	11.02
Wheat offal	4.50	3.70	3.70	3.70	3.70
Fish meal	11.50	11.50	11.50	11.50	11.50
Soya Oil	10.00	10.00	10.00	10.00	10.00
Soyabean meal	15.00	15.00	15.00	15.00	15.00
Vit. Premix	0.20	0.20	0.20	0.20	0.20
Limestone	0.20	0.10	0.10	0.10	0.10
Dicalcium phosphate	0.25	0.15	0.15	0.15	0.15
Hemicellulase	0.00	1.00	1.00	1.00	1.00
Titanium dioxide	2.50	2.50	2.50	2.50	2.50
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated Nutrients					
ME Kcal/Kg	3181.10	3133.00	3103.57	3104.24	3104.59
Crude Protein (%)	20.98	20.97	20.90	20.83	20.77
Ash (%)	3.83	3.87	3.95	4.03	4.11
Crude Fibre (%)	3.06	3.95	4.92	5.88	6.85
Ether Extract (%)	3.84	3.72	3.65	3.57	3.50
Nitrogen Free Extract	68.08	67.49	66.59	65.69	64.78

[1]Composition of vitamin premix per kg of diet: vitamin A, 12500 I.U; vitamin E, 40mg; vitamin K, 2mg; vitamin B1, 3mg; vitamin B2, 5.5mg; niacin, 5.5mg; calcium pantothenate, 11.5mg; vitamin B6, 5mg; vitamin B12, 0.025mg; choline chloride, 500mg, folic acid,1mg; biotin, 0.08mg; manganese, 120mg; iron 100mg; zinc, 80mg; copper, 8.5mg; iodine, 1.5mg; cobalt, 0.3mg; selenium, 0.12mg, anti-oxidant, 120mg, DGSH:Dried Groundnut Shell Meal

Table 2. Proximate Analysis of Dried Groundnut Shell Meal

Components	Dried Groundnut Shell Meal
Dry matter (%)	93.00
Moisture (%)	7.00
ME (Kcal/kg)	2129.68
Crude Protein (%)	7.50
Ash (%)	4.20
Crude Fibre (%)	37.80
Ether Extract (%)	1.31

ME-Metabolizable Energy

Table 3 Proximate Composition of Hemicellulase Supplemented Maize-Based Diets Containing Varied Levels of DGSM

Parameters	**T1 (control)**	**T2 (5%DGSM)**	**T3 (10%DGSM)**	**T4 (15%DGSM)**	**T5 (20%DGSM)**	**SEM**
Dry matter (%)	93.40	92.81	92.08	92.38	92.60	0.17
Moisture (%)	6.60	7.19	7.92	7.62	7.40	0.17
ME (Kcal/kg)	3031.64	2978.17	2916.35	2948.11	3052.40	17.29
Crude Protein (%)	25.27[a]	23.94[a]	24.62[a]	21.54[b]	24.96[a]	0.43
Ash (%)	6.13	6.47	6.31	6.25	6.17	0.07
Crude Fibre (%)	6.22[a]	6.84[b]	7.92[c]	7.73[c]	7.99[c]	0.19
Crude Fat (%)	3.13[a]	3.16[a]	3.04[a]	3.49[a]	5.50[b]	0.27
Nitrogen Free Extract	52.60[a]	52.41[a]	50.19[a]	53.30[a]	47.98[b]	0.60

DGSM = Dried Groundnut Shell Meal
[a,b,c] Same figures on the same row are not significantly different

Results and Discussion

Assessment of nutrients composition of feed materials is important for feed formulation (Adeolu and Enesi, 2013). Proximate analysis gives evidence on the basic nutrients present in feed samples (Akiode *et al.,* 2018). The proximate parameters include moisture, dry matter, crude protein, ash, crude fiber, ether extract and nitrogen free extract.

The moisture content of DGSM (7.0%) were higher than the recommended value (5.43%) for animal feeds (USDA, 2005) and this could be due to the drying method and period of experiments. Moisture content of a feed is an indicator of its freshness, and high levels of moisture make feeds to be more susceptible to deterioration from increased microbial activity. (Adepoju and Onasanya, 2008), thereby affecting their palatability (Oko and Onyekwere, 2010). Moisture contents are influenced by crop type and climatic conditions, such as precipitation and temperature (Méndez-Montealvo *et al.,* 2005).

Dry matter content of feeds gives room for the comparison of feeds' nutritional potentials (Malebana *et al.,* 2018). Dry matter content of DGSM is high (93%) compared to other crop residues, and this implies that DGSM has higher nutrient biomass than others.

Protein is a vital constituent of feed required for existence by both humans and animals, and they primarily supply amino acids required for normal functioning of the body system (Akiode *et al.,* 2018). Crude protein content is an essential pointer of the nutritional quality of feed ingredients (Okunade *et al.,* 2014). However, the crude protein value of groundnut shell obtained in this study (7.5%) was higher than the value (4.43%) documented by Abdulrazak et al. (2014). The variations in the crude protein of the crop residues reported could be due to plant variety, harvesting time, storage period, method of processing and environmental factors (Ghorbani *et al.,* 2018). Crude protein obtained in this study is comparable to the findings of the research reports of Ibude *et al.* (2021) and Eshag *et al.* (2015) which were documented as 6.94% and 8.40%, respectively.

Dietary fats have been reported to increase palatability of feed by absorbing and retaining flavours (Antia *et al.,* 2006). The result of ether extract of DGSM (1.31%) is very low but were similar to the values reported by Yalchi and Hajieghrari (2011) for maize stovers (1.27%), wheat straw (1.07%) and rapeseed straw (1.14%). They also compared with the works of of Adeyina *et al.* (2020) and Alaba et al. (2015), which are 3.25% and 3.50%, respectively. However, the ether extract value of groundnut shell obtained in this study was higher than the value (0.50%) documented by Abdulrazak et al. (2014). The implication of the low ether extract levels of the sample is that the crop residues are low in energy and therefore needed to be supplemented with energy concentrates (Babayemi and Bamikole, 2006). This difference could stem from differences in groundnut geographical location.

Fibre is an essential component of carbohydrate; it is a general term for the fractions that are not readily digestible (Tasie and Gebreyes, 2020). The crude fibre values in the present study (37.80%) were comparable to the values for other crop residues such as mango endocarp (49.47%) documented by Akiode et al. (2018), coconut husk (30.34%), cocoa pods (33.60%) and kola nut pod (26.84%) documented by Adeyi (2010), but higher than 8.10% to 15.50% values of plantain wastes documented by Okareh et al. (2015). Increased exclusion of impending mutagens, xenobotics and steroids have been attributed to high fibre content in diets because of adherence to dietary fibre components, thereby aiding digestion. Consequently, the health of the animals is improved (Okareh *et al.,* 2015). Hence, the high fibre content of crop residues makes them suitable to be included in ration formulation.

The result of energy (2129.68 Kcal/kg) is similar to the value documented by Millam et al. (2022), which was 2177.10 Kcal/kg. This similarity suggests that DGSM could also contribute energy to poultry diets; though it is relatively lower compared to maize, it can serve as an alternative energy feed ingredient.

Plant materials have been described to be good sources of mineral elements (Adedeji, 2020). Minerals are essential nutrients, which are said to be present in small amounts in the body or in several parts per million (Gafar and Itodo, 2011). The ash content of a feed offers an assessment of its mineral content (Ayoola *et al.,* 2012). The ash content suggests a significant presence of essential minerals such as calcium, magnesium, potassium, and phosphorus, which are dire for various physiological functions in birds. The ash content of DGSM (4.20%) agrees with the result of Alaba et al. (2015), which is 3.50%. The moisture, ash, and crude fibre content of the sample indicated that they can be easily dried so that they could easily burn when used as a source of heat (Jekayinfa and Omisakin, 2005). High ash content may affect the sensory quality of feed (Juliano, 1985). However, the values were lower than the values of other crop residues such as cocoa pods (12.67%), kola nut pod (7.67%), and ripe plantain peel (11.73%) as documented by Adeyi (2010). The variations in the ash contents of the crop residues might be due to the differences in mineral content of soils and the water used for irrigation (Shayo *et al.,* 2006).

The dry matter content of DGSM (93%) agrees with the result of Babalola et al. (2023), which is 89.28%. The variations in the nutrient compositions of DGSM could be due to plant variety, harvesting time, storage period, method of processing and environmental factors (Ghorbani *et al.,* 2018).

The result of the proximate composition among the different treatments (Table 3) shows that the moisture, metabolizable energy (ME), and ash content showed no significant (P>0.05) differences among the different treatments. For crude protein (CP), there was a significant (P<0.05) difference as T4 (21.54%), had the lowest value among the different treatments. For crude fibre (CF), there was significant (P<0.05) difference among the treatments, with T1 (6.22%) having the lowest value, followed by T2 (6.84%). Also, T3 (7.92%), T4 (7.73%), and T5 (7.99%), showed no significant (P>0.05) difference in crude fibre across the three treatments. Significant differences were observed for crude fat (P<0.05) in T5 (5.50%), which had the highest value. At the same time, there was no significant (P>0.05) difference in crude fat across the other treatments; T1 (3.13%), T2 (3.16%), T3 (3.04%) and T4 (3.49%). Nitrogen-free extract (NFE) had no significant difference (P>0.05) among T1 (52.60%), T2 (52.41%), T3 (50.19%), and T4 (53.30%), but T5 (47.98%) was significantly lower. The presence of these essential nutrients and minerals implied that groundnut shell could be utilized as a feed ingredient for poultry and domestic animal.

Conclusion

Based on the result obtained from proximate analysis, it is recommended to include dried groundnut shell meal (DGSM) up to 20% as a partial replacement of maize grain supplemented with hemicellulase in the diet of broiler finisher chickens. It is envisaged that the usability of dried groundnut shell meal as agricultural feed would solve a waste disposal problem, reduce the competition between humans and animals for grains, as well as reducing the cost of production and help in spinning the waste around us for treasure.

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