



Effects of Groundnut Shell Meal (GSM) on the Performance and Haematological Indices of Finisher Broilers

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ABSTRACT

In order to incorporate agro industrial by-products in poultry diets, the effect of feed substitution of the crude protein content of groundnut shell meal with that of palm kernel cake in the performance of broilers was investigated. The study involved 150 mixed sexed broiler finisher birds divided into five groups of 50 each. Five treatments corresponded to the five groups. The control treatment T₀ had no groundnut shell meal while the other four treatments included replacement of groundnut shell meal with palm kernel cake at 2.5, 5.0, 7.5 and 10 % (T₀, T_{2.5}, T₅, T_{7.5} and T₁₀ respectively). All treatments had the same calculated levels of crude protein and metabolisable energy contents. Results showed no evidence of the effect of treatments on feed efficiency (P > 0.05). However, there was evidence that feed intake, live weight gain, average final live weight of birds receiving the control diet T₀ were lower than those receiving 10% substitution with palm kernel cake (P < 0.05). There was evidence that carcasses of chickens fed the T₅ diet were lower (P < 0.05) than those fed T₁₀ but similar to T₀ and T_{7.5} (P > 0.05). T₁₀ proved to be the most profitable diet. Therefore, groundnut shell meal can be substituted up to 10% with palm kernel cake in the proportions used in this trial without detrimental effects on growth performance of broilers.

Keywords: Shell meal, Performance and Haematological Indices of Finisher Broilers.

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INTRODUCTION

Broiler production is one of the fastest means of bridging the animal protein gap in human nutrition (Ahaotu *et al.*, 2023a). Broilers are fast growing meat type birds (Ahaotu *et al.*, 2017). When compared to the beef industry, the poultry enjoys a relative advantage of easy management, higher turnover and quick return on investment (Okonkwo and Ahaotu, 2014; Anaetoet *et al.*, 2009). Groundnut cake is a protein source that has been used over a long time in poultry feed. Increased cost of feeding like groundnut cake is the greatest problem of the poultry farmers. It contains 40-48 % crude protein (Kwari *et al.*, 2004). However, the incorporation of this raw material in

monogastric feed has been faced with limitations as a result of the presence of anti-nutritional factors, its vulnerability to fungi (*Aspergillus flavus*), its limited content of some essential amino acids (Table 1), but also to its availability and high cost in the market. The most important sources of nutrients that can be utilized in broiler feeds are grains (Ahaotu *et al.*, 2024), plantain peel meal (Ahaotu *et al.*, 2025a) oilseed meals (Ahaotu *et al.*, 2025 b; Okedu *et al.*, 2024), fish meal and *Plumeria rubra* (Ahaotu *et al.*, 2023b).

There is therefore a challenge of finding alternatives to groundnut cake which are accessible to all poultry

Table 1: The Chemical Composition and Essential Amino Acids of Groundnut.

Content	Percentage
Protein	45.2
Oil	48.2
Starch	11.5
Soluble sugar	4.5
Crude fiber	2.1
Moisture	6.0
g (100 g of protein)	
Lysine	4.00
Threonine	3.12
Valine	4.59
Methionine+ Cysteine	2.56
Isoleucine	3.69
Leucine	6.95
Phenylalanine+ Tyrosine	10.12

farmers and could substitute groundnut cake in poultry feed. Ahaotu et al., (2016) stated that agro-industrial by-products have in recent years become important feed components in poultry diets in Nigeria due to the increased competition for the conventional ingredients by humans and the food industries. Ahaotu et al., (2015) further stressed the need to utilize alternative feed ingredients far removed from human and industrial interest in order to reduce feed cost and the cost of poultry products. Groundnut production and processing has been a traditional business in many countries of the world for centuries back. The result is a generation of various products for human consumption, animal feeding and industries (FORA, 2012). The most popular of the products in animal feeding is groundnut cake (a conventional feedstuff) and recently groundnut seed offal (Aduku, 2004). Many of the products from groundnut processing are used as feeding stuffs for livestock, apart from the human use. Unconventional feedstuffs are a sure way of reducing the cost of animal feeding and consequently, animal products because of the ease of accessing them and their low cost.

Groundnut availability worldwide is uncontested since world production is put at 34.9 million metric tons (FAO, 2007) and Nigeria produces 2 million metric tons (FORA, 2012). However, there is scarcity of groundnut cake and soyabean cake in many parts of Nigeria as a result of collapse of most oil milling industries (Musa, 2010), which should form a larger percentage of protein feedstuff for broiler nutrition (Nnadi et al., 2021). Even where these cakes are found, the cost is higher than their full fat seeds and unprofitable as a feedstuff to the small scale animal farmer.

According to (Boateng et al., 2008) palm kernel cake (PKC) is an agro-industrial by-product that is produced locally and within the West African sub-region in sizeable quantities. This feed should be fully utilized to reduce feed cost and also curb the problem of environmental

pollution that accompanies its disposal. PKC is a by-product of the extraction of palm kernel oil (Ahaotu et al., 2013a). PKC has been found to contain between 16.0 and 21.3% crude protein with low content of lysine, methionine, histidine and threonine (Ezieshi and Olomu, 2008).

It has not however been greatly used in monogastric feed because the crude fibre content ranges from 6.7% (Ahaotu et al., 2012) to 17.5% (Ayo-Enwerem, et al., 2017) PKC crude fibre is high and it is difficult to digest (Siregar et al., 2003 and Adua et al., 2012). The crude protein and cellulose contents are also high (Sukaryana, 2001). PKC is highly available and relatively less expensive compared to groundnut cake. It is not yet known to contain anti-nutritional factors that significantly affect poultry and has less palatability problems. However, existing data on its use in monogastric feeding focused on determining its optimal inclusion rate in feed rations and their influence on carcass characteristics of broilers (Sundu et al., 2006 and Ononiwu et al., 2017). Soltan, (2009) stated that 30% palm kernel cake-diet with high level of residual fat led to a higher average daily gain and better feed conversion efficiency compared to a low-fat palm kernel cake-based diet; but increased carcass fat with a consequent reduction in leanness in pigs.

A 20% palm kernel cake-diet also yielded positive responses in broilers and layers but beyond that, reduced egg numbers and quality were recorded (Oko et al., 2021 and Costa et al., 2001).

MATERIALS AND METHODS

Study site

The study was conducted at the Poultry Unit of University of Agriculture and Environmental Sciences Umuagwo, Imo State, Nigeria. University of Agriculture and Environmental Sciences Umuagwo is located at the site is situated between longitudes 7° 0' 06" E and 7° 03' 00" E and latitudes 5° 28' 00" N and 5° 30' 00" N in the humid tropical West Africa (IMLS, 2009). The climate is marked by two seasons.

Collection and processing of Ground Shell as ingredients

Five kilogram weight of groundnut shells used for this research was obtained from the rural women in Atta – Ikeduru, Imo - State, Nigeria where the shells were indiscriminately dumped after removing the groundnut seed. Other ingredients were purchased from feed ingredients vendor at Owerri, Imo – State, Nigeria.

The groundnut shells were pre-treated using hot air oven at 100°C until a constant weight was obtained for any dry matter. This was to obtain constant dryness and to prevent groundnut shells from being infected with fungi

such as aflatoxin before milling (Table 2).

Table 2: Proximate Composition of Ground Nut Shell

Parameters	%
Moisture	4.85
Crude protein	31.08
Crude fibre	7.50
Ether extract	19.30
Ash	5.00
NFE	32.27
Calcium	0.25
Phosphorus	0.20
ME* (kcal/kg)	3774.29

Animal Material, Experimental Diets and Experimental Design

A group of 150 Arbor Acres strain mixed chickens aged 29 days, with an average weight of 515 ± 83 g were distributed into 5 treatments of 30 birds each. The birds were fed in five pens and replicated thrice (forming an experimental unit) in wire cages, giving 15 replicates from 5 experimental treatments. The experiment lasted for five weeks. The food and water were served *ad libitum*. The birds were randomly assigned to five dietary groups in which groundnut shell meal (GSM) was replaced at varying levels with palm kernel cake (PKC) as follows:

- A = 0% GSM and 100% PKC
- B = 25% GSM and 75% PKC
- C = 50% GSM and 50% PKC
- D = 75% GSM and 25% PKC
- E = 100% GSM and 0% PKC

Two dietary types, one for the starter phase (23% crude protein (CP) and 2900kcal/kg metabolizable energy (ME) and the other for the finisher phase (20% CP and 2300 kcal/kg ME) of production, were formulated (tables 3). The test diets in each phase were formulated to be iso-caloric and iso-nitrogenous. Each treatment group consisted of thirty birds, divided into three replicates of ten birds each. Prior to the arrival of birds, the brooding and growing houses were disinfected and demarcated into five experimented units corresponding to the five dietary test groups. The birds were weighed on arrival to obtain their initial body weights and at weekly intervals thereafter. The experiment was terminated at the end of nine weeks.

Blood samples collected from the wing veins of three birds in each treatment group at the end of nine weeks of feeding were sent to a commercial Laboratory in Owerri, Imo State, Nigeria for the determination of the blood parameters and serum proteins. Parameters determined included packed cell volume (PCV), red blood cell counts

(RBC), haemoglobin concentration (Hb), white blood cell counts (WBC), erythrocyte sedimentation rate (ESR), blood coagulation time (CT) and serum proteins. From these parameters, mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC) were calculated using the method of Schalm *et al.* (1975). All data collected were analyzed using the modified S.A.S. (2000) computer software.

Data collection

Feed consumption was assessed daily, while growth was evaluated weekly. At the end of the trial, five birds per treatment were slaughtered for carcass evaluation (gizzard, intestine, bowel density, carcass yield) and average weight gain. The length of the intestine was measured from the beginning of the duodenum to the end of the cloacae with a tape.

Statistical analysis

For clarity of interpretation, the simple consumption index was shown. Feed consumption is proportional to metabolic weight. Feed consumption, average weight gain, feed efficiency, carcass yield and proportions of the internal organs were subjected to analysis of variance according to a Completely Randomized Design and Means will be separated by the Duncan's test (SAS, 2000; Gordon and Gordon, 2004).

RESULTS

The haematological and the serological indices of the Finisher broilers

Table 3: Formulation and production cost of experimental diets

Ingredients (g/kg)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Fish Meal	9.00	9.00	9.00	9.00	9.00
Maize	40.00	40.00	40.00	40.00	40.00
Palm Kernel Cake	10.00	7.50	5.00	2.50	0.00
Groundnut shell Meal	0.00	2.50	5.00	7.50	10.00
Wheat Offal	14.00	14.00	14.00	14.00	14.00
Soya bean meal	18.00	18.00	18.00	18.00	18.00
Bone Meal	5.00	5.00	5.00	5.00	5.00
Vitamin and Mineral	?	?	?	?	?
Premixes	2.00	2.00	2.00	2.00	2.00
Methionine	1.00	1.00	1.00	1.00	1.00
Lysine	1.00	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00	100.00
Calculated Crude Protein (%)	40.02	40.02	40.02	40.02	40.02
Cost of production (N/kg)	266.20	242.20	242.20	242.20	242.20
Calculated gross energy (kcal/100g)	12.07	12.07	12.07	12.07	12.07
Protein/Energy ratio	3.32	3.32	3.32	3.32	3.32

Table 3 showed the nutrient analysis of groundnut shell meal (GSM). Its protein content was 34.10%, thus

Table 4: The Haematological and Serological Indices of the Experimental Chickens

Dietary Groups Indices	A	B	C	D	E
RBC (mm ³ x 10 ⁶)	2.70±0.04 ^a	2.62±0.04 ^a	2.52±0.04 ^c	2.38±0.03 ^c	2.29±0.02 ^c
PCV (%)	29.05±0.65 ^c	30.50±0.52 ^b	32.45±0.42 ^a	32.35±0.02 ^a	33.55±0.64 ^a
Hb (g/100)	11.09±0.21 ^a	9.80±0.23 ^b	9.43±0.08 ^c	8.23±0.20 ^d	8.80±0.17 ^c
Coagulation Time (s)	177.80±1.55 ^d	184.50±1.97 ^c	189.60±1.78 ^b	190.60±1.31 ^b	193.10±1.03 ^a
ESR (mm/3hr)	5.50±0.05 ^a	4.41±0.12 ^b	4.19±0.13 ^c	4.21±0.17 ^c	4.03±0.11 ^d
MCV (fl)	124.26±1.35 ^c	110.88±1.23 ^b	121.03±1.09 ^d	136.34±1.95 ^b	141.27±1.98 ^a
MCH (pg)	41.07±1.05 ^a	37.40±1.53 ^b	37.42±1.21 ^b	34.48±1.08 ^c	34.06±1.21 ^c
MCHC (%)	33.10±1.09 ^a	33.73±1.52 ^a	30.91±0.95 ^b	25.36±0.89 ^c	24.11±0.58 ^d
WBC (mm ³ /103)	19.47±0.45 ^a	19.08±0.45 ^a	18.50±0.22 ^b	18.39±0.30 ^b	17.92±0.19 ^c
Serum Protein (g/d)	4.95±0.15 ^a	4.05±0.13 ^b	3.73±0.13 ^c	3.53±0.11 ^d	3.26±0.27 ^d

a,b,c Means with different superscripts in the same row are significantly different (P<0.05). A = 0% GSM, 100% PKC; B = 25% GSM, 75% PKC; C = 50% GSM, 50% PKC; D = 75% GSM, 25% PKC; E = 100% GSM, 0% PKC.

Table 5: Effects of varying levels of Groundnut Shell Meal on the Performance of Finisher Broilers

Dietary Treatment Parameters	T ₁ (0%)	T ₂ (2.5%)	T ₃ (5.0%)	T ₄ (10%)	T ₆ (10%)	SEM
Initial Body Weight (g).n	320	320	310	320	310	0.01
Avg. Final Body Weight (g).	2320 ^b	2520 ^a	2280 ^c	2270	1890 ^d	0.40
Avg. Daily Wt. Gain (g).	40.82 ^b	44.80 ^a	40.20 ^b	39.80 ^b	32.36 ^c	0.77
Avg. Daily Feed Intake (g).	129.39 ⁰	131.71 ^a	128.24 ^a	126.56 ^b	110.60 ^c	0.85
Feed Conversion Ratio (g).	3.17 ⁰	2.94 ⁰	3.19 ⁰	3.18 ⁰	3.43 ⁰	0.05

confirming its status as a high - protein feedstuff. The haematological and the serological indices of the broiler chicken fed the various test diets are presented in (table 4). With the exception of MCV, MCH and coagulation time, all other haematological and serological indices tended to decrease as greater proportions of PKC were incorporated into the diets. PCV for diet A (33.55%) was significantly (P<0.05) higher than those for the other levels of GSM inclusion (diet B = 29.05%; C = 30.45% and E = 32.35%). In the same vein, the PKC in diet A (2.7x10⁶/mm³) was significantly (p<0.05) higher than in all other levels of PKC substitution.

Serum proteins and WBC levels in the blood were significantly depressed as more GSM was included in the diets beyond 0% and 25% respectively. This implies that feeding over 25% GSM in broiler diets without further processing for prolonged periods may be detrimental to broilers since these two factors are involved in the formation of immunoglobulin responsible for the development of antibodies. Prolonged feeding of GSM in this form therefore posed health hazards to such birds when challenged with infections.

DISCUSSIONS

MCV generally tended to increase (P < 0.05) as the

proportion of GSM in the diets increased (table 4). Highest MCV was obtained in diet E (141.27 fl) with 100% PKC. MCV is an important trait which determines the cell size of erythrocytes and is therefore an important factor in determining the ability of birds to withstand prolonged oxygen starvation (Adeyemi *et al.*, 2000).

Average Daily Weight Gain (g)

Results presented in (table 5) shows that the highest daily weight gain (g) was observed in birds fed diet 2 (2.5% GSM), while the lowest was observed in birds fed diet 5 (10% GSM). It was observed that the body weight gain of birds decreases with increase in dietary levels of the GSM. The result agreed with the observation made by Ahaotu *et al.*, (2013b) where graded dietary inclusion of groundnut shell meal induced cause related depression in growth of chicken even when palm kernel cake was used to compensate for low metabolizable energy value of the groundnut shell meal. Similar observation of decreasing performance of broilers at high levels of GSM inclusion have been observed by Ahaotu *et al.*, (2010) who reported that the body weight gain of broilers drastically reduced at high levels of GSM incorporation. Akpodiete *et al.* (2006) followed the same suit with the incorporation of high levels of GSM. The

effect observed above could have resulted from imbalance nutrient value and improper metabolism associated with the GSM as reported by Anaeto *et al.* (2009). Other workers (Boateng *et al.*, 2008) have also reported the effect of nutrient imbalance on monogastric animals fed high levels of unconventional feed ingredients. This could also be probably due to the effects of incomplete elimination of toxic factors as reported by Ahaotu *et al.* (2013b).

Average Daily Feed Intake

The analysis of variance conducted on the daily feed intake showed that there was significant ($P < 0.05$) differences among the treatment means. The feed consumption of birds fed diet 1, 2 and 3 were similar ($P > 0.05$) but significantly ($P < 0.05$) higher than those of birds fed diets 4 and 5. However the feed intake of birds fed diet 5 was significantly ($P < 0.05$) lower than that of birds fed diet 4.

The observed general trend was that of decreasing average feed intake as level of supplementation increased. This might be attributed to the high crude fibre which reduced the palatability of the feed. This is in consonance with the observations of Abo-Donia *et al.* (2014) who fed finisher broilers with raw groundnut shell and reported reduced feed consumption among the sheep on the test diets. Ahaotu *et al.* (2013b) has also established the presence of fungi *Aspergillus flavus* and *Aspergillus parasiticus* mouldy groundnut shells. However, debitterization through water washing, alkali soaking and urea ammonization to improve palatability has been recommended (Coasta *et al.*, 2001). Also the decrease in feed intake observed could be as a result of anti-nutritional factors present in the test ingredient. This agreed with the findings of Akpodiete *et al.* (2006) who incorporated different levels of GSM noted for their anti-nutritional factors in the diets of poultry and observed decreases in feed intake.

Feed Conversion Ratio

The analysis of variance showed that there were significant ($P < 0.05$) differences among the treatment means. As shown in (table 5), the amounts of feed consumed by birds fed diet 1(0% GSM), diet 3 (5.0 % GSM) and diet 4 (7.5 % GSM) to gain the same unit (kg) of bodyweight, were similar ($P > 0.05$). However, birds fed diet 2 (2.5%, GSM) were significantly ($P < 0.05$) higher than those birds fed diet 5 (2%) to gain the same unit of body weight. The efficiency of feed conversion of birds fed diets containing more than 2.5% GSM were significantly ($P < 0.05$) lower when compared to those of birds fed diet 2 (2.5%, GSM). The poor utilization of diets containing higher levels of GSM might be related to the inability of the birds' enzyme to break down the active

bitter substance in the GSM and also the imbalance nutrient value and improper metabolism associated with the groundnut shell meal as reported by Cowart *et al.* (2016).

The results of this study showed that there were significant ($P < 0.05$) difference among the performance of birds across the various treatments in terms of average body weight gain, feed intake, and feed conversion ratio. Further supplementation of GSM beyond 5% showed decrease in average bodyweight gain and average final weight of the birds.

This study also showed that the supplementation of GSM had little or no effect on the hematological values of the birds, as the parameters evaluated for across the treatment groups fell within the accepted normal ranges for poultry birds.

CONCLUSION

The results of this study showed that the groundnut shell meal supplementation in broiler diets could be effectively utilized at 5% to obtain reasonably good growth rate and reduced disease infection risk in the finished broiler birds. Since the GSM has shown great promise as a possible substitute for PKC, processing methods should be improved in such a way that all traces of anti-nutritional and haemolytic factors which are capable of distorting the haematological parameters are eliminated.

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