DIGESTIBILITY OF CRUDE PROTEIN AND CRUDE FIBRE BY BROILER FINISHER CHICKENS FED DRIED GROUNDNUT HUSK MEAL-BASED DIETS SUPPLEMENTED WITH HEMICELLULASE AND DRENCHED WITH CITRIC ACID IN WATER

[1]Omileke, E. T., [1]*Ilaboya, I. I., [1]Imouokhome, J. I., [1]Bamigboye, D O., [1]Ehielu, R. O., [2]Ibiezugbe, J. E., [$]Osaro, G. O. and [3]Akaeze, N.C

[$]Department of Animal Science and Animal Technology, Benson Idahosa University, Edo State. Nigeria
[2]Regulatory Affairs Department, Nigerian Institute of Animal Science, Abuja. Nigeria.
[3]Department of animal Science, University of Benin, Benin City, Edo state, Nigeria
*Corresponding Author's Email: iilaboya@biu.edu.ng

ABSTRACT

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 design. The birds were used to investigate the digestibility of crude protein (CP) and crude fibre (CF) by broiler finisher chickens fed dried groundnut husk meal (DGHM)-based diets supplemented with hemicellulase and drenched with citric acid in water. Between days 43 and 45 post-hatch, samples of fresh excreta were collected once daily. On day 46, 4 birds per treatment were slaughtered and dissected to obtain digesta from the distal two-third of the ileum. Five experimental finisher diets were formulated which replaced maize at 0% (control, T1), 5% DGHM (T2), 10% DGHM (T3), 15% DGHM (T4) and 20% DGHM (T5). Ileal CP and apparent CP digestibility were not influenced (P>0.05) by feeding DGHM-based diets. Digested CP and retained CP were significantly (P<0.05) higher in birds on T5. Apparent CP retention significantly (P<0.05) increased in T5 as compared to birds on the control diets. Ileal crude fibre (CF), excreta CF and apparent CF digestibility of birds were not significantly (P>0.05) different across the treatments while digested and retained CF decreased significantly (P<0.05) across all the treatments. Apparent CF retention increased significantly (P<0.05) in T4 and T5. Therefore, digestibility of crude protein and crude fibre by broiler chickens fed d DGHM-based diets supplemented with hemicellulase and drenched with citric acid in water improved digested CP, retained CP, apparent CP retention and apparent CF retention in broiler chickens.

Keywords: Dried Groundnut husk meal, hemicellulase, organic acid, crude protein, crude fibre

INTRODUCTION

Nutritionally efficient and economically viable diets for broilers are formulated on the basis of digestibility results (Brumano *et al*., 2006). Groundnut husk (GH) can be used as a replacement ingredient which could lead to marked reduction in the feeding cost of birds. The limiting factor for its use in rations is the high crude fibre (CF) content because poultry cannot digest high levels of CF (Armayanti *et al.,* 2021). Groundnut Husk contain a remarkable amount of crude protein (11%), fibre (25%), calcium (1.3%), phosphorus (1.8%) and other nutrients (FAO, 2013). One of the ways to maximize the utilization of this feedstuff by broilers is the addition of exogenous enzymes to their diets, which optimizes nutrient digestibility and growth performance in broiler chickens (Ilaboya and Iyayi, 2021; Duarte and Kim, 2021). Exogenous Non-Starch enzymes are important component of poultry diet; they improve the digestibility of feed and reduce environmental pollution (Ilaboya and Iyayi, 2021). Hemicellulase belongs to the enzymatic family of glycoside hydrolyses; it breaks the bond of glucose and polymers present in plant fibre with water molecules. This reaction leads to hydrolysis of hemicellulose, and facilitates the digestion of carbohydrate to release energy. Legumes have non-starch polysaccharides (NSPs) like hemicellulose, mannan, and raffinose (Zdunczyk *et al.,* 2021). Enzyme supplementation is considered to break the bond among NSPs and result in improved nutritional value of feed materials. The use of antibiotic alternatives such as organic acids, probiotics and medicinal plants are highly supported by consumers (Elgeddawy *et al.,* 2020; Alagawany *et al.,* 2021). Furthermore, organic acids reduce microorganism growth in the gastrointestinal tract, change intestinal pH, and enhance feed utilization (Adams, 1999). However, few or no research has been carried out on the digestibility of GH supplemented with hemicellulase and drenched in organic acid (OA). Use of enzymes and organic acids in poultry nutrition supports the effective digestibility of broilers and enable the release of bound nutrients. Hence, the objective of this study was to investigate the digestibility of crude protein and crude fibre by broiler finisher chickens fed dried groundnut husk meal (DGHM)-based diets supplemented with hemicellulase and drenched with citric acid in water.

MATERIALS AND METHODS

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 design (CRD) were utilized in the study. The animals were adapted for one week before the commencement of the experiment. Five experimental finisher diets were formulated

which replaced maize at 0% (control, T1), 5% DGHM (T2), 10% DGHM (T3), 15% DGHM (T4) and 20% DGHM (T5). Titanium dioxide was added as an indigestible marker at the rate of 5g/kg of diet. Hemicellulase and citric acid were added to the drinking water of birds on T2, T3, T4 and T5 at the inclusion rate of 1g citric acid to 1liter of water. On day 39, the birds were individually weighed and transferred into metabolic cages. Between days 43 and 45 post-hatch, samples of fresh excreta were collected once daily. On day 46, 4 birds per treatment were slaughtered and dissected to obtain digesta from the distal two-third of the ileum (Rodehutscord *et al*., 2012) which was collected, and pooled according to cage, and dried.

Table 1: Gross composition of broiler finisher diet

Ingredients	T1 (control)	T2 (5%DGHM)	T3 (10%DGHM)	T4 (15%DGHM)	T5 (20%DGHM)
Maize	55.10	52.34	49.59	46.85	44.08
DGHM	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
Soybean 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					
DM	46.84	47.74	49.36	50.98	52.61
ME Kcal/Kg	3181.10	3133.00	3103.57	3074.24	3044.59
CP	21.18	20.97	20.90	20.83	20.77
Ash	3.83	3.87	3.95	4.03	4.11
CF	3.06	3.95	4.92	5.88	6.85
EE	3.84	3.72	3.65	3.57	3.50
NFE	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, DGHM:Dried Groundnut Husk Meal*

Chemical Analyses

Samples of DGHM, experimental diets, digesta and excreta were analysed for CP and CF according to the methods of AOAC (2000). Titanium concentration was determined using a colourimetric assay (Short *et al*., 1996). Data were analysed using the GLM procedure of SAS (SAS Institute, 2012).

Statistical Analyses

Means were separated using Analysis of Variance (ANOVA) and least significant difference (LSD) was used to separate means that were statistically different.Total $Nutrient_{output}$ (N_O) = N_i × $Ti_{diet}/Ti_{excreta\ or\ digesta}$, AND, % = 100 - [($Ti_{diet}$ /$Ti_{digesta\ or\ excreta}$) x ($N_{digesta\ or\ excreta}/N_{diet}$) x 100]. Where, N_i = Nutrient intake, Ti_{diet} =Titanium in diet, $Ti_{excreta\ or\ digesta}$ = Titanium in excreta or digesta, AND = Apparent nutrient digestibility, $N_{digesta\ or\ excreta}/N_{diet}$ = Nutrient in excreta or digesta.

RESULTS AND DISCUSSION

The result of the proximate composition of groundnut husk meal (DGHM) are Dry matter 93%; ME (Kcal/kg) 2129.68; Protein 7.50%; Ash 4.2%; Crude Fibre 37.8% and Ether Extract1.31%. The nutrient (proximate) composition of the diets is adequate and within the recommended range for broiler finishers as reported by Ahaotu et al. (2023a). Ileal CP and apparent CP digestibility were not influenced (P>0.05) by feeding DGHM-based diets supplemented with hemicellulase and citric acid. Digested CP and retained CP were significantly (P<0.05) higher in birds on the control and T5. Excreta CP decreased significantly in birds on T5 when compared with the birds on the control. Apparent CP retention significantly (P<0.05) increased in T5 as compared to birds on the control diets. This suggests that DGHM can be included up to 20% in the diets of broilers. The results obtained suggests that supplementation of DGHM diets with hemicellulase and citric acid is effective in improving the bioavailability of CP (Ndelekwute, 2019). This report supports the work of Iyayi (2013), who used cowpea as its test ingredient to improve CP digestibility with the supplementation of phytase. As diets were supplemented with hemicellulase, digestibilities and retention of CP (Table 2) were improved in birds fed 20% DGHM-based diet. Nevertheless, response of CP digestibility to hemicellulase supplementation can be due to complexes present in feedstuffs and de novo formation of protein complexes during intestinal transient of the animal, (Selle and Ravindran, 2007).

Table 2. Crude protein intake and CP outputs of broilers fed dried groundnut husk-based diets supplemented with hemicellulase and drenched with citric acid in water

Measurements	T1 (control)	T2 (5%DGH)	T3 (10%DGH)	T4 (15%DGH)	T5 (20%DGH)	SEM
ICP (kgDMI)	0.43	0.36	0.34	0.40	0.42	0.20
DCP (kgDMI)	8.08^{a}	6.92^{b}	6.24^{c}	6.80^{b}	7.93^{a}	0.19
ACPD (%)	94.98	94.00	94.80	94.48	95.03	0.23
ECP (kgDMI)	0.32^{ab}	0.34^{a}	0.20^{bc}	0.23^{ac}	0.16^{c}	0.02
RCP (kgDMI)	8.19^{a}	6.90^{b}	6.28^{c}	6.97^{b}	8.18^{a}	0.20
ACPR (%)	96.20	95.40	97.00	96.82	98.10	0.31

$^{a\,b\,c}$ Means in a row with different superscripts are significantly different from each other (P<0.05). Each value represents the mean of 5 replicates (6birds/replicate) SEM=Standard Error of Mean, DMI = dry matter intake, ICP: Ileal Crude Protein, DCP: Digested Crude Protein, ACPD: Apparent Crude Protein digestibility, ECP: Excreta Crude Protein, RCP: Retained Crude Protein, ACPD: Apparent Crude Protein retention

Table 3 shows Ileal crude fibre (CF), excreta CF and apparent CF digestibility of birds were not significantly (P>0.05) different across the treatments while digested and retained CF decreased significantly across all the treatments. Though digestibility of crude fibre did not improve, there were no negative effect on them as their respective values were similar to those of the control. This could be attributed to the presence of organic acid in their water. This report agrees with the work of Ndelekwute et al. (2019). Apparent CF retention increased significantly (P<0.05) in T4 and T5.

Table 3. Crude Fibre intake and Crude Fibre outputs of 46-day-old broilers fed dried groundnut husk-based diets supplemented with hemicellulase and drenched with citric acid in water

Measurements	T1 (control)	T2 (5%DGH)	T3 (10%DGH)	T4 (15%DGH)	T5 (20%DGH)	SEM
ICF (kgDMI)	0.02	0.02	0.02	0.03	0.02	0.001
DCF (kgDMI)	1.47^{a}	1.20^{e}	1.25^{d}	1.32^{b}	1.29^{c}	0.07
ACFD (%)	99.10	99.04	99.12	99.03	99.18	0.04
ECF (kgDMI)	0.04	0.03	0.04	0.03	0.02	0.003
RCF (kgDMI)	1.44^{a}	1.17^{b}	1.22^{c}	1.31^{d}	1.28^{d}	0.02
ACFR (%)	96.92	96.76	97.20	97.65	98.39	0.22

$^{a\,b\,c}$ Means in a row with different superscripts are significantly different from each other (P<0.05). Each value represents the mean of 5 replicates (6birds/replicate) SEM=Standard Error of Mean, DMI: dry matter intake, ICF: Ileal Crude Fibre, DCF: Digested Crude Fibre, ACFD: Apparent Crude Fibre digestibility, ECF: Excreta Crude Fibre, RCF: Retained Crude Fibre, ACFR: Apparent Crude Fibre retention

The highest apparent crude fibre digestibility (ACFD) was observed for birds fed 20% DGHM. The adverse effect on digested crude fibre on the birds as a result of 5% DGHM inclusion can be attributed to the lower dietary fibre output (i.e., non-starch polysaccharide and oligosaccharide concentrations). There was no significant effect (P>0.05) of dietary fibre on the birds excreta output as the level of dietary fibre varies in the diet. Hetland and Svihus, B. (2001) found that the inclusion of insoluble fibre such as oat hulls (5% of the diet) improve apparent ileal DM digestibility while feeding 7.5% oat hull had a negative effect. Ilaboya et al. (2021) further buttresses

poor utilization of crude fibre in pigs as the level of cabbage waste inclusion increase from 20% to 40% in their diet.

CONCLUSION

Hemicellulase and citric acid did not affect crude protein and crude fibre digestibility of dried groundnut meal-based diet. However, it rather increased retained CP and apparent CF retention while excreta CP was reduced in birds fed 20% DGHM. Therefore, the application of hemicellase and organic acid in broiler feed is recommended to poultry farmers as they provide less excretion of these nutrients into the environment.

REFERENCES

Adams, C. 1 (999). Poultry and dietary acids. Feed Int. 20:1370–1372.

Ahaotu, E.O, Okoro, C. N, Ukwuaba, S.I, Nwokeforo, C.U, Onuruka, A.C, Ikpe, J.N. and Oko E.C. (2023). Comparative Analysis and Efficiency of Poultry Enterprise in Ezinihitte Mbaise Local Government Council of Imo State, Nigeria. *Merit Research Journal of Agricultural Science and Soil Sciences. 11 (4): 042-047.*

Alagawany, M., M. Madkour, M. T. El-Saadony, and F. M. Reda. (2021). Paenibacillus polymyxa (LM31) as a new feed additive: antioxidant and antimicrobial activity and its effects on growth, blood biochemistry, and intestinal bacterial populations of growing Japanese quail. *Anim. Feed Sci. Technol. 276:114920.*

AOAC (1990). Official methods of analysis. Association of Official Analytical Chemists Ed., Washington DC.

SAS. (2012). Statistical Analysis System, User's Guide. Statistical. Version 9.1th ed. SAS. Inst. Inc. Cary. N.C. USA

Armayanti, A. K., Jamilah, J., Kurniawan, M. E. and Danial, D. (2021). Broiler performance with the utilization of various levels of fermented peanut shells meal. IOP Conference Series: *Earth and Environmental Science 788: 1-5.*

Brumano, G., Gomes, P. C., Albino, L. F. T., Rostagno, H. S., Generoso, R. A. R. and Schmidt, M. (2006). Composição química e valores de energia metabolizável de alimentos protéicos determinados com frangos de corte em diferentes idades. *Revista Brasileira de Zootecnia 35:2297-2302.*

Duarte, M.E.; Kim, S.W. (2021). Intestinal microbiota and its interaction to intestinal health in nursery pigs. Anim. Nutr.. In press.

Elgeddawy, S. A., H. M. Shaheen, Y. S. El-Sayed, M Abd Elaziz, A. Darwish, D. Samak, and S. S. Elnesr. (2020). Effects of the dietary inclusion of a probiotic or prebiotic on florfenicol pharmacokinetic profile in broiler chicken. *J. Anim. Physiol. Anim. Nutr. 104:549–557.*

FAO. Food and Agricultural Organization. (2013). Poultry feed availability and nutrition in developing country

Hetland, H. and Svihus, B. (2001). Effect of oat hulls on performance, gut capacity and feed passage time in broiler chickens. *Br. Poult. Sci. 42(3): 354-361*.

Ilaboya I. I and Iyayi E. A. (2021). "True phosphorus digestibility of cottonseed meal and rice husk supplemented with microbial phytase in broiler chickens". *South African Journal of Animal Science 51: 104-112.*

Ilaboya I. I., Imouokhome, J. O., Omatsuli, M. O., Imonikhe, E. and Ogum, J. (2021). "Growth Performance and Digestibility of Weaner Pigs Fed Diets Substituted with Fresh Cabbage (*Brassica oleracea* var. capitata) Waste". *Journal of Animal Production Research 33(2): 33-41.*

Iyayi, E.A. (2013). Effect of phytase supplementation on the digestibility of crude protein, amino acids and phosphorus of cowpea (Vigna unguiculata) in broilers. *Journal of Poultry Science 92:1595-1603.*

Ndelekwute, E.K, Assam E.D., Assam, E. M. (2019). Apparent nutrient digestibility, gut pH and digesta viscosity of broiler chickens fed acidified water. *MOJ Anat and Physiology 5(4): 250-253.*

Selle, P.H. and Ravindran, V. (2007). Microbial phytase in poultry nutrition. *Animal Feed Science and Technology 135: 1-41.*

Short, F.J., Gorton, P., Wiseman, J. and Boorman, K.N. (1996). Determination of titanium dioxide added as an inert marker in chicken digestibility studies. *Anim. Feed Sci. and Technol. 59, 215-221*.

Zdunczyk, Z., Jankowski, J., Mikulski, D., Zdunczyk, P., Juskiewicz, J. and Slominski, B.A. (2021). The effect of NSP-degrading enzymes on gut physiology and growth performance of turkeys fed soybean meal and peas-based diets. *Animal feed science and technology 263:114448.*