EFFECT OF PHYTASE SUPPLEMENTATION ON THE GUT MORPHOLOGY OF BROILER CHICKENS FED CABBAGE MEAL-BASED DIETS

[*#]Olaleye, C., [#]Aigbedion, F.O., [#]Bamigboye, D.O, [#]Ilaboya, I. I., [#]Imouokhome, J. I., [#]Oyedeji, J. O. [$]Olayemi, U.O. and [&]Iyayi, E.A.

[#]Department of Animal Science and Animal Technology, Benson Idahosa University, Edo State. Nigeria
[$]Vantage Agro Allied Ltd, Ibadan, Oyo State. Nigeria
[&]Department of Animal Science, University of Ibadan, Oyo State. Nigeria
*Corresponding author: talk2christianaholaleye@gmail.com

ABSTRACT

*Efficacy of phytase supplements on gut morphology was investigated in broilers fed diets containing cabbage meal (CM). A total of 144 one-day-old ROSS 308 broiler chickens (BC) were fed broiler starter diet till day 21. The birds were fed experimental diets from day 22-30, after which the length of BC's small intestines (SI), large intestine (LI) and SI diameter (SID) were recorded. The experiment had three replicates with eight birds per replicate. Six semi-purified diets with 100, 200, and 300g/kg CM and 0 or 1000 units of phytase (Natuphos) were formulated in a 2x3 factorial arrangement. Data were analysed using the general linear model of SAS. Orthogonal polynomial contrast was used to determine phytase and their interaction with CM. Diameter of the small SI was measured and their circumference calculated. Result shows that there was no significant difference (P>0.05) between means on all the parameters investigated. Though, phytase (Phy) and its interaction with CM (Phy*CM) had significant effect (P<0.05) on the large intestine (LI). The diameter of the small intestine was also affected significantly (P<0.05) by the interaction between Phy*CM. The effect of phytase, level of CM and its interaction with phytase was not significantly (P>0.05) observed in the SI and its circumference. In conclusion, addition of phytase to cabbage meal-based diets may be a suitable strategy for improving intestinal morphology in ROSS 308 broiler chickens.*

Keywords: Phytase, cabbage meal, intestinal morphology, ROSS 308 broiler, semi-purified diet

INTRODUCTION

The first week after hatch is the most challenging period in the life of broilers. The digestive tract of the newly hatched chick is immature and must undergo dramatic changes before it can efficiently digest and absorb nutrients. The gut is the vital organ where nutrient digestion and absorption take place. Ontogenic changes that accompany improved digestion and absorption include increased secretion of digestive enzymes, increase in the gut absorptive surface area, and enhanced nutrient transporters. The obvious limiting factors are the secretion and activities of digestive enzymes, and the surface area for absorption. These limitations are overcome as the birds grow older, with concurrent improvements in nutrient utilization. The digestive tract of birds is anatomically complete in the final period of the incubation process. However, its functional, digestive and absorptive capacities are still immature when compared with those of older birds. From the 17th day of incubation to the seventh day after birth, birds undergo morphological differentiations in the anatomy of their gastrointestinal tract. Most importantly, there is an increase in the number of enterocytes-epithelial cells with nutrient absorption function-as well as in intestinal size (Santos *et al.,* 2012). The small intestine of birds increases in weight at a faster rate than the body and essential organs such as the heart and lungs. Other organs of the digestive tract, such as the gizzard, also do not develop in proportion to the body (Uni *et al.,* 1999). The small intestine has a four-fold greater allometric growth than the entire bird carcass. During the first 27 days of life, goblet cells, which occur in the crypts and intestinal villi, are of fundamental importance for the proper development and preservation of the digestive system (Rocha *et al.,* 2016). According to Lumpkins (2007), the chicken digestive organs that develop are related to the performance of the small intestine as nutrient absorption site. This is also supported by the production of digestive enzymes by the pancreas which affects the development of the digestive tract. Based on the description above, this research investigated the gut morphology of the small and large intestine in ROSS 308 broiler chickens for the age of 30 days given phytase supplemented diets.

MATERIALS AND METHODS

This study was conducted at the poultry unit of the teaching and research farm of the Faculty of Agriculture and Agricultural Technology, Benson Idahosa University, Benin City, Edo State.

Experimental Birds and Management

One hundred and forty-four one-day-old Ross 308 broiler chicks was raised on floor pens in a well-ventilated and illuminated standard poultry house. On arrival, the birds were fed a commercial broiler starter diet that met (NRC, 1998) nutrient requirements for broiler chicks for 21days. At day 22 post-hatch, 120 birds were transferred to metabolic cages, before then, birds were tagged, individually weighed and randomly allotted to six experimental diets, with three replicates in a randomized complete block in a 2x3 factorial arrangement. Birds had free access to water and experimental diets for eight days, with the first two days allowed for acclimatization to the experimental diets. All necessary routine management practices as well as room temperature regulation were adhered to.

Experimental Diet

Sequential, semi-purified diets containing 100, 200 and 300g of CM/kg (table 1) with or without 1000 units of phytase/kg diet were formulated. The dietary inclusion levels of the test ingredients were obtained by the gradual replacement of cassava starch with the CM. Soya oil was added to the diets to obtain similar gross energy across the diets. Across all studies, varied dietary levels of limestone was added to the experimental diets to ensure that similar calcium: total phosphorus was maintained in the diets.

Table 1: Percentage Composition of Experimental Diet

	Without Phytase			Phytase Phytase)		
Ingredients	**CM 100g/kg of diet**	**CM 200g/kg of diet**	**CM 300g/kg of diet**	**CM 100g/kg of diet**	**CM 200g/kg of diet**	**CM 300g/kg of diet**
Cabbage Meal (CM)	100.00	200.00	300.00	100.00	200.00	300.00
Cassava Starch	522.50	420.75	319.00	512.50	410.75	309.00
Casein	220.00	220.00	220.00	220.00	220.00	220.00
Soya oil	10.00	10.00	10.00	10.00	10.00	10.00
Dextrose	102.25	102.25	102.25	102.25	102.25	102.25
Methionine	3.00	3.00	3.00	3.00	3.00	3.00
Lysine	2.00	2.00	2.00	2.00	2.00	2.00
Limestone	10.25	12.00	13.75	10.25	12.00	13.75
Vitamin-Premix	2.50	2.50	2.50	2.50	2.50	2.50
Salt	2.50	2.50	2.50	2.50	2.50	2.50
Phytase Enzyme	0.00	0.00	0.00	10.00	10.00	10.00
Titanium Dioxide	25.00	25.00	25.00	25.00	25.00	25.00
Total	**1000.00**	**1000.00**	**1000.00**	**1000.00**	**1000.00**	**1000.00**
Calculated Nutrients						
ME Kcal/Kg	3958.51	3909.13	3859.74	3923.61	3874.23	3824.84
CP (g/kg)	205.64	219.44	233.24	205.64	219.44	233.24
Ca (g/kg)	5.37	6.16	6.96	5.37	6.16	6.96
Total P (g/Kg)	2.85	3.50	4.15	2.85	3.50	4.15

[1]Composition of vitamin premix per kg of diet: vitamin A, 12500 I.U; vitamin E, 40mg; vitamin K_3, 2mg; vitamin B_1, 3mg; vitamin B_2, 5.5mg; niacin, 5.5mg; calcium pantothenate, 11.5mg; vitamin B_6, 5mg; vitamin B_{12}, 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. [2]Phytase premix prepared by mixing phytase with maize. [3]Titanium dioxide premix prepared by mixing 1g of titanium oxide with 4g of maize

Measurement of the intestines

Allometric assessments were performed by measuring the intestinal segments of the large intestine, small intestine, its diameter and circumference. They were all measured (cm) separately, using a string and a measuring tape.

Data Analysis

Data was analysed using the GLM procedure in SAS, (2012). Orthogonal polynomial contrasts were used to determine effects of graded levels of CM and phytase and their interaction. Tukey's test was applied to compare the means and α = 0.05 was considered significant.

RESULT AND DISCUSSION

Results showed that there was no significant difference (P>0.05) between means in all the parameters investigated. However, phytase (Phy) and its interaction with CM (Phy*CM) had significant effect (P<0.05) on the large intestine (LI). The diameter of the small intestine was also affected significantly (P<0.05) by Phy*CM. According to Sousa et al. (2015), some aspects related to the physiology of the digestive tract elucidate the greater development of certain organs, which occurs due to an increase in other organs with which they have a physiological relationship. The effect of phytase, level of CM and its interaction with phytase was not significantly (P>0.05) observed in the SI and its circumference. This shows that feeding graded levels of CM stimulated the optimal absorption of nutrients and stimulated the development of the digestive tract. The growth of the morphology of the small intestine might be faster, thus influencing the development of intestinal villi. Intestinal development is related to gizzard development, thus, increasing the number of coarse particles can cause an increase in enzyme absorption (Roger *et al.,* 2006).

Table 2: Selected growth performance indices of 30-day-old broilers fed dried cabbage meal-based diets supplemented without and with phytase

Parameter (cm)	Phytase (0 FTU/kg) DCM 100g/kg of diet	DCM 200g/kg of diet	DCM 300g/kg of diet	Phytase (1000 FTU/kg) DCM 100g/kg of diet	DCM 200g/kg of diet	DCM 300g/kg of diet	Pooled SEM	P-value Phy	CM	Phy*CM
SI	179.00	164.67	161.17	156.67	162.17	146.75	9.80	2.68	1.05	0.52
LI	14.25	12.78	15.00	14.53	12.67	14.92	1.01	0.001	2.67	0.02
SID	1.02	0.97	1.05	1.18	1.12	1.22	0.08	5.76	0.64	0.01
SIC	2.88	3.04	3.30	3.72	3.51	3.82	0.21	12.41	1.13	0.42

DCM: Dried Cabbage Meal, SI: Small Intestine, LI: Large Intestine, SID: Small Intestine Diameter, SIC: Small Intestine Circumference

The significant effect of the Intestinal morphology indicates enhanced absorptive surface which could suggest more efficient nutrient absorption and better gut health overall (Abadi *et al.,* 2019; Ding *et al.,* 2020). Previous studies have demonstrated that yeast cell wall supplementation can positively influence gut morphology by promoting beneficial gut microflora and modulating immune responses, which in turn could lead to improved intestinal structure (Liu *et al.,* 2022; Sayed *et al.,* 2023). A higher percentage of digestive organs may result in better use of the feed, since the size of the gastrointestinal tract as well as its efficiency in the breakdown and absorption of nutrients will positively affect nutrient utilization. Verdal et al. (2010) evaluated the morphology of the gastrointestinal tract of two broiler strains selected for high or low energy use of wheat-based diets. The authors found that the birds of the strain selected for high energy use had heavier gizzards and proventriculi than those with low energy use efficiency. Small intestine length can be considered an indicator of good intestinal mucosal development. This has a direct impact on intestinal health and nutrient absorption, since a longer intestine means a larger area of exposure of nutrients to absorptive cells (Guerra, 2018). The surface area of the small intestine is influenced by the length and width of the intestinal villi. The surface area of the small intestine can affect the ability to digest and absorb the feed, thus an increase in broiler chicken productivity can be associated with the increase in absorption activity in the small intestine. The increase in weight and length of the small intestine might be accompanied by the increase in surface area of the small intestine (Yamauchi, 2006). The present study agrees with the reports of these authors with an increase in intestinal surface area.

CONCLUSION

It can be concluded that supplementation of phytase to cabbage meal-based diets improved intestinal morphology of ROSS 308 broiler chickens.

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