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Full Length Research

Growth performance and carcass characteristics of broiler chickens fed diets supplemented with exogenous phytase

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ABSTRACT: This study was conducted at the Poultry Section of Rivers State University Teaching and Research Farm, Nkpolu-Oroworukwo, to examine the growth performance and carcass characteristics of broiler chickens fed diets supplemented with exogenous phytase. A total of 120 day-old ROSS 308 broiler chicks were used in the study and, after one week of brooding, were randomly allocated to four dietary treatments, each consisting of three replicates with 10 birds per replicate. The treatments included: T1 (control), T2 (basal + 1000 Phytase unit/kilogram diet), T3 (basal + 2000 FTU/kg diet), and T4 (basal + 3000 FTU/kg diet). The experimental design used in the study was a completely randomised design, and mean was separated using duncan multiple range test. Birds were fed a broiler starter diet for the first four weeks, followed by a broiler finisher diet with varying phytase inclusion rates. At the end of week six, birds were fasted for 12 hours, and growth parameters (final weight, weight gain, feed intake, and feed conversion ratio) were measured. Six birds per treatment were slaughtered, and their carcasses and internal organs(liver, gizzard, heart, intestines, kidney, crop, pancreas, proventriculus) were harvested and weighed. Carcass parts (thigh, drumstick, breast, wing), neck, head, and feathers were also measured. Initial weight, final weight, weight gain, feed intake and feed conversion ratio showed no significant differences at ($p = 0.33$, $p = 0.20$, $p = 0.21$, $p = 0.59$, and $p = 0.26$), respectively. However, highly significant differences ($P <0.01$) were observed in the heart, small intestine, large intestine and crop. For carcass parts, there were no significant difference on drumstick, although a trend was observed ($p = 0.06$) with T3 outperforming T1 and T2, while breast and wing showed significant differences ($p< 0.05$). Based on these findings, it is recommended that phytase be included at 2000 FTU/kg diet to improve growth and carcass quality in broilers raised in tropical conditions.

Keywords: Carcass, broilers, growth, phytase.

INTRODUCTION

Broiler chickens are birds bred for meat production, and they are fast-growing, attaining a reasonable weight within 5 to 6 weeks. At 4 weeks, they attain about 1.5 to 1.8kg if the right nutrient requirements are met, and one of their important advantages is that they possess better growth and feed efficiency compared to other chickens (Riber and Wurtz, 2024). The demand for broiler chickens has gradually increased due to the growing population of the world, as consumers of meat give more preference to white meat than red meat (USDA and Global Ag Media, 2025). Apart from their use as meat, broiler chickens are used for research purposes globally. In the production of broiler feeds, the plant based feedstuffs are basically used to furnish energy in their diets and most of these feedstuffs contain phytic acid (phytate) which nutritionist refer to as an anti-nutritional factor because of its chelating effect on minerals, and consequently amino acids, and carbohydrate biosynthesis, therefore, limiting these nutrients in terms of their bioavailability (Feizollahi *et al*., 2021). Furthermore, the limiting bioavailability is a result of the formation of insoluble phytate-mineral complexes in the gastrointestinal tract, leading to high levels of minerals and other nutrients in their manure, which causes eutrophication, the pollution of underground water by phosphorus and other minerals in the environment (Akinnawo, 2023).

Phytase is a phosphatase enzyme that aids in catalysing the hydrolysis of phytic acid. Dersjant-Li *et al* (2017), Walters *et al*. (2019), and Araujo *et al*. (2023) demonstrated that the inclusion of phytase in diets of monogastrics deactivates the chelating effect of phytic acid, which leads to the release of phosphorus and other minerals in the diet and consequently improves the absorption of nutrients. This has evidently shown that supplementation of phytase in monogastric animals, such as broiler chicken can cause a release of inorganic phosphate and other nutrients from phytic acid bound in cereals and legumes used as feedstuffs in monogastric diets. Therefore, it is important to investigate the effect of exogenous phytase inclusion in broiler chickens' diet on growth performance and carcass characteristics and to ascertain the optimum level of inclusion in plant-based diets in the tropics.

MATERIALS AND METHODS

Experimental site

The study was carried out at the Poultry Section of the Rivers State University Teaching and Research Farm situated on latitude 4.7923°N and longitude 6.9825°E.

Experimental animals

A total number of 120-day old broiler chickens were used for this study. The day-old broiler chicks were purchased from Agric International Technology and Trade (AGRITED) Farm in Ibadan, Oyo State, Nigeria through Animal Affairs located at Rumuokoro, Rivers State, Nigeria. Prior to the arrival of the broiler chicks, the floor of the pens was washed vigorously with hypochlorite water and then allowed to dry for two weeks before wood shavings were used to create beddings on the floor. All other sanitary and bio-security measures, such as cleaning around the pen and application of disinfectant in the deep of the pen, were put in place before the birds' arrival.

Experimental procedures

Upon arrival at the poultry unit of Rivers State University Teaching and Research Farm, the day-old chicks were brooded for two weeks. They were fed a common experimental broiler starter diet during the first week, after which the birds were weighed and randomly allotted to four treatment groups with three replicates. Each of the replicates had ten birds. The treatments were as follows;

T_I – basal diets (No phytase)
T_2 – basal diet + 1000 FTU/kg diet
T_3 – basal diet + 2000FTU/kg diet and
T_4 – basal diet + 3000FTU/kg diet

Phytase is represented as FTU OR FYU, and it is the amount of phytase enzyme that releases 1 micromole (µmol) of inorganic phosphorus per minute from sodium phytate at pH 5.5 and 37°C. To ensure usage, phytase is converted to grams by dividing the FTU values by 5000, which is the specific enzyme activity of the microbial phytase used in this study. The phytase product is labelled MicroTech 5000, produced by VTR Biotech, China. All feed ingredients and phytase were purchased at Modern Agro Enterprises, Rumuodomaya, Rivers State.

Basal diet of broiler starter and finisher were prepared at the Feed Mill section of Rivers State University Teaching and Research Farm. The ingredients were crushed to fine particle size separately using hammer mill, and they were weighed before mixing. Mixing was done manually using a hand shovel. Macro ingredients were first mixed properly to ensure uniformity before micro ingredients were weighed and mixed separately. After mixing the micro nutrients, a small portion of the already mixed macro ingredients were gradually used in mixing with the mixed micro ingredients before they were all emptied into the main formulated diet and were further mixed properly to ensure uniformity. T_2, T_3 and T_4 diets were evenly mixed with phytase enzyme at their prescribed levels using a mixer to ensure uniformity prior to feed administration and were not added at the point of formulation.

Ingredients and quantities in diets

Broiler starter and finisher diets were formulated to be isocaloric and isonitrogenous using the IDT Feed Formulation Software. The quantities of ingredients were used for broiler starter and finisher diet formulation are as shown in Table 1.

Proximate composition of diets

Proximate composition, as shown in Table 2, was done according to AOAC (1975) and carried out at Food Science and Technology Laboratory, Rivers State University, Nigeria.

Growth performance and carcass evaluation

Average initial weight was taken in all the treatment groups at one (1) week of age. This was done to mark the experimental period when phytase was administered, and at 6 weeks, average final body weight was also recorded. Weight gain and feed intake were determined and presented in grams including feed conversion ratio.

Table 1. Ingredients and quantities in diets.

Ingredients	Starter %	Finisher %
Maize	53	57
Palm Kernel Cake (PKC)	5	7
Soya Bean Meal (SBM)	24	15.85
Wheat Bran (WB)	4	6
Groundnut Cake (GNC)	10.65	13
Min/Vit Premix	0.25	0.25
Bone Meal	2.5	0.3
Methionine	0.1	0.1
Salt	0.4	0.4
Lysine	0.1	0.1
Total	100	100
Calculated		
Crude protein (%)	21.552	18.233
Crude fibre (%)	6.527	7.0
Fat (%)	3.817	4.3
Lysine (%)	1.0251	0.833
Methionine (%)	0.537	0.4
Calcium (%)	1.12	1.12
Avail. Phosphorus (%)	0.6427	0.574
Metabolizable energy (Kcal/kg)	2738.848	2720.20

ME was calculated using NRC (National Research Council), 1994 feedstuff energy values.

Table 2. Proximate composition of diets.

Items	Broiler starter	Broiler finisher
Moisture %	7.63	6.04
Ash %	5.35	3.68
Fat %	3.35	3.17
Crude Protein %	21.00	18.81
Crude Fibre %	9.01	10.05
Carbohydrate %	25.8	27.64
Metabolizable Energy (ME) Kcal/kg	2955.96	3023.16

ME = 37 (%CP) + 81.8 (%EE) + 35.5 (%NFE).

Dressed weight was obtained by weighing each carcass on a weighing scale calibrated in grams and values were presented as percentage of live weight. 6 birds from each group were randomly selected, weighed and slaughtered humanely. Their visceral organs (liver, gizzard, heart, small intestine, large intestine, kidney, crop, pancreas, and proventriculus) weights were measured and presented as a percentage of live weight. The carcass parts(thigh, drumstick, breast, and wing) were cut and weighed in grams and expressed as a percentage of carcass weight, while neck, head and feathers were cut, weighed and expressed in grams. Feathers were air dried for 30 minutes before weighing.

Statistical analysis

The data obtained were subjected to Analysis of variance (ANOVA) using the general linear model procedure. Treatment means were separated using the Duncan Multiple Range Test using statistical software (IBM, 2016). The experimental Design employed was Completely Randomized Design. The linear model used in this study is stated below:

$$X_{ij} = u + T_i + E_{ij}$$

Where: Xij = Value of any observation, u = unknown

Table 3. Effect of phytase supplementation on growth parameters in broiler chickens.

Parameters	T_1 (control)	T_2 (1000FTU/kg)	T_3 (2000FTU/kg)	T_4 (3000FTU/kg)	p-value
Initial weight(g)	293.33 ±3.33	290± 5.77	303.33± 3.33	293.33± 6.67	0.33
Final weight(g)	1310.00 ± 95.39	1300± 36.06	1420± 70.24	1483.33±27.29	0.20
Weight gain(g)	1016.67 ± 92.08	1010 ±32.15	1116.67 ± 71.73	1190± 32.15	0.21
Feed intake(kg)	2.57 ± 0.26	2.49 ± 0.14	2.72± 0.20	2.65 ± 0.29	0.59
FCR	2.55 ± 0.14	2.46 ±0.15	2.46± 0.08	2.24± 0.17	0.26

FCR = feed conversion ratio, Mean ± SEM (Standard Error of Mean).

Table 4. Carcass and visceral organ weights of broiler chickens supplemented with different levels of phytase expressed as percentage of live weight.

Parameters	T_1 (control)	T_2(1000FTU/kg)	T_3(2000FTU/kg)	T_4(3000FTU/kg)	p-value
Live weight (g)	1566.67+ 76.01	1766.67± 91.89	1800.00 ± 96.61	1600.00 ± 131.66	0.29
Carcass (%)	68.26 ± 1.00^{ab}	72.59 ± 1.64^{ab}	63.04 ± 0.54^{b}	75.90 ± 6.04^{a}	0.05
Liver (%)	2.23 ± 0.11	1.92 ±0.19	1.96 ± 0.08	2.16 ± 0.06	0.23
Gizzard (%)	2.72±0.14	2.66± 0.19	2.67± 0.07	2.38± 0.04	0.24
Heart (%)	0.53 ± 0.01^{b}	0.52 ± 0.03^{b}	0.61 ± 0.01^{a}	0.51 ± 0.02^{b}	0.00
Small Int. (%)	1.06 ± 0.02^{a}	0.91 ± 0.05^{b}	0.84 ± 0.08^{b}	0.78 ± 0.02^{b}	0.00
Large Int. (%)	6.46 ± 0.24^{b}	5.14 ± 0.30^{c}	7.29 ± 0.36^{a}	5.55 ± 0.13^{c}	0.00
Kidney (%)	0.76 ± 0.05	0.71 ±0.03	0.68 ± 0.08	0.71 ± 0.03	0.79
Crop (%)	0.89 ± 0.15^{a}	0.48 ± 0.05^{b}	0.44 ± 0.02^{b}	0.51 ±0.02^{b}	0.00
Pancreas (%)	0.38 ± 0.03	0.33 ± 0.05	0.37 ± 0.03	0.29 ± 0.01	0.25
Proventriculus (%)	0.79 ± 0.07	0.65 ± 0.05	0.72 ± 0.06	0.68 ± 0.02	0.32
Carcass (g)	1066.67 ± 42.16	1268.33 ± 83.27	1133.33 ± 55.78	1250.00 ± 192.35	0.53

^{abc}Means with different letters across rows are significantly different (*p<0.05*). Mean ± SEM, Int = intestine.

constant, the population mean common to all treatments, Ti = Treatment effect, and Eij = Error mean.

RESULTS

Growth performance

Table 3 shows the average growth performance parameters of the broilers fed diets supplemented with varying levels of exogenous phytase enzymes in comparison with birds from the control group. There were no significant differences ($p > 0.05$) in all the growth parameters measured. T4 had the numerically highest mean of final weight and weight gain, while T3 had the highest numerical mean in feed intake. Feed conversion ratio had a numerically lowest mean in T4

Carcass and organ weight

Carcass and visceral organ weight evaluated in broiler chickens as affected by graded levels of phytase are presented in Table 4. Dietary phytase has a marginal but significant effect on carcass percentage (p = 0.05) in T4 compared to T3. T4 had the highest mean weight compared to all the treatments. Heart showed highly significant differences (p < *0.01*) in T3 compared to other treatments. The small intestine and crop showed highly significant differences ($p < 0.01$) in T1 compared to other treatments. The large intestine showed highly significant differences ($p < 0.01$) in all treatment groups except for T2 and T4 that had similarities. All other parameters had no significant differences ($p > 0.05$) across the board.

Carcass parts of broiler chickens

Table 5 shows the primal cuts of the carcasses measured as a percentage of the live weight of broiler chickens from the respective treatment groups, they are randomly selected. Carcass parts showed no significant differences ($p > 0.05$) across the treatment groups except for breast and wing weight. Thigh, drumstick, breast, neck, and head weight showed the highest mean numerical value in T3, while wing and feather weight were numerically high in mean value in T1.

DISCUSSION

Across all treatment groups, the broiler chickens' initial body weight were statistically equal as there was no significant difference *(p = 0.33)* among the dietary

Table 5. Carcass parts weight of broiler chickens supplemented with different levels of phytase expressed as percentage of carcass weight and in grams.

Parameters	T_1(control)	T_2 (1000FTU/kg)	T_3(2000FTU/kg)	T_4(3000FTU/kg)	p-value
Thigh (%)	15.20 $\pm$ 0.58	13.36 $\pm$ 1.20	16.09 $\pm$ 0.45	15.94 $\pm$ 1.67	0.30
Drumstick (%)	7.56 $\pm$ 0.32^{b}	6.39 $\pm$ 0.55^{b}	8.13 $\pm$ 0.21^{a}	7.39 $\pm$ 0.53^{ab}	0.06
Breast (%)	32.82 $\pm$ 0.46^{ab}	27.77 $\pm$ 2.64^{b}	35.34 $\pm$ 0.75^{a}	28.72 $\pm$ 2.15^{b}	0.02
Wing (%)	13.72 $\pm$ 0.96^{a}	10.42 $\pm$ 0.68^{b}	12.13 $\pm$ 0.43^{ab}	10.74 $\pm$ 0.45^{b}	0.01
Neck (g)	70.67 $\pm$ 8.02	76.67 $\pm$ 5.68	84.67 $\pm$ 2.79	76.33 $\pm$ 10.23	0.60
Head (g)	42.33 $\pm$ 0.42^{ab}	36.00 $\pm$4.31^{b}	44.33 $\pm$ 1.12^{a}	40.00 $\pm$ 2.56^{ab}	0.16
Feather (g)	90.00 $\pm$ 2.76	89.00 $\pm$ 3.95	89.00 $\pm$ 2.03	87.33 $\pm$ 7.66	0.98

[ab]Means with different letters across rows are significantly different (*p<0.05*), Mean $\pm$SEM.

treatments. This corresponds with best practice in scientific research to ensure there is no bias in the aspect of initial body weight and age. This aligns with Diri *et al*. (2023), who demonstrated the use of broiler chickens at a uniform initial weight when the effect of vitamin C on growth characteristics was investigated. Final weight of broiler chickens showed no significant difference (*p =0.20*) in all dietary treatment groups, although the group that received phytase at 3000 FTU/kg diet had the highest mean. This suggests that there might have been a significant difference if the study duration had been prolonged more than six weeks. It means that phytase inclusion slightly increased the final body weight of broiler chickens at six weeks. This relatively agree with Sampath *et al*. (2023) who reported that phytase inclusion in broiler diets at 3000 FTU/kg diet showed no significant difference at the grower and finisher phase however, there was an increase in mean value while disagreeing with Martínez-Vallespín *et al.* (2022) who investigated the effect of phytase inclusion at different graded levels of phytase in low phosphorus diet and reported that phytase inclusion at 3000 FTU/kg diet improved broiler weight significantly when compared to the control group. Also, broiler chickens fed phytase at 3000 FTU/kg diet recorded the highest mean value; however, there were no significant differences in all treatment groups. This holds that phytase at 3000 FTU/kg can better improve the growth of broilers if they are reared for more than six weeks in real life situation. This also agrees with Sampath *et al*. (2023) and Shi *et al*. (2022), who reported that there were no significant differences when broilers were fed phytase-supplemented diets ranging from 2500FTU/kg diet to 10,000FTU/kg diet compared to the control group. However, this disagrees with Martínez-Vallespín *et al.* (2025), who reported that there were significant differences in broiler chickens fed phytase-supplemented diet at 500, 1000 and 3000 FTU/kg diet in respect to weight gain.

Feed conversion ratio is an essential indicator of production efficiency, representing the animal's ability to convert feed intake into biological outputs such as growth or product yield. In this study, there were no significant differences (*p = 0.26*) in all treatment groups for feed conversion ratio; however, the group that received 3000 FTU/kg diet mean was numerically the lowest, thus indicating that it could have performed better compared to other groups. This agrees with Sampath *et al*. (2023), who reported that FCR did not show a significant difference when phytase was added to the diet of broilers, but disagrees with Borges *et al*. (2025), who reported that phytase supplementation improves feed conversion ratio and performance in broiler chickens fed nutrient-deficient diets. The group which received phytase at 2000FTU/kg diet had the highest feed intake, although there were no significant differences for feed intake in all groups. This may indicate that while phytase at the inclusion rate of 2000 FTU/kg diet can improve feed intake, its effect may not always be statistically significant compared to other lower or higher doses or even the control group. This agrees with Mou (2016), who investigated the effect of different levels of phytaseon growth performance of broiler chickens and reported that there were no significant differences in feed Intake. Furthermore, the findings of this study disagreed with those of Mou (206).

Carcass evaluation and organ weights

Broiler chickens' live weight showed no significant difference (*p = 0.29*) in all dietary groups, although the group that received phytase at 2000 FTU/kg diet had the highest mean compared to other groups. This could have been attributed to the duration of the trial, which might have been short for phytase to effect significant growth. This corresponds with the work of Daramola *et al*. (2021), who reported that dietary supplementation of phytase had no significant differences when compared to the control group. Also, Fatufe *et al*. (2019) investigated the effect of dietary phytase and protease supplementation in broiler chickens and reported that there was a numerical increase in averagefinal body weight in the group that received phytase and both phytase and protease; however, there was no significant difference, which also corresponds with the findings of this study. In contrast to the result of this study, Sampath *et al*. (2023) reported that phytase inclusion in broiler diets showed a significant increase at six weeks.

This study showed that phytase improved carcass percentage and can be attributed to the fact that the bioavailability of calcium, phosphorus and other amino acids had translated to lean meat in the group that received phytase. Phytase at 3000FTU/kg diet had the highest mean carcass percentage, followed by the group that had phytase at 1000FTU/kg diet. Nacimento *et al*. (2021) suggested that super-dosing of phytase at 1500 FTU/kg diet and above may improve dressing percentage, and this suggestion corresponds with the findings of this study. Dos Santos *et al.* (2017) investigated the effect of super-dosingphytase at 1500FTU/kg diet on Cobb 500 male broiler chickens and reported that phytase increased carcass percentage and breast weight. This is also relatively not in agreement with the findings of this study, as it was shown that phytase improved carcass percentage at 3000FTU/kg diet.

Liver weight did not show a significant difference ($p = 0.25$) in phytase groups, and this agrees with Dersjant-Li *et al*. (2025) and Katukurunda *et al*. (2017), who in their independent studies reported that phytase inclusion in diets of broilers had no significant increase in liver weight expressed as percentage of live weight. However, findings of this study disagree with those of Khan *et al*. (2019), who investigated the consequence of adding phytase in diets of broilers on growth performance and some visceral organ weight and reported that there was a significant increase in liver weight expressed as a percentage of live weight.

Dietary phytase caused no significant increase ($p = 0.24$) in gizzard weight expressed as a percentage of live weight in this study, and this agrees with Katukurunda *et al*. (2017). This could be that gizzard is not a target for phytase as it has no link to phosphorus, and since gizzards play a mechanical role in feed digestion, it will require coarse feed particles to stimulate its development (Abdollahi *et al*., 2018). In this study, the feed was relatively ground to a fine level and not coarse enough to stimulate its development. Heart weight showed a highly significant difference ($p< 0.01$) in the group that received phytase at 2000 FTU/kg diet compared to all other treatment groups that showed no significant differences, thus indicating that phytase at 2000 FTU/kg has performed better. Giacona *et al*. (2024) reported that phosphorus bioavailability aided in the building and development of muscles. This is because Adenosine Triphosphate is a high-energy compound and phosphate is a key component of it that carries a driving force in muscle energy, and development of which the heart is made up of muscles. In this study, it could be that dephytinization of phytic acid via phytase improved phosphorus levels, which may have caused an increase in heart weight. The result in this study corresponds with that of Hafsan *et al*. (2023) who investigated the phosphorus storage and performance of broiler chickens using synthetic phytase enzyme and reported that the group that received phytase had significant increase in some visceral organs including heart however, it disagrees with the findings of Wang *et al.* (2013) who reported that there were no significant increase in heart with the use of phytase as supplement in broiler chickens diets when internal organs weight were investigated.

Small and large intestine weight showed significant differences ($p < 0.01$) in their treatment groups. In small intestine weight, the group that received phytase tends to have a slightly lower mean value compared to the treatment group, which performed better. This may indicate that dietary phytase did not have a total effect on the small intestine. Macambira *et al*. (2025) investigated the effect of phytase on intestinal size and reported that the phytase effect was somewhat restricted to the jejunum and caused no effect on whole small intestine weight. The finding agrees with that of Moradi *et al.* (2023), who reported that phytase inclusion reduced small intestine weight. Large intestine weight showed an increase in weight in the group that received 2000 FTU/kg diet compared to other treatment groups. This suggests that improved mineral bioavailability caused by dietary phytase enhanced large-intestine growth, although Bento Gonçalves*et al.* (2024) reported that minerals such as calcium, phosphorus, zinc, and magnesium influence gut length and morphology more than the weights of gastrointestinal organs. However, Macambira *et al*. (2025) reported that phytase supplementation has no significant difference in large intestine weight.

Kidney weight showed no significant difference ($p = 0.79$) in all treatment groups. The decrease in kidney mean weight observed in groups that received phytase could be that the availability of phosphorus and the improvement of amino acids by phytase had reduced the metabolic load of the kidney, thus leading to its decrease, since it is less functional in expelling nitrogenous wastes and indigestible mineral nutrients. The constant excretion of nitrogenous wastes and indigestible nutrients can lead to hypertrophy, an increase in mass, which can result in an increase in weight (Hu *et al*., 2024). It is important to note that increased kidney size is not a sign of healthiness. In this study, the slight decrease in the weight of the kidneys of chickens that received phytase may be due to efficient absorption of minerals and amino acids digestion might have led to a decrease in kidney stress. A different result was observed in crop weight as there washighly significant differences ($p < 0.01$) between the group that received phytase and the control. A less undigested phytic acid and fiberthat passes the crop can render it inactive (Kristoffersen *et al*., 2021), thus reducing stress that could cause hypertrophy.

This study showed that the pancreas weight showed no significant differences across all dietary treatment which corresponds with Liu *et al*. (2010) and the group that received phytase was numerically low in mean weight which agrees with Samat (2015). Phytase inclusion caused no significant difference ($p = 0.32$) in proventriculus weight among all treatment groups; however, there was a numerical decrease in weight of the groups that received phytase, with the 2000 FTU/kg diet group numerically the highest. This could be that nutrient absorption via phytase increased proventriculus weight, but it was not to the point of having a significant difference. This corresponds with Bournazel *et al*. (2018), who investigated the effect of phytase supplementation on a rich fibre diet, deficient in calcium and phosphorus and reported that there was a significant increase in the proventriculus of broiler chickens compared to the control group. However, this does not agree with that of Moss *et al*. (2019).

Thigh weight showed no significant difference ($p = 0.30$) among all treatment groups, but it was observed that the 2000 FTU and 3000 FTU/kg diet groups showed an increase; however, the 2000 FTU/kg diet group had the highest increase in numerical mean, suggesting that it may have performed better compared to other groups. One can suggest that phytase at the level of 2000 FTU/kg diet may have an increase in thigh composition of broiler chickens' protein source when added in the feed formulation ingredient. This finding corresponds with Prabhuraja *et al*. (2024), who investigated the effect of phytase supplementation on carcass characteristics in broilers and observed that there were no significant differences in thighs in all groups fed phytase compared to the control. Also in a similar study, Hao *et al*. (2018) investigated the phytase supplementation effect on meat quality and reported no significant difference in broiler thigh weight. The findings of this study disagree with those of Walk *et al*. (2024) and Kriseldi *et al*. (2021). The lack of a significant effect does not mean phytase caused no noticeable effect, just that it was not enough to be confidently measured.

Phytase was able to improve drumstick weight as seen in this study, where the 2000 FTU/kg group performed best, with the highest mean weight compared to other treatment groups. Although there were no significant differences. This agrees with Walk *et al*. (2024), Kriseldi *et al*. (2021). The same outcome for drumstick was also mirrored for breast yield in the current study. Phytase inclusion at 2000FTU/kg diet improved the muscle breast. This result exactly agrees with Mou (2016), who investigated the effect of various levels of phytase supplementation on growth performance and reported that phytase inclusion at 2000FTU/kg diet improved breast weight when compared to the control group. However, this disagrees with Prabhuraja *et al*. (2024), who reported that there was no increase in breast weight of broilers fed graded levels of phytase as dietary supplements. In the carcass of chickens, the breast region is one of the major areas of muscle deposit and can be used to assess the quality of the carcass.

Phytase inclusion showed a significant difference ($p = 0.01$) in wing weight, and it was also observed that there was a decrease in wing weight compared to the control group. When there is an improvement in nutrient bioavailability (due to phytase), the chickens may prioritise the growth of larger parts with muscle deposit, like breast, thigh, etc. This agrees with Walk *et al*. (2024) and disagrees with Daramola *et al*. (2021). There were no significant differences among all treatment groups when neck weight was measured as part of growth in body parts. Although those fed phytase at various levels had an increase in their mean numerically, the 2000 FTU/kg diet group was numerically the highest. Thus, indicating that phytase actually made a slight increase in neck development. This corresponds with Daramola *et al.* (2021) and de Freitas *et al*. (2019), who measured head and neck together as part of the carcass and reported that there was no significant effect on head-neck weight. In this study, head and feather were also measured, and it showed no significant differences across all dietary treatment which also corresponds with Daramola *et al*. (2021). While minerals are essential for the overall health of birds, it might not significantly improve feather growth.

Conclusion and Recommendation

Phytase supplementation at 1000, 2000 and 3000FTU/kg diet has no significant effect on growth parameters. There were significant differences observed in carcass yield and the relative weights of breast and wing, while major carcass parts, including the thigh, drumstick, head, neck, and feather, showed no significant differences. However, phytase supplementation significantly ($p < 0.05$) affected some visceral organs. Broiler chickens fed phytase-supplemented diets showed a decrease in crop and small intestine weights compared with the control group, while the heart and large intestine weights increased significantly at 2000 FTU/kg diet. The reduction in gut segment weights suggests enhanced nutrient digestibility and gastrointestinal efficiency, while the increased heart and large intestine weights may indicate improved physiological adaptation to better nutrient availability.

Overall, the study concludes that dietary phytase supplementation up to 3000 FTU/kg diet does not negatively affect growth or carcass characteristics of broiler chickens but exerts positive physiological effects on internal organs, especially at moderate inclusion levels. In conclusion, Phytase supplementation at 2000 FTU/kg diet is recommended for broiler chickens, as it maintains normal growth and carcass yield while promoting favourable changes in visceral organs such as increased heart and large intestine weights and reduced crop and small intestine weights, which may indicate improved digestive efficiency.

CONFLICT OF INTEREST

The authors declare no competing interests.

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