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THE EFFECT OF FEEDING RED SORGHUM SUPPLEMENTED WITH PHYTASE ENZYME ADDITIVE ON GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF BROILER CHICKENS

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Abstract
The study was carried out to determine the effect of feeding red sorghum supplemented with phytase on the growth performance and carcass characteristics of broiler chickens. One hundred and fifty (150) Agrited Anak broiler chicks at one week old were used for this study. The Red Sorghum supplemented with phytase enzyme was used to replace maize at various levels to determine the best replacement that would give optimal performance in broiler chicken diets. The anti-nutritional composition of red sorghum showed that it contained 0.31 (mg/100g) tannins and 0.50 mg/g trypsin. In the starter feeding trial, the red sorghum supplemented with phytase enzyme was used to replace maize at levels of 25%, 50%, 75% and 100% respectively in the control diet. Each starter diet was fed to a group of 30 starter broiler chicks for four weeks using Completely Randomized Design. Each treatment was divided into three replicates of 10 broiler chicks each. Parameters measured include initial body weight, final body weight, body weight gain, feed intake, feed conversion ratio and feed cost benefit. In the finisher feeding trial, the replacements were 25%, 50%, 75% and 100% sorghum supplemented with phytase enzyme. Each finisher diet was fed to a group of 30 finisher broilers for another four weeks using Completely Randomized Design. The parameters measured include initial body weight, final body weight, body weight gain, feed conversion ratio, cost of production and carcass characteristics. The cost of production of the finisher broiler chicken was lowest for those on the control diet (N390.51), while the costliest was for those on TMT5 (100% sorghum supplemented with phytase enzyme) (N459.16). The internal organs of the finisher broiler chickens expressed as percent of the live weight were not affected by the treatments. The feed cost benefit of the starter broiler chicks was lowest for those fed the control diet (TMT1), (N241.89) while the costliest was starter broiler chicks on TMT5 (100% sorghum supplemented with phytase enzyme (N412.30). In the starter feeding trial, red sorghum supplemented with phytase enzyme could be used up to 50% in their diets without affecting feed intake, body weight gain and feed conversion ratio. In the finisher feeding trial, red sorghum supplemented with phytase enzyme could be used up to 100% in their diets without affecting feed intake, body weight gain and feed conversion ratio. It was concluded that red sorghum supplemented with phytase enzyme could be used up to 50% in the diets of starter broiler chicks and up to 100% in the diet of finisher broiler chickens without affecting body weight gain, feed intake and feed conversion ratio as indicated in this study.

Keywords: Red sorghum, phytase enzyme, growth performance, carcass characteristics, broiler chickens

Introduction

In an intensive poultry enterprise feed is the major component cost and the ultimate challenge is to reduce its cost to a minimum without compromising the quality of the produce (Ziggers, 2011; Adegbenro *et al.,* 2018). Research efforts in the developing countries including Nigeria in recent times have been directed on the need to address the ever-increasing cost of animal feeds which has always constituted a perennial hindrance to the expansion of livestock industry (Aro and Ajiboye, 2016). The major source of energy feedstuff for monogastric animals such as poultry. The pigs is maize the production of maize is low and is at a very high cost following the high level of pest and diseases attacks at the early stage of cultivation. Human beings also compete with livestock for consumption of maize and as well as industries. Maize is also expensive and scarce all-round the year. Therefore, there is need for an

alternative energy source for poultry production. Sorghum is in expensive and nutritionally comparable or even superior to major cereals (FAO, 2014). The grains are rich in certain phytochemicals and trace minerals because of which, these are now considered as "nutritious grains". Sorghum is used in many food preparations, the most common forms being boiled grains or flour. More than 80% of global sorghum area of 42.12 million hectare (FAO, 2014) lies in developing countries mainly in Africa and Asian countries. Red sorghum is a rich source of phytochemicals including tannins and phenolic acids. The anti-nutritional factors present in sorghum grains are mainly polyphenols and phytic acid. Polyphenols are the secondary metabolites as they bind the protein present in grain and make them unavailable for the intestinal absorption. The polyphenols (tannins) and phenolic acids present in sorghum are generally associated with grain pigmentation. Polyphenols also interfere with bioavailability of other major nutrients (Jambunathan and Mertz, 1973). But, these phytochemicals have potential to significantly impact human health through high antioxidant activity against different free radicals in-vitro (Awika and Rooney, 2004). Some microorganisms do produce phytase, most frequently the *Aspergillus* genus. The monogastric animals like poultry birds are unable to utilize this phytate phosphorus, as they lack endogenous phytase, which necessitates in the addition of inorganic feed containing phosphates to poultry diets in order to meet the phosphorus requirements of poultry (Yu *et al.,* 2004). It is therefore assumed that supplementary red sorghum with phytase enzyme additive will help to improve growth performance and carcass characteristics of broiler chickens.

Materials and Methods

Experimental site

The experiment was carried out at the poultry unit of the teaching and research farm of Michael Okpara University of Agriculture, Umudike, located at latitude 5º 21`N and longitude 7º 32` E in the rainforest zone of Umuahia, Abia State of Nigeria. This site has a mean daily temperature of between 27ºC and 35ºC throughout the year and an average rainfall of 200mm per annum and an altitude of 122mm above, sea level NRCRI, Umudike (2017).

Procurement and Processing of Feed Ingredients

Phytase enzyme was procured from Mid-century agro-allied Ltd, Lagos State and red sorghum was bought from Umuahia, Abia State. The red sorghum grains were crushed using hammer mill to homogenize it and were stored in bags for use. Palm Kernel Cake (PKC), Maize, Brewers' Dried Grain (BDG), fish meal, lysine, methionine, soybean meal, wheat offal, bone meal, common salt and vitamin/mineral/premix were bought from Jocan Livestock Services in Umuahia, Abia State.

Chemical Analysis of Feed Ingredients

All the feed ingredients, red sorghum, Palm Kernel Cake (PKC), Brewers' Dried Grains, soyabean meal, wheat offal, were subjected to proximate analysis according to (AOAC, 1995) to determine their nutrients compositions and gross energy. All analysis was based on 100%, Dry Matter (DM). This was done so as to use the values that were obtained to determine the nutrient compositions of the experimental diets that were formulated from them. The components that were determined include: Dry Matter (DM), Crude Protein (CP), Ether Extract (EE) and Nitrogen Free Extract (NFE).

Anti-Nutrient Determination

The test material dried red sorghum was analyzed for anti-nutrients content such as phytic acid, oxalate, cyanide, tannins and saponins. Phytate was determined according to Joslyn (1970) oxalate was determined according to Adeniyi *et al.,* (2009), Cyanide content was determined using Picarate paper kit developed by (Bradbury *et al*., 1999), Saponin was determined according to Brunner (1984), Tannin was determined using, the spectrometric method of AOAC (2005) and Joslyn (1970) used for tannin analysis.

Experimental Diets

Five experimental broiler starter diets were formulated for the starter phase of the feeding trial. The control diet (Diet 1) contained maize as the main source of energy and fibre but had enzyme supplementation only. The red sorghum was used to replace maize in the diets by 25%, 50%, 75% and 100% in diets 2, 3, 4 and 5 supplemented with phytase enzyme. The enzyme supplementation was 0.15g to 1kg diet. The diets were formulated to meet nutrient requirements of broiler chicks as outlined by National Research Council (NRC, 1994) and they were approximately isocaloric and isonitrogenous. The dietary ingredients were presented in Table 1 (Starter) and 2 (Finisher). At the end of the starter feeding trial, five experimental finisher broiler diets were formulated. The control diet did not contain red sorghum, but maize as the main source of energy. Other diets were formulated such that diets 2, 3, 4 and 5 contained 25%, 50%, 75% and 100% red sorghum supplemented with phytase to completely replace maize. The enzyme supplementation was 0.15g to 1kg diet. Other dietary ingredients were varied in order to provide the required protein and energy for the broiler chickens. The following diets were produced and tested in the feeding trial as shown in table 2.

Experimental design

The design of the study was completely randomized design (CRD). The statistical model was

$Y_{ij} = \mu + T_i + e_j$

Where:

Y_{ij} =Individual observation

μ =Population mean

T_i =Treatment effect

e_{ji} =Error effect

Management of Experimental Birds

One hundred and fifty (150) day old Anak broiler chicks (Amobyng broiler chicks) were bought from Ibadan in

Western Nigeria. They were brood for one week with commercial starter broiler feed (Top feed) to stabilize them before distributing them into 5 treatment groups. Each treatment group contained 30 broiler chicks and was further subdivided into three replicates of 10 birds each and kept in a pen. The pen measured 3m by 4m was covered with black polythene sheets for conservation of heat. Heat was supplied through electricity and kerosene lantern during the brooding period. The floor of the pens was covered with wood shavings. Each treatment group was randomly assigned to an experimental starter broiler diet in a Completely Randomized Design (CRD) and was fed for 4 weeks. Feed was supplied in a feeding trough built in such a way as to minimize wasting of feed. Water and feed were given *ad libitum*. The birds were weighed at the beginning of the feeding trial and weekly after. Feed intake was recorded daily. The starter phase of the feeding lasted for four weeks while finisher phase lasted fed for another four weeks. The chicks were given anti-stress on arrival to boost their energy level. They were given Newcastle Disease Vaccine strain (NDV) by intraocular (1/0). The Gumboro vaccine was administered at the end of the second week through drinking water and lasota vaccine against Newcastle disease (Lasota strain) was administered at the end of the third week and the final Gumboro vaccine was administered at the end of the fourth week against the infectious bursal bursitis disease (Gumboro). Coccidiostat and other antibiotics were also administered by drinking water when there were signs of infections.

Carcass Evaluation

At the end of the feeding trial, three (3) broiler chicken from each treatment were randomly selected, starved of feed but not water for 24 hours and then weighed, slaughtered for the determination of the following internal organ weights (heart, kidney, spleen, lungs, abdominal fat), Cut part weights (thigh, muscle, wings, back cut, drumstick and breast muscle) and dressed weight. The internal organs weight was expressed as percentage of the live weight.

Data Analysis

The data collected were subjected to one-way Analysis of Variance (ANOVA) according to Snedecor and Cochran (1989), where significant treatment effects were detected from the ANOVA, means were separated using Ducan's New Multiple Range Test (Duncan. 1955).

Results and Discussion

Results

Data on the anti-nutrient composition of red sorghum was shown in Table 2. Red sorghum contained phytase, 59.7mg/g, Tannin 0.31mg/100g, oxalate, 1.54mg/g, trypsin, 0.53mg/g. Red sorghum is very high in phytate. The anti-nutritional factors present in sorghum grains are mainly polyphenols (tannins & phytic acid). Polyphenols (tannins) inhibit protein digestibility as they bind proteins present in grains and make them unavailable for the intestinal absorption. The polyphenols (tannins & phenolic acid) present in red sorghum are generally associated with grain pigmentation. Polyphenols interfere with bio-availability of other major nutrients (McDonald *et al*., 2000). Data on the proximate composition of raw sorghum as shown in (Table 3). Raw sorghum contained 13% moisture, 87% DM, 11.20% CP, 2.95% CF, 2.07% Ash, 2.50% EE and 68.25% NFE. The values obtained compared very favourably with that earlier report by (Aduku, 1993; Aletor, 1999 and Etuk, 2008). The analysis showed that the crude protein content of sorghum (11.20%) was higher than that of maize (10%). The result of the growth performance of the broiler starter chicks fed red sorghum supplemented with phytase was presented in Table 4. In the starter feeding trial, the average daily feed intake of the experimental groups were 42.00g, 49.19g, 42.12g, 37.38g, 39.23g for the broiler chicks group on control diet, 25% sorghum, 50% sorghum, 75% sorghum and 100% sorghum respectively. Significant differences ($P<0.05$) existed in feed intake among the various groups. The starter broiler chickens on 25% sorghum supplemented with phytase (diet 2) recorded the highest feed intake while the lowest feed intake were those on 75% and 100% sorghum based diet supplemented with phytase enzyme. Significant differences ($P<0.05$) existed among the treatment groups in their body weight gain. The starter broiler chicks on 25% sorghum and 50% sorghum compared favourably with those on the control diet in terms of body weight gain and were significantly ($P<0.05$) higher than those in other groups. Significant differences ($P<0.05$) existed among the starter broiler groups in their feed conversion ratio. The starter broiler chicks on 75% sorghum supplemented with phytase enzyme compared favourably with the control in their feed conversion ratios. Generally, their feed conversion ratios were better than their finisher broiler chicks on sorghum based diets. The result of the growth performance of the broiler finisher chickens fed red sorghum supplemented with phytase is presented in Table 5. The average feed intake of the experimental groups were 67.92g, 102.90g, 80.74g, 60.77g and 74.51g for the control diet, 25% sorghum, 50% sorghum, 75% sorghum and 100% sorghum supplemented with phytase enzyme. Significant differences ($P<0.05$) existed among the various groups in their feed intake. The finisher group on 25% sorghum supplemented with phytase recorded the highest feed intake of 102.90g which was significant ($P<0.05$) higher than other groups. The body weight gain of the experimental finisher broiler chickens was 707.00g, 946.00g, 729.67g, 518.00g, 877.00g for the control, 25% sorghum, 50% sorghum, 75% sorghum and 100% sorghum supplemented with phytase. Significant differences ($P<0.05$) existed among the various finisher broiler chicken in their body weight gain. The finisher broilers on 25% sorghum and 100% sorghum supplemented with phytase are similar in terms of body weight gain and significantly ($P<0.05$) higher than the finisher broilers on the control diet (Maize based diet). The feed conversion ratios of the finisher broiler chickens on the experimental diets is shown in Table 5

and the values obtained were 2.69, 3.06, 2.63, 2.13 and 2.38 for the control, 25% sorghum, 50% sorghum, 75% sorghum and 100% sorghum supplemented with phytase respectively. Significant differences (P<0.05) existed among the finisher broiler groups in the feed conversion ratios. The finisher broiler chickens on 75% sorghum supplemented with phytase recorded the best feed conversion ratio (FCR) of 2.13. The percentage internal organ weight of the experimental finisher broiler chickens is shown in Table 6. The weight of the organs (liver, gizzard, heart, kidney, spleen, large intestine, small intestine, lungs, crops, proventriculus etc) of the birds were not affected by the treatments (P<0.05). The percentage dressed weight is shown in Table 6. The finisher broiler chickens on diet 4 (75% sorghum) supplemented with phytase recorded significantly (P<0.05) the highest dressing percentage of 90 followed by those on 25% sorghum, 50% sorghum, and 100% sorghum supplemented with phytase. The percentage cut parts weights of the experimental finisher broiler chickens is presented in Table 7. There were significant differences (P<0.05) across the treatments in the percent cut part weights of the finisher broiler chickens especially on percent wings, back cut, neck, thigh and drumstick. The result of cost benefit of starter broiler chicks fed red sorghum based diets supplemented with phytase is shown in Table 8. The cost of production per kg of red sorghum based diets supplemented with phytase was cheapest for diet 1 (Control), N166.82 while the costliest was diet 5 (N217.00). The cost of production per kg broiler was cheapest for diet 1 (Control), N241.89 and the costliest was those on 100% red sorghum based diet (Diet 5) N412.30. The result of cost benefit of finisher broiler chicken fed red sorghum based diets supplemented with phytase is shown in Table 9. The cost of production per kg of red sorghum based diets supplemented with phytase was cheapest for diet 1 (control), N151.34 while the costliest was diet 5 (100% sorghum supplemented with phytase) N206.83. The cost of production per kg finisher broiler was cheapest for diet 1 (control) N396.51 while the costliest diet 4 (75% sorghum based diet supplemented with phytase) N653.54.

Discussion

The result of the trial with respect to the anti-nutrients content of red sorghum showed that it contained phytase, 59.7mg/g, tannin 0.13 mg/100g, oxalate, 1.54mg/g, trypsin, 0.53mg/g. The phytate content is very high. These polyphenols (tannins, phytic acid) inhibit protein digestibility as they bind proteins present in grains and make them unavailable for the intestinal absorption. Polyphenbols interfere with bioavailability of other major nutrients (McDonald *et al.,* 2000). Akinmutimi (2004) reported that phytate interferes with the utilization of anions and proteins resulting in complex compounds that are not readily broken down leading to poor absorption of anions and loss of proteins. According to Olomu (1995), also Ihekoronye (2009) reported that 1% of tannin in chicks can bring growth retardation as this is because of difficulty in breaking down protein tannin complexes. Tannins are the most important anti-nutrients found in red sorghum varieties. Inclusion of phytase as feed additive increases the availability of phosphate in plants but reduces environmental pollution (Khattal *et al.,* 2006).

Performance of starter broiler chicks fed experimental diet

There was significant difference (P<0.05) in feed intake of the starter broiler chicks among the various groups. The starter broilers on 25% sorghum supplemented with phytase enzyme recorded the highest feed intake while the lowest feed intake was those on 75% and 100% sorghum supplemented with phytase enzyme. According to (Yu *et al.,* 2004), the monogastric animals like poultry birds are unable to utilize the phytate phosphorus as they lack endogenous phytase, which necessitate in the addition of organic feed containing phosphates to poultry diets in order to meet the phosphorus requirements of poultry. The use of phytase as feed additive, as it not only increases the availability of phosphorus in plants but also reduces environmental pollution (Khattal *et al.,* 2006). The use of enzyme in poultry diets improved apparent metabolization of energy of the diet and increased feed intake, weight gain and feed gain ratio (Campbell *et al.,* 1992; Janson *et al.,* 1990; Annison and Choct, 1991; Bedford *et al.,* 1992, Benabdelijehl, 1992). Significant differences (P<0.05) existed among the treatment groups in body weight gain among the starter broiler chicks. The starter broiler chicks on 25% sorghum and 50% sorghum supplemented with phytase compared favourably with those on the control diet in terms of body weight gain and were significantly (P<0.05) higher than those in other groups. Significant differences (P<0.05) existed among the starter broiler chicks in their feed conversion ratios. The starter broiler chicks on 75% sorghum supplemented with phytase enzyme compared favourably with the control in terms of feed conversion ratio. The phytase enzyme improves feed conversion ratio (Broz, 1994).

Performance of finisher broiler chicken fed experimental diets

Significant difference (P<0.05) existed among the various groups in their feed intake. The finisher group on 25% sorghum supplemented with phytase recorded the highest feed intake of 102.90g which was significantly (P<0.05) higher than other groups. The inclusion of phytase enzyme in the diet improves feed intake in poultry (Campbell *et al.,* 1989). Significant differences (P<0.05) also existed among the various finisher broiler chickens in their body weight gain. The finisher broiler chickens on 25% sorghum and 100% sorghum supplemented with phytase enzyme are similar in terms of body weight gain and significantly higher than the finisher broilers on the control diet (maize based diet). The inclusion of phytase improves weight gain in poultry (Campbell *et al.,* 1989). Significant differences (P<0.05) also existed among the finisher broiler groups in their feed conversion ratio. The finisher broiler chickens on 75% sorghum based diet supplemented with phytase recorded the best fed conversion ratio

(FCR) of 2.13. According to (Campbell *et al.,* 1989) phytase improve feed conversion ratio in poultry. The weight of the organs (liver, gizzard, heart, kidney, spleen, large intestine, small intestine, lungs, crops, proventriculus etc.) of the birds were not affected by the treatments ($P<0.05$).

Conclusion

It was concluded that red sorghum contained anti-nutritional factors mainly polyphenol (Tannins) and phytic acid which inhibit protein digestibility as they bind proteins present in grains and make them unavailable for intestinal absorption. Polyphenols interfere with bioavailability of other nutrients. The supplementation of red sorghum with phytase improved apparent metabolizable energy of the diet, increased feed intake, weight gain and feed gain ratio. The enzyme also improved carbohydrate digestibility and reduce gut viscosity. It was concluded that red sorghum supplemented with phytase enzyme could be used up to 50% in the diets of starter broiler chicks and up to 100% in the diet of the finisher broiler chicken without affecting body weight gain, feed intake and feed conversion ratio as indicated in this study.

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Table 1: Percentage ingredients and nutrient composition of starter broilers chicks diets supplemented with phytase

Ingredients (%)	Diet 1 Control	Diet 2 25% SO	Diet 3 50% SO	Diet 4 75% SO	Diet 5 100% SO
Maize	55.00	41.25	27.50	13.75	0.00
Red Sorghum	-	13.75	27.50	41.25	55.00
Palm Kernel Cake	5.00	5.00	5.00	5.00	5.00
Wheat offal	5.00	5.00	5.00	5.00	5.00
Soyabean meal	28.20	28.20	28.20	28.20	28.20
Fish meal	3.00	3.00	3.00	3.00	3.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Vit/Min Premix**	0.25	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20	0.20
L-methionine	0.10	0.10	0.10	0.10	0.10
Total (%)	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated nutrient composition of the starter broiler chicken diets					
Crude protein (CP%)	23.17	23.07	23.15	23.29	23.73
ME Kcal/Kg	2885.80	2847.90	2829.75	2825.95	2822.15

SO = Sorghum

****To provide per kg of diet: Vit. A, 2,000000 iu; Vit D3: 4,000iu; Vit E, 80g; Vit. K, 0.49g; Choline, 48.00g; BHT, 32.00g; Manganese, 16.00g; Iron, 8.00mg; Zinc, 72gm; Copper, 0.32g; Iodine, 0.25g; Cobalt, 36.00g; Selenium, 16.00g***

Table 2: Percentage ingredient and nutrient composition of finisher broiler chickens fed diets supplemented with phytase enzyme

Ingredients (%)	Diet 1 Control	Diet 2 25% SO	Diet 3 50% SO	Diet 4 75% SO	Diet 5 100% SO
Maize	60.00	45.00	30.00	15.00	0.00
Red Sorghum	-	15.00	30.00	45.00	60.00
Palm Kernel Cake	4.50	4.50	4.50	4.50	4.50
Wheat offal	7.70	7.70	7.70	7.70	7.70
Soyabean meal	22.00	22.00	22.00	22.00	22.00
Fish meal	2.00	2.00	2.00	2.00	2.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Vit/Min Premix**	0.25	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20	0.20
L-methionine	0.10	0.10	0.10	0.10	0.10
TOTAL (%)	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated nutrients					
Crude protein (%)	19.30	19.45	19.60	19.75	19.90
ME Kcal/Kg	2989.84	2969.64	2950.24	2930.14	2910.64

****SO = Sorghum***

****To provide per kg of diet: Vit. A, 2,000000 iu; Vit D3: 4,000iu; Vit E, 80g; Vit. K, 0.49g; Choline, 48.00g; BHT, 32.00g; Manganese, 16.00g; Iron, 8.00mg; Zinc, 72gm; Copper, 0.32g; Iodine, 0.25g; Cobalt, 36.00g; Selenium, 16.00g***

Table 2: Anti-nutritional composition of red sorghum

Parameters	Red sorghum
Phytate (mg/100g)	59.7
Oxalate (mg/g)	1.54
Tannin (mg/100g)	0.31
Trypsin (mg/g)	0.53

Table 3: Proximate composition of raw sorghum

Parameters	Red sorghum
Moisture (%)	13.00
Dry Matter (DM %)	87.00
Crude protein (%)	11.20
Crude fibre (%)	2.95
Ash (%)	2.07
Ether extract (%)	2.50
Nitrogen free extract (%)	68.28

Table 4: Performance of starter broiler chicks fed red sorghum based diets supplemented with phytase

Parameter	Diet 1 Control	Diet 2 25% SO	Diet 3 50% SO	Diet 4 75% SO	Diet 5 100% SO	SEM
Initial body weight (g)	150.00	150.00	143.33	146.67	150.00	1.07
Final body weight (g)	881.67	855.00	873.33	850.00	748.33	31.53
Body weight gain (g)	831.67^{a}	705.00^{a}	730.00^{a}	690.00^{ab}	598.33^{b}	38.21
Daily body weight gain (g)	29.70^{a}	25.18^{a}	26.07^{a}	24.64^{ab}	21.37^{b}	1.36
Daily feed intake (g)	42.00^{ab}	49.19^{a}	42.12^{ab}	37.38^{b}	39.23^{b}	1.38
Feed conversion ratio	1.41^{a}	1.95^{b}	1.62^{ab}	1.52^{a}	1.84^{b}	0.10

^{abc}Means with different superscripts in the same row are significantly different (P<0.05)
SEM: Standard Error of Mean

Table 5: Performance of finisher broiler chicken fed red sorghum based diets supplemented with phytase

Parameter	Diet 1 Control	Diet 2 25% SO	Diet 3 50% SO	Diet 4 75% SO	Diet 5 100% SO	SEM
Initial body weight (g)	881.67	855.00	873.33	850.00	748.33	122.10
Final body weight (g)	1588.67	1801.00	1594.00	1368.00	1625.33	243.65
Body weight gain (g)	707.00^{ab}	946.00^{a}	720.67^{ab}	518.00^{b}	877.00^{a}	208.81
Daily body weight gain (g)	25.25^{ab}	33.79^{a}	30.74^{ab}	28.50^{b}	31.32^{a}	7.39
Daily feed intake (g)	67.92^{d}	102.90^{a}	80.74^{b}	60.77^{c}	74.55^{c}	15.06
Feed conversion ratio	2.69^{ab}	3.06^{c}	2.63^{ab}	2.13^{a}	2.38^{b}	0.70

^{abc}Means with different superscripts in the same row are significantly different (P<0.05)
SEM: Standard Error of Mean

Table 6: Internal organ weight of the finisher broiler chickens fed experimental diets

Parameter (%)	Diet 1 Control	Diet 2 25% SO	Diet 3 50% SO	Diet 4 75% SO	Diet 5 100% SO	SEM
Live weight (Kg)	1588.67	1801.00	1594.00	1368.00	1625.33	62.90
Dressed weight (Kg)	1383.33	1416.67	1340.00	1233.33	1333.33	34.63
dressed weight	86.67	87.00	84.33	90.00	83.00	1.09
Liver	1.49	1.43	1.60	1.46	1.43	0.05
Gizzard	1.51^{a}	1.44^{ab}	1.43^{ab}	1.48^{a}	1.09^{b}	0.06
Heart	0.44	0.35	0.40	0.35	0.37	0.01
Spleen	0.10^{a}	0.10^{a}	0.07^{c}	0.07^{b}	0.90	0.00
Abdominal fat	0.61^{a}	0.28^{b}	0.11^{b}	0.64^{a}	0.12^{b}	0.07
Small intestine	2.41^{c}	2.83^{bc}	2.94^{b}	3.52^{b}	3.17^{ab}	0.11
Large intestine	0.51^{b}	0.84^{a}	0.74^{ab}	0.72^{ab}	0.54^{b}	0.05
Proventriculus	0.17^{a}	0.14^{a}	0.08^{b}	0.06^{a}	0.14^{a}	0.01
Kidney	0.26^{b}	0.46^{ab}	0.51^{a}	0.58^{a}	0.48^{ab}	0.04
Lung	0.36^{ab}	0.28^{b}	0.42^{a}	0.40^{a}	0.40^{a}	0.02
Pancreas	0.40^{bc}	0.40^{ab}	0.53^{a}	0.43^{b}	0.35^{c}	0.02
Crop	0.33	0.30	0.26	0.30	0.26	0.01

^{abc}Means with different superscripts in the same row are significantly different (P<0.05)
SEM: Standard Error of Mean

Table 7: Cut part weight of the experimental finisher broiler chickens fed experimental/Diets

Parameter (%)	Diet 1 Control	Diet 2 25% SO	Diet 3 50% SO	Diet 4 75% SO	Diet 5 100% SO	SEM
Thigh	13.54^{b}	14.10^{a}	13.60^{b}	13.58^{b}	13.60^{b}	0.17
Drumstick	12.51^{b}	14.78^{a}	12.73^{b}	13.31^{b}	13.13^{b}	0.16
Shank	4.92	5.10	5.54	5.51	4.99	0.12
Breast muscle	22.42	21.15	23.06	21.97	24.53	0.47
Head	2.15^{b}	1.75^{c}	2.34^{ab}	2.52^{a}	1.81^{c}	0.09
Wing	8.40^{ab}	9.49^{a}	8.00^{b}	9.30^{a}	8.22^{b}	0.10
Back cut	11.34^{ab}	12.36^{a}	11.48^{ab}	10.03^{b}	10.72^{b}	0.15
Neck	6.26^{b}	6.46^{ab}	6.51^{a}	6.48^{ab}	6.48^{ab}	0.04

^{abc}Means with different superscripts in the same row are significantly different (P<0.05)
SEM: Standard Error of Mean

Table 8: Cost benefit starter broiler chicks fed experimental diets

Parameter	Diet 1 Control	Diet 2 25% SO	Diet 3 50% SO	Diet 4 75% SO	Diet 5 100% SO	SEM
Cost/Kg feed (₦)	166.82^{c}	181.58^{d}	194.72^{c}	205.86^{b}	217.00^{a}	4.72
Cost of production (₦)	241.89	357.71	327.13	317.82	412.30	20.00
Revenue (₦)	830.67^{a}	704.33^{c}	730.33^{b}	690.01^{d}	597.73^{c}	20.00
Gross margin (₦)	662.72^{a}	521.75^{c}	539.95^{b}	482.14^{d}	380.34^{c}	24.41
Return on Investment (₦)	273.98	145.86	165.06	151.70	92.25	-

^{abc}Means with different superscripts in the same row are significantly different (P<0.05).
SEM: Standard Error of Mean

Table 9: Cost benefit of finisher broiler chickens fed experimental diets

Parameter	Diet 1 Control	Diet 2 25% SO	Diet 3 50% SO	Diet 4 75% SO	Diet 5 100% SO	SEM
Cost/Kg feed (₦)	151.34^{c}	169.26^{d}	181.94^{c}	193.93^{d}	206.83^{a}	5.14
Cost of production (₦)	396.51	528.09	582.21	653.54	459.16	-
Revenue (₦)	707.06^{d}	946.11^{a}	720.41^{c}	518.04^{c}	876.80^{b}	39.82
Gross margin (₦)	554.82^{c}	776.20^{a}	538.09^{d}	323.37^{c}	670.39^{b}	40.47
Return on Investment (₦)	139.93	146.98	92.42	49.48	146.00	-

^{abc}Means with different superscripts in the same row are significantly different (P<0.05).
SEM: Standard Error of Mean