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Performance of broiler chickens fed diets containing four varieties of *Sorghum bicolor* supplemented with Maxigrain ® enzyme

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Target Audience: *Poultry farmers, Extension workers, Researchers and Crop breeders.*

Abstract

A study was carried out to evaluate the effects of feeding four varieties of Sorghum bicolor supplemented with Maxigrain ® enzyme on growth performance of broiler chickens in Kaduna state, Northern guinea Savannah of Nigeria. Five diets were formulated for the broilers at both the starter and finisher phases namely T_1 – Maize without Maxigrain ® enzyme supplementation, T_2 –Samsorg-14 supplemented with 0.01 % Maxigrain ® enzyme, T_3 –Samsorg-40 supplemented with 0.01 % Maxigrain ® enzyme, T_4 –Samsorg-17 supplemented with 0.01 % Maxigrain ® enzyme and T_5 –KSV-15 supplemented with 0.01 % Maxigrain ® enzyme in replacement for maize (T_1) on the performance of broiler chickens. Two hundred and twenty five (225), Arbor acre chicks were randomly distributed into five dietary treatment groups at five days old in a completely randomized design (CRD) with each treatment group having forty-five (45) birds per treatment and birds were allotted into three (3) replicates of 15 birds in each replicate. At the end of the feeding trial birds fed T_1 and T_4 had significantly ($P<0.05$) higher final weight and weight gain than birds in other dietary treatment groups. Birds fed T_4 had the best feed conversion ratio and feed cost/kg gain. In conclusion total replacement of Samsorg-17 (T_4) for maize (T_1) in broiler chickens' diet had no negative impact on growth performance. Therefore, Samsorg-17 supplemented with 0.01 % Maxigrain ® enzyme can be incorporated in the diets of broiler chickens at 100%.

Key words: *Broiler chickens, Sorghum varieties, Maxigrain ® enzyme, Growth performance.*

Description of Problem

Cereal grains are the major sources of energy in poultry diets in the tropics (1) and form the largest part of energy source and inclusion level in a standard poultry diet (2). Common cereals used in tropical countries include maize and guinea corn (sorghum) and to a less extent, millet and wheat (3). Sorghum is an indigenous cereal crop of Africa; it has the ability to tolerate drought, soil toxicities and extreme temperature effectively than other cereals. It is cultivated worldwide in warmer climate and can be grown on poor soil and in drier conditions than maize (3). Sorghum grain is probably the next alternative to maize in poultry feed (4) but farmers have the notion that sorghum has anti-nutritional factors such as tannin, phytic acid, oxalate and saponins which lowered the energy value (2650 kcal/kg) compared to maize (3300kcal/kg) which placed it as a constraint in poultry diets (5). Tannin content in the pericarp is one of the most important factors affecting the feeding value of sorghum grain and adversely affects its metabolizable energy and protein utilization in poultry (5).

Exogenous enzymes have been used extensively in the diets of poultry to improve productive performance and nutrient utilization (6; 7; 8). Studies showed that the use of protease and xylanase in sorghum based broiler diets have the potential to increase protein and starch digestibility (9). Maxigrain ® enzyme is a cocktail enzyme which has a

number of benefits ranging from optimizing the use of non- conventional feed ingredients, improving weight gain in broilers, improve litter quality and dropping consistency, improving feed conversion ratio (FCR), reduces levels of Di-calcium Phosphate (DCP) incorporation in the feed substantially (10). For the above reasons, the objective of this research was to determine the effect of Maxigrain ® enzyme supplementation on four sorghum varieties on the performance of broiler chickens.

Materials and Methods

Experimental site

The experiment was conducted at the Poultry Unit, Department of Animal Science Teaching and Research Farm, Ahmadu Bello University, Zaria, Kaduna State. It lies within the northern Guinea savannah zone of Nigeria on latitude $11^0$14`44 N and longitude $7^0$33'65 E at an altitude of 610 m above sea level, the climate is relatively dry, with a mean annual rainfall of 700-1400 mm (11).

Sources of sorghum

The sorghum grain used for this study were sampled from IAR crop breeding unit and were purchased from Local farmers selling IAR sorghum varieties in Giwa market while the red sorghum was purchased in Samaru market all in Kaduna State. The varieties used were:

S/N	**Colour**	**Scientific name**	**IAR name**	**Local name**
1	White sorghum	*Sorghum bicolor*	Samssorg -14	Fara fara
2	Cream sorghum	*Sorghum bicolor*	Samsorg – 40	Mori
3	Yellow sorghum	*Sorghum bicolor*	Samsorg – 17	Kaura
4	Red sorghum	*Sorghum bicolor*	KSV – 15	Jandawa

Enzyme Supplementation

Maxigrain® enzyme (a multi enzyme compound of α- amylase, β-glucanase, xylanase, cellulase, pectinase, protease, phytase and lipase) were added at a level of 10 gms (0.01 %) to the basal diet of 100 kg according to the manufacturers recommended dosage.

Experimental diet

Five diets were formulated to be iso-nitrogenous (approximately 23 % CP at starter phase and 21 % at finisher phase) and iso-caloric (approximately 2900 Kcal/kg at the starter phase and 3000 Kcal/kg at the finisher phase) in order to meet the standard requirements of broiler chickens in the tropics (12;7) which is as follows ; T_1 – Maize without Maxigrain ® enzyme supplementation, T_2 – Samsorg-14 supplemented with 0.01 % Maxigrain ® enzyme, T_3 –Samsorg-40 supplemented with 0.01 % Maxigrain ® enzyme, T_4 –Samsorg-17 supplemented with 0.01 % Maxigrain ® enzyme and T_5 – KSV-15 supplemented with 0.01 % Maxigrain ® enzyme as presented in Table 1 and 2.

Chemical analysis

The chemical composition for maize and four sorghum varieties were determined at the Biochemical Laboratory, Department of Animal Science, Ahmadu Bello University, Zaria. The analyses for each sample were done in duplicates. Moisture content was determined by subjecting the sample with known weight to drying in an oven at 100 - 102°C for 16 hrs. The loss in weight was reported as moisture content. The percentage dry matter content was obtained by subtracting the percentage moisture content from 100%. The Crude protein (CP) content was determined by the use of macro Kjeldahl procedure according to the method of A.O.A.C. 2005 (38). The percentage crude protein was calculated by

multiplying the total nitrogen by conversion factor calculated as N x 6.25. The Ash content was determined as the residue remaining after incinerating the sample at 600 ^{0}C for 3 hours in a muffle furnace. The A.O.A.C. 2005 (13) methods were employed for the Ether Extract (EE) and crude fibre was determined as loss of ignition of dried lipid-free residues after digestion with 1.25% or 0.255 N H_2SO_4 and 1.25% or 0.313 NaOH 10 ml of acetone was added to dissolve any organic constituent. Nitrogen-free extract (% carbohydrate) was determined by subtracting sum of (moisture % + % crude fat + % crude protein + % ash) from 100. The metabolizable energy was estimated for diets containing sorghum and maize, based on the proximate composition equation outlined by (14),

ME (kcal/kg) = (35.0 x % CP) + (81.8 x % EE) + (35.5 x % NFE).

Table1: Composition of the experimental broiler starter diets supplemented with Maxigrain ® enzyme (0-4 weeks)

Ingredients (%)	**Dietary Treatments**				
	T_1 (Control)	**T_2 (Samsorg-14)**	**T_3 (Samsorg-40)**	**T_4 (Samsorg-17)**	**T_5 (KSV-15)**
Maize	51.00	0.00	0.00	0.00	0.00
Sorghum	0.00	51.00	51.00	51.00	51.00
Palm oil	2.00	2.00	2.00	2.00	2.00
Soyabeans cake	15.60	15.60	15.60	15.60	15.60
Groundnut cake	27.00	27.00	27.00	27.00	27.00
Limestone	0.50	0.50	0.50	0.50	0.50
Bone meal	3.00	3.00	3.00	3.00	3.00
Common salt	0.25	0.25	0.25	0.25	0.25
Vitamin premix*	0.30	0.30	0.30	0.30	0.30
Synthetic lysine	0.20	0.20	0.20	0.20	0.20
Synthetic methionine	0.15	0.15	0.15	0.15	0.15
Total	100	100	100	100	100
Calculated analysis					
Maxigrain® enzyme	0.00	0.01	0.01	0.01	0.01
ME (Kcal/kg)	2981	2952	2941	2989	2935
Crude protein (%)	23.05	23.17	23.49	23.36	23.57
Ether extract (%)	5.83	5.46	5.60	5.27	6.03
Crude fibre (%)	4.03	4.81	3.98	3.98	5.37
Calcium (%)	1.19	1.18	1.18	1.18	1.18
Available phosphorus (%)	0.58	0.59	0.59	0.59	0.59
Lysine (%)	1.20	1.25	1.24	1.26	1.24
Methionine (%)	0.50	0.48	0.48	0.48	0.48
Methionine + cysteine (%)	0.83	0.83	0.87	0.86	0.91
[1]Cost/kg feed (₦)	78.76	76.26	76.26	76.26	89.01

* Biomix broiler starter premix supplied the following per kg diet: Vit. A, 1,000 I.U; Vit. D_3, 2000 I.U, Vit. E, 5.0mg; Vit. K, 2mg; Vit. $B_1$1.8mg; VitB_2, 5.5mg; Niacin, 27.5mg; Pantothenic acid, 0.5mg Vit.B_6, 0.30mg; Vit. B_{12}, 0.015mg; Folic acid, 0.75mg; Biotin 0.6mg; Choline Chloride,3000mg; Copper,3mg; Iodine, 1mg; Iron,20 mg; Manganese, 40mg; Selenium,0.2mg; Zinc,30mg; Antioxidant, 1.25mg, ME= Metabolizable Energy.
[1]Based on unit price of ingredients in January 2015

Table 2: Composition of the experimental broiler finisher diets supplemented with Maxigrain ® Enzyme (4 - 8weeks)

Ingredients (%)	**Dietary Treatments**				
	T_1 (Control)	**T_2 (Samsorg-14)**	**T_3 (Samsorg-40)**	**T_4 (Samsorg-17)**	**T_5 (KSV-15)**
Maize	57.00	0.00	0.00	0.00	0.00
Sorghum	0.00	57.00	57.00	57.00	57.00
Palm oil	3.00	3.00	3.00	3.00	3.00
Soyabeans cake	15.00	15.00	15.00	15.00	15.00
Groundnut cake	20.60	20.60	20.60	20.60	20.60
Limestone	0.50	0.50	0.50	0.50	0.50
Bone meal	3.00	3.00	3.00	3.00	3.00
Common salt	0.25	0.25	0.25	0.25	0.25
Vitamin premix*	0.30	0.30	0.30	0.30	0.30
Synthetic lysine	0.20	0.20	0.20	0.20	0.20
Synthetic methionine	0.15	0.15	0.15	0.15	0.15
Total	100	100	100	100	100
Calculated analysis					
Maxigrain® enzyme	0.00	0.01	0.01	0.01	0.01
ME (Kcal/kg)	3085	3063	3051	3096	3044
Crude protein (%)	20.58	20.72	21.20	20.92	21.39
Ether extract (%)	6.47	6.07	6.22	5.84	5.96
Crude fibre (%)	3.28	3.23	3.57	3.23	3.51
Calcium (%)	1.18	1.17	1.17	1.17	1.17
Available phosphorus (%)	0.57	0.58	0.58	0.58	0.59
Lysine (%)	1.09	1.15	1.14	1.16	1.14
Methionine (%)	0.46	0.46	0.46	0.46	0.48
Methionine + cysteine (%)	0.76	0.76	0.80	0.81	0.86
[1]Cost/kg feed (₦)	75.86	73.06	73.06	73.06	87.31

* Biomix broiler finisher premix supplied the following per kg diet: Vit. A, 10,000 I.U; Vit. D_3, 2000I.U; Vit. E, 23mg; Vit.K, 2mg; Vit.B_1, 1.80mg; Vit.B_2, 0.0mg; Niacin, 5.5mg; Pantothenic acid, 7.5mg ; Vit.B_6, 3.0mg; Vit. B $_{12}$, 0.015mg; Folic acid, 7.5mg; Biotin, 0.06mg; Choline Chloride, 300mg; Cobalt, 0.2mg; Copper, 3mg; Iodine, 1mg; Iron, 20mg; Manganese, 40mg; Selenium, 0.2mg; Zinc, 30 mg; Antioxidant, 1.25mg, ME = Metabolizable Energy.

[1]Based on unit price of ingredients in January 2015

Experimental design and management of experimental birds

At the starter phase two hundred and twenty five (225) day old broiler chicks of mixed sexes were used for this study and were given an adjustment period of four days and were fed a common diet before allotting them into treatment groups at day five (5). Birds were weighed at arrival and at the beginning of the experiment and allotted into five different dietary treatments in a completely randomized design (CRD). The birds were housed in deep litter pens; each treatment group had a total number of forty five (45) birds in three replicates of 15 birds per pen. Routine vaccination and medications were given as at when due while feed and water were provided ad- libitum. The study lasted for eight weeks

and mortality was recorded as it occurred and calculated in percentages.

Data collection

Growth parameters were measured and calculated, these included final body weight, daily weight gain, daily feed intake, feed to gain ratio and feed cost per kg gain. Broilers were weighed at the beginning of the experiment and weekly thereafter, feed and water was provided *ad libitum* daily. Left over feed was weighed and subtracted from the total feed supplied for the week to obtain feed intake per week while mortality was recorded as it occurred and calculated in percentages. The study lasted for four weeks at the starter phase and four weeks for the finisher phase (5 - 8weeks) that is the number of birds left from the starter phase were used for the finisher phase, growth parameters were measured and calculated as indicated in the starter phase.

Birds were replicated thrice for all the five treatments for this study, routine management practices and medications were carried out appropriately.

Statistical Analysis

All data obtained from the study were subjected to analysis of variance (ANOVA) using general linear model procedure of SAS 2008 (15). Significant levels of differences among treatment means were determined using the Tukey`s test (16) to separate the means.

The statistical model for the experiment was as follows:-

$$X_{ij} = \mu + t_i + e_{ij}$$

where X_{ij} = any observation made in the experiment

μ = the population mean

t_i = effect due to treatment added or treatment effect

e_{ij} = ramdom error

Results and discussion

Chemical composition of maize and four varieties of raw and processed S*orghum bicolor*

The results for the chemical analysis of maize and four varieties of sorghum are presented in Table 3.

Table 3: Chemical composition of maize and four varieties of *Sorghum bicolor* grains

Parameter	ME	%						
	(Kcal/kg)	DM	CP	CF	EE	ASH	NFE	Moisture
Maize (white)	3470.60	94.22	8.78	2.68	4.00	4.65	79.89	5.78
Raw Samsorg-14	3412.69	92.52	9.14	3.87	3.29	4.66	79.54	7.48
Raw Samsorg-40	3391.31	91.66	10.16	3.84	3.56	5.37	77.31	8.34
Raw Samsorg-17	3486.15	93.66	9.49	2.56	4.06	4.00	79.49	6.34
Raw KSV-15	3379.39	91.39	10.50	3.91	3.11	4.42	78.06	8.61

The result for the metabolizable energy of maize 3470.60 kcal/kg is within the range of 3432, 2617- 3516 and 3451.18 kcal/kg as reported by (17; 18; 19), respectively, but lower than 3510 kcal/kg reported by (3) the reason could be due to varietal difference, soil, environmental and storage conditions in which maize was raised which could affect the gross energy and metabolizable energy values (4).

The dry matter content of maize was 94.22 % which was higher than 91.80 and 90.10 % the reported by (29; 1) respectively but similar to the value of 94.10 % reported by Ibe (19).

The crude protein content of maize was 8.78 % which was similar to the reports of 8.8 % by (7) and slightly lower than values of 8.6 % reported by (19). Although, the crude protein content reported from the various authors

above were all within the range of 8 - 9 % crude protein as reported by (17).

The maize crude fibre value obtained in this study was 2.68 % which was similar to the reports of (17; 18) but differ from the findings of (3) and (19) they reported 2.1 and 3.2 % respectively. The ether extract value was 4.00 % was similar to the findings of (17; 3) but was lower than 3.6 and 3.82 % reported by (21; 19), respectively. The ash content of 4.65 % was higher than the values (1.3, 1.5 and 1 %) reported by (17; 21; 3), respectively.

The nitrogen free extract of 79.89 % for maize was higher than the values of 75.80 and 80.6 % reported by (3; 19), respectively. The differences observed in the values of the proximate composition varied which could be as a result of the variety of maize used, soil nutrients and storage conditions (4).

The metabolizable energy for four sorghum varieties unprocessed ranged from 3379 – 3486 kcal/kg which agreed with the findings of (24) that sorghum had a metabolizable energy range of 2617 to 3516 kcal/kg and (19) who reported 3379 – 3401 kcal/ kg) for yellow and white sorghum varieties.

The dry matter content for the four sorghum varieties ranged from 91.39 - 93.66 % which agreed with the findings of (20;3;19) and (7) for yellow sorghum (Kaura) and although the value was higher than 88.940 % as reported by (22) for brown coloured sorghum.

The crude protein results for the four sorghum varieties ranged from 9.14 – 10.80 %. The result supported the reports of (3;4;19) for white and yellow sorghum and (7) reported a range value of 8.53 to 9.27 % CP for yellow and red sorghum.

The crude fibre for the four varieties of *Sorghum bicolor* ranged from 2.56 % - 3.91 %, the results supported the findings of (3;4) while (19) reported 2.70 %, the value fell within the range obtained in this study despite the varietal differences. Higher values of crude fibre was reported ranging from 4.69 - 4.78 % and 3.47 - 4.71 %, respectively (19; 7). The ether extract values for the four varieties of sorghum ranged from 3.11% - 4.06 %. the results obtained for ether extract agreed with the reports of (24) that ether extract for sorghum ranges from 3.19 % - 3.82 % but the result did not conform with the reports of (8; 2) who reported that ether extract has a value of 2.50 and 2.55 % respectively.

The ash content for four sorghum varieties ranged from 4.00 – 5.37 % which was higher than the reports of (8; 34) these authors gave the values of (1.31 – 1.46 %) for yellow and red sorghum and (24) reported (1.86 – 1.89 %) for white and yellow sorghum.

The nitrogen free extract (NFE) for the four sorghum varieties ranged from 77.31 % - 79.54 %. These values were within the values reported by (3; 4; 19) for NFE in sorghum.

The variation in some of the chemical values of *Sorghum bicolor* from other authors could be due to environment, soil and variety as reported by (30; 3; 4).

The result confirmed the report by (12; 3) that sorghum had lower metabolizable energy, lower ether extract but higher crude protein than maize. The percentage recorded for crude protein and crude fibre in sorghum is in agreement with the reports by (17) that sorghum grains are higher in crude protein and crude fibre content than maize, The percent dry matter (DM), ether extract and nitrogen free extract (NFE) were higher in maize, this may be responsible for the higher value of ME (kcal/kg) in maize compared to the values recorded for raw sorghum as reported by (19).

The effects of feeding four varieties of S*orghum bicolor* supplemented with 0.01 % Maxigrain ®enzyme on the growth performance of broiler chickens is presented in Table 4.

The results showed significant ($P < 0.05$) differences in terms of final weight, daily

weight gain, daily feed intake, feed conversion ratio, cost/kg gain and mortality. Birds fed T_4 performed significantly ($P > 0.05$) better than the other sorghum based diets in terms of final weight (3038.5 g), daily weight gain (52.43 g), feed conversion ratio (2.28) and daily feed intake (119.75 g). However, these performance was similar ($P>0.05$) with birds fed T_1 (2987.20; 51.52 g; 2.37; 121.57 g) respectively.

Table 4: Performance of broiler chickens fed four varieties of S*orghum bicolor* supplemented with Maxigrain ® enzyme (5 days - 8weeks)

	Treatments					
Parameters	T1	T2	T3	T4	T5	SEM
Initial weight (g / bird)	102.20	102.20	102.20	102.20	102.20	0
Final weight (g / bird)	2987.20 [a]	2613.20 [b]	2142.20 [c]	3038.5[a]	2170.90 [c]	134.74
Average daily weight gain (g /bird)	51.52 [a]	44.84 [b]	36..43[c]	52.43 [a]	36.94[c]	2.41
Average daily feed intake (g / bird)	121.57 [a]	109.92[b]	98.25[c]	119.75 [a]	96.95 [c]	3.31
Feed conversion ratio	2.37[a]	2.45[a]	2.70[b]	2.28[a]	2.62[b]	0.12
Feed cost / kg gain (₦)	182.63 [a]	182.92[a]	201.58[a]	170.22 [a]	230.98[b]	16.63
Mortality (%)	13.33	15.54	17.78	13.33	17.78	2.44

[a,b,c..] Means on the same row with different superscripts are significantly ($P < 0.05$) different.
SEM = Standard error of means
T1- Control (0% sorghum supplemented with 0% Maxigrain ® enzyme), T2- Samsorg- 14 with 0.01g/kg Maxigrain ® enzyme, T3- Samsorg-40 supplemented with 0.01g/kg Maxigrain ® enzyme, T4- Samsorg -17 supplemented with 0.01g/kg Maxigrain ® enzyme, T5- KSV-15supplemented with 0.01g/kg Maxigrain ® enzyme.

The results are in agreement with the reports by (23; 24) that poorly digestible protein present in sorghum decreased feed intake and body weight gain. It also indicated that the multiple enzyme was not efficient in digesting the protein (Kafirins and tannin) present in the sorghum affecting the growth parameters measured.

Birds fed maize diet (T_1) and Samsorg-17 supplemented with 0.01 % Maxigrain® enzyme (T_4) had similar feed intake and were higher than birds fed other dietary treatments containing sorghum supplemented with 0.01 % Maxigrain ® enzyme , result was in agreement with the reports of (25; 26; 27; 28) that no significant ($P > 0.05$) differences were obtained in the feed intake of birds fed sorghum diets supplemented with multi-enzymes compared with those fed maize diet without enzyme supplementation as feed intake was improved. Higher feed intake observed by birds fed T_4 did not support the findings by (29; 34) that feeding sorghum diets supplemented with enzymes decreased feed intake, the reason could be due to varietal differences. The result also supported the findings by (30; 27; 23; 34) that multi-enzymes containing xylanase, phytase and protease reduced the negative effect of anti-nutritional factors in sorghum, thus enhancing feed intake, nutrient digestibility and bird performance as it is in birds fed T_4. Supplementation with 0.01% Maxigrain ® enzyme on the other three varieties of sorghum was not effective on feed intake, this might be as a result of high anti-nutritional factors present in the grains such as tannin and oxalate which the enzyme could not handle effectively due to the absence of

tannase and oxalase in the multi-enzyme. Maxigrain ® enzyme contained the following composition α- amylase, β-glucanase, xylanase, cellulase, pectinase, protease, phytase and lipase (10) which tannase and oxalase are not the target substrate. The reports goes in line with my earlier study that raw KSV-15 had the highest levels of phytic acid, tannin and saponin and was significantly ($P < 0.05$) different followed by Samsorg-14 and Samsorg-40 while the least anti- nutritional factors was observed with birds fed Samsorg - 17 (31) this could have affected the performance of birds T_3 and T_5.

The feed conversion ratio was best in birds in T_1, T_2, and T_4 Supplemented with multi-enzymes were not significantly ($P>0.05$) different from each other which is in agreement with the findings by (32;33;27;34;7) that enzymes improved feed conversion ratio of birds fed sorghum diet supplemented with exogenous enzymes. In addition, the result is in agreement with the findings by (29) that feeding sorghum diets supplemented with enzymes decreased feed intake and improved feed conversion ratio when compared with birds fed maize diets without enzyme supplementation. This result proved that a lower feed conversion ratio is an important parameter to the sustainability of the chicken meat industry as reported by (37; 36).

Birds in T_3 and T_5 performed poorly in most of the growth parameters such as final weight (2142.20 g; 2170.90 g), daily weight gain (36.43 g; 36.94 g), feed conversion ratio (2.70; 2.62) and had 5he lowest feed intake (98.25 g ; 96.95g) this result is in agreement with the findings by (37) that the composition and availability of nutrients in sorghum varieties are variable especially protein content and digestibility and these factors affect performance.

It was observed that the multi-enzyme used in this study was not effective in T_3 and T_5 which might had been due to high levels of anti-nutritional factors such as polyphenols, phytate, oxalate and kafirins present in the sorghum grains (25). High tannin sorghum are difficult to access by digestive proteases as reported by (38; 27) because of the presence of γ-kafirins. Birds fed on sorghum diets which had poor feed conversion ratio and weight gain indicated that high tannin depressed feed intake as a result of poor digestibility of protein which resulted in poor weight gain (39). The feed conversion also affected the feed cost /kg in a similar trend which affected the performance of birds fed the different dietary treatments.

In the present study, birds fed T_4 (Samsorg-17 supplemented with 0.01 % Maxigrain ® enzyme) reduced the cost of production per bird by 6.79 % (₦12.41k) compared to the control group. This will result in substantial savings and more income generation to the farmer.

The mortality percentage showed no significantly ($P > 0.05$) differences across the dietary treatments. The results agreed with the reports by (7,34) that birds fed sorghum diets supplemented with enzymes were not significant different from birds fed maize diets in terms of percentage mortality. The post mortem result for the mortality observed in birds fed the different dietary treatments showed that it had nothing to do with the diet.

Reports have it that enzymes decreased viscosity and sticky excreta which improved litter condition and reduced mortality (40). Mortality percentage was similar in percentage value for all treatment groups this is similar to the report by (40) that multi-enzyme complex supplemented in broiler diets decreased viscosity and sticky excreta which improved litter condition and reduced mortality, without compromising the health of broiler chickens.

Conclusion and Applications

1. The replacement of Samsorg-17 at 100 % supplemented with Maxigrain ® enzyme at

0.01% for maize as an energy source did not compromise the growth performance of broiler chicks.

2. The cost of production for feeding broiler chickens diet containing Samsorg-17 supplemented with Maxigrain ® enzyme at 0.01% at 100 % replacement was reduced by 6.79 % (₦170.22k) compared to the maize based diet (₦ 182.63k).
3. Poultry farmers are advised to use Samsorg-17(Kaura) supplemented with Maxigrain ® enzyme at 0.01% in replacing maize as the chief energy source during scarcity and hike in price during off seasons, because it is low in anti-nutritional factors such tannin, phytic acid, saponins and oxalate and can be used as a substitute.
4. Feed industries should produce effective multi enzymes that can unlock high tannin sorghum grains in order to improve the nutrient value and availability of sorghum grains in poultry feeds.

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