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Research Article
Physiological Implications of Broiler Chickens Diet Fortified with Tiger Nuts (*Cyperus esculentus*)

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Abstract

Background and Objective: The quest to ameliorate protein food shortages have continuously made researchers to seek alternative sources of feed stuff that will be cheaper and less competitive with man. Tiger-nut is the richest tuber in terms of protein. It is rich in vitamins and minerals. Using it in the diet of broiler birds in two growth phases (starter and finisher) promoted growth. This study was conducted to investigate the effect of tiger nut on the growth performance of broiler chicken. **Materials and Methods:** A total of eighty four broilers were used for the study. The birds were randomly assigned to four treatment groups with a total of 21 birds per treatment. The treatments were T_1 (0%) T_2 (5%) T_3 (10%) and T_4 (15%). T_1 served as the control. The treatments were replicated 3 times with 7 broiler birds per replicate. **Results:** Weight gain was significantly ($p<0.05$) higher among the tiger-nut fortified groups, with T_3 (5520 g) gaining the highest weight. Feed intake increased significantly ($p<0.05$) with increase in the quantity of tiger nuts. Feed efficiency was lower among the tiger nut fortified groups with T_2 (2.98) diet having the most efficient diet. Weight of prime cut parts like the back cut, breast muscle and paired wings were significantly higher among the tiger-nut fortified groups when compared with the control. The mean cell haemoglobin (MCH), mean cell volume (MCV) and white blood cells differed significantly among the treatment group in both the starter and finisher stage. **Conclusion:** The study showed that there were improvement in the growth rate of broilers fed tiger nut, this was witnessed in the weight of cut part of the broiler birds. The haematology was not affected by tiger-nut fortification. Therefore, increase in body weight gain and best feed efficiency was observed in T_2 (5%) that was the best level for maize replacement with tiger nuts.

Key words: Tiger nut, broiler chicken, growth performance, haematology, protein, poultry feed

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The problem of high price of conventional feed stuffs and stiff competition between man and industry has been a major concern in recent times among poultry farmers. The effects of these challenges have reflected on quality and quantity of animal protein available for human consumption[1]. To overcome these challenges, attention of animal nutritionist have been focused on the utilization of unconventional feed stuff that are readily available without stiff competition with humans and agro-allied industries such as tiger nuts[2].

Tiger-nuts (*Cyperus esculentus*) is a non-conventional feed stuff belonging to the family of *Cyperaceae*, is cultivated in Nigeria mainly for its rich vegetable milk as substitute for cow milk[3]. It is rich in Omega -3-fatty acids[4], crude protein (9%) and metabolizable energy (2700 kcal kg^{-1})[5], as well as minerals (potassium and phosphorus) and vitamins E and C[6]. Tiger nut is high in fiber and essential amino acids[7]. According to El-Shenawy *et al.*[8] its starchy content presumably provides prebiotic properties to colon bacteria in livestock. The milk has been found to be good in preventing arteriosclerosis[9]. Owing to these unique characteristics of tiger nuts, using it as a substitute for maize in the broiler chickens diets may improve the growth rate and blood statues. The objective of this study was to investigate the effect of tiger nut on the growth performance of broiler chicken.

MATERIALS AND METHODS

Experimental procedures: This research was carried out at the Teaching and Research Farm of Federal College of Agriculture, Ishiagu in Ivo Local Government Area of Ebonyi State, Nigeria 05°56[1] North and 07°31[1]E.

Eighty four (84) day old SAYED broiler chicks were assigned to four treatment groups, using the completely randomized design (CRD). The treatments were: Treatment one (T_1) no tiger nuts as control, treatment two (T_2) had 5% tiger nut, treatment three (T_3) had 10% tiger nut and treatment four (T_4) had 15% tiger nut inclusion level to replace maize. There were 21 birds per treatment group with 7 birds per replicate. Each treatment was replicated 3 times. The experiment lasted for 12 weeks.

The composition of experimental diet varied among the treatment groups as T_1 (19.62% CP and 2914.9 kcal kg^{-1}) T_2 (19.50% and 2906.2 kcal kg^{-1}) T_3 (19.50% CP and 2857.5 kcal kg^{-1}) and T_4 (19.40% CP and 2808.8 kcal kg^{-1}). The broiler birds were accommodated using an open space poultry house with demarcations between individual pens which served as the replicates.

Wood shaving was used as litter material. Feed and water were provided *ad-libitum* throughout the experimental period. The feeding of the birds was divided into starter phase (0-4 weeks) and the finisher phase (4-8 weeks). Data was collected on growth performance parameters which include initial weight, final body weight, daily weight gain, daily feed intake and feed efficiency. The weights were taken with electronic weighting balance. Blood samples were analyzed within one hour of collection. The haemoglobin (Hb) levels was determined using spectrophotometer (Environmental Scientific Instrument Co. Panchkula, Haryana, India) by diluting whole blood (1 mL in 20 L) in a modified Drabkin's solution, (Diagnostic Reagent Ltd Thame, Oxon UK) which contains potassium cyanide. This was converted by the cyanide to a stable HCN, which was absorbed at 540 nm, using the cyanmethemoglobin method. The packed cell volume (PCV) was determined using microhematocrit (Jouan S. A. Cedex, France) method as described by Saleh *et al.*[10]. The white blood cells (WBC) were estimated using the haemocytometer (Paul Marienfeld, Lauda-Konigshofen, Germany) as described by Saleh *et al.*[10]. The mean corpuscular volume, (MCV) (PCV÷RBC×10), mean corpuscular hemoglobin concentration MCHC (Hb÷PCV) ×100) were calculated from the Hb, PCV and RBC.

Statistical analysis: Data were analyzed using one way ANOVA[11]. Dietary treatments (T_1, T_2, T_3, T_4) were used as independent variables, while all data obtained on growth performance, haematology, carcass weight were regarded as dependent variables. Duncan HSD test was used for testing difference of means. The treatment effect was considered significant if p-values were less than 0.05.

RESULTS AND DISCUSSION

Table 1 shows the growth performance of broiler birds fed different levels of tiger-nut at starter phase. There were significant differences ($p<0.05$) in all the parameters measured. The fortification of feed with tiger nuts brought about significant increase ($p<0.05$) in the body weight. The increase in T_2 and T_3 having the highest. This shows that beyond (T_3) there may not be appreciable weight gain. The weight gained by birds fed diet 4 (15% inclusion of tiger-nut) was significantly ($p<0.05$) lower than that of birds fed diet 3 (10% tiger-nut).

The quantity of daily feed intake was higher among the tiger nut fortified group when compared with the control. T_4 group consumed the highest quantity of feed; this could be due to the low energy in the diet and the birds may consumed

Table 1: Growth performance characteristics of broiler starter fed different levels of tiger-nut meal

Parameters	T_1	T_2	T_3	T_4	SEM
Initial weight (g)	383.00^{d}	440.00^{b}	413.00^{c}	487.00^{a}	82.73
Final weight (g)	1033.00^{c}	1750.00^{a}	1750.00^{a}	1633.00^{b}	1.73
Total weight gain (g)	650.00^{d}	1310.00^{b}	1337.00^{a}	1146.00^{c}	1.41
Daily weight gain (g)	162.50^{c}	327.50^{ab}	345.00^{a}	311.75^{b}	256.25
Daily feed intake (g)	513.60^{b}	557.90^{c}	585.00^{b}	604.60^{a}	5.77
Feed efficiency ratio	5.53^{a}	2.98^{c}	3.97^{b}	3.39^{bc}	0.97

Means with different superscripts in the same row differ significantly ($p<0.05$)

Table 2: Carcass characteristics of broiler finisher fed different levels of tiger-nut meal

Parameters	T_1	T_2	T_3	T_4	SEM
Live weight (g)	2350.00	2100.00	2150.00	2400.00	0.06
Dressed carcass weight (g)	1750.00	1060.00	1750.00	1800.00	0.06
Dressed percentage (%)	74.60	75.60	81.60	74.90	1.41
Cut parts					
Drum stick (g)	190.00	290.00	360.00	530.00	0.05
Thigh muscle (g)	200.00	260.00	330.00	420.00	0.03
Breast muscle (g)	360.00^{b}	490.00^{a}	397.00^{b}	339.00^{bc}	0.97
Paired wings (g)	700.00^{b}	800.00^{a}	700.00^{a}	900.00^{a}	0.01
Back cut (g)	280.00^{b}	390.00^{a}	370.00^{a}	580.00^{a}	0.04

Means with different superscripts in the same row differ significantly ($p<0.05$)

Table 3: Haematological parameters of broiler starter fed different levels of tiger-nut meal

Parameters	T_1	T_2	T_3	T_4	SEM
Packed cell volume (%)	24.70	29.30	27.70	31.30	0.050
Haemoglobin (g dL^{-1})	13.07^{a}	11.87^{b}	8.30^{bc}	9.60^{c}	0.340
Red blood cell ($\times 10^6$ mm^3)	4.13	4.16	4.29	4.39	0.180
Mean cell haemoglobin conc. (%)	33.24	33.18	33.25	33.18	3.180
Mean cell haemoglobin (pg)	19.26^{b}	24.30^{a}	21.39^{b}	22.12^{ab}	0.740
Mean cell volume (fl)	59.75^{b}	73.23^{a}	64.35^{b}	66.64^{b}	0.150
White blood cell ($\times 10^3$ mm^3)	9.33^{a}	7.73^{c}	8.53^{b}	9.33^{a}	0.001

Means with different superscripts in the same row differ significantly ($p<0.05$)

more to meet the required energy level. This result confirms the results of the studies conducted by Lesson *et al.*[12] and Rosa *et al.*[13] who stated that feed intake increase linearly with decrease in dietary energy level. The feed efficiency was the highest in T_1 and the lowest in T_2. Feed efficiency is a measure of the ratio of the output (weight gain) when compared with input (feed). This confirmed that broiler feed fortified with tiger-nut gave the best result at 5% replacement level with maize when fed with the aim of gaining weight.

Table 2 shows the mean values of carcass characteristics of broiler birds fed different levels of tiger-nut meal at finisher phase. It indicates that there were significant differences ($p<0.05$) in breast muscles, the paired wings and back cuts which are prime cut parts, whereas mean live weight, dressed carcass weight, dressing percentage, drum stick and thigh muscles showed non-significant difference ($p>0.05$). These differences were notably higher among the tiger nut fortified groups. Therefore one can infer that feed fortification improved cut part weight even at 15% (T_4) replacement level. Table 3 shows that dietary treatments at starter phase had significant ($p<0.05$) influence on haemoglobin (Hb), mean cell haemoglobin (MCH), mean cell volume (MCV) and white blood cell (WBC), while the packed cell volume (PCV) and red blood cell (RBC) did not differ significantly ($p>0.05$). The result obtained for packed cell volume (PCV) was within the normal range (25-45%) as reported by Banerjee[14]. The PCV values for the tiger-nut fortified group was also in line with Ademola *et al.*[15] who used garlic, ginger and their mixtures in broilers diet. Therefore, the birds could be satisfactory healthy not anemic with these PCV values. The haemoglobin which is the iron containing the oxygen-transport metallo-protein in the red blood cells differed significantly among the birds. The values were lower among the tiger-nut fortified group. These lower values become more predominant as the level of tiger-nut increases but were still within the reported normal Hb range for chicken[16].

The RBC level which did not differ significantly but was high alongside the Hb is an indication of an efficient oxygen and carbon dioxide transportation within the animal body. An increase in the PCV, RBC shows more efficient erythropoiesis in the animal[17].

The MCH and RBC though differed significantly did not show any pattern that could be attributed to the effect of

Table 4: Haematological parameters of broiler finisher fed different level of tiger-nut meal

Parameters	T_1	T_2	T_3	T_4	SEM
Packed cell volume (%)	32.00	33.70	30.30	24.70	0.82
Haemoglobin (g dL^{-1})	10.70	11.30	10.10	11.00	1.09
Red blood cell ($\times 10^6$ mm^3)	3.75^a	4.57^a	3.28^b	3.86^a	1.17
Mean cell haemoglobin conc. (%)	33.60	33.70	33.50	33.80	1.00
Mean cell haemoglobin (pg)	28.60^a	25.60^b	30.70^b	28.70^a	0.92
Mean cell volume (fl)	85.40^a	76.20^b	91.60^a	84.80^a	0.92
White blood cell ($\times 10^3$ mm^3)	10.20	9.130	10.60	12.10	1.12

Means with different superscripts in the same row differ significantly ($p<0.05$)

tiger-nut. These MCV, MCH and MCHC are vital parameters used to ascertain anaemic conditions in experimental animals[10].

Table 4 shows the haematological parameters of broiler finisher fed different level of tiger-nut meal. The mean values of red blood cell (RBC), mean cell haemoglobin (MCH) and MCV differed significantly ($p<0.05$) among the treatment groups, whereas, packed cell volume (PCV), haemoglobin (Hb), mean cell haemoglobin concentration (MCHC) and white blood cell (WBC) did not differ ($p>0.05$). These variations did not show a definite pattern that could be attributed to the effect of fortification with tiger-nut. Similar results were reported by Alagbe[17]. Further studies are needed to evaluate the histology of the organs (liver and kidney) to check if there are detrimental effect of these tiger-nut on the broiler chicken.

CONCLUSION

The use of tiger-nut in the diets of broiler chicken did not have any harmful effect that could be attributed to its use on the haematology of the broilers. The result was best in terms of feed efficiency and weight gain at 5% fortification level. Therefore for better yield, tiger-nut can be used to replace maize at 5% inclusion level for both the starter and finisher broiler birds.

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