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Responses of Broiler Finisher Birds Fed Diets Containing Sweet Potato (*Ipomoea batata*) Root Meal

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Authors' contributions

This work was carried out in collaboration between all authors. Author PCJ designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors ED and MUO reviewed the experimental design and all drafts of the manuscript and the literature search. Authors SOO and VRU managed the analyses of the study and performed the statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

A twenty eight day feeding trial was conducted to evaluate the replacement value of sweet potato root meal (SPRM) as replacement for maize on feed intake, body weight changes, carcass and organ weight characteristics of broiler finisher birds. SPRM was processed and used to replace maize at 0%, 10%, 20% and 30% dietary levels, represented as T1, T2, T3 and T4 respectively. Two hundred and forty (240) four weeks old Anak chicks were randomly divided into four experimental groups with three replicates of twenty birds per replicate were assigned the four diets in a completely randomized design. Data collected showed significant ($p<0.05$) differences in feed intake, body weight changes and feed conversion ratio. T2 animals produced the best performance, while T4 had the least values. Drumstick, back, neck, shanks, gizzard/proventriculus, heart and

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kidney of the experimental birds were similar (P>0.05) among the treatments. The dressed weight, dressing percentage, weights of the thigh, wings, breast muscle, and liver of the birds diets differed (p<0.05) significantly with T2 animals showing superiority over the animals on the other diets. This experiment revealed that sweet potato root meal can best replacement maize in diets of finisher broiler at 10% dietary level and should be recommended for broiler finisher production.

Keywords: Broilers; sweet potato; alternative energy source; carcass and organ indices; performance.

1. INTRODUCTION

Broiler production is one of the fastest means of providing animal protein in developing countries like Nigeria due to its short generation interval, rapid weight gain and efficient feed utilization. The meat is rich in proteins, phosphorus, minerals, B-complex vitamins and less fat than most cuts of beef and pork [1]. Poultry liver is especially rich in vitamin A. The meat also has higher proportion of unsaturated fatty acids than saturated fatty acids hence suggesting that poultry meat may be a more healthful alternative to red meat. In Nigeria, the meat is widely consumed with no religious taboo or social constrain.

However, this class of animal with great potentials in ameliorating animal protein malnourishment in the developing countries is faced with serious challenges. According to [2] feeds have become very expensive resulting in decrease of livestock production. This may be attributed to the scarcity and high cost of energy sources, especially maize. Maize is one of the most expensive feedstuff with a unit cost of ^150 per kg and constituting about 35 - 60% of poultry feeds. Consequent upon this, research efforts are directed towards the use of cheaper, readily available feed resources that can possibly substitute conventional feed resources such as maize, which is mostly used as the major energy source in poultry feeds. Roots and tubers readily provide these alternatives.

Sweet potato belongs to the family *Convolvulaceae*, Genus *Ipomoea*, section *Batatas*. Sweet potato is generally considered a high-energy food and is the staple crop of many parts of the world [3]. The carbohydrates contained in sweet potato are highly available and can be greatly utilized by non-ruminant animals [4]. The dark orange flesh varieties of sweet potato are very rich in vitamin A and their increased cultivation is encouraged, to alleviate vitamin A deficiency in most African countries. Vitamin A is a fat-soluble vitamin and considered as an essential nutrient for normal growth and development of an organism [5]; thus corroborates the health benefit of sweet potato root meal for both the birds and man who consumes the meat. Sweet potato is widely cultivated and well consumed in south eastern part of the country. The cost of cultivation and production of sweet potato is lower compared to maize; thereby making the crop a cheaper alternative to maize. This study was therefore carried out to evaluate the growth performance, carcass and organ characteristics of broiler finishers fed sweet potato (*Ipomoea batata*) root meal (SPRM).

2. MATERIALS AND METHODS

2.1 Location of the Experiment

The research work was carried out at the poultry unit of Federal College of Agriculture, Ishiagu, Ivo Local Government Area, Ebonyi State, Nigeria. The College is located at about three kilometers (3 km) away from Ishiagu main town. The College is situated at latitude 5.56°N and longitude 7.31°E, with an average rainfall of 1653 mm and a prevailing temperature condition of 28.50°C and relative humidity of about 80%.

2.2 Sourcing and Processing of Experimental Material

Clean and uncontaminated raw sweet potato roots were sourced from National Root Crop Research Institute, Umudike, Ikwuano local government area, Abia State at the rate of ^500 for a jut bag. The roots were washed, weighed and chopped using kitchen knife. They were boiled at a 100°C temperature for 15 minutes using charcoal stove and later sundried. The chips were milled into sweet potato root meal and used in the formulation of the treatment diets.

2.3 Management of Experimental Animals

Two hundred and forty (240) four weeks old Anak chicks were randomly divided into four experimental groups with three replicates of twenty birds per replicate. The four treatment groups were assigned the four experimental diets in a Completely Randomized Design (CRD). Each replicate received an assigned diet for 28 days. The chicks were weighed using digital sensitive balance and randomly distributed accordingly. The chicks were reared in a deep litter system whose floor was covered with wood shavings at about 5 cm depth. Sufficient management conditions like floor space, light, temperature, ventilation and relative humidity were provided to each of the groups. The chickens were vaccinated against major poultry viral and bacterial diseases as per the recommended vaccination schedule. During the experimental period, they were fed *ad libitum* on replicate basis and provided with clean and wholesome water. Feed refusal was always measured and recorded. An adjustment was made in the feed to allow for about 10% refusal subsequently. Feed offered and refusal were recorded on a daily basis. Initial weights of the animals were taken at the beginning of the trial and weekly subsequently.

2.4 Experimental Diets

Four experimental diets were formulated and designated as T1, T2, T3 and T4 to contain sweet potato root meal (SPRM) at 0%, 10%, 20% and 30% respectively. Treatment one (T1) did not contain the test ingredient, thereby serving as the control as presented in Table 1.

2.5 Carcass and Organ Evaluation

At the end of the experiments, 2 birds per replicate were randomly selected and slaughter from each treatment for carcass evaluation. The birds were starved of feed for 24 hours, weigh before and after slaughter. The weight of the dressed and eviscerated carcass and the various organs were determined. The cut parts and the organs weights were expressed as percentage (%) of dressed weight.

2.6 Proximate Analysis

All feeds and experimental materials were analyzed for proximate compositions using the method of [6].

2.7 Statistical Analysis

The results were analyzed using the Special Package for Social Sciences Window 17.0. One - way analysis of variance (ANOVA) was employed to determine the means and standard error. Treatment means were compared using Duncan's new multiple range test.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition

The proximate composition of the experimental diets is presented in Table 2. The Ether Extract (EE) ranged from 7.17 – 8.57% and the crude fibre levels obtained, ranged from 7.31 – 8.01%. The ash content ranged from 6.85 – 8.78% and Nitrogen-free extract 46.43-50.85%, while the dry matter, crude protein and metabolizable energy ranged between 91.75-92.73%, 19.22-20.83% and 2989.05-3152.85 Kcal/kg respectively. The protein values are slightly higher than the recommended range of 18-20% for broiler finisher diets [7]. [8] however, recommended a range of 18-21% for broiler finisher diets. The EE range of the present study for broiler

Table 1. Composition of experimental diets

Ingredients	Dietary levels			
	T1	**T2**	**T3**	**T4**
Maize	60.00	50.00	40.00	30.00
Sweet potato meal	0.00	10.00	20.00	30.00
Soybean meal	24.00	24.00	24.00	24.00
Wheat offal	10.00	10.00	10.00	10.00
Fish meal	2.00	2.00	2.00	2.00
Bone meal	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00
Vitamin premix	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Total	100	100	100	100

Table 2. Proximate composition of the experiment diets

Parameters (%)	T1	T2	T3	T4	SPRM
Dry matter	92.73	92.39	91.75	92.07	87.22
Crude protein	19.22	19.79	20.58	20.83	6.78
Crude fiber	8.01	7.64	7.47	7.31	4.21
Ash	7.16	6.85	7.51	8.78	2.49
Ether extract	7.27	7.17	7.33	8.57	1.63
Nitrogen free extract	50.85	50.95	49.03	46.43	72.11
ME (Kcal/kg)	3152.85	3125.30	3057.70	2989.05	2899.70

SPRM = Sweet potato root meal

finisher diets is slightly higher than the 5-7% recommended by [9] in a diet. The crude fibre level obtained in this study for the finisher diets are comparable with the range of 6.77-8.85% reported by [10] and was higher than the level of 4.30 recommended by [8]. The ash and nitrogen free extract (NFE) of the diets are comparable with the range of 5.56-8.15% and 42.66-49.84% reported by [11,10] for broiler finisher Fed varying levels of tigernut (*Cyperus esculentus* L) meal as dietary supplement and broiler finishers fed graded levels of cooked and fermented castor oil bean (*Ricinus communis l*) meal respectively. These values reported for ash and NFE in this study can provide the necessary minerals such as calcium and phosphorus needed for development of bones. The dry matter, crude protein and metabolizable energy are within the recommended nutrient requirements for the broiler finisher birds. However, the observed variation in the proximate composition in this study is not surprising, as this may have resulted from the chemical composition of the different test ingredient used in the experiment and the processing methods. The proximate composition of SPRM in this present study somewhat compared with the findings of [12].

3.2 Growth Performance and Feed Intake

The growth performance of broiler finisher birds fed different levels of sweet potato root meal is presented in Table 3. Total weight gain showed a significant ($P<0.05$) difference with T1, T2 and T3 ($P>0.05$) being similar but differed ($P<0.05$) from T4. The average daily weight differed ($P<0.05$) significantly with T2 having the highest value (35.71 g) and T4 the lowest (25.94 g). The reason for the numerical improved performance in daily weight gain at 10% inclusion level of sweet potato root meal could be due the resulting diet was not high in crude fibre to the point of causing depression in mineral availability, trace mineral retention and increased metabolic nitrogen excretion [13]. It also implied that the increasing levels of the antinutritional factors arising from increasing inclusion levels of SPRM meal were tolerable at 10% as to depress performance. However, the lower weight gain observed in T4 suggests that nutrients in the SPRM at 30% inclusion were not as available as compared to other treatment diets. Sweet potato is implicated with antinutritional factors like oxalates, trypsin inhibitors, -solanine and host of others [3] which has been reported to affect nutrient availability and utilization by monogastric animals [14]. The poor body weight gain of the broilers in T4 could be due to the poor feed intake, digestibility, absorption of nutrients and possible cases of anti nutrients. Also the diets however became increasingly dusty with the increasing levels of the test ingredient and this may have negative influence on growth performance. The lower growth performance could also be the resultant effect of the observed lower feed intakes among T3 and T4. The result of this study on growth performance is in agreement with the findings of [15] and [3] who reported slight but consistent reduction in growth rate as sweet potato root replaced maize and hence attributed it to the presence of unidentified inhibitors of digestive and / or metabolic processes as suggested by [16] and trypsin inhibitors, which may reduce ability to utilize protein if eaten raw [17].

The total feed intake of the birds fed the different dietary treatments differed ($P<0.05$) with T2 having the highest and T4 having the lowest value over the period of the experiment, this could be attributed to the acceptability of the diets [18]. Birds are known to eat more when diets are acceptable and coarse than when they are finely ground and acceptable [19]. Daily feed intake followed a similar trend as the total feed intake. The birds consumed higher quantity of the T1, T2 and T3 diets, indicating that the toxic level of the antinutritional factors were not high enough as to depress feed intake, hence it did not lower the feed intake as is usually the case with the antinutritional factors [20]. There may also have been improved digestibility producing faster rates of passage of digesta through the digestive tract of the birds [21]. Furthermore, the lower feed intake observed in T4 birds could be attributed to higher antinutritional factors like oxalates, trypsin inhibitors, solanine and a host of others present in sweet potato [3] which limited the acceptability of the diet. Also, the observed lower feed intake could also be attributed to the dusty nature of the diet; hence birds eat more when the diet is coarse. The feed conversion ratio (FCR) in the different treatment indicated that T2 is the best, thus demonstrated that SPRM appeared to be better utilized by the broiler chicken at 10% inclusion level. The poor FCR of the T4 diet could be connected with the reduction in nutrient digestibility due to the presence of antinutritional factor and nature of the diets.

3.3 Carcass and Organ Studies

The results of carcass and organ characteristics of broiler finisher birds fed diets containing sweet potato root meal is summarized in Table 4. There were significant (P<0.05) differences in dressed weight and dressing percentage. Also thigh muscle, breast muscle and wing, were significantly affected while drumstick back, neck and shank were (P>0.05) among the treatments for the cut parts. For the organ weights, all the parameters (heart, kidney gizzard and proventriculus) considered were (P>0.05) similar apart from the liver which differed (P<0.05) significantly across the treatment groups.

The decrease in dressed weight, dressing percentage and cut parts at 20 and 30% inclusion could be due to the impaired utilization of nutrients occasioned by reduced feed intake and decreased body weight changes which

Table 3. Growth performance of broiler finisher birds fed different levels of sweet potato root meal

Parameters	T1	T2	T3	T4	SEM
Initial body weight (g)	890.13	923.00	895.67	821.00	22.18
Final body weight (g)	1872.59^b	1922.90^a	1794.38^b	1547.41^c	64.31
Total weight gain (g)	882.46^b	999.9^b	898.71^b	726.41^c	53.82
Av. Daily weight gain (g/day)	31.52^b	35.71^a	32.10^b	25.94^c	1.63
Total feed intake	4508.71^a	4735.36^a	4569.20^a	3704.85^b	60.58
Av. daily feed intake	161.02^a	169.12^a	163.19^a	132.32^b	2.16
Feed conversion ratio	5.11^a	4.74^b	5.08^a	5.10^a	0.74

a, b, c, Means within the same raw with different superscripts are significantly different (P < 0.05)

Table 4. Carcass and organ characteristics of broiler finisher birds fed sweet potato root meal

Parameters	T1	T2	T3	T4	SEM
Live weight (g)	1872.59^b	1922.90^a	1794.38^b	1547.41^c	64.31
Dressed weight (g)	1520.63^b	1610.04^a	1430.00^b	1191.99^c	56.11
Dressing percentage (%)	81.20^b	83.73^a	79.71^b	77.03^c	28.29
Cut parts (% of dressed weight)					
Drumstick (%)	16.78	18.05	17.13	16.62	10.63
Thigh muscle (%)	16.26^b	22.40^a	16.79^b	16.79^b	11.39
Breast muscle (%)	25.35^b	29.23^a	23.49^c	21.40^d	14.31
Wing (%)	14.18^a	15.86^a	12.99^b	13.91^b	9.96
Back (%)	16.22	18.60	16.07	16.94	9.56
Neck (%)	8.26	9.01	7.70	7.54	4.02
Shank (%)	4.32	4.37	4.58	4.22	2.96
Organ weight (% of dressed weight)					
Gizzard/ proventriculus (%)	4.99	4.86	4.70	4.47	2.21
Heart (%)	0.48	0.48	0.52	0.67	0.43
Kidney (%)	1.31	1.34	1.21	1.26	0.01
Liver (%)	1.12^c	1.99^c	2.15^b	2.68^a	0.91

a, b, c, d Means within the same raw with different superscripts are significantly different (P < 0.05) significantly (P<0.05) differed at dietary inclusion levels of SPRM particularly at 30% level. However, decrease in dressed weight of birds fed SPRM diets beyond 10% inclusion levels could be attributed to increase in weight of internal organs instead of muscle and bone formations reported by [22].

The weight of the cut-up parts; thighs, wings and breast muscle indicated significant differences among the treatment groups, but the weight of the cut-up parts (16.26-22.40, 13.91-15.86 and 21.40-25.23) for thigh, wing and breast muscle respectively reported in this study are well above the reported yield of broiler by [23] who reported values of 12.95, 8.21 and 17.40 weights for the thighs, wings and breast muscle respectively. The dressing percentage observed in this present study are all comparable to the dressing percentage of 73.15-89.49% reported by [24] for broiler chickens fed raw and processed pigeon pea (*Cajanus cajan*) seed meal.

The liver was significantly (P<0.05) higher in weight for birds fed T3 and T4 compared with treatment T2 and T1. The high percentage weight recorded at T3 and T4 could be attributed to higher physiological activities couple with metabolic stress triggered by the presence of antinutritional factors which were not effectively removed during processing of the SPRM; a view corroborated by [25].

The progressive linear decrease (P>0.05) in the observed weights of the gizzard/proventriculus may be attributed to the slight but consistent decrease in the fibre level of the diets from T1-T4 as evidenced in the proximate analysis of the experimental diets. However, the observed similarity of organ (gizzard and proventriculus, kidney and heart) weight among the experimental groups is supported by the reports of [26] that residual anti-nutritional factors do not adversely affect organ weight of chickens.

4. CONCLUSION

The results of this study showed that sweet potato root meal can best replacement maize in diets of finisher broiler at 10% dietary level. Inclusion at 10% produced the best performance in all the parameters evaluated without deleterious effect on performance, carcass and internal organs characteristics. Beyond 10% dietary levels there was decrease in feed intake, weight gain, carcass yield and cut parts indices and increase in organ weights which may be attributed to presence of antinutritional factors and the dusty nature of the diets.

ETHICAL APPROVAL

This paper followed all the guidelines for the care and use of laboratory animal model of the Federal College of Agriculture, Ishiagu, Ebonyi State, Nigeria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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