Archives of Current Research International
5(3): 1-7, 2016, Article no.ACRI.27951
ISSN: 2454-7077

SCIENCEDOMAIN *international*
www.sciencedomain.org

Replacement Value of Maize with Sweet Potato (*Ipomoea batata*) Root Meal on Growth Performance and Haematogical Characteristics of Broiler Starter Birds

P. C. Jiwuba[1*], E. Dauda[1], L. C. Ezenwaka[2] and C. J. Eluagu[3]

[1]Department of Animal Health and Production Technology, Federal College of Agriculture, P.M.B.7008, Ishiagu, Ebonyi State, Nigeria.
[2]Department of Biotechnology, National Root Crops Research Institute, P.M.B, 7006, Umudike, Abia State, Nigeria.
[3]Sweet Potato Programme, National Root Crops Research Institute, P.M.B, 7006, Umudike, Abia State, Nigeria.

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. Author ED managed the literature searches, and analyses of the study performed the spectroscopy analysis. Author LCE managed the experimental process. Author CJE identified the species of plant. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/ACRI/2016/27951
Editor(s):
(1) Jack Wong, Department of Cardiovascular Sciences, Institute for Academic Medicine, Houston Methodist Research Institute, USA And Department of Cardiothoracic Surgery, Weill Cornell Medical College of Cornell University, USA.
Reviewers:
(1) T. Srilatha, College of Veterinary Science, Korutla, India.
(2) Juxing Chen, Novus International Inc. St. Charles, MO, USA.
(3) Bharat Raj Singh, Dr APJ Abdul Kalam Technical University, Lucknow, India.
(4) Shivani Katoch, Himachal Pradesh Agriculture University, Himachal Pradesh, India.
Complete Peer review History: http://www.sciencedomain.org/review-history/15928

Original Research Article

Received 27th June 2016
Accepted 2nd August 2016
Published 25th August 2016

ABSTRACT

A 28-day experiment was conducted to determine the effects of graded levels of sweet potato (Ipomoea batata) root meal (SPRM) on growth performance and haematological parameters of broiler starter birds. 240 day old unsexed Anak broiler chicks were used for this experiment. The birds were randomly divided into 4 groups with three replicates of twenty birds per replicate. Four dietary treatments designated as T1, T2, T3 and T4 were formulated to contain 0%, 5%, 10% and

**Corresponding author: Email: jiwubapc@yahoo.com;*

15% levels of SPRM. The four groups were assigned the four experimental diets in a Completely Randomized Design. Feed and water were supplied ad libitum. Blood samples (4 ml) were drawn from the animals on the last day of the study through the wing vein and analysed for haematological indices. Results showed that treatment diet had significant (P<0.05) effect in all the growth and intake parameters evaluated. The average daily weight gain was highest (28.56 g) (P<0.05) for birds fed T2 diet and lowest (24.95 g) for T4 birds. The average daily feed intake was highest at T4 (62.62 g) and lowest (52.32) for T1. Feed conversion ratio was however relatively best for the birds fed T2 diet (1.90). Results also showed that mean cell volume (MCV), mean corpuscular haemoglobin (MCH) and white blood cell (WBC) counts differed (p<0.05) significantly among the groups. MCV and MCH was improved (p<0.05) by SPRT at 5% inclusion level. WBC count of birds in T1 was significantly (P<0.05) higher and better than the treatment groups. These results showed that inclusion of SPRM at 5% was best and supported weight gain, feed utilization and have no possibility of predisposing infections to broiler starters, nor interfere with haemapoetic process and therefore recommended for optimum broiler starter production.

Keywords: Growth performance; feed intake; alternative energy feedstuff; haematology; poultry.

1. INTRODUCTION

The state of the world animal protein inadequacy has presented the need to evaluate the possibilities of utilizing potential tuber energy sources in feeding poultry, since the major portion of cereal grain like maize are being competed with industries and man. Maize being the major source of energy in poultry feeds and constitutes about 60% in poultry diet [1] has resulted to high cost of this feedstuff. This consequent high cost of maize has resulted to high cost of poultry production and alteration of the finished feed quality (commercial feed millers often times do not meet the requirements of the animals due to the high cost of conventional feedstuffs), thus leading to gross inadequate animal protein intake as a result of poor performance of the host animals fed the poor quality diets. Thus, research attention is now geared towards lesser known energy ingredients that will not compromise the feed quality. Among the existing unconventional feed resources is sweet potato (*Ipomoea batatas*).

Sweet potato is a root crop that provides food to a large segment of the world population, especially in the tropics where it is widely cultivated. It is a herbaceous creeper plant with proven resistance to drought, high yield and short generation interval of about four months, which makes it possible for it to be planted twice a year [2]. It has a high energy value with high concentration of starch which is highly available and digestible because of its small granules. Patatin which accounts for 30-40% of protein in the sweet potato tuber is extremely well balanced, being nutritionally similar to casein [3]. Sweet potato is also high in carotenoids, particularly, the hydrogen carotenoid and ß carotene which is comparable with carrot. It also contains some free sugars which give the tuber its sweet taste [4]. Sweet potato is considered as a high energy food and is the staple crop of many parts of the world. The fresh root of sweet potato consists about 60-70% water, 15-28% starch. [5] in their experiment observed that orange-fleshed sweet potato tuber meal can be included up to 25% in diets of laying hens without any negative effect on egg quality. It is low in fibre and consists predominantly of starch between 4-7% which occurs as sugar [6]. It contains a reasonably high amount of most amino acids but is limiting in tryptophan and sulphur-containing amino acids [7]. Most studies on potato have indicated that it can be used to partially replace maize in the ration of layers [8] and broiler chickens [9]. Sequel to these reports, it could be a good alternative to maize fed chicken production. This study is therefore designed to determine the effects of different levels of sweet potato root meal on the performance and haematological characteristics of broiler starter birds. Since there are known cases of antinutritional factors like oxalates and trypsin inhibitors in sweet potato which can adversely affect the health of the animals, the haematological studies becomes necessary to determine the effect of this on the blood parameters of the birds.

2. MATERIALS AND METHODS

2.1 Experimental Site

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℃ and relative humidity of about 80%.

2.2 Processing of Sweet Potato Root Meal

Clean and uncontaminated raw sweet potato roots were sourced from National Root Crop Research Institute, Umudike, Ikwuano local government area, Abia State. The roots were washed, weighed and chopped using kitchen knife. They were boiled at a 100℃ 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 Experimental Animals and Management

Two hundred and forty (240) day old unsexed 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 the 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. Standard 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.

2.4 Experimental Diets

Four experimental diets were formulated and designated as T_1, T_2, T_3 and T_4 to contain sweet potato root meal (SPRM) at 0%, 5%, 10% and 15%respectively. Treatment one (T_1) did not contain the test ingredient, thereby serving as the control as presented in Table 1.

Table 1. Composition of experimental diets

	Dietary levels			
Ingredients	**T_1**	**T_2**	**T_3**	**T_4**
Maize	50.00	45.00	40.00	35.00
Sweet potato meal	0.00	5.00	10.00	15.00
Soybean meal	25.00	25.00	25.00	25.00
Groundnut cake	10.70	10.70	10.70	10.70
Wheat offal	9.05	9.05	9.05	9.05
Fish meal	2.00	2.00	2.00	2.00
Bone meal	2.00	2.00	2.00	2.00
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
Limestone	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**

2.5 Data Collection

Birds were weighed at the beginning of the experiment and thereafter on weekly basis. Daily feed intake was determined by obtaining the difference between the quantity of feed given and the quantity leftover. Feed conversion ratio was computed accordingly.

2.6 Haematological Analysis

Blood samples (4 ml) were drawn from the birds on the last day of the study. The birds were bled through the wing vein. The blood sample were collected in labelled sterile universal bottle containing 1.0 mg/ml ethylene diamine tetraacetic acid (EDTA) and used for haematological analysis. Haematological parameters were measured using Beckman Coulter Ac-T10 Laboratory Haematology Blood Analyzer. Mean cells haemoglobin (MCH), MCV and mean cell haemoglobin concentrations (MCHC) were calculated.

All feeds and experimental materials were analyzed for proximate compositions using the method of [10].

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 Compositions

The proximate composition of the experimental diets and SPRM meal is presented in Table 2. The proximate composition of SPRM showed a relative high value for dry matter (DM) and metabolizable energy (ME) with very low values of ether extract (EE) and and relative fair values of crude protein (CP), crude fibre (CF) and ash. The DM values of the treatment diets compared well with the control and failed to follow a specific pattern. The crude fibre values also followed similar trend, decreasing with increasing levels of SPRM. The CP values followed a specific trend, indicating decreasing values with increasing levels of the test diets. The EE and ash concentrations did not follow a particular trend. The NFE values of the treatment diets however compared with the control, but had a specific trend with increasing levels of SPRM. The metabolizable energy valuesin this present study have a specific trend, decreasing slightly with increasing levels the test diet. The proximate composition of SPRM in this present study somewhat compared with the findings of [11]. The lower fibre content of the test diets compared to control group is evident with the low value of the CF of SPRM as observed in this study: a view corroborated by [6]. The CP values of the experimental diets are within the normal range required by broiler starter birds. The metabolizable energy values of the diets were within the recommended values for broiler starter birds. This is evident as no treatment group lost weight during the experiment.

3.2 Growth Performance

The growth performance of broiler starter birds fed different levels of sweet potato root meal is presented in Table 3. Average final body weight of the birds did not show any particular trend. The values however, differed ($P<0.05$) significantly with T_2 having the highest value of 923 g and T_4 having the lowest value (821 g). Average daily weight gain were influence ($P<0.05$) by the treatment diets with T_2 and T_4 having the highest and lowest values respectively. Average total feed intake differed ($P<0.05$) significantly and tended to increase with increasing levels of sweet potato root meal. Average daily feed intake followed the same pattern as average total feed intake. Feed conversion ratio for T_1, T_2, and T_3 were similar ($P>0.05$), but differed ($P<0.05$) from T_4.

The average final weight of this present study is higher than the range of values (516 –572.2 g and 434.52 – 590.76 g) reported by [12] and [13] for broiler starters, but however compared with the range of 807 – 1279 g reported by [14]. The total weight gain recorded the highest value for the bird on 5% SPRM with a corresponding lowest value for the 15% SPRM treatment group. The average daily body weight gain reported in this study is lower than 39.65 – 42.96 g reported by [15], but higher than 16.58±0.15 - 16.76 g reported by [13] for broiler starters. The result of the present study compared well with 25.02 - 28.09 g/day reported by [16]. The higher average daily weight gain observed in T_2 relative to T_1 could be explained by the higher feed intake observed in T_2 compared to T_1; since birds eat primarily to meet their energy requirement. The lower growth rates of the broilers observed in T_4 could be a reflection of the stringent requirement for essential nutrients at this stage of life. Also the decrease in growth rate observed in T_4 may be due to the presence of unidentified inhibitors of digestive and / or metabolic processes as suggested by [9]. The diets however became increasingly dusty with the increasing levels of the test ingredient and this may have negative influence on growth performance.

Table 2. Proximate composition of experimental diets and sweet potato root meal

	Dietary levels				SPRM
Parameters (%)	**T_1**	**T_2**	**T_3**	**T_4**	
Dry matter	92.73	92.39	91.75	90.07	87.22
Crude protein (%)	22.57	22.11	21.83	21.33	6.78
Crude fibre	8.24	7.64	7.67	7.31	4.21
Ash	8.16	7.54	7.21	6.78	2.49
Ether extract	8.27	7.17	7.33	7.57	1.63
Nitrogen free extract	45.49	47.93	47.71	47.08	72.11
Metabolisable energy (kcal/kg)	3085.05	3060.85	3056.95	3037.80	2899.70

SPRM = Sweet potato root meal

The average total feed intake observed in this study is lower than the values (1732.03 - 1978.90 g) reported by [13], but however higher than the values 1067.90 – 1108.80 g reported by [17]. The average daily feed intake of this study is lower than the values 88.62 - 93.31 g/d reported by [15], but higher than 43.67 – 50.07 g/d as reported by [18] for broiler starters. The values for average daily feed intake however compared with 48.48 - 56.55 g/d reported by [19]. The higher feed intake of the birds on T_4 diet relative to other treatment groups might have resulted from the lower energy concentration of diet. Sweet potato root meal is low in energy when compared to maize and as the inclusion level increased, energy level of the diets also decreased. Since the T_4 diet is lower in energy levels, the birds apparently increased their intake in an attempt to satisfy their energy requirement due to calorie dilution of diets by the 15% SPRM inclusion. This is so because birds would normally adjust their feed intake to meet their dietary energy requirements. The observed higher values in feed conversion ratio for T_3 and T_4 could be attributed to the dusty nature of the diet, which may limits the amount of energy and protein available to the birds, and correspondingly contribute to excessive nutrient excretion.

3.3 Haematological Studies

The haematological indices of broiler starter birds fed different levels of sweet potato root meal are presented in Table 4. The packed cell volume (PCV), haemoglobin (Hb), red blood cell (RBC) and Mean corpuscular haemoglobin concentration (MCHC) were not ($P>0.05$) influenced by the treatment diets. The PCV did not show any specific trend, but T_2 had the highest and better value (31.33) while T_4 had the lowest (29.33). The haemoglobin values followed a similar trend as the PCV in this study with the highest value occurring in T_2 and the lowest in T_4 respectively. RBCs are within the normal range for healthy birds and however were decreasing slightly with increasing levels of SPRM. The MCHC also decreased with increasing levels of SPRM with T_1 birds having the best value relative to T_4 animals. Mean corpuscular haemoglobin (MCH), Mean corpuscular volume (MCV) and White blood cell (WBC) were significantly ($P<0.05$) influenced by the treatment diets.

The MCH values for T_2 and T_3 were statistically ($P>0.05$) similar but differed ($P<0.05$) with T_1 and T_4 which were also similar ($P>0.05$). MCH concentration for T_2 and T_3 were higher and better than T_1 and T_4. Mean corpuscular haemoglobin concentration in this study ranged between $27.05x10^{12}$L to $29.71\ x10^{12}$L, which falls within the reference values 25.3-33.4 $x10^{12}$/L for normal adult chicken as reported by [20]. This implies that the feed value of the diets was adequate and the replacement of maize with SPRM meal in the experimental diet did not reduce its nutritional quality. The Mean corpuscular volume values followed a specific trend as the MCH. However, the MCV concentration in this study ranged between 101.35 fl to 119.45 fl, which also fall within the reference values of 100.00 – 128.00 fl for normal adult chicken as reported by [20]. [21] explained that the MCV and MCH values could reflect anaemic condition and the capacity of the bone marrow to produce RBC of normal size and metabolic capacity. Thus, the normal MCV and MCH recorded in this study for the birds gave a clear indication of the absence of anaemia among the experimental groups. The white blood cell (WBC) concentration range of 11.07×10^3 mm^3 and 17.80×10^3 mm^3 obtained in this present study were within the reference values of 9.76×103 mm^3 and 31.00×10^3 mm^3 reported by [21]. The normal values of WBC obtained in this study suggest well developed immune system of the birds in different dietary groups with the lowest and highest concentrations obtained in diets T_4 and T_2, respectively.

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

Parameters	T1	T_2	T_3	T_4	SEM
Average initial body (g)	120.70	123.33	119.00	122.43	2.16
Average final body weight (g)	890.13^b	923.00^a	896.67^b	821.00^c	27.01
Average total body weight gain (g)	769.43^b	799.67^a	777.67^b	698.57^c	12.67
Average daily body weight gain (g/day)	27.45^b	28.56^a	27.77^b	24.95^c	3.11
Average total feed intake (g)	1465.00^c	1523.33^b	1596.67^b	1753.33^a	22.90
Average daily feed intake (g/day)	52.32^c	54.20^b	57.02^{ab}	62.62^a	2.47
Feed conversion ratio	1.91^a	1.90^a	2.05^{ab}	2.51^b	0.19

[a. b. c] Means within the same row with different superscripts are significantly different (p<0.05)

Table 4. Haematological indices of broiler starter birds fed different levels of sweet potato root meal

Parameters	T1	T_2	T_3	T_4	SEM
Packed cell volume (%)	30.67	31.33	31.00	29.33	0.70
Haemoglobin (g/dl)	10.47	10.67	10.52	9.93	0.22
Red blood cell ($x10^{12}$/L)	3.94	3.61	3.54	3.31	0.10
Mean corpuscular haemoglobin (pg)	27.05^b	29.71^a	29.61^a	27.54^b	3.23
Mean corpuscular volume (fl)	104.65^b	117.89^a	119.45^a	99.35^c	1.40
Mean corpuscular haemoglobin conc. (%)	29.66	29.29	27.78	26.86	0.11
White blood cell ($x10^3/mm^3$)	13.60^b	17.80^a	13.27^b	11.07^c	0.68

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

4. CONCLUSION

Replacement of maize with sweet potato root meal diets have resulted in a significant improvements on the growth performance and haematology. This suggests that sweet potato root meal could replace maize in broiler feed without any detrimental effect on the health of the birds. SPRM is a recommended alternative energy source for poultry. It is concluded that sweet potato root meal can replace maize meal in the diet of broiler starters up to 15%, with only a slight reduction in growth rate at 15% level. This is a fact that the replacement of maize by SPRM did not predispose the birds to anaemia or any health threat and thus supported haemapoetic process and growth performance.

ETHICS 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.

REFERENCES

1. Obun CO, Abia EE. Performance and hematological changes of broiler chicks fed. Agro- chemical treated maize. Journal of Sustainable Agric and the Environment, Umudike, Abia State. 2003;5(2):313-318.
2. Duyet HN, Son ND, Van-An N, Thuan TT. Effect of high dietary levels of sweet potato leaves on the reproductive performance of pure and crossbred Mong Cai Sows. Livestock Research for Rural Development. 2003;15:6.
3. Liedl BE, Kossier TD, Esborough SL. HPLC isolation and nutritional value of a major tuber proteins. Am. Potato. J. 1987;64:548-558.
4. Ingabire MR, Hilda V. Comparison of the Nutrient composition of four sweet potato varieties cultivated in Rwanda. Am. J. Food. Nutr. 2011;1(1):34-38.
5. Okereke CO, Oti E, Nwauzor EC. Effect of dietary inclusion of orange-fleshed sweet potato meal on egg quality of laying hens. Proceedings of 14th Annual Conference of Animal Science Association of Nigeria (ASAN). 2009;382-4.
6. Okereke CO. Utilization of cassava, sweet potato and cocoyam meals as dietary sources for poultry. World J of Engineering and Pure and Applied Sci. 2012;2(3):63.
7. Morrison FB. Feeds and Feeding. Morrison Publishing Co., Iowa; 1961.
8. Agwunobi LN. Performance of broiler chickens fed sweet potato meal (*Ipomoea batatas*) diets. Trop. Anim. Health. Prod.1999;31(6):383-389.
9. Gerspacio AL. Sweet potato and cassava based rations for broilers. The Philippines Agriculturist. 1978;4-11.
10. AOAC. Association of Official Analytical Chemists. Official Method of Analysis, Washington, D.C. Chapter. 1995;4:17-34.
11. Ukom AN, Ojimelukwe PC, Okpara DA. Nutrient composition of selected sweet potato (*Ipomea batatas (L) Lam*) varieties as influenced by different levels of nitrogen fertilizer application. Pakistan Journal of Nutrition. 2009;8(11):1791-1795.
12. Olabode AD, Onyimonyi AE, Ilo SU. Replacement of synthetic methionine with naturally compounded materials in broiler starter birds. In: Research and Value-Addition: Key to Transformation of the Nigerian Livestock Industry. Eds (Aduku AO, Oluwagbemi T, Aribido SO, Daikwo SI, Saliu OJ. Proceedings 16th Annual

Conference of Animal. Science Association of Nigeria (ASAN) September 12th-15th Kogi State University Anyigba, Anyigba, Nigeria. 2011;299-302.

13. Onu PN, Madubuike FN, Nwakpu PE, Anyaehie AI. Performance and carcass characteristics of broilers raised on three different litter materials. Agric. Biol. J. N. Am. 2011;2(10):1347-1350.
14. Uchegbu MC, Irechukwu NM, Omede AA, Nwaodu CH, Anyanwu GA, Okoli IC, Udedibie ABI. Comparative Evaluation of three commercial feeds on the performance of broilers. Report and Opinion. 2009;1(4):84-89.
15. Abdulrashid M, Joseph ZO, Mohammed A, Adamu HY. Response of broiler chickens fed cottonseed meal based diets. Int. J. Adv. Agric. Res. 2013;1:62-65.
16. Asaniyan EK, Akinduro VO. Performance of broiler chicks fed graded levels of heat - treated bambarra groundnut (*Voandzia subterranean (L) thouars*) offals. International Journal of Poultry Science. 2008;7(7):711-714.
17. Nworgu FC, Ogungbenro SA, Solesi KS. Performance and some blood chemistry indices of broiler chicken served fluted pumpkin (*Telfaria occidentalis*) leaves extract supplement. American-Eurasian J. Agric. & Environ. Sci. 2007;2(1):90-98.
18. Oyewole BO, Olarenwaju G, Dafwang II. Performance of broilers fed premix prepared from locally sourced materials. Standard Research Journal of Agricultural Sciences. 2013;1(2):17-20.
19. Ogbu NN, Ogbu CC, Okorie AU. Growth performance of broiler chickens fed raw and processed pigeon pea (*Cajanus Cajan*) seed meal. Animal Science Advances. 2015;5(7):1350-1356.
20. Mitruka BM, Rawnsley HM. Chemical, biochemical and haematological references values in normal experimental animal. Mason Publishing, USA Inc. N.V. 1977;88:142.
21. Johnson-Delaney CA. Exotic companion medicine handbook for veterinarians. Winger, Lake Worth Florida; 1996.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/15928