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Growth performance and carcass characteristics of finisher broiler chickens fed diet containing cooked cocoyam tubermeal

[1]Anyaegbu, B. C., *[1]Onunkwo, D. N., [2]Igwe, G., [1]Nathaniel, J. and[1]Nkwo, C. M.
[1]*College of Animal Science and Animal Production,*
[2]*College of Veterinary Medicine,*
Michael Okpara University of Agriculture, Umudike,
Umuahia, Abia State, Nigeria
***Corresponding author:** donunkwo1@gmail.com; +2348033388622

Abstract

This study was carried out to evaluate the growth performance and carcass characteristics of finisher broiler chickens fed diet containing cooked cocoyam tubermeal as energy source in place of maize. The proximate composition of cooked cocoyam tubermeal showed that it contained 13.11% moisture, 2.60% ash, 3.90% crude protein, 9.45% crude fiber, 1.85% ether extract and 70.13% NFE. In the finisher feeding trial, the cooked cocoyam tubermeal was used to replace maize at levels of 25%, 50%, 75% and 100% respectively in the control diet. Each finisher diet was fed to a group of 30 finisher broiler chicken for 4 weeks using completely randomized design. Each treatment was divided into 3 replicates of 10 broiler chicks each. The birds were kept on deep litter and were given feed and water ad-libitum. Parameters measured include ifinal body weight, body weight gain feed intake, feed conversion ratio, carcass characteristics and economics of production. In the finisher feeding trial, the feed intake of the finisher broilers on diets 2, 3 and 4 were similar and compared favourably with those on the control diet. The finisher group on 100% CCYM (diet 5) recorded the lowest feed intake possibly because of the dustiness of the feed. The body weight gain of the finisher broilers on diet 2 (25%) cooked cocoyam tubermeal compared favourably with the control group and was significantly (P<0.05) higher than those on other diets. It appeared that the finisher broilers could not tolerate high levels of cooked cocoyam meal due to dustiness of the feed and its anti-nutritional factors. The cost of production per kg finisher broilers was cheapest for diet 5(100% CCYM) (N356.72) and the costliest was for diet 3(50% CCYM) (N588.28). The internal organs expressed as percent of the live weight were not affected by the treatments. In terms of carcass characteristics, the finisher broilers on diet 2(25% CCYM) recorded the highest breast muscle which was significantly different (P<0.05) from other groups. There were no significant different (P>0.05) on percent back cut, drumstick, head, shank, thigh, neck and wings of the finisher broilers on all the treatments. There were no significant differences (P > 0.05) in percent dressed weight of the finisher broilers on cooked cocoyam based diets. The results of the trial have shown that cooking cocoyam corms (Xanthosoma sagittifolium) for 30 minutes was effective for reducing the cyanide oxalate, tannin, phytic acid and saponin content and that cooking did not affect the proximate composition of tannia. Cooked cocoyam tubermeal could be used to replace maize up to 25% in the diet of finisher broiler chicken without affecting body weight gain, feed intake and feed conversion ratio as indicated in this study.

Keywords: Nutritional evaluation, cooked cocoyam, growth performance, carcass characteristics, finisher broilers.

Introduction

Feed is the major component of the total cost of production for meat and egg production in poultry industry. Maize constitutes the bulk of the energy source used in compounding concentrate rations. Other grains used but to a lesser extent include sorghum, millet, wheat, barley and oats. Maize supplies the bulk energy in animal feed especially for poultry. It is currently expensive and scarce due to low production and higher consumption rates by man. Maize is also put into numerous industrial uses including production of agro fuels (Obasi, 2009; Adeola and Olukosi, 2009), thus diverting maize away from man and animal food chain and this has led to increase in the cost of maize and consequently increase in the cost of poultry feed which is reflected in the high cost of poultry production., In other to ameliorate this problem, alternative sources of energy feedstuffs that are less in demand with relatively lower cost must be exploited.

Besides, depending on maize alone as the sole source of dietary energy may be devastating to poultry production, because of the frequent drought and locust attack affecting some maize producing areas (Agwunobi and Essien, 1995). Therefore, there is need for continued and consistent search for alternative source of energy that is cheap when compared to maize that could take the place of maize in poultry ration formulation. Cocoyam products are recognized as cheaper carbohydrate sources than grains or other tuber crops. Thus, tannia cocoyam (*Xanthosoma sagittifoilum*) is a non-conventional feedstuff that provides readily available energy with easily digestible carbohydrate. *Xanthosoma sagittifoilum* is readily found in all hot and humid areas of the world as is cultivated extensively throughout West Africa (Onwueme, 1982). It was suggested that tannia cocoyam are now more important than taro cocoyam (*Colocasia esculenta*) being more popular (FAO, 1990) due to superiority of their corms and cormels in terms of energy, proteins and mineral elements (Mwenye, 2009). The nutritional quality of cocoyam compares favourably with cassava, potatoes and yam (Bello, 1976). *Xanthosoma sagittifoilum* is a high yielding, disease resistant crop. It is almost competition free with man in most places as it is eaten only as a last resort when a family can no longer afford garri or yam. It is therefore more likely to be available for use at lower cost. The substitution of grains with roots and tubers is an economical question, and roots have a great potential in many areas of the world as a major supplier of energy for animals (Gohl, 1975). Although, the root and tuber meals are low in protein, its energy content is remarkably high and its price relative to maize is low, hence the cost of production will be low. However, cocoyam contains anti-nutritional factors such as oxalates, tannin, saponin, cyanide and phytate, which could be a limitation to its use (Okon *et al.,* 2007). But these limiting factors can be removed by boiling or sundrying (Abdulrashid et al, 2006). Ohaemenyi (1993) reported that *Xanthosoma sagittifoilum* corms can be cooked and used to some extent in the diets of growing pigs. Esonu (2000) reported that starter broilers could tolerate up to 20% inclusion level of wild variegated cocoyam (*Canadiumhortulanum*). Anyaegbu *et al* (2018) reported that fermented cocoyam tubermeal (*Xanthosoma sagittifoilum*) could be used in the diet of starter and finisher broilers up to 25% and 100% respectively without affecting body weight gain, feed intake and feed conversion ratio. Anyaegbu *et al*. (2016) also reported that finisher broilers chicken group on 15 percent sundried cocoyam tuber meal diet replacing maize recorded the highest body weight gain, better feed intake and feed conversion ratio which were significantly different ($P<0.05$) from other groups. There is limited work on the proximate composition and optimum inclusion of cooked cocoyam tubermeal (*Xanthosoma sagittifolium*) in broiler rations. Hence, the need to investigate the nutritional evaluation of cooked cocoyam tubermeal on growth and carcass characteristics of finisher 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, Abia State in Nigeria. The area is located at latitude 05º 29` North, Longitude 07º 32` East in the rain forest zone in Umuahia, Abia State of Nigeria. This site has an ambient temperature of between 22ºC - 36ºC with relative humidity between 50 – 90%, an annual rainfall of 2177mm per annum and an altitude of 123m above sea level. It is therefore a humid tropical environment with temperature and relative humidity that are significant in agricultural production (NRCRI, Umudike, 2017).

Procurement and Processing of feed ingredient

Fresh cocoyam corms (*Xanthosomasagitifolium*) Nx 003 were obtained from Amaba in Ikwuano LGA in Abia State. The fresh tannia corms were cut into bits of about 0.2cm and put into boiling water for thirty minutes (30 minutes) and later brought out of the cooking drum to cool and later dried with an oven to remove the moisture content. The cooked dried cocoyam was milled to produce cooked cocoyam meal (CCYM) and stored for use. Other feed ingredient like maize, palm kernel cake, brewers' dried grains, blood meal, fish meaL, bone meal, vitamin/mineral/premix, lysine, methionine, salt were bought from Jocan Livestock Services in Umuahia, Abia State.

Chemical analysis of feed ingredients

Samples of fresh cocoyam corms and cooked cocoyam tubermeal were analysed for proximate composition according to (AOAC, 1990) to determine their nutrient composition from which its metabolisable energy (ME) was estimated (Morgan *et al.,* 1975). All analysis was based on 100% dry matter. This was done so as to use the value to determine the nutrient composition of the experimental diets which were formulated from them. The components determined were dry matter (DM), Crude protein (CP), Ether extract (EE) and Nitrogen extract (NFE).

Experimental design

The design of the study was completely randomized design (CRD)

The statistical model is:

$Y_{ij} = \mu + T_1 + e_{ij}$

Where:

Y_{ij} = Individual observation

μ = Population mean

T_1 = Treatment effect

e_{ij} = Error effect

Anti-nutrients determination

The test materials fresh and cooked cocoyam corms (*Xanthosomasagitifolium*) were analysed for the anti-nutrients content such as oxalate, phytic acid, saponins, tannins and cyanide.

Experimental finisher broilers diets

Five experimental finisher broilers diets were formulated for the feeding trial. Diet 1 (control diet) contained 60% maize as the major source of energy while diets 2,3 4 and 5 contained 25%, 50%, 75% and 100% of cooked cocoyam meal to replace maize in the control diet respectively. Other ingredients remained the same in the diets.

Management of experimental finisher broilers

A total of 150 unsexed Anak finisher broiler chicks at 4 weeks of age (Agrited Broilers) were for the experiment. They were divided into 5 treatment groups of 30 broilers each and each treatment was subdivided into 3 replicates of 10 broilers each. Each replicated was housed in a pen. The broilers were weighed individually at the beginning of the experiment and their average initial

Table 1: Percentage ingredient composition of finisher broilers experimental diets

Ingredients (%)	Diet 1 (Control)	Diet 2 25% CCYM	Diet 3 50% CCYM	Diet 4 75% CCYM	Diet 5 100% CCYM
Maize	60.00	45.00	30.00	15.00	0.00
CCYM*	-	15.00	30.00	45.00	60.00
Palm Kernel Cake	4.20	4.20	4.20	4.20	4.20
Brewers' Dried Grains	8.20	8.20	8.20	8.20	8.20
Soyabean meal	17.00	17.00	17.00	17.00	17.00
Fish meal	3.00	3.00	3.00	3.00	3.00
Blood meal	3.00	3.00	3.00	3.00	3.00
Bone meal	2.40	2.40	2.40	2.40	2.40
Vit/mineral Premix**	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Common salt	0.25	0.25	0.25	0.25	0.25
Palm oil	1.50	1.50	1.50	1.50	1.50
Total	100.00	100.00	100.00	100.00	100.00
Calculate nutrient composition of the experimental finisher broiler diets					
Crude protein (%)	20.47	20.27	20.07	20.05	20.00
Crude fibre (%)	4.46	6.99	4.73	4.85	4.97
Ether extract (%)	4.02	3.53	3.05	2.57	2.08
Ash (%)	2.77	3.27	2.52	4.26	4.75
Calcium (%)	1.300	1.309	1.306	1.303	1.300
Phosphorus (%)	0.86	0.82	0.77	0.73	0.69
M.E. Kcal/kg	3002.92	3000.82	2944.37	2900.58	2900.00

*cooked cocoyam meal

*To provide per kg diet: Vit. A 5,000,000 i.u.; Vit. D3 1,000,000

weight and sex balanced and weighed weekly thereafter for determination of their growth performance. The broilers were assigned the experimental finisher diets using completely randomized design for 4 weeks. Both water and feed were given ad libitum.

Carcass evaluation

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

Data analysis

The data were subjected to one-way analysis of variance (ANOVA) according to Snedecor and Cochran (1989), were significant treatment effects were detected from the ANOVA, means were separated using Duncan's New Multiple Range Test (Duncan, 1995).

Results and discussion

Data on anti-nutrients composition of fresh and cooked tannia (*Xanthosoma sagitifolium*) were shown in (Table 2). There was significant difference ($P < 0.05$) in cyanide, Oxalate and tannin content of both the fresh and cooked cocoyam tuber meals. The values obtained from the cooked samples were lower. There was no significant difference ($P>0.05$) in phytic acid and saponin content of both the fresh and cooked tannia (*Xanthosoma sagitifolium)* but numerically the values obtained from the cooked cocoyam tuber meal were lower. Showing that cooking was effective for reducing these anti-nutrients.

Table 2: Anti -nutrient composition of raw and cooked cocoyam tuber meal (*Xanthosoma sagittifolium*)

Parameters	Fresh Tannia	Cooked tannia	SEM
Cyanide (mgCN/g)	0.29^{a}	0.21^{b}	0.73
Phytic acid (%)	57.23^{a}	56.09^{b}	0.76
Oxalate (%)	17.34^{a}	11.53^{b}	0.83
Tannin (%)	1.83^{a}	0.46^{b}	1.02
Saponin (%)	24.10^{a}	22.02^{b}	1.71

^{a,b}Means within the same row with different superscripts are significantly different (P < 0.05)

Data on the proximate composition of fresh and cooked cocoyam tuber meal (*Xanthosoma sagittifolium*) were shown in (Table 3). There was significant difference (P< 0.05) in the percentage moisture and crude fiber of both the fresh and cooked cocoyam meal. Cooking and drying reduces the high moisture and crude fiber content to a tolerable level. There were no significant differences (P> 0.05) in the percent ash, crude protein, ether extract, and NFE of both the fresh and cooked cocoyam tubers, showing that cooking did not affect the proximate content of the cocoyam.

Table 3: Proximate composition of fresh and cooked cocoyam tuber (*Xanthosoma sagitifolium*)

Parameters	Fresh cocoyam tuber	Cooked cocoyam tuber	SEM
Moisture (%)	58.05^{b}	13.11^{a}	4.92
Ash (%)	4.80	2.60	0.78
Crude protein (%)	5.43	3.90	0.54
Crude fibre (%)	9.45^{a}	4.74^{b}	1.67
Ether extract (%)	2.40^{b}	1.85^{a}	0.09
NFE (%)	39.82	70.13	10.72

^{a,b}Means within the same row with different superscripts are significantly different (P < 0.05)

Table 4: Proximate composition of experimental finisher broiler diets

Parameters	Diet 1 (Control)	Diet 2 25% CCYM	Diet 3 50% CCYM	Diet 4 75% CCYM	Diet 5 100% CCYM	SEM
Moisture (%)	9.74	11.84	12.13	12.70	13.50	0.56
Ash (%)	6.74	9.00	9.69	10.50	11.48	0.72
Crude protein (%)	20.38	18.75	17.50	16.75	16.50	0.64
Crude fibre (%)	6.10	8.80	9.80	11.50	12.90	1.04
Ether extract (%)	3.80	3.38	3.00	2.80	2.65	0.19
NFE (%)	53.24	48.23	47.88	45.75	42.95	1.51

Feed intake

The average feed intake of the finisher broilers were 130g, 129.00g, 127.00g, 128.00g and 110.00g respectively for the control group diet 2, 3 4 and 5. The feed intake of the finisher broilers on diet 2, 3 and 4 were similar and compared favourably with those on the control diet and significantly different (P<0.05) from those on diet 5 (100% CCYM). The finisher broiler group on diet 5(100% CCYM) recorded the lowest feed intake of 110.00g. This could be due to the dustiness of the feed because of high content of cooked cum dried cocoyam tuber meal.

Body weight gain

The body weight gain of the finisher broilers were 1.40kg, 1.33, 0.859kg, 0.952kg and 0.780kg for the control group (Diet 1). 2,3, 4 and 5 respectively. The body weight gain of the finisher broilers on diet 2(25%) cooked cocoyam meal compared favourably with the control group and was significantly (P<0.05) higher than those on other diets. It appeared that the finisher broilers could not tolerate high levels of cooked cocoyam tuber meal in their diets. This could be due to the dustiness of the diets.

Feed conversion ratio

The feed conversion ratio of the finisher broilers on the control diet and diet 2(25% CCYM) were similar and significantly (P<0.05) higher than those on diet 3, 4 and 5 respectively (Table 5).

Table 5: Effects of the experimental diets on the performance of finisher broilers

Parameters	Diet 1 (Control)	Diet 2 25% CCYM	Diet 3 50% CCYM	Diet 4 75% CCYM	Diet 5 100% CCYM	SEM
Initial Body wt. gain (g)	900.00	869.37	830.27	597.20	519.70	69.09
Final body wt. gain (Kg)	2.30^{a}	2.20^{a}	1.69^{b}	1.55^{c}	1.30^{c}	0.15
Body wt. gain (Kg)	1.40^{a}	1.33^{a}	0.859^{b}	0.952^{b}	0.780^{b}	0.10
Daily body wt. gain (g)	50.00^{a}	47.50^{a}	30.68^{b}	34.00^{b}	27.86^{b}	2.06
Daily feed intake (g)	130.00^{a}	129.00^{a}	127.00^{a}	128.00^{a}	110.00^{b}	3.34
Feed conversion ratio	2.60^{a}	2.72^{a}	4.14^{b}	3.77^{b}	3.95^{b}	0.16

^{a,b,c}Means within the same row with different superscripts are significantly different (P < 0.05)

Percentage cut part weight of experimental finisher broiler

The percentage cut part weight of the experimental finisher broilers were shown in Table 6. The finisher broilers on diet 2 (25% CCYM) recorded the highest breast muscle which was significantly different from other groups. There were no significant different (P> 0.05) on percent back cut. Drumstick, head, shank, thigh, neck and wings of the finisher broilers on all the diets.

Table 6: Percentage cut part weights of the experimental finisher broilers

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	SEM
Back cut	13.03	12.25	15.73	14.63	14.36	0.55
Breast muscle	15.76^{c}	18.58^{a}	17.11^{b}	16.74^{c}	16.68^{c}	0.40
Drumstick	9.64	10.00	10.52	9.36	9.32	0.20
Head	2.86	3.47	3.83	3.62	4.28	0.21
Shank	4.76	5.14	5.52	4.12	4.74	0.21
Thigh	10.53	10.00	9.70	9.69	10.28	0.15
Neck	3.63	3.61	4.59	3.63	4.13	0.17
Wing	9.20	9.64	9.63	8.89	9.56	0.13

^{a,b,c}Means within the same row with different superscripts are significantly different (P < 0.05)

Internal organ weights

The percent internal organ weights of the experimental finisher broilers were shown in Table 7.

The weight of the organs (liver, gizzard, heart, kidney, spleen, large intestine, small intestine, proventiculus, lungs, abdominal fat of the birds in all the groups were not affected by the treatments (P <0.05), the birds in diets 2(25% CCYM and 3(50% CCYM) accumulated significantly (P<0.05) more abdominal fat than the others indicating higher efficiency of the birds in converting the carbohydrates of the diets into fat.

Percentage dressed weights

Percentage dressed weight of the experimental finisher broilers on cooked cocoyam based diets is shown in Table 8. There was no significant difference (P<0.05) in percentage dressed weight of the experimental finisher broilers on cooked cocoyam based diets in all the treatments.

Table 7: Percentage Internal organs weights of the experimental finisher broilers

Parameters	Diet 1 (Control)	Diet 2 25% CCYM	Diet 3 50% CCYM	Diet 4 75% CCYM	Diet 5 100% CCYM	SEM
Live weight (Kg)	1.65[a]	1.04[b]	0.90[c]	0.98[c]	0.76[c]	0.14
Dressed wt. (Kg)	1.08[a]	0.70[b]	0.58[b]	0.65[b]	0.66[b]	0.08
Percent dressed wt	65.45[b]	67.31[b]	64.44[b]	66.33[b]	86.84[a]	3.77
Liver	3.22	3.10	3.03	3.49	3.51	0.09
Gizzard	2.26	2.05	3.07	3.09	2.52	0.26
Heart (%)	0.59	0.63	0.68	0.66	0.61	0.02
Spleen (%)	0.18	0.18	0.19	0.16	0.20	0.01
Abdominal fat (%)	0.71[c]	1.45b	1.90[a]	1.06[ab]	1.45[b]	0.18
Large intestine (%)	1.91	1.58	2.17	2.24	3.05	0.22
Small intestine (%)	5.19	3.89	4.78	4.85	5.46	0.24
Proventiculus (%)	0.72	0.67	0.79	0.85	0.79	0.03
Kidney (%)	0.52	0.67	0.49	0.88	0.82	0.07
Lungs (%)	0.89	0.63	0.73	0.77	0.81	0.04
Crop (%)	0.58	0.49	0.48	0.61	0.61	0.03

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

Table 8: Percentage dressed weight

Parameters	Diet 1 (Control)	Diet 2 25% CCYM	Diet 3 50% CCYM	Diet 4 75% CCYM	Diet 5 100% CCYM	SEM
Dressed wt (kg)	1.08	0.70	0.58	0.65	0.66	0.08
Dressed (%)	65.45	67.31	64.44	66.33	86.84	3.77

Means within the same row with different superscripts are significantly different ($P < 0.05$)

Table 9: Economics of finisher broiler fed experimental diets

Parameters	Diet 1 (Control)	Diet 2 25% CCYM	Diet 3 50% CCYM	Diet 4 75% CCYM	Diet 5 100% CCYM	SEM
Cost/Kg feed	173.66[c]	147.86[c]	122.06[ab]	96.26[b]	70.44[a]	17.49
Cost of production/Kg broiler	411.82[c]	432.93[ab]	588.28[c]	381.20[b]	356.72[a]	36.36

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

Economics of finisher broiler fed experimental diets

In the finisher feeding trial, the cost of production per kg of cocoyam based finisher broiler diet was cheapest for diet 5(100% CCYM) (N70.44) while the costliest was those on diet 1 (maize based diet) (N173.66). The cost of production per kg broiler was cheapest for diet 5(100% CCYM) (N356.72) and the costliest was those on diet 3(50% CCYM) (N588.28).

Discussion

The result of the trials in respect to the anti-nutrient content of both raw and cooked cocoyam tuber meal showed that the raw cocoyam tuber contained cyanide up to 1.83 (mgCN/g) but cooking reduced it to 0.46 (mgCN/g) which was tolerable to the broiler chicken. Other anti-nutrient contents like tannis, oxalate were also reduced by cooking. (Agwunobi et al., 2002) recorded that cooking and sundried cocoyam reduces their oxalate, tannin and saponin contents, the tannin content of the cocoyam tubers were also reduced from 1.83% to 0.48% by boiling. According to (Onu et al, 2004) boiling and/or supplementation with oil are common acceptable means of detoxification among

Nigerians.

Performance of finisher broilers

The feed intake of the finisher broilers on diets 2, 3 and4 were similar and compared favourably with those on the control diet. The finisher group on diet 5 (100% CCYM) recorded the lowest feed intake possibly because of the dustiness of the diet and the anti nutrients. The body weight gain of the finisher broilers on diet 2(25% CCYM) compared favourably with the control group. It appeared that finisher broilers could not tolerate high levels of cooked cocoyam meal. This shows that cooking is an effective processing technique for cocoyam tubers for finisher broilers (Onu et al, 2004). The cost of feed per kg decreases linearly (P > 0.05) with increase in the level of CCYM. This was due to reduced cost of cocoyam compared to maize which has a high economic implication in the use of these diets. The lower cost of feed per kg in finisher broilers was achieved with the diets 5(100% CCYM) producing at N70.44per kg weight gain respectively. The cost of production decreases with increase in the level of CCYM in finisher phase. The lowest cost of producing/kg broiler was observed in 100% level of CCYM and the highest cost of production/kg broiler was N588.28 in diets 3(50% CCYM). This was due to reduced cost of feed consumed which indicates economic implications in the use of cooked sundried tannia. The values on the feed conversion ratio increases with increase in the levels of CCYM in the finisher phase, thus indicating that the higher the levels of CCYM, the less the utilization of the diets. This may be attributed to the inability of the birds to extract required nutrients from the feed because of the anti-nutritional factors and dustiness of the feed

Conclusion

It was concluded that 30 minutes cooking of cocoyam tubers (*Xanthosoma sagittifolium*) was quite an effective method of processing cocoyam tuber meal for use in finisher broilers because cooking reduces the anti-nutrients in cocoyam tubers to a tolerable level for broiler chicken as illustrated in this study. It was concluded that cooked cocoyam tuber meal (*Xanthosoma sagittifolium*) could be used in the diet of finisher broilers up to 25% without affecting body weight gain, feed intake, feed conversion ratio and carcass characteristics as indicated in this study.

Recommendations

It is therefore recommended that large scale production of cocoyam (*Xanthosomasagittifolium*) for poultry feeding be encouraged so as to reduce the pressure of demand on maize. This may help to reduce the cost of poultry production and hence the cost of poultry products, eggs, and poultry meat.

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