

Dietary substitution of maize with processed cocoyam (*Xanthosomasagittifolium*) as energy source for finisher broilers production

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Abstract

Energy feed source like maize is expensive contributing about 50-55% of the cost of poultry and pig diets. Thus, the study was carried out to determine the dietary substitution of maize with soaked cocoyam *Xanthosoma sagittifolium* as energy source for finisher broiler production. The soaked cocoyam tuber meal was used to replace yellow maize in the diets of finisher broilers. *Xanthosoma cocoyam* corms were harvested, cleaned of soil and chopped into bits of about 0.2 cm. The chopped tannia was soaked in water in a large vat for 24 hours to reduce the ant nutrients and later on separated from the water and dried with microwave oven. The dried cocoyam was milled and then used. The proximate chemical composition showed that soaked cocoyam tuber meal contained 8.05% moisture, 91.95% dry matter, 10.08% ash, 2.01% crude protein, 1.60% ether extract, 3.80% crude fibre, 74.46% NFE and 3158.92Kcal/kg DM metabolizable energy. In the finisher broiler trial, the control diet contained maize as the main energy source while diets 2,3,4 and 5 contained 15%, 20%, 25%, and 30% soaked cocoyam tuber meal finisher diet was fed to a group of 30 broiler chicks for 4 weeks using completely randomized design. Each treatment was further grouped into 3 replicated of 10 birds each. The broilers were kept in deep litter and given feed and water ad libitum. Parameters measured included: initial body weight, final body weight, body weight gain, feed intake, feed conversion ratio, cost of production and carcass characteristic. In the finisher feeding trial, the finisher broilers on the control diet, diet 5 (30% SCYM), and diet 3 (20% SCYM) recorded similar feed intake which were significantly different ($P < 0.05$) from those on the other diets. In terms of body weight gain, the finisher broilers on 20% soaked cocoyam tuber meal diet recorded significantly ($P < 0.05$) high body weight than those on other diets while the finisher broilers on 25% soaked cocoyam tuber meal recorded the poorest body weight gain. It appeared that, the finisher broilers could not tolerate high levels of soaked cocoyam tuber meal in their diets. Cost of production (cost of feed x feed conversion ratio) was lowest for diet 5 (30% SCYM) N375 versus N422.99 for control diet in the finisher trial. The internal organs expressed as percent of the live weight were not affected by the treatments. The finisher broilers on diet 3 recorded the highest dressing out percentage of 73.90. There were no significant difference ($p < 0.05$) on percentage wings and back cut of the finisher broiler group in all the diets. The finisher broilers on diet 4 (25% SCYM) yielded the highest percent breast muscle of 32.4% followed by those on 15% SCYM (diet 2) and 20 SCYM (diet 3). The finisher broilers on the control diet yielded the highest percent thigh of 18.3% and the poorest were those on diet 2 (15% SCYM). The results of the trial have shown that soaked cocoyam tuber meal can be used to substitute maize at 20% in the diets of finisher broilers without affecting the weight gain, feed intake and feed conversion ratios as indicated in this study.

Keywords: Dietary, substitution, maize, processed, cocoyam, energy source, finisher broilers, performance

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Introduction

Energy feed sources like maize is expensive contributing about 50-55% of the cost of poultry and pig diets. The production of maize is low which means, it does not meet its demand (Agbede *et al.*, 2008; Hamza *et al.*, 2003; Okereke *et al.*, 2006). The cost of feed has invariably raised the cost of animal production and hence the selling price of animal products such as eggs, pork, and meat. This has worsened the low animal intake of Nigerians. Every adult or grown up person should consume a minimum of 35g of animal protein daily (FAO, 1982). The average in West Africa presently is only 7g (Oluyemi, 1978). Adejinmi *et al.*, 2000 reported the rising cost of feed resources in livestock production have been established as a serious impediment to meeting the demand for animal protein particularly in developing countries. The high cost of feed can be reduced by compounding of feed in a way that all the required nutrients come from cheap alternative energy and protein sources (Onyimonyi and Okeke, 2005).

One possible source of cheap energy is the cocoyam (*Xanthosoma sagittifolium*), which possesses readily available energy with easily digestible carbohydrate. The cocoyam has been described as possessing nutritional quality which could compare favourably with cassava, potatoes and yam (Bello, 1976).

The starch content is 17 to 34.5 percent, the average approximate composition of the edible portion has been quoted as: energy 566kj/100g; water 70-77 percent; protein 1.3-3.7 percent; fat 0.2 – 0.4%, carbohydrate 17 – 20%, fibre 0.6 – 1.9%, ash 0.6 – 1.3%, calcium 20mg/100g; Iron 1mg/100g; ascorbic acid 6-10mg/100g (Gooding, 1978). In Puerto Rico, production appears to exceed 20,000t/a and in Dominica Republic, 30,000t/a Gooding (1987). About 10kg cocoyam (*Xanthosoma*

spp) yields 3kg of flour (Gooding 1978). According to Anyaegbu *et al.* (2016), the NFE of fresh *Xanthosoma sagittifolium* was 63.91% and dried cocoyam, 74.40% while crude protein and metabolizable energy were 3.94% and 3179kcal/kg DM respectively. However, its use in the feeding of monogastric animals could be encumbered by the presence of some anti-nutritional factors like Oxalate, tannins, trypsin inhibitors, saponins and cyanide which adversely affect protein and energy utilization in monogastric nutrition (Onu *et al.*, 2004). Cooking and or supplementation with oil are common acceptable means of detoxification among Nigerians.

Considering the various attributes of *Xanthosoma sagittifolium*, it would appear that appropriate utilization of this feed stuff can be used to replace maize to produce low cost diets that can be efficient in promoting performance of finisher broilers and reduce demand pressure on maize as well as cost of production.

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, Nigeria. The area is located on latitude 5°27' North, longitude 7°32' East, in the rain forest zone in Umuahia, Abia State of Nigeria. This site has a mean daily temperature of between 27°C-36°C and a minimum of 20°C - 26°C with relative humidity between 57 and 91% and annual rainfall of 200mm per annum and an altitude of 122m above sea level. It is therefore, a humid tropical environment with temperature and relative humidity that are significant in agriculture production (Eburuja, 2010).

Procurement and processing of feed ingredients

Tannia cocoyam corm (*Xanthosoma sagittifolium*) was obtained from Ikot Ekpene L.G.A, in Akwa-Ibom State. The corms were harvested, cleaned of soils and chopped into bits of about 0.2cm. Chopped Tannia cocoyam were soaked in water for about 24 hours to reduce the anti-nutrients and later on separated from the water and dried with Microwave oven. The dried cocoyam were milled and then stored. Other ingredients like maize, palm kernel cake, fish meal, blood meal, bone meal, vitamins premix, salt, etc. were procured from Jocan Agro Services Umuahia, Abia State.

Chemical analysis of feed ingredients

The processed feed ingredients; Tannia cocoyam, palm kernel cake, brewers dried grains, blood meal, fish meal, were subjected to proximate analysis according to AOAC (1995) to determine their nutrient composition and gross energy.. The components that were determined included dry matter (DM), Crude Protein (CP), Ether Extract (EE), and Nitrogen free Extract (NFE).

Experimental design

The design of the study was Completely Randomized Design (CRD).

The Statistical Model is;

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

Where;

Y_{ij} = Individual observation

μ = Population mean

T_i = Treatment effect

e_{ij} = Error effect

Anti-nutrients determination

The test materials; fresh and soaked cocoyam (*Xanthosoma sagittifolium*) were analyzed for the anti-nutrients content such as oxalate, phytic acid, saponins, tannins and cyanide.

Experimental finisher broilers diets

For the finishers broilers, a control diet (diet 1) containing maize as the major source of energy were also made such that diets 2, 3, 4 and 5 contained 15%, 20%, 25% and 30% of soaked cocoyam meal supplemented with palm oil to replace maize in the diets. Other dietary ingredients were varied in order to provide the required protein and energy for the broilers. The following diets were produced and tested in the feed trial.

Table 1: Ingredient and Nutrient Composition of the Experimental Finisher Broiler Diets

Ingredients %	Diet 1 control	Diet 2 15% SCYM	Diet 3 20% SCYM	Diet 4 25% SCYM	Diet 5 30% SYCM
Maize	60.00	51.00	48.00	45.00	42.00
SCYM*	-	9.00	12.00	15.00	18.00
Soyabean meal	18.00	16.40	16.40	16.40	16.40
PKC	5.60	5.60	5.60	5.60	5.60
BDG	6.10	6.10	6.10	6.10	6.10
Blood med	3.00	3.00	3.00	3.00	3.00
Bone meal	3.70	3.70	3.70	3.70	3.70
Vitamin/mineral Premix**	0.25	0.25	0.25	0.25	0.25
Palm oil	-	1.60	1.60	1.60	1.60
l-methionine	0.10	0.10	0.10	0.10	0.10
Common salt	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00

Calculated Nutrient Composition of the Experimental Finisher Broiler Diets

Crude protein (%)	20.62	19.38	19.19	19.00	18.81
Crude fibre (%)	4.64	4.60	5.05	5.05	5.05
Ether extract (%)	6.24	6.16	5.86	5.87	5.75
Ash (%)	2.03	3.00	3.02	3.02	2.99
Calcium (%)	1.75	1.74	1.77	1.741.74	1.72
Phosphorus (%)	1.38	1.37	1.81	1.81	1.80
M.E.kal/kg	2875.64	2952.00	2942.20	2932.00	2921.81

PKC: Palm kernel cake, BDG: Brewers' Dried Grain , *soaked cocoyam meal , **to provide per kg diet: see starter uf/remix

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Management of the experimental finisher broiler chicks

A four week feeding trial was conducted using unsexed 150 Anak finisher broiler chicks (Fidanbroiler Chicks) at four weeks of age. They were divided into five groups of 30 broilers each and each treatment was subdivided into three replicates of 10 broilers each. Each replicate was housed in a pen. The broilers were weighed individually at the beginning of the experiment and their average initial weight and sex balanced and weighed weekly thereafter for determination of their growth performance. The broilers were assigned

the experimental diets using completely randomized design for four weeks. Both water and feed were given ad libitum.

Carcass evaluation

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

Table 4: Proximate composition of Experimental Finisher Broilers Diets containing different level of processed cocoyam tuber meal

Parameters	Diet 1 control	Diet 2 15% SCYM	Diet 3 20% SCYM	Diet 4 25% SCYM	Diet 5 30% SYCM	SEM
Dry matter (%)	89.70	89.86	89.88	89.76	89.81	0.03
Moisture (%)	10.29	10.14	10.12	10.24	10.91	0.03
Ash (%)	7.91	11.26	13.20	11.77	7.79	0.97
CP (%)	20.40	19.45	19.66	20.30	20.85	0.57
EE (%)	3.65	5.30	3.85	2.70	4.45	0.39
CF (%)	8.15	8.60	6.40	6.50	6.60	0.67
NFE (%)	48.32	45.25	47.77	44.49	50.12	0.92

CP: Crude fibre, EE: Ether extract, CF: Crude fiber, NFE: Nitrogen free extract

Table 5: Performance of the Experimental Finisher Broilers FedCocoyam Diets

Parameters	Diet 1 Control	Diet 2 15% SCYM	Diet 3 20% SCYM	Diet 4 25% SCYM	Diet 5 30% SCYM	SEM
Initial body wt (kg)	1.19 ^a	1.03 ^b	1.04 ^c	1.04 ^c	1.22 ^a	0.04
Final body wt (kg)	2.33 ^{ab}	2.04 ^b	2.31 ^c	1.95 ^c	2.27 ^{ab}	0.06
Body wt. gain (kg)	1.14 ^{ab}	1.01 ^b	1.27 ^a	0.91 ^c	1.05 ^b	0.06
Daily body wt gain (g)	40.71	36.07	45.36	32.50	37.50	1.94
Daily feed intake (g)	139.12 ^a	129.17 ^b	134.17 ^a	132.50 ^b	136.67 ^a	5.22
Feed conversion ratio	3.41 ^{ab}	3.58 ^{ab}	2.96 ^a	4.08 ^b	136.67 ^a	0.16
Mortality	-	-	-	-	-	-

^{abc}means within the same row with different superscripts are significantly different (P<0.05)

Body weight gain

In the finisher feeding trial, the broilers on 20% soaked cocoyam tuber meal (SCYM) recorded the highest body weight gain of 1.27kg which was significant higher (P<0.05) than those on the control diet. The

finisher broilers group on 25% SCYM recorded the poorest body weight gain. This could be due to the high level of soaked cocoyam tuber meal in their diets.

In the finisher phase (Table 5) the feed conversion ratio of the group on 20% soaked

cocoyam tuber meal based diet was significantly superior ($P<0.05$) to other groups. The group on 25% SCYM recorded the poorest feed conversion ratio.

Percentage dressed weight

The finisher broiler on 20% SCYM (diet 3) recorded significantly ($P<0.05$) the highest dressing out percentage of 73.90 following by those on the control diet, 15% SCYM

(diet 2), diet 5 (30%SCYM) and diet 4 (25% SCYM) respectively.

Economics of production of experimental finisher broilers

In the finisher broiler trial, the cost of production of 1kg of cocoyam based finisher broiler diet was cheapest for diet 5 (₦109.65) and the costliest was the control diet (₦121.55).

Table 7: Economics of Finisher Broilers Fed Experimental Diets

Parameters	Diet 1 Control	Diet 2 15% SCYM	Diet 3 20% SCYM	Diet 25% SCYM	Diet5 30% SCYM	SEM
Cost/kg feed (₦)	121.55 ^c	116.53 ^b	113.73 ^b	111.73 ^{ab}	109.65 ^a	1.84
Cost of prod./bird (₦)	422.99 ^c	376.39 ^b	305.06 ^b	493.85 ^{ab}	375.00 ^a	27.80

^{abc} means within the same row with different superscripts are significantly different ($P<0.05$)

Discussion

Anti-nutrient content and proximate composition of cocoyam (*Xanthosoma sagittifolium*)

The result of the trials in respect to the anti-nutrients content of both fresh and soaked cocoyam tuber reaffirmed the earlier work of Ahamefule and Odemelan (2008) that 24 hours soaking duration produced better results and would be preferred for reducing tannin and cyanide in feed ingredients. The acidity factors due to the presence of oxalate are reduced by peeling, grading, soaking and fermentation operation during processing (FAO, 1990). It therefore follows that diets based on soaked cocoyam tubers as source of energy could contain very little trace of Cyanide, tannins, oxalate, saponnins and phytic acid.

Performance of finisher broilers fedprocessed cocoyam based diets

The response of the finisher broilers to the soaked cocoyam tuber meal based diets was quite different in terms of feed intake, body weight gain and feed conversion ratio.

The finisher broilers on the control diet (30% SCYM) and diet 3 (20% SCYM) recorded similar feed intake from those on other diets. In terms of body weight gain, the finisher broilers on 20% soaked cocoyam tuber meal recorded higher body weight gain of 1.27kg than those on the control diet. The finisher broilers on 25% soaked cocoyam tuber meal recorded the poorest body weight gain. It appeared that the finisher broilers could not tolerate high levels of soaked cocoyam tuber meal in their diets. In terms of cost of production, diet 5 (30% SCYM) was the most efficient, giving a cost of N375.00 versus (N422)for the control diet. Possibly, the finisher broilers could not tolerate high level of soaked cocoyam tuber meal based diets due to the remaining anti nutrients in the soaked cocoyam such as tannins, oxalates, cyanide, phytic acid and saponins which according to Onu *et al.* (2004) which adversely affected protein and energy utilization in broilers.

The percentage cut part weight of the experimental finisher broilers are shown in (table 6).

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Table 6: Percentage Cut Part weights of the Experimental Finisher Broilers

Parameters	Diet 1	Diet 2	Diet 3	Diet	Diet 5	SEM
% High	18.31 ^a	17.36 ^{ab}	16.67 ^b	17.83 ^{ab}	17.66 ^{ab}	0.20
% Drumstick	15.01 ^{ab}	14.10 ^b	14.75 ^b	16.12 ^a	13.59 ^c	0.38
% Breast muscle	29.85 ^c	31.14 ^{ab}	31.20 ^{ab}	32.48 ^a	30.59 ^b	0.38
% Wings	13.46 ^a	11.60 ^a	12.20 ^a	13.06 ^a	12.30 ^a	0.29
% Backcut	22.23 ^a	22.66 ^a	21.47 ^a	21.33 ^a	23.63 ^a	0.38

^{abc}means within the same row with different superscripts are significantly different (P<0.05)

There were no significant difference (P<0.05) on percentage wings and backcut of the finisher broilers group in all the diets. The finisher broiler on diet 4 (25% SCYM) yielded the highest percent breast muscle of 32.4% followed by those on 15% SCYM (diet 2) and 20% SCYM (diet 3).

Significant differences also occurred in the yield of percent thigh. The finisher broilers on the control diet (diet 1) yield the highest percent thigh of 18.31% and the poorest were those on diet 2 (15% SCYM).

Internal organ weights

The percentage internal organs weight of the experimental finisher are shown in (Table 7).

Table 7: Percentage Internal Organ weight of the Experimental Finisher Broiler

Parameters	Diet 1	Diet 2	Diet 3	Diet	Diet 5	SEM
Av. Liveweight (g)	1850 ^{ab}	1880 ^{ab}	2030 ^a	1780 ^b	1850 ^{ab}	36.88
Dressed weight (g)	1280 ^{ab}	1300 ^{ab}	1500 ^a	1150 ^b	1200 ^b	53.54
% Dressed weight	29.19 ^{ab}	69.15 ^{ab}	73.90 ^a	64.61 ^b	68.86 ^{ab}	1.52
% Liver	1.70 ^a	1.65 ^a	1.98 ^a	1.91 ^{ab}	1.89 ^a	0.06
% Gizzard	1.75 ^b	2.27 ^a	1.98 ^b	2.13 ^a	1.97 ^c	0.08
And Heart	0.43 ^a	0.44 ^a	0.42 ^a	0.44 ^a	0.51 ^a	0.01
% Spleen	0.11 ^a	0.14 ^a	0.15 ^a	0.14 ^a	0.14 ^a	0.009
% Abdominal fat	1.14 ^b	1.21 ^{ab}	1.87 ^a	1.24 ^{ab}	0.89 ^c	0.14
% Large intestine	0.95 ^a	1.06 ^a	0.89 ^a	0.76 ^a	0.40 ^a	0.10
% Small intestine	2.47 ^a	2.03 ^a	2.35 ^a	3.04 ^a	3.13 ^a	0.19
%Proventriculus	0.42 ^a	0.48 ^a	0.47 ^a	0.55 ^a	0.55 ^a	0.02
% Kidney	0.58 ^a	0.56 ^a	0.70 ^a	0.60 ^a	0.46 ^a	.15
% Lungs	0.51 ^a	0.68 ^a	0.66 ^a	0.77 ^a	0.71 ^a	0.04

^{abc}means within the same row with different superscripts are significantly different (P<0.05)

The weights of the organs (livers, gizzards, hearts, kidneys, spleen, large intestine, small intestines, proventriculus and lungs) of the birds in all the groups were not affected. The birds in diets 3,4,5 and 1 accumulated more abdominal fat than others indicating higher efficiency of the birds in converting the carbohydrates of the diets into fat.

Conclusion

The study showed that 24 hour soaking duration of cocoyam tuber (*Xanthosomasagittifolium*) for processing

broilers diets was not quite as effective method of processing cocoyam tuber meal for use in broilers as there were still traces of cyanide, tannins, phytic acid, saponins and oxalates in soaked cocoyam tuber meal as illustrated in this experiment but at a tolerable levels.

Finisher broilers on 20% soaked cocoyam tubermeal performed better than those on maize based diet (control diet). Soaked cocoyam tubermeal could be used in the diet of finisher broilers up to 20% without affecting weight gain, feed intake and feed conversion ratio.

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