Nig. J. Anim. Prod. 2019, 46(4):153 - 160
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Nigerian Journal of Animal Production

Dietary evaluation of starter broiler chicks fed cooked cocoyam tuber meal (*xanthosoma sagitifolium*) as energy source in place of maize

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Abstract

Considering the inherent attributes of tannia cocoyam (Xanthosoma sagitifolium) its appropriate utilization may enhance performance of starter broiler chicks. This study was therefore carried out to determine the dietary evaluation of starter broiler chicks fed cooked cocoyam tuber meal as energy source in place of maize. The cooked cocoyam tuber meal was used to replace maize at various levels of 25%, 50%, 75% and 100% respectively for diets 2, 3, 4 and 5 to determine the best replacement level that would give optimal performance in starter broiler chicks' diets. Result of the proximate composition of cooked cocoyam tuber meal showed that it contained 13.11% moisture, 2.60% ash, 1.85% ether extract, 3.90% crude protein, 9.45% crude fibre, 70.13% nitrogen free extract and 3004.37 Kcal/kgME. 150 day old Anak broiler chicks were used for the experiment. They were divided into 5 treatment groups of 30 broiler chicks each. Each treatment group was subdivided into 3 replicates of 10 broiler chicks each and kept in deep litter. Each starter diet was fed to a group of 30 starter broilers for 4 weeks using completely randomized design. They were given feed and water adlibitum. Parameters measured include initial body weight, final body weight, body weight gain, feed intake, feed conversion ratio and economics of production. In the starter broiler feeding trial, the starter broilers on 25% cooked cocoyam meal compared favourably with the control (P > 0.05) in terms of feed intake, body weight gain and feed conversion ratio and significantly (P > 0.05) performed between than those on 100% CCYM. The cost of production (N/Kg broiler) was however cheapest for diet 2 (25% CCYM) N395 versus control diet (N494.28). It was therefore concluded that cooked cocoyam tuber meal (Xanthosoma sagitifolium) could be used in the diets of starter broiler chicks' up to 25% without affecting the body weight gain, feed intake and feed conversion ratio as indicated in this study.

Keywords: Dietary, evaluation, cooked cocoyam, energy source, broiler starter chicks.

Introduction

Feed cost accounts for up to 60 – 80% of the total cost of production in intensive poultry production (Tewe, 1997). 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 (Adejinmi et al, 2000). Therefore, it is necessary to reduce the cost of feed ingredients for poultry if the industry should survive. The reduction in cost should be such that the performance of the birds is not affected. It involves compounding feed in such a way that the needed nutrients should come from cheap alternative energy and protein sources in developing countries (Adejinmi *et al.,* 2005). Maize is the major source of energy in the diets for monogastric animals in Nigeria and may constitute up to 60% of the commercial poultry ration (FAO, 2004). Other grains used to a lesser extent include sorghum, millet, wheat, barley and oats. The local

production of cereal grains remains grossly inadequate for direct human consumption, livestock feed and for other industries. These shortages have therefore resulted in astronomical increase in the prices of maize in recent times in Nigeria. This has adversely affected the cost of production of pigs and poultry which depend almost entirely on concentrate feeds. Therefore, there is the need to look for cheap alternative non – conventional feedstuffs as energy source in place of maize for domestic poultry ration in Nigeria.

Cocoyam (*Xanthosoma sagitifolium)* is another cheap source of available energy for monogastric animals. Its carbohydrate is easily digestible. Its nutritional qualities can compare favourably with yam, cassava and potato (Bello, 1926). It is high yielding, disease resistant and 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. Several studies have shown that cocoyam contain digestible starch, protein, vitamin C, thiamin, riboflavin, niacin and high score of amino acids (Oke and Bolarinwa, 2012). Cocoyam plays an important role in digestion because it consists of high level of dietary fibre (a single serving contains 11.32% of the daily requirements of dietary fibre) is very important for supporting of gastrointestinal health. Due to the fiber content of other feed ingredient and that of cocoyam, fermenting cocoyam will help to breakdown the fibre content thus increasing the absorption of nutrient. However, like most varieties of cocoyam, the problem with *Xanthosoma sagitifolium* is its content of some anti-nutritional factors such as oxalates, cyanide, phytate and saponin, which could be limitation to its use (Okon *et al*., 2007). These limiting factors can be removed by boiling or sun drying (Abdulrashid *et al.,* 2006). Oxalates impact acid taste or cause irritation when foods prepared from them are eaten. Ingestion of foods containing oxalates has been reported to cause caustic effects, irritation to the intestinal tract and absorptive poisoning; oxalates are also known to interfere with the bioavailability of calcium. Oke (2012) reported that fermentation affected the oxalate and some physio chemical properties of cocoyam flour. Anyaegbu *et al*. (2017) reported that processed tannia cocoyam (*Xanthosoma sagitifolium*) can be used to replace maize at 30% in the diets of starter broilers without affecting body weight gain, feed intake and feed conversion ratio. Anyaegbu et al (2016) reported that the finisher broiler 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. Onunkwo *et al*. (2016) also reported that starter broiler chicks fed 10% of sundried cocoyam tuber meal (*Xanthosoma sagitifolium*) compared favourably with those on control diet (maize based diet) in terms of feed intake, body weight gain and feed conversion ratio and recorded significantly ($P < 0.05$) the highest body weight gain. Ohaemenyi (1993) reported that *Xanthosoma sagitifolium* corms can be cooked and used to some extent in the diets of growing pigs. Esonu (2000) reported that starter broiler chicks could tolerate up to 20% inclusion levels of wild variegated cocoyam (*Canadium hortulanum*). Considering the various attributes of cooked cocoyam tuber meal (*Xanthosoma sagitifolium*), it would appear that appropriate utilization of this feedstuff can be used to replace maize to produce low cost diets that can be efficient in promoting performance of starter broiler chicks 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 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 (*Xanthosoma sagitifolium*) 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 uses. 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 (*Xanthosoma sagitifolium*) were analysed for the anti-nutrients content such as oxalate, phytic acid, saponins, tannins and cyanide.

Experimental starter broiler chicks' diets

Five experimental starter broiler chicks diets were formulated for the starter phase of the feeding trial. The control diet (Diet 1) contained 58% maize as the major source of energy while diets 2, 3, 4 and 5 contained as major source of energy, cooked cocoyam tuber meal at 25%, 50%, 75% and 100% supplemented with palm oil to replace maize respectively. Other ingredients remained the same in the diets (Table 1).

Management of the experimental starter broilers chicks

One hundred and fifty day old Anak broiler chicks (Agrited broiler chicks) were brought from Ibadan. They were brooded together for one week with commercial starter broiler diet (Top broiler starter feed) to stabilize them before distributing them into five experimental treatment groups. Each treatment group contained 30 broiler chicks. Then each treatment was subdivided into three replicates of 10 birds each. Each replicate was kept in a pen covered with black polythene sheets to conserve heat. Heat was supplied with electricity and

Table 1: Ingredients and nutrients composition of the experimental starter broiler diets

Ingredients (%)	Diet 1 (Control)	Diet 2 25% CCYM	Diet 3 50% CCYM	Diet 4 75% CCYM	Diet 5 100% CCYM
Maize	58.00	43.50	29.00	14.50	-
CCYM*	-	14.50	29.00	43.50	58.00
Palm Kernel cake	3.00	3.00	3.00	3.00	3.00
Brewers dried grains	3.00	3.00	3.00	3.00	3.00
Soya bean meal	26.30	26.30	26.30	26.30	26.30
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	2.00	2.00	2.00	2.00	2.00
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	1.00	1.00	1.00	1.00	1.00
Total	100	100	100	100	100
Calculated nutrient composition of the experimental starter broiler diets					
Crude protein (%)	23.00	23.06	23.05	23.04	23.03
Crude fiber (%)	3.88	3.13	4.11	4.23	4.34
Ether extract (%)	7.38	6.92	6.45	5.98	5.52
Ash (%)	3.28	3.77	4.24	4.72	5.20
Calcium (%)	1.052	1.050	1.047	1.044	1.041
Phosphorus (%)	0.80	0.76	0.72	0.68	0.64
ME Kcal/Kg	2940.81	2874.81	2837.21	2892.91	2800.61

*Cooked cocoyam meal

**To provide per kg of Diet: Vit. A. 2000000 iu. Vit D3. 4000 iu; Vit E, 80g; Vit K. 0.49; Vit B2 1.0g; Folic Acid, 0.2g; Biotin, 8.00mg; choln 4800g; BHT, 32.00G, Manganese, 16.00; Iron, 8.00; Zinc, 7.2g; Copper, 0.32g; Iodine, 0.25; Cobalt, 26.00mg; Selenium, 16.00g

kerosene lantern during the brooding period. The floor of the pen was covered with wood shavings. Each group was randomly assigned to an experimental starter broiler diet in a completely randomized design (CRD) and was fed for 4 weeks. Feed was supplied in feeding troughs built in such a way as to minimize wasting of feed. Water was supplied ad libitum. Feeding was done once daily around 8am. The birds were weighed at the beginning of the feeding trial and weekly thereafter. Feed intake was recorded daily by weighing the quantity of feed given and the left over the following morning. The starter phase of the trial lasted for 4 weeks. Health management practices were carried out on the broiler chicks. The chicks were given anti stress on arrival to boost their energy level. They were given Newcastle disease vaccine strain (NDV) by intraocular (1/o). The first Gumboro vaccine was administered at the end of the second week through drinking water and Lasota vaccine against New castle disease (Lasota strain) was administered at the end of the third week and the final Gumboro vaccine was administered at the end of the fourth week against infectious bursa disease (Gumboro). Coccidiostat and other antibiotics were also administered by drinking water when there were signs of infection.

Data collection

Parameters determined were: daily feed intake, body weight gain, final live weight, initial body weight, feed conversion ratio, mortality, cost of production.

Data analysis

The data collected were subjected to one

way analysis of variance (ANOVA) according to Snedecor and Cochran (1989), where significant treatment effects were detected from the ANOVA, means were separated using Duncan's New Multiple Range Test (Duncan, 1955).

Results

Anti-nutrient composition of fresh and cooked cocoyam tuber meal *(Xanthosoma sagitifolium*)

Data on the Anti-Nutrients composition of fresh and cooked Tannia *(Xanthosoma Sagitifollium*) were shown in (Table *2*). There were significant difference (P<0.05) in cyanide, Oxalate, Tannin and saponin content of both the fresh and cooked cocoyam tuber meals. The values obtained from the cooked samples were lower; There were no significant difference (P> 0.05) in phytic acid, and saponin content of both the fresh and cooked tannia *(Xanthosoma sagittifolium*) 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 fresh and cooked cocoyam tuberMeal *(Xanthosoma sagitifolium*)

Parameters	Fresh tannia	Cooked tannia	SEM
Cyanide (mg CN/g)	1.29[a]	0.21[b]	0.73
Phytic Acid (%)	57.23[a]	56.09[a]	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 significant ly different (P<0.05)

Proximate composition of fresh and cooked cocoyam tuber *(Xanthosoma sagittifolium)*

Data on the proximate composition of fresh and cooked cocoyam tuber meal *(Xanthosoma Sagitifollium*) were shown in (Table 3). There were 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 tolerable levels. 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.

Performance of the experimental starter broilers

Feed intake

In the starter feeding trial, the average feed intake of the experimental groups were 50.00, 46.25, 47.75, 15.26 and 12.84 for those on control diet (diet 1) 2, 3, 4, and 5 respectively (Table 5). The feed intake of the groups on the (diet 2) 25 % cooked cocoyam, diet 3 (50 % CCYM) diet 4 (75 % CCYM) were similar and compared

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

Parameter	Fresh Cocoyam tuber	Cooked Cocoyam	S.E.M
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 Fiber *%*	9.45[a]	4.74[b]	1.67
Ether Extract %	2.10[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 starter broiler diets

Parameters	Diet 1 (Control)	Diet 2 (25% CCYM)	Diet 3 (50% CCYM)	Diet 4 (75 % CCYM)	Diet 5 (100 % CCYM)	S.E.M
Moisture %	9.65	10.35	11.64	12.35	12.80	0.53
Ash %	7.85	8.14	8.60	9.55	10.68	0.46
Crude Protein %	20.13	19.88	19.05	18.38	18.00	0.37
Crude Fiber %	6.10	8.15	9.10	11.00	12.50	0.99
Ether Extract %	3.90	3.32	2.90	2.68	2.45	0.23
NFE %	52.37	50.23	48.71	46.04	43.57	1.38

favorably with those on the control diet (P<0.05). The starter group on diet 5 (100 % CCYM) recorded significantly (P<0.05) the lowest feed intake.

Body weight gain

In the starter feeding trial, significant differences (P<0.05) existed among the groups in body weight gain. The starter group on diet 2 (25 % CCYM) compared favorably with the control group in terms of body weight gain. The body weight gain of those on diets 3 and 4 were similar and significantly (P<0.05) higher than those on diet 5 (100 % CCYM).

Feed conversion ratio

The feed conversion ratio of the starter experimental groups were 1.95, 1.80, 2.03, 3.08 and 2.67 for the control diet, diet 2, 3, 4 and 5 respectively (Table 5). Significant differences (P<0.05) existed among the groups in feed conversion ratio. The starter groups on the control diet and diet 2 recorded similar feed conversion ratio which were significantly (P<0.05) better than other groups.

Mortality

There was no mortality recorded during the starter phase of the feeding trial.

Table 5: Effects of the Experimental Diets on the Performance of Starter Broilers

Parameters	Diet 1 (Control)	Diet 2 25% CCYM	Diet 3 50% CCYM	Diet 4 75% CCYM	Diet 5 100% CCYM	S.E.M
Initial Body wt. gain (g)	180.00	151.00	170.33	170.00	160.33	4.42
Final Body wt. gain (kg)	900.00^{a}	869.37^{a}	659.94^{b}	597.20°	519.70°	69.09
Body wt. gain (kg)	720.00^{a}	718.37^{a}	489.61^{b}	427.20^{b}	359.37^{c}	66.95
Daily Body wt. gain (g)	25.71^{a}	25.66^{a}	23.57^{b}	15.26^{ab}	12.84°	2.44
Daily Feed intake (g)	50.00^{a}	46.25^{a}	47.75^{a}	47.00^{a}	34.25^{b}	2.48
Feed Conversion Ratio	1.95^{a}	1.80^{a}	2.03^{ab}	3.08^{c}	2.67^{b}	0.22

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

Economics of production of experimental starter broilers

In the starter feeding trial, the cost of production of 1kg of cooked cocoyam based starter broiler diet was cheapest for diet 5 (100% CCYM) (N82.74) and the costliest was the control diet (N182.50). Consequently, the cost of production of 1kg starter broiler was cheapest for diet 2 (25% CCYM) N395.00 versus N494.28 for the control diet.

Table 6: Economics of production of experimental starter broilers

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Cost/kg feed	182.50^{c}	157.56^{ab}	132.64^{ab}	107.68^{b}	82.74^{a}
Cost of production/kg broiler	494.28^{b}	395.00^{a}	549.51^{ab}	776.70^{c}	615.38^{c}

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

Discussion

The result of the trials in respect to the anti-nutrient content of both raw and cooked cocoyam tuber showed that the raw cocoyam tuber contained cyanide up to 1.29 (mg CN/g) but cooking reduced it to 0.21 (mg CN/g) which was tolerable to the broiler chicken. Other anti-nutrients contents like tannins, oxalate were also reduced by cooking. (Agwunobi *et al.,* 2002) reported that cooking, sundrying cocoyam corms reduce 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 the starter broilers

The feed intake of starter broilers on diet 2 (25 % CCYM), diet 3 (50 % CCYM) and diet 4 (75 % CCYM) were similar and compared favorably ($P<0.05$) with those on the control diet. In terms of body weight gain, the starter group on diet 2 (25 % CCYM) compared favorably; ($P<0.05$) with the control group in terms of body weight gain. The better performance of the starter broilers on cooked cocoyam meal showed that cooking is an effective processing technique for cocoyam tubers for broiler chicks (Onu *et al.,* 2004).

Conclusion

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

Recommendations

It was therefore recommended that large scale production of cocoyam (*Xanthosoma sagitifolium*) 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 meat.

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Received: 16th August, 2019
Accepted: 19th December, 2019