Nutritional evaluation of fermented cocoyam tuber meal (*Xanthosoma sagitifolium*) as energy source in place of maize in starter broiler production

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Abstract

*Considering the inherent attributes of cocoyam tuber meal (*Xanthosoma Sagitifolium*), its appropriate utilization for chicken diets may enhance performance of broiler chicken. This study was therefore carried out to determine the nutritional evaluation of fermented cocoyam tuber meal as energy source in the diets of starter broilers production. The fermented cocoyam was used to replace maize at various levels to determine the best replacement that would give optimal performance in starter broilers diets. One hundred and fifty 150 day old Agrited starter broilers were used for this experiment. The proximate composition of fermented cocoyam tuber meal (FCYM) showed that it contained 19.5% moisture, 1.30% ash, 3.56% Crude protein, 5.30% crude fibre, 1.9% ether extract and 25.48% NFE. In the starter feeding trial, the fermented cocoyam was used to replace maize at levels of 25%, 50%, 75% and 100% respectively in the control diet. Each starter diet was fed to a group of 30 broilers chicks for four weeks using completely randomized design. Each treatment was divided into three replicates of 10 broiler chicks each. Parameters measured include initial body weight, final body weight, body weight gain, feed intake, feed conversion ratio and cost of production. In the starter feeding trial, the starter broilers on 25% FCYM compared favorably with those on the control diet ($P>0.05$) in terms of feed intake, feed conversion ratio and body weight gain and hence recorded the higher body weight gain. The cost per kg feed produced was N182.50 for the control diet and the lowest was diet 5 (100% FCYM) which was N82.74. The cost of production (cost/kg feed x feed conversion ratio) of starter broilers per kg body weight gain was lowest for diet 5 (100% FCYM) (N158.86), while the costliest was those on the control diet (N383.25). The results of the trial have shown that fermentation of cocoyam tuber meal for 4 days for formulating starter broiler diets was quite an effective method of processing because fermentation reduced the anti-nutrients content. It was concluded that fermented cocoyam tuber meal could be used in the diets of starter broilers up to 25% without affecting body weight gain, feed intake and feed conversion ratio as indicated in this study.*

Keywords: Nutritional, Evaluation, Fermented Cocoyam, Energy Source, Broiler Starter.

Introduction

The greatest proportional cost in livestock production is expended on feeding with the exception of ruminants whose feed is based on pasture. In non-ruminant animals such as pigs and poultry, feed ingredients represent 65 to 70% of the total cost in an intensive production system in Nigeria as in many developing countries (Tewe, 1997).

Energy source constitute between 45 and 60% of finished feeds for these animals (Tewe *et al.*, 1992), and at present, maize is the commonly used source of energy in livestock feeds (Olurin *et al.*, 2006). The increasing pressure on the use of maize by human population and livestock feed millers coupled with the cost of maize which fluctuates with the time of the year,

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thus making the cereal grain to be either scarce or expensive, stimulate the use of alternative sources of energy that are locally available, particularly the starchy roots and tubers that are abundant in many areas of humid tropics. Although roots and tubers are cheap sources of energy, the extent of their practical use in non-ruminant feeding has been limited. A lower percent of cocoyam produced is used as livestock feed (Tewe *et al.*, 1992). Cocoyam can be a source of energy in poultry diets. Cocoyam refers to members of the genus

Colocasia and the genus Xanthosoma which are used for food and feed when referred to separately, colocasia species are called taro while xanthosoma species are called tannia. Cocoyam is recognized as cheaper carbohydrate source than grains or other tuber crops (Obioha, 1972). It has high caloric yield per hectare, low production cost (Hahn, 1984) and relatively low susceptibility to insect and pest attack. Cocoyam has readily digestible starch content because of its small particle size (Lyonge and Nzetcheng, 1986; Ezedinma, 1987). 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 low cost. Its use in feeding of Monogastric animals could be encumbered by the presence of some anti-nutritional factors (Oxalate, tannins and trypsin inhibitors which adversely affect protein and energy utilization in broilers (Onu, *et al.*, 2004). Anyaegbu *et al.* (2016), reported that the finisher broiler group on 15% sun dried cocoyam tuber meal (*Xanthosoma sagittifolium*) diets 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 broiler chicks fed 10%

sun dried cocoyam tuber meal compared favorably with those on the control diet (maize based diet) in terms of feed intake, weight gain and feed conversion ratio and recorded significantly ($P < 0.05$) the highest body weight gain. Considering the attributes of fermented cocoyam tuber meal (*Xanthosoma sagittifolium*), it would appear that appropriate utilization of this feedstuff can be used to produce diets which can be efficient in promoting performance of starter broilers and reduce demand pressure on maize as well as cost of production of broilers.

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, Umuahia in Abia State. The area is located on latitude $05^{\circ} 27'$ North, longitude $07^{\circ} 32'$ East, in the rain forest zone in Umuahia, Abia State of Nigeria. This site has a mean daily temperature of between 27°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 agricultural production (Eburuaja, 2010).

Procurement and processing of feed ingredients

Tannia cocoyam (*Xanthosoma sagittifolium*) was obtained from Ehime Mbano Local Government Area in Imo State. The corms were harvested, cleaned and chopped into bits of about 0.20cm. Chopped cocoyam was fermented in water in large vats for 4 days to reduce the anti-nutrient content and later on separated from the water and dried with electric oven. The dried cocoyam was milled and then stored for use. Other ingredients like maize, palm kernel cake,

brewers dried grains, blood meal, fish meal, bone meal, vitamin premix, lysine, methionine, salt etc. were bought from Jocan livestock services, Umuahia, Abia State.

Chemical analysis of food ingredients

All the processed feed ingredients, fermented cocoyam tuber meal, palm kernel cake, brewers dried grains, blood meal, fish meal were subjected to proximate analysis according to (AOAC 1995) to determine their nutrients composition and gross energy. All analysis was based on 100% dry matter. This was done so as to use the values that were obtained to determine the nutrient composition of the experimental diets that were formulated from them. The components that were determined include; Dry Matter (DM), Crude Protein (CP), Ether Extract (EE), and Nitrogen Free Extract (NFE).

Anti-nutrients determination

The test materials fresh and fermented cocoyam tubers (*Xanthosoma sagittifolium*)

were analyzed for the anti-nutrients content such as oxalate, phytic acid, saponins, tannins and cyanide.

Experimental starter broiler diets

Five experimental starter broilers were formulated for the starter phase of the feeding trial. The control diet (Diet 1) contained 58% maize as the major sources of energy. Diets 2,3,4 and 5 contained as source of energy and fiber fermented cocoyam at 25%, 50%, 75% and 100% respectively to replace maize. Other ingredients remained the same for the diets (Table 1).

Experimental design

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

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

Where:

Y_{ij} = Individual observation

μ = population mean

T_i = Treatment effect

e_{ij} = Error Effect

Table 1: Percentage ingredients and nutrient composition of starter broilers fed experimental diets

Ingredients (%)	Diet1 Control	Diet 2 25%	Diet 3 50%	Diet 4 75%	Diet 5 100%
Maize	58.00	43.50	29.00	14.50	0.00
FCYM*	-	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
Soyabean 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					
Crude Protein %	24.08	23.84	23.69	23.50	23.30
ME Kcal/kg	2940.81	2874.81	2837.21	2892.91	2800.61

*Fermented Cocoyam Meal.

**To provide per kg of Diet: Vit. A 10,000 IU, Vit. D3: 2,000 IU, Vit:51 IU, Vit. K: 2.34mg, Riboflavin: 5.5mg, Calcium pantothenate: 10mg, Niacin: 25mg, Choline chloride: 250mg, Folic acid: 1mg, Manganese: 56mg, Zinc: 50mg, Copper: 10mg, Iron: 20mg, Cobalt: 1.25mg, Amprolium: 125mg and Te tracycline: 100mg.

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Management of the experimental starter broilers

One hundred and fifty days old Agrited broiler chicks were bought from C and G Agric Enterprises, Umuahia, Abia State. They were brooded 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 thirty (30) broiler chicks. Then each treatment was subdivided into three replicates of 10 birds each. Each replicate was kept in a pen and covered with polythene sheets to conserve heat. Heat was supplied with electricity and 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 diet using completely randomized design (CRD) and was fed for four weeks. Feeds were 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 four weeks.

Data collection

The parameters that were determined are; daily feed intake, body weight gain, final live weight, weekly body weight gain, feed conversion ratio, mortality and cost of production.

Data analysis

The data collected was 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 (Steel and Torrie, 1980).

Results

Data on the anti-nutrient composition of raw and fermented cocoyam tuber meal were shown in (Table 2). The cyanide content of the raw cocoyam was high but fermentation in water for 4 days and oven drying helped to reduce it from 1.30mg CN/g in the raw tubers to 0.15mg CN/g in the fermented cocoyam tuber meal, the tannin, saponin and the oxalate contents of the raw cocoyam tubers were also reduced by fermentation.

Table 2: Anti nutrient composition of raw and fermented cocoyam tuber meal (*xanthosoma sagittifolium*)

Parameters	Raw cocoyam tuber	Fermented cocoyam
Cyanide (mg CN/g)	1.30	0.15
Phytic acid (%)	54.74	51.70
Tannin (%)	1.51	0.14
Saponin (%)	26.42	23.30
Oxalate (%)	12.30	11.01

Data on the proximate composition of raw and fermented cocoyam tuber meal (*xanthosoma sagittifolium*) was shown in (Table 3). The moisture and crude fibre content of raw cocoyam tubers were high

but fermentation and drying reduced them to tolerable levels. The percent ash, crude protein, ether extract and NFE of both the raw and fermented cocoyam tuber meal were not affected by the fermentation process.

Table 3: Proximate composition of raw and fermented cocoyam tubers (*Xanthosoma Sagittifolium*)

Parameters (%)	Raw cocoyam Tuber	Fermented cocoyam
Moisture	58.05	19.15
Ash	3.95	1.30
Crude Protein	5.43	3.56
Crude Fibre	9.72	5.30
Ether extract	3.10	1.90
NFE	59.79	25.48

The results of the growth performance of broiler starter fed fermented cocoyam tuber meal (*Xanthosoma sagittifolium*) is presented in Table 4. In the starter trial, the average daily feed intake of the experimental groups were 32.50, 30.00, 30.50, 29.25, 27.25 for the broiler group on control diet, diet 2, 3, 4, and 5 respectively. There is no significant difference in their feed intake, although there were differences in their numerical values. The broiler group on the control diet (diet 1) recorded higher feed intake which was significantly ($p<0.05$) different from those on fermented cocoyam based diets. The starter broiler on diets fermented cocoyam based diet recorded the lowest feed intake.

No significant differences ($p>0.05$) existed among the treatment groups in their body

weight gain. The starter broilers on 25% FCYM recorded numerically higher body weight gain which were significantly ($p<0.05$) higher than other groups. The body weight gain of the starter broiler on diet 1 (control diet) and diet 3 (50%FCYM) were similar and significantly ($p<0.05$) higher than those on diets 4 and diet 5.

Significant differences ($p<0.05$) existed among the starter broiler groups in their feed conversion ratio. The starter broiler on diet 5 (100% FCYM) recorded the lowest feed conversion ratio of 1.34 which was significantly different from those in other groups. The feed conversion ratio of those on diets 2, 3, and 4 were similar and significantly ($p<0.05$) lower than those on the control diet.

No mortality was recorded during the starter broiler phase.

Table 4: Effects of experimental diets on the performance of starter broilers fed fermented cocoyam tuber meal in their diets

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	SE M
	(control)	25% FCYM	50% CYM	75% CYM	100%	FCYM
Initial body wt.(g)	186. 67	183. 33	186. 67	176. 67	183. 33	1. 63
Final body wt.(g)	776. 66	780. 00	776. 66	736. 66	736. 66	9. 02
Body wt. gain	589. 99 ^b	596. 67 ^a	589. 99 ^b	559. 99 ^c	553. 33 ^c	7. 92
Daily body wt.gain(g)	21. 07	21. 31	21. 07	20. 00	19. 78	0. 28
Daily feed intake	32. 50	30. 00	30. 50	29. 25	27. 25	0. 76
Feed conversion ratio	1. 54 ^b	1. 41 ^b	1. 45 ^b	1. 46 ^b	1. 34 ^a	0. 03

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

The results of cost benefit of starter broilers fed fermented cocoyam tuber meal is shown in Table 5. In the starter trial, the cost of production per kg of cocoyam based starter broiler diet was cheapest for diet 5

(100%FCYM), N82.74 while the costliest was the control diet N182.50. The cost of production per kg broiler was cheapest for diet 5 (N158.86) and the costliest was those on the control diet N383.25.

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Table 5: Cost benefit of broiler starter feed fermented cocoyam tuber meal in their diet

Parameters	diet 1	diet 2	Diet 3	diet 4	diet 5	SEM
Cost/kg feed (N)	182.50 ^c	157.56 ^{ab}	132.64 ^{ab}	107.68 ^b	82.74 ^a	15.77
Cost of production/kg	383 ^a	266.28 ^a	192.33 ^b	157.21 ^c	158.86 ^c	2.50

abc: Means on the same rows with different superscripts are significantly different (p<0.05)

Discussion

The result of the trials in respect to the anti nutrient content of both fresh and fermented cocoyam tuber showed that the fresh cocoyam tuber contained cyanide up to 1.30mg CN/g but its fermentation in large vats reduced it to 0.15mg CN/g which was tolerable to the broiler chicks. This reaffirmed the earlier work by (Anyaegebu *et al.*, 2012) that four days fermentation duration produced better results and would be preferred for reduction of cyanide in tuber crops like cassava and cocoyam. The tannin content of the cocoyam tubers was also reduced from 1.51% to 0.14% by fermentation. This also showed that fermentation was very effective for reducing the tannin content of the cocoyam tubers as well. 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 fermented cocoyam tuber meal as source of energy could contain very little trace of cyanide, tannin, oxalate, saponin and phytic acid.

Performance of the starter broilers

There were no significant (p<0.05) differences in the feed intake of the starter groups. The feed intake of the starter broilers on fermented cocoyam based diets was similar and compared favorably with those on the control diet. It appeared that the starter broilers could tolerate the high levels of fermented cocoyam tuber meal in their diets. In terms of the body weight gain, no significant differences existed among the starter broilers in their weight gain. The

starter broiler on 25% FCYM recorded numerically higher body weight gain than those in other groups. The better performance of the starter broilers on fermented cocoyam based diets in terms of feed intake and body weight gain agreed with the findings of (Anyaegebu *et al.*, 2012) who confirmed that four days fermentation duration produced better result and would be preferred for reduction of cyanide in tubers like cassava and cocoyam.

Conclusion

The study revealed that four days fermentation duration of cocoyam tubers (*Xanthosoma sagittifolium*) for processing broiler diets was quite an effective method of processing cocoyam tuber meal for use in starter broilers because fermentation reduced the cyanide, tannins, oxalate and saponin content of the cocoyam tubers to a tolerable levels for the broiler chicks as illustrated in this experiment. It was concluded that fermented cocoyam (*Xanthosoma sagittifolium*) could be used in the diets of starter broiler up to 25% without affecting body weight gain, feed intake and feed conversion ratio. This was shown by the superior performance of the starter broilers on diet 2 (25%FCYM).

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