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Effect of feeding different levels of fermented and unfermented cassava tuber meals on performance of broilers

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Abstract

Studies were conducted to determine the relative effects of fermented and unfermented sun-dried cassava tuber meals as source of energy in broiler diets. A batch of fresh bitter cassava tubers (TMS 30572 variety) was cut into pieces, dried in the sun and milled (UFC). Another batch was cut into pieces, fermented in water for 4 days, dried in the sun and milled (FC). Both fresh cassava tubers and processed meals were analyzed for proximate composition and cyanide contents. In the first experiment, the meals were used to make 7 iso-nitrogenous broiler starter diets such that diet 1 (the control) contained maize as source of energy while in diets 2, 3 and 4, 50%, 75% and 100% of the maize in the control diet was replaced with UFC and in diets 5, 6 and 7, the maize was similarly replaced with FC. Each diet was fed to a group of 24 broiler chicks replicated into 2 from 1 week old to 5 weeks old. In the second experiment, the meals were used to make 7 iso-nitrogenous broiler finisher diets, using replacement levels as in the starter trial, and each diet fed to a group of 22 broiler chicks replicated into 2 from 5 weeks old to 9 weeks old. Fresh cassava tuber contained 0.44mg HCN/gm while unfermented and fermented meals contained 0.15mg HCN/gm and 0.08mg HCN/gm, respectively. There were no significant differences ($P>0.05$) in proximate composition of the three samples. In the starter trial, the group that received the diet in which 50% of maize was replaced with UFC or FC compared favourably with the control in performance ($P>0.05$). Although at 100% replacement level, both UFC and FC significantly depressed performance of the chicks, UFC resulted in severe stunted growth and ruffled feathers of the chicks. In the broiler finisher trial, replacement of maize up to 75% with FC produced no adverse effect ($P>0.05$) whereas at that level, UFC significantly depressed performance ($P>0.05$).

Keywords: Fermented cassava tuber meal; unfermented cassava tuber meal; broilers

Introduction

Maize is the major source of energy in poultry diets and constitutes about 60% of broiler diets. It also serves as a major staple foodstuff for a good proportion of Nigerians. But its ever-increasing demand for human consumption, livestock feeds and industrial uses in the country has pushed its market price to alarming height. The increase in the price of maize has adversely affected the cost of production of poultry and pigs in the country as these animals depend almost entirely on concentrate feeds. Therefore, there is the need for exploitation of other energy sources as alternatives to maize if poultry enterprise in the country is to be sustained.

Cassava (*Manihot esculenta*) is capable of providing very high yields of energy per hectare, about 13 times more than maize or guinea corn (Oyenuga, 1961; Omole, 1977; Oke, 1978).

Cassava production in Nigeria is estimated at about 13 million metric tonnes per annum (FAO, 1985). It therefore has very high potential as alternative to maize as source of energy in poultry diets even though it is low in protein and other essential nutrients when compared with maize (Muller *et al*, 1975; Hutagalung, 1977; Asaodu, 1988; Odukwe, 1994).

One serious draw-back in the use of cassava as feedstuff for non-ruminants is its content of cyanogenic glucosides, linamarin and lotaustralin, which on hydrolysis inside the animal produces hydrogen cyanide (HCN) which is highly toxic (Nartley, 1973; Hill, 1977). The ability of cassava to produce cyanide is the basis of its toxicity. Okeke (1980) has suggested that for cassava root meal to be used in poultry feeds, it has to be processed so as to reduce its total cyanide content from about 360mg/kg to about 15-20mg/kg.

Various methods have been deviced for detoxifying cassava tuber meal, including cooking (Okeke *et al*, 1985), soaking in water (Rajaguru, 1975), sundrying (Odukwe, 1994) and use of additives (Obioha *et al*, 1984; Adegbola, 1977; Odukwe, 1994). Results of those processes are conflicting. Live animal experiments conducted using cassava tuber meal have also given contradictory results. Muller *et al* (1975) and Stevenson and Jackson (1983) reported that a rate of 50% of cassava in the diet by no means impaired the growth performance of broilers whereas Longe and Oluyemi (1977) as well as Willie and Kinabo (1980) observed linear decrease in weight of broilers resulting from increase in the quantity of cassava tuber meal in the ration. There is the need therefore to develop suitable method of processing cassava tubers for dietary inclusion for poultry and livestock. The study herein reported was therefore designed to determine the performance of broilers fed different levels of fermented and unfermented sun-dried cassava tuber meals as substitute for dietary maize.

Materials and methods

Source and Processing of Cassava Tubers

The bitter cassava tubers (TMS 30572 variety) used for the experiments were produced at Akokwa in Ideato North Local Government Area of Imo State – Nigeria. The unpeeled cassava tubers were divided into 2 batches. The first batch was washed to remove sand and then cut into small pieces of 1.0 – 2.0cm. The pieces were then spread on large polythene sheets and dried in January sunshine for 4 days until they were crispy. They were then milled to produce unfermented cassava tuber meal (UFC). The second batch was washed and cut into larger pieces. The pieces were then immersed in water in large vats, left outside and allowed to ferment for 4 days. The fermented cassava tubers were then put in sacks and manually pressed to remove water before sun-drying. Sun-drying took 3 days of the same January sunshine to dry to 90% dry matter. The fermented sun-dried cassava pieces were then milled to produce fermented cassava tuber meal (FC).

Samples of fresh unprocessed cassava tuber meal (FUC), fermented and unfermented cassava tuber meals (UFC and FC) were analyzed for proximate composition and content of hydrocyanide using the method of AOAC (1990). Hydrocyanide content was determined using the method of AOAC (1975).

Feeding Trial 1: Broiler Starter

Experimental Diets

Seven iso-nitrogenous broiler starter diets were made such that diet 1 (control) contained maize as the main source of energy and no cassava tuber meal. Diets 2, 3 and 4 were made such that 50%, 75% and 100% of the maize in the control diet was replaced with the unfermented cassava tuber meal (UFC), respectively, with adjustment in protein sources. Diets 5, 6 and 7 were made such that 50%, 75% and 100% of the maize in the control diet was replaced with the fermented cassava tuber meal (FC), respectively, also with adjustment in the protein sources. Ingredient composition of the diets is shown in Table 1.

Table 1: *Ingredient and nutrient composition of the experimental broiler starter diets*

Ingredients %	Control	50% UFC	75% UFC	100% UFC	50% FC	75% FC	100% FC
Maize	50.0	25.0	12.5	0.0	25.0	12.5	0.0
Fermented cassava (FC)	-	-	-	-	25.0	12.5	0.0
Unfermented Cassava (FC)	-	25.0	37.5	50.0	-	-	-
Soybean meal	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Palm kernel cake	6.0	4.5	4.0	3.0	4.5	4.0	3.0
Blood meal	2.5	4.0	4.5	5.5	4.0	4.5	5.5
Wheat offal	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Bone meal	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Common salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Trace Min/Vit. Premix*	0.25	0.25	0.25	0.25	0.25	0.25	0.25
L-Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25
L-methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Chemical composition (Calculated)							
Crude Protein (%DM)	22.82	22.78	22.78	22.80	22.79	22.81	22.81
Crude Fivre (%DM)	4.57	6.13	6.66	7.31	6.33	6.89	7.34
Ether Extract (%DM)	3.83	3.01	2.82	2.34	2.82	2.33	2.24
Total Ash(%DM)	2.85	2.96	3.93	4.14	2.96	3.93	4.14
ME (Kcal/g)	2.77	2.83	2.83	2.83	2.84	2.90	2.91

* Each kg feed contained: Vit.A, 2000,000iu; Vit.D_3, 400iu; Vit.E, 8.0g; Vit. K, 04g; Vit.B_1, 03g; Vit.B_2,1.0g; Vit.B6,0.6g; Vit.C,24.0g; Vit.B_{12},4.0g; folic acid, 0.2g; Biotin,8.0g; Choline. 48.0g; BHT, 32.0g; Mn. 16.0g; Fe, 8.0g; Zn, 7.29; Cu, 032g; Iodine,0.25g; Co,36.omg; Se,16.0mg.

Experimental Birds and Design

A total of 168 day-old broiler chicks (Avian 35k Anak breed) were selected from a batch bought from a hatchery at Abeokuta, Ogun State. The chicks were fed commercial broiler starter diet (Guinea broiler starter feed) for a week before distributing them into 7 treatment groups of 24 birds each and each group randomly assigned to a treatment diet. Each group was further sub-divided into 2 replicates of 12 birds each and each replicate kept in a compartment measuring 2m x 3m. Each compartment was covered with black polythene sheets for conservation of heat. Heat was supplied with both electricity and kerosene lantern. Feed and water were provided *ad libitum*. Feed offered and the left-over on the following day were weighed to determine the feed intake of the birds. The birds were weighed at the beginning of the trial and weekly thereafter. The trial lasted 4 weeks, from 1week old to 5 weeks old.

Data Analysis

Data collected (initial and final body weights, growth rate, feed intake and feed conversion ratio) were subjected to one-way analysis of variance as outlined by Snedecor and Cochran (1978). Where the analysis of variance indicated significant treatment effects, means were compared using least significant difference (LSD) as outlined by Snedecor and Cochran (1978).

Feeding Trial 2: Broiler Finisher Experimental Diets

Seven iso-nitrogenous broiler finisher diets were made like in experiment 1 with UFC and FC replacing maize in the control diet at the same levels. Ingredient composition of the diets are shown in Table 2.

Table 2: *Ingredient and nutrient composition of the experimental broiler finisher diets*

Ingredients %	Control	50% UFC	75% UFC	100% UFC	50% FC	75% FC	100% FC
Maize	60.00	30.00	15.00	0.00	30.00	15.00	0.00
Fermented cassava (FC)	-	30.00	45.00	60.00	-	-	-
Unfermented Cassava (FC)	-	-	-	-	30.00	45.00	60.00
Soybean meal	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Palm kernel cake	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Blood meal	3.00	4.50	4.50	4.50	5.00	4.00	5.00
Local Fish meal	1.00	2.00	2.50	3.00	2.00	2.50	3.00
Wheat Offal	8.00	6.00	5.00	4.00	6.00	5.00	4.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Common salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Trace Min/Vit. Premix*	0.25	0.25	0.25	0.25	0.25	0.25	0.25
L-Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25
L-methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Chemical composition (Calculated)							
Crude Protein (%DM)	19.10	19.10	19.10	19.10	19.10	19.10	19.10
Crude Fivre (%DM)	4.57	5.92	6.50	6.81	5.90	6.52	6.83
Ether Extract (%DM)	3.83	3.02	2.82	2.56	3.10	2.81	2.60
Total Ash(%DM)	2.96	3.32	3.60	3.82	3.36	3.64	5.80
ME (Kcal/g)	3.12	3.08	3.02	3.10	3.02	3.04	3.02

* Each kg feed contained nutrients as in table 1.

Experimental Birds and Design

A total of 154 5-week old broiler chicks were selected from the same batch as in trial 1 such that they were even in sex distribution and similar in weight. They were divided into 7 groups of 22 birds each and each group randomly assigned to one of the experimental diets. Each group was further sub-divided into 2 replicates of 11 birds each and each replicate housed in a compartment as in trial 1. Feed and water were provided *ad libitum*. The birds were weighed at the beginning of the trial to obtain their initial body weights and weekly thereafter. Feed offered and the left-over on the following day were weighed to determine their feed intake.

The trial last 4 weeks, from 5 weeks old to 9 weeks old. At the end of the feeding trial, 2 birds were selected from each replicate, starved of feed but not water for a day and then slaughtered. Their internal organs -livers, hearts, gizzards and kidneys – were removed, examined and weighed to check for possible treatment effects on them.

Data Analysis
Data collected (initial and final body weights, feed intake, growth rate, feed conversion ratio and weights of internal organs) were analysed as in trial 1.

Results and discussion

Cyanide and Proximate Analysis
The cyanide and proximate composition of fresh, fermented and unfermented sun-dried cassava tuber meals are shown in Table 3. The cyanide content of fresh cassava tuber meal, 0.44mg/gm, compared very favourably with the value of 360mg/kg earlier reported by Oke (1978). The analysis also showed that fermentation is a very effective method of eliminating HCN from cassava tubers. Whereas fermentation eliminated 82% of the HCN in the fresh tuber, sun-drying alone eliminated 66%. Proximate components of the meals, with exception of ash and ether extract, were relatively unaffected by treatments. The crude protein content of the processed and unprocessed meals remained as low as earlier reported (2-3%) (Muller *et al*, 1975; Hutagalung, 1977; Asaolu, 1988; Odukwe, 1994).

Table 3: *Cyanide and proximate composition of Fresh, Fermented and Unfermented Sun-dried Cassava Tuber Meals (DM basis)*

Parameters	FUC*	FC**	UFC***	SEM
Cyanide (mg HCN/g)	0.44[a]	0.08[b]	0.15[b]	0.016
Crude Protein (%DM)	2.51[a]	2.46[a]	2.38[a]	0.13
Crude Fibre (%DM)	2.31[a]	2.06[a]	2.42[a]	0.001
Total Ash (%DM)	1.62[b]	2.11[a]	2.16[a]	0.03
Ether Extract (%DM)	0.84[b]	1.20[a]	1.32[a]	0.02
Nitrogen Free Extract (%DM)	92.72	92.17	91.72	1.38

* Fresh unprocessed Cassava; ** Fermented Cassava; *** Unfermented Cassava
ab Means with a row within different superscripts are significantly different ($P<0.05$)

Broiler Starter Trial
Data on the effects of fermented and unfermented sun-dried cassava tuber meals on the performance of starter broilers are shown in Table 4. At 50% replacement level with either fermented or unfermented cassava tuber meal, the performance of the chicks in terms of feed intake, growth rate and feed conversion ratio compared very favourably with the control group ($P>0.05$). The performance was significantly ($P<0.05$) depressed at 75% replacement level. Although at 100% replacement level, both fermented and unfermented cassava tuber meals very significantly ($P<0.01$) depressed the performance of the chicks, unfermented cassava tuber meal resulted in severe stunted growth and ruffled feathers of the chicks. The reason for the development of ruffled feathers is not clear. It has, however, been established that dietary deficiency of panthothenic acid, vitamin D and zinc can cause ruffled feathers in chicks (Scott *et al*, 1982). The mechanism by which cassava tuber meal could cause deficiency of any of these micro-nutrients in the chicks could not immediately be established. It could be that cyanide interferes with the metabolism of such nutrients in the body in a way that renders them nutritionally unavailable. Cyanide was still relatively high in the unfermented cassava tuber meal and as reported by Hill (1977), small quantities of cyanide can cause severe effect on the growth and health of poultry and rabbits. It is also possible that high fibre content of the

cassava tuber diets contributed in part to the poor growth performance of the chicks.

Table 4: *Performance of sarter boilers fed Fermented and Unfermented Cassava Tuber Meals (1 – 5 weeks)*

Parameters	Control	50% UFC	75% UFC	100% UFC	50% FC	75% FC	100% FC	SEM
Initial body wt.(g)	106.0	106.2	106.7	106.4	106.3	06.0	106.2	0.51
Final body wt.(g)	862.2^{a}	791.2^{a}	651.3^{b}	372.6^{b}	790.8^{a}	670.3^{b}	660.0^{b}	16.72
Av. daily wt. gain (g)	27.0^{a}	24.5^{a}	19.5^{b}	9.5^{b}	24.8^{a}	20.2^{b}	19.9^{b}	1.33
Av. daily feed intake(g)	64.6^{a}	65.0^{a}	56.2^{b}	40.6^{b}	63.8^{a}	56.2^{b}	40.6^{b}	2.42
Feed/gain ratio	2.39^{a}	2.60^{a}	2.88^{a}	4.27^{b}	2.60^{a}	3.05^{b}	3.04^{b}	0.12
Mortality (%)	-	12.50	8.33	16.44	8.3	4.16	8.33	-

ab Means within a row with different superscripts are significantly different ($P<0.05$)

Broiler Finisher Trial

Data on the effects of fermented and unfermented cassava tuber meals on the performance of finisher broilers are shown in Table 5. At 50% replacement level, the birds on unfermented cassava tuber meal compared favourably with the control in all the parameters considered (growth rate, feed intake and feed conversion ratio) ($P>0.05$). Both 75% and 100% replacement levels resulted in significantly ($P<0.05$) depressed performance. The birds on both 50% and 75% replacement levels with fermented cassava tuber meal compared favourably with the control in growth rate, feed intake and feed conversion ratio. However, 100% replacement level with fermented cassava tuber meal significantly ($P<0.05$) depressed the performance of the birds. The birds on 100% replacement with fermented cassava tuber meal compared favourably with the group on 75% replacement with unfermented cassava tuber meal, indicating that the level of HCN intake at both levels was about even.

Table 5: *Performance of finisher broilers fed fermented and Unfermented Cassava Tuber Meals (5 - 9 weeks)*

Parameters	Control	50% UFC	75% UFC	100% UFC	50% FC	75% FC	100% FC	SEM
Initial body wt.(g)	540.6	560.0	560.8	558.4	540.6	560.0	562.2	1.72
Final body wt.(kg)	2.12[a]	2.12[a]	1.94[b]	1.82[b]	2.12[a]	2.06[a]	1.95[b]	0.03
Av. daily wt. gain (g)	56.4[a]	55.7[a]	49.3[b]	45.06[b]	56.3[a]	53.6[a]	49.6[b]	2.16
Av. daily feed intake(g)	170.0[a]	167.1[a]	161.7[b]	161.7[b]	163.8[ab]	163.0[ab]	161.3[b]	1.72
Feed/gain ratio	3.18[b]	3.00[b]	3.28[ab]	3.58[a]	3.00[b]	3.04[ab]	3.25[a]	0.08
Mortality (%)	4.55	-	9.10	9.10	-	-	-	-
Internal Organs (% of dressed wt)								
Liver	2.29[b]	2.72[a]	2.92[a]	2.73[a]	2.82[a]	2.85[a]	3.12[a]	0.04
Gizzard	2.88[a]	2.97[a]	2.78[a]	2.78[a]	2.74[a]	2.75[a]	2.55[a]	0.22
Kidney	0.20[a]	0.19[a]	0.21[a]	0.22[a]	0.24[a]	0.22[a]	0.24[a]	0.01
Abdominal fat	1.44[a]	0.86[b]	0.96[b]	0.91[b]	2.29[a]	1.73[a]	0.99[b]	0.08

ab Means within a row with different superscripts are significantly different ($P<0.05$)

The weights of the internal organs - livers, gizzards and kidneys – of the birds in all the groups were not affected by treatments ($P>0.05$). However, birds on the control diet, 50% and 75% replacements with fermented cassava tuber meal accumulated significantly ($P<0.05$) more abdominal fat than the others, indicating higher efficiency of the birds in converting the carbohydrates of fermented cassava tuber meal into fat.

The results of these trials tended to demonstrate that older broilers tolerate cassava tuber meals better than younger ones, confirming the earlier observations of Longe and Oluyemi (1977). Two factors might have given rise to the reduced performance of the groups on 100% cassava diets – presence of HCN and dustiness of the diets at that level of replacement. The diets at that level of replacement contained the highest level of HCN and appeared most dusty when compared to the other diets. Dustiness of cassava-based diets has been blamed for reduced feed intake and poor growth of poultry (Longe and Oluyemi, 1977) and of rats and rabbits (Tewe, 1975).

Conclusion

The results of this study have demonstrated that fermentation is a very effective method of processing cassava tubers for dietary inclusion for broilers. The results have also shown that for optimal performance of young broiler chicks only up to 50% of maize in the diet could be replaced with cassava tuber meal, whether fermented or unfermented. For finisher broilers, up to 75% of dietary maize could be replaced with fermented cassava tuber meal. It is therefore recommended that large scale production of cassava for animal feeding be encouraged so as to reduce the current pressure of demand on maize.

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