EVALUATION OF SUN-DRIED CASSAVA FUFU MEAL AS A SOURCE OF DIETARY ENERGY FOR FINISHER BROILERS

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Abstract
Sun-drying of cassava *fufu* was investigated as a method of processing cassava to eliminate its cyanide content and dusty nature, so as to enhance its nutritive value as a source of energy in finisher broiler diets. Cassava tubers were prepared in the traditional way into *fufu* and dried in the sun by flattening in bits on polyethylene sheets. The dried cakes were milled to produce sun-dried cassava *fufu* meal (DCFM). The raw cassava tubers and the DCFM produced were analyzed for proximate composition and cyanide content. Two broiler finisher diets were formulated such that diet 1 (control) contained maize as the main energy source while diet 2 contained DCFM as the main source of energy. Each diet was fed to a group of 42 finisher broilers for 4 weeks. At the end of the feeding trial, 4 birds from each group were selected and used for determination of haematological/serum biochemical indices and internal organ weights.
There were no significant ($P>0.05$) differences between the 2 groups in final body weights and daily body weight gain but the control group consumed significantly ($P<0.05$) more feed than the DCFM group (168.45 g/d vs 147.30 g/d). The DCFM group had superior feed conversion ratio and less cost of production. The DCFM group also developed significantly heavier livers, smaller gizzards and more abdominal fat than the control ($P<0.05$). There were no significant differences in most of the haematological and serum biochemical indices analyzed but blood cholesterol of the DCFM group was significantly higher ($P<0.05$).
Keywords: Finisher broilers, sun-dried cassava *fufu* meal, nutritive value.

Introduction

Maize has been the major source of energy in both human food and animal feed in Nigeria. It is also a major industrial raw material in the country. Because of the competitive need for maize in the country, its demand outstrips its supply, leading to outrageous increase in its price within the last 25 years (Udedibie, 2007). This has contributed to the high cost of poultry feeds with concomitant increase in the prices of poultry products. There is the need therefore to search for other sources of energy that could be used in poultry feeds to reduce the pressure on maize, and consequent decrease in price of poultry products.

Cassava which is the major source of calories for Nigerians could also serve as alternative to maize in livestock feeds. The FAO (2005) estimated cassava production in Nigeria in 2004 at 38.2 million metric tons, making Nigeria the largest producer of cassava in the world. This figure is expected to rise in view of the emphasis of the Federal Government on cassava production in the country.

Attempts have been made to use cassava as source of energy in poultry diets in the country as replacement for maize but the results have not been encouraging. This is because cassava tuber contains potentially toxic levels of a cyanogenetic glucoside, linamarin. Linamarin is deglycosylated by the enzyme, linamarase which is also in the tuber, yielding acetone cyanohydrins, which spontaneously converts into deadly hydrogen cyanide (HCN) once it is ingested (Sayre, 2007). Different methods have been employed in attempt to detoxify cassava tuber so as to render it utilizable as food for man and feed for livestock. These include sun-drying (Odukwe, 1994), cooking (Okeke *et al*., 1985; Chukwuemeka, 2009), use of additives (Obioha *et al*., 1984), fermentation (Udedibie *et al*., 2004), with fermentation proving to be the most effective. Recent studies in Australia (Bradbury, 2004) have demonstrated that wetting sun-dried cassava tuber meal for 5 hours before use reduces the cyanide content of the meal to about one-third of its previous level. Feeding trials with the meal so produced showed that it could completely and safely replace maize in broiler diets (Udedibie, 2007) but depressed feed intake and egg production of laying hens at 100% replacement of maize (Enyenihi *et al.*, 2009).

Another drawback in the use of cassava tubers as a feedstuff is the powdery nature of the meal and its short shelf-life. The powdery nature of the meal renders poultry feed very dusty, making feed intake of birds difficult (Tewe and Bokanga, 2001; Udedibie *et al*., 2004).

Udedibie *et al*. (2008) have been able to process cassava tubers into dried cassava *fufu* meal, a pelletinized, HCN-free, non-dusty, long-lasting product that could completely and effectively replace maize in the diets of laying hens. The efficacy of the product in broiler diets has, however, not been tested. This paper reports the performance of finisher broilers fed dried cassava *fufu* meal as replacement for maize in broiler finisher diet.

MATERIALS AND METHODS

Experiment Site

The experiment was carried out in the poultry unit of the Teaching and Research Farm of the Federal University of Technology, Owerri, Imo State, Nigeria. Haematological and serum biochemical aspects of the study were done at the Federal Medical Centre, Owerri.

Owerri, the Capital of Imo State, lies between latitude 4^0 4^1 and 6^0 3^1 and longitude 6^0 15^1 and 8^0 15^1 with average annual rainfall of about 2500 mm and mean annual temperature range of $26.5 – 27.5^{0C}$. The mean annual humidity range is 70 – 80% with dry season duration of 3 months. The annual evapotranspiration is 1450 mm and the soil type is essentially sandy loam with average pH of 5.5 (Adeyemi, 2011).

Source and Processing of Cassava Tubers

The fresh cassava tubers of bitter variety used for the study were bought from a local market in Owerri West Local Government Area of Imo State. The cassava tubers were peeled, weighed, cut into pieces and then put in vats filled with water and allowed to ferment under atmospheric temperature for 4 days. The fermented tubers were sieved into sacs, hand-pressed to remove water to produce fermented cassava tuber paste. The paste was then cooked into *fufu* as described by Udedibie *et al* (2008). The *fufu* was then collected in bits, flattened on polyethylene sheets and sun-dried for 2 - 3 days to produce dried cassava *fufu* cakes. The cakes were then milled using 2 mm sieve to produce dried cassava *fufu* meal (DCFM). Samples of the fresh cassava tubers and DCFM were subjected to proximate analysis according to AOAC (1995) and hydrogen cyanide (HCN) according to Bradbury *et al* (1999).

Experimental Diets

Two broiler finisher diets were made such that diet 1 (control) contained maize as the main source of energy while diet 2 contained DCFM as the main source of energy, completely replacing maize. Other ingredients were included in such a way as to make the 2 diets similar in nutrient composition (Table 1).

Experimental Birds and Design

A total of 84 broiler chicks at 5 weeks of age were divided into 2 groups of 42 birds each and each group randomly assigned to a treatment diet using completely randomizaed design. Each group was further sub-divided into 3 replicates of 14 birds each and each replicate housed in a 2 m x 2 m pen. Feed and water were provided *ad libitum*. The experiment lasted 4 weeks.

Data Collection

The birds were weighed at the beginning of the trial and weekly thereafter to obtain their body weight changes. Daily feed intake was determined by subtracting the weight of the left-over feed from the weight of the feed offered the previous day. Feed conversion ratio was determined by dividing daily feed intake by the daily body weight gain.

At the end of the feeding trial, four birds of similar weights were randomly selected from each treatment and used for determining haematological and serum biochemical indices as well as carcass and internal organ weights. Blood was collected as they were killed into 2 sets of specimen bottles, one set containing ethylene diamine tetracetic acid (EDTA) as anticoagulant and the other without EDTA for serum biochemical analysis. Blood was analysed within 3 hours after collection at the Federal Medical Centre, Owerri, using the methods outlined by Monica (1984).

The birds which are weighed before slaughter were then defeathered and eviscerated and their internal organs (liver, heart, gizzard, spleen and kidney) as well as the abdominal fat weighed and expressed as percent of live weight.

Data Analysis

Data generated were subjected to one-way analysis of variance (ANOVA) according to Snedecor and Cochran (1978). Where ANOVA indicated significant treatment effects, means were compared using least significant difference (LSD) as outlined by Snedecor and Cochran (1978).

Table 1: Ingredient Composition of the Experimental Broiler Finisher Diets.

Ingredients %	**Control Diet**	**DCFM Diet**
Maize	60.00	0.00
DCFM	0.00	55.00
Soybean meal	20.00	25.00
Fish meal	2.00	3.00
Blood meal	2.00	3.00
Wheat offal	7.00	5.00
Palm kernel cake	5.00	5.00
Bone meal	3.00	3.00
Common salt	0.25	0.25
Tm/vitamin premix *	0.25	0.25
L–lysine	0.25	0.25
L–methionine	0.25	0.25
Total	100.00	100.00
Calculated Chem. Composition (% of dm)		
Crude protein	19.84	19.84
Crude fiber	4.04	6.97
Ether extract	3.87	2.88
Ash	3.29	4.10
Nitrogen-free extract	68.96	67.45
ME (Mcal/kg)	3.07	2.97

* To provide the following per kg of feed: vitamin A, 10,000 iu; vitamin D_3, 1500 iu, vitamin E, 3 iu; vitamin K, 2 mg; riboflavin, 3 mg; panthothenic acid, 6 mg; niacin, 15 mg; vitamin B_{12}, 8 mg; choline, 350 mg; folic acid, 4 mg; Mg, 56 mg; iodine, 1.0 mg; Fe, 20 mg; Cu, 10 mg; Zn, 0.5 mg.
DCFM = dried cassava *fufu* meal

RESULTS AND DISCUSSION

Cyanide Content and Physico-chemical Nature of DCFM

No trace of HCN was detected in the DCFM as earlier reported by Udedibie *et al* (2008), as against about 800 ppm contained in the original cassava tubers used. However, unlike the golden colour of the product produced by Udedibie *et al* (2008), the DCFM produced in this study looked like milled polished rice. According to Udedibie *et al* (2008), the ash-coloured cassava *fufu* turned to golden colour as it dried in the sun. This could have resulted from the variety of cassava that they used.

The proximate composition of the DCFM was not very different from that reported by Udedibie *et al* (2008): 2.82% CP, 2.86% CF, 1.02% EE, 1.98% Ash and 91.68% NFE.

Performance of the Finisher Broilers

Data on the performance of the finisher broilers are presented in Table 2. There were no significant differences in total body weight gain and daily body weight gain of the groups (P>0.05). However, the DCFM group consumed significantly (P<0.05) less feed than the control group. The reason for this is not clear but it could be that the DCFM diet contained more metabolizable energy than the control diet since birds eat to satisfy their energy need. Another possible reason could be the retention time of the diet in the crop since cassava diets tend to stay longer in the crops (Aderemi *et al.*, 2006). Probably, the longer retention time of the DCFM diet enhanced the utilization of the diet, resulting in better feed conversion ratio of the group, as earlier postulated by Carre (2000). The feed conversion ratio of the DCFM group was significantly (P<0.05) better than that of the control group, contrary to the earlier reports of Udedibie *et al* (2008) and Enyenihi *et al* (2009) with laying hens. Consequently, even though the DCFM diet was more expensive than the control diet (₦93.16 vs ₦83.01), cost of production of the broilers was cheaper for the DCFM group.

Table 2: Performance of the Experimental Finisher Broilers

Parameters	Control	DCFM	SEM
Av. initial body wt. (g)	1432.40	1441.26	14.74
Av. final body wt. (g)	2526.66	2526.66	75.99
Av. total body wt gain (g)	1094.26	1085.46	67.78
Av. daily body wt. gain (g)	39.16	38.80	2.43
Av. total feed intake (g)	4716.66	4126.66	262.14
Av. daily feed intake (g)	168.45[a]	147.38[b]	6.24
Feed conversion ratio g feed/g gain)	4.35[a]	3.79[b]	0.16
Feed cost (N/kg)	83.01	93.16	-
Cost of production (N/Kg gain)	360.26	352.69	-
Savings (N/kg gain)		6.85	
% savings		1.82	
Mortality (number)	4	2	-

[ab]Means within a row with different superscripts are significantly different (P<0.05).
DCFM = dried cassava fufu meal; SEM = standard error of means

Carcass and Internal Organ Weights

Data on the carcass and internal organ weights of the groups are presented in Table 3. There was no significant difference in dressing percentage of the 2 groups (P>0.05). There were, however, significant differences in the internal organ weights. The livers of the DCFM group were significantly (P<0.05) heavier than those of the control group. Similar observations had earlier been made by Udedibie *et al* (2004) with broilers and Enyenihi *et al* (2009) with laying hens. The reason for this could not immediately be provided since the DCFM used in the study was devoid of HCN. Enlarged livers are usually associated with feeds with certain levels of toxicity (Atuehene *et al.,* 1986; Bamgbose and Niba, 1995). On the other hand, the gizzards of the DCFM group significantly (P<0.05) decreased in weight contrary to the earlier report by Udedibie *et al* (2008) and Aderemi *et al* (2006). This observation must have resulted from the coarse nature of the cassava tuber meal used. A rapid and conspicuous enlargement in size of the gizzard is observed when structural components such as hulls, wood shavings and large cereal particles are included in the diet (Hetland and Svibus, 2001; Williams *et al*., 2008; Amerah *et al*., 2009). The DCFM used in this study was milled with 2 mm sieve.

The weights of the kidneys were not affected by the treatments (P>0.05) but the group on DCFM diet developed significantly (P<0.05) more abdominal fat. A similar observation was made by Enyenihi *et al* (2009) in laying hens.

Table 3: Carcass and Internal Organ Weights of the Finisher Broilers

Parameter	Control	DCFM	SEM
Live weight (g)	2650.00	2725.00	51.03
Dressed weight (g)	1750.00	1850.00	36.00
Dressed weight (%)	65.94	67.95	1.93
Internal Organs (% LW)			
Heart	0.52	0.55	0.01
Liver	1.13[a]	1.65[b]	0.09
Gizzard	1.13[a]	0.87[b]	0.10
Kidney	0.19	0.18	0.004
Abdominal fat	1.29[a]	2.09[b]	0.16

[ab]Means within a row with different superscripts are significantly different (P<0.05)
DCFM = dried cassava fufu meal; SEM = standard error of the means
LW = Live-weight.

Haematological and Serum Biochemical Indices

Data on haematological and serum biochemical indices of the groups are presented in Tables 4 and 5. There were no significant differences in all the haematological indices analyzed for (P>0.05). There were also no significant differences in most of the serum biochemical indices except for cholesterol, potassium, uric acid and glutamate pyruvate transferase (GPT). Similar high cholesterol level had also been reported by Enyenihi *et al* (2009) in their studies with laying hens. The similarity in almost all the haematological and serum biochemical indices is an indication that DCFM did not pose any serious danger to the birds. The values were within the range regarded as normal for birds (Mitruka and Rawnley, 1977).

Table 4: Haematological Indices of the Experimental Birds

Indices	Control	DCFM	SEM
WBC (x 10^3/ul)	75.900	72.066	4272.46
RBC (x 10^3/ul)	2.21	1.95	0.216
Hb (g/dl)	8.24	7.03	0.760
PCV (%)	27.92	25.13	2.680
MCV (fl)	126.21	129.07	4.180
MCHC (g/dl)	29.23	28.14	0.710
MCH (pg)	36.93	36.23	0.920
Platelets (X 0^3/ul)	18000	18666	1247.22
Lymphocytes (%)	83.25	86.41	2.52
Neutrocytes (%)	16.83	13.72	2.51
Monocytes (%)	00	00	00
Eosinophils (%)	00	00	00
Basophils (%)	00	00	00

DCFM = dried cassava fufu meal; SEM = standard error of means

Table 5: Serum Biochemical Indices of the Experimental Birds

Indices	Control	DCFM	SEM
Urea (mg/cl)	37.1	37.04	0.470
Creatinine mg/dl)	0.64	0.62	0.067
Sodium (Mmol/l)	152.36	149.42	2.030
Potassium (Mmol/l)	3.42^a	4.22^b	0.130
Chlorine (Mmol/l)	123.21	116.43	4.270
$HC0_3$ (mmol)	29.35	29.34	1.200
P^H	7.60	8.04	0.062
Total billirubin (mg/dl)	0.17	0.17	0.017
Conjugated Billirubin (mg/dl)	0.09	0.08	0.009
ALP (iu/l)	1275	1180	71.900
GPT (iu/l)	4.61^a	3.34^b	0.33
GOT (iu/l)	317.43	291.52	13.250
Cholesterol (mg/dl)	127.00^a	149.33^b	7.440
TG (mg/dl)	83.66	89.33	20.70
Calcium (mc/dl)	6.74	6.17	0.71
Phosphate (mg/dl)	4.98	5.22	0.081
Total Protein (g/dl)	3.56	2.70	0.690
Albumin (g/dl)	1.57	1.41	0.087
Globulins (g/dl)	1.10	1.29	0.630
Uric acid (mg/dl)	5.87^a	4.01^b	0.550
Glucose (mg/dl)	245	251	10.30

[ab]Mean within a row with different superscripts are significantly different ($P < 0.05$).
DCFM = dried cassava fufu meal; SEM = standard error of means

Conclusion

The results of the trial have demonstrated that DCFM can completely and effectively replace maize in the diets of finisher broilers. Even though the diet based on DCFM appeared more expensive, the higher efficiency of its utilization by the birds compensated for the high cost. The DCFM diet tended to promote development of abdominal fat which may be objectional to some consumers.

It is recommended that further research should aim at developing technologies that would make the processing of cassava tubers into this form less laborious and expensive. In view of the fact that DCFM tended to induce abdominal fat in broilers, it may be advisable to avoid total replacement of dietary maize with it.

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