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Expanding Rural Poultry Production through thr Use of Low Cost Cassava Fruit Coat as Alternative Fibre Source for broilers

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ABSTRACT

The replacement value of a by-product of cassava harvesting – cassava fruit coat (CFC) meal for wheat bran (WB) for broiler production was investigated. CFC was produced by milling dried cassava fruits often discarded after harvesting the roots and stems. The CFC meal was used to replace 25, 50, 75 and 100% wheat bran (w/w) in a basal diet for broilers. Seventy-five one-week old broiler chicks were distributed into 15 pens each holding 5 birds. Each of the 5 experimental diets was allocated at random to 3 pens. At the end of the first 4 weeks (starter phase), the diets were switched to finisher diets for a further 4-week period. Feed and water were supplied ad libitum. Data were recorded and analysed on pen basis. CFC meal had a crude protein of 43.80 g/kg and crude fibre of 148.90 g/kg. Daily feed consumption was non-significantly reduced with increasing CFC meal levels. Daily weight, feed conversion ratio and efficiency of feed utilization were significantly ($p<0.05$) reduced with more than 50% level of CFC meal. Increasing levels of CFC meal had no significant effect on the carcass measures except the meat: bone ratio which was significantly ($p<0.01$) reduced. The weight of liver was significantly ($p<0.05$) decreased, while those of intestines, kidneys and gizzards significantly ($p<0.05$) increased. The digestibility (% nutrient retention) of dry matter, crude protein, ash, crude fat and nitrogen free extractives was significantly ($p<0.05$) reduced by 25, 29, 23, 24, 14 and 25%, respectively with increasing levels of CFC. Results suggest that CFC meal does have a potential for replacing the expensive wheat bran as a fibre source in broiler feeding. High levels (>136.50 g/kg) in the diets of broilers elicit reduced nutrient digestibility, reduced weight and accretion of intestinal and visceral organs.

INTRODUCTION

Rural chicken production systems are based on the scavenging indigenous domestic fowl (*Gallus domesticus*), the predominant species in the rural poultry sector in Africa. These local chickens remain predominant in African villages despite the introduction of exotic and crossbred types, because farmers have not been able to afford the high input requirement of introduced breeds (Kaiser, 1990; Safalaoh, 1997). Moreover, land - a critical production resource in rural areas - is not a limiting factor in rural chicken production systems. Consequently, disadvantaged groups in the community can be direct beneficiaries of rural chicken improvement programmes. Rural poultry is also an important element in diversifying agricultural production and increasing household food security. The village chickens provide readily harvestable animal protein to rural households, and in some parts of Africa are raised to meet the obligation of hospitality to honoured guests (Chale and Carloni, 1982). Therefore, several poultry scientists have recently suggested a specific scientific thrust for rural poultry, aimed at improving the understanding of the biological and socio-economic factors affecting the input-output relationships and the economic efficiency of the production systems.

Feed resources are a major input in poultry production systems, estimated to account for about 60 percent of total production costs in the commercial poultry sector (Renkema, 1992). The use of unconventional feed resources could be one way of expanding the feed resource base of rural poultry production because the unconventional ration is cheaper than grain-based ration and various techniques to produce unconventional feed resources in the tropics have been reported, although on a small-scale basis. Cassava, a widely grown crop in most tropical and subtropical countries of Africa, Latin America and Asia ranks as one of the main crops in these countries (Calpel, 1992). Cassava roots supply energy to millions of people in these regions but its fruit can also be of value for poultry feeding. Flowering in some cultivars is frequent and regular. After pollination and subsequent fertilization, cassava ovaries develop into young fruits. The mature fruit is a capsule, globular in shape with woody endocarp (fruit coat). The coat splits explosively to release and disperse the seeds when dry (Onwueme and Charles, 1994). Cassava fruit (CFC) is free of hydrocyanic acid (HCN), the antinutritive factor and toxic component in cassava which is found in the roots, branches and leaves of the plant. Cassava fruit coat is abundant in rural areas where flowering cultivars are grown. Its relatively low fibre content makes it a potential dietary fibre ingredient for rural poultry feeding. This study was aimed at estimating the effect of replacement of wheat bran (a conventional) poultry ingredient with cassava fruit coat on the nutrient digestibility, growth performance, carcass measures of broilers.

MATERIALS AND METHODS.

Cassava fruit coat was obtained from cassava plots at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. The material was milled. The sieve in the milling machine was adjusted such that the milled CFC had the same coarse size as the wheat bran used in the study. Thereafter its chemical composition was determined. Seventy-five one- week old broiler chicks were randomly distributed into 5 experimental treatments of 3 replicates. Each replicate therefore had 5 birds. The diets were formulated such that the cassava fruit coat meal replaced wheat bran at 25, 50, 75 and 100% levels in the diets at both the starter and finisher phases. The diets were made up with other ingredients such that the birds' requirements for nutrients were met (Tables 1 and 2). Their proximate compositions were analysed by the method of AOAC (1990). The birds were fed for 4 weeks on the starter diet. At the edn of the starter phase, the diets were switched to finisher diets for a further 4- week period. Vaccination and normal routine management were adhered to. Body weights of the birds were taken at weekly intervals and feed intake determined by deducting the remnant from the total quantity supplied the previous day at specific time. At the end of 8 weeks, another set of birds placed on the diets on pen basis in metabolic cages where feaces were collected for five days for nutrient digestibility (% retention) studies. Fresh feaces were weighed and recorded daily, oven-dried, and weighed again for percent dry matter. Proximate composition of the feaces was also carried out by the method of AOAC (1990). At the end of the finisher phase, feed was withdrawn from the birds for 12 hours (overnight). Their weights were recorded and they were killed by asphyxiation, quickly defeathered and the dressed weights taken. Each bird was cut open, the organs removed and their weights.relative to the respective body weight of the bird recorded. The eviscerated weights of the birds were also recorded. The length of the intestines was measured. The birds were then deboned and the weight of meat and bones recorded. These were used to compute the bone to meat ratio. All data were subjected to one-way analysis of variance (ANOVA) on pen basis. Means that were significant were separated by the Duncan multiple range test. Regression analysis was run using the general linear model (SAS, 1997).

Table 1. Composition of experimental diets for broilers at starter phase

	Diets				
Ingredients (g / Kg)	**1**	**2**	**3**	**4**	**5**
Level of CFC (%)	**0**	**25**	**50**	**75**	**100**
Maize	400	400	400	400	400
Wheat bran	273	204.75	136.50	68.25	-
Cassava fruit coat meal	-	68.25	136.50	204.75	273
Groundnut cake	150	150	150	150	150
Soy bean meal	100	100	100	100	100
Fish meal	40	40	40	40	40
Bone meal	20	20	20	20	20
Oyster shell	10	10	10	10	10
Premix*	2.5	2.5	2.5	2.5	2.5
Salt	2.5	2.5	2.5	2.5	2.5
Methionine	1.0	1.0	1.0	1.0	1.0
Lysine	1.0	1.0	1.0	1.0	1.0
Total	1000	1000	1000	1000	1000
Analysed chemical composition					
Crude protein (g/kg)	232.50	222.50	216.30	210.50	208.80
Crude fibre (g/kg)	56.90	59.70	66.90	67.30	69.80
Fat (g/kg)	52.80	52.30	51.60	42.90	41.60
Ash (g/kg)	159.70	159.10	150.70	128.60	127.90
Dry matter (g/kg)	807	855	828	843	850
ME (MJ)	10, 980	11, 013	11, 050	11, 087	11, 124

*Micro-mix broiler premix supplied the following per 2.5 kg: Vitamin A: 12, 500,000.00 I.U., Vita mine D_3: 2, 500, 000.00 I.U., Vitamin E: 40, 000, 000.00 mg; Vitamin B_2 5,500.00 mg; Niacin: 5, 500.00 mg; Vitamin B_1 3, 000.00 mg; Calcium Pantothenate: 11, 500.00 mg; Vitamin B_6: 500.00 mg; Vitamin B_{12}: 25.00 mg; Folic acid: 1,000.00 mg; Iron: 100, 000.00 mg; Zinc: 80, 000.00 mg; Copper: 8,500.00 mg; Iodine: 1, 500.00 mg; Cobalt: 300.00 mg; Selenium: 120.00 mg; Anti-oxidant: 120,000.00 mg

Table 2. Composition of experimental diets for broilers at finisher phase.

	Diets				
Ingredients (g / Kg)	**1**	**2**	**3**	**4**	**5**
Level of CFC (%)	**0**	**25**	**50**	**75**	**100**
Maize	400	400	400	400	400
Wheat bran	308	231	154	77	-
Cassava fruit coat meal	-	77	154	231	308
Groundnut cake	125	125	125	125	125
Soy bean meal	100	100	100	100	100
Fish meal	30	30	30	30	30
Bone meal	20	20	20	20	20
Oyster shell	10	10	10	10	10
Premix*	2.5	2.5	2.5	2.5	2.5
Salt	2.5	2.5	2.5	2.5	2.5
Methionine	1.0	1.0	1.0	1.0	1.0
Lysine	1.0	1.0	1.0	1.0	1.0
Total	1000	1000	1000	1000	1000
Analysed chemical composition					
Crude protein (g/kg)	218.30	216.4	215.50	208.80	201.80
Crude fibre (g/kg)	65.80	89.60	98.50	101.50	103.60
Fat (g/kg)	51.40	50.70	49.20	40.6	39.20
Ash (g/kg)	101	91.40	89.8	88.70	86.10
Dry matter (g/kg)	860.70	867.40	86.50	869.20	844.4
ME (MJ)	10, 856	10, 897	10, 939	10, 980	11, 021

RESULTS AND DISCUSSION

Table 3 shows the nutrient composition of cassava fruit coat. The protein content of the product is very low. The usefulness of it for poultry feeding therefore lies on its use as a fibre source. Thus it is a good product to replace the conventional fibrous ingredients like wheat bran in broiler diets when such diets are supplemented with protein or amino acids. The changes in feed consumption, weight gain, feed conversion ratio and efficiency of feed utilization are shown in Table 4. The feed consumption was not significantly changed with

Table 3. Proximate composition of cassava fruit coat meal

Nutrient	Composition (g / kg)
Dry matter	895.10
Crude protein	43.80
Crude fire	148.90
Crude fat	20.40
Ash	30.70
Nitrogen free extracts	651.30
Moisture	104.90

Table 4. Performance of broilers on experimental diets (0-8 weeks)

	Diet							
Parameters	**1**	**2**	**3**	**4**	**5**			
Level of CFC (%)	**0**	**25**	**50**	**75**	**100**	**Pooled SEM**	***P* (ANOVA)**	**Regression Equation**
Feed intake/bird (g/ d)	160.71	165.97	160.4	154.1	147.56	36.16	NS	Y= 157.78 -1.07x
Weight gain/bird (g / d)	65.90	68.05	67.37	54.09	48.03	17.00	<0.001	Y= 474.62-1.167x
Feed conversion ratio	2.43	2.43	2.38	2.84	3.07	0.164	<0.05	Y= 2.426 + 0.005x
Feed efficiency	0.41	0.41	0.42	0.36	0.33	0.022	<0.05	Y= 0.414 – 0.001x

increasing CFC levels even though there was a decreasing trend. But the daily weight gain, feed conversion ratio and efficiency of feed utilization were significantly reduced when the replacement level of CFC for wheat bran was above 50%. Daily feed consumption and weight gain were reduced by 1.07 and 1.167 units with a unit increase in the level of CFC. The carcass measures are shown in Table 5. Increasing levels of CFC had no significant effect on the carcass measures. But the meat: bone ratio was significantly (p<0.01) reduced indicating that as the level of CFC increased in the diet above 50%, the proportion of meat relative to that of bone reduced. The weights of liver, kidney, intestines and gizzard were significantly (p<0.05) influenced when CFC level was above 50% (Table 6). The liver weights decreased while those of intestines, kidneys and gizzards increased. The digestibility (% retention) of dry matter and nutrients (Table 7) were significantly (p<0.05) reduced by dietary increase in level of CFC. Up to the 50% level of inclusion of CFC, digestibility of the nutrients was similar but above this level there were significant changes. Digestibility of dry matter, crude protein, crude fibre, ash, crude fat and nitrogen free extracts were reduced by 25%, 29%, 23%, 24%, 14% and 25% respectively, with increasing levels of CFC.

The results of the study showed a depressed feed intake with increasing levels of CFC beyond 50%. Cherry (1983) reported that the extent to which an animal will increase its feed consumption is dependent on the fibre source, the lignification of the feed and the chemical variation in the fibre itself. Even though the CFC was milled to the same size as the wheat bran, the physical texture of the CFC which was reported by Onwueme and Charles (1994) to be woody could have caused a reduced intake by the birds because according to Abdelsamie *et al.,* (1983), fibre content and physical texture of the diet affect the performance of birds. The reduction in weight gain observed in this study is supported by earlier report of Summer and Leeson (1986) and Fahey et al (1992) that specific weight of birds reduced with increased dietary fibre level as well as nutrient density. Furthermore, reports of Linderman *et al*., (1986) and Gous *et al*., (1990) showed that feed volume increased with increasing levels of dietary inclusion of fibre. Under this condition the nutrient density is reduced. The birds that were on the high CFC based diets could not satisfactorily consume the requisite nutrient for growth. They also had higher values of FCR an indication of their consumption of more feed per unit weight gain compared to those on the control and lower CFC inclusion. The lower efficiency of feed utilization showed that above the 50% level of inclusion of CFC the feed was inefficiently utilized and so growth was significantly affected. The results of digestibility (% retention of the nutrients) agree with the reports of Ibrahim and El-Zubeir, (1991) and Lourdes, (1999). The decreased nutrient digestibility can be attributed to shorter resident time of the more fibrous diets in the intestines of the birds. It could also have been due to quick digesta transit as suggested by Calotaje *et al*., (1992) as often happens in birds on high fibrous diets. Birds on the high CFC diets also probably had reduced retention time of the feed and the potentiation of gastric emptying by dietary fibre. These factors caused reduction in the time of exposure of nutrients to enzymatic hydrolysis and nutrient contact with the absorptive membranes in consonance with the earlier report of Linnderman *et al.,* (1986). The reduced digestibility of the nutrients as the level of CFC was above 50% played a significant factor in the reduced weight of the birds observed even with the non-significant reduction in feed consumption. Relative weight of gizzard increased as the level of CFC increased in the diets. Schiedeler *et al*., (1998) reported similar findings. Higher levels of CFC elicited gizzard hypertrophy obviously because greater grinding action was required on the more fibrous diets.

Table 5. Carcass measures (g) of broilers on experimental diets

	Diet							
Parameters	**1**	**2**	**3**	**4**	**5**			
Level of CFC (%)	**0**	**25**	**50**	**75**	**100**	**Pooled SEM**	***P* (ANOVA)**	**Regression Equation**
Wings	3.56	4.02	3.66	3.81	3.98	0.146	NS	Y= 3.681+ 0.003x
Breast	17.80	15.22	18.05	17.43	17.92	0.838	NS	Y = 16.79 + 0.10x
Shank	2.17	2.02	1.75	1.93	2.09	0.162	NS	Y = 2.044-0.001x
Back	10.77	11.69	13.42	9.71	13.43	0.865	NS	Y= 1.138+0.013x
Drumstick	10.65	10.93	10.64	9.20	11.50	0.528	NS	Y= 10.59+0.0001x
Head	2.44	2.40	2.05	2.26	2.56	0.150	NS	Y= 2.322+0.0003x
Neck	4.53	4.09	4.22	4.37	4.02	0.412	NS	Y=4.394-0.003x
Thigh	4.90	4.46	4.65	4.82	4.87	0.36	NS	Y=4.683+0.001x
Bone: meat ratio	4.56	4.33	4.28	3.71	3.44	0.358	<0.001	Y=4.536-0.011x

Increasing levels of CFC increased the weights of kidneys and intestines and decreased that of liver as also has been reported by Pond *et al*., (1989) that relative weight (percentage of body weight) of intestines and kidneys were increased by high fibre in diets. Decreased liver weights in birds on the higher CFC diets meant the liver could not increase its bile formation for lipid metabolism hence the reduced crude fat digestibility obtained (Table 7).

Table 6. Relative weights and lengths of organs in broilers on experimental diets

	Diet							
Parameters	**1**	**2**	**3**	**4**	**5**			
Level of CFC (%)	**0**	**25**	**50**	**75**	**100**	**Pooled SEM**	***P* (ANOVA)**	**Regression Equation**
Spleen (g)	0.13	0.11	0.10	0.11	0.l4	0.012	NS	Y=0.121-0.0002x
Heart (g)	0.45	0.43	0.45	0.38	0.49	0.036	NS	Y=0.438+0.0001x
Lung (L & R) (g)	0.57	0.59	0.63	0.57	0.52	0.044	NS	Y=0.597-0.0001x
Pancreas (g)	0.24	0.25	0.22	0.25	0.25	0.018	NS	Y=0.238+0.0001x
Liver (g)	1.70	1.86	2.01	1.78	0.11	0.368	<0.01	Y=2.142-0.015x
Intestines (g)	5.13	5.25	4.90	5.25	5.42	0.224	<0.05	Y=4.914+0.002x
Kidney (L & R) (g)	0.69	0.75	0.82	0.74	0.73	0.040	<0.05	Y=0.031+0.0001x
Gizzard (g)	2.26	2.79	3.33	3.68	3.91	0.296	<0.05	Y=2.356+0.017x
Small intestines (cm)	177.7	217.20	196.00	210.4	203.23	9.337	NS	Y=192.05+0.177x
Caecum	21.83	23.03	20.73	24.67	23.80	1.498	NS	Y=21.50+0.022x

Table 7. Nutrient digestibility (% retention) in broilers fed experimental diets

	Diet							
Nutrient	**1**	**2**	**3**	**4**	**5**			
Level of CFC (%)	**0**	**25**	**50**	**75**	**100**	**Pooled SEM**	***P* (ANOVA)**	**Regression Equation**
Dry matter	73.77	68.49	68.63	62.44	45.41	5.930	<0.05	Y=76.302-0.251x
Crude protein	81.01	81.24	82.36	65.79	50.90	2.560	<0.01	Y=84.793-0.287x
Crude fibre	83.70	80.34	80.18	72.04	59.44	3.640	<0.01	Y=86.500-0.227x
Ash	77.43	72.21	72.16	65.58	50.82	4.510	<0.05	Y=79.607-0.239x
Crude fat	89.24	87.50	87.57	81.37	74.72	2.194	<0.01	Y=91.114-0.141x
Nitrogen free extracts	67.79	60.88	60.99	57.67	37.84	6.014	<0.05	Y=69.655-0.252x

The increased gastro-intestinal tract (GIT) length indicates hypertrophic response of the GIT to the high fibre diets as indeed reported by Stagnosis and Pearce (1985) and Pond (1986) in poultry and swine, respectively. Our present results extend information on tissue hyperplasia of chickens fed high fibrous diets especially with respect to the increased colon length observed. Our results agree with the report of Wyatt *et al*., (1998) that ceacal and colonic enlargement were due to tissue hypertrophy in response to increased bulk due to the high dietary fibre. However, the metabolic cost of hypersecretory responses may be considerable, and from the view of efficiency of conversion of the feed to tissue, this may have had considerable negative effect on the growth of the birds. Thus the implication of these findings is that the dietary nutrients were diverted from the formation and progressive development of muscle mass to accretion of intestinal and visceral organs. This is evident in the lower weight gains and meat: bone ratio of birds on the high CFC diets. It is concluded that CFC does have a potential for replacing the expensive wheat bran as a fibre source for broiler feeding. High levels in the diets of birds elicit reduced nutrient digestibility, reduced weight and accretion of intestinal and visceral organs. Results of the study suggest that CFC can replace up to 50% of the wheat bran requirement for feeding broilers to the finisher phase.

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