Effect of Feeding Cassava Wastes on the Performance and Meat Quality of Broiler Chickens

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Abstract

Utilization of cassava waste meal (CWM) by broilers may increase poultry meat production in the developing countries by reducing cost of production. A completely randomized design feeding trial of 120 Cobb chicks aged 22 d was conducted to evaluate the effect of CWM-based diets on carcass quality of broilers and to determine the cost effectiveness of CWM in the diets of broilers. Four diets comprising control and three CWM-based diets containing 10, 20 and 30% CWM graded levels, respectively, were fed to chickens for 24 d. Daily feed intake and weekly body weight of chickens were measured throughout the feeding trial. A metabolic trial was conducted at the end of the trial to determine utilization of nutrients, followed by carcass evaluation of treated chickens. Total cost of feeding per weight gain of chickens was also computed. Feed intake, body weight gain, feed conversion ratios of broiler chickens fed CWM based diets were comparable ($P > 0.05$) to control chickens. Similarly, increasing CWM levels in finishing diets did not affect ($P > 0.05$) the utilization of dry matter, ash, crude fibre and dressing percentage. None of the treatments significantly influenced ($P > 0.05$) breast cuts, drumstick, liver and lung weights. Supplementation of broiler finisher with CWM significantly reduced ($P< 0.05$) total feeding cost and cost of producing broiler meat compared to control diet. CWM supplementation of broiler finisher diets optimized the profit from broiler production. This study showed that inclusion of CWM up to 10% in the diets of broilers supported their growth performance, and carcass characteristics. The supplementation of broiler finishing diets with CWM was profitable than feeding maize based finisher diets.

Keywords: Cassava wastes, performance, meat quality, broilers

Introduction

At present the scarcity of conventional protein and energy resources is largely responsible for the high price of livestock feed in Fiji. The use of unconventional feed resources in poultry nutrition is one of the ways to overcome this feed crisis in the poultry industry. Alternative feed sources have proved valuable in supporting the performance of livestock and poultry at low cost of production (Babatunde and Oluyemi, 2000). Cassava has been reported as a major staple food widely cultivated in the lowlands of the humid tropics and capable of providing higher amount of energy/ha, about 13 times more than maize or guinea corn (Oke, 1978).

Cassava waste is one of the agro-industrial by-products available in Fiji where cassava is cultivated mainly for human consumption. In 2009 Fiji produced 42,332 tonnes of sweet varieties of cassava and the production rate is increasing yearly, slowly replacing other traditional food crops in the diet (FAO, 2009). The abundant cassava wastes containing 40 percent cassava peels and discarded small tubers were left unutilized in refuse dumps, thus polluting the environment.

Tewe and Kasali (1986) reported that cassava peel accounts for 10–13% of tuber by weight and contains about 5% crude protein and reasonable amount of minerals. However, the use of cassava peel as feed for non- ruminant animals is limited due to its high fibre content and hydro-cyanic acid which is deleterious to their growth and development (Tewe, 2004). Many processing methods that have been used to enhance the feeding value of cassava include sun-drying (Akinfala *et al*., 2007), parboiling (Salami, 1999), soaking in water and retting (Salami and Odunsi, 2003). These methods have however achieved different level of success.

Incorporation of cassava wastes into broiler's feed will reduce the environment pollution (Devendra, 1992) and reduce the cost of finished feed and eventual cost of meat chicken production in the region. Cassava wastes have been proved to be useful as a feed resource for raising goats, sheep and cows (Devendra, 1992). However the information on its utilization by broilers is scarce.

This study was therefore conducted to evaluate the effect of replacing maize with different levels of cassava waste meal (CWM) on performance and carcass characteristics of broiler chickens. The study also investigated whether it was possible to formulate cheap and practical nutritionally adequate diets from locally available cassava waste for smallholder poultry farmers.

Materials and Methods

Location

The feeding experiment was conducted at the Poultry unit of the Teaching and Commercial Farm of Fiji National University in the warm tropical maritime climatic central region of Viti Levu island of Fiji. The study area lies in the Southwestern Pacific Ocean between approximately 15^{o} to 20^{o} south latitudes and 175^{o} to 182^{o} east longitudes. The mean annual rainfall is between 2000 and 3000 mm with relative humidity of between 75 and 85% and mean annual temperature of 23.6 to 30.6 ^{o}C. The period of the experiment was between December and February.

Collection and Preparation of Cassava Waste Meal

Cassava wastes collected from an agro-marketing factory at Nausori Fiji Island were washed with clean water and cut with knives into smaller pieces. The cut pieces were dried with a rice dryer at 40^{o}C to constant weight for three days at the Rice Section of Koronivia Research Station in Fiji, ground with hammer mill to produce cassava waste meal (CWM) and stored for subsequent use. A representative sample was collected for proximate composition analysis.

Other feed ingredients used in the experiments were bought from a local livestock feed miller at Nausori Fiji Island. The proximate composition of CWM and other ingredients used in the feed formulation was determined at the Chemistry Laboratory, Koronivia Research Station of Ministry of Agriculture according to the AOAC methods (1990).

Preparation of Experimental Diets

A corn/pea meal based diet was formulated as the control diet with no CWM. In the other diets CWM was incorporated at 10, 20, 30% graded levels and were formulated to meet the nutrient requirements of finisher broilers as recommended by NRC (1994). The percentage composition of ingredients in the diets is presented in Table 1.

Experimental Birds and Housing

The present research study was approved by Fiji National University Research Committee and was conducted in compliance with Fiji research ethics guidelines for animal welfare. A total of 120 day-old Cobb broiler chicks were obtained from a local hatchery and raised on the littered floor brooders. The birds received commercial broiler starter and grower diets from day old to 21th day. On day 22, they were randomly allotted to four treatment groups consisting of thirty birds per treatment. Each treatment was replicated three times with 10 birds per replicate in a completely randomized design experiment. The birds were given four dietary treatments comprising control diet with no CWM, and three test diets containing 10, 20 and 30% graded levels of CWM respectively for 24 days. The birds were housed in a deep litter housing system with feed and water offered *ad libitum* throughout the experimental period.

Table 1: Percentage composition of experimental diets

Ingredients	Control	CWM graded levels (%)		
	0	10	20	30
Maize	26.90	-	-	-
Crushed wheat	9.00	24.7	9.30	0.40
Pea meal	11.60	12.82	18.20	24.10
CWM	-	10.00	20.00	30.00
Fixed ingredients*	52.50	52.50	52.50	45.50
Calculated composition				
Crude protein	20.16	20.16	20.20	20.20
Ether extract	6.20	6.60	7.20	7.60
Crude fibre	4.10	5.10	5.50	5.60
Metabolizable Energy (kcal/kg ME)	3361	3032	3067	3084
Lysine	0.8	0.8	0.8	0.9
Methionine	0.6	0.6	0.6	0.6
Ca	1.1	1.1	1.1	1.1
Phosphorus total	0.7	0.7	0.6	0.7
Na	0.2	0.2	0.2	0.2

*Fixed ingredients (dry matter basis): copra meal 10%; fish meal, 7%; meat meal 7%; coral sand, 4%; mill mix, 21%; salt, 0.25%; soy oil, 2%; molasses, 1%; vitamin /mineral mix, 0.25%; [b] fixed ingredients has copra meal, 8%, coral sand, 2%; mill mix 18%. Vitamin/mineral composition: Vitamin B, 6,000,000 IU; Vitamin D_3, 2000000 IU; Vitamin E, 4000mg; Vitamin K_3, 600 mg; Vitamin B_1, 300mg; Vitamin B_2, 3500 mg; Vitamin B6, 800 mg; Vitamin B_{12}, 40 mg; pantothenate, 1100 mg; nicotinic acid, 15000 mg; folic acid, 250 mg; Biotin, 80 mg; Na_2SeO_3, 200mg; $FeSo_4H_2O$, 85g; $ZnSO_4H_2O$, 90g; $CuSO_4$ H_2O, 5g; $MnSO_4$ H_2O, 85g.

Data Collection

The feed intake of the birds was measured daily by subtracting left over feed from feed offered daily to obtain daily feed intake, while the birds were weighed weekly until the end of the experiment. Weekly body weight gains of the birds during the experiment were obtained by subtracting their final body weight at the end of feeding trial from initial body weight and later converted to daily weight gain by dividing by seven. The daily feed efficiency was calculated as the ratio of daily feed intake to daily body weight gain.

Cost Analysis

Cost analysis of CWM supplementation was assessed using prevailing market prices at the time of the experiment. The cost of the CWM-based diet was estimated by computing the cost of labour for collection and processing of cassava wastes. Feed consumption was multiplied with cost per kg feed to obtain the cost of feeding. The feed cost per kg of body weight gain (BWG) was calculated by dividing the cost of feeding by BWG. All costs were calculated in Fijian dollars (1F$ = 0.56AU$).

Metabolic Trial

At the end of the feeding trial, two representative chickens from each treatment were kept in the metabolism cages for seven days to measure nutrient digestibility by total feacal collection method. The first three days enabled the chickens to adapt to the feed offered ad libitum. Feed intake was measured during the last four days and all excreta were collected and dried daily.

Daily feacal collection was weighed and dried to constant weight at 65°C for 48 h. At the end of the metabolic trial, the dried feaces from each replicate were pooled and ground to obtain homogenous feacal samples. The representative dried feed and feacal samples were analyzed for crude protein, crude fibre, ash and fat contents according to AOAC methods (1990). Dry matter digestibility and apparent nutrient utilization were computed.

Carcass Evaluation

At the end of the metabolic trial, two chickens per replicate (bird/treatment) were fasted for 24 h to empty their gut but they were given water, weighed individually and slaughtered by cervical dislocation. The chickens were scalded, plucked and weighed before evisceration. Carcass weights were taken after plucking and removal of feet, head and viscera. Weights of liver, gizzard, kidney, heart and lung were taken with a sensitive weighing balance. Dressing percentage was calculated as the percentage of live body weight, while breast, drumstick, back, kidney, heart, gizzard, lungs, total meat, liver and total bone were expressed as a percentage of dressed weight.

Statistical Analysis

Data were analyzed using the general linear model of SPSS, version 18 (SPSS Inc, 2010) at $P < 0.05$ level of significance.

Results and Discussion

The analyzed nutrient composition of the CWM and experimental diets are shown in Table 2. CWM had 2562 Kcal/kg metabolizable energy (ME), 3.10% crude protein (CP), 9.4% crude fibre (CF), 67.58% nitrogen free extract (NFE), 0.6% ether extract (EE) and 9.8% ash contents. The CP contents of CWM-based diets were similar to the control diet. Dietary ME decreased in proportion to incremental CWM level in the diets with 10% CWM-based diet having the highest 2847 ME value and 30% CWM-based diet having the lowest ME (2338 Kcal/kg). Calorie to Protein ratio of CWM-based diets followed similar pattern when compared with the control diet. The highest value was recorded for 10% CWM-based diet (145) and lowest in 30% CWM-based diet (116).

Table 2: Analyzed nutrient composition of CWM and experimental diets

Nutrients (%)	CWM	Control	CWM-based diets		
		0 %	10 %	20 %	30 %
DM	90.40	88.90	88.10	82.00	82.00
CP	3.10	19.60	19.60	19.60	20.10
CF	9.40	5.10	2.90	5.10	4.50
EE	0.60	1.40	1.30	2.50	0.70
Ash	9.80	10.00	7.50	13.00	13.40
NFE	67.58	52.8	56.80	41.80	43.30
ME* (Kcal/kg)	2562	2713	2847	2412	2338
Calorie: Protein		138	145	123	116

*Metabolizable energy value was calculated using the method 37 x %CP + 81x %Fat + 35.5 x %NFE for poultry (Fisher and Boorman, 1986)

Table 3 shows the performance and nutrient utilization of broiler chickens given CWM-based and control diets from 22 to 49 days of age. Average feed intake and body weights of broiler chickens given CWM based diets were not affected (P>0.05) but the weight gain and feed conversion ratio of experimental birds reduced significantly (P < 0.05) at 30% CWM inclusion level.

Significant differences (P < 0.05) were observed in the cost of producing a kilogram CWM-based feed. The cost of producing a kilogram of broiler finisher ration increased with increasing proportion of CWM in the diets which cost F$1.12 to produce a kilogram of 10% CWM-based feed and was significantly cheaper (P < 0.05) than the cost of producing a kilogram of 20% CWM-based feed (F$1.21). While the costs of producing control and 30% CWM feeds were not significantly different (P > 0.05) but were more expensive (P< 0.05) than 10 and 20% CWM-based feed. The cost of feeding finishing broilers with CWM-based feeds did not differ significantly (P > 0.05) from control diet.

The cost of producing a kilogram of gain of chickens given 10% CWM-based feed was significantly cheaper (P < 0.05) than other treatments but similar to that of chickens fed the control diet. Although, average cost per kilogram body weight gain of chickens given CWM-based feeds improved (P < 0.05) with increasing proportion of CWM in the diets, it was not significantly different (P > 0.05) from the control group.

Table 3: Performance and nutrient utilization of broiler finisher fed CWM-based diets from 22 to 49 days

Performance parameter	Control	CWM-based diets		
	0 %	10 %	20%	30 %
Average feed intake (kg)	2.50^{a}	2.68^{a}	2.52^{a}	2.42^{a}
Final body weight (kg)	1.44^{a}	1.50^{a}	1.24^{a}	1.16^{a}
Weight gain (kg)	1.13^{a}	1.18^{a}	0.91^{ab}	0.84^{b}
Feed conversion ratio	2.3^{b}	2.3^{b}	2.8^{ab}	2.9^{ab}
Cost/kg feed (F$)	1.28^{c}	1.12^{a}	1.21^{b}	1.28^{c}
Total cost of feeding (F$)	3.20^{a}	3.00^{a}	3.04^{a}	3.09^{a}
Cost /weight gain (F$/kg)	2.83^{bc}	2.54^{c}	3.34^{b}	3.67^{b}
<u>Nutrient utilization (%)</u>				
Dry matter	87.33^{a}	83.46^{b}	85.69^{a}	87.45^{a}
Crude protein	88.31^{a}	80.10^{b}	87.11^{a}	86.86^{a}
Crude fibre	98.97^{b}	98.86^{b}	99.55^{a}	99.63^{a}
Fat	85.10^{a}	53.77^{b}	75.08^{ab}	20.73^{c}
Ash	79.29^{a}	49.41^{b}	71.32^{a}	75.82^{a}

[abc]Means within rows with common superscripts are not significantly different (P > 0.05)

The nutrients utilization of experimental diets differed (P < 0.05) significantly between the treatments (Table 2). Broiler chickens given 10% CWM based diet had the lowest significant (P < 0.05) dry matter, crude protein, and ash utilization values than other treatments. However, crude fibre utilization of chickens given 10% CWM-based diet was not significantly different (P > 0.05) from control group but differed significantly (P < 0.05) from 20 and 30% CWM treatments. The supplementation of CWM at 20 and 30 % dietary inclusion levels did not influence (P > 0.05) dry matter, crude protein, and ash utilization significantly relative to control group. It was also observed that increasing dietary levels of CWM significantly reduced (P < 0.05) crude fat utilization of experimental chickens especially when given 30% CWM diet compared with control group.

Table 4: Carcass cuts of broilers fed CWM-diets (expressed as % dressed weight)

Parameter	Control	CWM-based diets		
	0%	10%	20%	30%
Dressing %	71.88[c]	74.98[ab]	76.95[a]	77.61[a]
Breast	25.63[a]	29.49[a]	29.18[a]	22.42[a]
Drumstick	26.05[a]	26.73[a]	26.08[a]	24.92[a]
Kidney	1.13[b]	1.26[ab]	0.99[b]	0.74c
Gizzard	6.76[a]	5.19[b]	5.02[b]	4.98[b]
Lung	2.05[a]	1.45[a]	1.25[a]	1.29[a]
Liver	4.53[a]	3.47[b]	3.55[b]	3.43[b]
Heart	1.39[b]	1.34[b]	1.14[b]	1.30[b]
Total bone	17.31[ab]	14.89[b]	18.33[ab]	21.70[a]
Total meat	82.69[ab]	85.11[a]	81.67[ab]	78.30[b]

[abc]Means within rows with common superscripts are not significantly different (P > 0.05)

The weights of carcass cuts and internal organs as a percentage of dressed weight of broilers fed CWM-based diets are presented in Table 4. The dressing percentages of broiler chickens differed significantly (P < 0.05) between treatments. Even though the dressing percentage of chickens given CWM treatments were similar (P > 0.05) they were significantly higher (P < 0.0%) than the control. None of the treatment significantly influenced (P > 0.05) breast cuts, drumstick, liver and lung weights of broilers. On the other hand, increasing levels of CWM in finishing diets significantly reduced (P < 0.05) gizzard and kidney weights of broiler chickens.

The nutrient composition of CWM in this study was lower than the proximate composition values of sundried cassava peal meal DM (88.8%), CP (5.24%), CF (12.38%), EE (3.97%), Ash (5.16%) and NFE (73.25%) reported by Oladunjoye *et al.* (2010) but higher than the values reported by Gomez (1979) for fresh cassava roots. Similarly, it had higher ME than oven dried cassava peel meal (2044.8 kcal/kg ME) reported by Eshiette and Ademosun (1981) and lower ME value when compared with 3870 kcal/kg ME of unpeeled cassava root meal (Tion and Adeka, 2000). The differences in nutrient composition of CWM relative to previous studies might be due to the composition and proportion of whole cassava root to peels in cassava wastes, variety differences, differences in soil conditions and rainfall distribution (Osei and Twumasi, 1989). The low crude protein and high energy contents of the CWM suggested its potentiality as energy feedstuff and confirmed various reports of previous studies that peeled cassava root meal and other cassava products could be used effectively for broilers (Ademosun and Eshiett, 1980; Tewe and Egbunike, 1992).

The decline in dietary ME in proportion to increasing CWM in the present experiment might probably be due to the low ME content in CWM which diluted energy component of finished feed (Odunsi *et al*., 2001).

The similarity in feed intake and nutrient utilization of birds given CWM based diet contradicted the report of Tewe (1983) and Odunsi *et al.* (2001) that cassava peel meal based diet fed at 0 and 30 percent replacement of maize resulted in increased feed intake of starter and finisher broilers. However, reduced body weight gain and feed conversion ratio of broiler finisher chickens observed in this study was consistent with the report of Tewe and Egbunike (1988). Conversely, the depression in nutrient utilization at 10% level CWM could not be accounted for as the growth performance of the chickens given 10% CWM supplementation was superior to all other treatments.

Chickens in this study gained some weight at the end of the experiment. This was an indication that the diets had sufficient nutrient composition to sustain growth of broilers. The results obtained in this study was consistent with the findings of Longe and Oluyemi (1977) and Wyllie and Kinabo (1980) who reported a linear decrease in weight of broilers given progressive increase in quantity of cassava in the ration. Similarly, Gomez (1985) demonstrated that the diets having more than 10 to 20% cassava products with low or high hydrocyanic contents caused similar decrease in weight of broilers. Good weight gain response of broilers given CWM- based diets relative to control group is also an indication of feed utilization and thus implies the CWM contains safe level of toxic factors that could impede feed utilization. The insignificant variations in apparent digestibility of the dry matter and nutrients clearly showed that CWM could partially replace maize in the diets of growing meat birds without adverse effect on nutrient digestibility.

The reduction in the unit cost of diet containing CWM up to 20% level relative to control diet could be attributed to the lower price of cassava wastes in comparison to that of maize. On the other hand, the higher unit cost of diet at 30% CWM inclusion level might probably be due to higher price rate charged for the drying and grinding of cassava wastes in a commercial mill. The cost of processing could be reduced adequately for future studies if mini mill, mixer and dryer could be purchased purposely for the feed evaluation studies. High moisture levels predispose cassava products to spoilage during processing, therefore, the construction of drying facilities that can be utilized in rural areas should be considered so that the processing can be carried out near farm sites.

Although during the dry season, cassava can also be sun-dried but the only limitation to this processing method had been affirmed by Tewe and Egbunike (1992) that when cassava chips were sun-dried on the floor, they could be infected by microorganisms such as *Aspergillus niger* and *Eschericia* species which might predispose young chicks to aflatoxicosis and mortality. Therefore, proper technology to produce cassava products of guaranteed quality that will meet the nutritional needs of broiler chicken for satisfactory productivity in commercial farms is required for the utilization of cassava wastes (Tewe and Egbunike, 1988).

However, the lower feed cost per kilogramme weight gain of birds given CWM-based diets was in agreement with the report of Obikaonu and Udedibie (2008) who stated that the inclusion of cassava peel meal in poultry could result in significant economic benefits.

The non significant effect of cassava treatments on carcass evaluation in this study was consistent with the findings of Eruvbetine *et al*. (2002) who observed no significant effect of cassava treatments on dressing percentage. Similarly, Osei and Duodu (1988) reported that dietary treatments had no influence on carcass quality characteristics such as dressed weight and eviscerated weight. Eruvbetine *et al*. (2002) observed no significant differences in weights of liver, crop, caecum, kidney, lung, spleen and heart weight as a result of the treatments (cassava root and leaf meal). Gizzard weight and proventriculus weights were however, significantly higher in the groups fed 30% cassava concentrate which could be attributed to the increased size of the gizzard as a result of handling bulky feeds.

Conclusion

This study showed that inclusion of CWM up to 10% in the diets of broilers supported their growth performance, and carcass characteristics. Thus the supplementation of cassava and its products in broiler's diets has some beneficial potential that can be utilized to reduce cost of producing broiler's feeds for small scale poultry farmers.

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