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Growth Performance, Carcass Measurements and Organs Weight of Broiler Chickens Fed Cassava Copra Meal-based or Commercial Finisher Diets in Samoa

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ABSTRACT
A three-week experiment was conducted to investigate the utilisation of a diet based on Cassava Root Meal (CRM) and copra meal by finishing broiler chickens. A total of (96) 21-day old Cobb broilers were used for the experiment. The birds were weighed and allotted to 6 pens containing 16 birds each. A finisher diet based on cassava and copra meal and a commercial broiler finisher diet were fed each to 3 randomly selected pens for a period of 21 days. Results showed poorer ($p<0.05$) final body weight, daily feed intake, daily gain and feed: Gain ratio on the test feed compared to the control commercial feed, but feed cost of meat production (WST$/kg live weight) was reduced ($p<0.05$) on the test feed. Birds on the commercial feed had higher ($p<0.05$) carcass and breast meat yields, while the yields of thighs and drumsticks were not affected ($p>0.05$) by the diet. There were no treatment effects ($p>0.05$) on the weights of the liver, heart and ceaca, but birds on the test feed recorded higher ($p<0.05$) weights of the pancreas, gizzard and small intestine. Birds fed the control commercial feed deposited more ($p<0.05$) fat than those fed the test feed. It was concluded that cassava copra meal-based finisher diets could be used to reduce cost of meat production and carcass fat content and thus meat quality of broiler chickens. Further research into appropriate combinations of these ingredients for optimum growth and feed utilisation by broilers is recommended.

Key words: Cassava root, copra meal, enzyme, commercial feed, broiler performance

INTRODUCTION
Poultry meat and eggs form important components of the diets of Samoans but their domestic production is constrained by several factors among which the high cost of feed. Because the conventional ingredients used in diet formulation such as maize, wheat, soyabean and groundnut are not grown in the country, commercial poultry farming relies solely on the importation of feed from overseas. Where feed mills exist, they simply mix rations based on imported raw materials. There are however, locally available raw materials with potentials as feed ingredients in poultry diets (FAO, 2012) which could be used to reduce the cost of poultry production in the country.

Cassava, manioc, tapioca (*Manihot esculenta*) roots and copra meal (a by-product of coconut oil extraction) are readily available and have limited food or industrial uses, thus cheap, in Samoa. Cassava root is a good source of energy but poor in protein and the protein is deficient in amino acids (Silva *et al.*, 2000). Copra meal is moderate in protein, ranging from 19% (Sauvant *et al.*, 2004) to 22.4% (Mondal *et al.*, 2008) but its use as source of dietary protein for poultry is limited by the high fibre (Kim *et al.*, 2001) and low essential amino-acid (Sundu *et al.*, 2009) contents.

Cassava root and copra meal have been used as replacements for the conventional feed ingredients in poultry rations with varying degrees of success. Rougiere and Carre (2010) observed that feeding concentrates supplemented with 50% cassava root meal showed advantages in broiler chickens compared to the use of commercial broiler finisher feed based on imported ingredients. Glatz (2012) and Buitrago and Luckett (1999) reported that in pelleted feeds, cassava meal can totally replace the cereal grains in poultry diets, but finely ground cassava will cause difficulties in consumption due to its dustiness.

Despite the availability of cassava and copra meal in Samoa, documented information on their feeding as major energy and protein sources respectively in poultry diets is limited. This experiment was conducted to investigate the utilisation of a cassava-copra meal based diet by finishing broiler chickens in Samoa.

MATERIALS AND METHODS

Experimental site: The experiment was conducted at the Poultry Unit of the University of the South Pacific, Alafua Campus Livestock Farm, Apia, Samoa (Latitude~13.5°S, Longitude~172.5°W). The sweet variety of cassava which is the most available cultivar is not a staple food for the people in the study area. Copra meal is also readily available year-round in Samoa from the Pacific Oil industry as well as small scale home processors of coconut oil.

Processing of cassava root and formulation of the experimental diet: Fresh cassava root purchased from the market was peeled, grated and sun-dried for 72 h. The dried product was then ground to pass through a 2 mm sieve and labelled Cassava Root Meal (CRM). A broiler finisher diet (Table 1) was formulated to contain 20% crude protein and 3000 kcal kg^{-1} Metabolisable energy

Table 1: Ingredient composition and calculated analysis of the experimental broiler finisher diet

Ingredients	Quantity (g kg^{-1})
Cassava root meal	340.30
Copra meal	500.00
Coconut oil	12.50
Fish meal	102.70
Limestone	30.00
Enzyme	3.00
Lysine	3.00
Methionine	3.00
Premix	2.50
Salt	3.00
Total	1,000.00
Calculated analysis	
Crude protein (g 100 g^{-1})	20.00
Metabolisable energy (kcal kg^{-1})	2,999.16

using CRM as the main energy source and copra meal (from the Pacific Oil, Samoa) as the major protein source. The diet was supplemented with Allzyme SSF (from Alltech) which has seven major enzyme activities, namely: Amylase, cellulase, phytase, xylanase, betaglucanase, pectinase and protease. The diet was also supplemented with L-lysine HCl and DL-methionine to compensate for the deficiencies of these amino acids in copra meal and fortified with vitamins/mineral premix to satisfy the requirements of broiler chickens (NRC, 1998).

Birds and management: A total of 96 Cobb broiler chicks brooded together on commercial feed for the first 21 days were used for the experiment. On the 22nd day, the birds were weighed (720±3.7 g $bird^{-1}$) and assigned to 6 groups of 16 birds each. Each group was housed in an open-sided deep litter house measuring 8.97 m^{-2} with wood shaving as litter material. Commercial broiler finisher (control) and the formulated (test) diets were fed to 3 randomly selected pens for a period of 21 days. The diets and clean drinking water were provided *ad libitum* throughout the period of the experiment.

Data collection: Growth performance (feed intake, weight gain and feed conversion), carcass measurements and organs weight formed the major response criteria. Feed intake was monitored by feeding weighed quantities of feed daily and subtracting the left-over from the quantity fed the previous day. The birds were weighed weekly and weight gain calculated by difference between 2 consecutive weighing. Feed Conversion Ratio (FCR) was derived as the ratio of feed consumed to weight gain.

At the end of the experiment (42nd day of age), 2 birds were randomly selected from each pen (6 birds per treatment) for carcass and organs weight measurements. The birds were fasted overnight, weighed early in the morning (6.00 am) and slaughtered. Slaughtered birds were scalded in hot water (55°C) for 2 min, plucked and eviscerated. The eviscerated weights (carcasses), the weight of carcass cut-up parts (breast, thighs, drumsticks) and organs (liver, gizzard, small intestine, caeca, pancreas, heart) and abdominal fat were expressed as percentages of the slaughter weight.

Chemical and statistical analyses: Cassava Root Meal (CRM), copra meal, fish meal and the formulated diet were analysed for proximate composition according to the AOAC (1995).

Data on growth, carcass and organs weights were subjected to analysis of variance for a completely randomised design (Steel and Torrie, 1980) using the SPSS (2007) software. Where significant differences existed between treatments, means were separated using the Least Significant Difference (LSD).

RESULTS

The results of chemical analysis are presented in Table 2. The crude fibre content was high in the experimental copra meal which was reflected in the crude fibre content of the formulated diet compared to the control commercial diet.

Data on the growth response of the birds to the two diets are presented in Table 3. Birds fed the commercial feed (control) ate more feed, gained more weight and converted their feed more efficiently ($p<0.05$) than those receiving the test diet based on cassava-copra meal. Despite the lower weight gain and the poorer feed conversion on the test diet however, feed cost of meat production (WST\$ kg^{-1} live weight) was significantly reduced on this diet as compared with the

Table 2: Proximate composition of the cassava root meal (CRM), copra meal, fish meal and the formulated and commercial finisher diets

Constituents (g 100 g^{-1})	CRM	Copra meal	Fish meal	Formulated diet	*Commercial diet
Dry matter	91.67	90.25	97.19	92.44	86.00
Crude protein	5.91	24.90	68.70	19.25	20.20
Ether extract	0.14	6.61	13.27	4.96	5.30
Crude fibre	2.25	11.29	0.16	6.44	4.00
Total ash	2.15	6.60	12.69	9.66	5.70
Nitrogen free extract	81.22	47.46	2.37	56.13	NR
Metabolisable energy (kcal kg^{-1})	2,873.00	2,683.00	3,250.00	3,095.00	3,200

*Values from the feed company; NR: Not reported

Table 3: Growth performance of broiler chickens fed a commercial finisher (CF) or a cassava- copra meal based finisher (CCMF)

Variables	CF	CCMF	SEM
Initial weight (g $bird^{-1}$)	722.00	721.25	0.87^{ns}
Final weight (g $bird^{-1}$)	$2,247.10^{a}$	$1,764.00^{b}$	108.96*
Daily feed intake (g $bird^{-1}$)	149.13^{a}	132.17^{b}	3.82*
Daily weight gain (g $bird^{-1}$)	72.63^{a}	49.63^{b}	5.18*
FCR (feed: gain)	2.05^{b}	2.66^{a}	0.14*
Cost of kg feed (WST$)	1.76	1.02	NA
Feed cost (WST$ kg^{-1} live weight)	3.61^{a}	2.71^{b}	0.17*
Mortality (No.)	0.00	0.00	NA

a, b: Means within the row with different superscripts differ significantly (p<0.05), NS: Not significant (p>0.05), *Significant (p<0.05), SEM: Standard error of the mean; WST$ 1 = $ 0.45 at the time of experiment

Table 4: Carcass measurements and organs weight of broiler chickens fed a commercial finisher or a cassava copra meal based finisher (CCMF)

Variables	CF	CCMF	SEM
Slaughter weight (g $bird^{-1}$)	$2,192.00^{a}$	$1,692.00^{b}$	117.73*
Dressing (%)	81.52^{a}	69.38^{b}	2.29*
Carcass cut up parts (% live weight)			
Breast	17.99^{a}	15.90^{b}	0.54*
Thighs	12.13	11.45	0.22^{ns}
Drumsticks	10.71	9.98	0.18^{ns}
Organs weight (% live weight)			
Liver	2.12	2.13	0.04^{ns}
Pancreas	0.18^{b}	0.29^{a}	0.03*
Heart	0.52	0.61	0.03^{ns}
Gizzard (full)	0.25^{b}	2.37^{a}	0.26*
Small intestine (full)	0.55^{b}	4.56^{a}	0.53*
Ceaca (full)	0.43	0.48	0.02^{ns}
Abdominal fat	0.30^{a}	0.62^{b}	0.42*

a,b: Means within the row with different superscripts differ significantly (p<0.05), NS: Not significant (p>0.05), *Significant (p<0.05), SEM: Standard error of the mean

control. Litter moisture was exceptionally high in pens fed the test diet during the first week due to the excretion of large quantities of watery dark-brown faeces. Litter moisture content was reduced and faeces colour and consistency improved from the second week. Despite the high litter moisture content which is a favourable ground for the growth of pathogenic organisms, no health problem or mortality was recorded throughout the period of the experiment.

Results of carcass and organs weight measurements of the broilers (Table 4) showed higher (p<0.05) dressing percentage and breast meat yield in the control group compared to the group fed the test feed. Percent thighs and drumsticks were not affected ($p>0.05$) by dietary treatment. The weight of the organs as percentage of the live weight showed no statistical differences ($p>0.05$) for liver, heart and ceaca but the values for pancreas, gizzard and small intestine were significantly ($p<0.05$) higher in the group receiving the test feed compared to the control group. Birds on the control feed deposited more ($p<0.05$) abdominal fat than the test diet fed birds.

DISCUSSION

The protein content of cassava root meal used in the present study is higher than the 2.8% (Buitrago and Luckett, 1999) and 3.6% (Chauynarong *et al*., 2009; Uchegbu *et al*., 2011) reported. Factors such as cultivar, conditions of the soil and stage of maturity, which have all been reported to affect the composition of cassava products (Ravindran and Ravindran, 1988; Agwunobi and Okeke, 2000) may be reasons for the higher protein content observed in the present study compared to values in literature. The protein, fat and fibre contents of the experimental copra meal are comparable to the values reported for solvent extracted copra meal (Thorne *et al*., 1989; NRC, 1994). The protein content of the formulated diet was comparable to that of the commercial diet but the Metabolisable energy level was slightly lower than that of the formulated feed.

As poultry consume feed to meet their energy requirement, a higher intake would have been expected on the lower energy test diet as compared to the commercial feed with higher energy content. Structural feed components have been reported to be retained in the gizzard for a longer time (Rougiere and Carre, 2010; Svihus, 2011; Meremikwu *et al*., 2013). The high fibre content of the test diet which must have resulted in increased digesta retention time in the gastro-intestinal tract may be a reason for the lower feed intake observed in the present experiment. The reduced feed intake on the cassava-copra meal diet resulting in low intake of essential nutrients may probably be the main reason for the poor growth performance observed. Similar results were reported by Thomas and Scott (1962). These authors observed poor growth performance of broilers fed a diet based on 40% copra meal compared to a standard corn-soyabean diet. Although the final body weight was depressed on the test diet compared to the control, the value was within the range (1,736-1,893 g $bird^{-1}$) observed by Reddy *et al*. (2008) in six-week old Cobb broilers fed millet, sorghum or corn/soyabean diets supplemented with enzymes. Despite the lower weight gain and the poorer feed conversion on the test diet, feed cost of meat production (WST$ kg^{-1} live weight) was significantly reduced on this diet as a result of the difference in the cost of the two diets (WST$ 1.02 and WST$ 1.76 kg^{-1} for the test and commercial feeds, respectively). The reduced litter moisture and improved faeces consistency in birds fed the test diet during the second week are indications of adaptation of the birds to the diet. This trend may be used to speculate that an increase in the length of the period of data collection could result in a compensation for weight gain and feed utilisation.

The mean carcass yield on the test diet is within the range (67-68%) reported by Patra *et al*. (2002) for six week-old broilers but birds fed the commercial diet had exceptionally higher carcass yields than values reported in literature. The higher carcass fat content on this group must be a contributing factor to the increase carcass yield due to the heavier weight of fat.

As the liver, assisted by the heart, has major role in detoxification, the similarities in liver and heart weights in the two groups suggest that there were no serious toxicity problems with the test diet. Sweet cassava is a glandless cultivar and there are no reports of major toxic substances in the other ingredients used in the formulation. The increased weight of the pancreas on the test feed was probably an attempt to increase the secretion of pancreatic juice to cope with the hydrolysis of this structurally rich feed. The significant increases in full gizzard and small intestine weights were attributed to the increased retention time of digesta on fibrous diets as earlier observed (Rougiere and Carre, 2010; Svihus, 2011; Meremikwu *et al.*, 2013). Increased gizzard volume with increasing structural components in the diet has also been reported by Amerah *et al.* (2009). The lower fat content of the carcass of birds fed the fibrous test diet suggests that these birds fed to meet their energy requirement with no extra energy for fat deposition.

It is concluded that using cassava root meal and copra meal could be used as major energy and protein sources respectively in the diet of finishing broiler chickens will reduce cost of production and carcass fat content. However, when weight gain and efficiency of feed utilisation form the major response criteria, the substitution is not rewarding. Further research into appropriate combinations of the ingredients in the diet is recommended.

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