THE SUBSTITUTABILITY OF MAIZE WITH CASSAVA ROOT AND LEAF MEAL MIXTURE IN BROILER DIETS

S. Ochetim[1]

School of Agriculture, University of the South Pacific
Alafua Campus, Apia, Western Samoa

Summary

Two experiments were conducted to investigate into the effects of replacing maize with a mixture of cassava root and leaf meal (CRLM) on the performance of broiler chickens. In experiment 1, CRLM replaced 50 or 100 percent of maize in the control diet. In experiment 2, the 100 percent CRLM based-diet was fortified at a further 3 percent level with coconut oil. A total of 180, one-day old Shaver Starbro chicks, raised up to 49 days of age, were used. There were no significant ($p > 0.05$) differences in final body weights, feed intake and feed efficiency between the control group and the group fed the diet in which 50 percent of the maize was replaced with CRLM. At the 100 percent level of replacement of maize with CRLM, however, final body weights, feed efficiency and carcass yields, were significantly ($p < 0.05$) reduced. Dressing percentage and feed intake were not affected ($p > 0.05$) by level of substitution of maize with CRLM. In experiment 2, when the diet in which all of the maize was replaced with CRLM was fortified with coconut oil at an additional 3 percent level, broiler performance improved and equalled ($p = 0.05$) that obtained on the control maize diet. It was concluded the CRLM can replace 50 percent of maize in broiler diet without adversely affecting performance. However, for the complete replacement of maize with CRLM, it is necessary to further supplement such a diet with a high energy density ingredient if broiler performance is to be maintained.
(**Key Words**: Maize, Cassava Root and Leaf Meal Mixture, Substitutability, Broiler Performance)

Introduction

A major portion of imported poultry feed resources into the South Pacific region is made up of energy feed ingredients, and principally cereal grains such as maize and wheat (Ochetim, 1987). Wheat is not grown in any of the island countries of the region, while the cultivation of maize is too insignificant to meet the demands of the livestock feed industry. But in virtually all countries of the region, there are large quantities of roots and other starchy crops being produced, mainly for human consumption. Given the high level of grain importation for use in poultry feeding, and the high level of production of roots and other starchy crops in the region, it does seem desirable that greater consideration should be given to the potential of using these roots and other starchy crops in poultry feeding.

[1]Address reprint requests to Dr. S. Ochetim, School of Agriculture, University of the South Pacific, Alafua Campus, Apia, Western Samoa.

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Cassava (*Esculenta manihot*) is an important crop in Fiji, Tonga, Solomon Islands, Vanuatu and to some extent in Western Samoa and Cook Islands. The part of the crop that is most valued is the root because of its high energy feeding value due to the high content of starch. But leaves are also valuable in that they are reasonably rich in protein. The possibilities of using cassava roots and leaf meal mixture as substitutes for maize in broiler diets were the objectives of the present study. In experiment one, the effects of partial (50 percent) and complete (100 percent) replacement of maize with a mixture of cassava root and leaf meal mixture (CRLM) on the performance of broiler chickens raised from one day old to 49 days of age was investigated. The second experiment examined further the effects of supplementing the diet based wholly on CRLM with coconut oil added at an additional 3 percent level in the diet.

Materials and Methods

Cassava roots and leaves used were obtained from a farm in Apia, Western Samoa. Fresh unpeeled roots were chopped using a bush knife into small chips and then sun-dried on corrugated aluminium roofing sheets. The dried chips were ground in a hammer mill using 2 mm sieve at Samoa Feeds Ltd. Fresh cassava leaves were dried in shed and similarly ground at Samoa Feeds Ltd. Three parts by weight of dried root meal were mixed with one part of dried ground leaf meal. This mixture, called cassava root and leaf meal mixture (CRLM), was used in the formulations of rations to replace part or all of the maize in experimental diets.

Diets

In experiment 1, three experimental diets were formulated (table 1). The control diet was based on maize. In the other two diets, CRLM replaced either half or all of the maize used in the formulation of the control diet. In experiment 2, three diets were also formulated (table 2). The control diet used was similar to that used in experiment 1, as was the formulation for the diet in which all of the maize was replaced with CRLM. However, in the third diet, the diet in which all of the maize was replaced with CRLM, was further fortified with coconut oil at an additional 3 percent level.

All diets were formulated to contain 23 percent protein and were fortified with minerals and vitamins to satisfy the requirements of broiler chickens (NAS-NRC, 1971).

TABLE 1. COMPOSITION OF DIETS USED IN EXPERIMENT 1

Ingredients (%)	Maize-based	Maize and CRLM[1] in 1:1 ratio	CRLM based
Maize	54	27	0
Cassava root and leaf meal mixture	0	25	50
Copra meal	15	15	15
Meat meal	26	28	30
Coconut oil	4.4	4.4	4.4
Salt	0.3	0.3	0.3
Premix[2]	0.2	0.2	0.2
Methionine	0.1	0.1	0.1

[1] CRLM: Cassava root and leaf meal mixture.

[2] Premix supplied the following in mg kg^{-1} diet: retinol, 3; cholecalcipherol, 55; thiamine, 5; riboflavin, 12.5; pyridoxine, 7.5; biotin, 0.2; pantothenic acid, 25, choline chloride, 2250; menadione sodium bisulphite, 2.5; niacin, 75; cyanocobalamin 0.04; tocopherylacetate, 25; pteroylmonoglutamic acid, 3.5; Mn, 175; Zn, 100; Fe, 75; Cu, 7.5; I, 1.2; Co, 5; Mo, 0.2; Se, 0.15.

TABLE 2. COMPOSITION OF DIETS USED IN EXPERIMENT 2

Ingredients (%)	Maize-based	CRLM[1] based	CRLM and Extra Coconut oil
Maize	54	0	0
Cassava root and leaf meal mixture	0	50	49.5
Copra meal	15	15	15
Meat meal	26	30	30.5
Coconut oil	4.4	4.4	4.4
Salt	0.3	0.3	0.3
Premix[2]	0.2	0.2	0.2
Methionine	0.1	0.1	0.1

[1] CRLM: Cassava root and leaf meal mixture.

[2] Premix. See footnote of table 1.

Birds and management

The experiments were of a completely randomised disign. Each experiment consisted of three dietary treatments replicated three times. A total of 180, day-old Shaver Starbro broiler chicks were used.

In experiment 1, 90 such birds were randomly divided into nine groups, with each group consisting of ten birds. Three such groups, with each group representing dietary replication, were randomly allotted to each of the three dietary treatments. Each group of ten birds was raised on deep litter floor system. Feed and water were available to birds at all times. The birds were weighed as a group at the beginning of the experiment and thereafter every seven days until the termination of the feeding trial at 49 days of age. At the end of the feeding trial, three birds from each dietary replicate group were randomly selected and slaughtered for the determination of carcass yield and dressing percentage. Carcass yield was measured as the dressed weight of the chicken following slaughter and removal of shanks and giblets. Dressing percentage was the percentage expression of carcass weight over live weight at slaughter time.

In experiment 2, another lot of 90 day-old Shaver Starbro broiler chickens were again randomly divided into nine groups and with each group consisting of ten birds each. Again three such groups were randomly allotted to each dietary treatment. Other management aspects were similar to those described for experiment 1.

Chemical and statistical analyses

Cassava root meal, cassava leaves, CRLM, maize and the formulated diets were analysed in triplicates for proximate components according to standard methods (AOAC, 1980).

Performance data were subjected to analysis of variance with significant differences reported at the 5 percent level of probability (Steel and Torrie, 1980).

Results

Proximate analysis data on dried cassava root meal, leaf meal, CRLM, maize and experimental diets are presented in tables 3 and 4. Cassava root meal used was typically high in nitrogen free extractives but low in protein, fibre and ash. The cassava leaves were moderately high in protein, but lower in nitrogen free extractives and higher in fibre than root meal.

The CRLM mixture contained very nearly similar levels of all proximate components as maize. This was expected as the formulation of the mixture was intended to approximate the proximate composition of maize in order to effectuate reasonable substitutability of maize with locally available cassava root meal and leaves. However, CRLM contained slightly lower level of nitrogen free extractives and was higher in fibre content.

Experiment 1

Data on performance of experimental birds are presented in table 5. The replacement of half of the maize in the control diet with CRLM did not significantly ($p > 0.05$) affect the performance of birds in terms of feed intake, feed efficiency, final body weights at 49 days of age, carcass yield and dressing percentage. However, while there

TABLE 3. CHEMICAL COMPOSITION OF MAIZE, CASSAVA ROOTS, LEAVES, AND ROOT AND LEAF MEAL MIXTURE

Items	Chemical content (%)[1]					
	Dry matter	Crude protein	Fat	Fibre	Ash	NFE[2]
Maize	89	8.6	3.8	2.1	1.2	73.3
Cassava root meal	89	3.1	0.9	2.2	4.1	78.7
Cassava leaf meal	89	25.5	1.3	6.5	6.7	49.0
Cassava root and leaf mixture (CRLM)	89	8.7	1.2	3.3	5.8	70.0

[1] Chemical content means of triplicate analysis.
[2] NFE Nitrogen free extractives.

TABLE 4. CHEMICAL ANALYSIS OF EXPERIMENTAL DIETS

	Diets			
	Maize based	Maize + CRLM in 1:1 ratio	CRLM based	CRLM + 3% coconut oil
Analysis (%)				
Dry matter	89.5	89.7	89.6	89.5
Protein (N × 6.25)	23.0	23.1	23.2	23.1
Ether extract	5.1	4.9	3.9	5.0
Fibre	4.3	4.9	5.2	5.1
Ash	5.4	5.6	5.8	5.8
NFE	62.2	61.5	61.9	61.0
Calcium	1.2	1.2	1.3	1.3
Phosphorus	0.7	0.7	0.7	0.7
Calculated values:				
Metabolisable energy (kcal/kg)	3190	3150	3010	3170
Lysine (%)	1.2	1.2	1.2	1.2
Methionine + Cystine (%)	0.8	0.8	0.8	0.8

TABLE 5. PERFORMANCE OF BIRDS IN EXPERIMENT 1

	Diets			
	Maize based	Maize and CRLM[1] based	CRLM based	SE[2]
No. birds	30	30	30	
Initial weight (gm)	50	50	50	
Final weight (kg)	1.95[a3]	1.93[a]	1.62[b]	0.81
Feed intake per bird (kg)	4.10	4.08	4.09	0.61
Feed conversion ratio	2.10[a]	2.11[a]	2.52[b]	0.11
Dressed carcass weight (kg)	1.38[a]	1.37[a]	1.15[b]	0.10
Dressing percentage	70.7	70.9	70.8	1.53

[1] CRLM: Cassava root and leaf meal mixture.
[2] SE: Standard error of dietary treatment means.
[3] Dietary treatment means with similar or no superscripts are not significantly ($p > 0.05$) different.

were no significant differences between all the dietary treatments in terms of feed intake and dressing percentage, the complete replacement of maize with CRLM, significantly ($p < 0.05$) reduced final body weights, feed efficiency and carcass yield. Carcasses from chickens fed diets containing CRLM had more attractive yellow skin colour than those fed the maize based control diet which tended to be rather whitish in appearance.

Experiment 2

When the diet in which all the maize was replaced with CRLM was supplemented with coconut oil included at a further 3 percent level in the diet, the performance of birds equalled ($p = 0.05$) those of birds fed the maize control diet (table 6). However, as in experiment 1, birds fed the diet in which all the maize was replaced with CRLM but without additional coconut oil supplementation, still recorded lower ($p < 0.05$) final body weights, dressed carcass weight and feed efficiency.

Discussion

The results obtained on the chemical composition of cassava roots and leaves are typical to

TABLE 6. PERFORMANCE OF BIRDS IN EXPERIMENT 2

	Diets			
	Maize	CRLM[1]	CRLM and 3% coconut oil	SE[2]
No. birds	30	30	30	
Initial weight (gm)	50	50	50	
Final weight (kg)	1.91[a3]	1.60[b]	1.90[a]	0.50
Feed intake per bird (kg)	4.08	4.03	4.06	0.69
Feed conversion ratio	2.13[a]	2.52[b]	2.14[a]	0.12
Dressed carcass weight (kg)	1.38[a]	1.13[b]	1.35[a]	0.11
Dressing percentage	70.8	70.9	70.8	1.52

[1] CRLM: Cassava root and leaf meal mixture.
[2] SE: Standard error of dietary treatment means.
[3] *Dietary treatment means with similar or no superscripts are not significantly ($p > 0.05$) different.*

those reported elsewhere in literature and indicate that cassava root meal is very high in nitrogen-free extractives, a measure of carbohydrate content and therefore energy; while leaves are moderately high in protein (Agudu and Thomas, 1982).

The CRLM was made by mixing three parts by weight of root meal with one part of leaf meal. Such a mixture was expected to have a chemical feeding value similar to that of maize. However, the chemical analysis of CRLM indicated that, relative to maize, it contained a slightly lower level of nitrogen-free extractives and a higher level of fibre. Since dietary energy is influenced largely by these factors, it therefore followed that CRLM had a relatively lower energy feeding value than maize. This is reflected in the calculated ME values presented in table 4. Thus, when CRLM was used to replace maize in broiler diet in experiment 1, performance of birds was adversely ($p < 0.05$) affected at the complete level of substitution of maize with CRLM. However, performance was not affected at the partial, 50 percent, level of replacement of maize with CRLM, indicating that the reduction in energy level in the diet through partially using CRLM was not so serious as to reduce performance.

The more yellowish appearance of the skin of birds fed CRLM based diets was a reflection of the high level of carotene in cassava leaf meal used. This in itself, may be an important economic attribute in marketing broiler chickens in the South Pacific region, as this skin colour appearance resembles that in the preferred meat of chickens raised under traditional system of management.

In experiment 2, the diet in which all of the maize was replaced with CRLM was either further supplemented with or without coconut oil at an additional 3 percent level. Supplementation with additional coconut oil resulted in increased ($p < 0.05$) performance over that obtained on unsupplemented diet; and equalled ($p = 0.05$) that obtained on the maize control diet. This finding suggests and concurs with our hypothesis that the factor limiting performance at the level of complete replacement of maize with CRLM was dietary energy. The calculated ME values on the control, 50, 100 percent and 100 percent CRLM diet plus three percent coconut oil were 3190, 3150, 3010, 3170 kcal/kg, respectively.

These performance data are interesting and indicate the potential for replacing maize with locally produced cassava root and leaf meal. Cassava is widely cultivated in many island countries such as Fiji, Tonga, Vanuatu and Solomon Islands. In these countries, there are usually reasonable quantities of cassava roots available all year round that could be used in livestock feed production. Similarly, leaves are available in large quantities at harvest time, and currently very limited use, if any, is being made of them. Small amounts of leaves are at times consumed by people in some communities. Thus, if appropriate methods of collecting and drying cassava roots and leaves could be developed, this crop could become an important local feed substitute in the South Pacific region in place of the currently imported and expensive cereal grains such as maize and wheat.

Conclusions

The results of this feeding trial indicate that a mixture of cassava root and leaf meal, made up by mixing three parts by weight of dried ground root meal with one part of dried ground leaf meal can successfully be used to replace half of the maize in a practical broiler diet without impairing performance. However, if CRLM is to be used to completely replace maize in the diet, the diet must be fortified with an additional high energy feed ingredient, in order to avoid impairment in performance of broilers.

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Literature Cited

Agudu, E. W. and P. Thomas. 1982. Availability of carbohydrate in cassava meal determined by chick bioassay. Poultry Sci. 61:1131-1136.

AOAC. 1980. Association of Official Analytical Chemists. Official Methods of Analysis. 13 Ed. Washington, D.C., USA.

NAS-NRC. 1971. National Research Council-National Academy of Sciences. Nutrient Requirements of Poultry. 6 Ed. National Academy of Sciences, Washington, D.C., USA.

Ochetim, S. 1987. Efficacy of some alternative energy sources to maize in diets of broiler chickens in the South Pacific region. Alafua Agric. Bull. 12:13-17.

Steel, R. G. D. and J. H. Torrie. 1980. Principles and Procedures of Statistics. McGraw-Hill Book Company, New York, USA.