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Effects of Replacing Maize with Cassava Root-Leaf Meal Mixture on the Performance of Broiler Chickens

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ABSTRACT

In a feeding trial that lasted 56 days (8 weeks), cassava root-leaf meal mixture (CRLMM) was evaluated as a replacement for maize in broiler starter and finisher diets. Five experimental diets were formulated in which maize was replaced with 0%, 25%, 50%, 75% and 100% CRLMM as treatments 1, 2, 3, 4 and 5 respectively. All the experimental diets were pelletised and isonitrogenous. Thirty (30) birds were assigned to each of the treatment diets in a randomised complete block design and each treatment was replicated three times with 10 birds per replicate. The birds (Marshall Broiler chicks) were 7 day old at the inception of the experiment. The experimental starter and finisher diets were fed *ad libitum*. Data were collected for feed intake, weight gain, feed conversion ratio, mortality and nutrient digestibility. Economic performance such as feed cost, cost of total feed intake and feed cost per kilogram weight gain were also determined. Feed intake was significantly higher ($P<0.05$) in CRLMM based diets than control in starter, finisher and overall phases. There was no significant difference ($P>0.05$) at all phases of growth for weight gain and feed conversion ratio. The low mortality recorded indicated that CRLMM has little or no deleterious effects on the performance of broiler chickens. The nutrient digestibility were significantly different ($P<0.05$) between treatment for dry matter, ether extract, nitrogen free extract and ash. Feed cost Naira per kilogram weight gain was least for birds on diet 75% CRLMM. CRLMM showed a good promise when included in the diets of broiler starter and finisher up to 75% without a harmful effect on the performance of broilers reared in the northern guinea savannah. It was concluded that 75% of maize can be replaced with CRLMM in broiler diets in Mubi and environs.

Keywords: *Replacing; maize; cassava root-leaf meal; performance, broiler chicken.*

1. INTRODUCTION

In poultry, feed cost accounts for up to 80% of the total cost of production and is a very important component in determining the extent of poultry survival and profitability (Olugbemi *et al*., 2010). Its important role as a human and industrial food ingredient coupled with drought in some parts of Africa has sometimes caused relative scarcity of the ingredient and an attendant increase in price invariably leading to an increase in feed costs. Maize, on the other hand, has been playing a key role as a source of energy in poultry diets in Nigeria. However, because maize is one of the major staple foods and also used for various industrial raw materials in the country, its demand outstrips its supply, leading to over 2000% increase in price within the last 20 years (Enyenihi *et al*., 2009) and this has invariably contributed to the high cost of poultry feeds with concomitant increase in the prices of poultry products (Enyenihi *et al*., 2009). Cassava products had been in use for a long time as an energy source in place of cereal grains for livestock (Eruvbetine *et al.*, 2003). There is thus the likelihood of continued use of cassava in animal feeding in the 21st century and beyond.

The increasing competition between man and livestock for available grains and tubers for food, feed and industrial raw materials coupled with Nigeria's sole concentration on oil sector to the utter neglect of agriculture, has further led to the high cost of available food/feed resources (Udedibie and Durunna, 2000). Poultry feed producers are thus faced with the task of finding alternative feedstuffs that will not compromise quality. The search of such alternatives has occupied the attention of Animal Nutritionists in Nigeria for over a decade (Onyimonyi and Okeke, 2002; Onyimonyi and Onukwufor, 2003; Oke *et al*., 2005; Onyimonyi and Okeke, 2005; Tuleun *et al*., 2005). Cassava appears to possess the potential of serving as an alternative to maize.

However, Cassava root meal is deficient in protein and essential amino acids. Cassava root products are also deficient in carotene and other carotenoids. Consequently, one of the ways of addressing these deficiencies is the supplementation of cassava root meal with cassava leaf meal which is high in carotene and proteins (Omole, 1977**).** Cassava leaf can produce very high amounts of protein/ha even in the dry season in situations where no irrigation or fertilization is practised (Montaldo and Montilla, 1976; Wyllie, 1979), the seasonal distribution of the available forage being dependent on the cutting system used.

Therefore upgrading of cassava root meal with the leaf meal could result in a product that could serve as a good substitute for maize.

The leaves and tender stems are under utilised as they are often left to rot away on farms and homesteads in cassava producing areas (Aderemi *et al*., 2006). In view of the above, combining cassava tuber, which is high in energy content but low in crude protein, with the cassava leaves, which have high crude protein content and low energy could result in a product which could serve as a substitute for maize in broiler diets.

2. MATERIALS AND METHODS

Study Area

The study was conducted at Livestock Teaching and Research Farm, Adamawa State University Mubi, Nigeria. Mubi is situated within the Northern Guinea Savannah on a latitude 10.00^{0}N and longitude 13^{0}30E and about 305 metres above sea level. It has a tropical climate marked by rainy and dry seasons. Rainfall commences in April and ends in late October. The dry season starts in November and ends in March. Annual rainfall is about 900 mm to 1050 mm per annum. The relative humidity is extremely low about 20 – 30% between January and March and starts increasing as from April and reaches a peak of about 80% in August and September and later declines from October following the cessation of rains. The average minimum temperature is about 12ºC in December and January and maximum of 40ºC in April (Adebayo and Tukur, 1999).

Preparation of Cassava Root and Leaves

Fresh cassava roots (sweet variety) were procured from Mubi market, and Leaves were harvested from farms near Mubi Metropolis after harvesting the cassava. The cassava roots were washed and cut into small pieces. The leaves were chopped into smaller pieces using kitchen knife. The root and leaves were sun-dried on a tarpaulin sheet for about 5 days with regular turning. The chopped root and the leaves were milled separately using a hammer mill before mixing. The cassava flour and leaf meal was mixed in a ratio of 2.6:1. The proximate composition of cassava roots, leaves and cassava root-leaf meal mixture is presented in Table 1.

Experimental Animals

A total of 150 day-old Marshall broiler chicks were randomly allotted to the five (5) experimental diets. They were subdivided into three replicates of ten (10) birds each. They were housed in a deep litter pens. Routine vaccinations and medication schedule were adhered to strictly. The birds were allowed access to dietary treatments and fresh clean water *ad libitum* for a period of eight weeks. Records of performance and economics of production were kept on a weekly basis.

Experimental Diets

Isonitrogenous diets containing 22% CP and 20% CP were formulated for the broiler starters and finishers respectively. Maize was replaced with the cassava root and leaf meal mixture at 0, 25, 50, 75 and 100% levels coded as diets 1, 2, 3, 4 and 5 respectively. All the diets were pelletised. The ingredient composition of the starter and finisher diets are shown in Tables 2 and 3 respectively.

Experimental Design

The design used for the experiment was randomised complete block design. There were five treatments and three replicate. Ten birds were randomly allotted to each replicate.

Data collection

The following data were collected:

Performance parameters

Feed intake was calculated by subtracting the left over feed from the initial feed given to the birds daily. Data were collected on initial and weekly weight so as to determine their weekly weight gain. Final body weights were taken at the end of the experiment.

The feed conversion ratio was computed using the formula:

$$FCR = \frac{\text{feed intake}}{\text{Weight gain}}$$

Digestibility

Digestibility trial was conducted at the end of the 8^{th} week. Two birds per replicate were transferred to metabolic cages and allowed three days adjustment period. Faecal droppings were collected and weighed, oven dried and re-weighed for four days. The faecal collection per replicate were bulked, milled and analysed for proximate constituents along with the experimental diets using standard methods of Association of Official Analytical Chemist (AOAC, 2002). Nutrients digestibility was calculated as follows:

$$ND = \frac{(\text{Nutrient in feed x FI}) - \text{Nutrient in faeces x FO}}{\text{Nutrient in feed x FI}} \times \frac{100\%}{1}$$

Where: ND = Nutrient Digestibility; FI = Feed intake; FO = Faecal output

The economic performance was determined by computing the Feed cost per kilogram (₦/kg).

Cost of total feed intake = Total feed intake x feed cost per kilogram.

Feed cost per kilogram weight gain = cost of total feed intake (₦) / total weight gain (kg)

Chemical Analysis

Chemical analysis of the cassava root, cassava leaf meal and cassava root and leaf meal mixture diets and faecal samples were subjected to proximate analysis according to Association of Official Analytical Chemist (AOAC). Similarly the anti-nutritional factor (cyanogenic glucosides) was determined using AOAC (2002) methods.

Statistical Analysis

The data obtained were subjected to a two – way analysis of variance (ANOVA) of the randomised complete block design using the General Linear Model procedure of Statix 8.0 U. S. A. version 2004 to assess the main effect of treatments. Differences between treatment means were separated using the least significant difference (LSD).

3. RESULTS

The proximate composition of cassava root, cassava leaf and cassava root-leaf meal mixture (CRLMM) showed that, the leaves contain higher crude protein, crude fibre, ash and cyanogenic glucosides than the roots and the CRLMM (refer to Table 2). Cassava roots had higher dry matter and nitrogen-free extract compared to the leaves and CRLMM, while it had the least crude protein, ether extract and ash content. The proximate composition of the starter and finisher diets are presented in Table 4. The crude protein and crude fibre contents of the five experimental diets (starter) are similar as expected, with slight increase in crude protein and crude fibre as the levels of CRLMM increased. Similarly the five experimental diets for the finisher are similar as formulated. Crude protein and crude fibre increased, while nitrogen-free extract content of the diets decreased as the levels of CRLMM increased.

Table 1: Proximate Composition of the Cassava Roots, Leaves and Cassava Root-Leaf Meal Mixture (CRLMM)

Nutrients (%)	Cassava root	Cassava leaves	CRLMM
Dry Matter	92.50	90.90	91.70
Crude Protein	5.60	26.70	18.90
Crude Fibre	2.75	14.50	12.60
Ether Extract	0.85	2.50	3.50
Nitrogen-Free Extract	79.10	37.00	61.60
Ash	4.20	10.20	5.10
Cyanogenic glucosides (mg/HCN/kg)	13.40	22.10	18.30

Means of three (3) determinations

Table 2: The Composition of the Experimental Broiler Starter Diets

	Level of maize replaced by cassava root-leaf meal mixture (%)				
Ingredient	0	25	50	75	100
Maize	50.00	37.50	25.00	12.50	0.00

CRLMM	0.00	12.50	25.00	37.50	50.00
Groundnut cake	27.00	27.00	27.00	27.00	27.00
Maize offal	13.00	12.00	11.50	10.50	10.00
Fishmeal	6.00	6.00	6.00	6.00	6.00
Palm Oil	0.00	1.00	1.50	2.50	3.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Salt	0.50	0.50	0.50	0.50	0.50
Premix+	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated Analysis					
Crude Protein (%)	22.09	22.10	22.16	22.23	22.23
ME (kcal/kg)	2871.00	2838.00	2781.00	2749.00	2692.00
Protein: Energy Ratio	1:130	1:128	1:125	1:124	1:121
Calcium (%)	1.55	1.56	1.67	1.73	1.79
Phosphorus (%)	0.93	0.91	0.90	0.89	0.86

+Supreme Vitamin – Mineral Premix contains per 1.25 kg of the following: Vitamin A, 15,000,000 I. U; Vitamin D_3, 3,500,000 I. U; Vitamin E, 30,000 I. U; Vitamin K, 3,000 mg; Thiamine B_1, 3,000 mg; Riboflavin B_2 8,000 mg; Pyridoxine B_6, 4,000 mg; Niacin, 4,000 mg; Vitamin B_{12}, 20 mg; calpan 10,000 mg; Folic acid, 1,000 mg; Biotin, 30 mg; Antioxidant, 125 g; Choline Chloride, 500 g; Manganese, 96 g; Zinc, 80 g; Iron, 40 g; Copper, 6 g; Iodine, 1.4 g; Selenium, 300 mg; Cobalt, 240 mg.
CRLMM = Cassava root-leaf meal mixture

Table 3: The Composition of the Experimental Broiler Finisher Diets

	Level of maize replaced by cassava root-leaf meal mixture (%)				
Ingredient	0	25	50	75	100
Maize	56.00	42.00	28.00	14.00	0.00
CRLMM	0.00	14.00	28.00	42.00	56.00
Groundnut cake	22.00	22.00	22.00	22.00	22.00
Maize offal	13.00	12.00	11.50	10.50	10.00
Fishmeal	5.00	5.00	5.00	5.00	5.00

Palm Oil	0.00	1.00	1.50	2.50	3.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Salt	0.50	0.50	0.50	0.50	0.50
Premix+	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated Analysis					
Crude Protein (%)	19.78	19.80	19.88	19.90	20.00
ME (kcal/kg)	2924.00	2882.00	2815.00	2774.00	2708.00
Protein: Energy Ratio	1:148	1:145	1:141	1:139	1:135
Calcium (%)	1.47	1.55	1.62	1.68	1.75
Phosphorus (%)	0.89	0.87	0.86	0.84	0.83

+Supreme Vitamin – Mineral Premix contains per 1.25 kg of the following: Vitamin A, 15,000,000 I. U; Vitamin D_3, 3,500,000 I. U; Vitamin E, 30,000 I. U; Vitamin K, 3,000 mg; Thiamine B_1, 3,000 mg; Riboflavin B_2 8,000 mg; Pyridoxine B_6, 4,000 mg; Niacin, 4,000 mg; Vitamin B_{12}, 20 mg; calpan 10,000 mg; Folic acid, 1,000 mg; Biotin, 30 mg; Antioxidant, 125 g; Choline Chloride, 500 g; Manganese, 96 g; Zinc, 80 g; Iron, 40 g; Copper, 6 g; Iodine, 1.4 g; Selenium, 300 mg; Cobalt, 240 mg.
CRLMM = Cassava root-leaf meal mixture.

Table 4: Proximate Composition of the Experimental Broiler Starter and Finisher Diets

	Level of maize replaced by cassava root-leaf meal mixture (%)				
Nutrients (%)	**0**	**25**	**50**	**75**	**100**
Starter diet (1-28 days)					
Dry matter	94.80	94.60	94.60	94.90	95.15
Crude protein	21.00	21.02	21.12	21.25	21.30
Crude fibre	3.90	4.62	5.54	6.40	7.10
Ether extract	3.20	2.80	2.70	3.00	3.20
Nitrogen-free extract	57.60	56.56	56.14	55.05	54.05
Ash	9.10	9.60	9.10	9.20	9.50
Finisher diet (29-56 days)					
Dry matter	94.70	95.35	95.30	95.00	94.80
Crude protein	19.62	19.65	19.67	20.12	20.25

Crude fibre	3.95	5.02	5.74	6.42	7.70
Ether extract	3.40	2.40	2.60	2.40	2.20
Nitrogen-free extract	60.93	61.38	59.59	58.16	55.05
Ash	6.80	6.90	7.70	7.90	9.60

These are means of three (3) determinations

The performance of broilers fed varying levels of cassava root leaf meal mixture (CRLMM) during 1 to 28 days, 29 to 56 days and 1 to 56 days are presented in Table 5. Significant differences (P<0.05) were observed in feed intake among the treatments for both the starter phase (1 to 28 days) and finisher phase (29 to 56 days). The overall phase (1 to 56 days) showed a similar pattern. During the starter phase, birds on the CRLMM-based diets recording higher feed intake (P<0.05) (66.36 to 69.24 g/d) compared to control treatment 1 (0% CRLMM) which recorded the lowest feed intake (62.04 g/d).

Between 29 to 56 days (finisher phase), result of feed intake revealed a significant difference (P<0.05) with treatment 1 (0% CRLMM) which recorded 124.44 g/d which was inferior to the value (137.28 g/d) recorded in treatment 5 (100% CRLMM). Overall performance (1 to 56 days) revealed a significant difference (P<0.05) with treatment 5 (100% CRLMM) recording the highest feed intake (125.68 g/d) and treatment 1 (0% CRLMM) recorded the lowest feed intake followed by treatments 2, 3 and 4 (25, 50 and 75% CRLMM) respectively.

The performance of broiler starter and finisher showed that there were no significant differences (P>0.05) in daily weight gain, feed conversion ratio and mortality among the treatments at starter phase (28.88 g to 31.68 g) and finisher phase (38.88 g to 41.88 g) as well as the overall performance (33.46 g to 37.25 g) over the different phases of growth (Table 5). The FCR results followed the same pattern with the weight gain in all the groups. During the starter phase (1 to 28 days) there was no mortality recorded, while in the finisher phase (29 to 56 days) a total of 3.34% mortality was recorded in treatments 1, 2, 4 and 5 (0, 25, 75 and 100% CRLMM).

Table 5: Performance of Broilers Fed Varying Levels of Cassava Root-Leaf Meal Mixture (CRLMM)

	Level of maize replaced by cassava root-leaf meal mixture (%)					
Parameters	**0**	**25**	**50**	**75**	**100**	**SEM**
Period: 1 – 28 days						
Daily feed intake (g/d)	62.04^{b}	66.36^{a}	67.20^{a}	69.24^{a}	68.04^{a}	1.39*
Daily weight gain (g/d)	31.44	28.88	31.68	30.72	30.00	1.69 ^{NS}
Feed conversion ratio	2.24	2.43	2.29	2.39	2.49	0.06 ^{NS}
Mortality (%)	0.00	0.00	0.00	0.00	0.00	0
Period: 29 – 56 days						
Daily feed intake (g/d)	124.44^{b}	126.60^{ab}	127.68^{ab}	131.60^{ab}	137.28^{a}	2.29*
Daily weight gain (g/d)	41.76	40.08	39.00	38.88	41.88	2.85 ^{NS}
Feed conversion ratio	3.15	3.46	3.79	4.16	3.80	0.12 ^{NS}
Mortality (%)	0.08	0.16	0.00	0.16	0.08	0.06 ^{NS}
Period: 1 – 56 days						
Daily feed intake (g/d)	111.49^{c}	117.99^{b}	121.81^{ab}	120.12^{ab}	125.68^{a}	1.29*

Daily weight gain (g/d)	37.15	35.58	33.46	37.25	36.49	1.44^{NS}
Feed conversion ratio	2.69	2.94	3.04	3.27	3.15	0.06^{NS}
Mortality (%)	0.04	0.08	0.00	0.08	0.04	0.03^{NS}

a, b, c – Means in the same row bearing different superscripts differ significantly (P< 0.05)

NS – Not Significant (P> 0.05). SEM – Standard error of the mean. * Significant (P< 0.05)

Nutrient Digestibility

Nutrient digestibility of broilers fed varying levels of CRLMM is presented in Table 6. Significant differences (P<0.05) were observed in the digestibility of dry matter, ether extract, nitrogen-free extract and ash. However, the digestibility of crude protein and crude fibre were not significantly different among the treatments. Treatment 1 (0% CRLMM) recorded better dry matter, ether extract, nitrogen-free extract and ash digestibilities than treatments 4 and 5.

Table 6: Nutrient digestibility (%) of broilers fed varying levels of cassava root-leaf meal mixture CRLMM)

	Level of maize replaced by cassava root-leaf meal mixture (%)					
Parameters (%)	**0**	**25**	**50**	**75**	**100**	**SEM**
Dry Matter	77.30^{a}	76.82^{ab}	76.69^{ab}	76.44^{bc}	76.04^{c}	0.16^{*}
Crude Protein	79.13	79.08	78.91	78.47	77.92	0.24^{NS}
Crude Fibre	53.95	53.85	53.73	53.51	53.49	0.16^{NS}
Ether Extract	78.45^{a}	77.91^{ab}	77.14^{ab}	76.91^{b}	76.66^{b}	0.22^{*}
Nitrogen-Free Extract	75.41^{a}	74.59^{ab}	74.30^{ab}	73.49^{b}	69.56^{c}	0.24^{*}
Ash	71.86^{a}	71.32^{ab}	71.13^{ab}	70.63^{b}	70.15^{b}	0.22^{*}

a, b, c – Means in the same row bearing different superscripts differ significantly (P< 0.05)
NS – Not Significant (P> 0.05). SEM – Standard error of the mean. * Significant (P< 0.05)

Economic Performance of Broilers Fed Cassava Root-Leaf Meal Mixture (CRLMM)

The economic analysis (refer to Table 7) revealed that feed cost per kilogram reduced as the percentage of CRLMM increases; 0% CRLMM recorded the highest cost (₦70.03) while 100% CRLMM replacement recorded the lowest (₦62.42). Treatment 4, (75% CRLMM) replacement had the highest total weight gain with less cost compared to the control (0% CRLMM).

Table 7. Economic performance of broilers fed varying levels of cassava root-leaf meal mixture (CRLMM)

	Level of maize replaced by cassava root-leaf meal mixture (%)					
Parameters	**0**	**25**	**50**	**75**	**100**	**SEM**
Initial weight (g)	110.00	110.00	108.33	106.67	110.00	0.67 ^{NS}
Final weight (g)	2190.67	2102.50	1982.33	2192.42	2153.33	68.35 ^{NS}
Total Feed Intake (kg)	6.243^{c}	6.607^{b}	6.821^{ab}	6.726^{ab}	7.038^{a}	80.35*
Feed Cost/kg (₦/kg)*	70.03	68.37	66.22	64.57	62.42	-
Total WG (kg)	2.080	1.992	1.874	2.086	2.043	67.68 ^{NS}
Cost of TFI (₦)	437.20	451.72	451.69	434.30	439.33	-
Feed Cost /kg wt. gain ₦/kg)	210.10	226.76	241.05	208.21	215.04	-

a, b, c – Means in the same row bearing different superscripts differ significantly (P< 0.05)
NS – Not Significant (P> 0.05). SEM – Standard error of the mean. * Significant (P< 0.05)
TFI = Total Feed Intake, WG = Weight Gain, N/Kg = Naira per Kilogram.
***Prices as at January, 2012**

4. DISCUSSION

The observed value of 91.70% dry matter for CRLMM was higher than that contained in cassava plant meal (CPM) as reported by Akinfala *et al.* (2011). Ash and ether extract recorded similar values but nitrogen free-extract values were lower than that reported by same authors. The proximate composition of cassava roots and leaves revealed a higher crude protein and lower crude fibre values of 5.6 and 2.75% respectively for roots and 14.5% for leaves compared with the values of 3.22 and 5.0% reported by Uchegbu *et al.* (2011) for roots. Okorie *et al.* (2011) reported 23.66 and 15.72% for leaves. However, the proximate composition of CRLMM revealed a higher crude protein and crude fibre values of 18.90 and 12.60% compared to CPM used by Akinfala *et al.* (2011) who reported 9.4 and 4.96% values respectively. The same authors however reported higher HCN content values of 33.5 mg/HCN/kg compared with 18.30mg/HCN/kg obtained in this study. These differences could be as a result of varietal/processing differences.

The diets formulated were adequate in crude protein according to the recommendation of Aduku (1990) who reported 22 and 20% CP for starter and finisher diets. The metabolizable energy content of the diets were quite similar to that reported by the same author, except treatments 4 and 5 (75 and 100% CRLMM) which showed slightly lower values.

Daily feed intake was significantly (P<0.05) influenced by the dietary levels of cassava root-leaf meal mixture (CRLMM). During the starter phase (1 to 28 days) feed intake was observed to be significantly (P<0.05) higher in birds fed all treatments than those on 0% CRLMM. This result agreed with the result of Akinfala *et al.* (2003) who reported an increase in feed intake as the level of cassava meal increased in broiler starter diets.

This explains the lower (124.44 g/d) feed intake at finisher phase (29 to 56 days) of birds on treatment 1 (0% CRLMM) because of its high energy density than those on CRLMM – based diets. Birds on 100% CRLMM recorded the highest (137.28 g/d) feed intake during the finisher phase. This is in agreement with the work of Ukachukwu (2008) who reported a significant (P<0.05) increase in feed intake with increase in the level of composite cassava meal in the diets. Chen *et al.* (1992) explained that increased fibre content in the diet would probably stimulate higher feed intake since birds eat to satisfy their energy requirement, hence the increase in feed intake of the birds.

Overall performance (1 to 56 days) showed that, the group fed 100% CRLMM diet consumed significantly (P<0.05) higher feed (125.68 g/d) than those on treatments 3 (50% CRLMM) and 4 (75% CRLMM) which are higher (121.81 g/d and 120.12 g/d) than those on 0% CRLMM (111.49 g/d) and 25% CRLMM (117.99 g/d). Similar observations were made by Udedibie *et al.* (2004) and Udedibie *et al.* (2009) when sun-dried cassava tuber meal replaced 75% and 100% of maize respectively in broiler diets. The higher feed intake of birds on 100% CRLMM might be due to higher fibre content of the feed which might have diluted the energy content of the diet. High fibre levels in the diet of monogastric animals are associated with reduced nutrient density, low digestibility and high feed intake (Rausch and Belyea, 2006).

The non significant difference observed among the treatments for daily weight gain, in all the different phases of growth (1 to 28 days, 29 to 56 days and 1 to 56 days) is at variance with the findings of Ukachukwu (2008) who reported a decrease in performance as the inclusion level of cassava composite meal fed to broilers in the ratio of 5:2:2 (root:leaf:stem) increased. The difference may be due to the product used in this study. A ratio of 2.6:1 cassava roots to leaf meal was utilised. Addition of cassava leaves in the present study enhanced the protein and amino acid profile of the diets. Moreover, the sweet variety of the cassava used is known to contain lower levels of cyanide; an anti-nutritional factor associated with cassava and cassava products which depresses performance.

The similarities among all treatments in the feed conversion ration (FCR) indicate that the CRLMM treatment diets were favourable compared to 0% CRLMM replacement of maize. The comparable FCR was in agreement with the report of Eruvbetine *et al.* (2003) who included cassava root meal and cassava leaf meal (50:50) in the diets of broilers. The non-significant difference recorded in mortality during the starter, finisher and the overall phases of growth showed that processing of the cassava products by sun-drying and pelleting of the experimental diets have adequately reduced or eliminated the little toxic cyanogenic glucosides associated with sweet cassava. Sun-drying has been reported by Ravindran (1992) as one of the effective methods of reducing HCN in cassava products.

Nutrient Digestibility

The results of nutrient digestibility revealed that treatment diets with fairly high fibre content have low nutrient digestibility coefficient. This was consistent with the report of Balagopalam *et al.* (1988) who pointed out that fibre content of a diet is a contributory factor to the reduced digestibility and utilisation of nutrients by monogastric animals. High level of dietary fibre decreases FCR, digestibility and nutrient utilisation (Isikwenu *et al*., 2000). However, this was only applicable to dry matter, ether extract, nitrogen-free extract (NFE) and ash digestibilities of the groups on 75% and 100% CRLMM diets. This is in agreement with the report of Udedibie *et al*. (2004) and Khempaka *et al*. (2009) whose findings revealed that high level of fibre in diet may reduce dry matter digestibility. This shows that the ether extracts and NFE digestibilities decrease as the level of fibre increases. The decreased nutrient digestibility can be attributed to shorter resident time of the more fibrous diets in the intestine of the birds (Cabotaje *et al*., 1992).

The utilisation of crude protein and crude fibre decreased slightly with increasing levels of CRLMM although there was no significant difference among the treatment means. The result revealed that the inclusion of leaf meal in the diets may be responsible for the lack of variation in crude protein and crude fibre digestibility of the diets. The diets were pelletised to overcome the menace of dustiness of the feed which was a constraint in Bokanga's (1994) experiment. Consequently, Adeyemi *et al.* (2008) recommended pelleting of diets as a means of improving nutrient retention by broilers. This is also consistent with the earlier reports of Mitchell *et al.* (1972) and Janssen *et al*. (1979).

Economic analysis

The economic value of inclusion of CRLMM in diets of broilers was depicted with the decreased cost of feed per kilogram. A general trend revealed that feed cost per kilogram decreased with increasing level of CRLMM. The highest replacement value (100% CRLMM) recorded the lowest (₦62.42) feed cost per kilogram, while the 0% CRLMM inclusion level recorded the highest (₦70.03) feed cost per kilogram. The reduction in feed cost per kilogram was due to inclusion of CRLMM in the diets. This is in line with the work of Ukachukwu (2008) and Akinfala *et al.* (2011).The total feed cost was higher (₦451.70 and ₦451.73) in birds fed 25 and 50% CRLMM while treatment 4 (75% CRLMM) recorded the lowest (₦434.33) cost of total feed intake. This could be as a result of high intake as more feed was consumed as the levels of CRLMM increased in the diets.

The lowest feed cost per kilogram weight gain (₦208.21) was recorded at 75% CRLMM level of replacement. This indicated that inclusion of 75% CRLMM is more cost effective than other treatments. This therefore indicated that the use of CRLMM is cost effective when used as a replacement for maize at 75% level of inclusion of CRLMM. Ukachukwu (2008) reported similar findings when broilers were fed cassava-based diets.

5. CONCLUSION

The major findings was that although daily feed intake, was higher in the cassava based-diets than the control in all the phases of growth, daily weight gain, feed conversion ratio and nutrient digestibility of the test diets compared favourably with the control diet. Economic analysis indicated that substitution of maize with 75% CRLMM is more cost effective compared to other treatment groups.

The low mortality rate at both phases showed that the test diet had no deleterious effect on the chicks. It can be concluded that CRLMM could completely (100%) replace maize in the diets of broilers without depressing performance, and nutrient digestibility. However, birds on diet 4 (75% CRLMM) seemed to be most economical.

Cassava root-leaf meal mixture could therefore be a possible alternative cheaper energy source for broiler chickens. 75% CRLMM replacement can be recommended for better and optimal performance. These findings need to be corroborated by further study on the utilisation of bitter cassava root-leaf meal mixture with a view to exploit its nutritional potentials as alternative feed for broiler chickens.

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