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Substituting Maize for Processed Cassava Peels: A Cost Benefit Analysis in Poultry Farming

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***Abstract* – The scarcity of cereals recently has become a serious issue in several parts of the globe. When compared to beef industry, poultry enjoys a relative advantage of ease of management, higher turnover, quick returns to capital investment and wider acceptance of its product for human consumption. Depending on maize as the only source of dietary energy in poultry diet will have an adverse effect on the poultry industry in the near future if an alternative source of energy is not found. Processed cassava peels have become very appropriate for this purpose. It is therefore the intention of this paper to assess the performance of broilers based on the haematology, serum chemistry and enzymes, as well as to determine the mortality rate, digestibility and economic benefit of treatment diets as influenced by the processed cassava peels. A total of 225 broiler birds were randomly assigned to the five treatments (45 birds per treatment) and each treatment consisted of three replicates with 15 birds per replicate. The findings revealed that cassava peels can completely substitute maize in ration for broiler with increase in economic benefit. To achieve the lowest cost/kg live weight gain, 50% substitution is recommended.**

***Keywords* – Broilers Performance, Dietary Energy, Economic Benefit, Processed Cassava Peels.**

I. Introduction

According to Technical Centre for Agriculture and Technical Cooperation - CTA (2004), the second half of 1990 saw a sharp rise in imports of poultry into sub-Saharan Africa. Thus, in a developing country like Cameroon, where the utmost priority is to achieve self-sufficiency in food production with special emphasis on crop and animal products, it becomes imperative to encourage farmers to venture into chicken production. This is because the birds could be profitably produced under semi-intensive system of management with readily available resources at the farmers' disposal. Sonaiya *et al*.,1999)**.**

Cereals such as maize, wheat and rice are the world's most important food crops. They provide three-quarters of the world's energy and more than half of its protein need. Maize which is a major crop for human consumption is also used in animal feed and other industrial raw materials. Unfortunately and especially in the developing world, annual maize production has declined mainly due to insect attack (Odeyemi *et al*., 2006).

Environmental hazards such as draught and flood partly contribute to the scarcity and high cost of feed and feed ingredients especially in the northern regions of Cameroon where maize and other cereals are grown in large quantities. Therefore, depending on maize as the only source of dietary energy in poultry diet will have an adverse effect on the poultry industry in the near future if an alternative source of energy is not found. (Mhone *et al.*, 2011).

In Cameroon like other sub-Saharan African countries, production of chicken has not kept pace with the increasing demand, due to high cost of feed and feed ingredients. This has led to the importation of frozen chicken from Western Europe to the tune of 24,478 tons per year (Etchu *et al.,* 2013). A direct consequence is felt on the indigenous farms, for instance, 92% of small scale producers (farms with less than 500 chicks) in Cameroon, identified in1996, had ceased activity in 2002 (Anon, 2004 as cited by Etchu *et al*., 2013).

Substantial efforts have been made, in the past few decades, to replace cereals with cassava in poultry feeding. Available reports have showed variation and conflicting results regarding, what products can be used, how they can be fed and how much cassava can successfully be fed to each poultry type. Cassava peels which is a by-product of cassava, considered as a waste in the processing of cassava either into starch, cassava flour or garri, is a non-competitive feed material that can be developed as component of poultry feed (Dairo, 2011; Apata *et al.*, 2012).

It is apparent that cassava peels which are readily available in poultry production, which constitutes more than 90% of all commercial livestock feeds produced as a substitute to maize, will therefore make its greatest impact when incorporated into commercial poultry feed (Apata *et al*., 2012). In Africa, little research has been carried out in countries Nigeria, Tanzania, Kenya and Ghana on the use of cassava peels to substitute maize in poultry feed. Considering the few studies, percentage substitution has mostly been below 50. Perhaps just one (Abubakar and Ohiaege, 2011) had 100% substitution and this was in the finisher phase only. It equally appears none has substituted up to 100% in both the starter and finisher phases.

II. Uses of Cassava

According to Ganiyu (2006), approximately 10 million tonnes of cassava are processed into garri annually in Nigeria alone. Given the fact that these peels could constitute 10% of the wet weight of the roots, they constitute an important potential resource for animal feed if properly processed in a biosystem. The peels constitute 11-12% of total cassava root and with regards to their chemical and proximate composition, they have a high gross energy value of 3810 Kcal/Kg ME, low protein content of 4.0%, digestible fats of 0.9%, crude fibre 4.7%, ash 1.9% and nitrogen free extract 88.5%, which could be efficiently utilized by poultry (Obioha, 1992 cited by Abubakar, 2011).

Cassava is widely used in most tropical areas in feeding pigs, cattle, sheep and poultry. Dried peels of cassava roots are fed to goats and sheep while the raw or boiled root are mixed into a mash with protein concentrate and used to feed livestock. Many feeding experiments have shown that cassava provides a good quality carbohydrate which may be substituted for maize or barley and that cassava rations are especially suitable for swine, dairy cattle and poultry (Ukwuru and Egbonu, 2013).

Combination of cassava root and leaves in the ratio 4:1 could replace maize in poultry diets and reduce feed cost without a loss in weight gain or egg production (Apata and Babalola, 2012). A 100kg of processed cassava roots gives 10-15kg of peels as by-product. Not more than 2kg cassava peel meal should be used in a 10kg ration (FAO, 1995).

Cassava peels usually have a higher concentration of cyanogenic glucosides than the parenchyma (pulp), thus making the peels unsuitable as animal feed. However, fermentation of the cassava peels with waste water from the fermented cassava pulp significantly reduced ($P<0.05$) the cyanide content of the cassava peels (6.2-23.5 mg/kg) compared to the unfermented cassava peels that had 44.6 mg/kg cyanide content. The reduction in cyanide content was found to be much lower in cassava peels that were fermented with waste water from cassava pulp that was fermented with a mixture of *Saccharomyces cerevisea*, *Lactobacillus delbruckii* and *Lactobacillus coryneformis* than in those cassava peels that were fermented naturally with waste water from fermented cassava pulp (Ganiyu, 2006).

Several processing methods (boiling, sun drying, oven drying, fermentation, grating and sun drying, freezing, ensiling, parboiling and sun drying) have been applied to fresh cassava peels to reduced the cyanide content and the optimal inclusion level and utilization of the cassava peels depends on the processing method (Salami and Odunsi, 2003). Ensiling and fermentation have proven to be the most efficient methods and oven drying the least in reducing the cyanide content of fresh cassava peels.

III. Experimental Design

The peels were collected mostly from cassava that was harvested in the rainy season. These peels, which contain high levels of hydrogen cyanide and fibre, were processed to reduce the cyanide content by sun-drying and the use of methionine as an additive to enhance its utilization. After drying, samples of red cassava peels (RCP), white cassava peels (WCP) and a mixture of red and white cassava peels (MRWCP) were ground. The crude protein (CP), crude fibre (CF), ether extract (EE), dry matter (DM), ash (ASH) and nitrogen free extract (NFE) were determined according to the methods of (AOAC 1995). About the same quantities of RCP and WCP were mixed together to form MRWCP.

The experimental set up consisted of 5 treatments of 3 replicates each. Each treatment and replicate contained 45 and 15 birds respectively. A total of 225 broiler chicks were used. The walls were of height 120cm with each replicate of area $1.3m^2$. Each replicate was provided with a feeder, a drinker and a 100watt bulb to serve as a heating source during the first two weeks of the starter phase when the chicks could only regulate their body temperature partially due to partial development of feathers and as a lighting source during the night for the rest of the experimental period. Data was collected for 56days after two weeks of brooding. Average weight of birds was taken on the day of arrival and at the end of the brooding period, where weeks 3-6 constituted the starter phase and weeks 7-10 the finisher phase.

IV. Findings and Discussions

Haematology, serum chemistry and enzymes

Serum values for total protein, albumin, globulin and enzyme (AST and ALT) concentration were significantly ($P<0.05$) affected with increasing inclusion levels of cassava peels in the broiler diets as well as the Haematology values for Hb, RBC and WBC which were equally significant.

Table I: Haematology, enzyme and serum chemistry

Parameter	T0	T1	T2	T3	T4
Total Protein(g/dl)	29.125	23.333	35.667	37.000	33.000
Albumin(g/dl)	1.000	1.000	1.333	1.333	1.333
Globulin(g/dl)	28.167	22.333	34.333	35.667	31.667
ALT(u/l)	4.250	13.000	11.000	12.000	8.000
AST(u/l)	1.385	0.855	2.868	0.312	1.102
Hb (g/dl)	9.292	12.667	13.333	13.667	12.333
RBC /µl	2.317×10^6	2.130×10^6	2.280×10^6	2.090×10^6	1.295×10^6
WBC/µl	1300	1150	1017	4267	817

Considering haematological parameters, the RBC count in T4 was very low (1.295×10^6/µl) and out of the normal range of RBC in birds (1.5- 4.5×10^6 /µl reported by Filipe, 2012). The lowest RBC count in T4 might be attributed to a lesser number of cells in the bone marrow that reached advanced developmental stage. It could also be that the metabolic activity of RBC in birds of this treatment was low. Haemoglobin concentrations obtained in this study (9.292-13.667g/dl) were much higher which could indicate that the body temperature and metabolic rate of RBC that consumed higher rate of oxygen for birds that were used in this study. The difference in haemoglobin concentration could also be due to difference in haemotopoiesis (haemoglobin synthesis).

Furthermore, WBC count was lowest in T4, followed by T2. This could be due to high cyanide (toxic) content of the diet of T4 which was on 100% cassava peels. For T2, it could be due to white diarrhea from which birds of this treatment suffered most. Contrary, the high WBC in T3 suggests that the diet provided a better level of immunity to birds of this treatment.

Although there was a significant difference in haematological parameters (Hb, RBC, WBC) between treatments, their values were still within the normal range for birds and in line to the findings of Chinrasri and Aengwanich (2007). The high concentration of the enzyme ALT in T1, T2 and T3 compared to T0 and T4, suggest that there was some damage caused in the liver of birds in this treatments by the cassava peels (Odeyemi *et al*., 2006).

Serum values for total protein (23.333-37.000g/dl), albumin (1.000-1.333g/dl) and globulin (22.333-35.667g/dl) that were obtained in this study differed (higher, except for albumin) from those recorded by Dairo (2011) when he investigated the performance of broiler birds fed ensiled metabolisable mixture of cassava peel and cage layer manure as energy source and had the ranges:9.12-9.39g/dl, 1.06-1.28g/dl and 8.06-8.18g/dl respectively. The high total protein values in T2, T3 and T4 of this study compared to the control, could be attributed to the high concentration of the enzyme ALT (protein in nature) in these treatments compared to the control that might have improved the quantity and quality of protein in diets.

Digestibility

Findings on digestibility indicate that T1 had the highest digestibility for lipid but the third highest digestibility for proteins. T2 had the highest digestibility for protein but the lowest for lipids. Digestibility of ash and crude fibre was very low and negative in all treatments. Metabolizable energy was very low in T2 (0.6kcal/kg), followed by T4 (5.7kcal/kg). It was very high in T3 (36.5kcal/kg).

Table II: Digestibility by treatment and by nutrients

	ASH (DM%)	LIPIDS (DM%)	Crude Fibre (DM%)	Crude proteins (DM%)	ME (kcal/kg DM)
T0	-232.9	27.8	-363.9	20.5	20.1
T1	-234.4	28.6	-125.1	23.8	23.6
T2	-235.1	5.3	-130.8	40.5	0.6
T3	-140.9	23.8	-121.4	-12.7	36.5
T4	-154.5	21.1	-130.7	33.4	5.7

The higher percentage of lipids in diets than in faecal samples, resulting in positive percentage digestibility, implied that they were well utilized by the birds. The higher live weight, digestibility and second highest digestibility of lipids for TO compared to T2 that had highest protein digestibility and lowest for lipids implies that T0 yielded chicken with good weight but more fat and T2 yielded chicken that weighed less compared to T0 because of less fat but had more flesh. The lowest percentage digestibility of lipids in T2 could be linked to rancidity. Generally, poultry being monogasric animals, find it difficult to digest lipids. Also, it should be noted that the negative percentage digestibility of crude fibre for all treatments confirmed the fact that crude fibre hinders digestibility of nutrients.

Mortality Rate

Their results on mortality differ from the present study in that, while we recorded 0.00% in T0 and T4, 2.22% and 4.44% in T1 and T3 respectively, they recorded 6.67% in T1 and T5 and 0.00% in T2 and T4. The low mortality rate might be due to the inclusion of methionine whose sulphur content helped in the detoxification of cyanide. Also, most of the peels were collected from cassava that was harvested during the rainy season when cyanide content of cassava is minimum. It could also be due to the fact that peels were collected from cassava grown on volcanic soil that contain sulphur which might have played the same role of detoxification before cassava tubers were harvested as was specified from the low cyanide content of fresh peels.

Economic benefit: A cost analysis

Table III: Cost analysis starter phase

Ingredient	Quantity	Unit price in CFA francs	T0	T1	T2	T3	T4
Maize	24.62	220	5416.4	4063.4	2708.2	1355.2	0.00
PCP	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SBC	8.08	470	3797.6	3797.6	3797.6	3797.6	3797.6
GNC	7.29	300	2187	2187	2187	2187	2187
WB	5.5	150	825	825	825	825	825
FM	3.0	470	1410	1410	1410	1410	1410
BM	1.2	300	360	360	360	360	360
Methio -nine	0.05	225	225	225	225	225	225
Salt	0.15	30	30	30	30	30	30
Vit./min.Premix	0.13	212.5	212.5	212.5	212.5	212.5	212.5

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Cost of 50kg	-	-	14463.5	13110.5	11755.3	10402.3	9047.1
Cost of 1kg	-	-	289.3	262.2	235.1	208.0	180.9
Cost reduct. (%)	-	-	0.0	9.5	18.7	28.1	37.5
Quantity of feed (g) consumed / bird	-	-	1612.1	1676.7	1673.5	1694.5	1638.1
Cost of feed consumed /bird	-	-	466.38	439.63	393.44	352.46	296.33
Cost of feed /kg weight gain	-	-	769.86	725.70	707.88	714.49	726.48
Initial weight (g/bird)	-	-	165	165	165	165	165
Final weight (g/bird)	-	-	770.8	770.8	720.8	658.3	572.9
Weight gain (g/ bird)	-	-	605.8	605.8	555.8	493.3	407.9

Cost per chick =500 F / chick. Drug=50000, 223 F / Chick. Poultry house: 10000 F per production cycle, 45 F/Chick. Drinkers: 15x2300=34500 F, can be used for three years at a cost of 11500frs per year and a depreciation cost of 11500/4=2875F, cost per chick=13 F / Chick. Smaller feeders: 3x800=2400 F, can be used for three years at a cost of 800 per year and a depreciation cost of 800/4=200, cost per chick=1 F / Chick. Feeders: 3x1000=3000 F, can be used for three years at a cost of 1000 per year and a depreciation cost of 1000/4=250, cost per chick =1 F / Chick. Charcoal =3000, cost per chick = 3000/225= 14 F. Cassava peel collection transportation and processing=15,000 F, can be used for three years at a cost of 5000F per year and a depreciation cost of 5000/4=1250F, cost per chick=6 F / Chick. Labour: 30,000 F/month, Cost per chick =133 F/month. Total cost of other consumables and labour =1202 F.

Table IV: Cost analysis finisher phase

Ingre-dient	Quantity	Unit price in CFA francs	T0	T1	T2	T3	T4
Maize	26.68	220	5869.6	4402.2	2934.8	1467.4	0.00
PCP	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SBC	9.04	470	4248.8	4248.8	4248.8	4248.8	4248.8
GNC	5.27	300	1581	1581	1581	1581	1581
WB	6.5	150	975	975	975	975	975
FM	1	470	470	470	470	470	470
BM	1.2	300	360	360	360	360	360
Methio- nine	0.05	225	225	225	225	225	225
Salt	0.15	30	30	30	30	30	30
Vit./ min. Premix	0.13	212.5	212.5	212.5	212.5	212.5	212.5
Cost of 50kg	-	-	13971.9	12504.5	11037.1	9569.7	8102.3
Cost of 1kg	-	-	279.4	250.1	220.7	191.4	162.0
Cost reduct. (%)	-	-	0.0	10.5	21.0	31.5	42.0
Quantity of feed(g) consumed/bird	-	-	3313.3	3441	3530.4	3420.1	3338.9
Cost of feed consumed/bird	-	-	925.74	860.59	779.16	654.61	540.90
Cost of feed/kg weight gain	-	-	659.26	727.22	670.25	717.38	756.93
Initial weight (g/bird)	-	-	770.8	770.8	720.8	658.3	572.9
Final weight (g/bird)	-	-	2175	1954.2	1883.3	1570.8	1287.5
Weight gain (g/bird)	-	-	1404.2	1183.4	1162.5	912.5	714.6

The high reduction that was recorded in cost of 50kg starter and finisher feed, cost of 1kg feed, cost of feed consumed per bird, cost of feed per kilogram weight gain as the level of cassava peels increased in the diet. The progressive decrease in cost of feed from T0 to T5 was also reported by Abubakar and Ohiaege (2011) in rations for broiler finisher. Increase in cost reduction with increased level of cassava peels inclusion was also in line with the findings of Abubakar and Ohiaege (2011). Money was spent only to transport them and to grind. The cost of feed per kilogram live weight gain that was higher in T4 and lower in T2 in the starter phase, and lower in T0 and T2 in the finisher phase, is an indication that more meat could be obtained at less cost for using T2 diet in the starter phase and T1 and T2 diets respectively in the finisher phase (Abubakar and Ohiaege, 2011).

CONCLUSION

Digestibility of nutrients showed no particular pattern and was negative in the case of ash and CF. Cost of 50kg feed, feed consumed per bird, final weight and weight gain per bird decreased with increase in level of substitution. Therefore, cassava peels can replace maize up to 100% in ration for broilers without any adverse effects, with increase in economic benefit. For a good weight gain and live weight, partial substitution is preferred.

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