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CARCASS QUALITY AND COST-BENEFIT OF RABBITS FED CASSAVA PEEL MEAL

CALIDAD DE LA CANAL E IMPLICACIONES ECONÓMICAS DE LA ALIMENTACIÓN DE CONEJOS CON HARINA DE PELADURAS DE YUCA

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ADDITIONAL KEYWORDS

Ensiling. Hydrogen cyanide. Organoleptic property. Retting. Sun-drying.

PALABRAS CLAVE ADICIONALES

Ensilaje. Ácido cianhídrico. Propiedades organolépticas. Enriado. Secado al sol.

SUMMARY

A study was conducted to assess the effects of dietary inclusion of processed cassava peel meals (CPM) on the carcass characteristics, meat quality and economy of production of thirty-two growing rabbits. The rabbits, aged 6-week old with an initial average weight of 567±23 g, were allocated to a completely randomized design in a 9-week experiment. There were four diets consisting of a control (without cassava peel meal) and 200 g kg^{-1} of ensiled cassava peel meal (ECPM), sun-dried cassava peel meal (SCPM) and retted cassava peel meal (RCPM), respectively. The hydrogen cyanide (HCN) contents of processed CPM followed this rank order: RCPM (98.10 mg/kg) < SCPM (165 mg/kg) < ECPM (299.21 mg/kg) < unprocessed cassava peel meal (710.98 mg/kg). Live, slaughter and dressed weights, dressing percentage, meat to bone ratio, and pelt, shoulder, loin and leg expressed as the percentage of the dressed weight were lower ($p<0.05$) in ECPM than other diets. Other carcass parameters, meat organoleptic properties and savings on cost of feeding were not significantly influenced by the dietary treatments. Feed cost/kg body weight gain (BWG) decreased ($p<0.05$) with inclusion of 200 g/kg CPM in the diets. Differential cost/kg BWG and relative cost benefit/kg BWG showed similar trend and followed this rank order: RCPM > SCPM > ECPM (all $p<0.05$). Meat to bone ratio was positively and significantly ($p<0.0001$, R^2= 0.9996) influenced by live, slaughter and dressed weights. The results indicate the efficacy of the processing methods in cassava peels detoxification, cost effectiveness of the 200 g kg^{-1} CPM diets and absence of negative effect of residual HCN contents of the detoxified CPM on the meat quality of the experimental rabbits.

RESUMEN

Se realizó un estudio para determinar los efectos de la inclusión en la dieta de peladuras de yuca (CPM) sobre las características de la canal, calidad de la carne y economía de la producción de 32 conejos en crecimiento. Los conejos, de 6 semanas de edad y peso inicial de 567±23 g, fueron organizados en un diseño completamente al azar en un experimento de 9 semanas de duración. Se utilizaron cuatro dietas una dieta control (sin CPM) y otras con 200 g kg^{-1} de CPM ensilada (ECPM), secada al sol (SCPM) o enriada (RCPM) respectivamente. El contenido de ácido cianhídrico (HCN) de la CPM procesada fue: RCPM (98,10 mg/kg) < SCPM (165 mg/kg) < ECPM (299,21 mg/kg) < CPM sin procesar (710,98 mg/kg). Los pesos vivo, al sacrificio y de la canal, el rendimiento canal, carne/hueso, y los porcentajes sobre la canal de piel, lomo, espalda y pierna fueron menores ($p<0,05$) en la dieta ECPM. Otros parámetros de la canal, propiedades organolépticas, y ahorro en el coste de alimentación no fueron significativamente influidos por los tratamientos. El coste de alimentacion por kg de ganancia de peso vivo (BWG) disminuyó ($p<0,05$) con la inclusión de 200 g kg^{-1} de CPM en la dieta. El coste diferencial por kg de BWG y la relación coste/beneficio por kg BWG mostraron tendencias similares y mostraron la

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siguiente jerarquización: RCPM > SCPM > ECPM (todos p<0,05). La relacion carne/hueso fue positiva y significativamente (p<0,0001, R^2= 0,9996) influida por los pesos vivo, al sacrificio y faenado. Los resultados muestran la eficacia de los métodos de procesamiento en la desintoxicación de las peladuras de yuca, la eficacia económica de la inclusión de 200 g kg^{-1} de CPM en las dietas y la ausencia de efectos negativos del HCN residual de la CPM desintoxicada sobre la calidad de la carne de los conejos experimentales.

INTRODUCTION

The past few years have witnessed a rapid growth in human population of developing countries including Nigeria with resultant increase in demand for protein of animal origin which is in short supply. The increase in feed prices and the scarcity of grains and protein plant supplements are important constrains hampering livestock production sector in Nigeria and in many other countries. Therefore, reducing the production cost is the main objective of farmers to maximize their net revenue. The agroindustrial by-products (AIBs) can have a major influence on reducing the production cost. Hence, the need to harness the potential of the numerous AIBs and the so-called wastes as part replacement for expensive ones have been advocated (Aletor, 1986). Overall, the purpose of using alternative feedstuffs in livestock diets is to reduce the cost while improving or at least not affecting carcass characteristics and meat quality (Obeidat *et al*., 2009). One of such AIBs is cassava peel. However, the existence of cyanogenetic glycosides, linamarin and loutastralin, which on hydrolysis produce poisonous hydrogen cyanide (HCN), has made some form of detoxification or processing a pre-requisite for the use cassava peels in animal feeding. It thus becomes imperative to process cassava peel before its incorporation into livestock feeds and evaluate the influence of its processing on the carcass quality and cost of production of the fed animals. This study aimed at assessing the effect of different processing methods, ensiling, sun-drying and retting, on cassava peels and the consequence of inclusion of processed cassava peels meal (CPM) on the carcass characteristics, organoleptic qualities of meat and economy of production of growing rabbits.

MATERIALS AND METHODS

HUSBANDRY AND EXPERIMENTAL DESIGN

This study was carried out at the rabbit unit of the Teaching and Research Farm of Federal College of Wildlife Management, New Bussa, Niger state. It is located between latitude 7° 80' and 10° 00' N longitude 4° 30' and 4° 33' E. The temperature and relative humidity averaged 34°C and 60% during the period of the study.

Thirty-two clinically certified healthy male rabbits, aged 6 week-old, of mixed breeds purchased from homes in the neighbourhood of the College were used. The rabbits, with an initial body weight (BW) of 567 ± 23 g, were balanced for their weight. Each animal was housed individually in a standard hutch during the 2-week preliminary period and throughout the experimental period, which lasted for 9 weeks. The entire hutch system was of two-tier model, housed in well ventilated pen and raised 120 cm above the ground. The hutches were cleaned, washed and disinfected before the onset of the experiment. Prior to the experiment, each animal was dewormed using albendazole. Feed, in mash form, and water were served *ad libitum.*

THE TEST INGREDIENTS AND EXPERIMENTAL DIETS

Fresh cassava peels of *bitter* variety TMS 30572 were collected from the field, mixed and divided into three fractions. The first fraction was spread on concrete floor and exposed to the sun for 5 days to a constant weight, milled and tagged sun-dried cassava peel meal (SCPM). The second fraction was tightly compressed into a plastic container to ensure air elimination, covered with polythene sheets and heavy stones to ensure compaction. At 14 days of ensiling, the ensiled material was uniformly light brown and firm with pleasant odour without fungal growth. The ensiled material was later sun-dried for 5 days to a constant weight and milled to produce ensiled cassava peel meal (ECPM). The last fraction was packed into a plastic bucket and soaked in water at room temperature for 5 days. By the fifth day, the water had turned turbid with the cassava peels becoming soft and swollen. It was then drained, sun-dried for 5 days to a constant weight and milled to produce retted cassava peel meal (RCPM). Retting is the term used for prolonged soaking of cassava root and by products in water to effect the breakdown of tissue (Ayenor, 1985). In addition to the control, three other diets were formulated by incorporating ECPM, SCPM and RCPM at 200 g/kg, respectively, and they were called cassava peel meal (CPM) diets. The diets were formulated to be isonitrogenous, isocaloric and had similar crude fibre level.

CARCASS AND MEAT QUALITY EVALUATION

At the end of the experiment (63 days), eight rabbits from each treatment were taken and starved overnight, slaughtered and skinned. The pelts of the slaughtered rabbits were removed with sharp scalpel and scissors. The scalpel was used in making a ring round one of the hind legs just above the hock. A scalpel was inserted under the skin of the leg to open it up to the root of the tail. The same was repeated with the other leg. From pelvic region, another incision was made up to the neck region. The pelt was pulled along with the skin. The carcasses were washed and eviscerated with subsequent removal of the heads and legs. The dressing weights were taken which were subsequently used to determine dressing percentages for the rabbits. The carcasses were then divided into primal parts and each part expressed as a percentage of the dressed carcass.

In order to assess the meat quality, 12 panelists (6 males and 6 females) ranging in age from 25-30 years were randomly allocated to the four treatments. Meat samples were weighed and then cooked into a plastic bag in a water bath at 75°C until an internal temperature of 71°C was achieved. After cooling, the samples were taken from the bags, dried with filter paper to remove cooking drip and reweighed. Cooking loss was expressed as the percentage loss related to the initial weight. After the cooking loss determination, samples for sensory evaluation were cut into approximately 1 x 1cm sub-samples (four equal bite sizes for each of the assessed meat quality indices per treatment), transferred into a pre-warmed glass beaker, covered and placed into an oven at 60°C to equilibrate their temperature prior to being served. Samples were coded and served in an odourless plastic container while the serving sequence was randomised. The panelists were made to rate each of the 4 replicates of the meat samples per meat quality index per treatment. Each sample was evaluated independent of the other. The panelists rated the sample on a 9-point hedonic scale for colour, flavour, tenderness, juiciness and overall acceptability.

CHEMICAL AND STATISTICAL ANALYSES

Feed, faecal samples and HCN were analysed according to the official methods of analysis (AOAC, 1990). Gross energy of the cassava peels was determined with a ballistic oxygen bomb calorimeter (A. Gallenkamp & Co., Ltd, UK).

Data were subjected to one way analysis of variance using completely randomized design (Steel and Torrie, 1980) and significant means were separated using Duncan's multiple range test (Duncan, 1955). Differences between treatment means were considered significant at the $p<0.05$ level. Relationship between meat/ratio and live, slaughter and dressed carcass weights was determined using multiple regressions as applicable to parametric analyses.

ECONOMIC ANALYSIS

The variable cost of feeding the rabbits was considered as the cost of the feeds as all other costs (ie labour, capital investment, housing) were the same for all the treatments. The cost of processing the cassava peel was included as the feed cost.

RESULTS AND DISCUSSION

The chemical compositions of the test ingredients and experimental diets are shown in **tables I** and **II**, respectively. The drastic reduction in HCN content of the processed cassava peel meals compared with the fresh peels explicitly demonstrated the efficacy of these processing methods in cassava peels detoxification. The HCN content of processed CPM followed this rank order: RCPM < SCPM < ECPM which makes retting the most effective method. However, the HCN contents of all the processed cassava peel meals were below the toxic level of 100 mg/kg reported for cassava by-products (Agunbiade *et al*., 2002). The chemical compositions of the processed CPM compared with the previous reports (Okeke *et al*., 1985; Sogunle *et al*., 2007).

The carcass characteristics of the experimental rabbits are shown in **table III**. Live weight of rabbits fed ECPM diet was lower ($p < 0.05$) than other experimental diets which implies that ECPM diet possibly depressed the final weight of the experimental rabbits. This could probably be attributed to relatively higher HCN content of the diet which has been implicated for reduced growth rate (Iyayi and Odueso, 2003). With the exception of dressing weight which was higher in the control compared to SCPM, slaughter weight and dressing percentage showed the same trend as the live weight. The significant ($p<0.05$) differences in the slaughter weight, dressing weight and dressing percentage of the carcasses could be attributed to variations in the live weights of the experimental rabbits. The difference in slaughter weight is in agreement with that of Retore *et al*. (2008) who fed diets of varying fibre quality to growing rabbits. However, their slaughter weight which ranged between 1.92 and 2.19 kg was higher than that obtained in the present experiment.

Table I. *Chemical composition (g kg^{-1}DM) of the experimental feedstuff*[a]. (Composición química (g kg^{-1}DM) del material alimenticio experimental).

Composition	Cassava peel meals UCPM	ECPM	SCPM	RCPM
Crude protein	62.1	61.7	68.5	64.4
Crude fibre	125.7	88.9	109.8	85.4
Fat	14.2	19.8	12.0	19.0
Ash	70.0	69.7	44.2	55.1
Nitrogen free extract	728.0	759.9	765.5	776.1
Organic matter	930.0	930.3	955.8	944.9
Gross energy (MJ/kg)	16.19	16.23	16.44	16.65
Hydrogen cyanide (mg/kg)	710.98	299.21	165.36	98.10

[a]Triplicate subsamples were analysed.
UCPM: Unprocessed cassava peel meal; ECPM: ensiled cassava peel meal; SCPM: sun-dried cassava peel meal; RCPM: retted cassava peel meal.

Table II. *Composition of the experimental diets.* (Composición de las dietas experimentales).

Ingredient (g kg^{-1})	Control	ECPM	SCPM	RCPM
Maize	300.0	120.0	120.0	120.0
Corn bran	310.0	370.0	365.0	340.0
Ensiled cassava peel meal	0.00	200.0	0.00	0.00
Sun-dried cassava peel meal	0.00	0.00	200.0	0.00
Retted cassava peel meal	0.00	0.00	0.00	200.0
Palm kernel cake	100.0	115.0	110.0	100.0
Groundnut cake	140.0	140.0	140.0	140.0
Rice husk	100.0	20.0	15.0	25.00
Blood meal	20.0	20.0	20.0	20.0
Bone meal	15.0	15.0	15.0	15.0
Oyster shell	10.0	10.0	10.0	10.0
Premix[a]	2.50	2.50	2.50	2.50
Salt	2.50	2.50	2.50	2.50
Determined content (g kg^{-1}DM)				
Crude protein	169.1	168.6	167.8	166.7
Crude fibre	157.4	157.1	156.8	155.6
Fat	30.0	23.0	22.0	21.8
Ash	74.5	51.0	66.0	75.2
Nitrogen free extract	569.0	600.3	587.4	580.7
Hydrogen cyanide (mg/kg)	ND[c]	53.86	28.98	16.30
Digestible energy (MJ/kg)	13.27	10.35	12.65	13.22

ECPM: ensiled cassava peel meal; SCPM: sun-driedcassava peel meal; RCPM: retted cassava peel meal. [a]Contained per kg premix: Vitamin A, 4 000 000 IU; Vitamin D3, 2 000 000 IU; Vitamin E, 7000 IU; Vitamin B2, 4000 mg; Nicotinic acid, 15 000 mg; Calcium D-pentothenate, 8000 mg; Biotin, 40 mg; Vitamin $B_{12,}$ 10 mg; Mn, 20 000 mg; Fe, 50 000 mg; Zn, 100 000 mg; Cu, 10 000 mg; Iodine, 750 mg; Co, 3000 mg. ND: not determined.

The variation in the slaughter weight could be due to differences in the breed, nutrition and age at slaughter. The dressing percentages, in the current study, were higher than the ranges of 43.24 to 53.83%, 48.70 to 49.45% and 52.05 to 53.36% indicated by Akinmutimi and Akufo (2006), Oteku and Igene (2006) and Sobayo *et al*. (2008), respectively, but similar to the ranges of 50.7 to 58.5%, 51.61 to 59.00 and 52.00 to 59.00 reported by Memieth *et al*. (2004), Dairo *et al*. (2005) and Ani (2006), respectively. The variations in results could be ascribed to disparity in the nutrition, live and slaughter weights, age and breeds of the experimental rabbits. The pronounced ($p<0.05$) effect of dietary treatments on dressing percentage agrees with that of Akinmutimi and Akufo (2006), but contradicts that of Ani (2009) who assessed the effect of graded levels of raw bambaranut waste on the performance of rabbits. Pelt percent varied significantly ($p<0.05$) among the diets and was lower ($p<0.05$) in rabbits fed ECPM compared to other diets. The variation in the pelt percent could be due to different levels of subcutaneous fat deposition attributable to the dietary treatments, slaughter and dressed weights variation. Butcher *et al*. (1983) opined that external offal percent tended to increase as slaughter weight of rabbit increased. The

Table III. *Carcass characteristics of rabbits fed cassava peel meal diets.* (Características de la canal de los conejos alimentados con dietas a base de peladuras de yuca).

Parameter	Control	ECPM	SCPM	RPCM	SEM
Live weight (g)	1860[a]	1640[b]	1810[a]	1840[a]	34.89
Slaughter weight	1792.85[a]	1594.57[b]	1754.80[a]	1775.97[a]	31.25
Blood loss	3.61	2.77	3.05	3.48	0.45
Dressed weight	1088.29[a]	820.49[c]	1026.63[b]	1064.62[ab]	24.56
Dressing %	58.51[a]	50.03[b]	56.72[a]	57.86[a]	3.01
Head	9.80	9.22	9.10	9.40	0.98
Carcass length	27.20	24.27	25.07	25.89	1.90
Pelt	10.21[a]	8.97[c]	9.58[b]	9.88[ab]	0.27
Gastrointestinal tract	14.78	14.21	15.46	15.09	1.09
Shoulder	12.05[a]	10.22[b]	11.56[a]	11.92[a]	0.58
Rib	5.10	3.68	4.20	4.80	0.30
Loin	9.59[a]	7.60[b]	8.69[a]	8.97[a]	0.43
Leg %	18.90[a]	16.11[b]	17.92[a]	18.95[a]	0.80
Meat:bone ratio	3.94[a]	3.00[b]	3.49[a]	3.70[a]	0.17
Cooking loss	26.30	24.97	25.89	26.12	2.40

Means in the row with different superscripts are significantly different ($p<0.05$).
ECPM: ensiled cassava peel meal diet; SCPM: sun-dried cassava peel meal diet; RCPM: retted cassava peel meal diet.

result concurs with that of Sobayo *et al.* (2008). However, the pelt percent is lower than the 11% reported by Ready *et al.* (1977) for temperate breeds of rabbit. Environmental factors may be responsible as Nigeria rabbits have less need for fur than the temperate breeds.

The division of a carcass into primal parts enables comparison to be made between various defined areas of the carcass (Davendra, 1966). Blood loss, head, carcass length, gastrointestinal tract and the rib expressed as the percent of the dressed weight were not significantly ($p>0.05$) influenced by the dietary treatments. However, primal cuts like the shoulder, loin and leg were significantly ($p<0.05$) lower in rabbits submitted to ECPM diet than the other diets. Parallel results were obtained by Akinmutimi *et al.* (2006)

Table IV. *Organoleptic properties of meat of rabbits fed cassava peel meal based diets.* (Propiedades organolépticas de la carne de conejos alimentados con dietas a base de residuos de yuca).

Parameter	Control	ECPM	SCPM	RCPM	SEM
Colour	5.36	5.61	5.43	5.50	2.40
Flavour	5.06	5.00	4.98	5.12	0.10
Tenderness	6.00	6.13	6.06	5.90	0.15
Juiceness	5.35	5.52	5.40	5.37	0.12
Overall acceptability	6.24	6.19	6.28	6.33	0.25

Means in the same row without superscripts are not significantly different ($p>0.05$).
ECPM: ensiled cassava peel meal; SCPM: sun-dried cassava peel meal; RCPM: retted cassava peel meal.

Table V. *Economics of feed conversion of rabbits fed the experimental diets.* (Economía de la conversión alimenticia de conejos alimentados con las dietas experimentales).

	Control	ECPM	SCPM	RCPM	SEM
Feed cost (naira/kg)[a]	27.80	21.33	20.55	20.74	-
Total weight gain (kg)	1.30[a]	1.12b	1.25[a]	1.28[a]	0.05
Total fed consumed (kg)	5.10	4.80	5.10	4.98	0.09
Cost of feed consumed (naira)	141.78[a]	102.38[b]	104.81[bc]	103.29[c]	0.11
Savings on cost of feeding (%)		27.79[a]	26.08[a]	27.15[a]	1.97
Cost of feed/kg BWG (naira)	109.02[a]	91.14[b]	83.66[bc]	80.70[c]	3.22
Cost differential/kg BWG (naira)	-	17.88[c]	25.36[b]	28.32[a]	1.05
Relative cost benefit/kg BW gain (%)	-	16.40[c]	23.26[b]	25.98[a]	1.01

Means in the same row with superscripts are significantly different ($p<0.05$).
ECPM: ensiled cassava peel meal; SCPM: sun-dried cassava peel meal; RCPM: retted cassava peel meal.
[a]Determined using the market price at the time of the experiment (April 2007) 1$= (120 naira).

and Idowu *et al*. (2006) who reported significant variations in primal cuts, the back cut, drum stick, forearm, chest, head, shoulder, rack, loin and thigh, of weaner rabbits fed ripe plantain and yam peels and growing rabbits fed cassava root sievate and cassava peel diets, respectively. Dietary treatments had significant ($p<0.05$) effect on meat to bone ratio with rabbits fed ECPM having the least ($p<0.05$) value. The result which showed the same trend as that of the live weight (LW), slaughter weight (SW) and dressing percentage (DP) suggested a positive correlation between meat/bone ratio and these carcass characteristic indices. This conjecture was corroborated by the result of multiple regression analysis which showed that meat to bone ratio was significantly ($p<0.0001$) and positively correlated ($r= 0.9998$) with LW (X1), SW (X2) and DP (X3), with about 100% ($R^2= 0.9996$) of variation in meat to bone ratio being due to these independent variables. The regression equation is:

$$Y= -103.19 + 0.1426X1 + 0.03491X2 + 0.08774X3$$

However, LW had a slightly more pronounced contribution ($R^2= 0.9258$) to meat/bone ratio than DP ($R^2= 0.9253$) and SW ($R= 0.90820$). Szendro *et al*. (1998) and Oteku and Igene (2006) reported a meat/bone ratio of 2.8 to 3.7 and 2.86 and 4.06, respectively, which compare favourably with the values obtained in the present study. Cooking loss values, which were within the range of 23.94 to 39.18% reported by Omojola and Adesehinwa (2006) and Sobayo *et al*. (2008), were not significantly ($p>0.05$) different among the treatments. In general, except for ECPM diets where few of the studied carcass characteristics parameters were affected, the non-significant differences between the control diet and the other two CPM diets confirms the previous study (Lanza *et al*., 2001) who demonstrated that inclusion 10% of alternative feedstuffs, orange pulp and carob pulp, did not impact carcass characteristics.

The effect of the dietary treatments on the organoleptic properties of meat of the experimental rabbits is presented in **table IV**. The non-significant ($p>0.05$) effect of the test diets on the meat quality suggests the efficacy of the processing methods in CPM detoxification and that the residual HCN in the experimental feedstuffs had no negative effect on the meat quality. Lanza *et al*. (2003) studied the effect of feeding peas for lambs and found the meat quality (i.e. ultimate pH, meat colour, and cooking loss) to be similar to lambs fed diets containing soybean meal. Similarly, Omoikhoje *et al*. (2008) observed no significant effect of feeding cassava root meal based diets on the organoleptic properties of the experimental rabbits.

The result of comparative cost advantage of inclusion of detoxified CPM in growing rabbits' diets is shown in **table V**. The feed cost showed a reduction of N6470, N7250 and N7060/tonne from the control to the ECPM, SCPM and RCPM diets, respectively. Similarly, CPM diets significantly ($p<0.05$) lowered cost of feed consumed/day and the cost of feed/kg BWG compared to the control diet. Among the CPM diets, RCPM diet was more ($p<0.05$) cost effective than ECPM diet which compared ($p>0.05$) with SCPM diet. The result showed that it was cheaper and more economical to produce 1 kg of BW by feeding CPM diets, and that even among the CPM diets; RCPM was more cost effective than ECPM diet. This appears plausible considering the lower feed and feeding costs of CPM diets than the control and that of RCPM than ECPM. Differential cost benefit/kg BWG and relative cost benefit/kg BWG showed a parallel trend and significant ($p<0.05$) reduction in the following order: ECPM < SCPM < RCPM. However, savings on cost of feed consumed were not significantly varied among the CPM diets.

The results obtained in the present study confirms the aim of using alternative feedstuffs in ration formulation, which is to reduce the cost of production and benefits accruable to farmers without compromising the carcass characteristics and meat quality. Previous studies and the current study have shown the possibility of using alternative or unconventional feedstuffs without causing problems to carcass characteristics and meat quality.

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