CARCASS AND ECONOMIC VALUE OF RABBITS RAISED ON RIPE GMELINA FRUIT PULP BASED DIETS

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ABSTRACT

Carcass and economic indices of rabbits fed dietary ripe Gmelina fruit (RGFP) pulp were assessed. Sixty rabbits, aged six weeks (New Zealand White x Chinchilla cross) of mixed sexes (25 males and 35 females) were shared into five groups of 12 animals each and balanced on sex and initial weight and randomly allotted to the five experimental diets. Maize, the only energy source of diet I was replaced with 25, 50, 75 and 100% RGFP in diets II, III, IV and V, respectively in the 16 weeks trial. Carcass characteristics were determined pre-chill. Completely Randomized Design, one-way analysis of variance was used and significant (p<0.05) means were separated using least significant difference. The cost of feed (₦/kg), cost of feed consumed (₦/animal), cost of feed per weight gain (₦/kg weight gain), final weight, fasted weight, percentage weight loss, dressed weight and dressing percentage ranged from 55.07 – 28.21, 407.07 – 213.55 and 307.68 – 207.34, 1900 – 1605g, 1884.90 – 1589.78g, 15.23 – 15.09%, 1206.42 – 1017.46g and 64.01 – 63.97%, respectively. As a percentage of the dressed carcass, the shoulder, loin, rack, thigh, head, tail, belly fat, lung, kidney, liver and heart weights (g) ranged from 33.53 – 33.47, 8.97 – 8.74, 6.28 – 6.18, 35.29 – 35.16, 5.20 – 5.13, 3.29 – 3.19, 3.30 – 2.89, 0.32 – 0.30, 1.50 – 1.47, 2.80 – 2.77 and 0.18 – 0.15, respectively. Diet I had the highest cost of feed, cost of feed consumed, cost of feed per kilogramme weight gain, pre-slaughter weight and percentage belly fat, while diet V had the least values of the above parameters except percentage belly fat and dressed weight. Also, the values for these indices decreased as dietary RGFP increased. Though undesirable, the meat of control rabbits was the fattiest. Dietary inclusion of RGFP did not affect percentage weight loss, shoulder, loin, thigh, head, tail, lung, kidney, liver, heart and dressing percentage. For optimal returns on investment, RGFP may not replace above 75% of maize in rabbit diets.

Keywords: Rabbit, New Zealand white x Chinchilla cross, *Gmelina,* Fruit pulp, Carcass, Economic value

INTRODUCTION

The search for novel feedstuffs to broaden options available to livestock farmers in their quest for cost minimization and profit maximization in livestock farming enterprises is a continuous process. High nutritive value and assurances of safety of feed for livestock does not guarantee the adoption and use of novel feedstuffs by farmers. Economic returns as indicated by cost benefit indices and impact of the feed on the target products like carcass quality, milk yield and egg production determine to a greater extent farmer decision to adopt feed innovation (Barnard, 1969). Ripe *Gmelina* fruit pulp (RGFP) meal has been under consideration as a novel energy source (Annongu and Foluronso, 2003; Amata, 2012). It has been reported to be good for feeding livestock with a little nutritive boost (Ingweye and Okon, 2012; Amata, 2012). Dietary evaluation with rats has recommended 25% replacement for maize (Ingweye and Okon, 2013; Ingweye and Kalio, 2013). Evaluation of its economic value when fed to rabbits as well as the carcass characteristics of the rabbit meat is yet to be carried out. Hence, the present study was designed to find out the carcass and economic worth of RGFP based diets on rabbits to recommend same for adoption by farmers.

MATERIALS AND METHODS

Study Location: The experiment was carried out at the Rabbit Unit, Faculty of Agriculture Teaching and Research Farm, University of Calabar. Calabar is located at latitude 04.57^{o}N and longitude 08.20^{o}E.

Feed Ingredient and Processing: The *Gmelina* plant was identified by a plant taxonomist at the Botany Department, University of Calabar. The ripe *Gmelina* fruits were obtained from the Nigeria Newsprint and Paper Manufacturing Company *Gmelina* plantation in Akamkpa Local Government Area, Cross River State. The maize, palm oil, groundnut oil, soybeans and vitamin/mineral premix were bought from markets in Calabar.

The fruits were depulped by removing the hard woody seed inside the fruit. The mucilage, juice and pericarp together formed the pulp. The pulp was sun dried to a constant weight, milled, packed in jute bags and stored in a cool dry place at room temperature for use in compounding the diets. All dietary ingredients were subjected to proximate analysis (AOAC, 2005).

Experimental Animals: Sixty rabbits (25 males and 35 females) were obtained from a reputable rabbit farmer in Calabar metropolis at the age of six weeks (42 ± 3 days). The rabbits were of the New Zealand White x Chinchilla cross.

Housing: The rabbits were housed individually in cages measuring 76 x 62 x 42 cm, elevated at 90cm above the ground (Akinfala *et al*., 2003). Well ventilated wire mesh (2.5 x 2.5 x 1.25 cm gauge) and hard wood were used to construct the cages. Each cage had two concrete bowls; one for holding concentrate feed and the other for drinking water.

Experimental Diets and Feeding: The five diets (Table 1) were iso-nitrogenous and iso-caloric. Diet 1 was the control with maize as the sole energy source (0% level of replacement). The maize was then replaced with 25, 50, 75 and 100% RGFP in diets II, III, IV and V, respectively. The diets were subjected to proximate analysis (AOAC, 2005) to ensure that the calculated and analyzed proximate values were similar. The diets had 17% crude protein and 2500 kcal (ME)/kg (Aduku, 1993). The rabbits were fed and watered *ad libitum* throughout the study period.

Medication: The cages were cleaned with Izal solution (disinfectant) each day. A dewormer (Albendazole) was administered to the rabbits before the start of the growth trials at the rate of 2.5 mg/kg body weight. As the situation demands, broad spectrum antibiotics were administered on the rabbits to keep them in a healthy active state. Coccidiosis was treated with a coccidiostat while mange was treated with ivermectin injection.

Performance Characteristics: Feed intake, body weight gain and feed conversion ratio (FCR) were measured and calculated. animals were daily offered fresh concentrate feed, water and forage with one half provided in the morning (07:30 hours) and the other half in the evening (16.00 hours). The leftover feed at the end of each day was subtracted from the feed supplied the previous day to obtain the daily feed intake. The feed conversion ratio was calculated by dividing the mean feed intake per treatment by the mean body weight gain at a point in time. Feed intake and body weight were recorded before serving fresh feed and water in the morning. The feed cost/kg weight gain was calculated by multiplying feed cost/kg by feed conversion ratio. The animals were individually weighed at the start of the trial and thereafter after every seven days. On the last day of the experiment, the final weight was taken. Weekly weight gain in grammes was calculated by subtracting the current week weight from the preceding week's weight.

Carcass Evaluation: Three animals per treatment (i.e. two females and one male) weighing close to the group average were selected and used for the carcass evaluation. Prior to slaughtering, the animals were starved of feed for 16 hours but offered water. They were then stunned and bled by hanging the carcasses on rails upside down for proper bleeding. The carcasses were defurred by burning off the fur over open fire. The carcasses were then scraped and washed with cold water.

Evisceration was done by first cutting the head between the zygomatic arches and the atlas. A cut was made down the breast plate through the abdomen to the pelvis. The anus was cut round and retracted together with the trachea and esophagus. The esophagus was cut round at the distal end to separate it from the diaphragm. The lungs and the trachea were removed intact and weighed while the gastro intestinal tract was removed intact and weighed. The breast, shank and flank were removed by cutting from the face of the leg parallel to the vertebral axis, cutting through the fore shank, breast and shank. The shoulder was removed by cutting across between the fifth and sixth thoracic vertebrae while the leg was separated by cutting between the last lumbar and the first sacral bone or at the tip of the ilium. The ribs and loin were separated by cutting after the 13^{th} rib through the lumbar vertebrae. Carcass weight, relative cut-up parts and organ weights were determined pre-chill. The relative weights were calculated by expressing the weights of the cut parts and organs as percentage of the dressed carcass weight. Each primal cut was weighed and its proportion relative to the carcass was determined. The procedures were carried out as reported by Ukah *et al*. (2006).

Experimental Design: Sixty rabbits, aged six weeks (New Zealand White x Chinchilla cross) of mixed sexes (25 males and 35 females) were shared into five groups of 12 animals each and balanced on sex and initial weight. The groups were randomly allotted to the five experimental diets. Diet I had maize as the only energy source. The maize was replaced with 25, 50, 75 and 100% RGFP in diets II, III, IV and V, respectively. The diets were supplemented with *Calopogonuim muconoides* leaves as fed in the 16 weeks trial.

Data Analysis: Completely Randomized Design, one-way analysis of variance was used and significant ($p<0.05$) means were separated using least significant difference using SAS statistical package.

RESULTS AND DISCUSSION

Carcass Indices of Rabbits Raised on Ripe Gmelina Fruit Pulp Based Diets: The carcass indices of rabbits fed ripe *Gmelina* fruit pulp (RGFP) based diets indicated that the final weight, fasted weight, percentage weight loss, dressed weight and dressing percentage ranged from 1900 – 1605g, 1884.90 – 1589.78g, 15.23 – 15.09%, 1206.42 – 1017.46g and 64.01 – 63.97%, respectively (Table 2). Diet I had the highest ($p<0.05$) fasted or pre-slaughter weight, while diet V had the lowest ($p<0.05$). The highest ($p<0.05$) fasted weight was not different from that recorded for diets II, III and IV implying that administration of treatment reduced ($p<0.05$) the fasted weight when RGFP completely replaced maize. As dietary RGFP level increased, the pre-slaughter weight decreased meaning that overnight fasting must have led to dehydration and breakdown of body reserves which affected live weight of diet V. Compared to reported values of Idowu *et al*. (2006), the values obtained for the present study were higher. It could be due to the carry over effect from the higher final live weight in the present study.

Table 1: Composition of diets for experimental rabbits

Ingredients	**Diets**				
	I	II	III	IV	V
Maize	44.27	32.20	22.14	11.07	-
RGFP	-	14.26	25.29	37.86	50.38
Soybeans	20.73	18.54	17.57	16.07	14.62
Shrimp waste	2.00	2.00	2.00	2.00	2.00
Wheat offal	27.00	27.00	27.00	27.00	27.00
Palm oil	3.00	3.00	3.00	3.00	3.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Vitamin premix	0.50	0.50	0.50	0.50	0.50
Common salt	0.50	0.50	0.50	0.50	0.50
Total	**100**	**100**	**100**	**100**	**100**
Calculated					
Crude protein	17.00	16.87	16.97	17.00	17.00
Crude fibre	5.27	6.15	6.83	7.27	8.45
Ether extract	9.99	11.07	12.00	13.00	14.01
ME (kcal/kg)	2,518	2,516	2,510	2,500	2,497
Analyzed					
Crude protein	17.11	17.00	17.20	17.00	16.98
Crude fibre	5.56	6.11	7.01	7.42	8.60
Ether extract	10.00	10.59	12.30	13.01	14.20
ME (kcal/kg)	2,505	2,500	2,500	2,498	2,498

Table 2: Carcass indices of rabbits raised on gmelina fruit pulp based diets

Parameter	**Diets**				
	I	**II**	**III**	**IV**	**V**
Final weight (g)	1900.00±55.00^{a}	1899.86±55.11^{a}	1890.95±56.00^{a}	1800.20±57.12^{a}	1605.00±58.28^{b}
Fasted weight (g)	1884.90±56.01^{a}	1884.74±56.00^{a}	1875.86±55.88^{a}	1784.97±55.98^{a}	1589.78±57.01^{b}
Weight loss (%)	15.10±0.02^{NS}	15.12±0.011^{NS}	15.09±0.03^{NS}	15.23±0.01^{NS}	15.22±0.00^{NS}
Dressed weight (g)	1206.15±36.02^{a}	1206.42±35.59^{a}	1199.99±36.00^{a}	1142.02±35.99^{a}	1017.46±36.02^{b}
Dressing percentage	63.99±6.99^{NS}	64.01±6.98^{NS}	63.97±7.00^{NS}	63.98±7.02^{NS}	64.00±7.03^{NS}
Carcass quality [% dressed carcass]					
Shoulder	33.48±0.02^{NS}	33.49±0.01^{NS}	33.53±0.03^{NS}	33.47±0.00^{NS}	33.48±0.01^{NS}
Loin	8.76±0.04^{NS}	8.97±0.00^{NS}	8.74±0.01^{NS}	8.80±0.03^{NS}	8.92±0.01^{NS}
Rack	6.19±0.00^{b}	6.18±0.00^{b}	6.27±0.01^{a}	6.28±0.02^{a}	6.21±0.03^{ab}
Thigh	35.16±0.02^{NS}	35.19±0.00^{NS}	35.29±0.02^{NS}	35.29±0.01^{NS}	35.22±0.03^{NS}
Head	5.14±0.00^{NS}	5.13±0.00^{NS}	5.19±0.01^{NS}	5.20±0.00^{NS}	5.18±0.00^{NS}
Tail	3.22±0.02^{NS}	3.23±0.02^{NS}	3.23±0.02^{NS}	3.29±0.01^{NS}	3.19±0.03^{NS}
Belly fat	3.30±0.08^{a}	3.00±0.07^{b}	2.89±0.09^{b}	2.99±0.08^{b}	3.00±0.08^{b}
Lung	0.31±0.00^{NS}	0.30±0.00^{NS}	0.32±0.00^{NS}	0.31±0.00^{NS}	0.32±0.00^{NS}
Kidney	1.49±0.00^{NS}	1.48±0.00^{NS}	1.47±0.00^{NS}	1.49±0.00^{NS}	1.50±0.01^{NS}
Liver	2.79±0.00^{NS}	2.79±0.00^{NS}	2.79±0.00^{NS}	2.77±0.00^{NS}	2.80±0.00^{NS}
Heart	0.16±0.01^{NS}	0.15±0.01^{NS}	0.18±0.01^{NS}	0.16±0.01^{NS}	0.18±0.01^{NS}

^{NS} Not significantly different (p>0.05); $^{a-d}$ means in the same row with different superscripts are significantly different (p<0.05)

Table 3: Economic indices of rabbits raised on ripe gmelina fruit pulp based diets

Parameter	**Diets**				
	I	**II**	**III**	**IV**	**V**
Cost of feed/kg (₦)	55.07±5.17^{a}	50.11±5.00^{b}	47.87±4.99^{b}	33.25±4.98^{c}	28.21±5.10^{d}
Cost of feed consumed/animal (₦)	407.07±41.20^{a}	407.39±41.00^{a}	387.27±40.99^{b}	256.69±41.12^{c}	213.55±41.22^{d}
Cost of feed/kg weight gain (₦)	307.42±23.31^{a}	307.68±23.50^{a}	294.40±22.99^{b}	209.81±23.00^{c}	207.34±23.23^{c}
Savings on cost of feeding (%)	0.00	-0.08±0.00^{c}	4.24±0.01^{b}	31.75±4.01^{a}	32.55±3.99^{a}

^{NS} Not significantly different (p>0.05); $^{a-d}$ means in the same row with different superscripts are significantly different (p<0.05)

The percentage weight loss was not affected ($p>0.05$) by RGFP dietary inclusion. Diet II had the highest ($p<0.05$) dressed weight, while that of diet V was the least ($p<0.05$). However, diet II dressed weight was similar ($p>0.05$) to values obtained for diets I, III and IV. The trend showed decreasing dressed weight as dietary RGFP level increased depicting a carryover effect from the fasted weight and that administration of treatment did not affect ($p>0.05$) the by-products of carcass dressing like blood and intestine. The dressing percentage values were unaffected ($p>0.05$) by dietary inclusion of RGFP. Similar results were obtained when rats were fed with increasing levels of RGFP (Ingweye and Okon, 2013).

As a percentage of the dressed carcass, the shoulder, loin, rack, thigh, head, tail, belly fat, lung, kidney, liver and heart weights (g) ranged from 33.53 – 33.47, 8.97 – 8.74, 6.28 – 6.18, 35.29 – 35.16, 5.20 – 5.13, 3.29 – 3.19, 3.30 – 2.89, 0.32 – 0.30, 1.50 – 1.47, 2.80 – 2.77 and 0.18 – 0.15, respectively. The percentage shoulder, loin, thigh, head, tail, lung, kidney, liver and heart showed no significant ($p>0.05$) difference among the treatment means. The percentage weight of rack at diet IV was the highest ($p<0.05$) though not different ($p>0.05$) from values obtained for diets III and V. The least ($p<0.05$) percentage rack weight was obtained for diet II which was not different ($p>0.05$) from the values obtained for diets I and V. The trend shows an increasing percentage rack weight as the level of RGFP in the diet increased though it could not be traced to a particular reason.

Diet I had the largest ($p<0.05$) percentage belly fat while that of diet III was the smallest ($p<0.05$). However, the least ($p<0.05$) percentage belly fat was not different ($p>0.05$) from figures obtained for diets IV, V and II. The trend shows that the control rabbits accumulated the most ($p<0.05$) fat than any other group. This could be due to the complete use of maize in this diet and poor forage intake by this group. The net impact will be a negative influence on meat quality as the meat becomes too fatty and extracellular fat so accumulated is not desirable in carcasses.

Economic Indices of Rabbits Raised on Ripe Gmelina Fruit Pulp Based Diets: The economics of production of rabbits fed graded levels of RGFP indicated that the cost of feed (₦/kg), cost of feed consumed (₦/animal) and cost of feed per weight gain (₦/kg weight gain) ranged from 55.07 to 28.21, 407.07 to 213.55 and 307.68 to 207.34, respectively (Table 3). The control diet (diet I) was the most expensive ($p<0.05$), while diet V was the cheapest ($p<0.05$). Feed cost decreased as RGFP level increased. Ingweye and Okon (2013) had indicated similar reduction in feed cost when increased level of RGFP was incorporated into diets fed to rats.

This implied that inclusion of RGFP in the diet reduced ($p<0.05$) the cost of feed and could potentially reduce the cost of rabbits feeding. The cost of feed was higher than that reported for cocoa pod husk as feed for rabbits (Adejinmi *et al*., 2007). This could be due to the cost of processing RGFP which was higher than that of cocoa pod husk. Diet II had the highest ($p<0.05$) cost of feed consumed while diet V was the least ($p<0.05$). The highest ($p<0.05$) value was similar ($p>0.05$) to that of the diet I. The cost of feed consumed rose as the level of RGFP in the diet decreased implying that inclusion of RGFP in the diets reduced ($p<0.05$) the cost of feeding rabbits.

Diet I had the highest ($p<0.05$) cost of feed per kilogramme weight gain while diet V had the least ($p<0.05$). The highest ($p>0.05$) cost of gain was not different ($p>0.05$) from the cost of gain obtained for diet II while the least cost of gain was also similar ($p>0.05$) that recorded for diet III. As RGFP level in the diet increased, the cost of feed per kilogramme weight gain decreased implying that it was cheaper to produce rabbit meat by feeding the animals with diets V and IV but more expensive to produce the same quantity of rabbit meat feeding the animals on diets I and II.

Conclusion: The study assessed the carcass and economic indices of rabbits fed diets incorporating ripe gmelina fruit. Diet I had the highest cost of feed, cost of feed consumed, cost of feed per kilogramme weight gain, pre-slaughter weight and percentage belly fat while diet V had the least except percentage belly fat where diet III was the least and dressed weight where diet II was the highest. Also, the values for these indices and dressed weight decreased as the level of RGFP increased. Though undesirable, the meat of control rabbits was the fattiest. The percentage weight loss, shoulder; loin, thigh, head, tail, lung, kidney, liver, heart and dressing percentage were not affected by dietary inclusion of RGFP. Therefore, for optimal returns on investment, RGFP may replace up to 75% of maize in rabbit diets.

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REFERENCES

ADEJINMI, O. O., HAMZAT, R. A. and FAPOHUNDA, J. B. (2007). Performance and nutrient digestibility of rabbits fed fermented and unfermented cocoa pod husk. *Nigerian Journal of Animal Production,* 34(1): 63 – 68.

ADUKU, A. O. (1993). *Tropical Feedstuff Analysis Tables*. Ahmadu Bello University Press, Zaria, Nigeria.

AKINFALA, E. O., MATANMI, O. and ADERIBIGBE A. O. (2003). Preliminary studies on the response of weaner rabbits to whole cassava plant meal basal diets in the humid tropics. *Livestock Research for Rural Development,* 15(4): Retrieved March 13, 2015, from http://www.lrrd.org/lrrd15/4/akin154.htm

AMATA I. A. (2012).Comparative evaluation of the amino acid and mineral contents of the fruits of gmelina arborea tree during growth and development. *International Journal of Plant, Animal and Environmental Sciences,* 2(2): 264 – 269.

ANNONGU, A. A. and FOLORUNSO, A. S. (2003). Biochemical evaluation of *Gmelina arborea* fruit meal as a swine feed stuff. *Biokemistri,* 15(1): 1 – 6.

AOAC (2005). *Official Methods of Analysis.* 12th Edition, Association of Official Analytical Chemists (AOAC), Washington DC, USA.

BARNARD, C. S. (1969). Economic analysis and livestock feeding. *Journal of Agricultural Economics*, 20: 323 – 330.

IDOWU, O. M. O., SOGUNLE, O. M., IDOWU, O. A., JEGEDE, A. V., ALABI, E. E., ADENUGBA, A. O. and BAMGBOSE, A. M. (2006). Performance and carcass characteristics of weaner rabbits fed diets containing cassava root peel and cassava root sievate. *Tropical Journal of Animal Science,* 9(1): 81 – 87.

INGWEYE, J. N. and OKON, B. I. (2012). The proximate composition and phytomorphometry of gmelina (*Gmelina arborea*) fruit and fruit pulp from Calabar, Nigeria. *Journal of Agriculture, Forestry and the Social Sciences*, 10(2): 239 – 244.

INGWEYE, J. N. and OKON, B. I. (2013). Growth performance and organ characteristics of rats fed gmelina (*Gmelina arborea*) fruit pulp. *African Journal of Livestock Extension*, 11: 1 – 5.

UKAH, O. G., OMOJOLA, A. B., OGUNSOLA, O. O. and OKUBANJO, A. O. (2006). Carcass and meat characteristics of grass cutter (*Thryonomys swinderianus*). *Tropical Journal of Animal Science,* 9(1): 31 – 38.