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Replacement value of shea nut meal for dietary maize on growth performance and economics of production of rabbits

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Abstract

Shea nut meal is a by-product that is cheaper than maize though its replacement value for min rabbit diet is not yet determined. It is however, hoped that the use of shea nut meal in diet would reduce the cost of production and increase profit. A twelve-week trial was therefore conducted to determine the replacement value of shea nut meal (SNM) for dietary maize on growth performance and economics of production of rabbits. Forty rabbits were divided into five, replicated eight times and allotted to five dietary treatments in a completely randomized design. Diet 1 had maize as major energy source and without SNM, while in diet 2, 3, 4 and 5, SNM replaced maize at 25, 50, 75 and 100% respectively. Proximate composition of SNM, feed intake, weight gain, feed cost, cost of production, revenue and profit were determined. The study revealed that SNM has 16.83 % ether extract (EE) and 46.66 % nitrogen free extract (NFE), low in crude fibre (CF) and 8.74% crude protein (CP). Daily feed intake was higher ($p<0.05$) for rabbits fed control (65.79g/day) than those fed the test diets (50.90-60.10g/day). Rabbits fed control diet gained similar ($p>0.05$) weight as those fed diets 2 or 3, but higher ($p<0.05$) than those fed diets 4 or 5. Feed gain ratio by rabbit were similar ($p>0.05$) except rabbits fed diet 5 which were significantly less. Cost per kg diet decreased ($p<0.05$) as level of replacement increased, and the control diet cost (₦88.75) more than any (₦72.77 - ₦84.76) of the test diets. Cost of feeding and total cost of production were reduced ($p<0.05$) by 16.86 – 36.55% due to replacement. The cost to gain a kg of weight was similar ($p>0.05$) for each of diets 1 to 4 but significantly ($p<0.05$) less than that of diet 5. The gross margin was lesser when SNM replaced maize in diets at 100%. Replacement of maize with SNM in diets up to 75% has no negative effect of growth performance and economics of production, however, at 100% replacement levels; there was a decreased feed intake, increased cost per kg weight gain, and a reduced gross margin.

Keywords: Non-conventional, Energy, oil-seed-meal, by-product, Rabbit, Shea nut meal in rabbit diets

Introduction

Human food is maximally utilized only when the nutrient requirements of man is provided by the foodstuff consumed. Obioha (1992) recommended a minimum animal protein intake of 28g/head/day. Only 29% of the animal protein required by man is provided in Nigerian home menu. This is partly because majority of Nigerians are earning very low and cannot rank and place animal protein high in their scare of preference. Especially that, there is low production of meat animal; making it scarce and expensive, compare to protein of plant source. The low production of these animal species is in turn due to high cost of production which feed alone contributes above 60 % in monogastric feeding since conventional feeding stuff are not always available at cheap rates (Garba and Mohammed, 2015). Conventional feedstuff like Grains (Maize, Sorghum, Guinea Corn) and Plant oil seeds (Soya beans, Groundnut, Sesame) and their by-products have been in use as energy and protein sources of feed but could be in short supply and expensive at times, especially during draught and non-production periods. The shortage is

sometimes compounded by government policies like ban on food importation. A search for cheaper sources of agro-industrial by- products, that have been in use and emerging ones that are non-competitive, readily available at cheaper price can replace the conventional energy and protein feedstuffs in animal diet formulation (Tuleun and Patrick, 2007). Shea butter mainly used in Africa as food (e.g. cooking oil), industrially (cosmetics, candles, waterproof agent etc) and as an ingredient in medicinal ointment is derived from Shea nuts, for which Nigeria is known worldwide as the biggest Shea nut belt in the world (Ugese *et al*., 2010). The kernel contains up to about 60 % of fat (Shea butter) and the solid residue obtained after extraction of butter from the kernel has been described as Shea nut meal, and is a major by-product of the Shea nut industry and is therefore as well available in large quantities. Shea butter contains these nutrients in g/kg dry matter basis; 80-250 Crude Protein (CP), 17-362 Ether Extract (EE), 53-138 Crude Fibre (CF), 33-76 Ash and 318-675 Nitrogen-Free-Extract (NFE) (Adeogun, 1989). The variability in nutrients depends on the processing method, either traditionally or industrially (Davrieux *et al*., 2010; Hemat, 2003). It is rich in carbohydrates, has moderate protein but the presence of anti-nutritional factors, mainly theobromine and tannins limits its use as an animal feed ingredient, for monogastric in particular (Oddoye*et al*., 2015). However, Alamede *et al*. (2013) recommend up to 25 % inclusion of Shea butter meal in rabbit diets. Rabbit is a monogastric herbivour, prolific and the meat is of high quality and can cheaply and easily be multiplied using agricultural and industrial by-products as feed ingredients. The study was carried out to investigate the replacement value of maize for shea nut meal on performance and economics of production of rabbit.

Materials and methods

The research work was conducted at the Rabbit unit of University of Agriculture, Livestock Teaching and Research Farm, Makurdi. Makurdi is located on latitude 70° 43′ North and Latitude 80 3I East; a rainy season from April to November during which an average of 1200mm of rain falls. Ambient temperature ranges from 17.3°C - 24.5°C minimum and 29.8°C-35.6°C and maximum (Dzungwe, 1991; TAC, 2002) while relative humidity is between 47-85% (NMA,2004).

Shea nut meal was purchased from Oracle Farm situated at Naka Road, Industrial Layout Makurdi. Other feed ingredients were purchased from a reputable commercial feed store, market and rice processing industry in Makurdi.The proximate composition of shea nut meal and the experimental diets were determined according to official methods of analysis (A.O.A.C., 2002). Forty rabbits with an average weight of 688.75gwere divided into five, replicated eight times and allotted to five dietary treatments in a completely randomized design. The hutches were disinfected before stocking. On arrival, the rabbits were given antibiotics, dewormer and mineral vitamin mix in water and allowed to acclimatize for a week before commencement of the experiment. The rabbits were housed individually and each rabbit represented a replicate. Five diets were formulated, and diet 1 (T1) was the control where maize was used as major energy source in the feed, without SNM, while diet 2, 3, 4 and 5, SNM replaced maize at 25, 50, 75 and 100% respectively, coded T2, T3, T4 and T5 (Table 1).

Table 1: Percent ingredient and nutrient compositionof experimental diets

Ingredient	T1 0% SNM	T2 25% SNM	T3 50% SNM	T4 75% SNM	T5 100%NM
Maize	31.98	23.99	16	8.00	0.00
Shea butter meal	0.00	8.00	16.00	23.99	31.99
Full fat Soya bean	35.22	35.22	35.22	35.22	35.22
Rice Offal	30.00	30.00	30.00	30.00	30.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Table salt	0.30	0.30	0.30	0.30	0.30
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
Nutrient analysis					
Crude protein	17.71	17.68	17.67	17.55	17.63
Crude fibre	12.48	13.66	11.79	13.03	13.22
Calcium	0. 79	0.99	0.48	0.85	0.89
Phosphorus	0.54	0.70	0.86	1.02	1.19
Lysine	1.15	1.44	1.67	1.34	1.67
Methionone	0.32	0.49	0.56	0.74	0.90
ME (kcal/kg)	2916.35	3331.96	3427.50	3171.92	3243.58

*Premix (Agrimix Broiler Starter) manufactured by AGRITED NIG. LTD. Supplying the following per kg of diet: Vit. A -10,000 iu, Vit . D3 -3000 iu, Vit. E -30 iu, Vit. K -0.0023g. Thiamine (B1) -0.0017g, Riboflavin (B2) -0.005g, Pyridoxine (B6) -0.0031g, Vit. B12 -0'o16mg, Biotin -006mg, Niacin -0.031g, Pantothenic acid -0.008g, Folic acid -0.0008g, Manganese -0.085g, Zinc -0.05g, Iron -0.025g, Coppe r-0.006g, Iodine -0.001g, Selenium -0.12mg, Cobalt -0.22mg, B.H.T. -0.06G, Ethoxyquine-0.065g, Choline Chloride-0.2g.

Initial weights of the rabbits were taken on the 1st day of the trial and weekly thereafter to know the weekly weight gain which was divided by 7 to determine average daily weight gain. Feed intake was determined by difference between feed supply at the beginning of the week and feed left over at the end of the week and divided by 7 to obtain average daily feed intake. Feed cost per kilogram weight gain was determined based on the feed cost as of July/August 2019 in Makurdi, Benue State, Nigeria. Other costs were determined according to Shaahu (2011) where cost/kg diet = Σ(cost/kg ingredient x % inclusion in the diet); cost of feeding = (cost/kg diet x total feed intake in kg); Feed cost/kg weight gain= (cost of feeding/total weight gain in kg). Total cost of production was calculated on the assumption that feeding constitutes 60% of total cost of producton. Gross margin= Total revenue-total cost of production, and cost benefit ratio = total cost of production/total revenue. Data collected were subjected to analysis of variance (ANOVA) for Complete Randomized Design using the statistical package for Scientific Solutions (SPSS 16) software in accordance with Snedecor and Cochram (1967) and where significant differences existed among treatment means, they were separated using Duncan's Multiple Range Test according to (Duncan, 1955).

Results and discussion

Proximate analysis revealed that shea nut meal contained 8.75%, 16.83%, 7.27% 16.18% 4.31% and 46.66% of crude protein, fats/oils, ash, moisture, crude fibre and NFE respectively. Shea nut meal is rich in carbohydrates, has moderate protein (Oddoye *et al*., 2015). This is an indication that SNM has nutritional value and relative to other oil seed meals such as soybeans meal, and ground nut cake. It is low in crude protein and high in energy. Feed intake was significantly ($p<0.05$) reduced as levels of

SNM were increased in diets to replace maize (Table 2). Daily feed intake of rabbits fed the test diets were similar ($p>0.05$) and significantly ($p<0.05$) less than 65.79g/day by rabbits fed control. Rabbits fed T3 however, had significantly ($p<0.05$) higher feed intake (60.10g/day) than those of T5 whose feed intake was the least. Feed intake is a function of feed quality, palatability and especially energy value of the feed and capacity of the gastrointestinal tract. Reduced feed intake by the rabbits fed SNM may be implicated by the palatability of diets, since SNM is reported to contain some anti-nutritional factors. According to Oddoye *et al.* (2015), the presence of anti-nutritional factors, mainly theobromine and tannins limits the use of SNM as an animal feed ingredient, for monogastric in particular. Rabbits are expected to take in 5% of their live weight daily, however, the feed intake by rabbits in this study were between 3-4% of their live weights. The feed intake of 50.9-65.79g/rabbit/day by the rabbits was more than 15.64-18.32 g/rabbit/day, reported by Odedire and Oloidi (2018), but similar to 48.70-57.02g/rabbit/day reported by Dairo *et al.* (2018).

Weight gain of experimental rabbits significantly decreased as the level of of SNM was increased in diets to replace maize. Rabbits fed control diet gained similar ($p>0.05$) weight as those fed diets 2 or 3, but significantly ($p<0.05$) higher than those fed diets 4 or 5. Rabbits fed T3 diet gained significantly ($p<0.05$) higher than those fed T5 diet. Growth is a response to feed quality, adequacy and utilization. The growth trend in this study is directly related to the feed intake by the experimental rabbits. The study revealed that up to 50% of maize was replaced by SNM in diet without any influence on weight gain, however, beyond 50%, weight gain decreased. The daily weight gain was less than 14.59-15.13 and 12.64- 14.98g/rabbit/day, reported by Odedire and Oloidi (2018) and Mohammed *et al*. (2018) respectively.

Table 2: Replacement value of shea nut meal (SNM) for dietary maize on growth performance of rabbits

Parameters	T1 0% SNM	T2 25% SNM	T3 50% SNM	T4 75% SNM	T5 100%SNM	SEM
Initial weight (g)	692.50	680.00	686.25	692.50	692.50	20.83
Total feed intake (g)	5526.00^{a}	4695.88^{bc}	5048.13^{b}	4753.13^{bc}	4276.00^{c}	94.80
Daily feed intake (g)	65.79^{a}	55.90^{bc}	60.10^{b}	56.58^{bc}	50.90^{c}	1.13
Total weight gain (g)	1018.50^{a}	1001.63^{a}	903.38^{ab}	852.50^{b}	487.63^{c}	36.74
Daily weight gain (g)	12.13^{a}	11.92^{a}	10.75^{ab}	10.15^{b}	5.81^{c}	0.44
Feed to gain ratio (g)	5.49^{b}	4.72^{b}	5.77^{b}	5.65^{b}	9.14^{a}	0.30
Mortality (%)	12.50	0	0	12.50	12.50	-

The value of 10.15 -12.13 by rabbits fed T1-T4 were within the average daily weight gain values of 10-20g/rabbit/day reported for rabbits reared in tropical environment (Cheeke, 1987). The daily weight gain range of 10-12 g/rabbit/day is common with the rabbits around and within the country of study (Aderinola *et al*., 2018; Nsa *et al*., 2019; Shaahu and Tiough. 2019a; Sogunle *et al*., 2019; Ukorebi *et al*., 2019). The rabbits used for study within the study area were mostly from eight weeks old, such that, the study period coincided with the slow growth rate time (12 weeks and above) for rabbits. Feed gain ratio by rabbit fed T1, T2, T3, or T4 (4.72-5.77) were similar

($p>0.05$) and significantly ($p<0.05$) less than (9.14) by rabbits fed T5. As the feed quality, quantity, and utilization declined, the amount of feed required to gain a unit weight by the rabbits increased. The feed conversion ratio of 3-5 is common amount rabbits in the study area (Wafar *et al.,* 2018; Shaahu and Tiough 2019b). The expected average daily feed intake and average daily weight gain reported by Aduku and Olukosi (1990) for growing rabbit in first 8 weeks of life is not achieved by these rabbits. The rabbits were weaned at 8 weeks with average weights of 687g only when they were expected to weigh 1658 according to the report. Feed constitute between 45-50% of total cost of rearing rabbits to market weight of 2kg, however, a higher feed to gain ratio can swell the cost of feeding to be up to 60% the cost of production. The difference in the growth performance of rabbits when all the nutrients are balanced in each diet, and especially when difference feed sources are used, is viewed to be due to nutrient quality and utilization.

Table 3: Replacement value of shea nut meal (SNM) for dietary maize on economics of production of rabbits

Parameters	T1 0%SNM	T2 25%SNM	T3 50%SNM	T4 75%SNM	T5 100%SNM	SEM
Total feed intake(g)	5526.00^{a}	4695.88^{bc}	5048.13^{b}	4753.13^{bc}	4276.00^{c}	94.80
Total weight gain (g)	1018.50^{a}	1001.63^{a}	903.38^{ab}	852.50^{b}	487.63^{c}	36.74
Cost per kg diet(₦)	88.75^{a}	84.76^{b}	80.77^{c}	76.77^{d}	72.77^{e}	0.90
Total cost of feeding(₦)	490.43^{a}	398.02^{bc}	407.74^{b}	364.90^{c}	311.16^{d}	10.87
Cost/ per kg weight gain(₦)	487.45^{b}	400.06^{b}	466.37^{b}	433.78^{b}	665.37^{a}	19.83
Total cost of production(₦)	817.39^{a}	663.37^{bc}	679.56^{b}	608.16^{c}	518.67^{d}	18.11
revenue(₦)	1273.13^{a}	1252.03^{a}	1129.22^{ab}	1065.63^{b}	609.53^{c}	45.92
Gross margin(₦)	455.74^{a}	588.86^{a}	449.66^{a}	457.46^{a}	90.92^{b}	35.36
Cost benefit ratio	0.65^{b}	0.53^{b}	0.62^{b}	0.58^{b}	0.89^{a}	0.03

Mortalities were recorded for rabbits fed T1, T4 and T5, and which has no particular relation with the treatment and cannot be explicitly explained. Result of production economics of rabbits fed diet containing shea nut meal is presented in Table 3. Cost per kg diet significantly ($p<0.05$) decreased as the level of replacement of maize for SNM increased in diets and the control diet cost (₦88.75) more than any (₦72.77 - ₦84.76) of the test diets. The difference in the cost per kg diet is because; maize is priced higher than SNM, in the location and at the time of purchase. This is true when the prices of most agro and agro-industrial by-product are compared with agricultural products. Cost of feeding and total cost of production were significantly ($p<0.05$) reduced by 16.86 – 36.55% when SNM replaced maize in diets. The cost of kg feed, the quantity of feed consumed and the weight gain by the rabbit influence cost of feeding and to a large extent the cost of production of rabbits. The cost to gain a kg of weight was similar ($p>0.05$) for each of diets 1 to 4 but significantly ($p<0.05$) less than that of diet 5. This is a manifestation of the feed to gain ratio of the experimental rabbits. The cost per kg diet showed a decreasing trend from treatment 1-5 and the total cost of feeding was significantly ($p<0.05$) higher for control diet, than other treatments but the same ($p>0.05$) for treatment 2 and 3. The lowest cost of production was from rabbits fed treatment 5. The gross profit made (₦455.74, ₦588.86, ₦449.66, ₦457.46, and ₦90.92) in that order of treatments favoured diet 2

even though significant profit was also made with diets 1, 3 or 4 more compared to diet 5.

Conclusion

The study revealed that share nut meal could be used as an energy source in rabbit diets with a positive effect on feed intake and a resultant weight gain for up to 75% replacement level for maize (24% in diet).
Total replacement of maize with shea nut meal in diet as the major source of energy for rabbits resulted to reduced feed efficiency, high cost of feed per kg weight gain and low revenue. Processing of the meal would enhance removal of anti-nutrients, palatability and more effective utilization.

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