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By-Products as Protein Source for Lactating Grasscutters

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Abstract

The potential of grasscutters (*Thryonomys swinderianus temminck*) as a source of animal protein can be exploited with better understanding of its nutrient requirement. An experiment was conducted to determine the protein requirement of lactating grasscutters fed agro-industrial by-products namely; wheat offal and soybean meal. Sixteen 13 months old lactating grasscutters, in groups of four, were randomly allotted to four treatment diets formulated to respectively supply 10, 14, 18 and 22% crude protein (CP). Performance in respect of weight of does at end of lactation, daily weight gain of pups, daily weight gain of doe and litter, weaning weight of pups, feed conversion ratio, and cost to gain ratio, were significantly ($P<0.05$) higher on the 22% CP diet. The daily weight loss of does and percentage mortality among pups were significantly lower on the 22% CP diet. Though the percentage mortality among pups was significantly ($P<0.05$) higher, the litter size weaned was significantly ($P<0.05$) higher on the 18% diet. Given the overall economic importance of low mortality rate in the expansion of farm animal populations and profitability thereof, these results suggest that 22% is the optimum crude protein level for lactating grasscutters, when industrial by-products, soybean meal and wheat offal, are used as dietary supplements.

Keywords: lactating grasscutters, protein requirement, agricultural by products

1. Introduction

The very low level of consumption of animal protein accounts for the higher prevalence of malnutrition in West Africa, with its debilitating effect, especially on children. Unconventional livestock (also called microlivestock), such as the grasscutter, constitute an important source of much-needed animal protein in West Africa (Baptist and Mensah, 1986) and other poor countries where, even the middle class eats less meat in a year than the populations of North America and Europe eat in a month (The Futurist, 1992). The grasscutter belongs to a group of wildlife animal species, which hold promise as farm animals for the supply of animal protein. Further, in West Africa where the hunting and trapping of animals in the wild for "bushmeat" has become a very serious existential threat to already endangered wildlife species, the farmed grasscutter is a promising substitute in the bushmeat trade.

In Nigeria, the demand for animal protein is greater than supply (Akinmutimi and Onwukwe, 2002). The insufficient supply of animal protein has translated to prohibitive prices for available animal products (Okon et al., 2008). Two possible areas of focus for alleviating the animal protein shortage have been identified to include increased production of prolific and fast growing animals and the reduction of the cost of production of meat and other animal products (Ojebiyi et al., 2010). Biobaku and Ekpenyong (1991) suggested that non-traditional meat sources suitable for small-scale farming need to be introduced. The potentials of some micro-livestock such as snails, grasscutters, bush-fowl and giant rats can be exploited when reared and managed at least cost under intensive system of production (Odunaiya & Akinyemi, 2008).

The grasscutter is a wild rodent specie of high nutritional value, which has potential as a healthy source of animal protein (Okon et al., 2008). Much of the potential of the grasscutter is for subsistence production. It holds promise for peasants who cannot afford the high cost of protein from conventional livestock sources, but who can afford to raise grasscutters at subsistence level on feeds that are cheap and easily available. Such feedstuffs, which include roughages and other high fibre feedstuffs are utilized by microorganisms of the caecum of the grasscutter in digestive processes that are similar to those of rumen microbes (Michalet-Doreau, 2002). The

volatile fatty acids (VFA) and microbial cells of caecal fermentation are absorbed across the epithelial membrane and serve as precursors for nutrients, which can be utilized by the animal (Kristensen, 2005).

It has been shown that total feed intake and productivity of animals are affected by the physiological status, such as pregnancy and lactation (Allison, 1985) as well as feed type (Keunen et al., 2002). Arnold (1970) found greater digestible organic matter intake for pregnant and lactating ewes than for dry ewes. Most grasscutter diets are fibrous and relatively low in protein content, which suggests the importance of protein supplements in the diets of grasscutters in captivity. It has been reported that the optimum dietary crude protein of 14% for gestating grasscutters (Wogar, 2011a) and 12% for growing grasscutters (Wogar, 2011b) could be supplied from locally available soybean meal and wheat offal. Lameed and Ogundijo (2006) reported best performance among grasscutters fed 24% crude protein in diets compounded with agro-industrial products.

It is suggested that the long-term growth of animal production in Nigeria depends on the effective utilization of by-products of farming (Tewe, 1997) and agro-industrial processing (Okon et al., 2007). This suggests that the nutrient requirements of farm animals could be sourced from feeding these by-products of agricultural production. The performance of growing grasscutters has been shown to be significantly higher on palm kernel cake diet than on diets of other agro-industrial by-products studied (Wogar, 2012).

This study was designed to determine the protein requirements of lactating grasscutters fed low-cost agro-industrial by-products namely; wheat offal and soybean meal.

2. Materials and Methods

The study was carried out at the Grassccutter Research Farm at Calabar, under the supervision of the Department of Animal Science, University of Calabar, Calabar, Nigeria. Calabar is at latitude 3^0 North and longitude 7^0 East. It has an annual rainfall of 2650 to 3000 mm and relative humidity of 57 to 93%. The annual temperatures are between 25 and 32 ^{0}C (World Weather Online, 2012). The study, which lasted for twelve weeks, was conducted between the months of January and May, 2009.

2.1 Experimental Diets

Four experimental diets containing 10, 14, 18 and 22% dietary crude protein levels were formulated using the agro-industrial by-products, wheat offal and soybean. The protein contents of the diets were calculated from the protein contents of each ingredient of the diets. Cassava was used as an additional energy source and also served as a binding agent in the diets. The energy contents of the diets were calculated from the energy density of each ingredient of the diets.The estimated energy content of each diet was 2400 kcal ME/kg. All the feed ingredients were purchased from the local market in Calabar. The pelleted diet was made from a cassava paste of the ingredients and dried in a kerosene-fired oven at 75 ^{0}C. The composition of the test diets is shown in Table 1.

Table 1. Composition of experimental diets for determination of protein requirements of lactating grasscutters, %

Ingredients	**Experimental diets (% CP levels)**			
	10	**14**	**18**	**22**
Cassava	5.60	47.10	40.20	35.10
Wheat offal	40.00	35.00	31.00	26.00
Soybean meal	4.40	12.90	23.80	33.90
Vitamin premix	3.00	3.00	3.00	3.00
Bone meal	1.50	1.50	1.50	1.50
Salt	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00

2.2 Research Animals

Sixteen lactating grasscutters were used in the study. The lactating grasscutters were 13 months old and weighed between 3.18 and 3.57 kg.

2.3 Management of Research Animals

The grasscutters were individually housed in clearly-labelled concrete cells measuring 150 x 75 x 35cm (length x width x height). The housing provided for only one opening (35 high x 45cm wide) into the cell in order to eliminate cross-ventilation and prevent the adverse effect of cold on grasscutters, which are very susceptible to pneumonia. Temperatures in the cells were in the range of 28 - 33^{0}C during the experimental period.

The grasscutters were randomly allotted, in groups of four, to the four treatment diets. Each group was randomly fed one of the four dietary protein levels. There were four replicates per treatment, with one (1) grasscutter per

replicate. To minimise any stress that could result from the change in diet, during the physiological transition from gestation to lactation, grasscutters were fed the same diet used during gestation. The animals were dewormed and provided with anti stress agents in drinking water before introduction into the experimental housing. Elephant grass (*Pennisetum purpureum*) was fed daily as basal diet after it had been cut and allowed to wilt for two days. Water, diet and elephant grass were supplied *ad libitum*.

The animals were weighed, at the beginning and every two weeks thereafter, during the 12 weeks of the study. All cells were cleaned daily in order to ensure adequate sanitation.

2.4 Data Collection and Statistical Analysis

Data collection on the various parameters of interest was started at kindling. Records were kept of the following observations: daily forage intake (g); daily forage dry matter intake (g), which was estimated as 12% dry matter content of elephant grass; daily diet intake (g); daily total feed intake (g), which was the total intake of forage dry matter and diet; daily weight gain of does (g); weight of does at the end (terminal weight) of lactation (g); average number of pups (No/litter size) weaned; average weaning weight (g) of pups and cost of diet (N. K).

The lactating grasscutters were of the same age. The differences between the weights of grasscutters used in the study were within a close range. Grasscutters were randomly allocated to the four test diets, therefore, from a pool without consideration to differences in weight and age. The design of the experiment was the completely randomized design. All the data collected during the period of the experiment were subjected to analysis of variance, using the Genstat (2007) software. Significant means were separated by Duncan's Multiple Range test (Steel & Torrie, 1980).

3. Results and Discussion

The proximate composition of the experimental diets (Table 2) shows that, except for crude protein, crude fibre and ether extract fractions, which were significantly ($P<0.05$) different, the proximate composition of other fractions (Dry matter, ash and nitrogen free extract) did not differ significantly among the test diets.

Table 2. Proximate composition of experimental diets for Determination of protein requirements of lactating grasscutters

Nutrients (% of DM)	**Experimental Diets (% CP level)**			
	10	**14**	**18**	**22**
Dry matter	85.77	85.75	85.72	85.68
Crude protein	10.45	14.25	17.85	21.90
Crude fibre	15.98	14.52	13.61	11.65
Ether extract	7.64	7.19	4.93	4.01
Ash	11.75	11.77	11.83	11.87
Nitrogen Free Extract	39.95	38.02	37.50	36.25
Calculated ME (kcal/kg)	2430.46	2465.61	2395.33	2425.34

The effects of feeding different energy levels, on gestating grasscutters, are presented in Table 3.

3.1 Growth Performance

3.1.1 Feed Intake

The results indicate that forage intake increased with increase in dietary protein levels to 14% CP, but decreased at higher protein levels. This finding suggests that intake of forage, which is the basal diet, by lactating grasscutters would increase only to the extent of the required (optimum) dietary protein intake. Further, the results suggest that the lower (10% CP) level of supplementation enhanced increased forage intake due to increased digestibility of roughage and diet. The depressed forage intake at the higher (22 % CP) level was, therefore, due to decreased digestibility of roughage and diet at that level of supplementation. Similar results by Orskov (1986) indicate that a small amount of grain (20-30% of the diet) produced little or no depression in feed intake and digestibility of roughages, but that higher levels depressed feed intake to the extent that it no longer served as a supplement, but had become a substitute for the basal diet. This finding suggests that the higher forage intake at the lower (10%) level of supplementation was a physiological modification to satisfy the increased demand for protein during lactation (Lebas et al., 1996). The high intake of concentrate and decreased intake of forage at the higher (22% CP) level of supplementation suggests that the concentrate had become a substitute for forage at the 22% dietary CP level.

Table 3. Performance of Lactating Grasscutters Fed Varying Dietary Protein Levels

PARAMETERS	TREATMENTS (% CP Level)				
	10	14	18	22	SEM
Initial weight of does (g)	3188.31	3575.20	3356.12	3438.14	193.30
Final weights of does (g)	2955.13^{b}	2801.01^{b}	2815.04^{b}	3362.31^{a}	169.00
Daily weight loss of does (g)	-3.90^{c}	-13.00^{a}	-7.30^{b}	-3.80^{c}	1.30
Initial weight of pups (g)	130.50	142.50	122.00	189.00	4.30
Weaning weight of pups (g)	714.23^{a}	612.30^{b}	401.22^{c}	759.21^{a}	93.90
Daily weight gain of pups (g)	10.50^{a}	8.50^{b}	5.10^{c}	10.10^{a}	1.40
Daily weight gain of doe and litter(g)	6.92^{a}	-4.52^{b}	-2.30^{b}	6.40^{a}	1.5
Average daily forage intake (g)	646.20^{b}	730.21^{a}	625.04^{b}	577.10^{c}	58.22
Daily forage DM intake (g)	77.50^{b}	87.71^{a}	73.43^{bc}	69.51^{c}	7.00
Average daily diet intake (g)	414.14^{a}	400.04^{a}	350.34^{b}	388.13^{a}	35.23
Daily total feed intake (g)	491.51^{a}	484.80^{a}	423.30^{b}	453.61^{a}	40.20
Daily cost of diet (N.K)	28.96^{a}	28.01^{a}	24.51^{b}	27.12^{a}	2.34
Cost to gain ratio (N.K/g)	4.62^{a}	-8.62^{b}	-14.60^{b}	4.13^{a}	3.47
Initial litter size (No/litter)	4.50	6.00	8.00	3.0	0.60
No. of pups weaned per litter	3.80^{bc}	5.00^{ab}	5.80^{a}	2.80^{c}	0.50
Mortality of pups, %	17.00^{b}	17.00^{b}	28.00^{a}	8.00^{c}	2.60

^{abc}Means along the same row having no common superscript differ significantly at $P<0.05$.

ns refers to non-significant differences between means.

N.K = Naira.Kobo (Nigerian currency: US$1.00 = N162.00)

SEM : Standard mean.

3.1.2 Daily Weight gain/Loss of Lactating Does

The results indicated that lactating grasscutters fed dietary protein levels of 10% and 22% CP, which had smaller litter sizes, lost less weight than those fed dietary protein levels of 14 and 18% CP. This reflected the greater demand for milk from lactating grasscutters with larger litter sizes, which were fed the 14 and 18% CP. It is, therefore, suggested that the daily weight loss among lactating grasscutters could be attributed more to the litter size weaned than to the level of dietary protein fed. The negative weight changes observed in this experiment are indicative of the increased utilization of nutrients to satisfy the demands of lactation. This finding agrees with the report of Smith and Somade (1994) on the adjustments in nutrient demands of lactation and other postpartum physiological processes such as uterine involution, maintenance of body condition and reinitiation of ovarian activity. The adjustments or modifications were more efficient (indicated by less weight loss) among grasscutters with smaller weaned litter sizes due to the lower demand of lactation. The loss of body weight observed for all grasscutters in this study agrees with the findings of Iyeghe–Erakpotobor et al. (2007) that crude protein digestibility and the mobilization of fat and protein for milk synthesis increase during lactation in rabbits. Mobilization of body protein stores in lactating doe rabbits to support protein synthesis has been reported (Fraga, 1998). The 22% CP diet was observed to significantly ($P<0.05$) have the most favourable adjustments on weight loss among lactating grasscutters in this study.

3.2 Reproductive Performance

3.2.1 Daily Weight Gain and Weaning Weight of Pups

The results of this study suggest that the pups on the 22% CP diet had significantly ($P<0.05$) high average daily weight gain (10.10 g) and higher weaning weight (759.21 g) than those on the 10, 14, and 18% CP diets. This finding reflects the significantly ($P<0.05$) high total feed intake on the 22% CP diet than on other diets. This agrees with the findings of Gu et al. (2006) that rabbit kits fed the higher (17.5%) crude protein diet had higher average weaning weight of litter than those fed the lower (16 and 14.5%) CP diet. It is, however, suggested that the smaller litter size also meant higher feed intake per pup on the 22% CP diet. Similarly, the smaller litter size suggests greater access by pups to the milk of lactating does. The average daily weight gain of pups (5.10 to 10.50 g) was within the 8 to 13 g range reported by Jori and Chardonnet (2001) and 7 to 12 g reported by Mensah (1995).

3.2.2 Mortality and Litter Size at Weaning

Significantly ($P<0.05$) higher survival rate (92%) of pups was recorded for litters on the 22% CP diet. This finding reflects the significantly ($P<0.05$) higher total feed intake on the 22% CP diet than on other diets. This agrees with the findings of Gu et al.(2006) that rabbit kits fed the higher (17.5%) crude protein diet had higher survival rate (95%) at weaning than those fed the lower (16 and 14.5%) crude protein diet. It was also observed that the survival rate of pups was higher when litter sizes were smaller. The high survival rate among smaller litters was, therefore, consistent with the higher per caput total feed intake and access to the milk of lactating does. The litter size (2.80 to 5.80 pups/litter) at weaning was within the range of 3.8 to 5.7 (Mensah, 2000) and 2 to 6 (Addo *et al*., 2007) pups per litter.

3.2.3 Weight of Lactating Grasscutters at the End of Lactation

The weight at the end of lactation is indicative of the effect of adjustments by lactating grasscutters to satisfy the demand for nutrients. The higher weight at the end of lactation on the 22% CP diet was indicative of better maternal body condition and welfare on that diet. This finding indicated that the significantly ($P<0.05$) higher weight at the end of lactation was consistent with the significantly ($P<0.05$) high total feed intake, the smaller litter size and the higher per caput feed intake per litter mate on the 22% CP diet. These results agree with the findings (Yahaya, 1993; Smith and Somade, 1994) that maternal nutrition was important for neonatal survival of rabbits.

3.3 Cost to Gain Ratio

The indication was that protein supplementation was most cost effective on the 22% CP diet. The cost of diet consumed per unit weight gain was lowest (N4.13/g) on the 22% CP diet but comparable to that (N4.62/g) of the 10% CP diet. The negative cost to gain ratio for the 14 and 18% CP diets reflected the negative weight changes (i.e. weight loss) among the lactating grasscutters.

4. Conclusion

It is, therefore, concluded that the optimum crude protein requirement for lactating grasscutters fed agro-industrial by-products, soybean and wheat offal, is 22% CP.

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