

# Influence of Three Protein Sources on Performance of Grasscutters (*Thryonomys swinderianus*) Fed Diets with or without Fishmeal

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**Abstract:** An 8-week feeding trial was conducted to assess the effect of soybean meal (SBM), groundnut meal (GNM) and blood meal (BM) addition in diets with or without (1%) fishmeal on the performance, N-digestibility and cost of production of growing grasscutters. Fifty-four grasscutters (9-week-old) of mixed sexes were randomly assigned to six dietary treatments, using a completely randomized design (CRD) in a  $2 \times 3$  factorial arrangement, with three grasscutters per treatment and three replicates each. Treatments 1-3 (T<sub>1</sub>-T<sub>3</sub>) contained no fishmeal, whilst treatments 4-6 (T<sub>4</sub>-T<sub>6</sub>) had 1% fishmeal added. The diets were formulated to be isocaloric and isonitrogenous. N-digestibility was significantly high for SBM diets with or without fishmeal, 83.91% and 82.19%, respectively, followed by BM diets. Average daily gain (ADG) was significantly ( $P < 0.05$ ) high (12.95 g) for BM diet without fishmeal. Feed cost per kg diet was the lowest (US\$0.195) for the same BM diet. The results indicated that the inclusion of SBM and BM in the diet of grasscutters with or without 1% fishmeal could improve performance and it may be the most economical for feeding BM in the diet without fishmeal.

**Key words:** Alternative feed, digestibility, economic viability, fishmeal, greater cane rat, protein sources.

## 1. Introduction

The backyard rearing of greater cane rat also known as grasscutter (*Thryonomis swinderianus*) provides income for smallholder farmers and also upgrades the diet of poor rural and urban households. Grasscutter rearing fits well into household production as investment, and labour costs are low. Being herbivores, grasscutters do not compete with humans for food. They consume nuts, bark of trees and soft parts of grasses and shrubs. However, they prefer, particularly, elephant grass (*Pennisetum purpureum*) and sweet potatoes [1]. The economic potential of

their meat is high within the West Africa sub-region and has an extensive market due to its high demand. The meat of grasscutter is preferred by most people in the sub-region, comparison to that of every other kind of domestic livestock and commercially available game, because of its excellent taste and nutritional value (low fat, low cholesterol, rich in protein, vitamins and minerals) [1]. Grasscutters are highly productive, as they have a short gestation period and are highly prolific. Agboola [2] reported that, for grasscutters raised in confinement to be in good health, reproduce and maintain a steady growth rate, they must be provided a balanced diet. The presence of fishmeal in a complete diet will correct any

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deficiencies of amino acids in vegetable protein [3]. However, fishmeal is expensive.

Soybean meal (SBM) has been used widely in monogastric diets and has one of the highest levels (47.6%) of essential amino acids among the common plant proteins used in animal feeds [4]. Blood meal (BM) and groundnut meal (GNM) have also been used, but all the three have not been extensively used to feed growing grasscutters, which are monogastric herbivores. GNM is the residue from extraction of oil from groundnut. It is normally the richest source of vegetable protein food containing about 45%-50% crude protein and about 5%-7% cellulose. The protein of GNM has sub-optimal amounts of lysine and methionine. As a source of the essential amino acid lysine, it is however inferior to SBM [5]. A more detailed study of these by-products could lead to the improved performance as well as cutting down on feed cost in the domestic rearing of grasscutters. The aim of the study was to identify protein sources that could replace fishmeal, improve performance as well as cut down on production cost.

## 2. Materials and Methods

### 2.1 Animals and Experimental Procedure

A total of 54 grasscutters of nine weeks of age, with a mean body weight of  $3,570 \pm 2.1$  g, treated for both internal and external parasites, were used in a completely randomized  $3 \times 2$  factorial design feeding trial over an eight week period. The factors were three protein sources—SBM, GNM and BM, and two levels of fishmeal (0% and 1%). There were six dietary treatments (Table 1) and three replicates per treatment with three animals each. The treatments were designated as T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> for SBM, GNM and BM with 0% fishmeal, respectively, and T<sub>4</sub>, T<sub>5</sub>, T<sub>6</sub> for SBM, GNM and BM with 1% fishmeal, respectively. The grasscutters were housed in wire battery designed cages (0.5 m  $\times$  0.5 m), which allowed for ease of faeces and urine collection. Feed and water were given to the animals *ad libitum* throughout the

experimental period. The grasscutters were allowed one-week adaptation period to both the feed and cage before the 8th weeks of data collection commenced. The pens, feed and water troughs were properly cleaned and disinfected. Thereafter, the feed and water troughs were cleaned on a daily basis before the administration of the allocated feed and water. The animals were supplied with fresh, clean drinking water every day.

### 2.2 Data Collection

The body weight of each animal was taken prior to the beginning of the experiment (at the start) and 12 h after withdrawal of feed (at the end). The mean of the initial and final weight of the replicate grasscutters represented the initial and final live weights. The average daily gain (ADG) was obtained by dividing the mean weight with the total number of days for the experiment (56 d). Feed conversion ratio (FCR) was calculated as the weight of feed of the grasscutters consumed over a unit live weight. This was done on weekly basis, and the FCR for the whole experimental period was determined by using the values obtained on weekly basis. On each of the intake measurement days (days 15-21), samples of feed offered and feed refusals were weighed daily for measuring voluntary feed intake, dry matter (DM) and N [6]; all the faeces voided daily for each animal were also collected, weighed and mixed, and samples of about 20% of total fresh weight of the faeces were dried in a hot air oven (60 °C) for 48 h and the dried samples analyzed for DM and N [6]. The urine was also measured and aliquots taken for each animal daily, and stored frozen at -20 °C pending chemical analysis for urine-N, which would subsequently be used for N-balance and apparent whole tract nitrogen digestibility determination. To ensure that the pH of the urine was less than 3 to avoid loss of nitrogen, 100 mL of 0.2 N HCl was added. The feed cost was calculated as the total cost of ingredients per kg of diet for each of the six treatments.

**Table 1** Composition of the experimental diets.

Ingredients	0% fishmeal			1% fishmeal		
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>	T <sub>6</sub>
Fishmeal	0.0	0.0	0.0	1.0	1.0	1.0
Maize	36.0	38.5	42.2	38.0	37.0	41.0
SBN	11.5	-	-	10.0	-	-
GNM	-	10.5	-	-	9.0	-
BM	-	-	5.0	-	-	4.0
Wheat offal	9.0	8.0	12.0	7.0	8.0	12.0
PKC	20.0	20.0	20.0	20.0	20.0	20.0
Maize bran	19.5	19.0	17.0	20.0	21.0	18.0
Bone meal	2.5	2.5	2.5	2.5	2.5	2.5
Oyster shell	1.0	1.0	1.0	1.0	1.0	1.0
Salt	0.3	0.3	0.3	0.3	0.3	0.3
Vitamin premix	0.2	0.2	0.2	0.2	0.2	0.2
Total	100.0	100.0	100.0	100.0	100.0	100.0
Calculated values						
CP (%)	14.1	14.0	14.0	14.0	14.1	14.0
ME (kcal/kg)	2,802.2	2,803.4	2,801.4	2,801.4	2,802.0	2,801.6

PKC: palm kernel cake; CP: crude protein; ME: metabolizable energy.

**Table 2** Effects of three protein sources with or without fishmeal on growth performance of grasscutters, nitrogen digestibility and nitrogen balance values.

Parameters	0% fishmeal			1% fishmeal			LSD	Significance
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>	T <sub>6</sub>		
Mean daily feed intake (g)	22.03 <sup>c</sup>	23.86 <sup>bc</sup>	28.40 <sup>ab</sup>	22.27 <sup>c</sup>	27.85 <sup>ab</sup>	29.05 <sup>a</sup>	4.56	*
ADG (g)	11.62 <sup>ab</sup>	8.93 <sup>b</sup>	12.95 <sup>a</sup>	12.44 <sup>ab</sup>	9.52 <sup>b</sup>	12.70 <sup>ab</sup>	2.24	*
FCR (feed/gain)	1.90 <sup>de</sup>	2.67 <sup>ab</sup>	2.19 <sup>cd</sup>	1.78 <sup>e</sup>	2.93 <sup>a</sup>	2.31 <sup>bc</sup>	0.40	*
Feed cost/kg (US\$)	0.205	0.199	0.195	0.215	0.205	0.205	-	
Nitrogen digestibility (%)	95.65 <sup>a</sup>	76.53 <sup>b</sup>	79.00 <sup>b</sup>	91.78 <sup>a</sup>	77.42 <sup>b</sup>	78.95 <sup>b</sup>	6.12	*
Nitrogen balance (g/kg)	3.80 <sup>d</sup>	7.20 <sup>a</sup>	6.30 <sup>bc</sup>	6.00 <sup>c</sup>	7.10 <sup>ab</sup>	5.70 <sup>c</sup>	0.90	*

FCR: feed conversion ratio; LSD: least significant difference. Means in the same row followed by different letters are different by LSD test ( $P < 0.05$ ). \* means significant difference at  $P < 0.05$ .

### 2.3 Statistical Analysis

The data obtained from the intake and digestibility measurements were subjected to analysis of variance (ANOVA) using GenStat version 7.22 [7] for windows 7, and differences between treatment means were detected using the least significant difference (LSD) test at the 5% significant level.

## 3. Results

A summary of the growth performance of the experimental grasscutters fed diets containing three protein sources with or without fishmeal, as well as the nitrogen digestibility and nitrogen balance values are presented in Table 2.

### 3.1 Feed Intake

Feed intake was numerically higher for the 1% supplemented fishmeal diets T<sub>4</sub>, T<sub>5</sub> and T<sub>6</sub> as compared to those without fishmeal T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>. Intake was significantly ( $P < 0.05$ ) higher for BM diets (T<sub>3</sub> and T<sub>6</sub>) than SBM diets (T<sub>1</sub> and T<sub>4</sub>). Intake of BM diets with or without fishmeal was significantly high, whereas the intake of SBM diets with or without fishmeal were significantly ( $P < 0.05$ ) low.

### 3.2 Growth Rate

ADG of grasscutters fed BM diet without fishmeal (T<sub>3</sub>) was significantly ( $P < 0.05$ ) higher compared to those in treatments T<sub>2</sub> and T<sub>5</sub> and similar with T<sub>4</sub> and

T<sub>6</sub>. From Table 2, the ADG of grasscutters on dietary treatments T<sub>4</sub> and T<sub>6</sub> were not significantly ( $P > 0.05$ ) different from each other, however, those on dietary treatments T<sub>2</sub> and T<sub>5</sub> were similar and significantly ( $P < 0.05$ ) lower.

### 3.3 FCR

The efficiency with which feed was converted to body weight was significantly ( $P < 0.05$ ) higher for grasscutters fed on GNM diet than SBM.

### 3.4 Feed Cost Analysis

Feed cost was marginally the lowest for BM without fishmeal diet T<sub>3</sub> (US\$0.195/kg) and the highest for SBM with 1% fishmeal diet T<sub>4</sub> (US\$0.215/kg). In terms of feed cost, the protein sources had no major impact on the prices of feed. The BM and GNM based diets were comparable, costing US\$0.195/kg and US\$0.199/kg, respectively; but SBM diets were the most expensive, costing US\$0.205/kg, even though still comparable ( $P > 0.05$ ). The diets without fishmeal supplementation tended to be slightly cheaper than those with the 1% fishmeal inclusion (US\$0.205/kg, US\$0.199/kg and US\$0.195/kg, respectively). Feeding BM in the diet without fishmeal was the cheapest US\$0.195/kg of diet.

### 3.5 Apparent Whole Tract Nitrogen Digestibility and Nitrogen Balance

Retained nitrogen was similar and significantly ( $P < 0.05$ ) higher for T<sub>2</sub> and T<sub>5</sub> than T<sub>1</sub> and T<sub>4</sub>. Apparent nitrogen digestibility was significantly ( $P < 0.05$ ) higher for T<sub>1</sub> (95.65%) and T<sub>4</sub> (91.78%) than the values for T<sub>2</sub>, T<sub>3</sub>, T<sub>5</sub> and T<sub>6</sub>, which were all similar to one another.

## 4. Discussion

The energy contents of the six experimental diets (Table 1) were compared favourably with the values of 2,801-2,805 kcal/kg suggested by Mensah and

Okeyo [8] for the grasscutter species. BM, which is an animal protein source, has been shown to be high (80%) in crude protein and uniquely rich in lysine, which is three times of the level in SBM [9] and this might have contributed to the better weight gain (12.95 g) obtained for the grasscutters fed BM. Protein, as a nutrient, is responsible for growth and muscle building. BM is reportedly poor in protein quality [10]. This is in reference to its amino acid profile. BM is deficient in isoleucine. Spreadbury [11] reported that feed intake is a reflection of protein quality. The grasscutters, in this study, might have increased the intake of BM diets to make up for the amino acid deficiencies.

The dry matter intakes obtained in the present study were lower than 89-124 g reported by Annor et al. [12] and 61-65 g obtained by Obi et al. [13]. This may be due to the fact that in the earlier studies, the experimental grasscutters were fed forages. On concentrate diets, the animals do not need to consume high amounts of feed to meet their nutrient requirements. The nitrogen digestibility results showed that the grasscutters fed SBM recorded the best N-digestibility values (95.65% without fishmeal and 91.78% with 1% fishmeal, respectively). Grasscutters fed GNM and BM registered lower digestibilities of 76.53% and 79.00%, respectively.

## 5. Conclusions

The inclusion of SBM and BM with or without 1% fishmeal in the diet for growing captive grasscutters could improve performance compared with those fed GNM. Furthermore, it may be the most economical feeding BM in the diet without fishmeal.

## Acknowledgments

The authors are grateful to the Directorate of Animal Production, Nungua Livestock Breeding Station, Ministry of Food and Agriculture, Accra-North, Ghana for providing animals for the study.

## References

- [1] Food and Agriculture Organization (FAO). 2001. *World Watch List for Domestic Animal Diversity*.
- [2] Agboola, P. O. 2000. "Grasscutter Farming." Presented at Seminar of Forest and Wildlife Conservation Division, Forestry Research Institute, Ibadan, Nigeria.
- [3] Miles, R. D., and Jacob, J. P. 1997. "Fishmeal: Understanding Why This Feed Ingredient Is So Valuable in Poultry Diets." University of Florida Cooperative and Extension Service, Institute of Food and Agricultural Sciences. Accessed March 2011. <http://ufdc.ufl.edu/IR00004264/00001>.
- [4] Fualefac, D. H., Kenfack, A., Ngoula, F., Awah-Ndukum, J., Manfouo, Z., and Tchoumboué, J. 2014. "Effect of Graded Levels of Full-Fat Toasted Soya Bean Meal (*Glycine max*) on the Performance of Grower Cane Rats (*Thryonomys swinderianus*) under Captivity." *International Journal of Science and Technology* 3 (8): 475-8.
- [5] Say, H. 1995. "The Influence of Lysine and Methionine on the Net Energy Value of Diets for Growth in Pigs." *Livestock Production Science* 9: 569-80.
- [6] Association of Official Analytical Chemists (AOAC). 1990. *Official Methods of Analysis*, 15th ed.. Washington, DC: AOAC.
- [7] GenStat. 2008. *GenStat Release 7.22 Discovery*, 3th ed.. UK: VSN International Limited, GenStat Cooperation.
- [8] Mensah, G. A., and Okeyo, A. M. 2005. "Continued Harvest of the Diverse African Animal Genetic Resources from the Wild through Domestication as a Strategy for Sustainable Use: A Case of the Larger Grasscutter (*Thryonomis swinderianus*)." International Livestock Research Institute, Swedish University of Agricultural Sciences. Accessed March, 2012. [http://agtr.ilri.cgiar.org/index.php?option=com\\_content&task=view&id=177&Itemid=199](http://agtr.ilri.cgiar.org/index.php?option=com_content&task=view&id=177&Itemid=199).
- [9] Crawshaw, R. 1994. *Blood Meal: A Review of Its Nutritional Qualities for Pigs, Poultry and Ruminant Animals*. United Kingdom: Nutritional Renderers Association Technical Review.
- [10] Pond, W. G., Church, D. C., and Pond, K. R. 1995. *Basic Animal Nutrition and Feeding*, 4th ed.. Canada: John Wiley and Sons, 74, 453.
- [11] Spreadbury, D. 1978. *Animal Nutrition*. New York: John Wiley and Sons, 290-9.
- [12] Annor, S. Y., Kanya-Agyemang, J. K., Abbam, J. E. Y., Oppong, S. K., and Agoe, I. M. 2008. "Growth Performance of Grasscutter (*Thryonomys swinderianus*) Eating Leaf and Stem Fractions of Guinea Grass (*Panicum maximum*)." *Livestock Research for Rural Development* 20 (8): 125.
- [13] Obi, O. O., Omole, A. J., Ajasin, F. O., and Tewe, O. O. 2008. "Nutritive Potentials of Four Conventional Forages Fed to Growing Grasscutter (*Thryonomys swinderianus*)." *Livestock Research for Rural Development* 20 (11): 179.