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Effects of Pelleted Feed on the Performance of the Grasscutter *(Thryonomys swinderianus)*

Swallah Abdul Majid Marani*
University of Education Winneba, Mampong, Ashanti, Ghana

***Corresponding author:** Marani MAS, University of Education Winneba, Mampong, Ashanti, Ghana, Tel: +233322053616; E-mail: majidmaranilz@gmail.com

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Abstract

The research was conducted to evaluate the effect of pelleted feed (PF) on the performance of the grasscutter (*Thryonomys swinderianus*). The work was carried out at the grasscutter unit of the University of Education, Winneba, Faculty of Agriculture Education, Mampong-Ashanti. The experiment lasted for sixteen (16) weeks starting from the 27th November 2012 to 2nd March 2013. A total of fourteen (14) post weaned grasscutters with average live weight of 842 grams, comprising eight (8) males and six females were allocated to three treatments with three replications in a Randomized Complete Block Design (RCBD). Three dietary treatments were formulated to contain 17.13, 18.3 and 20.33 crude protein. In T1, the protein was derived from plant source and concentrate. In T2 (Pelleted), the protein was derived from plant sources only. In T3 (Pelleted), the protein was derived from plant sources and urea. Water was supplied ad-libitum. The parameters measured were; feed intake, initial weight, final weight, weight gain, feed conversion ratio, carcass traits, haematology and feed wastage. Feed intake was significantly ($P<0.05$) affected by the experimental diets. However, feed intake in T1 was extremely higher in the experimental diets. Mean daily weight gain was not significantly ($P>0.05$) affected by dietary treatments. Grasscutters fed on T1 diet had the highest weight gain though not significantly different ($P>0.05$) from T2. Mean final body weight of grasscutters followed a similar pattern to mean daily weight gain. Feed conversion ratio (FCR) was not significantly ($P>0.05$) affected by the dietary treatments. However, grasscutters fed on diet T2 were marginally more efficient in converting feed to gain than those fed on other dietary treatments. Dietary treatments significantly ($P<0.05$) influence the protein content among animals fed on T3 but not significant ($P>0.05$) influence on animals in T1 and T2. Grasscutters fed on diet T2 had the highest protein content in their meat. Percentage fat content of grasscutters followed a similar pattern as percentage protein. Ash content was not significantly ($P>0.05$) affected by the diets. Apart from the heart, empty intestine, spleen and kidney weights which were not significantly ($P>0.05$) affected by the dietary treatments. The diets significantly ($p<0.05$) affected other carcass characteristics that were measured in all the treatments. Also, apart from mean cholesterol and platelet which were affected ($P<0.05$) by the diets, other blood parameters were not significantly ($P>0.05$) affected by the dietary treatments. Daily feed wastage was significantly ($P<0.05$) affected by the experimental diets. However, feed wastage was extremely higher in T1 when compared with T2 and T3. Analysis on feed wastage revealed that feeding pelleted diets resulted in reduced feed wastage. It was concluded that feeding grasscutters with Pelleted feed (PF) as a replacer for non-pelleted diets may not affect the growth, carcass and blood characteristics of the grasscutter. However, there will be improved feed and a minimum feed wastage by grasscutters therefore boosting the economic gains of the production.

Keywords: Protein; Grasscutter; Pellet feed; Hematology

Introduction

Background information

The grasscutter (*Thryonomys swinderianus*) is a non-ruminant wild herbivorous rodent which belongs to the class mammalian and order rodentia. It originates from Africa. The grasscutter is found in the sub-Saharan Africa wherever the grass species they prefer for food are located. Captive rearing of the grasscutter has been identified as a potential source of income and employment and an important source of animal protein for both rural and urban people. The intake of animal protein of an average adult in the sub-region is estimated at 15% of the total per capita protein intake as against average intake of 55% for his European counterpart. This is below the recommended minimum daily protein requirements of 70-80 g of which 50% should be of animal origin [1-3].

In an attempt to address this shortfall, households have undertaken food production which involves not only the cultivation of rice and corn which are basic staple food but also the production of food rich in protein to keep them healthy and resistant to disease. Although the importation of animal protein sources has increased dramatically since independence, there is less meat available per capita. If the deficiency in the national diet is to be reversed, then additional animal protein food will have to be imported or produced locally. Grasscutter meat is considered a delicacy and many West African sub-regions relish it. However, feeding the rodent still remains a challenge since farmers apparently find it difficult to feed them especially during the dry season [2,4].

Problem statement

The key to successful grasscutter (*Thryonomys swinderianus*) domestication is proper feeding combined with good health and maintenance measures. But the study of the grasscutter in Ghana is a relatively young scientific discipline. Therefore, the local farmers in

Ghana do not have adequate scientific information about the animal in terms of behavior, feeding, watering and reproductive development.

Grasscutters are fed on forages including *Pennisetum purpureum* (elephant grass), *Panicum maximum* (guineagrass), *Saccharum* spp (sugar cane); herbaceous legumes like *Stylosanthes* spp (stylo) and *Pueraria phaseoloides* (tropical kudzu). However, some of these gramineous species especially the *Pennisetum purpureum* (elephant grass) and *Panicum maximum* (guinea grass) are found to have low protein and vitamin levels and when fed to grasscutters account for high wastage of the feed. According to Schrage and Yewadan, about 70-80% of the feed fed to grasscutter goes waste and only about 20% is utilized by the rodent. This calls for the production of pellet feed to help curb the wastage and also improve upon the nutritional composition of the grasscutter feed [5,6].

Benefits of the study

It is the hope of the researchers that the study will encourage grasscutter farmers to use pelleted feed in all areas of grasscutter production in Ghana so that feed wastage by the rodent is curbed and improve on the nutrition of the feed. It will also serve as an opportunity for most pellet feed producers to produce more inorder to maximize profit. It will also make the packaging, handling and transportation of the pellet feed easier as this will help reduce the bulky nature of grasses and losses will be reduced.

Objective of the study

The main objective of this study was to find the effect of pelleted diets on the performance of the grasscutter (*Thryonomys swinderianus*).

Specific objectives

- The specific objectives of the experiment were to evaluate the effect of pelleted diets on:
- The growth performance of grasscutters.
- The carcass characteristics of grasscutters.
- The haematological parameters of grasscutters.
- The feed wastage of grasscutters.

Literature Review

The grasscutter

The grasscutter (*Thryonomys swinderianus*) is a wild herbivorous rodent which belongs to the class mammalian and order rodentia. It originates from Africa. The grasscutter occurs throughout the sub-Saharan Africa wherever the grass species they prefer for food are available. They do not inhabit in rain forest, dry scrub or dessert but often live in forest clearings area where adequate grass is present. There are different breeds of grasscutters, the giant (*Thryonomys swinderianus*) and small/medium grasscutter called (*Thryonomys gregorianus*). They differ in color, body size, weight, number of teats and head shape. In West Africa, the giant grasscutter is mostly used on commercial bases. In West Africa, where grassland provides its main habitat and food, it is commonly known as the "grasscutter" or "cutting grass" while in other parts of Africa, particularly Southern Africa, where it is closely associated with cane fields, it is known as "cane rat" [2].

Unique biology of the grasscutter

Grasscutters are vigorous animals, with short stocky legs, a relatively short tail, with coarse, bristly and even spiny hairs which look like short soft quills. They also may have yellow-brown bodies with whitish bellies. The fur is extremely coarse, firm and bristly, reflecting the animal's kinship to the porcupine. It is heavy, compact and the largest African rodent after the porcupine (*Hystrix cristata*). The digestive system is remarkable for its adaptations, by employing the caecum as the main fermentative site which is often associated with coprophagy. This habit has been recognized in horses, rabbits, guinea pigs and the African giant rat. The large intestine consists of the colon, the caecum and the rectum. The caecum is the most significant portion of the large intestines which defines the nutritional physiology of the grasscutter. The digestibility of fibre (i.e., neutral detergent fibre, NDF) is estimated to be 58.5% compared to 21% for the rabbit. The grasscutter is more efficient at fibre digestion than the guinea pig [2,6].

Promotion of grasscutter farming in Ghana

Bushmeat (meat from wild animals) contributes substantially to meat consumption in rural and urban areas. For many rural and urban people in West Africa, it is highly valued forest product. Bushmeat constitutes an important source of animal protein in diets of both rural and urban household. It is an evidence that bushmeat has been and still is a major food item (contributing from 20% to 90% of the total animal protein consumed) for most rural dwellers. Grasscutter meat is an important non-traditional export commodity and could become even more important as a foreign exchange earner for the country if more value was added to its processing and packaging. Farming of grasscutters could serve as a means of conserving the environment. It has been reported that if grasscutter farming was intensified, the demand for bush meat could be met without undue pressure on the environment [2,4,7].

Domestication of grasscutter

Grasscutter domestication can be defined as the production process of a captured species under complete control of man. It is the most difficult aspect of grasscutter rearing. Mensah stated that, as a general rule, adult and sub-adult grasscutter takes a much longer time to be tamed than the young ones. A grasscutter reportedly takes about a month to adjust to confinement. During the first few weeks of life in captivity, in an attempt to escape, the grasscutter injures itself on the wire mesh or walls of the cage, they bang onto to and fro and eat just very little during this transition period. For the purpose of domestication, proper handling of grasscutter is very important to ensure least possible stress for the animal and also avoid all risks of cuts, bites and bruises. It is very important to know how to handle grasscutters in the right way [4,8].

Schrage and Yewadan [6], made the following recommendations for handling grasscutters:

- Approach the animal gently and confidently with either a sudden movement or hesitation.
- The animal should be held by the tail, rum and scruff.
- Once the animal is grasped, it should be held firmly but not so tightly as to suffocate it.

Actogram for the grasscutter in captivity

Generally, the grasscutter is a nocturnal animal, i.e., most of its life activity is carried out at night. According to Birchfield et al. [9] the actogram for the grasscutter in captivity is as shown (Table 1).

Time	Activity
00.00-05.00	Rest
05.00-07.00	Rest, coprophagy and sanity
07.00-09.00	Grooming, play and feeding
09.00-10.00	Rest
10.30-12.00	Feeding
12.00-18.00	Watering, suckling and rest
18.00-22.00	Feeding
22.00-24.00	Watering and rest

Table 1: Actogram for the grasscutter in captivity. Source: [9].

Feeds and feeding of grasscutter

The idea of feeding an animal in captivity is to provide it with a balance combination of nutrients for optimum productivity, be it meat production or milk production or some other product of interest. The grasscutter is selective in its feeding and prefers the most succulent portion of graminaceous plants. This feeding habit, though makes available a better food to animal than the feed on offer, it also results in a lot of wastage [2]. Table 2 shows food items used in the grasscutter industry.

Type	Name	Scientific Name
Leafy material	Cassava	*Manihot esculenta*
	Guinea grass	*Panicum maximum*
	Elephant grass	*Pennisetum purpereum*
	Spear grass	*Heteropogon contortus*
	Plantain pseudo-stem	*Musa paradisiacal*
	Fresh groundnut tops	*Arachis hypogea*
	Fresh maize stover	*Zea mays*
	Centro	*Centrism pubescen*
	Sweet potato	*Ipomea batatas*
	Cane sugar	*Saccharum officinarium*
	Oil palm seedlings	*Elacis guinensis*
	African marigold	*Aspilia africana*
Tubers and Underground stems	Spear grass	*Heteropogon contortus*
	Cassava	*Manihot utilissima*
	Yam	*Dioscorea spp*
	Sweet potato	*Ipomea batatas*
Fruits and grains	Mango (unripe)	*Mangifera indica*
	Oil palm	*Elaeis guinensis*
	Pineapple	*Ananas sativa*
	Maize	*Zea mays*
Miscellaneous	Wheat bran	---------

Table 2: Food items used in the grasscutter industry. Source: [2].

Nevertheless, fodder like elephant and guinea grass remains the basic feed of the grasscutter. Grasscutters prefer to gnaw hard feed; hence the ingredients listed above could be compounded and pelleted for the animals. Pelleted feed for grasscutters constituting 70% forage, 20% concentrate, 1% oyster shells, 0.5% salt and 0.5% termite hill with cereal flour or cassava dough (2.5%) as binders has been reported. The work of Ewer throws light on the chemical composition of the elephant grass and guinea grass in as shown in Table 3 [10,11].

Composition	Elephant grass	Guinea grass
Dry matter	20	23.3
Nitrogen matter	11.5	10.3
Fat	1.1	3.1
Raw cellulose	33.9	34.7
Minerals	7.2	11.9
Calcium	0.3	0.4
Phosphorus	0.4	0.2

Table 3: Nutrient composition of elephant and guinea grass. Source: [2].

Feed intake of the grasscutter

Feed intake refers to the amount of feed eaten by an animal or group of animals during a given period during which they have free access to feed. Non-ruminants increase their feed intake in response to an increase in demand for energy, exercise and for countering extreme cold stress. Appetite is driven by the need for energy in all species of livestock, so the dry matter/feed intake of animals is dependent on the energy density of the ration. Animals will eat fewer grams of dry matter/feed of high energy density than they will derive from rations of low energy density because it will take less dry matter/feed from high-density rations to meet their energy requirements [12-14] (Table 4).

Water

A common assumption is that the grasscutter does not drink water and can completely satisfy its water requirement from the fresh forage diet. This practice however causes a higher still-birth rate (12.3% to 1.5%) and a low birth weight (98 g to 129 g). Availability of water is of critical importance, particularly during pregnancy and lactation [2,15].

Individual	Fodder	Feed supplement
Young grasscutter	100-150	10-150
Adolescent	150-250	50-100

Adult	250-400	100-200

Table 4: Feed intake (g) per grasscutter per day. Source: [4].

Feed conversion efficiency of grasscutters

Grasscutters fed with protein concentrate improve feed conversion efficiency (FCE), thereby resulting in faster growth. Dry matter intake of 269.94 g/day for grasscutters fed on guinea grass was reported. Daily dry matter intakes of grasscutters fed on elephant grass were reported as 400.40 g, 370.20 g, 371.14 g and 374.20 g. Grasscutters fed on diets containing 15%, 17%, 19% and 21% protein, daily dry matter intake was reported as 178.02 g, 202.97 g, 244.01 g and 262.05 g respectively [15-17].

The digestive system of the grasscutter

According to Skinner and Smithers, the grasscutter is a monogastric herbivore. This means that it can thrive on the feed that is eaten by monogastric animals as well as feed eaten by ruminants. The digestive system of the grasscutter (Figure 1) is unique because it has an enlarged caecum, which is part of the large intestine. The grasscutter possesses a simple stomach (Figure 1). It is relatively small in relation to the animal, with a thin wall, inverted J-shaped and relatively distended sac-like when full. Viewed from the exterior, the stomach is divided into the cardia (entrance), fundus and pylorus (terminus), the cardia and pylorus being sphincters controlling the passage of feed through the stomach. The small intestine comprises the duodenum, jejunum and the ileum. The large intestines consist of the caecum, the colon and the rectum (Figure 1). The caecum is slightly longer than the stomach and it is the largest organ in the abdominal cavity, like that, of the horse. The caecum of the grasscutter occupies about 60 percent of the abdominal cavity and harbors microbial organisms for efficient fermentation and utilization of fibrous diets. The colon is the longest segment of the gastrointestinal tract with a wide lumen and it contains the faecal balls. The rectum is relatively short and straight and terminates at an enlarged region, the anal orifice [1,6,18,19].

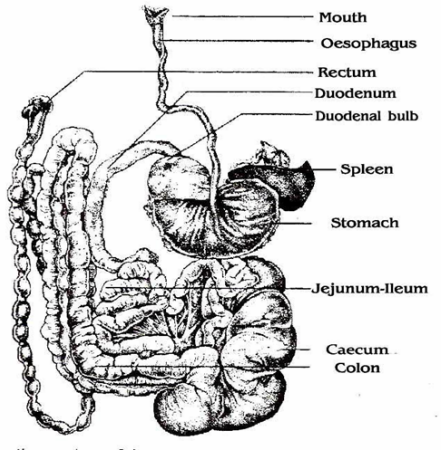

Figure 1: Digestive System of the Grasscutter. Source: [6].

Growth rate of the grasscutter

A major concern of any animal farm enterprise is knowledge about the nutrition of the animal as this directly affects its growth and survival. Grasscutter which are home raised average mature weight is 4-5 kg and slaughtered carcass yield per animal is about 2.5-3 kg. Grasscutter growth depends on the feed given and maintenance practices. A report of 7.1 g weight gain per day of grasscutter was made by Karikari and Nyameasem. The grasscutter makes excellent use of low-grade feed. Average rate of 15% to 18% crude protein value and 10% to 18% crude fibre are recommended for grasscutter feed. Ajayi and Tewe and Adeola reported that the mature live-weight of grasscutter is 4.30 kg-6.83 kg and 5.0 kg-8.0 kg respectively. Annor et al. reported a daily weight gain of 3.28 g and a total weight gain of 275 g for grasscutters fed on guinea grass. Karikari and Nyameasem reported a weight of 7.1 g gain by grasscutter per day [2,15,20-24].

Carcass characteristics of grasscutter

Many parameters are used to evaluate the carcass traits of farm animals. Some of these parameters include (a) trimmable or omental fat which is the fat deposited or attached to offals which partly determines the dietetic and sensory quality traits of meat (b) weight of organs (c) meat color and flavor. Animals that are young have a lower dressing percentage than older animals because, as the animal becomes older and gains in weight, the proportion of the viscera to the rest of the body decreases. Gillespie identifies factors that affect dressing percentage in animals as amount of gut fill, weight of animal, degree of muscling and degree of fatness. According to Ajayi and Tewe the carcass of grasscutter is low in fat, comparatively high in protein (19%-23%) compared with beef, mutton and pork with protein content of 19.35%, 16.80% and 19.25% respectively [23,25-27].

Meat quality of the grasscutter

The grasscutter is a prominent and steady source of alterative dietary animal protein in many rural areas of Nigeria and other West African countries like Benin, Ghana, Togo, Cote D' voire. It is reported that the grasscutter meat is of high protein quality, but lower fat content than the meat from cattle, sheep and goat and is greatly appreciated for its tenderness and taste. The approximate composition (%) and mineral content (mg 100 g^{-1}) of the grasscutter meat in relation to that of other domesticated animals' meat is shown in Table 5. In Ghana, grasscutter is an important source of animal protein and the rest of West Africa. The meat is appreciated because of its culinary properties (Table 5) with high protein, calcium, phosphorous and moisture contents. The relatively low-fat content makes the grasscutter meat a choice meat for patients with cardiac problems [4,5,15,17,22,23].

Meat	Moisture	Ash	Protein	Fat	Fe	Ca	P
Beef	73.8	1	19.6	6.6	5.1	3.9	57
Mutton	78.5	1	17.2	2.9	3.1	9	80
Pork	64.8	0.9	19.4	13.4	1	3	72
Grasscutter	72.3	0.9	22.7	4.2	2.8	8.3	111

Table 5: Proximate composition (%) and mineral content of the grasscutter meat in relation to another domestic animal meat. Source: [22].

Haematology of the grasscutter

Studies have shown that certain factors influence the haematological parameters of animals. Haematological analyses of an animal's blood represent a good diagnostic acid for the assessment of physiological, nutritional and pathological conditions of animals. Nutrition, age, sex, genetics, reproduction, housing, starvation, environmental factors, stress, transportation and diseases are known to affect haematological and biochemical values and thought to play major roles in the differences in haematological and biochemical parameters observed between tropical and temperate animals. Ogunsanmi et al. determined the haematological, plasma biochemical and whole blood electrolytes profile in the normal live-captive and rehabilitated adult African grasscutters. They reported no statistical evidence of sexual dimorphism in the values of theses parameters of the cane rat, except plasma alanine transaminase (ALT), which was significantly higher ($p<0.001$) in the males than in the females [28-32].

Pellet feed (PF)

Definition of pellet feed: Pellet feed is any feed material which is processed by forcing and shaping the feed through die with specific dimensions of openings and thickness. The aim of pelleting feed is to obtain feed with optimized physical and nutritional quality in order to meet the requirement for specific animal category (in terms of better feed intake and improved nutritional value) [33].

Making of good pellets: Although, it is generally recognized that good pellet quality improves feeding efficiency, growth, and uniformity of animals. The level of quality is generally dictated by economics. However, feed with good physical quality is always too expensive. Many variables affect the pelleting process, including weather, meal moisture, and ingredient source. Evaluation of pelleting factors over a short period of time minimizes some of these uncontrolled variables. Variables that cannot be eliminated (conditioning temperature, pelleting amperage) must at least be accounted for [34].

Qualities of good pellets: As a rule, feeding pellet feed improves animal performance and feed conversion compared with feeding a meal form of a diet. According to Behnke, the improvements in performance have been attributed to:

- Decreased feed wastage.
- Reduced selective feeding.
- Decreased ingredient segregation.
- Less time and energy expended for prehension.
- Destruction of pathogenic organisms.
- Improved palatability.

It is not always easy to make a good quality pellet. Research and practical findings on commercial farms with good quality pellets, feed conversions were always better than when the feed was fed as mash or had a high percentage of fines. Grasscutters do not eat fines at all. In contrary, fines may even cause health problems. Grasscutters are very sensitive to respiratory problems. When for example, dusty pellets are fed; the dust is easily inhaled, which can cause respiratory problems [33,35].

Materials and Methods

Location of the study area

The experiment was carried out at the grasscutter section of the Department of Animal Science Education, University of Education, Winneba, Ashanti-Mampong. Geographically, the area is within the Transitional zone lying between the Guinea savanna in the North, and the Tropical forest in the South. Mampong lies on 07°03° North and longitude 01°24° West. The experiment which lasted for sixteen weeks begun on 27th November 2012 to 2nd March 2013 [36].

Experimental design

A total of fourteen (14) post weaned grasscutters with average live weight of 842 grams comprising eight (8) males and six (6) females were allocated to three treatments with three replications in a Randomized Complete Block Design (RCBD). Each grasscutter was confined in individual cage.

Experimental diets

Three (3) experimental diets were formulated such that diet 1 which served as the control diet contained elephant grass with concentrate (non-pelleted), diet 2 and 3 contained plant protein (Pelleted), and plant and urea protein source (Pelleted), and designated as T1, T2, and T3 diets respectively (Table 6).

Feed Ingredients		**Percent Level**	
	T1%	T2%	T3%
Pennisetum purpureum	47	45	43
Maize	18.5	----	----
Gliricidia	----	33	30
Cassava and with peels	----	10	13.5
Fish meal	8	----	----
Soya beans	10	10.5	----
Urea	----	----	12
Wheat bran	13	----	----
Oyester shell	2	----	----
Dicalcium phosphate	0.5	0.5	0.5
Premix	0.5	0.5	0.5
Common salt	0.5	0.5	0.5
Crude Protein (CP)	17.13	18.3	20.33
Crude Fiber	4.49	3.57	4.15
Ether Extract	2.17	1.49	2
Ash Content	4.5	4.98	5
Moisture Content (MC) (%)	14.58	13.3	13.28

Metabolizable Energy (MJ/Kg)	12.964	10.065	10.964

Table 6: Percentage Composition of Pelleted and Non-Pelleted Diets.

Management of experimental animals

A three tier wooden cages were used to house the grasscutters for the study. The cages were made from wood and wire mesh. There were holes in the cage floor (wire mesh) to allow the passage of the urine and faecal matter. The gates were made of wire netting and wooden frame to protect the grasscutters from predators and other intruders as well as to provide adequate ventilation. Feed and water were provided ad libitum. Feed was provided in the morning (7:00 GMT) and in the evening (17:00 GMT). Clean water was offered on daily basis to the animals. The cages were initially disinfected and hygienically managed so as to reduce or curb the incidence of diseases and parasites. Sick animals were isolated and treated. Postmortem examination was carried out on dead animals. The drinkers and feeding troughs used for the experiment were cleaned daily before new feed and water were supplied. Visual observation of the grasscutters was made during the experimental period for the presence or absence of disease conditions.

Data collection

The parameters of interest were collected and recorded during the experiment.

Daily feed consumption: Feed was weighed daily before being offered. Feed leftovers were also weighed. The difference between feed left over was recorded as daily feed intake. These were added at the end of each week to give the weekly consumption. Mathematically, daily feed intake was calculated as:

Daily feed intake (g)=feed offered–feed leftover

Body weight and body weight gain: Body weight of grasscutters was taken at the start of the experiment. Body weight were also taken at two weeks intervals, weight taken at every two weeks had the previous week's weight deducted from it to give the weight gain for the week that just ended. Thus, body weight gain was recorded as the difference between the initial and final body weight.

Mathematically body weight gain was calculated as:

Body weight gain (g)=final weight–initial weight

Feed conversion ratio: Feed conversion ratio was expressed as feed to gain ratio; that is total feed consumed in grams throughout the experimental period divided by total weight gain also in grams during the experimental period.

Feed conversion ratio=Total Feed Consume (g)/Total Weight gain (g)

Blood collection: Blood samples were collected from two grasscutters from each treatment making a total of six at the sixteen weeks for haematological analysis. The blood samples were collected from each grasscutter using a sterilized disposable syringe and needle between 6.30 and 7.30 am. An initial 2.0 ml blood was collected into labeled sterile universal test tubes containing Ethylene- Diamine-Tetra-Acetic acid (EDTA) as anticoagulant.

Haematological parameters: Using the standard techniques as reported by Jain, the Cholesterol (CHO), Erythrocyte Counts (RBC), Haemoglobin Concentration (HB), Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin Concentration (MCHC), Mean Corpuscular Haemoglobin (MCH), Total Leucocyte Counts (WBC), Mean Platelet (PLT) for the grasscutters were determine [29].

Carcass analysis: At the end of the experiment, two (2) matured grasscutters from each of the treatments were selected, starved overnight to empty their stomach, slaughtered, fur removed and eviscerated. Complete fur removal was performed by hand and fur weight recorded. Grasscutters were then eviscerated by making a ventral incision posterior to the keel and towards the anus. The digestive track was carefully removed, and carcass weighed. Weight of the heart, liver, intestines, spleen and kidney were recorded. Internal content was observed for any abnormalities. The weight of the animal after slaughtering and dressing was also taken. Carcass dressing was done using hot water to remove the fur. Carcass dressing percentage was determined as the ratio of the eviscerated animal's weight to the live weight of the animal.

Dressing percentage=Carcass dressed weight/Live Weight × 100

Chemical analysis of meat

To obtain the chemical composition of the meat, samples were taken from the neck region, thigh, abdomen and the back. The samples were analyzed separately to obtain the chemical composition of the respective parts of the meat according to the procedure outlined [37].

Feed wastage

During feeding some of the feed given was splashed out of the feeders. This passed out through the cages and was mixed with the faecal droppings and the urine of the grasscutters. In quantifying feed wastage, the faecal droppings were separated and the remaining feed sundried to remove the urine after which it was weighed and recorded. The percentage feed wastage was calculated as:

Weight of Feed Wasted (dry)/Total feed supplied (wet) × 100

Proximate analysis

Proximate analysis of samples of the treatment diets were analyzed in Animal Science laboratory at the Kwame Nkrumah University of Science and Technology- Kumasi.

Statistical analysis

Data were analyzed using Analysis of Variance (ANOVA) and General Linear Model (GLM) procedures of Statistical Analysis System (SAS, 2008). Differences between means of significant effects were separated by the Probability of Difference (P.D.I.F.F.) procedures of Statistical Analysis System [38].

Results and Discussion

Proximate analysis of experimental diets (%DM)

The proximate analysis of the experimental diets for grasscutter is presented in Table 7. The dietary treatment T3 (pelleted diet) in the experiment was slightly higher in crude protein (CP) than the other two (2) treatments (i.e., T1 and T2). It was also realized that T1 and T3 had higher crude fibre (CF) content than T2. The treatment diets also recorded higher moisture content value in T1 and the lowest was T3. Ash content of the diets appeared to be similar. The crude protein

content of the experimental diets analysed were of different calculated values. The crude protein requirement of growing grasscutters is about 18% and therefore only T2 and T3 diets met this requirement [39].

Content	Control (T1)	Pelleted Soya (T2)	Pelleted Urea (T3)
Crude protein	17.13c	18.30b	20.33a
Crude fiber	4.49	3.57	4.15
Ether extract	2.17	1.49	2
Ash content	4.5	4.98	5
Moisture content	14.58	13.3	13.28

Table 7: Nutrients composition of pelleted and non-pelleted feed.

Performance of grasscutters on pelleted feed (PF)

The effect of experimental diets on the performance of grasscutters is presented in Table 8.

Parameter	Control	Pelleted Soya	Pelleted Urea
	T1	T2	T3
Initial mean body weight (g)	1062.8 ± 193.0^{a}	848.5 ± 104.5^{b}	1013.0 ± 163.4^{a}
Final mean body weight (g)	1432.2 ± 129.9^{a}	1183.6 ± 70.4^{b}	1156.6 ± 110.0^{b}
Mean daily feed intake (g)	708.8 ± 54.3^{a}	277 ± 29.4^{c}	298.8 ± 46.0^{b}
Daily mean weight gain (g)	3.3 ± 1.2^{a}	3 ± 0.65^{a}	1.3 ± 1.0^{b}
Feed conversion ratio	178 ± 128.1^{b}	134.1 ± 69.3^{c}	199.6 ± 108.5^{a}

Table 8: Effect of Pelleted diet on Performance of Grasscutters (mean ± standard error).

Feed intake: There was significant difference ($p<0.05$) in feed intake among the treatment means (Table 8). The mean daily feed intake of grasscutters in T1 (control diet) was the highest as compared to the others (T2 and T3). In this study, crude protein levels of the diets were different and hence could possibly explain the different feed intake patterns recorded. Using pellet diets revealed that there was no difference in feed intake in T2 and T3 but rather an increase in feed intake in T1 (control diet). T1 initial good performance in the experiment is since animals in T2 and T3 might have adjusted to their dietary regimes. T1 contains elephant grass and according to Adjanohoun, the grasscutter has much preference for it [40].

Body weight and weight gain: There was no significant difference ($p>0.05$) among the initial mean body weight of the grasscutters in T1 and T3 but T2 was significantly different ($p<0.05$) (Table 8). Also, there was no significant difference ($p>0.05$) in the daily weight gain in the treatments, but T1 recorded higher numerical values. It was realized that all the animals fed on the various diets benefited from microbial protein, but the quantities of the microbial protein could not be estimated. For animals fed on diet T1 and T2 probably, the supply of amino acids for body protein synthesis was in right proportions and quantities hence the better performance. Age might have also affected the weight gain of the grasscutters especially in T3. The difference in the rate of daily weight gain indicated might be since the animals used for the experiment were at different stages of growth and development. The lower weight gain of grasscutters fed on T3 diet despite its higher crude protein content might be due to the physiological malfunction and negative effect of the antinutritional factors present in the diet on the grasscutter [21].

Feed Conversion Ratio (FCR): Feed conversion ratio was not significantly affected ($P>0.05$) by the dietary treatments (Table 8). Grasscutters fed on diet T2 were numerically more efficient in converting feed to gain than those fed on diets T1 and T3. Grasscutters fed on diet T2 might have had better quality protein and hence the higher efficiency of utilization of feed. The highest FCR by T3 was probably due to combined effect of age and feeds. According to Zohou, feed consumption in grasscutter varies with age and thus weight. This invariably influences FCR which have feed intake and weight as it factors. The FCR values of the treatments were inconsistent and this might be due to weekly weighing exercise the animals were taken through. This conforms to report by Schrage and Yewadan, that weighing constitute a stress factor for the grasscutter and that weight loss is practically always observed over the following days [6,41].

Carcass characteristics

The effect of experimental diets on the carcass characteristics is presented in Table 9.

Paramater	Control	Pelleted Soya	Pelleted Urea
	T1	T2	T3
Live weight (g)	1434^{a}	1206^{c}	1213^{b}
Slaughter weight (g)	1245^{a}	1087^{c}	1099^{b}
Dress weight (g)	871.5^{a}	772.0^{b}	618.5^{c}
Fur removed weight (g)	1183^{a}	1036^{b}	1007^{c}
Full intestine weight (g)	281.0^{c}	299.5^{b}	310.5^{a}
Empty intestine weight (g)	71.5	73	67
Heart weight	8	7.5	6.5
Liver weight	20.0^{a}	18.0^{b}	16.0^{c}
Spleen weight (g)	0.65	0.5	0.45
Kidney weight (g)	7	5	5
Dressing percentage (%)	60.6^{b}	64.1a	53.5^{c}

Table 9: Effect of Pelleted feed on Organ Weight of Grasscutters. $^{a, b, c}$: Treatment means with different superscripts within the same row are significantly different at $p<0.05$; SEM=Standard error of mean.

Effect of pelleted feed on organ weight of grasscutters: There was no significant difference ($p>0.05$) in the heart, intestine, spleen and kidney weight of the animals. But there was significant difference ($p<0.05$) among other carcass characteristics that were measured in all

the dietary treatments (Table 9). Dressing percentage was not significantly (P>0.05) affected by dietary treatments. Grasscutters fed on diet T2 had significantly (P<0.05) higher numerical dressing percentage than those fed on diet T1 and T3. The mean dressing percentage value of 64% obtained in this study is lower than the mean dressing percentage of 70% reported by Annor et al. The heart was not significantly (P>0.05) affected by dietary treatments. However, grasscutters fed on diet T1 had a numerically higher weight compared with those fed on diets T2 and T3. The mean heart in this study is however, higher than the value of 6.0 obtained by Omole et al. [15,42].

Meat quality

The effect of experimental diets on the meat quality is presented in Table 10.

Parameter	T1	T2	T3	SEM
Crude protein	78.60^{a}	79.45^{a}	62.95^{b}	0.33
Crude fat	4.00^{a}	4.00^{a}	2.50^{b}	0.03
Ash	7.75	7.25	8	0.03

Table 10: Effect of Pelleted feed on Meat Quality. $^{a, b, c}$: Treatment means with different superscripts within the same row are significantly different at p<0.05; SEM=Standard error of mean.

Protein content of grasscutter meat: There was significant (P<0.05) difference among animals fed on the T3 but no significant (P>0.05) difference on animals in T1 and T2 (Table 10). The significantly (P<0.05) higher protein concentration in grasscutter meat of animals fed on diet T1 and T2 might probably have resulted from the inclusion of fish meal in T1 and the addition of soya bean meal in T2 which might have supplied amino acids in adequate quantities and proportions which were used for tissue synthesis, which resulted in an increased concentration of protein in the meat [43].

Fat content of grasscutter meat: The dietary treatments have significantly (P<0.05) influenced animals fed on the T3 compared to those fed on diets T1 and T2 which were not significantly (P>0.05) affected by the diets. It was observed that as the protein content increases, fat content increases in all the treatments. The study agrees with other reports that carcass protein and fat content have a positive relationship. It is reported that consumption of high levels of fat is associated with high incidence of heart diseases in humans. Reduced dietary fat intake therefore is appropriate for good health [20,44,45].

Ash content of grasscutter meat: There was no significant difference (p>0.05) in ash content among treatment means (Table 10). The ash content in the meat of grasscutters fed on the T1 diet was numerically higher than the ash content in the meat of grasscutters fed on diet T2 and T3. The significantly high ash content in the meat of grasscutters fed on diet T1 could probably be due to the high calcium phosphorus and contents of the fish meal [12].

Hematological analysis of grasscutters fed on pelleted feed (PF)

The effect of experimental diets on the blood of the grasscutter is presented in Table 11.

Parameter	Control	Pelleted Soya	Pelleted Urea	SEM
	T1	T2	T3	
CHO	71.70^{b}	69.0^{c}	80.30^{a}	4.66
HCT	40.1	39.9	40	1.72
HBG (g/dl)	11.53	11.9	11.27	0.63
MCH (pg)	17.33	18.37	17.53	0.09
MCHC (g/dl)	27.43	28.93	27.7	0.22
MCV (fl)	61.5	63.4	62.33	0.61
PLT	27.0^{b}	114.0^{a}	28.0^{b}	49.2
RBC (10^{6}/µl)	6.43	6.26	6.49	0.2
WBC (10^{3}/µl)	2.53	2.83	2.4	0.3

Table 11: Effect of Pelleted feed on Blood. $^{a, b, c}$: Treatment means with different superscripts within the same row are significantly different at p<0.05; SEM=Standard error of mean.

Effect of pelleted feed on haematology: All the haematological indices were not significantly different (p>0.05) except for mean cholesterol and mean platelets (PLT) which were significantly (p<0.05) affected by the dietary treatments (Table 11). Haematological blood components are influenced by the quantity and quality of feed and the level of anti-nutritional elements or factors present in the feed. Grasscutters on dietary treatment T1 and T3 recorded high Cholesterol levels as compared to Ogunsanmi, who worked on the haematology of both wild and captive grasscutters.

Grasscutter on dietary T1 and T3 recorded the lowest Platelet values whiles their counterparts on T2 Pelleted diet recorded the highest. The general non-significance of the White Blood Cells (WBC) across treatments indicates that the experimental diets neither impaired nor enhanced the grasscutters' ability to wade off infection. The values obtained for Red Blood Cells (RBC) of grasscutter fed on Pelleted diets were within the range of 6.26 to 6.49 × 10^{6}/m as reported by Ogunsanmi. The study revealed that the health status of the grasscutters during the experimental period did not seem to have been affected by the Pelleted diets [31,32].

Feed wastage

Effect of feed wastage in presented in Table 12.

Parameter	Control	Pelleted Soya	Pelleted Urea
	T1	T2	T3
Daily mean feed wastage	632.5 ± 17.3^{a}	57.4 ± 9.3^{b}	34.3 ± 14.6^{c}
Percentage feed wastage	42.5 ± 1.2^{a}	17.4 ± 0.7^{b}	10.3 ± 1.0^{c}

Table 12: Effect of Pelleted feed on Feed Wastage. $^{a, b, c}$: Treatment means with different superscripts within the same row are significantly different at p<0.05; SEM=Standard error of mean.

Effect of pelleted diet on feed wastage: There was significant difference (p<0.05) among the treatments means. The results of analysis (Table 12) showed that the feed wastage reduced with

increasing in the Pellet diets. T1 indicated high percentage of feed wastage whilst T2 and T3 recorded the lowest. Schrage and Yewadan reported a reduction in the wastage of feed indicates a high proportion of feed ingested. This could be concluded that Pelleted feeds are better in terms of curbing feed wastage [6].

Conclusion

The experiment was conducted to evaluate the effects of pelleted feed on the performance of grasscutters. From the study conducted, it could be concluded that:

- The results on weight gain and feed conversion ratio revealed no significant ($P>0.05$) difference among the treatment means. The results indicated that grasscutters on T1 (control) had the highest feed intake as compared to the rest.
- It was also observed that pelleted diets of grasscutters in this study did not have any adverse effect on their health and carcass quality.
- With regards to the blood of the grasscutters, besides the cholesterol and platelet levels which were significantly ($P<0.05$) affected by pelleted diets, there was no significant ($P>0.05$) difference among other treatment means when subjected to statistical analysis.
- The results of the feed wastage analysis revealed that feeding pelleted diets to grasscutters reduces feed wastage and hence feed cost. Therefore, there was significant ($P<0.05$) difference among treatments means.

Recommendations

- Pelleted feed is recommended to farmers especially as a replacer for non-pelleted diets in the grasscutter production to improve nutrition and control feed wastage by the grasscutter.
- For efficient feed utilization, pelleted feed should be preparing to meet appropriate nutrient levels of grasscutters.
- For effective work, students who want to embark on this project should as much as possible use grasscutters of the same age.
- Enough grasscutters should be procured for future experiment to allow for replication of the treatments to ensure more qualitative results.
- The grasscutter should be experimented on pelleted feed as a more improved feed.
- The grasscutters should be kept in some much-isolated areas to ensure minimal disturbance to the animals.
- Enough catcher boxes should be constructed for catching of the grasscutters to reduce stress in forcing the animals into boxes and nets for weighing.
- The weighing of the grasscutters should be done on monthly bases to reduce stress on the animals going through the exercise.
- The studies should be done over a much longer period to ensure more effective results.

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