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Growth response, nutrient digestibility and physical body measurements of Grasscutter (*Thryonomys swinderianus*) fed whole cassava (*Manihot esculenta*) root meal fortified with selected fermented protein sources

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Abstract

Grasscutter serves as a major tool for improved household income generation, nutrition and bio-diversity in Nigeria. It provides a quick turnover, foreign exchange earner and reduce unemployment rate of the country. In order to assess the feeding values of concentrates used as supplement, studies were conducted in captivity to evaluate the performance of Grasscutter (*Thryonomys swinderianus*) using 20 growing Grasscutters comprising 16 females and 4 males who were balanced for weight and grouped into four treatments. Inclusion of whole cassava meal that was incorporated at 80% of the total bulk acted as the control (T_0) while 10% of whole cassava root meal was replaced by fermented soybean meal in (T_1), fermented locust bean meal in (T_2) and fermented melon seed meal in (T_3) respectively were considered as experimental using a complete randomized design. Elephant grass (*Pennisetum purpureum*) was used as the basal diet and water were given *ad libitum*. There were significant difference in the final body weight gains ($P < 0.05$) between treatments. The mean final body weights were 1175.0 ± 302.01 , 1266.7 ± 302.01 , 1215 ± 302.01 and 1143.0 ± 302.01 g for animals on T_0 , T_1 , T_2 and T_3 respectively. The corresponding mean for final body weight gains were found to be 481 ± 209.55 , 536.7 ± 209.55 , 507 ± 209.55 and 407 ± 209.55 g for T_0 , T_1 , T_2 and T_3 respectively. There were significant differences ($P < 0.05$) in the trunk length in T_1 over T_2 , T_0 and T_3 and were recorded at the level of 4.78 ± 0.19 , 4.56 ± 0.18 , 4.55 ± 0.18 and 4.12 ± 0.16 respectively. The nutrient digestibility of CP, EE, NFE, ADF and ADL were significantly different ($P < 0.05$). The whole cassava root that was combined with fermented soybean meal supported a highest growth rate than those of other treatments. It was therefore concluded that fermented soybean meal may be used as an ideal diet for sustainable Grasscutter production when whole cassava root is combined with this ingredient.

Introduction

The Grasscutter (*Thryonomys swinderianus*) production serves as a major tool for improved household income generation, nutrition and bio-diversity. It provides a quick turnover; serves as a foreign exchange earner; helps reduce unemployment rate of the country; additionally, it provides employment avenues for the physically challenged and people suffering from HIV/AIDS. Environmentally, Grasscutter rearing is very friendly. It helps to meet the demand for the supply of bush meat without undue pressure on the environment in many rural areas of Nigeria and other West African countries like Benin, Ghana, Togo and Ivory Coast. Grasscutter meat is greatly appreciated for its tenderness and taste and is an important source of animal protein in Ghana and the rest of West Africa. The meat is appreciated because of its culinary properties with high protein, calcium, phosphorous and moisture contents (Rahman *et al.*, 2015; Rahman *et al.*, 2016).

In Nigeria there is a diverse wildlife resource capable of supporting the protein intake of animal origin. Nonetheless in recent years, there had been significant shortfall between the production and supply of animal

protein to feed the ever increasing population (Akpan, *et al.*, 2009) in Nigeria. Thus, in order to improve and foster the protein intake, efforts had been directed towards boosting the micro livestock sector and with an ever increasing demand, there is a consistent and sustained outstripping of supply (National Research Council, 1991; Anon., 1993).

The grasscutter is primarily an herbivore animal in which major part of its diet is composed of grasses with fairly high crude fibre content (Schrage and Yewandan, 1995; Adu, 2005). It can apparently tolerate a certain level of tannin found in leaves and bark as well as cyanogenic glycosides present in green maize, sorghum and *Manihot* spp. and other agro-products (Ewer, 1969; Obi *et al.*, 2009; Eniolorunda and Olamilusi, 2016). However, the nutritional status of Grasscutter has been reported to be improved through the provision of pelleted concentrate for supplementary feeding especially when they are reared in captivity (Ayodele and Meduna, 2007). Good carcass quality and highest live weight were reported by Henry and Njume, (2008), when Grasscutters were fed with a metabolizable energy of 2000 Kcal/kg- in combination with chopped elephant

grass (*Pennisetum purpureum*). Feeds containing 12-20% crude protein have been reported to be suitable for Grasscutter (Meduna, 2002) while 18% crude protein (CP) was required for optimum growth of Grasscutter from weaning to reproductive age (Kusi, 2012).

Fermented foods have a long tradition and historically have been produced in order to extend the shelf life of raw material and increase their safety. In their production, micro-organisms plays vital and essential role contributing to the improvement of the physicochemical, sensory and safety characteristics of the final products (Cocolin and Ercolini, 2009). In addition, the fermentation is usually carried out in a moist solid state, involving contact with appropriate inocula of assorted microorganisms and is accomplished by the natural temperatures of the tropics. Therefore, the aim of this study was to determine the feed efficiency on growth response, nutrient digestibility and physical body measurement of growing Grasscutter fed cassava root meal and fortified with selected protein sources.

Materials and Methods

Study location

The study was carried out at the Grasscutter housing unit of the college of Agricultural Sciences, Olabisi Onabanjo University, Yewa campus, Ayetoro. Ayetoro is located in latitude 7^o15¹N and longitude 3^o3¹E indeciduous derived savannah zone of Ogun State. Climate is sub humid tropical with an annual rainfall of 763.3mm in 74days. Maximum temperature varies between 29^oC during the peak of wet season (Feb and March) and 34^oC during the dry season, mean annual relative humidity is 81% (Onakomaya et al., 1992).

Housing and Animal Management

The experimental animals were housed in cages in a long tier metal cage supported at the base with strong iron rods such that the cage were raised to 45cm from the floor level (the dimension of each cage was 60cm x 50cm x 40cm). The cages were placed inside a well-ventilated and naturally illuminated Animal Nutrition Laboratory in the College of Agricultural Sciences at the Olabisi Onabanjo University, Yewa Campus, Ayetoro, Ogun State, Nigeria. The metal cages were washed dried and sanitized before the animals were moved into them.

Feed preparations and feeding regimes

Ingredients that were used in the preparation of the diet is shown in Table 1. The control diet had contained 80% of whole cassava root meal T₀, while other three had 10% fermented soybean (T₁), locust bean (T₂) and fermented melon seed meal (T₃). The level of crude protein was found to be different according to the treatments; while vitamins, minerals, palm kernel cake (PKC) and other ingredients had equal percentage of incorporation value within the treatment. The dietary treatments were designated as T₀ (control), T₁, T₂ and T₃ and the trial continued for a period of 105 days.

Table 1. Composition of experimental diet fed to the animal

| Ingredients (g) | T ₀ | T ₁ | T ₂ | T ₃ |
|------------------------|----------------|----------------|----------------|----------------|
| Whole cassava meal | 80 | 70 | 70 | 70 |
| Fermented soybean | - | 10 | - | - |
| Fermented locust bean | - | - | 10 | - |
| Fermented melon | - | - | - | 10 |
| Palm kernel cake (PKC) | 15 | 15 | 15 | 15 |
| Bone meal | 2 | 2 | 2 | 2 |
| Urea | 2 | 2 | 2 | 2 |
| Salt | 0.5 | 0.5 | 0.5 | 0.5 |
| Vitamin premix | 0.5 | 0.5 | 0.5 | 0.5 |
| Total | 100 | 100 | 100 | 100 |

The experimental diets used were made up of Elephant grass (*Pennisetum purpureum*) plus concentrate supplements. The concentrates were made up of fermented soybean, locust bean and melon seeds. The cassava which constituted the major bulk of the diets was washed to remove soil particles, milled and sundried on large tarpaulin sheets for 5 days before being incorporated into the diet. Soybean, locust bean and melon were purchased from the local market and were fermented, mixed with required additives transformed into pellet to carry out the experiment. Young succulent Elephant grass which was harvested and wilted for six hours was and was also fed to the animal *ad libitum*. Fresh water was made available all the times.

Elephant grass weighing 600g was fed per head/day as the basal diet. The concentrate feed weighing 125g per pelleted ration (experimental diet) was fed per treatment per day every alternate days (after every single day). The daily feed consumption rates were estimated indirectly by the method of difference which involved subtracting the quantity of leftover from the measured earlier served to the animals at the beginning of each feeding day. The growth rate of the individual animals were measured once in a week following Morrison (2008). The morphometric measurement were carried out every 2 weeks and the average daily and weekly growth rates per treatment were calculated from the individual values. Anti-stress comprising of glucose solution was administered during each weighing session as minimize stress.

Management of experimental animals

20 Grasscutters (16 females and 4 males) 5-7 months old with an average body weight 717 ± 21g were used in the completely randomized design experiment that continued for a period of 15 weeks. Animals were divided into four treatments: each treatment included 4 females and 1 male and designated as T₀, T₁, T₂ and T₃ groups. The experimental diets were fed to the animals accordingly for a period of fifteen weeks. Fresh clean water was provided *ad libitum*. Pelleted meal and cassava root meal were offered every morning. The feed refusal of the previous day's feeding were cleared out

and weighed. The quantity of pelleted meal given was weighed daily into specially made ceramic feeding to minimize spillage and wastage. The animal was sanitized and quarantined to avoid ecto and endo-parasites at the beginning of the experiment.

Morphometric analyses

The following linear body measurements were obtained in the morning before animals were offered forages:

- head length was measured from the base of neck to the tip of nose;
- body length was measured from the tip of the nose to the end of the tail;
- trunk length was measured from the tip of the nose to the attachment of the tail;
- heart girth was measured from the fore limb round the circumference of the chest;
- height at withers was measured from the fore limb to the back;
- fore limb was measured from the hitch bone to the claw; hind limb was measured from the pelvic bone to the feet;
- tail length was measured from the attachment of the tail to the end of tail;
- ear length was measured vertically within the ear while ear width was measured horizontally along the ear.

Chemical Analysis

The total daily faecal output was weighed for each animal and 25% of the sample were collected and stored in a freezer (-4°C). These were bulked for each animal and dried in an oven at 105°C for 24 hours to determine the dry matter (DM) contents. The sun dried and pulverized sample of Elephant grass blades, basal diets and faecal samples were analysed for proximate composition (AOAC, 2002). The ground sample of dried whole cassava root was also analysed. The total nitrogen in the feed was determined by macro Kjeldahl procedure (AOAC, 1995). Soxhlet extraction procedures were used to determine of ether extract. Gross energy content of the diets was estimated by adiabatic bomb calorimetry. Phytic acid was determined using the method of Buetler *et al.* (1980). Oxalic acid was determined using the precipitation method of AOAC (2002). Each animal was also weighed weekly. The feed conversion ratio (FCR) was calculated from records of average daily feed consumption and daily weight gain.

Statistical Analysis

Data were subjected to Analysis of variance (ANOVA) using (SAS, 2002) and mean comparison was performed with Duncan Multiple Range Test (DMRT).

Results

The results of chemical composition of the experimental diets with the basal diets, elephant grass (*P. purpureum*) are shown in Table 2. The level of crude protein differs between treatment groups, thus T₁ was found to be greater than those of T₀, followed by T₃ and T₂ was the lowest percentage respectively. The result of the study revealed that the neutral detergent fibre (NDF) and the acid detergent fibre content of the experimental diets followed the same trend (Table 2). The value recorded in the chemical composition of diets were not significantly different (P>0.05). Thus, there were no significant (P>0.05) differences in the level of dry matter intake and ash content within the treatments. Energy content of the experimental diets indicates that T₃ have the highest value recorded followed by T₀, T₁ and T₂ has the lowest energy content. The differences in the value recorded for ash and ether extract showed similar difference among the treatment groups.

Table 2. Chemical Composition of concentrate and forage fed to experimental animals

| Parameters (%) | Concentrate Diets | | | | Elephant grass |
|----------------|-------------------|----------------|----------------|----------------|----------------|
| | T ₁ | T ₂ | T ₃ | T ₄ | |
| Crude protein | 24.28 | 25.06 | 22.98 | 24.01 | 8.80 |
| Crude fibre | 8.35 | 8.16 | 8.52 | 8.25 | 15.15 |
| Ether extract | 11.75 | 10.69 | 11.32 | 12.04 | 6.67 |
| Ash | 11.20 | 10.82 | 11.38 | 10.84 | 3.99 |
| NFE | 44.42 | 45.27 | 43.80 | 44.86 | 65.39 |
| Energy | 1413.13 | 1324.53 | 1045.86 | 1421.11 | 509.63 |
| NDF | 75.61 | 78.32 | 74.66 | 79.45 | 61.36 |
| ADF | 31.62 | 33.44 | 32.16 | 35.48 | 25.67 |
| ADL | 12.38 | 14.81 | 14.22 | 12.98 | 9.69 |

The performance of the Grasscutter is shown in Table 3 and the duration of the experiment was 15 weeks. There was significant difference (P<0.05) in average feed intake forage which treatment 3 carries the lowest value and the other treatment are similar in their value recorded. There was also significant difference (P<0.05) in average concentrate intake. The lowest total feed intake was observed in T₃. Total value for dry matter intake (DMI) indicate that animals in the T₂ consumed less feed (P>0.05) within the treatment. There were significant (P<0.05) differences in the level of dry matter concentrate in T₁, which has the highest value compared to T₃, followed by T₀ and T₂ having the lowest value of the feed concentrate. Weight gain was lower (P>0.05) in treatment 3 compared to the animal on the T₀, T₁ and T₂ respectively. While T₁ had highest weight gain within the experiment accordingly, there were significant (P<0.05) difference in feeding conversion ratio in the treatment.

Table 3. Production performance of cane rat fed the experimental diets

| Parameters | T ₀ | T ₁ | T ₂ | T ₃ | SEM |
|--------------------------------|---------------------|---------------------|---------------------|---------------------|-------|
| Duration of experiment (weeks) | 15 | 15 | 15 | 15 | |
| Average feed intake forage (g) | 297.37 ^a | 302.3 ^a | 295.41 ^a | 274.16 ^b | 27.02 |
| Average feed intake conc. (g) | 76.51 ^b | 78.57 ^a | 74.84 ^c | 76.89 ^b | 1.65 |
| Total feed intake (g) | 373.88 ^b | 380.95 ^a | 370.25 ^b | 351.05 ^c | 5.19 |
| Dry matter forage (g) | 105.55 ^a | 101.41 ^a | 99.08 ^a | 91.95 ^b | 5.17 |
| Dry matter concentrate (g) | 59.23 ^a | 67.51 ^a | 53.39 ^b | 66.90 ^a | 3.89 |
| Total dry matter (g) | 164.78 ^a | 168.92 ^a | 152.47 ^c | 158.85 ^b | 3.01 |
| Initial live weight (g) | 694 ^a | 730 ^a | 708 ^a | 736 ^a | 42.07 |
| Final live weight (g) | 1175 ^a | 1266.7 ^a | 1215 ^a | 1143 ^a | 51.55 |
| Weight gain (g) | 481 ^{ab} | 536.7 ^a | 507 ^b | 407 ^c | 39.55 |
| Daily weight gain (g/head/day) | 4.51 ^b | 5.11 ^a | 4.83 ^{ab} | 3.88 ^c | 0.28 |
| Feed conversion ratio | 1.29 ^b | 1.41 ^a | 1.36 ^{ab} | 1.16 ^c | 0.07 |

^{abc}mean within a row with unlike superscript letters were significantly different (P<0.05). For details of diets and procedure, see Table 1.

The physical body measurement of the Grasscutter within the treatment is shown in Table 4. T₁ have the higher weight gain when compared to those of other treatments. There were no significant (P>0.05) differences in head, body and tail length within the treatments. However, there were significant differences (P<0.05) in the trunk length of T₁ over T₂, T₀ and T₃. No significant differences (P<0.05) were observed in the height at withers and fore limbs within the treatment. On the other hand, significant difference (P<0.05) were found in ear width within the treatment. T₂ which had the highest value followed by T₁, T₃ and T₀.

Table 4. Physical body measurement of Grasscutter fed experimental diets

| Parameters | T ₀ | T ₁ | T ₂ | T ₃ | SEM |
|-------------------------------|-------------------|--------------------|--------------------|--------------------|-------|
| Duration of experiment (days) | 105 | 105 | 105 | 105 | |
| Body weight gain (g) | 481 ^{ab} | 536.7 ^a | 507 ^b | 407 ^c | 214.4 |
| Head length (cm) | 1.08 ^a | 0.16 ^c | 0.96 ^a | 0.46 ^b | 0.04 |
| Body length (cm) | 5.50 | 5.56 | 5.42 | 4.81 | 1.11 |
| Trunk length (cm) | 4.55 ^b | 4.78 ^a | 4.56 ^{ab} | 4.12 ^a | 0.19 |
| Tail length (cm) | 0.75 | 1.02 | 1.82 | 1.48 | 0.07 |
| Heart girth (cm) | 2.17 ^a | 2.94 ^b | 5.00 ^{ab} | 4.60 ^{ab} | 0.98 |
| Height at withers (cm) | 2.35 | 1.42 | 2.46 | 2.61 | 0.16 |
| Fore limb (cm) | 2.80 | 1.43 | 2.06 | 3.16 | 0.27 |
| Hind limb (cm) | 1.37 ^a | 0.98 ^b | 1.24 ^a | 1.19 ^a | 0.06 |
| Ear length (cm) | 0.10 | 0.10 | 0.14 | 0.17 | 0.01 |
| Ear width (cm) | 0.10 ^a | 0.16 ^a | 0.22 ^b | 0.11 ^a | 0.01 |

^{abc}mean within a row with unlike superscript letters were significantly different (P<0.05). For details of diets and procedure, see Table 1.

The mean for the nutrient digestibility of the experimental diets were shown in Table 5. The percentage crude protein were significant differences (P<0.05) among the treatment groups. T₂ have had highest value of 10.03 which made the feed more nutritious and supported the growth of animals. The value recorded for ether extract, energy and acid detergent fibres showed significant difference (P<0.05) with the treatment in which T₁>T₂>T₃>T₀ respectively. The levels of crude fibre with the treatment were significantly different and T₁ had the highest value while lowest value for crude fibre was recorded from T₂.

However, there was significant difference in the level of ash and acid detergent fibre content; T₀ had the highest percentage value within the treatments. The energy content of the experimental diets was higher in T₁ which was considered to be significantly different (P<0.05) within the treatment and the lowest energy value was recorded from T₃. The highest acid detergent fibre was found in T₀ that made it significant within the treatment.

Table 5. Nutrient digestibility of Grasscutter fed experimental diets

| Parameters (%) | T ₀ | T ₁ | T ₂ | T ₃ | SEM |
|----------------|--------------------|--------------------|--------------------|--------------------|------|
| Crude protein | 8.29 ^c | 10.03 ^a | 9.16 ^b | 8.59 ^{bc} | 0.81 |
| Crude fibre | 7.06 | 8.84 | 6.84 | 7.20 | 0.62 |
| Ether extract | 8.56 ^c | 11.13 ^a | 9.28 ^b | 9.10 ^{bc} | 0.71 |
| Ash | 7.83 ^a | 8.04 ^a | 6.99 ^c | 7.21 ^b | 0.23 |
| NFE | 81.81 ^c | 89.43 ^a | 84.17 ^b | 63.11 ^d | 2.33 |
| NDF | 54.02 ^b | 59.11 ^a | 56.42 ^b | 46.16 ^c | 2.57 |
| ADF | 34.97 ^a | 32.67 ^b | 29.04 ^c | 31.79 ^b | 2.27 |
| ADL | 11.30 ^c | 19.21 ^a | 14.14 ^b | 10.93 ^c | 2.81 |

^{abcd}mean within a row with unlike superscript letters were significantly different (P<0.05). For details of diets and procedure, see Table 1.

Discussion

The chemical composition of the experimental diets compared favorably with the recommended diets found in literature. The level of acid detergent fibre in the treatment diets was found to be higher than the 13-17% level recommended by Pound *et al.*, (1995). While neutral detergent fibre level should be within the range of 42-74% Mensah and Okeyo (2005) for adult cane rat. The present results have shown that Grasscutter may not grow well when fed acid detergent fibre beyond 17%. The crude protein levels of the four diets were higher than the minimum of 17% suggested by Pound *et al.* (1995), for herbivores in captivity. The energy content in T₃ was slightly higher as compared to those of T₀, T₂ and T₁ which had the least value. The metabolisable energy (ME) value of the four experimental diets was high enough to support at least a moderate growth rate as seen in the literature. The chemical contents of the

diets, therefore, appeared to be optimum to support a reasonable since all the experimental animals gained weight over the period of 15 weeks survived the experimental period.

The current dry matter intake was greater than the 89-124g for forage with the range of 31-65g reported earlier by Mensah, (2000). But this may be due to the fact that the earlier researchers fed forage only and it may be mentioned here that Grasscutters may not require to eat much if they are supplied with feed which well balanced in energy and other nutrients. The value for dry matter intake (DMI) showed that the animals in T₂ consumed less of the concentrate diets. Furthermore, the crude fibre of the experimental diets was all lower than 25-45% that was recommended for adult Grasscutter (Mensah, 1993, 1995). The present experiments have shown that with the same level of feeding, there was no significant difference in the mean final weights (P<0.05). Although there was significant difference in the value recorded in the final weights in animal supplied diet T₁ which had the highest weight gain than the corresponding T₃, T₂ and T₀.

Consumption of feed always affected by the level of crude fibre of the feed. However, no significant difference (P>0.05) was observed in the mean total weights of the Grasscutter. The highest total mean weight gain was recorded for Grasscutter fed with whole cassava root meal combined with fermented soybean meal, followed by whole cassava meal combined with fermented locust bean, closely followed by whole cassava meal combined with fermented melon and lastly followed by whole cassava meal.

There was a higher feed intake in T₁ in the experiment compared to those in T₀, T₂ and T₃. Animals in T₁ had an average intake but rather have a lower average total weight gain as opposed to those of other animals on the treatment. This could be explained by the fact that animals on T₁ (whole cassava root meal combined with fermented soybean meal) had the highest feed intake and the nutritional quality of their feed was also very high. These were in agreement with the report of Onyeansi and Famoyin (2005) who found that cassava is superior to other sources of carbohydrate particularly when fed along with balanced protein sources.

The morphometric results showed that animals within the treatment gained most weight in their trunk which made them to shrink and stretch. Little differences were however, observed in tail, head, fore limb, hind limb, ear length and ear width respectively. By and large, when fed whole cassava root meal combined with fermented soybean meal to the Grasscutters were found to be more efficient to convert feed into muscle, when compared with the other treatments.

Conclusion

The whole cassava root combined with fermented soybeans meal supported high growth rate than other treatments– used during this study. It is therefore recommended that the whole cassava root combined with fermented soybeans meal could be used as complete diets for sustainable Grasscutter production. However, further work on the mineral excretion and use of phytase enzymes to maximize absorption of essential and trace minerals from feeding cassava root combined with fermented soybeans meal may be required.

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