NIGERIAN AGRICULTURAL JOURNAL
ISSN: 0300-368X
Volume 50 Number 2, December 2019. Pp.157-165
Available online at: http://www.ajol.info/index.php/naj

GROWTH AND ECONOMIC BENEFITS OF CANE RATS FED DIASTIC-MICROBES DEGRADED SAWDUST: SOLID WASTE MANAGEMENT STRATEGY

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ABSTRACT
The experiment analysed weight gain, feed conversion efficiency and economic benefit of Cane rats. Thirty weaned Cane rats, about 3 months of age were obtained from Benin Republic by a contracted agent and quarantined for 21 days, from where 20 Cane rats were selected for the study, and fed diastic microbes degraded sawdust (DMDS) based diets. Experimental design used was Complete Randomized Design with 5 Diet groups replicated 4 times per diet group. The DMDS included as follows: Diet 1 (0% DMDS); Diet 2 (5% DMDS); Diet 3 (10% DMDS); Diet 4 (15% DMDS) and Diet 5 (20% DMDS) that replaced cassava meal in the diets. The trial lasted for 60 days, where result showed no significance (p>0.05) in the initial weight, while the average daily weight gain, average daily feed intake and feed conversion ratio differed significantly (p<0.01, p<0.05) in all the treatments in favor of the DMDS fed Cane rats. Base on the economic benefits measured, there were significant (p<0.05) effect in the cost/kg weight gain, cost of feed consumed, cost of production, gross revenue and revenue, while the cost differential and relative cost benefit were also significant (p<0.01). These findings could be as a result of the inclusion of DMDS as component of formulated feed in Cane rats' diets, which might have added some unknown active benefiting factors that caused the increased performance noted in this study. The result of this study has showed that DMDS can be utilized by Cane rats up to 20% in diet.

Keywords: Can rats, Degraded sawdust, Diastic microbes, Diets, Weight gain, and Cost benefits

Introduction

Recently, the fear about the future availability of energy feeds for use in the farm animal diets, around the world has been evident of discussion at various meetings and conferences as revealed by Anigbogu and Adekule-Agbale (2013).The relevance of animal protein in human and animal nutrition cannot be over emphasized (Owen *et al.*, 2009, Owen and Amakiri, 2009). In recent times, there is significant short fall between production and supply of animal protein to feed the increasing world population (Anigbogu and Adekule-Agbale, 2013; Akpan, *et al.*, 2009). To ameliorate this unacceptable trend, efforts have been directed towards boosting the micro-livestock sector. In Africa, annual quantity of fibrous agricultural residue which is a component of municipal organic waste (MOW) available was put at about 340 million tonnes (Belewu and Popola, 2007). In Nigeria, large amount of sawdust that made up part of municipal organic waste produced annually is estimated to be 30,643,230m^2 (Babyemi and Dauda, 2009), and are not utilized for animal feed energy purposes. This results to poor waste disposal in the municipalities, which contributes to environmental pollution that constitutes public nuisance and eyesore according to Anigbogu and Madu-Ijeoma (2016) and Anigbogu and Obioma (2015). In Nigeria, this enormous amount of sawdust represents valuable material for future biotechnology exploitation for animal feeds. If this huge amount of sawdust could be recycled or converted to useful feed stuff such as Life-enzyme, based on the findings of Anigbogu and Madu-Ijeoma (2016), our environment will be cleaned of pollution, thereby help to improve human health (Anigbogu and Ezekwe 2013; Belewu and Popola 2007).

In the South-East Nigeria, the scarcity of feed for farm animal husbandry has been a constraint militating against the animal industry, while there has been abundance of sawdust from the wood-milling industries causing pollution (Anigbogu and Ibe, 2005). There has been calls for research on the use of sawdust as suitable feeds in the farm animal feeding system, to help improve animal production, health and to control our environment of pollution as revealed by Anigbogu *et al.*(2011a). The limitation in the use of sawdust as feed is that, it contains about 62.1% crude fiber, a ligno-cellulosic plant material that has crystalline nature of the cellulose and recalcitrance of lignin (Anigbogu, 2011). This lignin constitutes a physical barrier to the utilization of sawdust. Though, the physical barrier of lignin could be broken down either by physical, chemical or biological treatments (Anigbogu and Ezekwem 2013). Based on the findings of Anigbogu (2011), the biological treatment of fibrous materials is not entirely new, and the biotechnological techniques are gradually being introduced in the field of animal nutrition and production throughout the globe. The introduction of the recent microbial technology using efficient microbes on the innovation of solid-state fermentation (SSF) technology based on the findings of Anigbogu *et al.*(2009a), and Anigbogu *et al.*(2011b) may be appropriate for the biological conversion of ligo-cellulosic wastes, such as sawdust to valuable feed resources, and to make enzyme hydrolysis more available in the rumen, this is found (Anigbogu and Madu-Ijeoma, 2015).

The giant African snail (*Achatina fulica*) known to be omnivorous in nature; has diastic microbes in its specialized crop with symbiotic microorganisms 'composition. This helps in the breakdown of polysaccharide into simple sugars in the crop. The crop contains a whole series of enzymes, including a cytase (cellulose splitting enzyme), which digest complex carbohydrates and plant cell walls to liberate their contents into valuable feed nutrients mainly protein and energy (Anigbogu *et al.* 2018).

Globally, it has been noted that, wildlife has great potential for meat production and serves as important source of highly needed animal protein for human race, and are widely accepted as food. The Cane rat (*Thryonomys swinderianus)* a hystricomorphic rodent, is widely distributed in the African sub-region and been exploited in most areas as source of food and animal protein. It is the most preferred and most expensive meat in the sub-region (Abioye *et al.* 2008). Feeding is the most essential factor of Cane rats in production captivity, since feed quality and quantity determines the level of output of animals under the intensive husbandry as noted by Adu (2002), and Olomu *et al.*(2003). In captivity husbandry of Cane rat, poor nutrition leads to sickness and mortality, especially among the young where low weight at birth and maturity has always been a problem. The poor availability of quality grasses and legumes and other feed resources has been recognized to make feeding a major problem, especially in the dry season (Yeboah and Simpson, 2004). So far, the knowledge in feeding Cane rats remains fundamental, and the feeding method used has proven to be inadequate for growth and reproduction (Yeboah and Adamu, 1995).

Grass being a major feed for Cane rat production, is generally poor in protein, high in fiber and low in digestibility, and generally is being constrained by inadequate supply of quality nutrients (Afocha and Anigbogu, 2011b).This is because of its poor metabolism (Alawa and Oyarole, 2004). Furthermore, in an attempt to reduce or eliminate the problem of feed scarcity, other feed resources like agro and industrial by-products which constitute a major bulk of municipal organic wastes, should be exploited as feeds for livestock and poultry (Anigbogu and Uchealor, 2014).

Materials and Methods

Experimental Site

The experiments were carried out at the Grasscutter Unit of the National Root Crop Research Institute (NRCRI), Umudike, Abia State, Nigeria. The site lies between Latitude of 5^0-28^0 North, and Longitude of 7^0-32^0 East, and at an Altitude of 123m above sea level. It is ecologically situated in the Rainforest Zone of South-East of Nigeria (Keay, 1959), with the Annual Rain Fall of 2177mm, Temperature at 22^0C – 36^0C on Relative Humidity of 50% to 90%.

Materials Used

About 100kg sawdust was obtained at the Timber-milling industry in Umuahia, Abia State, Nigeria. The feeds and the chemical compositions of the diets used are shown in Table 1. A 100ml diastic microbes suspension was obtained from a Food Microbiologist for the preparation of the inoculums, and was stored at an Ambient Temperature of 23.1^0C to 24.6^0C under laboratory room condition.

Preparation of Starter Inoculum

The starter inoculum was prepared under the laboratory condition using Fermentation vat, volume at about 10liters. The following materials were weighed and homogenously mixed: 6liters of water poured into the vat with 1500g sawdust as substrate, plus 300ml diastic microbes' suspension, then stirred to obtain a homogenous mixture. The vat mixture was kept air-thigh and at room temperature of 23.1^0C to 24.6^0C for 10 days, after which the product was used as Starter Inoculums (Fermented dough) for the experiment.

Preparation of Life-Enzyme/Degraded Sawdust

The Life-enzyme was prepared using Fermentation vat (Volume = 100 liters): 15kg of sawdust with 40liters of water added to 2kg previously fermented dough that contains diastic microbes, that acted as starter inoculum. The samples were homogenously mixed, air-tight and then allowed to degrade for 10days at room temperature of about 23.95^0C. The degraded product was harvested and sun-dried, analyzed and stored as diastic microbes degraded sawdust (DMDS) for the experiment.

Chemical Analysis

Feed samples were analyzed for dry matter, crude protein (N x 6.25), ether extract, nitrogen free extract, crude fiber and ash based on AOAC (1990).

Housing and Pen Preparation

The house and pens were cleaned of unwanted materials, and then washed with water and disinfected using detergent and Izal, respectively. After which, the pens were allowed to dry. Wood shavens were placed at level of about lcm above floor, on floor space of 60cm by 70cm per animal/pen.

Experimental Animals

Thirty weaned Cane rats of about 3 months of age were obtained from Benin Republic through a contracted agent. They were housed in individual pens with feeders and waterers, and quarantined for 3 weeks to observe their health condition, and to acclimatize to the new environment before the actual study, which lasted for 60 days from where 20 Cane rats were selected and used for the study.

Experimental Diets

The experimental diets consist of: Diet 1 = 20% Cassava meal + 0% DMDS, Diet 2 = 15% Cassava meal + 5% DMDS, Diet 3 = 10% Cassava meal + 10% DMDS, Diet 4 =5% Cassava meal + 15% DMDS, Diet 5 = 0% Cassava meal + 20% DMDS, where maize, wheat offal, rice chaff, soybean meal, palm kernel cake and 3% Cane rat concentrate mixed were used to balance the diets (Table 1).

Feeding and Watering Procedure

The animals were housed in individual cages and fed diets for 60 days. The water and diets were provided *ad libitum* to the Cane rats, first at 9:00am and later at 4.00 pm each day. Diet intake was measured by difference between each time before the next feeding

Economic Benefit Analysis

Economic benefit analysis was based on the method of Anigbogu and Adekule-Agbale (2013). The cost of dietary ingredient (₦/kg) was used to calculate the cost/kg of each diet.

i. Cost of total Feed Consumed(₦) = Total feed intake x Cost per kg feed.
ii. Cost per kg Weight gain(₦) = Cost per kg x Feed conversion ratio.
iii. Cost of production (₦) = Cost of inputs (cost of feed and Cost of Cane rat).
iv. Gross Revenue (₦) = Price/Kg Meat x Quantity (kg) of the meat.
v. Revenue (₦) = Gross Revenue – Cost of production.
vi. Cost differential(₦) = Cost/kg weight gain of Control diets – Cost/kg Weight gain of test diets.
vii. Relative cost benefit (%)

$$= \frac{\text{cost differential}}{\text{Cost/kg weight gain of control diet}} \times \frac{100}{1}$$

Experimental Design

The Complete Randomized Design (CRD) was used, while 20 experimental Cane rats selected from a population of 30 Cane rats randomly divided into 5 groups (Treatments) of 4 animals replicated per group. Each group was assigned to one of the 5 diets.

Data Collection

The initial weight of the Cane rats were determined with a weighing scale at the beginning of the study, then at weekly intervals till the end of the study for 60 days. The diets were measured before giving to the Cane rats and the left over was measured to determine their diet intakes. At the end of the study, weight gain, diet intake and feed conversion ratio were calculated.

Statistical Analysis

The Complete Randomized Design was used for the study and data collected were subjected to Analysis of Variance Procedure, while the mean Separation for Significant Effect was done using Duncan's New Multiple Range Test as described by Gomez and Gomez (2005).

Result and Discussion

Weight gain, Feed Intake and Feed Conversion Efficiency of the Cane Rats

Average daily weight gain: As in the Table 2, the average daily weight gain was significant ($p<0.05$) among the treatments. The Diet 2 had the highest with 13.30g, followed by the Diet 4, Diet 3, and Diet 5, respectively, while the poorest was observed in Diet 1 (7.50g). The improvement in the average daily weight gain as observed among the treatment groups as noted in this study was as a result of the inclusions of DMDS in the diets. The improved weight gain as seen in Diets fed DMDS Cane rats could be an indication of the imbibitions of unknown active nutriments into saw dust, due to the action of the diastic microbes during degradation for the formation of DMDS as feed material. This agrees with the findings of Anigbogu and Ezekwem (2013), Onodeko and Amubode (2002) in similar studies.

Average daily feed intake: As shown in Table 2, the average feed intake of the Cane rats showed significant ($p<0.05$) difference among the treatments. The Diet 1 had better average feed intake value of 152.10g, while the Cane rats on Diet 4 had the lowest (88.10g). The Diets 2, 5 and 3 had better results than the control, respectively; and is comparable to the studies of Adu *et al.* (1999), and Annor *et al.* (2011) in similar studies. The good performance as noted in this study could be as a result of the inclusion of the DMDS in the diets, which is as a result of the sawdust degraded diastic microbes. Though, the Cane rats had a low intake on the diets with DMDS to meet their energy/nutrients needs, as shown in this study.

Feed conversion ratio: There were significant ($p<0.05$) differences as noted in Table 2 among the treatments on the Cane rats fed diets, where the Diet 1 had the highest value of 20.28, then followed by the Diets 5, 4 and 3, while the Diet 2 had the lowest value (6.74). The best feed conversion ratio was found on Diet 2, and is because the lower feed conversion ratio, the better the diet. This implies the lesser the quantity of diet consumed to convert to 1kg weight, the better the diet (Anigbogu and Adekule-Agbale, 2013; Anigbogu and Ezekwem, 2013). The least value as observed in Diet 1(20.28) might be due to the non-inclusion of the DMDS in the diet, which retarded the ability of the Cane rats to convert the feed into product, based on the high level of carbohydrate present in the cassava meal that resulted to poor metabolism. This is as noted by Anigbogu and Anosike (2010), and Anigbogu *et al*. (2010) in similar studies, where goats and sheep were fed sawdust as part of formulated diets.

Cost Benefits Analyses

Cost/kilogram of feed: The cost/kilogram of feed among the Cane rats was significant (p<0.05) among the treatments (Table 3), where the highest cost/kilogram of feed was found on Diet 1 (₦8.39) followed by Diets 3, 2, and 5, while Diet 4 had the lowest with the value of ₦4.17. This lower cost/kilogram of feed as observed among the Cane rats fed diets with DMDS was as a result of the inclusion of DMDS in the Diets (Boateng, 2005; Anigbogu and Adekule-Agbale, 2013), which helped to reduce the cost and stimulated growth as noted in this study.

Cost/kilogram weight gain: Table 3 shows the cost/kilogram weight gain among the Cane rats was significant (p<0.05) among the treatments, where Diet 4 had the best value at ₦31.48 followed by Diets 2, 5 and 3, respectively, while the Diet 1 showed the poorest result of ₦170.15. It was noted that, the positive result of the cost per kilogram weight gain as observed in the Diets with the inclusion of DMDS could be an indication that, growth was inconsistent and costly in the absence of DMDS (Onodeke and Ambubode,2002; Anigbogu and Nwagbara, 2013). So, DMDS is needed to be included in Diet 1 to get the same proportion of weight gain as in the DMDS Cane rats fed diets. All other diets containing DMDS were observed to require lesser amount of feed intakes to obtain a measure of weight gain (Onyeanusi, *et al.* 2008; Anigbogu *et al.* 2009b).

Cost of production: As shown in Table 3, the cost of production was significant (p< 0.05) among the Cane rat treatment diets, though Diet 4 had the lowest cost of production (₦804.20) followed by the Diet 3, while the highest were generally noted on the Diets 5, 1 and 2, respectively; which is in agreement with Fayenuwo *et al.* (2003), and FAO (2013).

Gross revenue: The gross revenue of the Cane rats as shown in Table 3 differed significantly (p<0.05) as noted among the diet treatments with DMDS. The best was observed in Diet 5 (₦1700.00), followed by Diets 3, 4, and 2, respectively, while the poorest was obtained in Diet 1 (₦1400.00). The poor result as observed in Diet 1 could be as the result of the non-inclusion of DMDS in the Cane rat diet. The best gross revenues were obtained among the diets with the DMDS inclusion, which resulted to better performances, when the DMDS was fed to the Cane rats as part of formulated diets and as revealed in this study (Anigbogu and Ezekwem, 2013; Jori *et al.*, 1995).

Revenue: The revenue for the Cane rats as found in Table 3 was significant (p<0.05) among the treatment groups. The poorest value of ₦491.61 was recorded on the Diet 1 and 2, respectively, while the highest was found in Diet 3 (₦795.20) followed by Diets 4 and 5, respectively. The best values as noted among the DMDS Cane rats fed diets could be as a result of degradation of sawdust with diastic microbes, and included as part of formulated diets that resulted to better weight gain and commanded a good price for better profits. This is in line with and comparable to the studies of Jori *et al.* (1995), and Fayenuwo *et al.* (2003); who worked on Cane rats and rabbits with their market potentials and cost implications on food security.

Relative cost benefit: Table 3 showed that the relative cost benefit differed significantly (p<0.01) and generally among the diets fed Cane rats, the value was high in Diet 4 (81.51%), followed by Diets 2, 5, 3, while Diet 1 (0.00%) had the least result. The best values obtained were found among the diets with DMDS fed Cane rats, which were as a result of the degrading sawdust with diastic microbes to obtain better gain, feed conversion ratio and lower feed intake. Onyeanusi *et al.* (2008), Afocha and Anigbogu, (2011a) had comparable results using Cane rats as experimental animals in similar studies.

Cost differential: While the cost differential was significant (P<0.01) among the treatments as noted in Table 3. The value was better in Diet 4 (₦138.67), followed by Diets 2, 5 and 3, respectively, where the least was observed in Diet 1 (₦0.00). These best values obtained in Cane rats fed Diets with DMDS could be an indication of efficient utilization of sawdust as treated product that resulted to better weight gain that commanded good prices. Generally, this resulted to better economic returns noted in this study, and is in line with the finding of Boateng (2005), and Bulletin BEDIM (2005).

Other Observations/Medicinal Traits of DMDS fed Cane Rats

During the quarantine of the experimental Cane rats, an outbreak of diseases was noted that led to general health disorders and sickness (pneumonia, diarrhoea, etc.) among the animals. The administration of drugs was done to the Cane rats with the help of the health officers and the illness persisted. There was a great response when the DMDS treated diets were given to the Cane rats, and after some days, they started to recover. Furthermore, there was increase in feed intake and efficiency of weight gain among the Cane rats. Favourable results were generally noted among the DMDS fed Cane rats with Diet 2 to Diet 5. Based on our observations it was noted that, DMDS product exhibited favourable health/medicinal traits by controlling the un-beneficial factors that caused the unhealthy condition to the Cane rats. It aided the high metabolic rate on the Cane rats and conserved energy to the animals (Awah-Ndukum *et al.,* 2001). Continuous feeding of DMDS based diets after the 15 days quarantine significantly improved not only the health of the Cane rats, but their rate and efficiency of gain, feed intake, together with other parameters studied (Anigbogu *at el.,* 2018; Yaboah and Adamu, 1995; Opara and Fagbemi, 2008a; Opara and Fagbemio, 2008b).

As revealed in this study, the energy availability from sawdust in its true form is limited due to its complex fiber concentration and ligno-cellulosic materials, with the recalcitrance of lignin that constitutes the physical barrier in the utilization of sawdust in its untreated value, as was previously revealed by Anigbogu (2011) and Anigbogu (2013). Because, the diet is slowly and incompletely metabolized as in the Diet1 which resulted to the poor performance among the Cane rats fed the said diet. While the cell soluble incorporated into sawdust as a result of the diastic microbes degradation as noted in Diets 2, 3, 4 and5 fed Cane rats; with DMDS as feed component of formulated diets were almost and completely metabolized (Bifarin *et al.* 2008, Borin *et al.* 2005, Caspary 1999). This resulted to better energy yield (Afocha and Anigbogu 2011a). Thus, since the proportion of fiber to cell soluble is a major determinant of energy availability in sawdust. Sawdust normally has high fiber than cassava meal. DMDS fiber is more digestible and effective than that of non-degraded sawdust; here the DMDS diets fed Cane rats digested at a faster rate (Afocha and Anigbogu 2011b). According to Anigbogu and Associates, it was observed that ruminants digest 40–50% of legume fiber and 60–70% of grass fiber. From this study, it is clearly observed that most fiber cannot be digested no matter how long it remains in the rumen of the animal. Lignin is among the interfering factor with microbial degradation of fiber polysaccharides. This acts as a physical barrier and as a cross-linked to polysaccharides by ferulate bridges (Afocha and Anigbogu, 2011a; Afocha and Anigbogu, 2011b). However, in addition to the effects of lignin, physical and structural barriers may limit fiber digestibility in the sawdust and wood by-products as further noted in this study. Based on the observations of Anigbogu and Obioma (2015), the middle lamella and the primary wall of thick-walled cells of woods and wood by-products are also highly lignified, in such case; many cells can be digested only from the interior of the cell or when properly processed. For many cells, access to cell interiors is limited because of large particle sizes. In this case woods and wood by-products must be reduced to smaller particles before feeding to farm animals (Anigbogu and Ezekwem, 2013). Based on our observations as in this study, roughage metabolism such as in sawdust could be improved by reducing the amount of lignified cells, and by microbial degradation or by developing improved cultivars so that, lignified cells will be digestible and acceptable to the animals (Anigbogu and Obioma, 2015; Belewu and Popola, 2007).

In our study it was noted that, the Cane rats fed DMDS diets were generally healthy when compared to those fed the Diet 1, which exhibited poor and unhealthy conditions. We also noted that, the diastic microbes' metabolites to be generally safe in the microbial ranking as feed material as in this study. Medicinal properties (antibiotics, vitamins and other essential metabolites) that might have imbibed into the sawdust by the action of the daistic microbes could be another factor that contributed to the healthy condition of the Cane rats fed the DMDS (Anigbogu *et al.,* 2018). If the sawdust could be treated with diastic microbes to produce DMDS as feed for the livestock and poultry, this could help to minimize environmental pollution, help improve health generally and contribute to the environmental friendliness as well as serve as component of the formulated farm animal diets (Afocha and Anigbogu, 2011a; Anigbogu, 2013).

Conclusion

The results of this study have shown that:Diastic microbe degraded sawdust (DMDS) can be used as a component of feed in Cane rat diets. The incorporation of up to 20% DMDS in the diets improved weight gain, feed conversion efficiency and economic benefit of the cane rat in captivity. The DMDS when used as component of feed in the Cane rat feeding system could help solve the problem of sawdust waste disposal, and help improve the environment. It is thereby recommended that in places where sawdust is cheap and abundant, farmers should be encouraged to use them in nutritional system for Cane rat up to 20%, when degraded with diastic microbes. There is the need for further studies of diastic microbes degraded sawdust in the Cane rat feeding system and in other livestock and poultry. The utilization of the sawdust wastes in the Cane rat feeding nutrition could help solve the problem of sawdust waste disposal and as feed for Cane rats.

Acknowledgements
The recognition of 1st position in Sample Records for *Zymomonas mobilis* Cells treated sawdust in the world by the WorldWideScience.org, and the commendation by the Michael Okpara University of Agriculture Umudike on the above achievement to the 1st author, Prof. N.M. Anigbogu is gratefully acknowledged. The material assistance and expertise on the study of *"Growth and Economic Benefits of Cane Rats Fed Diastic Microbes Degraded Sawdust: A Solid Waste Management Strategy*" provided by him is well appreciated. The authors also extend many thanks to the Dr. J. C. Okonkwo, a former Executive Director, National Root Crop Research Institute (NRCRI), Umudike, Abia State, Nigeria for approving the conduct of this work in the Grasscutter Unit of the National Root Crop Research Institute (NRCRI), Umudike, Abia State, Nigeria, also the authors send great thanks to referenced authors whose works were sighted in this study.

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Table 1: Feed Composition of Cane Rats Fed the Experimental Diets (Kilograms)

Compositions	**Diet 1**	**Diet 2**	**Diet 3**	**Diet 4**	**Diet 5**
Cassava meal	200.00	150.00	100.00	50.00	0.00
DMDS	0.00	50.00	100.00	150.00	200.00
Maize	200.00	200.00	200.00	200.00	200.00
Wheat Offal	150.00	150.00	150.00	150.00	150.00
Rice chaff	20.00	20.00	20.00	20.00	20.00
Soybean meal	200.00	200.00	200.00	200.00	200.00
Palm kernel cake	200.00	200.00	200.00	200.00	200.00
3% Cane rat Conc. Mixed[1]	30.00	30.00	30.00	30.00	30.00
Total	1000.00	1000.00	1000.00	1000.00	1000.00
Chemical Analysis (%)					
Crude Protein	16.94	17.04	17.26	17.42	17.50
Oil (Ether)	4.31	4.37	4.36	4.34	4.35
Crude Fibre	7.56	10.13	14.69	12.91	17.82
Ash	4.965	5.035	4.695	5.175	4.425
Calcium	0.811	0.811	0.811	0.811	0.791
Phosphorous	0.606	0.608	0.621	0.614	0.634
Available Phosphorus	0.327	0.327	0.344	0.328	0.361
Salt	0.301	0.303	0.346	0.305	0.391
Lysine	1.290	1.294	1.072	1.293	1.678
Available Lysine	0.862	0.863	2.518	0.865	4.174
Methionine	0.401	0.408	0.500	0.408	0.599
Methionine + Cystine	0.649	0.649	0.807	0.699	1.075
MER/M/J/Kg[2]	9.490	9.760	9.270	10.300	9.050
Digestible Energy/MJ/Kg	13.130	13.430	13.430	14.030	15.550

[1]Cane rat 3% conc. Mixed: Protein 0.2%, Oil 0.0% ,Fibre 0.0%. Ash 1.27,%, Calcium 0.3%, Phosphorus 0.20%, Available phosphorus 0.28%. Salt 0.2%, Lysine 0.078%, Methionine 0.10%, Methionine + Cystine 0.10%, MER 0.04 MJ/KG. Vitamin A IU, 8,000,000;Vitamin D_3 Iu, 2,000,000;Vitamin E mg 8,000;Vitamin k_3 mg 2,000; Vitamin B_1 mg 1,500;Vitamin B_2 mg, 4,000;Vitamin B_6 mg 1,500; Vitamin B_{12} mcg,10;Niacin mg 15,000;Panthotenic acid mg, 5,000; Folic acid mg 5,000; Biotin mcg, 20;Cholinchloride mg,100,000;Manganese mg, 75,000;Zinc mg 45,000;Iron mg, 20,000;Copper mg 4,000;Iodine mg 1,000;Selenium mg,200;Cobalt mg,500;Antioxidant mg, 125,000;Viscosity strength 680 (BU). [2]MER = Metabolized Energy Ruminant; MJ/Kg = Mega Joule/Kilogram.

Table 2: Weight Gain, Feed Intake and Feed Conversion Ratio of Cane Rats Fed Experimental Diets

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Sig
Initial weight /g	800.00	850.00	900.00	900.00	900.00	ns
Average daily weight gain/g	7.50^{d}	13.30^{a}	10.83^{c}	11.67^{b}	10.00^{c}	**
Average daily feed intake/g	152.10^{a}	89.60^{b}	95.40^{b}	88.10^{b}	93.50^{b}	**
Feed conversion ratio	20.28^{a}	6.74^{b}	8.81^{b}	7.55^{b}	9.35^{b}	**

^{a,b,c} Means in the same row with different superscripts differ significantly at 1%. ** = P<0.01; not significant at 5%. ns = P>0.05.

Table 3: Cost Benefits of Cane Rats Fed the Experimental Diets [Naira (₦)]

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Sig
Cost/kg feed	8.39^{a}	4.71^{b}	4.76^{b}	4.17^{b}	4.19^{b}	**
cost/kg weight gain	170.15^{a}	31.75^{c}	41.94^{b}	31.48^{c}	39.18^{b}	**
Cost of production	908.40^{b}	904.70^{b}	804.80^{c}	804.20^{c}	1104.10^{a}	*
Gross revenue	1400.00^{c}	1500.00^{b}	1600.00^{b}	1550.00^{b}	1700.00^{a}	*
Revenue	491.60^{c}	595.30^{b}	795.20^{a}	745.80^{a}	595.90^{b}	*
Cost differential	0.00^{c}	138.40^{a}	128.21^{b}	138.67^{a}	130.97^{b}	**
Relative cost benefit (%)	0.00^{b}	81.34^{a}	75.35^{a}	55.60^{a}	33.30^{a}	**

Means in a row with different superscript were significant different (P< 0.05, p<0.01).