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Comparative value of kola testa, corn-bran and rice- bran with maize for mature african giant land snail *(Archachatina marginata)*

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Abstract

This study was designed to compare the effect of kola testa, which is rich in fibre with maize the conventional energy source and other sources of fibre such as corn bran and rice bran. A total of two hundred and forty African giant land snails (Archachatina marginata) with an average live weight of 177.69 ± 10.87g were assigned to four dietary treatments: a maize-based diet (Diet 1) served as control, in a completely randomized design. The other diets were kola testa – based (Diet 2), corn bran – based (Diet 3) and rice bran-based (Diet 4) diets. The percentage of each test ingredient and that of maize was 31.30g/100g. Each treatment consisted of sixty growing snails, which were subdivided into 3 replicates of 20 snails each. The snails received the diets over a period of 20 weeks. Weight gain was significantly higher (P<0.05) for the kola testa-based diet in comparison with the corn and rice bran-based diets. Depression of magnesium and iron in the shell, flesh and fluid of snails fed corn and rice bran diets was observed. The trial revealed that kola testa-based diet compared favorably well with the corn and rice bran- based diets.

Key words: Kola testa, fibre sources, snails, performance, mineral profile

Introduction

Microlivestock has a great potential of supplying the much-needed animal protein in human diet (Morkramer, 1992). African giant snail (*Archachatina marginata*) is one of the microlivestock that could serve as ready meat for a vast majority of the populace especially in the tropics (Ngoupayon, 1992). It has a highly palatable flesh of about 60% crude protein on a dry matter basis and shell made up of calcium carbonate (Stievenant, 1992). Snail meat competes favourably with poultry egg and meat in essential amino acids and digestible protein (Imevbore, 1990).

Snail as microlivestock, has recently attracted attention among agriculturists and farmers in Nigeria as an aftermath of the alarm raised by Food and Agriculture Organisation (FAO) on animal protein deficiency among Nigerians (Akinnusi, 2000). Unfortunately, the conventional and regular sources of animal protein supply in the country like beef, pork, goat meat and poultry meat, are getting out of reach of the common populace due to economic down-turn. The challenge falls on the micro- livestock with which Nigeria is richly endowed. This study focuses on the snails as one of such micro- livestock. The high reproductive rate of the snail coupled

with its non- religious bias in Nigeria is an added advantage to its production. The snail (especially the African giant land snail) is common in Nigeria and it is an excellent source of animal protein. It has small body size and it is easy to manage (Nodu and Adesope, 2002). It forms a very important part of the diet of many households in the rainforest belt. Snails occur in the wild and are gathered by villagers for consumption and for sales. The snails consumed in Togo had its source from different gathering or handpicking (Leboterf, 1981).

It is also to be recalled that the role played by snails in pharmacopoeia cannot be over-emphasized. This includes the wet inner part, which has curative effects on different ailments; the flesh without fat, is very useful in human nutrition, the ground flesh perhaps can be able to replace fish flour, and the shell in nutritional formation of animal diets as calcium source etc (Mondain, 1993; Morkramer 1990).

The conventional feeds of snail as reported by Awesu (1980), Akinnusi (1998), Amusan, *et.al.*, (1998), Ayodele and Asimolowo (1999) comprise of breadfruit, waterleaf, pawpaw leaf and fruit, sweet orange, mango fruit, ripe fruit of plantain and banana, etc. These feeds are mainly of plant origin, seasonal, perishable, and relatively scarce during the dry season and cannot supply all the nutrients needed for optimum performance of snail partly due to their fibrous nature.

Van Soest and Robertson (1979), defined fibre as the polymeric substance from plants that are resistant to mammalian digestive system. The fibre content of a feedstuff is therefore an important factor determining the nutritive value. This is because it largely determines the proportion of chemically available nutrients, which can be utilized by animals. In some monogastrics, the volatile fatty acids produced as a result of microbial fermentation of fibre residue are irritants that stimulate peristalsis. The use of fibre as a treatment for lowering cholesterol cannot be overemphasized. A reduction in cholesterol level in man on consumption of 2.6g of oat bran a day was reported (Ferdinandez and Hattner, 1999). The present study was therefore designed to compare the utilization of kola testa (DKT) in comparison with corn bran (CB) and rice bran (RB) to maize (MZ) by African giant land snail.

Materials and Methods

Animals and diets

The cage used was made of a wooden frame. The base was however made of metal lined with wire mesh to hold the soil and snails but allowed water drainage while preventing entrance of rodents. The wire mesh was covered with a jute bag on which the soil was spread. The sides and the top of the cage were covered with mosquito net and reinforced with wire mesh. The net was meant to prevent entrance of rodents and flies from the sides. The feeding trial was conducted in wooden cages containing 12 compartments each of which was 0.5 x 0.5 x 0.5m^3 in size. The legs of the cages were dipped in plates containing engine oil to prevent ants from climbing the cage. Loamy soil was used as bedding material inside the individual units to a level of about 6.5cm depth. Dried kola leaves were used as mulching material in the cage since the snails do not feed on them. A total of two hundred and forty African giant land snails (*Archachatina marginata*) with an average weight of 177.69 $\pm$ 10.87 were used for this experiment, which lasted 20 weeks. Four experimental diets were formulated in order to assess the quality of kola testa when compared with other known dietary fibre sources. The treatments were maize-based (Diet 1, control); Kola testa-based (Diet 2); Corn bran-based were incorporated at 31.30kg diet in diets 1, 2, 3 and 4 (Table 1). The experiment was designed as a Completely Randomized Designed (CRD).

Sixty (60) growing snails were allocated to each treatment containing three replicates of 20 snails each. After an initial adaptation period of one week, individual measurements were made: A vernier caliper was used to measure the shell breadth (the length of the middle of the shell), aperture radius and shell length (longest part of the shell to the tip) while feed intake and weight gains were taken on a weekly basis using an electronic balance.

Carcass analysis

At the end of the feeding trial, 24 snails were selected randomly from each treatment. The snails were washed thoroughly with clean water and starved overnight. They were killed by striking an iron rod carefully on the snail shell. The shells of the snails were removed and the individual parts - the shell, the visceral and flesh were then separately weighed using an electronic balance. The data generated was analyzed using the Statistical Analysis System Package (SAS, 1999).

Sensory appraisal

The foot of the slaughtered snails from each replicate was washed with alum. They were cooked separately in 300mls of water with 3g salt at 60°C for 15 minutes and fried to tenderness. The fried snail was served to panelists together with drinkable water, for mouth rinsing before and after each test. Twenty (20) copies of questionnaire were distributed to panelists to assess the flavour, taste, mouth feel, chewness and overall acceptability. Ratings were based on nine (9) – point hedonic scale with 1 corresponding to extremely dislike and 9 extremely like (Larmond, 1977).

Digestibility trial

The digestibility trial was carried out at the end of the feeding trial. Four mature snails were randomly assigned to each treatment and housed in a cage of 0.2 x 0.2m^2 compartment lined with foam of 0.5cm height as bedding material for easy collection of the excreta. The snails were fed with the same diets offered during the feeding trial. Each treatment was replicated four times. Records on feed intake and excreta were taken on a daily basis with the use of electronic weighing balance. The daily excreta from each replicate were dried to a constant weight at 80°C in the oven. The dried samples were ground in a hammer mill and stored at room temperature for proximate analysis. The digestibility trial lasted 14 days: 11 days for excreta collection and 3 days for acclimatization. The gross energy content of the feed was determined using a ballistic bomb calorimeter.

Chemical assay

The samples of excreta collected for each replicate were oven dried and ground in a hammer mill to a mesh size of 1mm. Similarly, samples of diets were ground to the same 1mm before analysis. Samples were analyzed for dry matter by drying in an oven at 105°C and ashed in a furnace at 550°C using the AOAC (1990) method. The gross energy was measured with a Peribol calorimeter (Parr 1261, Moline Illinois, and USA). To determine the mineral contents of the four test ingredients (maize, kola testa, corn bran and rice bran), the shell, snail flesh (edible portion), were ashed at 600°C. The snail fluid, and the ashed samples were then acid digested according to the method of AOAC (1990) and analyzed for nitrogen, phosphorus, calcium, magnesium, iron and copper in an atomic absorption spectrophotometer (AAS, Model 703).

Results

The proximate composition of experimental diets is shown in Table 3. The differences in the test diets appeared distinctly in the crude fibre content. The pattern can be summarized as RB > CB > KT > MZ. The values of the crude protein,

Table 1: Gross composition of experimental diets

Ingredients	Diets			
	Maize-based	Kolatesta-based	Corn bran-based	Rice bran-based
Maize	31.30			
Kola testa		31.30		
Corn bran			31.30	
Rice bran				31.30
Brewers dried Grain	10.00	10.00	10.00	10.00
Wheat offal	6.00	6.00	6.00	6.00
Palm Kernel Cake	4.20	4.20	4.20	4.20
Groundnut cake	10.00	10.00	10.00	10.00
Soyabean meal	25.00	25.00	25.00	25.00
Fish meal	4.00	4.00	4.00	4 .00
Oyster shell	8.05	8.05	8.05	8.05
Bone meal	1.20	1.20	1.20	1.20
Premix	0.25	0.25	0.25	0.25
Total	100	100	100	100
Calculated Analysis:				
Crude Protein (%)	23.95	24.44	24.21	24.31
Metabolisable Energy(kcal/kg)	2499.85	2326.35	2339.21	2396.33

Table 2: Proximate and mineral composition of components of test ingredients (%DM)

*Constituents	Samples			
	Maize	Kola testa	Corn bran	Rice bran
Crude Protein	9.600	13.200	13.100	13.100
Ether extract	4.900	1.400	13.600	13.600
Ash	1.600	12.170	10.400	10.400
Nitrogen	1.600	2.600	1.200	2.100
Phosphorus	0.320	0.180	0.210	0.003
Calcium	0.040	0.300	0.020	0.004
Magnesium	0.101	0.550	0.120	0.110
Iron	0.003	0.100	0.001	0.001
Copper	0.010	0.140	0.002	0.002

* **Average of six determinations**

Table 3: Proximate analysis of experimental diets (%)

	Diets			
***Constituents**	**Maize-based**	**Kola testa-based**	**Corn bran-based**	**Rice bran-based**
Dry matter	89.68	90.72	91.22	90.52
Crude protein	24.27	24.39	24.52	24.41
Crude fibre	3.49	4.73	4.79	5.28
Ash	8.61	8.73	9.02	8.94
Ether extract	3.53	3.46	3.62	3.51
Nitrogen free extract	60.10	59.69	59.05	9.46
Energy (kcal/g)	3.51	3.21	3.15	3.32

*Average of six determinations

ether extracts, and ash contents were similar. The energy value of the maize-based diet was higher than other diets.

The results obtained for mean weekly feed intake presented in Table 4 showed that there were significant differences ($P < 0.05$) among the treatment means. The mean weekly feed intake of 25.21, 26.92, 27.93 and 25.25g were recorded in maize-based, kola testa-based, corn bran-based and rice bran-based diets respectively.

The weight gain of experimental snails (Table 4) was significantly affected by the dietary treatments ($P < 0.05$). The results showed that snails on the maize-based diet had the highest mean weight gain of 188.70g while the least mean weight gain of 158.72g was observed in corn bran-based diet. The mean shell length, width aperture and thickness increments showed no significant differences ($P > 0.05$) among the treatment means.

Table 4 summarizes the nutrient digestibility data among the treatments. Dry matter, crude protein, nitrogen free extract, crude fibre and ash digestibility were significantly ($P<0.05$) higher in the control diet (Maize-based). The nutrient digestibility pattern among the treatments is shown as follows: maize-based> kola testa-based> corn bran-based> rice bran-based diet.

Table 4 presents results of foot yield, visceral and shell components of the snails. Foot weight was significantly different ($P < 0.05$) in snails on the diets. The highest value and the least value were found in snails fed maize-based and rice bran-based diets respectively. The values of the shell weight and shell/liveweight visceral/ liveweight percentages were significantly different ($P > 0.05$) among the treatment means. The different diets had no significant ($P > 0.05$) influence on the ratings of the mouth feel, chewness and overall acceptability of the snail meat However, significant differences ($P < 0.05$) occurred in flavor and taste of snail meats among the treatments.

Table 2 presents the mineral profile of the test ingredients. The patterns of the content of nitrogen, phosphorus, calcium, magnesium, iron and copper in the ingredients are shown as follow: nitrogen (Kola testa > Rice bran >Maize > Corn bran), phosphorus (Maize > Corn bran >

Table 4: Performance characteristics and Nutrient digestibility of mature snails fed fibrous diets

Parameters	Diets				
	Maize-Based	Kola testa-Based	Corn bran-based	Rice bran-based	SEM
Mean weekly Feed intake (g/s)	25.21[c]	26.92[b]	27.93[a]	25.25[c]	0.11
Mean total weight gain(g/s)	188.70[a]	176.70[b]	158.72[d]	169.60[c]	0.21
Mean total shell length increment(cm/s)	3.57	3.68	3.70	3.59	0.01
Mean total shell width increment (cm/s)	1.80	1.82	1.87	1.80	0.23
Mean total shell aperture increment(cm/s)	1.38	1.44	1.44	1.39	0.61
Mean total shell thickness increment(cm/s)	1.24	1.27	1.21	1.29	0.01
DM feed Intake (g)	3.57[a]	3.77[a]	3.83[a]	3.63[a]	0.19
DM Excreta (g)	0.60[a]	0.67[a]	0.73	0.68[a]	0.06
DM Digestibility (%)	73.19[a]	62.32[b]	70.94[a]	61.27[b]	1.02
Crude Protein	75.79[a]	65.31[d]	72.71[b]	70.66[c]	0.47
Digestibility (%) Nitrogen Free	79.71[a]	70.68[c]	74.97[b]	68.56[d]	0.22
Extract Digestibility Crude Fibre	5.53[a]	74.18[b]	72.11[c]	71.53[c]	0.30
Digestibility (%) Ash Digestibility (%)	79.65[a]	76.05[b]	54.56[c]	53.72[cd]	0.46

abcd- means on the same row with different superscripts are significantly different ($P < 0.05$).
SEM- Standard Error of Means.

Kola testa > Rice bran>), calcium (Kola testa > Maize > Corn bran > Rice bran), magnesium (Kola testa > Corn bran > Rice bran > Maize), Iron (Kola testa > Maize > Corn bran = Rice bran) and copper (Kola testa > Maize > Corn bran = Rice bran).

Table 5 shows the mineral profile of snail components (shell, flesh and slime). In the shell, the phosphorus was found in trace amounts. The iron and copper contents were not detected. It was observed that. there were no significant differences ($P > 0.05$) in the contents of nitrogen and calcium, but significant differences ($P < 0.05$) occurred in the magnesium contents of the shell of snails on the different diets. The shell of snails on maize-based diet had the highest magnesium content while the least content was recorded in snail fed rice bran-based diet. In the flesh, copper was not detected. It was observed that there were no significant differences ($P > 0.05$) in the

Table 5: Effect of feeding different fibrous diets on the mineral profile of snail (Archachatina marginata) components[1].

Source	Constituents	Maize-Based	Kola testa-based	Diets Corn bran-Based	Rice bran-based	SEM
Shell	Nitrogen (%)	0.11^{a}	0.13^{a}	0.10^{a}	0.10^{a}	0.001
	Phosphorus (%)	trace	trace	trace	trace	-
	Calcium (%)	12.5^{a}	12.6^{a}	12.3^{a}	12.5^{a}	0.31
	Magnesium (mg/kg)	37.5^{a}	30.6^{b}	17.9^{c}	16.3^{d}	0.12
	Iron (mg/kg)	nd	nd	nd	nd	-
	Copper (mg/kg)	nd	nd	nd	nd	-
Flesh	N (%)	9.16^{a}	9.15^{a}	9.11^{a}	9.07^{a}	0.26
	P (%)	0.28^{a}	0.26^{a}	0.28^{a}	0.27^{a}	0.04
	Ca (%)	0.25^{a}	0.26^{a}	0.26^{a}	0.23^{a}	0.03
	Mg (mg/kg)	6.75^{a}	6.72^{a}	2.57^{b}	2.78^{b}	0.07
	Fe (mg/kg)	275^{a}	280^{a}	124^{b}	112^{c}	7.85
	Cu (mg/kg)	nd	nd	nd	nd	-
Fluid	N (%)	0.20^{a}	0.18^{a}	0.21^{a}	0.18^{a}	0.01
	P (%)	0.06^{a}	0.05^{a}	0.05^{a}	0.07^{a}	0.06
	Ca (%)	0.09^{a}	0.08^{a}	0.08^{a}	0.09^{a}	0.001
	Mg (mg/kg)	75.0^{a}	72.5^{b}	33.4^{c}	32.1^{cd}	1.03
	Fe (mg/kg)	1.00^{a}	0.92^{a}	0.47^{b}	0.39^{b}	0.001
	Cu (mg/kg)	49.5^{a}	50.4^{a}	48.9^{a}	48.8^{a}	3.28

abcd – Means on the same row with different superscripts are significantly different ($P < 0.05$).
nd – not detectable
[1]Means are an average of six determinations

T able 6: Carcass Analysis

No of snails	24	24	24	24	
Mean liveweight (g/s)	370.02^{a}	368.72^{a}	367.81^{a}	369.67^{a}	0.14
Foot weight (edible portion)(g)	170.21^{a}	161.49^{b}	139.77^{c}	133.08^{d}	0.73
Viscerals (g)	85.10^{c}	92.23^{b}	99.31^{a}	99.81^{a}	2.31
Shell weight (g)	92.51^{c}	99.55^{b}	110.34^{a}	110.90^{a}	2.41
Dressing (%)	45.98^{a}	43.83^{a}	38.01^{b}	36.06^{b}	2.10
Shell Liveweight (%)	25.10^{a}	27.08^{b}	30.03^{b}	29.90^{a}	1.61
Visceral Live weight (%)	22.99^{a}	24.88^{b}	26.92^{a}	27.03^{a}	0.0

abcd- means on the same row with different superscripts are significantly different ($P < 0.05$)
SEM- Standard Error of Means

Table 7: Sensory evaluation of snail meat fed different fibrous diets

Sample	Flavour	Mouth feel	Taste	Chewness	Overall Acceptance
HRA_1	7.74^b	8.74^a	8.29^b	8.77^a	8.85^a
HRA_2	8.63^a	8.81^a	8.71^a	8.19^a	8.73^a
HRA_3	7.46^b	8.68^a	8.33^b	8.79^a	8.64^a
HRA_4	7.56^b	8.76^a	8.55^{ab}	8.88^a	8.84^a
Means	7.84	8.75	8.44	8.79	8.77
S.E	0.22	0.20	0.22	0.21	0.21

ab- means on the same column with different superscript are significantly different ($P < 0.05$).
HRA_1-Snail meat from maize-based diet
HRA_2-Snail meat from Kola testa-based diet
HRA_3-Snail meat from corn bran-based diet
HRA_4-Snail meat from rice bran-based diet

Table 8: Economic analysis of mature snails fed fibrous diets

Measurements	Diets			
	Maize-based	Kola testa-based	Corn bran-based	Rice bran based
Average daily feed intake (g/snail)	3.60	3.85	3.99	3.61
Total fed intake (g/snail)	540.00	577.50	598.50	541.70
Body weight gain (g/snail)	188.70	176.70	158.72	169.60
Feed cost (N/snail)	21.83	19.36	22.32	19.84
Feed cost (₦ /kg diet)	40.42	33.53	37.29	36.66
Feed cost (₦ /100kg diet)	4042.03	3353.43	3729.09	3666.43
Feed cost saving (%)	0.00	17.05	7.74	9.30

abcd – Means on the same row with different superscripts are significantly different ($P < 0.05$). The costs of feed ingredients (₦ /Kg) were maize, 25; kola testa, 3; corn bran, 15; rice bran, 13; BDG, 7.5; wheat offal, 13; PKC, 10; GNC, 44; SBM, 63; fishmeal, 220; oyster shell, 6.5; bone meal, 31; vit-min premix, 320.

contents of nitrogen, phosphorous and calcium, but significant differences ($P < 0.05$) occurred in the magnesium and iron contents of the snail flesh on the different diets. The flesh of snails on both kola testa based and maize-based diets had the highest iron and magnesium contents while the least contents were found in snail on corn bran based and rice bran-based diets respectively. In the slime, all the minerals studied were detected. It was observed that, there were no significant differences ($P > 0.05$) in the contents of nitrogen, phosphorus, calcium and copper but significant differences ($P < 0.05$) occurred in the magnesium and iron contents of the snail slime on the different diets. The slime of snails on maize-based diet had the highest magnesium content while the least content was recorded in snail fed rice bran-based diet.

The slime of snails on both maize-based and kola testa - based diets had the highest iron content while the least content was recorded in snails fed corn bran based and rice bran-based diets respectively.

The results of the economic analysis of the experimental diets are shown in Table 8. It was observed that the maize-based diet was the most expensive (₦40.42/kg diet) while kola testa based diet was the cheapest (₦ 33.53/kg). The feed cost saving (%) in relation to the control was found to be significant ($P < 0.05$).

Discussion

Fibre is often used as a negative index of nutritive value in the prediction of total digestible nutrients and net energy (Van Soest, et. al., 1991). The high crude fibre contents of the rice and corn brans suggest a low nutritive value for the snails. Though, kola testa is fibrous in nature, it has lower fibre than the rice and corn brans and hence the next most utilized after maize, which is known to be a feedstuff with a more balanced and richer nutrient content.

Snails on the control diet consumed the least amount of feed. This could be due to less bulk (Table 4). Ogutuga (1975) reported that the palatability of kola testa is due to the presence of sugar and polyphenolic compounds. This may partly explain the characteristic high feed intake recorded by snails fed kola testa-based diet.

Variation occurred in the chemical composition of the dietary fibre sources (Table 3) used in this study; hence one would expect differences in the physical, biological and nutritional properties of the different sources. The reduction in the rate of body gain observed in this study may be due to the high level of fibre in the corn and rice brans. This assertion has been supported by a similar report (Thompson and Weber, 1981). The authors reported that the brans, especially, the rice bran, resulted in lowered performance when 6% of it was included in the diet of poultry chicks. The depression in the foot weight is as a result of the impairment of the snails' tissue growth, which was caused by the inhibition of nutrient absorption by the fibre constituents of the corn and rice bran, and to a lesser extent, kola testa (Thompson and Weber, 1981). The significant differences ($P < 0.05$) observed for taste, flavor and mouth feel in HRA_2 for the sensory assessment of the snail meat, could be as a result of total polyphenol (a flavor impacting chemical component) in kola testa.

Kola testa is a good source of mineral. This is due to its high ash content (Table 2). The depression in the contents of magnesium in the shell, flesh and slime components of the snails on corn and rice bran diets and to a lesser extent on kola testa, was as a result of complexing of magnesium ion with pectin in the cell wall (Selvendran, 1987). This effect was not noticed in the maize-based diet. The high content of magnesium in kola testa and magnesium and iron in snail flesh notwithstanding, there were depression of magnesium in snails fed kola testa and iron and magnesium in snails fed corn and rice bran diets. This might be as a result of their phytate contents, which inhibited their absorption (Cilli and Hevia, 1989). In assertion, dietary fibre may also result in an inhibition of mineral absorption. Under certain conditions, some feedstuffs (wheat, corn and rice bran), high in complex carbohydrate may reduce the bioavailability of essential minerals by impairing intestinal absorption as a result of the active mineral-binding constituent called phytate (Fairweather-Tait and Wright, 1990).

The snail slime is generally a good source of minerals. This is shown by its high contents of the minerals, most especially magnesium, copper

and iron. The shell is a very good source of calcium and magnesium while the snail flesh (edible part) is revealed to be very rich in iron, magnesium, phosphorus, calcium, and nitrogen. The high content of iron in snail meat makes it useful in correcting the problem of iron deficiency in man (Cobbinah, 1992). In respect of mineral iron, together with the high quality protein is vital in the formation and maintenance of red blood cell and prevention of anaemia. Snail meat is one of the best sources of phosphorus. Phosphorus, like calcium, is an essential component of bones and teeth and is essential for muscles, fetal development, lactation, nerves and many organs. However conventional meat sources are poor sources of calcium (Ikeme, 1990). But the snail meat is very rich in calcium, containing about 212.38mg/100g (Adeyeye, 1996). The gain in weight, sensory qualities and economic analysis of the diets revealed the following trend: maize-based > kola testa-based> rice-bran based > corn-bran based. This study indicated that kola testa – based diet compared favourably well with the corn and rice bran - based diets, hence valuable as feed resource for snails.

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