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Full Length Research Paper

Performance, proximate and mineral analyses of African giant land snail (*Archachatina marginata)* fed different nitrogen sources

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The effect of different nitrogen sources in the diets offered to caged African giant land snail, *Archachatina marginata*, was investigated in a six months experiment. Four experimental diets I, II, III and IV containing soybean, fishmeal, poultry dropping and urea as the only nitrogen source, respectively were formulated. Diet V (Pawpaw leaves) served as the control. Growth parameters (weight gain, feed intake, shell length gain and shell circumference gain), hemolymph and flesh minerals and proximate composition of the snails were determined. Snails fed diet III (poultry droppings) recorded the highest weight gain while the snails fed diet IV recorded the least value. Snail fed diet I had the highest feed conversion ratio (FCR}. The least FCR value was recorded for snails on diet V. The feed intake of snail on diet V was significantly higher ($p < 0.05$) than those of other diets. The highest shell length gain and shell circumference gain was recorded in snails fed diet III. Analysis of the Hemolymph mineral composition revealed that snails fed Diet I had the highest value for Ca^{2+}, Mg^{2+} and Fe^{2+} while the highest value in Na^{+} and Zn^{2+} was recorded in snails on diet V. The chemical analysis of the flesh showed that snails fed diet V had highest value in Na^{+}, K^{+}, Zn^{2+} and Cl^{-} while snails on diet III had the least value in Mg^{2+} and Cl^{-}. Proximate analysis of the snails flesh revealed that crude protein value was least in snails fed diet IV and highest in snails fed diet III. Snails fed diet V had the highest ash content value closely followed by snails on diet I while those on diet IV recorded the least value.The result of the study showed that higher growth performance for *Archachatina* was favoured by diet III.

Key words: Snail, feed, proximate, nitrogen sources, diet.

INTRODUCTION

Snail meat is a high quality food that is rich in protein, low in fats and a source of iron (Orisawuyi, 1989). Imevbore and Ademosun (1988) has assessed the nutritive value of snail meat in relation to some popular conventional animal protein sources, and discovered that snail meat has a protein content of 88.37%, a value which compare favourably with conventional animal protein sources whose value ranged from 82.42% (pork) to 92.75% (beef).

The popularity of giant land snails in the world is increasingly reduced by indiscriminate hunting and deforestation, which destroys the snail's habitat. Rearing of the giant land snails as a domestic animal would therefore help in some measure to satisfy the demand for the meat and ensure the survival of the species. However one problem facing rearing of snail is formulating an improved diet that will meet the nutrient requirements of the snails. In order to do this successfully, attention has to be given to protein, because of its immense role in animals' well-being which includes growth, maintenance, hormonal and enzymatic activities. The aim of this work was therefore to

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Table 1. Composition of the experimental diet (g / 100g).

Ingredients	Diet I	Diet II	Diet III	Diet IV	Diet V
Soybean	43.45	---	---	---	---
Fishmeal	---	30.80	---	---	---
Poultry dropping	---	---	70.67	---	---
Urea	---	---	---	2.76	---
Fresh Pawpaw leaves	---	---	---	---	100
Corn Starch	53. 25	65.90	26.03	94.14	
Oyster shell	1.5	1.5	1.5	1.5	
Bone Meal	1.5	1.5	1.5	1.5	
Minerals/Vitamins	0.3	0.3	0.3	0.3	
Total	100kg	100kg	100kg	100kg	
Calculated proximate analysis (%)					
Crude protein	19.12	22.18	20.00	7.73	32.6
Crude fibre	2.82	0.40	10.52	---	3.0
Ether extract	1.52	2.35	1.20		0.80
NFE	68.90	62.63	44.98	90.06	-
Ash	2.61	5.24	19.79	---	11.00
Ca	2.98	1.18	7.31		ND
Ph	1.20	0.54	2.00	---	ND

investigate the effect of different nitrogen sources on performance of giant land snail *Archachatina marginata.*

MATERIALS AND METHODS

This research study was carried out in the Animal House of the Department of Biological Sciences, University of Agriculture, Abeokuta, Nigeria. The Animal House's measurement is 2.7 x 1.8 x 2.1 m with the window allowing for cross ventilation. The house was shaded by pawpaw trees and the mean daily temperature during the experiment was 26.5 ± 0.5^oC.

One hundred and fifty snails with average weight of 10.37 ± 0.9 g (one month old) were obtained from the snail pen of the Department of Forestry and Wildlife Management in the University of Agriculture, Abeokuta.

Four experimental diets were formulated with each diet having different nitrogen source. Each diet was formulated to contain 20% crude protein. Diet I has soybean as the sole nitrogen source. Diet II, III and IV had fishmeal, poultry dropping and urea as nitrogen sources respectively. Pawpaw leaves served as the control (diet V) (Table 1).

One hundred and fifty snails used in this experiment were allotted randomly to five diets of 30 snails per treatment. Each treatment was further subdivided into 3 replicate groups of 10 snails each. The diets were presented to the snails in plastic troughs inside their respective cages. The snails were duly fed *adlibitum* with feed being provided everyday between 4 to 5 p.m. for twenty-four weeks. Water was also made available to the snails in the plastic troughs present in each cage.

Data were collected weekly on the following parameters: body weight, shell length (measured in centimetre), shell circumference (measured in centimetre by coiling the canvas tape round the snail), feed intake, specific growth rate, relative growth rate and feed conversion ratio during the experimental period.

Chemical analysis

Nine snails from each treatment were randomly picked and the shells broken at the apex to collect the haemolyph after which the flesh was removed. Haemolyph and flesh collected were analysed for potassium and sodium by means of flame photometer (Corning UK model 405). Calcium, magnesium, iron and zinc were analysed by means of atomic absorption spectrophotometry (AAS) (Pye Unican, UK Model Sp9). Chloride was determined using spectrophotometric method (SQ118 Photometer)

Chemical analysis for the proximate composition of the flesh, that is the crude protein, crude fiber, ash, moisture content and fat content were carried out according to AOAC (1990)

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Statistical analysis

The result obtained were analyzed using one-way analysis of variance (ANOVA). Duncan multiple range test (Steel and Tories, 1980) was also used to separate significant difference among means, and regression analysis was also used to determine the relationship between the measured parameters.

RESULTS

The observation made in the present study revealed that the experimental snails ate mainly at night. Even though the diets were presented to the animal around 5 p.m., feeding did not start until late in the night around 10 p.m. and continues until 1a.m. Before the consumption of the diet, however the snails used their tentacles to explore the feed and later protruded their lips to taste the food.

All the diets were well received and eaten by the snails. However, there was a significant difference ($p<0.05$) in

Table 2. Feeding Performance of *A. marginata* fed on different nitrogen based diets.

Parameter	Diet I	Diet II	Diet III	Diet IV	Diet V
Feed Intake (g)	218.02 ± 0.84^{c}	220.64 ± 0.56^{c}	495.37 ± 2.93^{b}	116.37 ± 0.6^{d}	902.23^{a}
Relative Consumption Rate	0.08 ± 0.001^{c}	0.078 ± 0.01^{c}	0.154 ± 0.02^{b}	0.068 ± 0.01^{d}	0.304 ± 0.05^{a}
Relative Growth Rate	0.003 ± 0.001^{b}	0.0033 ± 0.001^{Bb}	0.0044 ± 0.001^{a}	0.002 ± 0.001^{c}	0.0040 ± 0.001^{a}
Feed conversion ratio	4.84 ± 0.2^{a}	4.25 ± 0.1^{b}	2.83 ± 0.1^{d}	3.59 ± 0.02^{c}	1.33 ± 0.02^{e}
Weight Gain (g)	10.55 ± 0.5^{c}	9.37 ± 0.4^{c}	14.02 ± 0.6^{a}	5.97 ± 0.1^{d}	11.97 ± 0.4^{b}

*Mean values in each row with the same superscript are not significantly different (p<0.05).

Table 3. The growth performance of snails on the experimental diets (g).

Parameters	Diet I	Diet II	Diet III	Diet IV	Diet V
Initial mean weight	9.96±1.05^{b}	10.45±2.77^{a}	10.55±2.67	10.46±2.51^{a}	10.26±1.97^{a}
Final mean weight	20.51±2.5^{b}	19.82±1.6^{b}	24.57±3.5^{a}	16.43±0.6^{c}	22.23±2.6^{a}
Weight gain	10.55±0.08^{c}	9.37±0.09^{c}	14.02±0.012^{a}	5.97±0.09^{d}	11.97±0.09^{b}

*Mean values in each row having the same superscript are not significantly different (p<0.05).

Table 4. The shell parameters of Snails, fed different nitrogen based diets.

Parameter	Diet I	Diet II	Diet III	Diet IV	Diet V
Initial average Shell Length (cm)	3.61± 0.04^{c}	3.71± 0.02^{b}	3.80 ± 0.04^{a}	3.60 ± 0.04^{c}	3.58 ± 0.04^{c}
Final average Shell Length (cm)	4.70 ± 0.03^{c}	4.59 ± 0.03^{c}	4.96 ± 0.04^{b}	4.46 ± 0.04^{d}	5.05 ± 0.05^{a}
Shell Length gain (cm)	1.01 ± 0.01^{b}	0.88 ± 0.02^{c}	1.16 ± 0.02^{b}	0.86 ± 0.02^{c}	1.47± 0.01^{a}
Length Gain (%)	30.19	23.72	30.53	23.87	41.06
Initial average Shell Circumference(cm)	8.64 ± 0.04^{b}	8.64 ± 0.03^{c}	8.66 ± 0.07^{a}	8.46 ± 0.05^{c}	8.56 ± 0.06^{a}
Final average Shell Circumference(cm)	9.74± 0.04^{b}	9.45 ± 0.03^{c}	10.50 ± 0.02^{a}	9.49 ± 0.05^{c}	10.06 ± 0.06^{a}
Shell Circumference Gain (cm)	1.28 ± 0.01^{b}	0.81 ± 0.02^{C}	1.84 ± 0.02^{a}	1.03 ± 0.02^{b}	1.50 ± 0.02^{a}
Circum Gain (cm)	15.13	9.38	21.25	12.17	17.52

*Mean values in each row with the same superscript are not significantly different (p<0.05).

the amount of different diets consumed by the snails (Table 2). For example, pawpaw leaves was the most consumed, while diet IV (urea-based diet) was the least consumed. There was no definite pattern of feeding during the experimental period. For example, the amount of feed consumed was high in the first three weeks of the experiment with diet III being the most consumed. A decline in feed intake was noticed as from week four and this was more pronounced in diet III followed by diet V (Figure not shown). The result of statistical analysis showed a significant difference in the FCR. Snails on diet I recorded the highest value followed by diet II, while diet V had the lowest value (Table 2).

There was an appreciable weight gain by the experimental snails (Table 3). Statistical analysis showed a significant difference (p<0.05) in weight gained by the snails with experimental diets. The total weight gained by snails fed diet III was 14.02 g followed by snails on diet (V) which gained 11.97 g while snails fed diet (IV) gained the least weight. There was a weekly variation in weight gain of the snails. Also, the growth curve of the experimental snails followed a normal sigmoid. There was a significant difference (p<0.05) in the relative growth rate of the experimental snails. The snails on diet III had the highest growth rate while those on diet IV had the least relative growth rate (Table 2). There was appreciable shell length gained by the experimental snails Specimen fed diet V had the highest shell length gain followed by the snails fed diet III, while snails on diet IV recorded the least shell length gain (Table 4). Statistical analysis showed a significant difference (p<0.05) in the shell circumference gain. For example snails on diet III has the highest shell circumference gain followed by snail on diet V while snails on diet II recorded the least shell circumference gain (Table 3). Correlation coefficient showed a strong positive relationship between

Table 5. Correlation coefficient between length and circumference of shell.

Diets	Shell length (cm)	Shell circumference (cm)	Significance
I	0.9830	0.9587	**
II	0.9335	0.9674	**
III	0.9374	0.9830	**
IV	0.9830	0.9523	**
V	0.9761	0.9687	**

** Significant at 99% (P<0.01)

Table 6. Minerals composition of the haemolymph of snails, *A. marginata* fed on different nitrogen based diets (mg/ml).

Parameter	Diet I	Diet II	Diet III	Diet IV	Diet V	SEM
Calcium	13.25^a	5.65^b	0.20^c	5.52^b	5.00^b	1.12
Magnesium	3.50^a	2.70^b	1.93^d	2.23^c	3.58^a	0.176
Sodium	7.50^b	7.53^b	6.00^c	5.50^{Dd}	9.00^a	0.353
Potassium	0.000^b	0.000^b	0.500^a	0.500^a	0.000^b	0.066
Zinc	0.28^b	0.38^a	0.10^c	0.24^b	0.36^a	0.05
Iron	82.10^a	45.00^c	30.70^d	65.81^b	69.30^b	4.91
Chloride	5.00^c	10.00^b	35.00^a	10.00^b	10.00^b	2.36
Total value of mineral tested	111.64	71.6	74.45	89.93	97.26	

Mean values in same row having the same superscript are not significantly different (P< 0.05).
SEM= standard error of mean.

Table 7. Flesh mineral composition of snail meat fed with different nitrogen sources (mg/ 100g).

Parameter	Diet I	Diet II	Diet III	Diet IV	Diet V	SEM
Calcium	47.77^c	46.75^c	53.82^d	941.50^a	783.53^b	107
Magnesium	52.10^a	52.69^a	50.25^b	50.33^b	51.35^b	0.314
Sodium	76.26^b	66.25^c	83.75^a	67.00^c	86.00^a	0.19
Potassium	20.00^c	16.25^d	22.50^B	18.75^c	26.25^a	0.93
Zinc	7.33^b	6.05^c	6.78^c	8.50^a	8.20^a	0.24
Iron	2533^a	2040^b	1845^c	1475^d	2070^b	90.2
Chloride	25.03^b	37.44^a	12.50^c	37.00^a	37.50^a	2.69
Total value of mineral tested	2741.8	2266.50	2074.6	2598.2	3062.80	

Mean values in same row having the same superscript are not significantly different (P<0.05).
SEM = Standard error of mean.

the weight and the shell circumference and shell length. However snails on diet V and III had the best relationship. (Tables 4 and 5).

The results of the analysis of the mineral composition of the flesh and haemolymph showed the presence of Ca^{2+}, Mg^+, Na^+, K^+, Zn^+, Fe^+ and Cl^- in both the flesh and the haemolymph. Statistical analysis showed a significant difference ($p<0.05$) in the concentration of the minerals present in the experimental snails. The experimental snail on diet V had the highest Na^+ concentration in both the flesh and haemolymph while snails on diet II recorded the least sodium concentration in the flesh. The highest concentration of Zn^+ in both the flesh and haemolymph of the experimental snail was recorded by snails on diet III while diet II recorded the least concentration of haemolymph and flesh respectively (Tables 6 and 7).

Snail on diet I recorded the highest concentration of Fe^+ in both the flesh and haemolymph of the experimental snails, while snails on diet III and diet IV recorded the least concentration of Fe^{2+} in the haemolymph and flesh, respectively. Of all the minerals tested for in both the flesh and haemolymph, Fe^{2+} recorded the highest concentration. In summation snails on diet I had the highest total mineral concentration in

Table 8. Proximate composition of Snails, A. marginata fed on different nitrogen based diet (DM).

Parameter	Diet I	Diet II	Diet III	Diet IV	Diet V	SEM
Moisture Content	83.33[a]	72.78[c]	81.66[a]	79.50[b]	82.93[a]	1.06
Crude Protein	83.04[b]	59.63[d]	87.94[a]	47.54[e]	70.63[c]	4.01
Crude Fibre	0.15[b]	0.08[c]	0.03[d]	0.22[a]	0.15[b]	0.023
Fat	1.70[a]	1.38[b]	1.18[c]	i1.47[b]	1.62[a]	0.043
Ash	1.41[a]	1.30[b]	1.18[c]	1.16[c]	1.42[a]	0.034

Mean values in same row having the same superscript are not significantly different (P<0.05).
SEM = Standard error of mean.

their haemolymph while snails on diet V had the highest total mineral concentration in their flesh.

The result of the proximate analysis of the flesh of the experimental snails revealed a significant difference (P<0.05) in the chemical composition of the experimental snails. The moisture content of the experimental snails varied from 72.77 to 83.33%. Snails fed diet I had the highest moisture content (Table 8). The crude protein ranged from 47.54 to 87.94%. Snails placed on diet III had the highest crude protein while snails fed on diet III recorded the least crude protein (Table 8). Snails on diet I recorded the highest fat content, while snails on diet III had the least fat content in their flesh. The ash content ranged from 1.16 to 1.42%, while snails fed on diet V recorded the highest value, and snails on diet IV had the least (Table 7).

DISCUSSION

The results of the study showed that snail emerged to feed only at night between the hours of 10.00 p.m. and 1.00 a.m. even though the diets were presented to them earlier in the day. This observation agreed with the findings of Amusan and Omidiji (1998) and Akinnusi (2002). Feeding was preceded by exploration of the diet by the snails with their tentacles and lips, which is an indication that the snails depend on their olfactory and gustatory cues to explore their environment before ingesting food (South, 1992).

Snail feeding pattern is spasmodic and is done in bursts, interspersed with probing movement or resting (South, 1992). The snails follow this pattern, as there was no definite trend in feeding among snails during the experiment. However, there was a gradual increase in feed intake especially for diets III in the first three weeks which is a confirmation of South (1992) findings that snails have more preference for new food than a familiar food. Feeding activity was low in weeks 8 to 12 which fell in the month of August known to be the coldest month and hence affect the activities of the snails (Hodasi, 1986).

Pawpaw leaves (diet V) was the most preferred of all the experimental diets (Table 2), just as observed earlier by FAO (1986), Amusan, and Omidiji (1998). Also, the result of feed conversion ratio revealed that pawpaw leaves was the most converted diet by the snails .Although, the reason for this high feed intake cannot be ascertained, it is possible that the presence of fibre in pawpaw leaves aids digestion and motility of alimentary canal. Snails fed pawpaw leaves recorded the highest shell length gain and this observation is in conformity with the report of Okonkwo et al. (2000) that snails fed pawpaw leaves had better shell growth than those fed other diets. The mineral analysis of the snails flesh shows that those fed pawpaw leaves have the highest total mineral composition (Table 7). Snails on diet III had the least total mineral composition. Elbously and Vander poel (1994) had earlier reported that uric acid from poultry dropping could inhibit microbial synthesis of vitamins or other mineral nutrients being essential to the host.

The concentration of iron was the highest of all the minerals analyzed in the haemolyph of the snails. The high concentration of iron and the presence of other vital minerals like calcium, magnesium and zinc may be responsible for the high intake of snails' haemolymph by pregnant women as reported by Adeyeye (1996).

The highest mineral concentration in experimental snail flesh was iron. This is supported by the report of Adeyeye (1996) and Ayodele and Asimalowo (1999) that snails' body contains a high concentration of iron. Hence, snails are a good source of iron which contributes significantly to the prevention of anaemia.

The result of mineral analysis of the snails' flesh and haemolymph showed that snails with high haemolymph mineral concentration also have high body mineral concentration. This observation was also made by Akinloye and Olorode (2000) that haemolymph is the fluid that bath snails and any physiological process taking place in the body must be reflected by the haemolymph.

Snails fed poultry droppings based diet (diet III) recorded the highest total weight gain, best relative growth rate and highest shell circumference gain. This good performance of poultry dropping as opined by Elbously and Vandan poel (1994) may be due to the fact that poultry dropping contains undigested feed and metabolic excretory products, which may enhance the growth of its consumers. Result of the proximate analysis also showed that snails fed diet III had the highest crude protein (Table 8). Studies have shown that poultry dropping has a moderate nitrogen content, which could be utilized by animals (Elbously and Vander poel, 1994), and snails, thus, have the ability to convert animal waste into body protein. The results of the study showed that soybean based diet (diet I) was the least utilized (Table 2). Similar observations were reported by Mcdonald et al. (1988) and Carter et al. (1994) when soybean meal was fed to cow and fish, respectively. This may likely be due to absence of essential vitamins in the diet (Mcdonald et al., 1988). Snail fed diet IV had the least feed intake and the least weight gain (Table 2). This low feed intake may likely be due to the taste of urea. Bogogl (1981) had reported that urea has bitter taste, which limit its intakes by animals. The low weight gain by the snails corroborated findings of Violer and Zoher (1984) who found that inclusion of urea in the diet of fish reduced their growth rate.

The results of this study showed that higher growth performance was favored by diet III while diet V positively affected the haemolymph and flesh mineral composition. Therefore, the use of poultry dropping and pawpaw leaves in the formulation of feed for *A. archachatina* will positively affect the performance and the nutritive value of the snail. These materials are affordable to the farmers since they will be available to him almost free of charge.

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