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Growth performance and carcass characteristics of African Giant Land Snail (*Archachatina marginata)* fed different dietary protein supplements

Orsar, T. J[1]., Danjuma, J[2]. and Tyowua, B. T[1].

[1]*Wildlife and Range Management Department, Federal University of Agriculture Makurdi*
[2]*Department of Forestry and Wildlife Science. Federal University of Wukari Taraba State*

*Corresponding Author: *E-mail. tjorsar3@gmail.com* **Telephone Number:** *+2347068010360*

Target Audience: *Mini-livestock farmers, Nutritionists and Students*

Abstract:

To produce high growth rate and improve carcass quality in Archachatina marginata, this study was carried out to determine which protein source would supplement pawpaw (Carica papaya) leaves in their diets. Five diets of 20% crude protein level each, were formulated. Diet 1, was fresh leaves of pawpaw alone as control. Diets 2, 3, 4 and 5 contained in addition to processed pawpaw leaves, groundnut cake, fishmeal, soybean meal and their combinations respectively. 150 snails were allotted to five dietary treatments, replicated 3 times with 10 snails/replicate, in a Completely Randomized Design. Weight of snails and feed intake were monitored weekly. Shell parameters were measured at the start and end of study. After 10 weeks, 2 snails per replicate were randomly selected, starved for 24hrs and sacrificed for carcass analysis. Proximate analysis of feed and flesh of snails were done according to Official Methods of Analysis. Data collected were analysed using Analysis of variance in Statistical Package for Social Sciences (SPSS), version 20. Results revealed that total feed intake was highest ($p<0.05$) in snails fed diet 1 (93.57±8.81g) and least in snails fed diet 4 (42.35±3.64g). Snails fed diets 4 and 5 gained more weight 16.73±4.32g and 15.67±2.35g respectively ($p<0.05$) than those fed diets 2 (1.00±9.17g) and 3 (1.63±8.79g). Snails fed diets 3, 4 and 5 produced more meat ($p<0.05$) than those fed diet 1. The result suggests that protein supplement from soybean meal and a combination of groundnut cake, fish meal and soybean meal elicited higher growth performance and carcass yield in Archachatina marginata than pawpaw leaves alone. Diets 4 and 5 were therefore recommended for adoption by snail farmers.

Key words*: Growth performance; Carcass characteristics, Archachatina marginata, Protein supplements*

Description of Problem

In the natural environment of African Giant Land Snails (AGLS), they feed on a variety of food sources. Under captive conditions however, a combination of food sources that ensure high growth performance is a major concern of snail farmers. Growth performance of AGLS (*Archachatina marginata)* fed Pawpaw (*Carica papaya*) leaves have long been acknowledged as being better than those fed other plant leaves as a sole diet (1, 2, 3, 4, 5). Higher growth performance had been recorded when more than one source of feed was used in feeding the snails (4). In order to keep pace with the growing need for increased snail production in Nigeria, researchers have been investigating alternative feed sources that could replace or supplement pawpaw leaves in feeding snails (6). Improvement in the quality of dietary protein is known to positively influence growth performance and carcass quality of the

snails (7). A combination of different protein supplements in the diet improves amino acids profile of the diet and hence growth performance. Pawpaw leaves when used in combination with other protein sources may further improve the nutrient profile of the feed for snail feeding. This may also reduce overdependence of snail farmers on pawpaw leaves, which is likely to cause rifts between snail and pawpaw farmers (8). The objective of this study was to investigate growth performance and carcass characteristics of *Archachatina marginata* when pawpaw leaves is supplemented with protein sources in the diets of the snails. The result of this study will help in selecting a protein supplement that will give better results in snail meat production and at the same time reduce overdependence of snail farmers on pawpaw leaves for feeding snails.

Materials and Methods

Study area

The experiment was conducted at the Federal University of Agriculture Makurdi, Benue State Nigeria with the following Geographic coordinates: $7^0 47' 42.9'' E$ and $8^0 37' 02.5'' N$. The area is a Guinea savanna, characterized by wet and dry climatic seasons. Rainy months extend from April to October while dry months last from November to March. Annual rainfall ranges from 100-200mm, while mean monthly temperature ranges between 21-37^{o}C.

Experimental house and cage design

The snails were reared in a house constructed under a *Gmelina aborea* tree, (in a residential environment). The house was built with burnt bricks to 1.25metres height and completed to the roof with wooden poles and poultry wire mesh, reinforced with a 5cm x 5cm galvanized wire to allow good aeration. Corrugated iron sheets were used to roof the house. Brazilian Ceiling board were used to provide cooling effect inside the house. Wooden tables were designed and installed inside the house on which plastic cages were placed to reduce drudgery associated with management. Snails were reared in plastic cages designed with perforations on all sides to allow good aeration. Dimensions of the baskets were: 37cm x 25cm x 23cm corresponding to length by breadth by height respectively. The cages were filled to 10cm depth with loamy soil that was heat treated (sterilized), to get rid of harmful soil microorganism. The soil was moistened (sprinkled) regularly with water during the period of experiment to ensure favorable moisture for the growing snails.

Preparation of experimental diets

Pawpaw (*Carica papaya)* leaf meal (PLM) was prepared as described by (9). Fresh leaves of pawpaw were plucked and chopped into small pieces, then sundried for three days before milling by pounding in a wooden pestle and mortar. The milled product was sieved through a 0.2mm mesh size and kept in a dry polythene bag ready for incorporation in the diets. Four diets were formulated from feed ingredients obtained from open market in Makurdi. Diet 1, was fresh pawpaw leaves which were harvested daily and fed to snails in treatment 1, as the control diet. Diet 2 contained Groundnut cake (GNC), diet 3, contained fish meal (FM). Diet 4, contained soybean meal (SBM), while, diet 5, had the combination of all the three protein supplements (GNC + FM + SBM). PLM was included at 20% level in Diets 2, 3, 4 and 5. Rice husk, Bone meal, Vitamin/mineral premix and Industrial salt were included at the levels of 3, 3, 0.5 and 0.5 percent in Diets 2, 3, 4 and 5 respectively as shown in Table 1. All the diets were formulated to contain 20.0% crude protein.

Experimental design and management of snails

AGLS purchased from an open market in

Niger State were transported to Makurdi and used in this study. The snails were allowed to acclimatize for two weeks. Initial weight of the snails was taken after which 150 healthy looking snails, were divided into 5 groups of thirty snails each such that there was no significant difference in the group mean weight. The groups were allotted to 5 treatments with 3 replicates per treatment in a completely randomized design (CRD). Each replicate contained 10 snails. Feed was served on free choice basis daily. Once every week, feed was weighed and recorded before serving to the snails. Remnants of feed were collected the following morning, sundried, weighed and recorded. Water containers were cleaned and fresh water served daily.

Carcass analysis:

At the end of 10 weeks, 2 snails per replicate were randomly selected, starved for 24 hours, weighed to determine live weight and sacrificed for carcass analysis. Flesh of the snails were carefully removed from the shells using table fork and dissected to separate the edible parts (head & foot) and offal (visceral). Mortality was recorded whenever observed. Edible weight, offal and shell weights were taken and recorded. Dressing percentage was determined by expressing the edible weight as a percentage of live weight. Offal weight was also expressed as a percentage of the live weight.

Proximate analysis:

Proximate composition of all diets (1-5) and edible weights of snails were determined at the Animal Science Laboratory of the University of Agriculture Makurdi (10).

Statistical analysis

All data collected on performance and carcass evaluation of the snails were subjected to One - Way analysis of variance (ANOVA) using IBM SPSS Version 20, Separation of treatment means was done using Duncan's New Multiple Range Test in the SPSS package.

Results

The proximate composition of experimental diet is shown in Table 2. Crude protein was 20% in Diets 4 and 5, 21% in diet 2, and 22% in diets 1 and 3. Ether extract, Crude fibre and ash content of the control diet was higher than their values in diets 2-5. However, Nitrogen free extract of the control diet (49%) was less than its value of 64% in diets 2 and 5 respectively. Growth performance of *Archachatina marginata* fed different protein based diets is shown in Table 3. Total feed intake of snails fed diet 1, was significantly ($p<0.05$) higher than diets 2, 3 and 4. Feed intake of snails fed diet 2 was however similar ($p>0.05$) to those fed diet 5. Average daily consumption of snails fed diet 1, was more ($p<0.05$) than those fed diets 2, 3, 4 and 5. Feed to gain ration of diets 4 and 5 was significantly ($p<0.05$) better than that of diet 1, which was also better ($p<0.05$) than diet 2 and 3. Final weight of snails fed diet 4 was significantly higher ($p<0.05$) than those fed diets 1, 2 and 3. The final weight of snails fed diet 4, did not differ significantly ($p>0.05$) from those fed diet 5. Total weight gain showed a similar trend as final weights, where snails fed diet 4 gained similar weight ($p>0.05$) to those fed diet 5. These two were significantly higher ($p<0.05$) than those fed diets 1, 2 and 3. Average weight gain followed a similar trend as total weight gain. Snails fed diets 4, and 5, weighed significantly ($p<0.05$) higher than those fed diets 2 and 3. Daily weight gain of snails fed the control (diet 1), was not different ($p>0.05$) from that of snails fed diet 4 and 5.

There was high mortality rate in snails fed diets 3 and 4, followed by diet 2. The least mortality rate was observed in snails fed diet 5.

Figure 1, shows cumulative growth curve

of *Archachatina marginata* fed different sources of protein supplements. Snails fed diets 4 and 5 showed a similar and higher growth rate followed by those fed the control diet. Snails fed diet 1 and 3 lost weight in week 4 before picking up again in week 5. Snails fed diets 2 and 3 lost weight in week 4 and 7 respectively, and could not benefit from compensatory growth (12, 13.), before the end of study.

Table 4, showed carcass Analysis of *Archachatina marginata* fed different sources of protein based diets. Shell length and shell thickness of snails did not differ significantly ($p>0.05$) with the dietary treatments. However, the trend revealed the highest value in snails fed diet 4, while the least was in diet 3. Shell thickness was highest in snails fed diet 5, and lowest in diet 2. Shell diameter was highest in snails fed diet 5 and least in those fed diet 3. Edible weight of snails was highest in snails fed diets 5 and lowest in diet 1. Dressing percentage of snails was highest in diet 5 and least ($p<0.05$) in snails fed diet 1.

Table 5 contains proximate composition of carcasses of *Archachatina marginata* fed the experimental diets. It showed that crude protein of carcasses fed different dietary treatment were similar, ranging from 17.00% in Diet 1 to 17.94% in Diet 5. Percentage oil content of carcasses ranged from 5.98 in diet 3 to 6.38% in the control. Percentage ash content of carcasses ranged from 13.14% in the control to 15.20% in diet 4. Crude fibre was not detected (ND) in carcasses of the snails.

Table 1: Composition of experimental diets (%)

	Experimental diets				
Ingredients	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Maize	0.00	50.04	48.38	47.18	48.76
Fresh pawpaw leaves	100.00	0.00	0.00	0.00	0.00
Pawpaw leaf meal (PLM)	0.00	20.00	20.00	20.00	20.00
Groundnut cake (GNC)	0.00	22.96	0.00	0.00	10.71
Fishmeal (FM)	0.00	0.00	24.62	0.00	5.00
Soybean meal (SBM)	0.00	0.00	0.00	25.82	8.53
Rice husk	0.00	3.00	3.00	3.00	3.00
Bone meal	0.00	3.00	3.00	3.00	3.00
Vitamin/Mineral Premix**	0.00	0.50	0.50	0.50	0.50
Industrial salt	0.00	0.50	0.50	0.50	0.50
Calculated % Crude protein	20.0	20.0	20.0	20.0	20.0

** Composition of 2.5Kg of DAVO Premix: Vit A =10,000,000.00 I.U, Vit B3= 2,000,000.00 I.U, Vit E= 20,000.00 mg, Vit K3 =2,000.00mg, Vit B1= 3,000.00mg, Vit B2 =5,000.00, Niacin =45,000.00mg, Calcium pantothenate=10,000.00mg, Vit B6=4,000.00mg, Vit B12= 20.00mg, Choline Chloride= 300,000.00mg, Folic Acid =1,000.00mg, Biotin= 50.00mg, Manganase =300,000.00, Iron=120,000.00mg, Zinc=80,000.00mg, Copper=8,500.00mg, Iodine=1,500.00mg, Colbalt=300.00mg, Selenium=120.00mg, Anti-Oxidant = 120,000.00mg

Table 2, Proximate composition of experimental diets on dry matter basis

	Experimental diets				
Feed Ingredients	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Crude Protein (%)	22	21	22	20	20
Ether Extract (%)	7	5	5	5	5
Crude Fibre (%)	9	4	4	5	4
Ash (%)	13	6	6	7	7
Nitrogen Free Extract (NFE)	49	64	63	63	64

Table 3, Growth performance of *Archachatina marginata* fed different protein supplements

	Experimental diets					
Performance Variables	Contl.(Diet 1)	Diet 2	Diet 3	Diet 4	Diet 5	P Val
Initial weight of snails (g)	101.93±0.83	102.97±1.77	102.37±0.32	103.43±2.40	100.87±2.06	0.427
Final weight of Snails	108.80±5.04^{bc}	103.97±8.00^{c}	104.00±7.92^{c}	120.17±3.55^{a}	116.53±3.40^{ab}	0.023
Total feed Intake (g)	93.57±8.81^{a}	59.01±7.94^{b}	44.71±8.70^{c}	42.35±3.64^{c}	51.38±4.53^{bc}	0.000
Ave. Feed Intake/Snail/day(g)	1.34±0.12^{a}	0.77±0.10^{b}	0.58±0.11^{c}	0.55±0.05^{c}	0.67±0.06^{bc}	0.000
Total weight gain /Snail(g)	8.87±5.86^{ab}	1.00±9.17^{b}	1.63±8.79^{b}	16.73±4.32^{a}	15.67±2.35^{a}	0.033
Ave. weight gain/Snail/day (g)	0.097±0.081^{ab}	0.013±0.129^{b}	0.023±0.117^{b}	0.240±0.061^{a}	0.223±0.035^{a}	0.031
Feed Gain Ratio (FGR)	10.54±3.54^{b}	59.23±7.13^{c}	25.22±5.98^{c}	2.29±0.76^{a}	3.00±0.82^{a}	0.025
Mortality rate (%)	30	43	47	47	7	

Numbers are means and standard deviation from the means. Means with different superscripts $^{a, b, c}$ within the same rows are significantly *($p<0.05$)* different.

Table 4, Carcass analysis of *Archachatina marginata* fed different sources of protein based diets

	Experimental diets					
Performance Variable	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	P.Val
Live weight (g)	87.73±2.15	81.57±9.25	87.13±2.67	85.70±1.78	90.70±5.48	0.341
Shell length (cm)	8.26±0.33	8.06±0.09	8.00±0.40	8.34±0.11	8.30±0.12	0.376
Shell diameter (cm)	4.07±0.19^{ab}	3.84±0.09^{c}	3.95±0.02^{ab}	4.16±0.23^{a}	4.01±0.02^{ab}	0.046
Shell thickness (mm)	1.30±0.07	1.06±0.48	1.27±0.10	1.48±0.30	1.49±0.13	0.321
Edible Weight (g)	20.10±2.52^{b}	25.97±4.65^{ab}	30.67±4.21^{a}	28.57±5.58^{ab}	32.17±6.89^{a}	0.041
Offal Weight (g)	7.83±2.05^{b}	20.93±1.67^{a}	25.70±2.30^{a}	24.53±4.49^{a}	26.73±3.94^{a}	0.000
Shell weight (g)	13.64±0.41^{abc}	12.95±0.63^{c}	13.22±0.33^{bc}	13.98±0.12^{a}	13.81±0.20^{ab}	0.042
Dressing percentage	22.87±2.31^{b}	32.00±5.69^{ab}	35.13±4.37^{a}	33.37±6.79^{a}	35.30±5.46^{a}	0.045

Numbers are means and one standard deviation from the mean.
Means with different superscripts within the same row are significantly ($p<0.05$) different.

Table 5, Proximate analysis of carcasses of *Archachatina marginata* fed diets supplemented with different protein sources

	Experimental diets				
Variables	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Moisture content (%)	10.64	10.50	11.03	10.40	10.46
Dry matter (%)	89.36	89.50	88.97	89.60	89.54
Crude protein (%)	17.00	17.50	17.56	17.88	17.94
Crude fiber (%)	ND	ND	ND	ND	ND
Oil (%)	6.38	6.19	5.98	6.10	6.36
Ash (%)	13.14	14.10	13.88	15.20	14.80

ND = Not detected

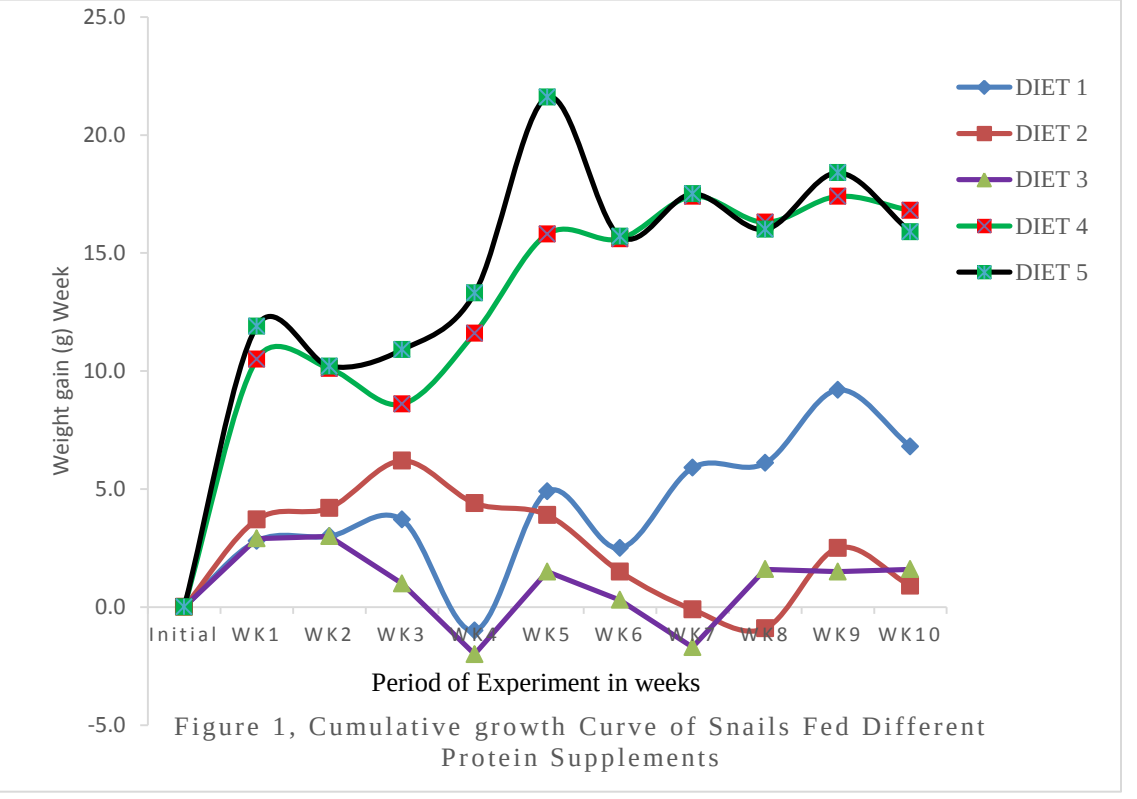

Figure 1, Cumulative growth Curve of Snails Fed Different Protein Supplements

Discussion

Diets were formulated to be iso-nitrogenous and the 2% variation were within the tolerable limit. The higher ash content (13%) of pawpaw leaves (diet 1), above all other diets suggests that mineral content especially phosphorus, calcium and magnesium which are high in leaves of pawpaw (15, 16), could be responsible for this elevation. Other diets containing 20% PLM (diets 2, 3, 4 and 5) had lower ash content. Lower content of carbohydrate (49%) suggest that energy level of diet 1, may be comparatively lower than diets 2, 3, 4 and 5.

Higher fibre level (9%) in diet 1, was still within the tolerable limit, since leaves of *Carica papaya* are normally used as sole diets for snail feeding with impressive results (5). The level of fibre here was comparable with that of 7.8% (5), in which snails fed *Carica papaya* leaves performed better than those fed leaves of *Calopogonium mucunoides*, *Musa paradisiaca*, *Mucuna purensis* and *Moringa oleifera*. The observation in this study which, pawpaw leaves alone (diet 1), produced snails with higher growth performance when compared to PLM supplemented with Groundnut cake (diet 2) and Fish meal (diet 3) is inconsistent with earlier study, where inclusion of groundnut cake and fish meal in the experimental diets respectively produced higher growth performance, when compared with the combination of soybean, groundnut cake and fish meal in one diet (17). Source and handling of feed ingredients prior to purchase for the study could be responsible for this inconsistency. If soybean meal could supplement PLM and give growth performance results comparable with a combination of groundnut cake, fish meal and soybean meal in one diet, it means soybean meal alone is able to improve the amino acid profile of diet 4, and hence enhance growth performance and carcass quality. Shell weight and diameter were the only carcass parameters affected by dietary treatments. *Archachatina marginata* is known to have a short and stout frame. This means shell diameter and weight appear to be the most responsive parameters of shell development. In order to accommodate and protect the flesh of growing snail, increase in width is more important than the length of the shell. This could be the reason why the diameter of the snail shells fed diet 2 was less than that of all snails in other dietary treatments. Proportionately, edible weight of snails fed diets 3 and 5 suggest that fish meal elicited production of more edible meat in snails than vegetable protein supplements. The dressing percentage of snails fed fish meal, soybean meal and a combination of groundnut, fish, and soybean meals means more meat is produced by using these protein supplements compared to use of pawpaw leaves alone. Dietary treatments appear not to have affected proximate composition of snail meat as the tested parameters were similar. Oil content of all snails was characteristically low which earns snail meat its quality that makes it useful in treating people with coronary heart disorders. Cause of mortality was not known but it was suspected that high ambient temperatures in the Savanna area of Makurdi (21^0C to 37^0C), compared to the rainforest area (21^0C to 25^0C) in Owode-Yewa, Ogun State (9) may have induced stress factors, especially that it was observed in the first few weeks of the experiment.

Conclusion and Applications

1. Pawpaw leaf meal supplemented with soybean meal elicited better growth performance in *Archachatina marginata*, than pawpaw leaves alone however, a combination of groundnut cake, fish and soybean meals as supplements to pawpaw leaf meal produced comparable growth performance.
2. Carcasses of snails fed diets supplemented with fish meal and a combination of groundnut, fish and soybean meal supplements produced proportionately more edible meat than those fed pawpaw leaves alone.
3. There is need to investigate appropriate level of supplementation of pawpaw leaf with soybean meal that would elicit the best growth performance and carcass quality in *A. marginata*
4. Diets 4 and 5 are recommended for adoption by snail farmers.

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