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Growth performance of (*Archachatina marginata*) snail, under the diets of soya beans powder, green beans, and tomatoes in Joseph Sarwuan Tarka University, Nigeria

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Abstract

A study was conducted to determine the growth performance of the African giant land snail *Archachatina marginata* using different feedstuffs in the Laboratory of the Wildlife and Range Management Department of the Josep Sarwuan Tarka University Makurdi, Benue State, Nigeria. Forty (40) juvenile snails with an initial average weight of 47.95g were purchased from Wadata market in Makurdi, acclimatized, quarantined, and made to starve for 2 days before the commencement of the experiment. Forty (40) snails were allotted at random to each of the 4 hutch boxes and were subjected to four treatments A, B, C, and D in replicates of 10 snails per each of the four replicates. Each snail in the group was numbered using an indelible marker. The initial body weight of the snails was measured on the first day, and the subsequent weights were taken every week till the end of the experiment using a sensitive weighing balance, the shell length and shell width of the snails were measured with thread and straight on the ruler to ascertain the width on weekly basis. Data obtained were subjected to descriptive statistics such as tables, charts, percentages, and analysis of variance (ANOVA). Significantly different means were separated using Duncan's Multiple Range Test to determine the relationship between growth parameters. The result obtained revealed that snails fed with Diet 1 (Green beans) had the highest shell development at 8.75cm, while snails fed with Diet 3 (Tomatoes) had the least 8.20cm. For weight gain, the initial weight was similar across the treatments, after subjecting to various treatments it was found that snails fed with Diet 3 (Tomatoes) had the highest mean weight gain value of 62.65g while those fed with Diet 1 (Green beans) had the least value 56.29g). The average feed intake of snails fed with experimental diets showed that T1 (93.57g) had superior values compared to T2 (59.01g) and T3 (51.38g) while T4 was the least (44.71g). The study recorded a mortality rate of 8 snails, 2 (25%) for Diet 1 while Diet 2 and 4 recorded

a high mortality rate of 3 (37.5%) each with no mortality recorded in Diet 3. Treatment 3 (T3) had the highest survival rate followed by T1 while T2 and T4 had a low survival rate as they both recorded the highest mortality rate. In conclusion, It could be noted in this study that; not all single plant matters are suitable as feed for African giant land snails.
Keywords: *Archachatina marginata,* diet, growth, land snail

Introduction

Accelerated deforestation has rendered the local gathering of snails from the wild a very difficult task because of rapidly declining snail populations (Raimi & Olomola, 2020). Snail farming, or heliciculture, has gained increasing attention in recent years due to its potential to contribute to food security and economic development in various regions. The quest for increased animal protein intake in the diets of the rural and urban Nigerian populace has increased the costs of available conventional animal proteins making them inaccessible to the poor (Rahji & Rahji, 2014; Abdulraheem et al., 2016). Therefore, there is a need to find additional non-traditional meat protein sources that are just as nutritious but more readily available to fill the gap. Additionally, the availability of several edible snails in Nigeria, their widespread acceptance and appeal, the possibility of exporting them, and evolving methods for their production, have all greatly influenced the current revitalization and enthusiasm for snail farming (Henchion & Zimmermannm 2021).

The growth performance of snails is influenced by various factors, with nutrition playing a crucial role. Adequate nutrition is essential for optimal growth, reproduction, and overall well-being of snails. Felici *et al*. (2020), submission revealed that its traditional feed consists of fresh leaves and shoots (such as pawpaw, lettuce, cabbage, cassava, cocoyam, African spinach, and water leaf), ripe fresh fruits (such as pawpaw, mango, banana, and plantain), kitchen and agricultural wastes (Babalola & Akinsoyimn, 2010). In addition to these feeds, snails require calcium to build and repair their shell. They must get enough because without enough calcium their shell will become thin and rough instead of being thick, smooth, and glossy. The survival, growth performance, development, and reproduction of snails like that of other species depend highly on the quality of feed consumed. Therefore, exploring and identifying suitable dietary options for enhancing the growth performance of *Archachatina marginata* snails is of significant importance for snail farmers and the agricultural sector at large.

The findings of this research could contribute to the development of more effective and sustainable feeding strategies for snail farming, ultimately leading to improved snail growth

rates, better meat quality, and increased economic returns for snail farmers. While nutrition plays a pivotal role in snail growth and development, there is a paucity of scientific data exploring the impact of specific ingredients such as soya bean powder, green beans, and tomatoes on the growth of these snails. Although studies have indicated the significance of protein, vitamins, and minerals for snail nutrition, a gap exists in understanding how these specific ingredients might influence growth rates, weight gain, and shell development in *Archachatina marginata* snails. Furthermore, while studies have investigated the effects of different diets on other snail species, there is limited research specifically targeting *Archachatina marginata* (Kumar et al., 2017). The main objective of this research is to investigate the effects of diets containing soya bean powder, green beans, and tomatoes on the growth performance of *Archachatina marginata* snail, To evaluate changes in shell development, including shell size and morphology, among *Archatina marginata* snails fed with the experimental diets; To assess the weight gain of *Archatina marginata* snails fed with the experimental diet; To analyze and compare survival rates among snails in each treatment group, to determine any variations attributed to the different dietary components

Snail farming, a sustainable protein source, has gained importance due to its potential for food security and economic growth. Despite the nutritional value of snail meat, achieving optimal growth in *Archachatina marginata* remains a challenge. This study addresses the gap in research regarding the effects of diets containing soya bean powder, green beans, and tomatoes on snail growth. The chosen ingredients are rich in protein, vitamins, and minerals, essential for snail nutrition. By investigating their impact on growth, shell development, and survival rates, this study aims to inform tailored feeding strategies. Successful outcomes could enhance snail farming's economic viability, mitigate malnutrition, and contribute to sustainable agriculture. Moreover, it may advance animal nutrition knowledge by evaluating alternative feed sources' effectiveness (Chen et al., 2016).

Material and methods

Study Area

The study was conducted in the laboratory of the Department of Wildlife and Range Management, College of Forestry and Fisheries, North Core, Joseph Sarwuan Tarka University, Makurdi, Benue state, Nigeria. The study area lies between Longitude 8°35'and 9°E and Latitude 7°45'and 7°52'N, in the southern Guinea ecological zone (Fig. 1). The area is characterized by two distinct seasons, the wet and dry seasons respectively. The wet season is

between April to October while the dry season is between November to March. Rainfall distribution is bimodal with maximum rainfall occurring between June and September. Mean annual rainfall is between 1000mm and 1500mm. Mean annual temperature is 30^0C and relative humidity is about 80% but decreases in the early months of the dry season (Ikyaagba, 2008).

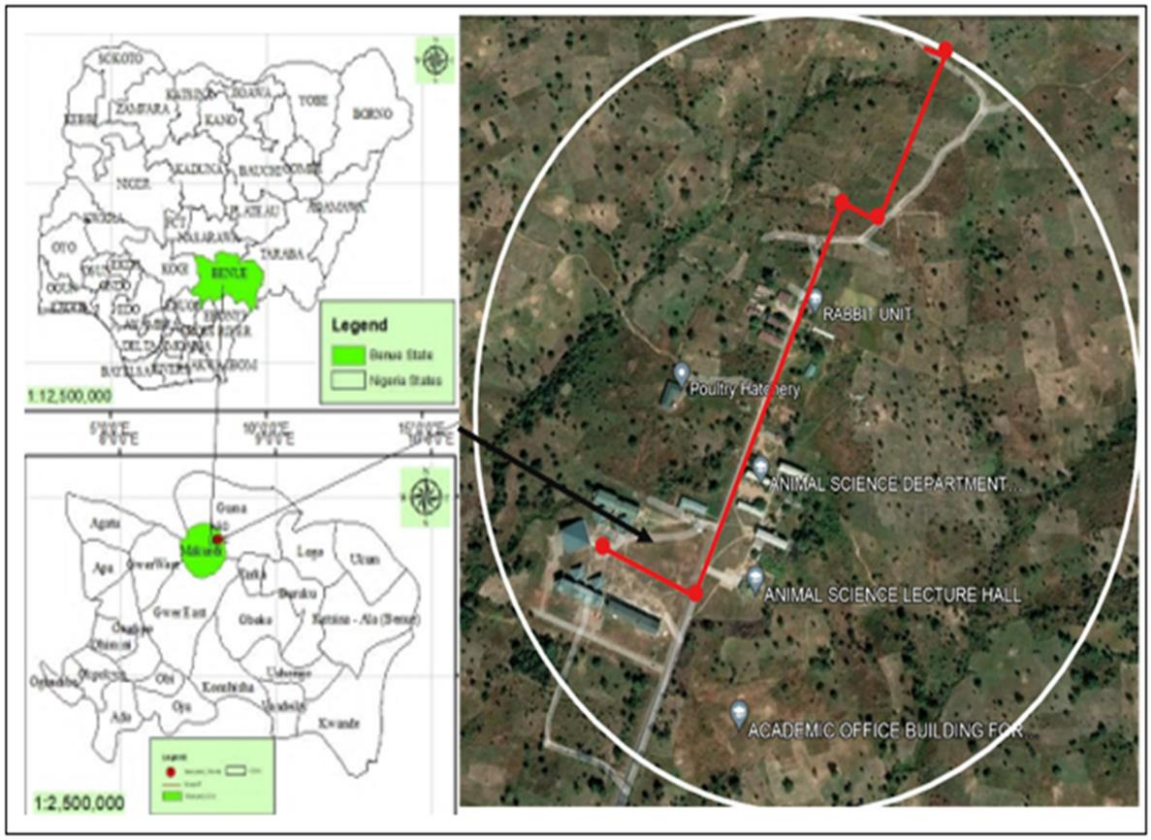

Figure 1. Map of Benue State showing the study area.
Source: Benue State Ministry of Land and Survey, 2023

The following equipment was used during the study period; Hutch boxes, weighing balance, Feeding and Watering troughs, Broom, Record book, Bucket, 24cm Ruler, Measuring tape, Callipers, Thread, Knife, Shovel, and Cutlass.

Sample Collection

Forty juvenile snails with an average weight of 47.95g were purchased from Wadata market in Makurdi, acclimatized, quarantined, and made to starve for 2 days before the commencement of the experiment. Hutch boxes were used for the experiment and were covered with wire mesh at the top for adequate ventilation. Forty (40) snails were allotted at random to each of the 4 hutch boxes and were subjected to four treatments in replicates of 10 snails per each of the four

replicates to study the growth performance of juvenile *A. marginata* fed with different diets of soya beans powder, green beans, and tomatoes. Each snail in the group was numbered using an indelible marker. The treatment boxes were filled with sandy loam soil to a depth of 5cm to serve as bedding media for the snails and the soil was moistened regularly to prevent aestivation. Each snail in all the groups was weighed using a weighing balance to ascertain the initial weight The feedstuffs were weighed before feeding the snails, and snails were fed daily in the evening, between 5 pm and 6 pm fresh feed and clean water were given to the snails daily, and remnants were collected and weighed. The housing units, feeding, and watering troughs were cleaned daily before serving fresh feed and water. Feces were scooped out of the box daily to prevent disease outbreaks. The growth parameters of snails on different feeding trials were measured bi-daily and weekly during the growth experiment.

Experimental Diet

Group A: were fed with Green beans (Diet 1)
Group B: were fed with Soya bean powder (Diet 2)
Group C: were fed with Tomatoes (Diet 3)
Group D: were fed with a combination of soya bean powder, green beans, and tomatoes.

Data Collection

The initial body weight of the snails was measured on the first day, and the subsequent weights were taken every week till the end of the experiment using a sensitive weighing balance, the shell length and shell width of the snails were measured with thread and straight on the ruler to ascertain the width on weekly basis. The total feed intake was measured by weighing out a given quantity of feed, using a sensitive scale, for each replicate every week. The snails were fed from this given quantity daily and the leftover collected was subtracted from the measured quantity to obtain the total feed intake per week. Data collected were subjected to descriptive analysis (Tables, Percentages, and Charts) and one-way analysis of variance (ANOVA) as described by Steel and Torrie (1980).

Results

The growth performance of juvenile snails fed with different treatments indicated that Snails fed with Diet 1 (Green beans) had the highest shell development 8.75cm, followed by Diet 4 (Combination of both green beans, soya beans powder, and Tomatoes) 8.40cm and Diet 2 (Soya beans powder) 8.30cm while snails fed with Diet 3 (Tomatoes) had the least 8.20cm (Table 1).

The performance (final weight, average weight gain, and daily weight gain) of *A. marginata* fed with four different feedstuffs are shown in Tables 3 and 4. For weight gain, the initial weight was similar across the treatments, indicating homogeneity in randomizing and allotting snails to treatment (Table 2). After subjecting to various treatments it was found that snails fed with Diet 3 (Tomatoes) had the highest mean weight gain value of 62.65g while those fed with Diet 1 (Green beans) had the lowest value of 56.29g (Table 3). Also, the average feed intake of snails fed with experimental diets showed that T1 (93.57±8.81) had superior values compared to T2 (59.01±7.94) and T3 (51.38±4.53) while T4 was the least (44.71±8.70). The result of the mortality rate is presented in Table 5, the study recorded a mortality rate of 8 snails, 2 (25%) for Diet 1 while Diet 2 and 4 recorded a high mortality rate of 3 (37.5%) each.

Analysis of survival rate as appeared in Figure 1 showed that; T3 had the highest survival rate followed by T1 while T2 and T4 had a low survival rate as they both recorded the highest mortality rate (Figure 2).

Table 1. Changes in shell development among *Archachatina marginata* snails fed with the experimental diets (cm)

S/NO	Diet 1	Diet 2	Diet 3	Diet 4
1	9.0	8.0	8.0	8.5
2	8.0	8.0	8.0	8.5
3	8.5	9.0	8.0	8.5
4	9.5	9.0	8.0	7.5
5	9.5	8.0	9.0	9.0
6	10.0	8.0	9.0	9.5
7	9.0	9.0	8.0	8.0
8	8.0	8.0	8.0	7.5
9	8.0	8.0	8.0	8.5
10	8.0	8.0	8.0	8.5
Total	**87.5**	**83.0**	**82.0**	**84.0**
Mean ($\bar{X}$)	**8.75^{b}±0.03**	**8.3^{a}±0.02**	**8.2^{a}±0.02**	**8.4^{a}±0.03**

Means with the same letters are not significantly different (P>0.05)

Table 2. Initial mean weight gained (g) of *Archachatina marginata* snails during purchase

	T1	T 2	T 3	T 4
1	59.4	65.4	47.3	50.3
2	44.7	44.9	55.6	53.2

3	38.3	56.8	39.1	57.9
4	61.4	57.7	46.8	35.8
5	58.8	42.7	61.2	45.8
6	55.2	46.5	62.4	62.8
7	43.3	48.7	49.7	39.6
8	42.7	39.7	49.1	40.1
9	44.0	38.6	43.1	40.5
10	44.8	49.6	36.8	60.7
Total	**492.6**	**490.6**	**491.1**	**486.7**
Mean ($\bar{x}$)	**49.26**	**49.06**	**49.11**	**48.67**

Table 3. Mean weight gained (g) of *Archachatina marginata* snails fed with the experimental diet.

	Diet 1	Diet 2	Diet 3	Diet 4
1	71.3	76.1	63.8	66.0
2	52.6	55.3	64.0	66.4
3	35.3	72.2	49.7	73.3
4	72.4	69.7	62.3	46.8
5	68.7	47.7	81.5	63.2
6	47.1	58.8	75.6	79.6
7	55.0	64.3	64.8	48.8
8	54.5	44.6	62.3	41.4
9	45.4	45.7	56.9	54.4
10	60.6	64.7	45.6	78.5
Total	**562.9**	**599.1**	**626.5**	**618.4**
Mean	**56.29^{a}± 3.14**	**59.91^{a}±3.21**	**62.65^{b}± 3.15**	**61.84^{a}± 2.57**

^{abc} Means with the same letters are not significantly different (P>0.05)

Table 4. Growth performance of *Archachatina marginata* fed different experimental diets

Performance Variables	**Diet 1**	**Diet 2**	**Diet 3**	**Diet 4**
Initial weight of snails (g)	49.26±0.83	49.06±1.77	49.11±0.32	48.67±2.06
Final weight of Snails	56.29^{a}± 3.14	59.91^{a}±3.21	62.65^{a}± 3.15	61.84± 2.57
Total feed Intake (g)	93.57±8.81	59.01±7.94	51.38±4.53	44.71±8.70
mean weight gain/Snail/day (g)	56.29^{a}± 3.14	59.91^{a}±3.21	62.65^{a}± 3.15	61.84± 2.57
Mortality rate (%	2	3	-	3

Means with different superscripts within the same row are significantly ($p<0.05$) difference
Note: Diet 1= Green beans, Diet-2 = Soya beans powder, Diet-3 = Tomatoes, Diet 4: Mixture

Table 5. Mortality rate of the snails (%)

Treatments	Mortality	Mortality Rate (%)
T1	2	25.00
T2	3	37.50
T3	-	-
T4	3	37.50
Total	**8**	**100.00**

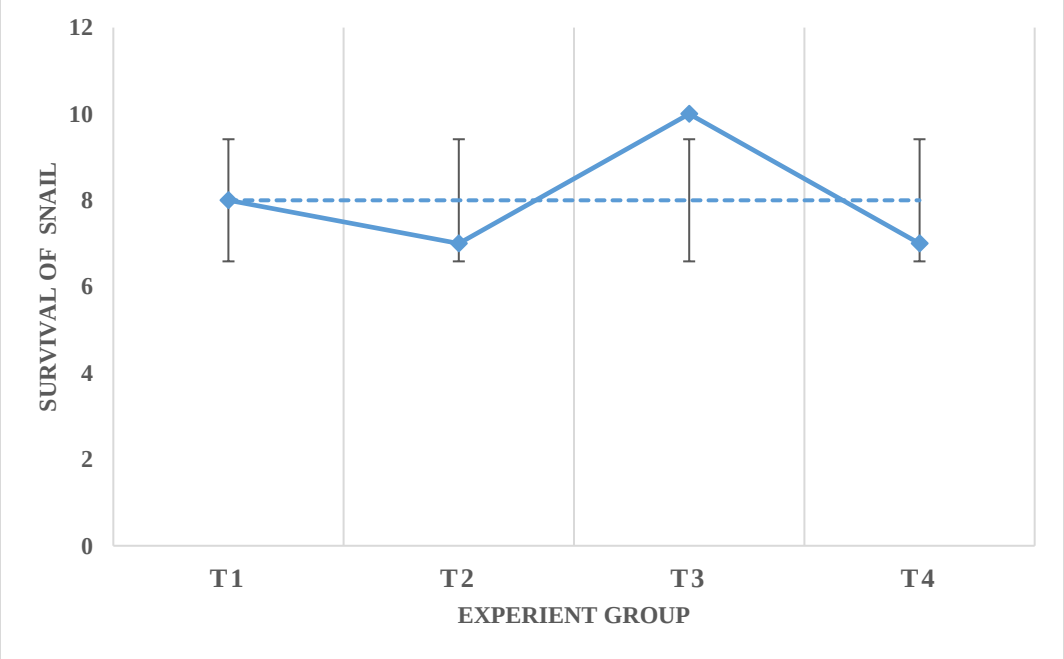

Figure 2. Survival rates of snails in each treatment group

The result obtained indicated that the type of diet used in feeding *Archatina marginata* can affect its growth and survival rate. Snails fed with Diet 1 had the highest shell development while snails fed with Diet 3 had the least value of shell increment. For weight gain, snails fed with Diet 3 had the highest mean weight gain while those fed with Diet 1 had the least mean weight gain. However, the active feeding of snails on all the experimental diets with some resultant level of shell increment and weight gain is an indication that the diets are all accepted

by the snails and were able to support snail growth, though the capacity of each diet to support snail growth varies. This observation is corroborated by Anigbogu et al., (2011), who reported that both nutrient quality and level in the diet are important for animal production to be successful. The highest weight gains by snails fed with tomatoes might have been influenced by the crude protein content, which was highest among the vegetables used though proximate analysis of the treatment diet was not conducted. This finding is similar to the report of Babadoye et al., (2010) who had good growth performance when Soya bean meal was replaced with Chromoleana leaf and mulberry leaf as sources of protein in the diet of *Achatina achatina*. Ani et al., (2013), reported that high protein levels in diets improved growth performance in snails with appropriate energy balance and recommended 24% crude protein + 3.2Mcal/kg metabolizable energy combination. Babalola and Owolabi (2014) also obtained better growth performance when high-protein vegetable diets such as milk leaf (*Euphorbia heterophylla*) of 22.7% crude protein, pawpaw leaf (*Carica papaya*) of 29.3% crude protein, and concentrate feed of 46.3% crude protein were fed to snails. It could also be suggested that tomatoes used in feeding the Giant African Land Snails (GALs) have some other intrinsic qualities which may include their chemical composition and content. Snails' preference for green beans (vegetable) over soya bean powder diet in this study agreed with earlier findings that the conventional feeds of snails consisting of breadfruits, water leaf, pawpaw leaf and fruit, sweet orange, mango fruit, ripe fruit of plantain and banana and other feeds of plant origin as reported by Awesu (1980); Ayodele and Asimolowo (1999). Martin and Bergey (2013) also reported rapid growth in snails fed with fresh plant materials (vegetables and fruits) as compared to snails given dry matter such as leaf litter as feed. Preference for fresh plant materials is further confirmed by the findings of Omole et al. (2011), Alikwe et al. (2013), and Ani et al. (2014) who obtained better or similar growth performance in snails when concentrate feed was replaced with graded levels of pineapple waste, *Asplenium barteri* leaf and *Moringa oleifera* leaf meals at 10, 15 and 20% respectively. The African giant land snail fed on diet treatment 1 had the highest feed intake with relatively low final weight gain and mean weight gain/Snail/day Table 4, indicating that the nutrients in green beans might not be sufficient for the African giant land snail to perform well. This summarizes the call for a balanced nutrient formulation to meet the production requirement of snails. This is important to enhance the growth rate and development of snails. According to (Profit, 2015; Oyeagu et al., 2018), the most important factor influencing the

performance of animals in captivity is the quality of diet offered to the animals. In the course of the study, a mortality rate of 8 occurred, 2 (25%) for Diet 1 while Diet 2 and 4 recorded a high mortality rate of 3 (37.5%) each however, reasons remained unknown to the researcher but it was suspected that water used during this experiment could be a contributing factor as the quality of water from Wadata differs from that of Joseph Sarwuan Tarka University Makurdi

Conclusion

Archachatina marginata cultural characteristics have made it the object of interest in mini livestock farming in Nigeria. The growing advancement in its farming has necessitated increased interest in nutritional requirements at lower stages of life. The experiment aimed to assess the growth performance of *Archachatina marginata* when fed with diets containing soybean powder, green beans, tomatoes, and a combination of both. The results revealed a noteworthy outcome, with green beans leading in shell increase, and tomatoes showing the least growth in shell size but exhibiting the highest final weight gain. Additionally, green beans recorded the highest feed intake, indicating a potential correlation between feed consumption and shell growth. However, it is crucial to acknowledge the concerning findings of elevated mortality rates associated with green beans, soya bean powder, and the combination diet. These results underscore the complexity of dietary influences on snail growth, emphasizing the need for further research to optimize nutrition and minimize adverse effects on mortality rates in *Archachatina marginata*. It could be noted in this study that; not all single plant leaves are suitable as food for African giant land snails.

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