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Evaluation of Growth Performance in Juvenile *Achatina achatina* Fed Diets of Cassava Leaves (*Manihot esculenta*) and Plantain Leaves (*Musa paradisiaca*)

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Abstract

This study evaluated the growth performance of juvenile *Achatina achatina* snails over five weeks, focusing on three dietary treatments: cassava leaves (T1), plantain leaves (T2), and poultry feed (T3) as a control, contributing valuable insights into alternative feeding strategies that could improve snail farming sustainability. Results indicated a gradual increase in weight across all diets, with the highest average weight gain observed in snails fed T2 (3.03 ± 0.16), followed by T3 (2.94 ± 0.10) and T1 (2.84 ± 0.17). However, the differences in weight gain were not statistically significant (F=1.28, P=0.31). Shell length and circumference also increased over time, with T3 showing the greatest increases in both metrics (1.64 ± 0.02 and 1.84 ± 0.11, respectively), while T1 exhibited the smallest increases. Again, no significant differences were found (F=0.01, P=0.9863 for shell length; F=0.31, P=0.9691 for shell circumference). Proximate analysis revealed T3 had the highest levels of crude protein (20.02), crude fat (7.00), and carbohydrates (56.06), while T1 contained the highest moisture (10.03), crude fiber (15.63), and ash (16.07). Mortality rates were highest in snails fed T3 (10%), compared to T1 and T2 (6.67% each). Overall, while plantain leaves demonstrated superior weight gain, poultry feed provided the best nutritional profile, albeit with higher mortality rates, indicating a complex interaction between diet composition and growth performance in juvenile *A. achatina*. Future research should focus on the optimal ratios of cassava and plantain leaves in combination with other feed types to maximize growth while minimizing mortality rates.

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Introduction

The Giant African Snail, *Achatina achatina*, has garnered significant attention in recent years due to its potential for sustainable protein production and its role in local ecosystems. As an herbivorous mollusk, its growth performance is heavily influenced by dietary composition. Traditional feed sources for *Achatina achatina* often include agricultural by-products; however, the nutritional value of unconventional feed sources, such as cassava leaves (*Manihot esculenta*) and plantain leaves (*Musa paradisiaca*), remains underexplored. Recent studies have highlighted the importance of dietary diversity in enhancing growth rates and overall health in mollusks. For instance, research by Osei *et al*. (2021) demonstrated that incorporating varied plant materials can significantly influence the growth and reproductive performance of snails. However, there is a notable lack of comprehensive studies focusing specifically on the effects of cassava and plantain leaves on the growth performance of *Achatina achatina*. While cassava leaves are rich in protein and micronutrients (Nwosu *et al*., 2020), and plantain leaves are known for their high fiber content (Ogunbiyi *et al*., 2022), their specific impacts on the growth metrics of juvenile snails remain inadequately documented. Furthermore, the existing literature primarily addresses the nutritional profiles of these leaves without correlating them to practical growth outcomes in *Achatina achatina*. This gap presents an opportunity to explore how these readily available and cost-effective feed sources can optimize growth performance in juvenile snails, potentially leading to enhanced aquaculture practices. Thus, this study aims to evaluate the growth performance of juvenile *Achatina achatina* fed diets comprising cassava and plantain leaves, contributing valuable insights into alternative feeding strategies that could improve snail farming sustainability.

Materials and Methods

Study Location: The research was conducted in the laboratory of the Department of Biological Science at Paul University Awka. Awka is located at geographical coordinates 6° 16' 0" North and 7° 3' 0" East (Fig. 1). It is situated within Nigeria's tropical rainforest zone, experiencing two distinct seasons: the

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wet season from April to October and the dry season from November to March. The average temperature ranges from 28.5°C between June and December to 33°C from January to April (Okeke et al., 2021)

Experimental Design: A total of ninety (90) juvenile African giant snails (*Achatina achatina*) were utilized for the experiment. The snails were divided into three dietary treatment groups: cassava leaf, plantain leaf, and poultry feed, with each group consisting of thirty (30) snails. Each treatment was further divided into three (3) replicates, with ten (10) snails assigned to each replicate.

Experimental Animal Used: For this experiment, juveniles of the African giant snail (*Achatina achatina*) were utilized. The snails were sourced from the Nkwo Igbo-ukwu market in the Aguata Local Government Area of Anambra State. The snails, weighing between 4-5 kg, were randomly assigned to different treatment groups. Key characteristics of this species include its shell coloration and the pointed shape of the shell apex.

Experimental Procedure: The snails were acclimatised to the laboratory environment for one week and were provided with pawpaw leaves as their nutritional source before the experiment. They were kept in rectangular plastic boxes measuring 47.5 cm x 32 cm x 26 cm, which were covered with nets to ensure air circulation while preventing the intrusion of insects and parasites. Following this acclimatization period, the snails were randomly assigned to one of three dietary treatments: cassava leaf, plantain leaf, and poultry feed as a control. Each treatment group consisted of thirty snails, divided into three replicates of ten snails each. The feeding regimen lasted for five weeks, with the snails receiving a diet equivalent to 2% of their body weight (Ogunyemi, 2021). Fresh water was provided continuously throughout the experimental period using shallow drinking plates. To facilitate ingestion and minimize respiratory issues, the snails were fed moistened food (Ugwuowo and Anyaokei, 2020). Feeding occurred in the evenings, between 16:00 and 18:00 hours, in alignment with the nocturnal feeding habits of the snails. The leaves used in the diets were freshly harvested from trees or plants. Any leftover food was removed and discarded daily from the feeding trough. The feed provided to the snails was weighed before introduction, and any uneaten portions were collected, dried, and weighed to calculate daily feed intake. The trays used for food and water were cleaned daily to prevent microbial growth (Ugwuowo and Anyaokei, 2020). Additional sanitary measures included the daily removal of snail feces to avoid the accumulation of pathogens (Ugwuowo and Anyaokei, 2020). The snails were weighed at the beginning of the experiment, and subsequently weighed weekly for a duration of five weeks. The feed utilized as poultry feed was Vital Growers Feed, which was obtained from the market.

Data Collection and Analysis: In this study, several parameters, including weight gain, shell length increase, shell circumference, growth rate, and mortality rate were measured (AOAC, 2019).

Weight gain (Wg) in snails was calculated using the formula: $Wg = \log(Wt) - \log(Wo) / (t - to)$, where Wo represents the mean initial weight, Wt denotes the mean final weight, to is the initial time, and t is the final time.

The increase in shell length was assessed using twine, which was subsequently stretched along a meter rule from the apex to the base of the shell, measured to the nearest centimeter (AOAC, 2019). The increase in shell length is calculated using the formula: Mean Final Shell Length – Mean Initial Shell Length / Final Time – Initial Time.

The increase in shell circumference was assessed by wrapping a piece of cellulose tape around the snail's shell. The tape was then removed and measured to the nearest centimeter. The increase in shell circumference is calculated using the formula: (Mean final shell circumference - Mean initial shell circumference) / (Final time - Initial time).

The Specific Growth Rate was determined following the AOAC (2019) methodology and is represented by the formula: $(\log W2 - \log W1) \times 100 / (T2 - T1)$, where W1 denotes the initial weight, W2 indicates the final weight, T1 is the initial time, and T2 is the final time.

Diet samples were analyzed for proximate composition at Springboard Research Laboratory in Awka, following the official methods outlined by the Association of Official Analytical Chemists (AOAC, 2019).

Statistical Analysis: The growth parameter data were statistically analyzed using Analysis of Variance (ANOVA) at a confidence level of $P = 0.05$, employing SPSS version 20.0 for Windows. Mean comparisons were conducted using the Tukey post hoc test.

Results

The result from the five-week study of the growth performance of juvenile snails (*Achatina achatina*) subjected to three dietary treatments is presented in the tables 1 and 2

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Weight Gain: The result for the weight gain of snails is presented in Fig. 2 below

Figure 2 illustrates a gradual increase in weight over time for all snails that were fed the three different diets. The greatest weight gain was observed in snails fed with diet T2 (plantain leaf), which recorded an average of 3.03 ± 0.16, followed by those on diet T3 (poultry feed) with an average gain of 2.94 ± 0.10. In contrast, the lowest weight gain of 2.84 ± 0.17 was noted in snails fed with diet T1 (cassava leaf). Nevertheless, the differences in weight gain among the groups were not statistically significant (F=1.28, P=0.31, P>0.05) when compared to the control group

3**Shell Length Increase:** The result for shell length increases of the snail (Achatina achatina) is presented in Fig. 3 below

Figure 3 illustrates that the greatest increase in shell length (1.64 ± 0.02) was observed in snails fed with diet T3 (poultry feed), followed by those on diet T2 (plantain leaf), which showed an increase of 1.51 ± 0.07. The smallest increase in shell length (1.43 ± 0.05) was noted in snails fed with diet T1 (cassava leaf). Statistical analysis revealed no significant difference in shell length increase among the diets (F=0.01, P=0.9863, P>0.05).

Shell Circumference Increase: The results for the mean shell circumference increase for snails (Achatina achatina) is presented in Fig. 4

Figure 4 illustrates a gradual increase in shell circumference over time for snails across all dietary treatments. The most substantial increase in shell circumference (1.84 ± 0.11) was observed in snails fed with diet T3 (poultry feed), followed by those on diet T2 (plantain leaf) with an increase of 1.50 ± 0.05. In contrast, the smallest increase (1.31 ± 0.06) was noted in snails on diet T1 (cassava leaf). Statistical analysis revealed no significant difference in the increase of shell circumference (F=0.31, P=0.9691, P>0.05).

Proximate Analysis of Treatment and Control Diets: The proximate composition of the dietary treatments is presented in Table 1 .

The proximate analysis of the various feed samples indicated that T3 (poultry feed) had the highest levels of crude protein (20.02), crude fat (7.00), and carbohydrates (56.06), whereas T1 (cassava leaf) exhibited the lowest levels of crude protein (14.69) and carbohydrates (37.69). Conversely, T1 (cassava leaf) contained the highest amounts of moisture (10.03), crude fiber (15.63) and ash (16.07) and, while T3 (poultry feed) had the lowest moisture (7.6), crude fiber (3.10) and ash (6.22).

Mortality of the Snails: The mortality of snails subjected to the three dietary treatments is presented in Table 2 below.

Table 2 presents the mortality rates of snails exposed to various feeds. The snails fed with Diet T3 (poultry feed) exhibited the highest mortality rate at 10%, whereas the lowest mortality rates were observed in snails fed with Diet T1 (cassava leaf) and Diet T2 (plantain leaf), both at 6.67%.

Discussion

The evaluation of growth performance in juvenile *Achatina achatina* fed diets of cassava leaves (*Manihot esculenta*) and plantain leaves (*Musa paradisiaca*) provides valuable insights into the dietary preferences and nutritional requirements of this economically important species. The study's findings indicate that while all dietary treatments resulted in gradual weight gain, the most significant weight increase was observed in snails fed with plantain leaves (diet T2), followed closely by those on poultry feed (diet T3). The observed weight gain of 3.03 ± 0.16 grams in snails fed with plantain leaves aligns with previous studies that highlight the nutritional benefits of plantain as a feed source for gastropods. Plantain leaves are rich in carbohydrates and essential nutrients, which may contribute to enhanced growth performance (Obakanurhe *et al*., 2024). Conversely, the lower weight gain in snails fed with cassava leaves (T1) may be attributed to their lower protein and carbohydrate content, as indicated by the proximate analysis. This finding is consistent with research by Iwar *et al*. (2024), which demonstrated that higher protein diets significantly enhance the growth rate of *Achatina fulica*. It also aligns with previous research suggesting that plant-based diets can enhance growth performance in gastropods due to their nutritional profiles (Kumari *et al*., 2021; Owolabi *et al*., 2022). Despite the observed differences in weight gain, shell length, and shell circumference among the dietary treatments, the lack of statistically significant differences (P>0.05) suggests that while certain diets may be more favourable, they do not drastically outperform others in terms of growth metrics. This finding is consistent with earlier studies that reported similar trends in growth performance among different feed types for *Achatina* species (Nwafor *et al*., 2020). The increase in shell length and circumference was

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most pronounced in snails fed with poultry feed (T3), which had the highest crude protein levels. This suggests that protein-rich diets may be essential for optimal shell development, as supported by studies indicating that dietary protein is crucial for shell formation in mollusks (Hernandis *et al*., 2022). The lack of significant differences in shell growth metrics among the diets, however, indicates that other factors, such as environmental conditions and genetic factors, may also play a role in shell development.

The proximate analysis of the feed samples indicates that poultry feed (T3) contains higher levels of crude protein, fat, and carbohydrates compared to cassava leaves (T1), which may explain the enhanced growth performance observed in snails fed this diet. However, the higher mortality rate associated with poultry feed (10%) raises concerns about its long-term sustainability as a primary feed source, as excessive protein or inappropriate feed formulations can lead to health issues in snails (Akinmoladun *et al*., 2023). The nutritional composition of cassava leaves, although lower in crude protein and carbohydrates, is noteworthy for its high moisture, crude fiber, and ash content. These components are essential for maintaining hydration and digestive health in snails (Fagbenro *et al*., 2023). The lower mortality rates observed in snails fed cassava and plantain leaves suggest that these diets may be more suitable for long-term cultivation, particularly in regions where these plants are readily available and can be sustainably harvested. The highest mortality rate (10%) in snails fed with poultry feed (T3) suggests potential adverse effects associated with high-protein diets or the specific formulation of the poultry feed used. This finding is critical as it underscores the need for careful formulation of diets for juvenile snails to balance growth performance with health and survival. Previous studies have reported similar trends, where high-protein diets can lead to metabolic stress and increased mortality in gastropods (Popoola *et al*., 2023). Future research should focus on longer-term studies to assess the long-term effects of different dietary treatments on growth performance, reproductive success, and overall health of *Achatina achatina*. It could also investigate the optimal ratios of cassava and plantain leaves in combination with other feed types to maximize growth while minimizing mortality rates. In conclusion, while the current study provides a foundational understanding of the growth performance of *Achatina achatina* fed different diets, further investigations are necessary to optimize feeding strategies and ensure the sustainability of snail farming practices

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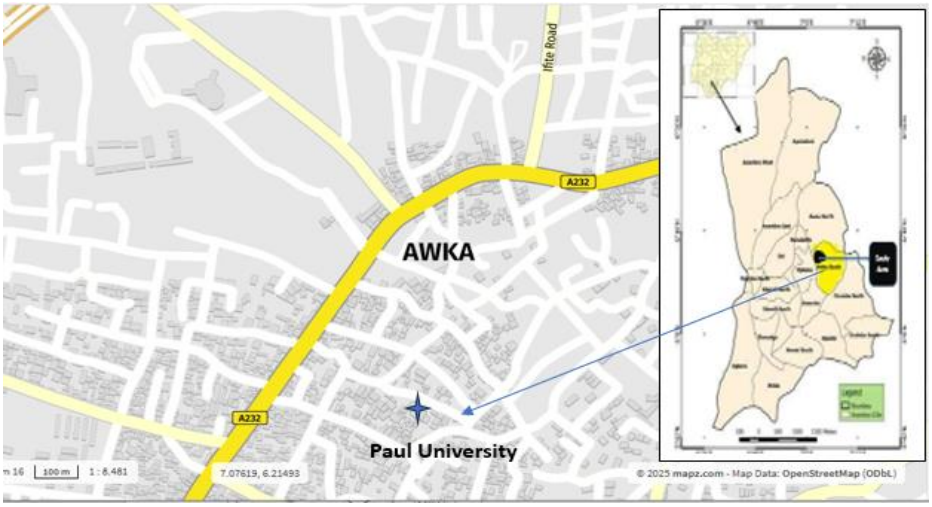

Fig 1. Location of study laboratory

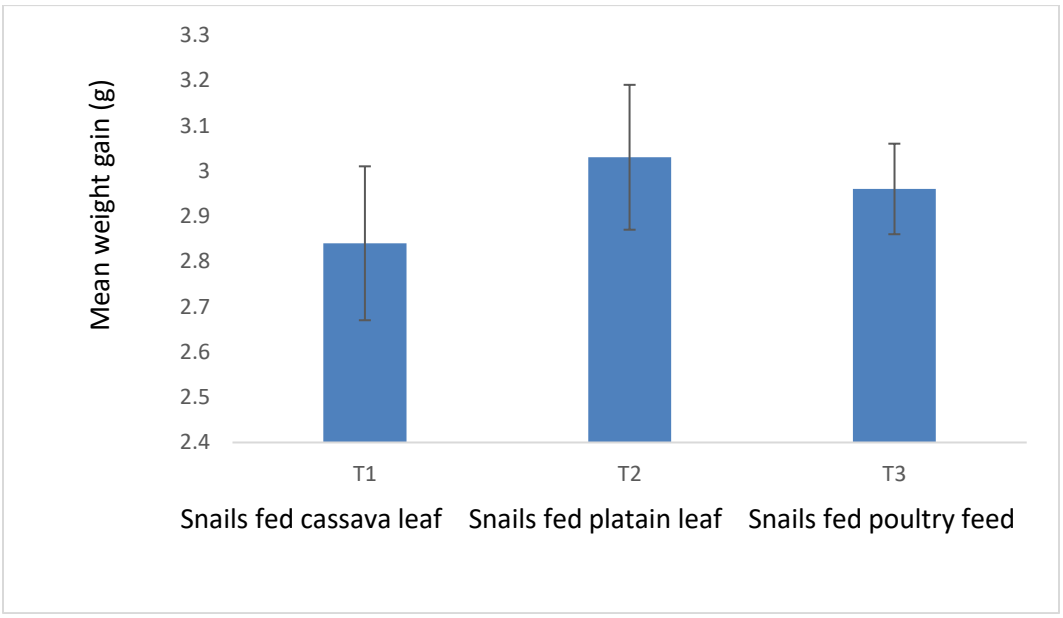

Fig 2: Mean weight gain of snail (*Achatina achatina*) under three dietary treatments for 5 weeks.

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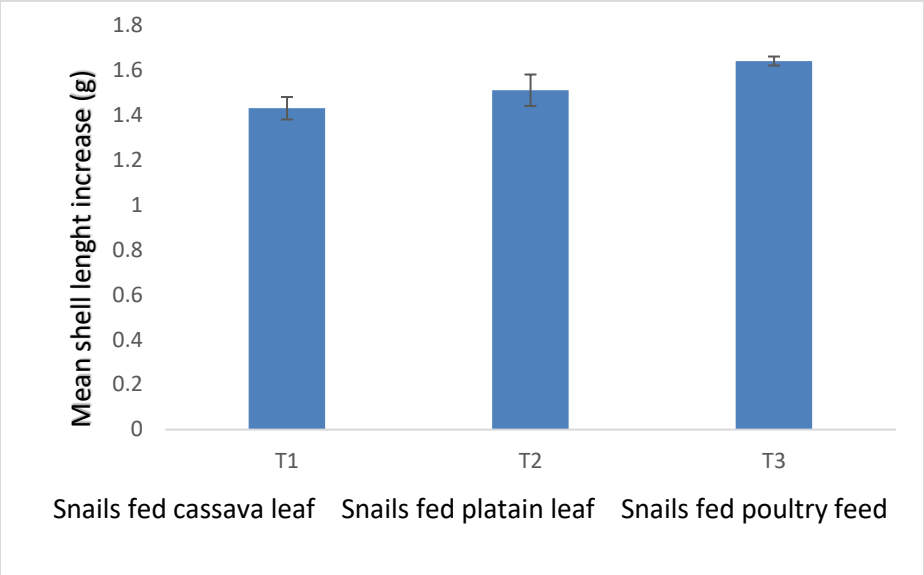

Fig 3: Mean shell length increase of snail (*Achatina achatina*) under three dietary treatments for 5 weeks

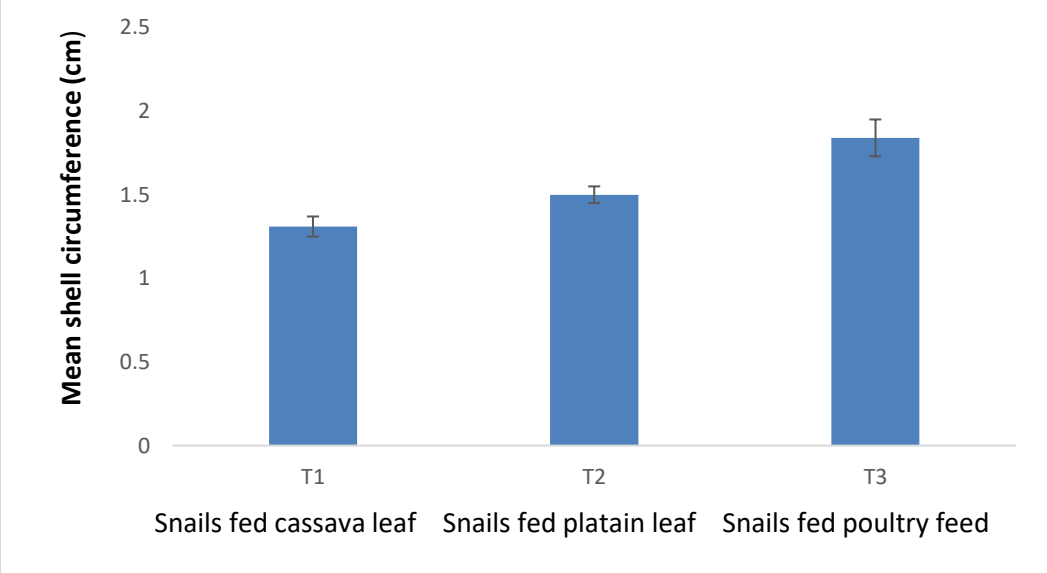

Fig 4. Mean shell circumference increase of snail (*Achatina achatina*) under three dietary treatments for 5 weeks

Table 1: proximate analysis of the dietary treatments

Diets	Crude protein	Moisture	Crude fiber	Crude fat	Ash	Carbohydrate
T1	14.69	10.33	15.63	5.59	16.07	37.69
T2	19.4	9.4	8.1	1.8	7.2	54.1
T3	20.02	7.6	3.10	7.00	6.22	56.06

Table 2: Mortality of the snail subjected to the dietary treatment

Treatment	Mortality	Percentage mortality (%)
T1	2	6.67
T2	2	6.67
T3	3	10