PAWPAW LEAVES SUPPLEMENTED WITH THREE CALCIUM SOURCES AND THEIR EFFECTS ON THE AFRICAN GIANT LAND SNAIL IN HUMID NIGERIA

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ABSTRACT
The response of one hundred and thirty-two (132) grower African giant land snail (Archachatina marginata) with a weight range of 231.33-234.00 g and fed fresh pawpaw (Carica papaya) leaf-based diet supplemented with three mineral calcium sources was investigated in a humid tropical environment of Nigeria. The grower snails received either pawpaw leaves alone (T_1: control), pawpaw leaf + egg shell (T_2), pawpaw leaf + oyster shell (T_3) or pawpaw leaf + periwinkle shell (T_4). Each treatment groups was replicated 3 times in a Completely Randomized Design. The results showed that pawpaw leaf and calcium intakes differed ($p < 0.05$) ranging from the lowest for T_1 to the highest for T_3. Weight gain varied ($p < 0.05$) between 261.34 g for the T_1 to 385.33 g for T_2 while, feed conversion ratio ranged from 0.58 for T_2 to 0.77 for T_1. While shell length and width increments were not significantly different ($p > 0.05$), shell thickness was significantly different ($p < 0.05$) varying between 0.15 cm for T_1 to 0.27 cm for T_3. The study suggests that dietary calcium supplementation in the diets of the African giant land snail will improve the intake of a pawpaw leaf basal diet and mineral calcium, weight gain and feed conversion ratio with the oyster supplemented group performing better.

Key words: *Archachatina marginata*, Calcium supplementation, *Carica papaya*, snail, performance

INTRODUCTION
The shell of the edible giant land snail (*Archachatina marginata*), regarded as the "snail's home", is a very vital component of its body. It enables the snail to maintain a constant water balance between its tissues and the environment with regard to the relative humidity for its life (Tell Communication and Songhai centre, 2006). The shell represents, approximately, one-third of the total weight of the snail with about 98% of its composition made of calcium carbonate (Akinnusi, 2004; Thompson and Cheney, 2004; Tell Communication and Songhai Centre, 2006). Mineral supplementation (calcium carbonate supply) in the diet of snail is an important component of snail farming systems (Akinnusi, 2002; Thompson and Cheney, 2004). Although there are several sources of calcium for snails, most of the research efforts aimed at identifying such cost-effective sources for mineral supplementation or calcium carbonate supplies to snails through their diets have always focused on the use of egg shell. As a result, egg shell has for long remained the major dietary calcium source recommended to heliculturists (snail farmers). Unfortunately, the unprecedented global onset of the H5N1 virus (bird flu) pandemic threatens the continuous reliance on egg shell as a sustainable dietary calcium source for snail farming and requires identifying other alternatives. The study was designed to carry out a comparative evaluation of egg, oyster and periwinkle shells in a humid part of Nigeria.

MATERIALS AND METHODS

Study site

The experiment was conducted in hutches placed inside a semi-open-sided locally built house at the Teaching and Research Farm of the Rivers State College of Education, Ndele Campus (Latitude 4° 58' N and Longitude 6° 48' E), Nigeria. A total of 12 hutches each measuring 50 cm x 40 cm x 60 cm and covered with wire nettings and mosquito net to ensure adequate ventilation and tidiness were used. The open-sided house was barricaded with well-woven thatches on its sides over a thatch roof, shaded under trees to create a cool, dim and humid micro-environment. The pens had 15 cm deep well-textured garden soil covered on its surface with dried leaf litter.

Snails and experimental design

A total of one hundred and thirty-two (132) grower snails (*Archachatina marginata*) with a weight range of 231.33-234.00 g were randomly assigned to the four treatment groups. Treatment groups were fed pawpaw (*C. papaya*) leaf-based diet (Table 1).
Treatment 1 (T_1) – Control (Pawpaw leaves alone);
Treatment 2 (T_2) – Pawpaw leaves + egg shell supplementation;
Treatment 3 (T_3) – Pawpaw leaves + oyster shell supplementation, and
Treatment 4 (T_4) – Pawpaw leaves + periwinkle shell supplementation.
The treatment groups were replicated three times giving a total of twelve replicates with eleven (11) snails per replicate randomly assigned in a completely randomized design (C.R.D). The experiment was conducted for 16 weeks from the date of the arrival of the grower snails. The uniformity of the weights, shell length and width of snails assigned to the different treatment groups were put into consideration.

Table 1. Mean proximate composition of pawpaw (*Carica papaya*) leaf used for study

Nutrient	Percentage composition (%)
Dry matter	22.12
Crude fibre	10.50
Crude protein	22.70
Ether extract	0.38
Nitrogen-free Extract	36.70
Ash	7.60

The pawpaw (*C. papaya*) leaves, supplemental calcium sources (egg, oyster and periwinkle shells) and water were placed in plastic troughs and were provided *ad lib.* to the snails between 17:00 h and 18:00 h in the evenings on daily basis, since the snails are nocturnal and most active at night. The feed and soil were sprinkled with water, regularly, to enhance feed utilization and improve the humidity within the hutches, respectively. Feed and calcium supplement refusals were collected and their weights recorded the next day prior to the replacement of fresh feed, calcium source supplements and water. Feed intake, supplementary calcium source intake and mortality records were taken on daily basis. Body weight data, weight gains, shell length and width were recorded while, feed conversion ratios were then computed fortnightly (at 2 weeks intervals) till the termination of the experiment. Shell length and width measurements were taken with the use of vernier callipers.

Chemical analysis

Proximate analysis of the pawpaw (*C. papaya*) leaves was carried out using the procedures of AOAC (1990).

Statistical analysis

Data from the study were subjected to statistical analysis using analysis of variance (ANOVA) procedures (Steele and Torrie, 1980). Treatment means were compared using the least significant difference (LSD) option at the 5% probability level.

RESULTS

Table 2 presents the performance of the edible giant land snail (*A. marginata*) fed pawpaw (*C. papaya*) leaf-based diet supplemented with the different dietary calcium sources: egg shell, oyster shell, periwinkle shell and control (zero calcium source or no calcium supplementation) and revealed that pawpaw leaf and calcium intake varied significantly ($p < 0.05$). The snails on the control diet recorded the lowest pawpaw leaf and calcium intakes while, those supplemented with oyster shell recorded the highest pawpaw leaf and calcium intakes whereas the snails fed supplemental periwinkle and egg shells were similar.

Similarly, the initial weights of the snails did not differ ($p > 0.05$) while, the weight gains were significantly different ($p < 0.05$) ranging from the lowest for the control group to the highest for the egg shell supplemented group (Table 2). Also, Table 2 indicates that the feed conversion ratio varied from 0.58 for the egg shell supplemented group to 0.77 for the control group. The variations in shell length and width by edible giant land snail fed pawpaw leaf supplemented with calcium from three sources over 16 weeks are shown in Table 3. There were no significant increments ($p > 0.05$) in both shell lengths and widths of the snails. However, shell thickness of snails was significantly different ($p < 0.05$). The shell thickness ranged from 0.15 cm in the control group to 0.27 cm in the oyster shell supplemented snail group.

Table 3: Variation in shell length and width by the edible giant land snail (*Archachatina marginata*) fed pawpaw (*Carica papaya*) leaf supplemented with calcium from three sources over 16 weeks

Parameter (cm/snail)	**Calcium (Ca) sources**				**Mean**	**SE(df = 8)**
	Control (Zero Ca)	**Egg shell**	**Oyster shell**	**Periwinkle shell**		
Initial shell length	3.13	3.11	3.11	3.10	3.11	0.312
Final shell length	7.14	7.11	7.35	7.24	7.60	0.269
Changes in shell length	4.01	4.00	4.24	4.14	4.10	0.164
Initial shell width	2.70	2.70	2.70	2.70	2.70	0.130
Final shell width	3.92	4.36	4.05	3.95	4.07	0.390
Changes in shell width	1.22	1.67	1.34	1.24	1.37	0.161
Shell thickness	0.15^{b}	0.20^{ab}	0.27^{a}	0.22^{a}	0.21	0.048

^{a,b} Means bearing different superscripts along the same row are significantly different ($P < 0.05$).

DISCUSSION

Results in Table 2 of the study showed differences in calcium intake by snails from the different calcium sources (egg shell, oyster shell and periwinkle shell). These compounds are required for growth and repair of damaged shells of the snails (Thompson and Cheney 2004; Tell Communication and Songhai Centre, 2006). Similarly, pawpaw (*C. papaya*) leaf intake was higher for snails whose diets were supplemented with calcium sources, although superior values were obtained for snails with dietary supplementation of oyster shell. However, the observed mean feed intake by the snails was lower than the mean 390.53 g reported by others (Ademolu *et al*, 2004). The poor intake of pawpaw leaf by snails with zero calcium supplementation in the control group may be attributed to the lack of fortification of the pawpaw diet with any form of calcium source which stands to enhance its intake (Akinnusi, 2002).

Furthermore, the weight gain results also revealed poor weight gains amongst snails in the control group which had the diet not supplemented with any calcium sources (Table 2). This is in agreement with the report by Ebenso (2003), who recorded lower mean weekly weight gains amongst snails maintained on diets fortified with egg shell, limestone, wood ash, oyster shell, and bone meal at 10% inclusion levels as compared to 20% of these compounds in a pawpaw leaf-based diet. The recorded mean weight gains for the present study were higher than the values reported in a study where the African giant land snails were fed different nitrogen based diets (Ademolu *et al*, 2004). However, the feed conversion ratios of the snails in all four treatments were, generally, very low compared to observations by others (Adu *et al*, 2002).

The shell length and width increments for the snails were similar for all the experimental groups (Table 3). The mean shell length gain (4.10 ± 0.164 cm) reported for the snails in the study was higher that the range of 0.88 to 1.47 cm reported for snails fed different nitrogen based diets (Ademolu *et al*, 2004). The snails of the "zero calcium" group may have, persistently, derived their exchangeable calcium from the soil (Thompson and Cheney, 2004), which would have enhanced their shell growth. "Zero calcium" inclusion in the diets of snails affected their shell thickness as was observed to have recorded the least thickness (Table 3). This is in agreement with the reports by Thompson and Cheney (2004) that, low calcium intake will slow growth rate in growing snails and cause their shells to be thinner. In addition, shell thickness has been identified as a measure of the health status of snail (Adeyemo and Borire, 2002). This observation corroborates the reports by Ebenso (2003) and contrary to reports of Ireland (1991) that mortality occurred only in snails fed lower calcium diets.

CONCLUSION

The study suggests that the edible African giant land snail (*Archachatina marginata*) performed, favorably, well with mineral (calcium source) supplementation to a basal diet of pawpaw leaf (*Carica papaya*) intake, weight gains, and shell thickness. The poor performance by snails in the control group or "zero calcium" supplementation suggests the importance of dietary calcium supplementation in snail farming. Furthermore, the study has also identified oyster shell as an alternative mineral calcium source that could replace egg shell in the face of global avian influenza (bird flu) pandemic. Thus oyster shell is recommended to snail farmers for use in snail diets due to its abundance and as a cheap calcium source. Calcium supplementation is, therefore, encouraged to improve the nutritive value of snail meat and ultimately the health of rural children and pregnant women.

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