Nig. J. Anim. Prod. 2018, 45(4):27 - 31
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Survival and biophysical changes of three common species of land snails in Edo and Delta States during a 12-week aestivation

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Abstract

The experiment was conducted to determine the changes in the biophysical parameters during starvation in three common species of land snails identified in Edo and Delta States. A total of 252 matured healthy snails comprising three species (Archachatina marginata, Archachatina papyracae and Achatina fulica) were used. A completely randomized design was used in a 3 x 4 factorial arrangement. At the end of two weeks acclimation period, feed and water were withdrawn for 4, 8 and 12 weeks. Result shows that A. marginata has significantly (P<0.05) highest initial liveweight. A. papyracae had the least weight but was not significantly (P>0.05) different from the weight of A. fulica used in the study. During the 12 weeks of starvation, A. papyracae recorded the highest mortality rate of 24.58 %. A. marginata and A. fulica respectively recorded mortality rate of 9.05 and 6.52 %. A. marginata reflected two stages of major weight decline; 2nd and 9th weeks. The A. papyracae and A. fulica however declined conspicuously only at the 1st week. The weight of the muscular foot which constitutes the edible portion of the three species decreased between 0, 4 and 8 weeks. There were no significant differences in weight in each of the three species. Twelve weeks aestivation eventually resulted in further and significant weight loss. The aestivation lengths did not affect the shell weight in the three species, except A. marginata with significant decline at the 12th week. This study indicates that A. marginata and A. fulica are bigger in size and more tolerant to extended starvation than A. papyracae.

Keywords: Biophysical, aestivation, *Archachatina marginata*, *Archachatina papyracae*, *Achatina fulica*

Introduction

Land snails usually exhibit cycles of activity and dormancy (aestivation or hibernation). The transition of these two states is accompanied by a range of behavioural, morphological and physiological responses to ensure their survival under adverse environmental conditions. The humid rainforest climatic condition of Edo and Delta States, Nigeria provides favourable factors for the proliferation of different species of snails. When conditions become unfavourable; naturally or otherwise – resulting in starvation, they aestivate. Besides, snails are perceived to be hardy. It is therefore a common practice to leave snails unfed (starved) for days. This is also seen when food is limited and vegetations are scarce particularly during the long dry season in the tropics. During this period, snails aestivate as a means of coping with the unfavourable conditions.

The study was therefore carried out to examine the biophysical changes as well as the tolerance and survivability of three species of land snails common in both Edo and Delta States, Nigeria, during aestivation.

Materials and methods

Experimental site

The research work was carried out at the University of Benin Teaching and Research Farm, Benin City, Edo State, Nigeria. The farm is located within the tropical rainforest

vegetation zone of southern Nigeria lying between longitude 5°E and 6° 42'E and latitude 5° 45 and 7° 34'N of the equator (FAAN, 2016). Edo is bounded by Kogi. Anambra, Delta and Ondo States on the North, East, South and West respectively. The climate of Edo is humid.

Experimental materials

From a preliminary survey in markets in Edo and Delta States, three common species of land snails were identified. These include; *Archachatin amarginata*, *Archachatina papyracae* and *Achatina fulica*. A total number of 252 healthy snails comprising of the three species were purchased from Edo and Delta State. Well ventilated plastic basket, weighing scale, vernier caliper were used. Feed and water were made available two weeks prior to the experiment (during the period of acclimation)

Experimental design and procedure

The experiment was laid out in a completely randomized design (CRD), in a 3 (species) x 4 (starvation length) factorial arrangement. Seven snails constituted each of the replicates

The experiment was conducted between the months of December, 2015 to March, 2016. Well ventilated plastic baskets, (40 cm x 25 cm x 20cm with cover) were prepared and filled with humus soil to a depth of 5 cm and moistened with water. Snails were weighed and allotted based on sizes. This was done using an electronic weighing scale and randomly allocated to the treatment groups.

Optimum hygiene was ensured by removing excreta and left-over feed on a daily basis and the soil moistened as required. Feed (layers mash, fresh pawpaw leaves, plantain leaves, cocoyam leaves, pawpaw fruit and water melon) were provided during the acclimation period, watering of the soil was stopped two days to the end of acclimation period.

At the end of the two weeks acclimation period, the live weight of the snails (fed weight) weretaken; feed and water were also withdrawn to induce starvation. Snails on 0W were immediately dissected, haemolymph collected, and the foot (mass) also obtained. Similar data were collected from snails in treatment group 4W, 8A and 12A after 4, 8 and 12 weeks of starvation respectively.

Data collection

The data collected on the biophysical parameters of snails were weight gained measured weekly with a sensitive weight scale, shell thickness, shell weight, and mass. Mortality rate was also recorded.

Statistical analysis

All data were subjected to two-way analysis of variance and the means were separated using Duncan multiple range test. The analysis was carried out using Genstat (2006), 12th edition statistical package.

Results and discussion

A. marginata, *A. papyracae* and *A. fulica* were the common species of snails observed to be consumed in Edo and Delta States. In this study, epiphragm formation was observed while the snails were subjected to starvation. According to Arad and Avivi (1998), the secretion of a calcareous epiphragm is one of several water preserving mechanisms in land snails (Arad and Avivi, 1998) and accounts for up to 20 % of their resistance to evaporative water loss during dormancy (Egonmwan, 2012). Figure 1 shows the mortality rate of the three species of land snails in Edo and Delta States over the 12 weeks starvation length. *A. papyracae* recorded the highest mortality rate of 24.58 % while *A. marginata* and *A. fulica* recorded mortality rate of 9.05 and 6.52 %, respectively.

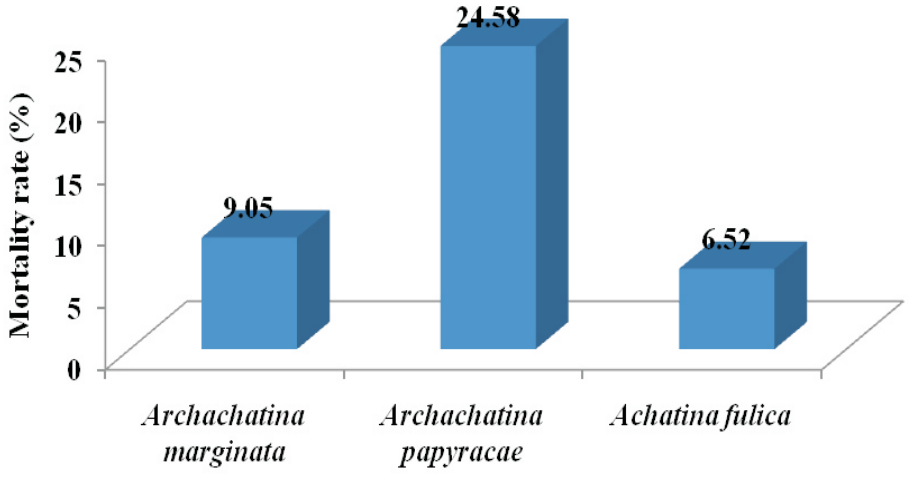

Figure 1: Mortality rate of three (3) common species of land snails in Edo and Delta States during starvation

The biophysical responses of three (3) species of snails (*Archachatina marginata*, *Archachatina papyracea* and *Achatina fulica*) in Edo and Delta States during 12 weeks starvation period are shown in Tables 1. The initial and abrupt decline in liveweight (first week in *A. papyracae* and *A. fulica* and up to the 2nd week in *A. marginata*) due to starvation (Figure 2) could be attributed to dehydration.

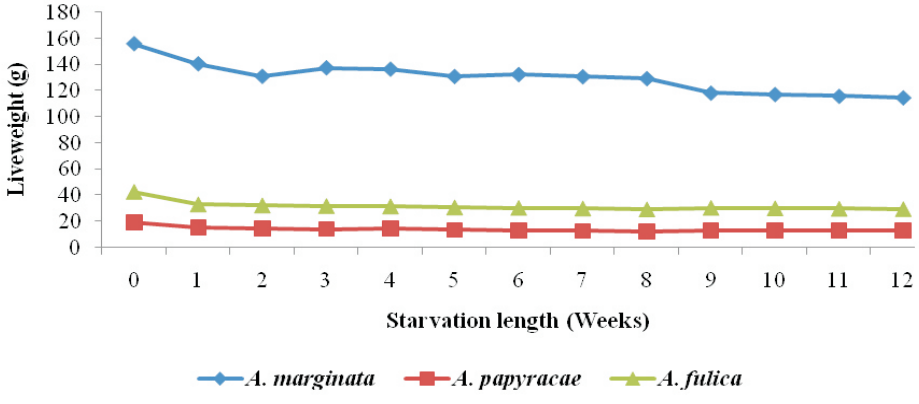

Figure 2: Trend in liveweight of three species of snails in Edo and Delta States during starvation treatment

Cumulatively, Emerson and Duer (1967) reported weight reduction of 62 % in *Littorinaplanoxis*. About 50 % loss in weight was also reported by Russel-Hunter and Eversole (1976) after 132 days of starvation in the fresh water pulmonate snail, *Helisonatrivolvis*. Lukong and Onwubiko (2004) reported a liveweight decline of 44.60 % in *Achatina achatina* aestivated for 4 months. Omoyakhi (2007) and Abdusamad *et al.* (2010) reported a liveweight decline of 52.40 % and 35.60 %

respectively in *A. marginata* after six weeks of aestivation.

A. marginata showed significant (P<0.05) differences with aestivation lengths but *A. papyracae* and *A. fulica* reflected no significant change in Liveweight at 0, 4, 8 and 12 weeks starvation lengths.

Table 1: Changes in the biophysical parameters in three (3) common species of land snails in Edo – Delta State during starvation

CIES	Starvation length	Biophysical variables			
		Liveweight (g)	Muscular foot (g)	Shell weight (g)	Shell thickness (mm)
arginata	0W	156.07_a	96.80_a	45.00_a	1.17_{ab}
	4W	136.53_b	52.50_b	43.03_a	0.90_{ab}
	8W	129.27_b	51.00_b	43.77_a	1.42_a
	12W	114.50_c	37.33_c	30.73_b	1.23_a
pyracae	0W	19.00_{ef}	14.30_e	4.23_d	0.85_{ab}
	4W	14.06_f	6.70_{ef}	5.93_{ed}	0.62_b
	8W	11.99_f	4.70_f	3.73_d	1.21_a
	12W	12.88_f	5.33_f	4.33_d	1.04_{ab}
lica	0W	42.33_d	27.03_d	9.00_{cd}	1.19_{ab}
	4W	31.3_{de}	10.53_{ef}	7.83_{cd}	0.97_{ab}
	8W	29.04_{de}	12.20_{ef}	13.43_c	1.08_{ab}
	12W	29.27_{de}	11.83_{ef}	14.10_c	1.41_a
M		4.50	2.54	2.59	0.17

$_{ABC}$ Means with different subscripts within the same row differ significantly (P<0.05)

At 12W, *A. marginata* eventually resulted in further and significant weight loss, presumably due to dehydration between 0W and 4W and consumption of endogenous food reserve thereafter. In *A. papyracae* and *A. fulica*, after the initial decline between 0W and 4W, the weights at subsequent starvation lengths, no significant weight loss was observed suggesting better resistance of these species than *A. marginata*. The weight of the muscular foot which constituted the edible portion of the three species decreased between 0W and 4W. Between 4W and 8W, there were no significant differences in weight.

The respective weight of shell in *A. marginata*, *A. papyracae* and *A. fulica* represented 28.83 %, 22.26 % and 21.26 % at pre starvation which tend to correlate directly with body weight of the respective species and shell thickness. The starvation lengths did not affect the shell weight in the three species, except *A. marginata* with significant decline at the 12W. The thickness showed similar trend indicative of the larger the body weight, the thicker the shell. The significant decline in shell weight at the 12th week starvation length in *A. marginata* may be connected with calcium and potassium mobilization from the shell for metabolic processes and epiphragm formation at prolonged starvation length as it was observed that epiphragm formation was occasionally been replaced; similar but no significant decline was observed with *A. marginata* aestivated for 12 weeks (Omoyakhi *et al*., 2015). The result showed 26.73 and 26.52 % for *A. marginata* aestivated for 6 and 12 weeks lengths of aestivation. Adu *et al*. (2002) in a study of performance and carcass analysis of *A. marginata* also reported a range of 24.94 to 25.48 % and Omoyakhi (2007) similarly reported a range of 27.56 and 30.56 %.

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Received: 15th August, 2018
Accepted: 21st December, 2018