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Original Research

Comparative analysis of growth performance and body measurements of *Achatina achatina* crosses

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Abstract

The hatchling snails of *Achatina achatina* were obtained from three (3) crosses groups (black-skinned × black-skinned [BS × BS], white-skinned × white-skinned [WS × WS], and black-skinned × white-skinned [BS × WS]). A total of seventy-two (72) hatchlings of A. achatina snails, with twenty-four (24) hatchlings for each mating group were used in this research to measure body trait and growth performances of hatchling snails. The snails were grouped into three (3) treatments on the basis of their crosses and monitored for six (6) weeks in a compartmented cage. The results obtained from this study showed a high significant difference ($p<0.01$) between the hatchlings of the three (3) treatments and within the age groups for both growth and body trait measured. Notwithstanding, all the hatchling snails performed well in terms of body traits measured, while only white-skinned hatchlings performed best for the growth traits. The results obtained in this study will be of importance to farmers, researchers and snail breeders in the development of breeding stocks and domestication, there enhancing better management and greater production of snail and food security globally.

Keywords: Growth performance; body measurement; hatchlings; crosses; snails; *Achatina achatina*

1. Introduction

Africa, which is the second largest continent, is richly blessed with abundant animals of different forms and variety of these animals are distributed in different places depending on environmental conditions [1, 2, 3, 4]. Micro livestock has a great potential of supplying the much-needed animal protein in human diet [5, 6]. Giant African land snail (*A. achatina*) is one of the microlivestock that could serve as ready meat for a majority of the populace especially in tropics [4, 7, 8, 9]. Meat from snail competes favorably with the poultry eggs and meat rich in essential amino acid and digestible protein [6,10].

The growth performance and body increment of snails depends solely on the type of diet presented to them, environmental conditions and the stocking density/management [4]. Snails that fed on pawpaw leaves have been recorded the highest shell length gain than those fed with other diets such as fruits [4, 11]. Therefore, snails exhibit a preference for diet based on vegetables rather than animal protein for growth performance and development [8, 12].

The size and body components of the snail vary with age of the snail [4]. The rapid growth of snails takes place during the juvenile stage of development and protein, energy and calcium are highly needed for the healthy growth and development of the snails [13]. There is variation in growth rate of snails between individuals in each population group, and snails show differences with respect to growth rate [13, 14].

There is paucity of information on the growth rate for *A. marginata, A. achatina,* and *A. fulica* snails as reported previously [13, 15]. Therefore, the outcome of this study with *A. achatina* crosses will be used as baseline information for other researchers, farmers and breeders to rely on. This study on comparative analysis of growth performance and body measurement of *A. achatina* crosses, will provide information to snail farmers, breeders and researchers for snail management, improvement and production.

2. Materials and Methods

2.1 Experimental site and animals

The research was conducted behind the Biological Sciences Laboratory at Topfaith University, Mkpatak, Akwa Ibom State, Nigeria. The area features a variety of succulent plants and shade-providing trees, creating a microenvironment suitable for snail rearing. Snails were housed in constructed wooden cages, where the local climatic conditions closely resemble their natural habitat, supporting their growth, reproduction, and survival.

Seventy-two (72) hatchling snails of *A. achatina*, consisting of thirty-six (36) white-skinned and thirty-six (36) black-skinned snails, were selected at hatching from a pool produced by three (3) crossbreeding groups. The crossbreeding combinations included black-skinned (BS) × black-skinned (BS), white-skinned (WS) × white-skinned (WS), and black-skinned (BS) × white-skinned (WS), each involving twenty-four (24) parent snails. The parent snails used for breeding weighed between 40 and 45 g. Hatchlings were selected based on active appearance and the absence of injuries, lesions on the foot, or shell damage. The selected hatchlings were then assigned to three (3) treatment groups based on the mating combinations. Each treatment was replicated four (4) times, with six (6) hatchlings per replicate, following a complete randomized design (CRD).

2.2 Management of the hatchling snails

The hatchling snails were managed in constructed wooden cages compartments measuring 0.60 × 0.50 × 0.30 cm^3, embedded with sterilized loamy soil up to 10 cm deep. The soil in the cage was sprinkled with water on daily basis to moisten the soil and to facilitate the borrowing activities of the snails. The experimental animals were fed on a mixed feeding regime of *Carica papaya* leaves and fruits, supplemented with formulated diet. The formulated diet contained 23.04 % crude protein (CP), 2995 Kcal/kgME and 15 % calcium. The ingredients used for the diet formulation include vitamin/mineral premix (1.00 %), bone meal/oyster shell (3.00 %), soybean meal (38.40 %), and sundried cocoyam (57.60 %). Feed and water were administered ad libitum throughout six (6) weeks of the experiment.

2.3 Growth and body measurement of the hatchling snails

Growth traits measured include: body weight, weight gain, feed intake and feed efficiency or conversion ratio, while the body measurements were body shell length, body shell width, mouth shell length, and mouth shell width. All the traits were measured at hatch and weekly for six (6) weeks using an electronic scale with 0.01 g sensitivity for body weight, and vernier caliper for body measurements, respectively. Body weight gain was calculated by subtracting the present week's weight from the previous week's weight. Feed intake was measured daily by subtracting between quantity of feed served after 24 hours, while the feed conversion ratio or efficiency was calculated as the ratio of the feed intake to weight gain.

2.4 Statistical analysis

Data collected were subjected to analysis of variance using SPSS statistical software package [16]. Least significant difference was used to separate the significant means [17].

3. Results and Discussion

3.1 Growth traits of hatchlings of *A. achatina* snails

The results for growth traits obtained from hatchlings of *A. achatina* snails are presented in Table 1. There were high significant differences ($p<0.01$) between the three (3) crosses and within the age groups (6 weeks). The highest body weights (0.61 to 1.12 g) were recorded for white-skinned purebred hatchlings from hatch to six (6) weeks of age, followed by the black-skinned purebred hatchlings (0.6 to 1.02 g), while the black-skinned and white-skinned crossbred recorded the lowest values (0.59 to 1.02 g). The results obtained for body weights indicated a progressive increase across the three (3) crosses groups at different developmental stages. Among the mean final body weight between the three (3) crosses groups showed high significant difference ($p<0.01$), with white-skinned purebred hatchlings recording the highest value of 6.04 g, followed by purebred black-skinned with 5.72 g, while the lowest value of 4.64 g was recorded for crossbred. The disparities recorded among the body weights in this study may be attributed to breed and strain effects, age and size of the parental breeder snails used, size and weight of eggs laid, diet type (sole or mixed), climatic and environmental factors as well as stocking density (13, 22]. It has been reported that the weight of hatchlings at hatch depend on the yolk sac residual and affected directed by the size of the egg [13, 24]. A significant correlation between egg weight and hatchling weight, and also parental breeder snails and hatchling weight was also reported by the same authors. The same authors concluded that egg weight affect weight at the hatch of hatchlings. This rapid and progressive increment in body weights is in line with the findings of other previous reports [13, 18, 19, 20, 21, 22].

The mean weight of hatchling snails at day old presented in Table 2 shows no significant genotypic effect ($p>0.05$), irrespectively of the highest initial weight of 0.61 g recorded for white-skinned purebred genotype. The mean initial weights at hatch observed in this study (Tables 1 and 2) were in line with the mean hatchling weight of 0.60 g reported previously [22, 23] for *A. achatina* juveniles fed with pawpaw leaves and formulated diet containing 20.56% CP and 2727.94Kcal/kgME, but lower than value of 0.69 ± 0.03 g and 1.08 ± 0.08 g obtained by Ref. [20] for white-skinned and black-skinned purebreds, respectively, that were fed with pawpaw leaves and formulated diet containing 24% CP, 2650 Kcal/kgME and 15% Ca. Hatchling weights of a day-old snail is used as an indicator of the growth and development of snails [13, 23].

The body weight gain within the three (3) crosses showed no significant difference ($p>0.05$) (Table 1). There was a high significant difference ($p<0.01$) among the three (3) crosses with the white-skinned purebred recorded the highest value of 0.50 g/wk mean weight gained, while the lowest mean weight gain of 0.38 g/wk was recorded for crossbred (Table 2). The mean weight gain obtained in this study were higher than the values of 0.063 ± 0.002 g/wk that was reported by Ibom and Okon [21] for black-skinned juveniles of *A. marginata* but were in the same range with the values of 0.42 and 0.48 g/wk, and 0.50 g/wk reported by other researchers [13, 22] for black-skinned purebred, white-skinned purebred and crossbred of *A. fulica* and *A. achatina*, respectively. More so, the results were higher than the value of 0.26 g/wk body weight gain for *A. marginata* that was fed with plant food [25]. The variation observed between the growth trait values might be due to differences in the age range of the hatchlings and the total number of hatchlings used for the study. Some researchers [13, 22] grouped the juvenile phase to be from one day to six weeks of age and used one hundred (100) juvenile snails, while Ref. [13], used fifty (50) juvenile snails with the same six weeks of age, but in this study, seventy-two (72) hatchlings derived from three (3) crosses groups or mating groups or mating groups were used with the same six (6) weeks of age.

Table 1: Mean weekly (g) of hatchlings of *A. achatina* snails (1 day to 6 weeks of age)

Growth traits	Age (weeks)																							
	BS×BS								WS×WS								BS×WS							
	0	1	2	3	4	5	6	p-value	0	1	2	3	4	5	6	p-value	0	1	2	3	4	5	6	p-value
BWT (g)	0.60	0.71	0.76	0.83	0.86	0.94	1.02	p<0.01	0.61	0.69	0.78	0.86	0.95	1.03	1.12	p<0.01	0.59	0.66	0.75	0.79	0.83	0.83	1.02	p<0.01
BWTG (g/wk)		0.11	0.05	0.07	0.03	0.08	0.08	p>0.05		0.07	0.09	0.08	0.09	0.08	0.09	p>0.05		0.07	0.09	0.04	0.04	0.05	0.09	p>0.05
FI (g/wk)		4.10	5.62	6.06	7.13	8.21	9.40	p<0.01		5.31	6.50	7.72	8.33	9.47	10.12	p<0.01		4.00	5.16	6.22	7.59	8.68	9.24	p<0.01

BWT = Body weight, BWTG = Body weight gain, FI = Feed intake, BS = Black-skinned, WS = White-skinned, WK = week, p>0.05 = Non-significant at 5% level, p<0.01 = High significant at 10% level

Table 2: Growth Traits of hatchlings of *A. achatina* snails

Growth traits	Mating Groups/crosses		
	BS×BS	WS×WS	BS×WS
Mean initial weight (g)	0.60[a]	0.61[a]	0.59[a]
Mean final weight (g)	5.72[a]	6.04[a]	4.64[b]
Mean weight gain (g/wk.)	0.42[b]	0.50[a]	0.38[c]
Daily weight gain (g/d)	0.03[a]	0.02[b]	0.02[b]
Total feed intake (g)	40.52[b]	47.45[a]	40.89[b]
Daily feed intake (g/d)	0.912[b]	1.110[a]	0.918[b]
Feed efficiency (FE)	0.033[a]	0.018[c]	0.022[b]

[ab] Means along the same row

There was a significant daily feed intake among the three (3) crosses groups with white-skinned purebred recording the highest and significant value of 1.110 g/d, while 0.912 g/d and 0.918 g/d were recorded for black-skinned purebred and crossbred respectively (Table 2). The results obtained in this study for daily feed intake of black-skinned purebred and crossbred were in the same range with the values of 0.965, 0130, 0.974, 0.990 and 0.819 g/d recorded in Refs. [13, 22] for black-skinned, white-skinned and crossbred juvenile of *A. achatina* snails, respectively. On the other hand, the results of the daily feed intake were higher than the values of 0.0153 ± 0.0001 g/d for black-skinned and 0.00141 ± 0.0001 g/d for white-skinned juveniles of *A. marginata* snails as reported in Ref. [20].

Significant ($p<0.01$) feed efficiency was obtained among the three (3) crosses in this study (Table 2), with the white-skinned purebred hatchling snails showing active and best feed utilization potentials. These results were lower than the values (0.89, 0.78, and 0.70) feed efficiencies reported in Ref. [23], for black-skinned, white-skinned and crossbred juvenile *A. marginata* snails respectively, but higher than the values of 0.010, 0.011, 0.009 and 0.012, 0.011 and 0.013 feed efficiencies values recorded for black-skinned, white-skinned and crossbred, respectively, as reported in Refs. [13, 22] for juvenile *A. achatina* snails.

3.2 Body traits of hatchlings *A. achatina* snails

The results obtained for body traits measurements were significantly different ($p<0.01$) among the three (3) crosses studied (Table 3). There was no significant difference ($p>0.05$) in the mean body shell lengths and shell mouth lengths but high significant difference ($p<0.01$) in mean body shell width and shell mouth width among the three (3) crosses studied (Table 4). The purebred black-skinned recorded the mean final body shell length of 13.01 mm, followed by crossbred (12.81 mm) and the lowest mean final body shell length was recorded for white-skinned purebred hatchlings. More so, the highest value of 10.03 mm was recorded for the mean final body shell width, while the lowest value of 9.25 mm was recorded for purebred white-skinned snails. Similarly, crossbred hatchlings recorded the highest (10.61 mm) mean final shell mouth length, while the lowest mean shell mouth length of 10.35 mm was recorded for black-skinned purebred hatchlings. The highest mean shell mouth width of 5.61 mm was recorded for crossbred hatchlings, while the lowest value of 5.35 mm was recorded for purebred black-skinned hatchling snails.

The body traits measurements for hatchlings recorded in this study were all higher than the values obtained in Ref. [13] for juveniles of *A. achatina* snails of six (6) weeks old. These disparities may be due to the species of snails used in the study. Hatchlings of *A. achatina* were used in this study against the juveniles of *A. fulica* of the same age reported in Ref. [13]. These differences may be attributed also to the genotypic effect, age and size of the parent and hatchling snails used, period of study, diet (sole or mixed) as well as dietary protein and energy levels used in feeding the experimental snails.

Table 3: Mean weekly body measurements of hatchling of *A. achatina* (1 day to 6 weeks)

	Age (weeks)																			
	BS×BS							WS×WS							BS×WS						
Body traits	1	2	3	4	5	6	p-value	1	2	3	4	5	6	p-value	1	2	3	4	5	6	p-value
BSL (mm)	12.14	12.56	12.87	13.10	13.46	13.93	p<0.01	12.00	12.33	12.78	12.96	13.15	13.29	p<0.01	12.12	12.51	12.80	12.99	13.12	13.30	p<0.01
BSW (mm)	9.10	9.54	9.87	10.22	10.51	10.94	p<0.01	8.12	8.34	9.00	9.48	10.10	10.45	p<0.01	9.00	9.36	9.71	9.99	10.32	10.60	p<0.01
SML (mm)	9.43	9.60	10.12	10.78	10.96	11.20	P<0.01	9.10	9.70	10.18	10.24	11.32	11.68	p<0.01	9.35	10.00	10.47	11.01	11.26	11.54	p<0.01
SMW (mm)	4.43	4.60	5.12	5.78	5.96	6.20	P<0.01	4.10	4.70	5.18	5.24	6.30	6.68	p<0.01	4.35	5.00	5.47	6.01	6.26	6.54	p<0.01

BSL = Body shell length, BSW = Body shell width, SML = Shell mouth length, SMW = Shell mouth width, WS = White-skinned, BS = Black-skinned, p<0.01 = High significant at 10% level

Table 4: Body traits of hatchlings of *A. achatina* snails

Body traits	Mating groups/crosses		
	BS×BS	WS×WS	BS×WS
Mean initial BSL (mm)	12.14	12.00	12.12
Mean final BSL (mm)	13.01[a]	12.75[a]	12.81[a]
Mean initial BSW (mm)	9.10	8.12	9.00
Mean final BSW (mm)	10.03[a]	9.25[b]	9.83[a]
Mean initial SML (mm)	9.43	9.10	9.35
Mean final SML (mm)	10.35[b]	10.37[b]	10.61[a]
Mean initial SMW (mm)	4.43	4.10	4.35
Mean final SMW (mm)	5.35[b]	5.37[b]	5.61[a]

[ab]Means along the same row with different superscripts are significantly different (P<0.01), BSL = Body shell length, BSW = Body shell width, SML = Shell mouth length, SMW = Shell mouth width, BS = Black-skinned, WS = White-skinned.

4. Conclusion

The results of this study showed a rapid and progressive growth and increment in the hatchling snails derived from the three (3) crosses, with significant difference ($p<0.01$) in the mean final body weight among the crosses from week one to week six of age. There was also a significant difference ($p<0.01$) in daily weight gain and feed efficiencies among the three (3) crosses. Daily feed intake had a greater and significant effect on the growth performance and the body traits among the three (3) crosses. This effect notwithstanding, has been passed down into the mean final body measurements with high significant differences ($p<0.01$) among the hatchling snails of *A. achatina* studied. These results would be of importance to farmers, researchers and snail breeders in the development of breeding stocks and domestication, there enhancing better management and greater production of snail and food security globally.

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Conflict of Interests

The authors declare that they have no conflict of interest.

Author Contributions

All authors have read and approved the final version of the manuscript.

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