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GROWTH PERFORMANCE EVALUATION OF JUVENILES OF *Archachatina marginata* OVUM AND *Archachatina marginata saturalis* SNAIL SUBSPECIES FED FORAGES AND THEIR NUTRIENT COMPOSITION IN CROSS RIVER RAINFOREST ZONE, NIGERIA

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ABSTRACT: *The growth performance characteristics of juveniles of Archachatina marginata ovum and Archachatina marginata saturalis snail subspecies were evaluated using a feeding regime of forages. The forages of choice utilized were: Sweet potato (T_1), Cocoyam (T_2), Banana (T_3), pawpaw (T_4) and Okra (T_5) respectively. The nutrient composition of these forages was equally determined. Results from this study revealed that juveniles of Archachatina marginata ovum recorded better feed intake than those of Archachatina marginata saturalis. The weight gain showed significant difference (P<0.05) between juveniles of the two subspecies. Results of the feed conversion ratio (FCR) were also significantly different (P<0.05) between the subspecies. Treatment 1 (Sweet potato leaves) recorded overall best result in terms of performance compared to other forages used in this study. Results of proximate composition of forages showed that Dry matter (DM), Crude protein (CP), Crude fibre (CF), Ether Extract (EE), Nitrogen Free Extract (NFE) and Ash ranged from 75.16 - 79.62%, 10.88 - 12.76%, 14.45 - 19.68%, 16.82 – 69.00%, 31.10 - 32.63% and12.63 - 17.94% respectively. Okra leaves had the highest Dry matter and Ash contents which were significantly different (P<0.05) from other forages. Sweet potato leaves recorded the least Dry matter and Ash contents and the highest Crude protein content while Okra leaves had the least. However, values of CP in sweet potato leaves were significantly different (P<0.05) from Cocoyam and Okra leaves. The EE content in all the forages were relatively low but sweet potato recorded the highest and Okra the least. There was no significant difference (P>0.05) in Ether extract among the forages. Result of CF showed relative increase across the five forages. Banana leaves had the highest value and was significantly different (P<0.05) from those of sweet Potato and pawpaw leaves. The highest NFE content was recorded in sweet potato leaves. There was significant difference (P<0.05) in the Ash content among all the forages except sweet potato. Results from this study were within the normal proximate values of these forages and confirmed that these leaves (plant protein sources) are good forages for farm animals especially micro-livestock like snails and can enhanced optimum growth characteristics.*

Key words: *Growth Performance, Juvenile Snails, Nutrient, Composition, Forages*

ORIGINAL ARTICLE

INTRODUCTION

In Nigeria as well as other developing nations of the world, the problem of protein deficiency in human diets is a common phenomenon. The geometric rise in human population is in conflict with the arithmetic growth of the livestock subsector. Snail captivity is attracting the keen interest of scientists and farmers suggesting the potentials of these species for commercial farming in humid tropics (Ubua et al., 2012). The population explosion implies that many people require the supply of adequate protein in their diets because of the important roles it play in human wellbeing which include growth, maintenance of hormonal and enzymatic activities as well as improvement of the defence mechanism of the body (Ademolu et al., 2004). The survival, growth, development and reproduction of snails like that of other animal species depend largely on the quality of feed consumed. Thompson and Cheney (2004) identified various factors that could greatly influence the survival and growth of snails. These factors include husbandry, population density, stress, and temperature, feed and breeding technology used. Most of the conventional protein sources like beef, pork, poultry and rabbit meat are presently too expensive for the common man. The advent of heliculture (Snail farming) will go a long way in bridging the protein inadequacy gap faced by Nigerians.

According to Ebenebe (2000), the problem of animal protein intake in Nigeria can be ameliorated if there is integration into our farming system some non-conventional meat sources to complement the conventional animal sources. The challenge lies on the micro-livestock sub-sector in which the snail is one of such micro-livestock species (Nodu and Adesope, 2002). Edible African giant land snail is a small animal commonly classified as mini-

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livestock and unduly distributed all over the humid tropical zone of Africa (Ibom et al., 2008). The snail has been reported to constitute an important source of animal protein for many local communities in Nigeria (Fagbuara et al., 2006). Omole (1997) stated that the Africa giant snail (*Archachatina marginata)* (Swainson) is the most common edible land snail found and reared in Nigeria. Ogogo (2004) recognized *Archachatina marginata* as the most common breed in Cross River and Akwa Ibom States of Nigeria. Snails have high rate of productivity and attains sexual maturity at about 4-6 months (Akintomide, 2004). Snails are herbivores and are known to feed on a wide range of plants, especially wild and cultivated species of Angiosperm (Ajayi et al., 1978; Imevbore and Ajayi, 1993). Awesu (1980); Akinnusi (1998) as well as Ayodele and Asimolowo (1999) stated that the conventional feeds for snails include bread fruit, water leaf, pawpaw leaf and fruit, sweet orange, mango fruit, ripe banana and plantain.

Cross River rainforest zone has variable environmental conditions such as vegetation, rainfall pattern, daylight hours, temperature and relative humidity. The variations in these conditions will likely influence the growth and reproductive performance of snail species including *Archachatina marginata* (ovum and saturalis). As a result of the variation in environmental conditions, three agro-ecological zones have been identified in the zone viz: Northern, Central and Southern agro-ecological zones (Ojanuga, 2006). The study was carried out in Calabar which belongs to southern agro-ecological zone, a humid tropical (rainforest) environment. While a lot have been done on the reproductive and morphometric characteristics of *Archachatina marginata* (Swainson) probably because of its abundance (Stievenart 1992, Ebenso et al., 2002, Ibom et al., 2008), not much has been done on the performance evaluation of juveniles of two sub species of this *Archachatina marginata* fed different diets of plant origin in the humid tropical environment. Thus, the aim of this study was to evaluate the performance of juveniles of subspecies of *Archachatina marginata* (ovum and saturalis) fed forages and the nutrient composition of these forages which serve as diets.

MATERIALS AND METHODS

Location of study

The study was carried out at the Snailery Unit (Botanic garden) of the Biological Sciences Department, University of Calabar, Calabar. This study area was chosen because it provided a near environment to the natural habitat of snails. The area is planted with plantain, banana and avocado trees which provided shade that protected the hutches and snails from direct sunlight and rainfall.

Construction of cages and soil collection

Cages with measurement 45 x 45 x 40cm were constructed using wood and wire gauze. The wire gauze was nailed to the sides of the wooden frame to form the top lid for proper ventilation. Mosquito net was nailed on the wire gauze to prevent flies from entering the cages. All the cages were raised on wooden stands measuring 40cm from the ground level. The stands were placed in containers of condemned engine oil to prevent ants and crawling predators from attacking the snails. Loamy soil was preferred because snails show preference for neutral to slightly alkaline soil. The pH range was 7.0 - 8.0. The soil was filled into each cage compartment to a depth of about 20cm from the base to enhance the burrowing activity of snail for egg laying and during unfavorable conditions.

Collection of forages and diets

The forages of choice used in this study were sweet potato, cocoyam, banana, pawpaw and okra leaves. This is because snails show preference for these feeds according to reports by Awesu (1980) and Imevbore (1990). The forages used for this study were collected from the botanic garden environment. The juveniles were randomly allocated to five treatment groups and fed these forages (sweet potato-T_1), (Cocoyam –T_2 (Banana-T_3), (Pawpaw-T_4) and (Okra-T_5) respectively. The forages were supplemented with a formulated ration containing 24% crude protein (CP) and 2,453kcal/kg metabolizable energy (ME) recommended for snails by Hamzat et al. (2008).

Experimental Snails

The experimental snails consisted of two subspecies of juveniles; *Archachatina marginata* ovum and *Archachatina marginata* saturalis with initial weight ranging between 1.75 - 2.15g and 1.98 - 2.06g, respectively. The juveniles (snailets) were obtained from the hatching of eggs laid by the adult (parent stock) snails of *Archachatina marginata* ovum and *Archachatina marginata* saturalis. A total of two hundred and forty (240) juvenile snails of two subspecies were used in this study with one hundred and twenty juveniles per subspecies. Twenty four snails each were randomly allotted to the five dietary treatments. The juveniles were allowed to acclimatize in the experimental Snailery for fourteen days before the actual commencement of the experiment which lasted for another four months (120 days).

Determination of Chemical Composition of Forages

The proximate chemical fractions of all the five types of forages feed used in this study were determined by the Standard Laboratory Methods of AOAC (1990).

Determination of Growth Performance Parameters

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Body weight gain: Each juvenile was weighed individually at the commencement of this study and weekly thereafter using the scout^{Tm}pro electronic scale having a sensitivity of 0.01g. The body weight gain for each juvenile snail was obtained by difference.

Feed intake and Feed Conversion Ratio (FCR): Feed intake was determined daily by the difference between quantity of feed served and quantity left over. The Feed Conversion Ratio (FCR) was also determined as the ratio of feed intake to weight gain.

Experimental design

The experimental design used in this study was a two way Randomized Complete Block Design (RCBD) and significant means were compared using the Fisher's Least Significant Difference (FLSD).

RESULTS AND DISCUSSION

The growth performance characteristics of juveniles of *Archachatina marginata* ovum and *Archachatina marginata* saturalis were evaluated for 16 weeks and results are presented in Table 1.0. Parameters evaluated were Feed intake, Feed Conversion Ratio and Weight gain. Results showed that juvenile snails of *Archachatina marginata* ovum consumed more of the diets (forages) than *Archachatina marginata* saturalis. The average feed intake of *Archachatina marginata* ovum *ranged from 5.16 - 10.28g while that of Archachatina marginata* saturalis ranged from 5.68 - 9.95g, respectively. Juvenile snails of *Archachatina marginata* ovum subspecies preferentially consumed (10.28g) banana leaves (diet 3) compared to 9.95g consumed by *Archachatina marginata* saturalis of the same diet. Similar preference was also observed in sweet potato leaves (diet 1) with *Archachatina marginata* ovum consuming 10.26g and *Archachatina marginata* saturalis 7.56g. All the five diets recorded significant (P<0.05) difference in feed intake between the two subspecies of juvenile snails. *Archachatina marginata* ovum fed banana leaves (diet 3) recorded the highest feed intake values. The results of feed intake for juveniles of both subspecies were lower than 12.81g and 11.79g for black-skinned and white-skinned juveniles respectively of the same subspecies as reported by Ibom et al. (2008). This trend is an indication that the different experimental diets depressed feed intake of the juveniles in this study. This result agrees with the observations of Lukefahr (1992) that high crude fibre of forage could hinder effective intake of feed. The author added that variation in feed intake may also be attributed to the difference in nutritional value of individual forage served to the juveniles.

Table 1 - Growth Performance of juveniles of *Archachatina marginata* ovum and *Archachatina marginata saturalis* fed forage as diets

Parameters (g)	*Archachatina marginata* ovum Diets					*Archachatina marginata saturalis* Diets					SEM	LDS	SIG
	1	2	3	4	5	1	2	3	4	5			
FI	10.26	6.66	10.28	6.71	5.16	7.56	8.72	9.95	5.68	9.28	3.26	1.63	*
FCR	18.90	24.52	29.96	23.77	18.64	36.55	18.91	18.56	19.15	42.69	37.01	25.58	*
WW	4.01	3.35	5.29	2.82	2.75	2.89	2.90	3.28	2.69	3.37	0.36	0.12	*
WWG	0.57	0.49	0.39	0.37	0.33	0.28	0.49	0.52	0.36	0.38	0.70	0.25	*

* Means are Significant at P < 0.05. Diets: 1= Sweet potato leaves, 2= Cocoyam leaves, 3 Banana leaves, 4 pawpaw leaves, 5= Okra leaves. FI:
FCR: Feed Conversion Ratio, WW: weekly weight, WWG: weekly weight Gain
SEM Standard Error of Mean. LSD: Least significant Difference.

Feed conversion ratio for juveniles of *Archachatina marginata* ovum ranged from 18.64 - 29.96 while those of *Archachatina marginata* saturalis ranged from 18.56 - 42.69. Juveniles of Archachatina *marginata* ovum fed diet 3 had the highest FCR (29.96) compared to the value (18.56) obtained for *Archachatina marginata* saturalis on diet 3. The more efficient conversion ratio obtained for *Archachatina marginata* ovum juveniles on diets 2,3 and 4 compared to those of *Archachatina marginata* saturalis was due to the fact that the former (*Archachatina marginata* ovum) on these diets (2,3 and 4) accommodated some of the nutrients required for efficient utilization of their diets than *Archachatina marginata* saturalis on the same diet. Also, result of FCR of *Archachatina marginata* ovum on diets 2, 3 and 4 revealed that cocoyam, banana and pawpaw leaves (diets 2, 3 and 4) were the most efficiently utilized. Similarly, result of FCR of *Archachatina marginata saturalis* on diets 1 and 4 confirmed efficient utilization of sweet potato and okra leaves (diets 1 and 4) by the juveniles. Results on weight gain showed a progressive trend throughout the feeding trial. The mean weekly weight gain ranged from 0.33g (diet 3) to 0.57g (diet 1) for *Archachatina marginata* ovum juvenile, while those of *Archachatina marginata* saturalis ranged from 0.28 to 0.52 g for diets 1 and 3 respectively. Mean weekly weight gain favoured *Archachatina marginata* ovum sub-species. The highest weight gain of 0.57g was obtained by the subspecies fed diet 1 with a corresponding value of 0.28g obtained by *Archachatina marginata* saturalis on the same diet. Mean weekly weight gains showed relative growth rate of the two subspecies on the different diets. Values of mean weight gain of juvenile of *Archachatina marginata* ovum on diet 1 are significantly (P<0.05) different from those of juveniles of

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Archachatina marginata saturalis on the five dietary treatments. Juveniles of *Archachatina marginata* saturalis showed depression in their weight gain which was not comparable to the values recorded by juveniles of *Archachatina marginata* ovum. This could be as a result of low level of protein, ash and mineral contents in the different diets. This finding was confirmed by Omole (2002) that weight gain of snail is directly proportional to the level of protein in the diet. Similarly, *Archachatina marginata* ovum on diet 3 recorded the highest weight (5.29g) compared to *Archachatina marginata* saturalis that weighted 3.28g on the same diet. The least mean weight was observed in *Archachatina marginata* ovum on diet 5 (2.75g) while *Archachatina marginata* saturalis had the least value on diet 4. The progressive increase in body weight of snails observed in this study is in agreement with the report of Odunaya and Akinyemi (2008). However the fast growth rate demonstrated by *Archachatina marginata ovum could* be due to their inherent genetic potential which is a bigger subspecies than *Archachatina marginata* saturalis.

The proximate composition of the forages (diets) fed to the juveniles is presented in Table 2.0. The results showed that the Dry matter (DM), Crude protein (CP), Crude fibre (CF), Ether extract (EE), Nitrogen free extract (NFE) and Ash contents evaluated in the diets ranged from 75.16 - 7.62%, 10.88 - 12.76%,74.45 - 19.68%, 1.68 - 2.69%, 31.10% - 32-63% and 12.63 -17.74%, respectively. Diet 5 had the highest Dry matter and Ash contents which was significantly different ($P<0.05$) from other diets. Diets 1 had the least dry matter and ash contents compared to other diets. The variation in dry matter content could be attributed to the difference in the amount of moisture present in each forage (diet) and also the time which the leaves were harvested and fed to the juveniles. The Crude protein values obtained in this study ranged from 10.88 - 12.76%. The highest CP content was recorded in diet 1 and the least in diet 5. Difference in the CP content of the diets (forages) may be as a result of the age of the forages which were harvested and fed to the juveniles. This finding was confirmed by the report of McDonald (1995) that Crude protein (CP) of forages decreases with plant age. The Ether extract (EE) in diets 1-5 were relatively low and almost evenly distributed, with diet 1 having the highest EE value and diet 5 the least value. The EE value from diets 1-5 were 2.69, 2.35, 2.62, 2.20 and 1.68% respectively. There was no significant difference ($P>0.05$) in EE among the diets. The EE value obtained in this study were higher than those reported by Ejidike et al. (2000); Ademolu et al. (2004) that is 0.80 and 1.62% respectively for the same forages. The Crude fibre (CF) values of the five diets (forages) fed to the juveniles of the two subspecies ranged from 14.4 - 19.48%. The results show a gradual increase in CF level due to the increase in age of the plants. Values of CF obtained were higher than those reported by Ejidike et al. (2000) as 12.1 and 0.15%, respectively. The difference could be due to the structural strengthening of the plant tissues by lignification. Furthermore, the Nitrogen Free Extract (NFE) of the five diets revealed a range from 31.10 - 32.63%. Diet 1 recorded the highest NFE value and diet 3 the least. The Ash content also recorded a similar trend with the highest in diet 5 and least in diet 1, respectively. There was significant difference ($P<0.05$) in the Ash content in diets 3, 4 and 5.

Table 2 - Proximate Chemical Composition of Experimental Diets (forages)

Diets / Fraction (Mg /100g)	1	2	3	4	5	SEM
Dry matter	75.16^{c}	77.11^{b}	79.50^{a}	78.52^{a}	79.62^{a}	0.76
Crude Protein	12.76^{a}	11.40^{b}	12.62^{a}	12.67^{a}	10.88^{c}	1.15
Ether Extract	2.69	2.35	2.62	2.20	1.68	3.47
Crude Fibre	14.45^{c}	18.90^{a}	19.68^{a}	17.16^{b}	16.68^{b}	0.75
Nitrogen Free Extract	32.63	31.69	31.10	31.56	42.49	1.17
Ash	12.65^{c}	12.77^{c}	13.48^{c}	14.93^{b}	17.94^{a}	12.24

a.b.c.d: Means on the same row with different superscripts are significantly different ($P<0.05$). Diets: 1: Sweet potato leaves, 2: cocoyam leaves, 3: Banana leaves, 4: pawpaw leaves, 5: Okra leaves. SEM: Standard Error of Mean.

CONCLUSION

Research results from this study revealed that juveniles of *Archachatina marginata* ovum consumed more feed which was efficiently converted and utilized than juveniles of *Archachatina marginata* saturalis . Evaluation of growth performance showed that the weight gain in juveniles revealed a significant difference ($P<0.05$) between the two subspecies. The proximate values of the diets were within the normal ranges for the forages fed to juvenile snails in this study.

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