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Growth and digestibility of cereal meal in *Archachatina marginata* Swainson and effects of variation of some abiotic (environmental) factors

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ABSTRACT: The sutitability of cereal meal as a snail feed and the effects of variation of some abiotic factors were investigated in *Archachatina marginata*. Guinea corn meal was found to be better digested and assimilated than corn meal. The ECD and ECI of the younger and matured snails were higher than the older snails, although the latter assimilated more food. Activity, aestivation and mortality to different eenvironmental or abiotic factors showed appreciable or detrimental effects. Adequate temperature (27°C – 31°C) and water (moisture) had a positive effect on the snails while extremes or lack of these factors had a negative effect. Unfavourable environmental conditions led to mortality which is usually avoided by aestivation an ecophysiological adaptive process.

Key Words: Snail feed; Cereal meal; Abiotic factors; Giant African snail; *Archachatina marginata* Swainson.

Introduction

The phylum mollusca has the most named species next to the Anthropods of which *Archachatina marginata* belongs to. It is a pulmonate gastropod belonging to the family Achatinidae and order Stylommatophora.

The type of food take in by this terrestrial pulmonate has tremendous effect on its growth. In nature, *A. marginata* feeds on both leaves and fruits of agricultural and wild plants. It is omnivorous and also considered as a scavenger. According to Ajayi et al (1978) the nutrition taken by the snail are numerous. Hodasi (1979) noted that the main source of food apart from soil on which they feed was parboiled and oven dried leaves of wild lettuce (*Lactuca taraxacifolia)* and fresh cultivated lettuce (*Lactuca sativa*).

A. marginata like other terrestrial animals, is exposed to environment which is changing in time and space as a result of climatic fluctuations. The principle factors of concern in the environment for this animal are: water, temperature, humidity, space, shelter, vegetation, photoperiodism, interspecific and intraspecific relationship and food chain. Drastic changes in any of these factors would have a tremendous effect on the snails behaviour, growth, metabolism and reproduction.

During adverse conditions, snails go into a state of aestivation. This occurs when the snail withdraws into its shell and the aperture is closed with a mucous film which dries to form a calcified slime known as epiphragm (Segun, 1975). In tropical areas, aestivation occurs when the temperature is high and the humidity is low (Oke, 1992). This offers the snail increased protection from dehydration.

Snails are economically important because they in high demand as a protein source in many West African Countries and sought after as a delicacy in some European countries (Bequaert, 1950; Yoloye, 1984). Therefore there is need for increased commercial breeding of snails. But adequate knowledge of food efficiency coupled with the use of favourable environmental factors will yield the most desired production (Bowman, 1977). Therefore this work entail a study on the growth and assimilation rate of *A. marginata* to corn meal feed in conjunction with the effect of various environmental (abiotic) factors to bring about increased sustainable development in snail farming.

Material and Methods

Source and maintenance of the snails

The West African giant land snail, *Archachatina marginata* weighing between 38grams to 242 grams were purchased from two local markets which were the Bariga and Yaba markets.

The snails were allowed to acclimatize for two weeks before data collection started, in a stocking vivarium of length 120cm, width 50cm and height 60cm. They were fed with various food items apart from cereal meal and the vivarium was regularly cleaned to prevent fungal and bacterial growth or infection.

Determination of growth by effect of cereal meal

The experiment was carried out with 4 sets of snails each. The food used was in powdered forms, obtained by grinding. They were corn (*Zea mais*) and guinea corn (*Sorghum bicolor*) which has been used by Chavalier (1982) for fattening snails during acclimatization. This exercise was done in order to note the powdered food preference by snails and whether cereal meal which is abundant can be used for commercial breeding of snails.

The experiment was of five days duration and six snails of varying sizes were taken at random and starved for a week to clear their gut (Egonmwon, 1988). The snails were then weighed and then placed in labeled bowls containing 20ml of water and 10gms of powdered feed each. Growth was then estimated by the difference between the initial and final weight.

Two controls were set up and the first was to find out the food preferred by the snails. A snail was weighed and placed in a bowl containing 2 dishes (10gms of corn and 20mls of water and 10gms of guinea corn and 20ml of water). The amount of food eaten by the snails was noted. The second set up had labeled bowls with snails but without food.

After the duration of five days, the snails were removed, cleaned with distilled water and weighed. Their feaces and left over food were also collected. All these were placed in an oven at 60°C for a week. Replicates of the food given (10gms of feed + 20ml of water) were also placed in the oven which constitute the dry weight of the food.

Measurement of food assimilation and digestibility

The data collected in section 2.2 would provide a reliable and accurate method for determining the weight of food ingested, the weight of feaces which corresponds to the ingested food and the weight gained by the snails during the experiment. These three measurements were necessary for the calculation of the rate of feeding, the digestibility and the efficiency of conversion of food to body substance (ECD) (Waldbauer, 1968). The following calculation used by Egonmwan (1988) was also used to calculate the required data:

1. Efficiency of conversion of digested food (ECD) $= \frac{G}{F-E} \times 100$

2. $\% \text{ Assimilation} = \frac{F-E}{F} \times 100$

3. $\text{Efficiency of Conversion of Ingested Food to Biomass} = \frac{G}{F} \times 100$

G = weight gained by snails
F = food eaten
E = weight of faeces.

Effect of variations of Abiotic Factors

The second phase of this work was to investigate and determine suitable environmental conditions that *A. marginata* could best dwell in and carry out normal and efficient metabolic activities including the rate at which snails go into aestivation in adapting to unfavourable conditions.

Fifteen snails each were placed into four different vivaria of the same size to test for their response towards changes in abiotic factors. The four vivaria were labeled A, B, C and D.

Vivarium A was placed in a greenhouse which had a higher temperature range (32°C – 37°C) than the surrounding atmosphere and was not sprinkled with water. Vivarium B was placed in a cool shaded place with ambient temperature range (27°C – 30°C) and was sprinkled with water twice daily. Vivarium C was also placed in the green house as Vivarium A, but it was sprinkled with water twice daily. Vivarium D was placed also in a cool shaded place but was not sprinkled with water. The response of these snails to these various abiotic conditions were recorded as: number of active snails; number of snails not active and not aestivating; number of snails aestivating and number of dead snails. The snails were considered active when their tentacles were fully everted and moving. The experiment lasted for 30 days.

Results

Effect of Cereal Meal on Growth

Table 1 and 2 represents the growth, assimilation rate, ECI and ECD of *A. marginata* fed with guineacorn and corn feeds respectively.

Table 1: Mean weight gain and utilization parameters of *A. marginata* fed on guinea corn.

Mean Initial Weight of Snails	Mean Final Weight of Snails	Gain in Weight	Dry Weight of Food Given	Weight of Food Eaten	Dry Weight of Faeces	% Assimilation	ECI %	ECD %
90	91.5	1.25	9.02	3.32	0.65	80	37	47
128.5	129.4	0.93	9.02	3.67	0.48	80	29.5	44.7
152	153.65	1.25	9.02	3	0.42	84	41.6	49.5
217.5	218.61	0.86	9.02	5.15	0.66	86	16.5	20

Table 2: Mean weight gain and utilization parameters of *A.ginata* fed on corn.

Mean Initial weight of snails (g)	Mean Final weight of snails (g)	Gain in weight (g)	Dry weight of food given (g)	Weight of food eaten (g)	Dry weight of faeces (g)	% Assimilation	ECI %	ECD %
42.8	44.05	1.25	8.96	3.21	0.54	83	48.5	47.5
58.01	58.92	0.91	8.96	3.95	0.7	82.5	24	39.9
144.6	145.5	0.85	8.96	4.19	0.625	86.6	22.5	29.75
238.5	239.0	0.5	8.96	3.13	0.21	93	16	17.1

Analysis from Table 1 and 2 showed that guinea corn was found to be more efficient in being converted to biomass than corn. The growth rate was also relatively high. As shown on both tables, the matured snails that are between 140 – 160 grams converted more of their food to biomass and also digested more of their food. The older snails, 200 grams and above although assimilated more food, their ECI and ECD were very low. Whereas in contrast, the ECI and ECD of the younger snails between 40-90 grams was higher in comparison.

Figure 1 displays the graph of the ECI and ECD of snails fed with guinea corn and corn. Based on the ECI and ECD of both feeds, it is evident that guinea corn is more efficiently converted into biomass than corn. From the controlled experiments, snails also showed preference to guinea corn. Food eaten during this period was 3.00 grams of guinea corn to 1.46 grams of corn.

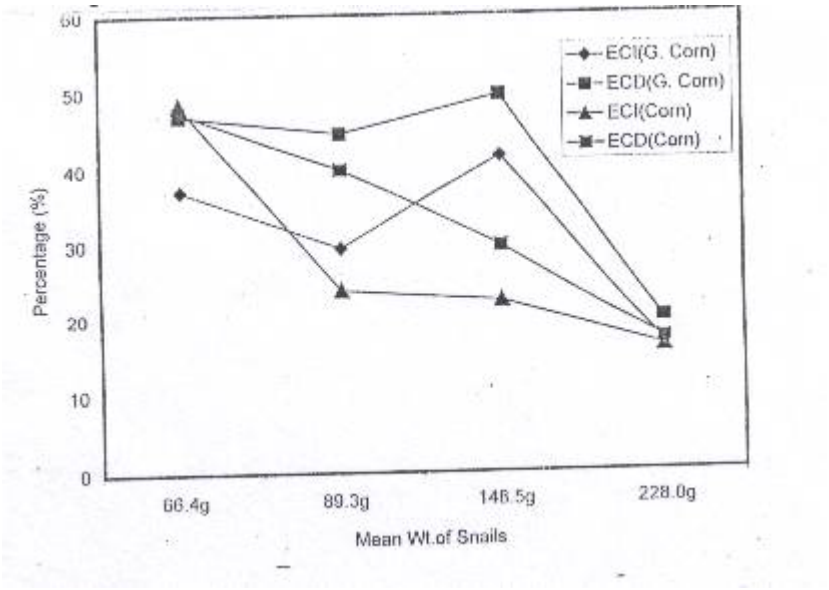

Fig. 1: Graph showing ECD and ECI of *A. marginata* fed with guinea corn and corn.

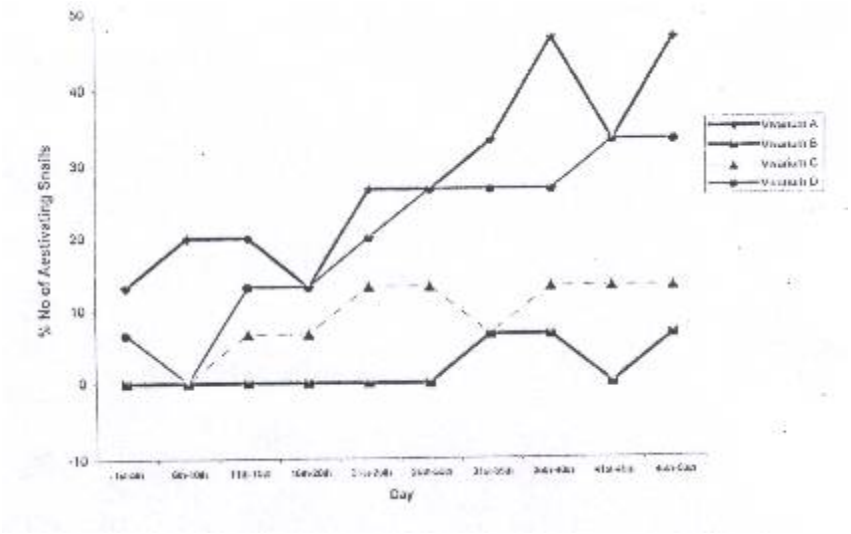

Fig. 2: Graph showing percentage number of aestivating snails in various vivaria of different abiotic conditions.

Effects of variation of Abiotic factors

The effect of the variation of abiotic (environmental) factors on the four vivaria (A, B, C and D) that were subjected to different treatment were recorded on Table 3.

In vivarium B, the first death took place on the 7th day. By the end of the experiment, a total of seven snails were aestivating and only one snail was active. There was a total of four dead snails giving a mortality of 27%.

In vivarium B, there was no death recorded. Only onesnail was found aestivating. Eleven snails were still found active which was the highest recorded.

In vivarium C, two snails were found aestivating and two werefound dead, givinga mortality of 13%. In vivarium D. at the end of the experiment, five snails were aestivating and three snails were dead. The mortality was 20%.

Analysis of the graph shows that aestivating snails were highest in vivarium A and lowest in vivarium B. Observation also showed that there, were reduction at one time or the other in the aestivating snails. This means that those concerned snails, left the state of aestivation of which the reason was not known in this work, but will be investigated in subsequent work.

Discussion

The availability of suitable food and environmental factors are the ultimate factors that prompts an animal to grow and breed at certain times of the year (Owiny, 1974). This statement is certainly true of *Archachartina marginata*.

The experiment with cereal meal (guinea corn and corn), the snails showed preference to guinea corn. Guinea corn had a higher digestibility and assimilation rates than corn feed. This is attributed to their structural composition. Corn has a great deal of indigestible husk covering it, therefore when grinded, this forms part of the biomass of the corn feed. This accounts for the snails' inability to digest the corn feed, whereas guinea corn does not have the indigestible husk. Therefore guinea corn could be used for rearing the snails on a commercial basis as an artificial feed. Wright (1973)cited by Egonmwan (1988) showed that artificial diet for rearing slugs (*Anon ater*) produced faster growth than when they are fed with a natural diet.

Table 3: Effect of variation of Abiotic conditions on Activity and habit of *Archachatina marginata.*

Days	Number of snails at the beginning				Number of active snails				Number of snails not active and not aestivating				Cumulative number of snails aestivating				Cumulative number of dead snails				% Total dead snails			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
1-5	15	15	15	15	9	12	11	12	4	3	5	2	2	0	0	1	0	0	0	0				
6-10	15	15	15	15	7	13	9	10	4	2	5	3	3	0	0	1	1	0	0	1				
11-15	15	15	15	15	6	10	10	10	5	5	4	2	3	0	1	2	1	0	1					
16-20	15	15	15	15	6	11	9	8	4	4	3	1	3	0	1	2	2	0	1	2				
21-25	15	15	15	15	4	10	9	7	5	5	3	3	4	0	2	3	2	0	1	2				
26-30	15	15	15	15	4	10	7	6	4	5	3	3	4	0	2	4	3	0	1	2	27%	0	13%	20%
31-35	15	15	15	15	3	11	7	5	4	3	4	4	5	1	2	4	3	0	2	2				
36-40	15	15	15	15	4	10	5	5	2	4	6	3	6	1	2	4	3	0	2	3				
41-45	15	15	15	15	3	10	6	3	2	4	4	4	6	1	2	5	4	0	2	3				
46-50	15	15	15	15	1	11	3	3	3		5	4	7	1	2	5	4	0	2	3				

A Vivarium placed in green house (32°C-37°C) without sprinkling of water
B Vivarium placed in cool shaded place (27°C – 30°C) without sprinkling with water
C Vivarium placed in green house (32°C – 37°C) sprinkled with water
D Vivarium placed in cool shaded place (27°C – 30°C) without sprinkling of water.

Results obtained from corn meal feeding indicated that the ECI and ECD of both the matured and younger snails were higher than that of the older snails. The matured snails converted more of their food to biomass which might be related to egg production while the younger snails needed more assimilated, digestible and ingestible food for growth and development.

The effects of variation of abiotic factors showed that the activities of *A. marginata* are influenced mainly by temperature and humidity. Relative humidity is the percentage of water vapour in the air and it increases with temperature (Schmidt-Nielsen, 1975). High relative humidity are favoured by the snails which occurs during the rainy season. But when the environmental situations get unfavourable, they go into a state of aestivation characterized by low metabolic rate and retarded growth. Aestivation occurs in response to low relative humidity and after increased protection from dehydration.

The effect of these two factors (temperature and humidity) were drastic in vivarium A which had a warm temperature and without sprinkling of water thereby creating very low humidity. The dryness coupled with the warm temperature give the highest mortality and aestivation which was 27% and 46.7% respectively. Whereas in vivarium B., there was adequate temperature and high humidity (from regular sprinkling of water). There wasn't any mortality. From this study, it was discovered that the effect of humidity has greater influence than that of temperature, recorded and aestivation was just 6.7% which gives a good account of a right environmental situation. There was higher mortality and aestivation, 20% and 33.3% respectively in vivarium D that had very low humidity but had a favourable temperature than vivarium C whose mortality and aestivation were 13% and 13.3% respectively that had high humidity and lack favourable temperature. This proves the fact that, these snails are usually seen during the rainy season when the humidity is high. But during the dry season when the forest floor is usually cool due to shade formation by tree canopies, these snails are not seen because, though the temperature is favourable, there is humidity lacking.

It can be said that the absence or unproportional presentation of any one of these climate factors has a detrimental effect on the life and activities of the snails. Humidity and temperature are however interrelated, and *A. marginata* thrives best in humidity (60 – 100%) and favourable temperature (26°C – 30°C).

The results of this work has demonstrated that *A. marginata* can be reared successfully in an artificial environment fed with artificial food for commercial purposes. This is very important because snails are economically important and there is need for adequate knowledge of food efficiency coupled with the use of favourable environmental factors to yield greater production.

References

Ajayi, S.S.; Tewe, C.M. and Awesu, M.O. (1978). Observation on the biology and nutritive value of the African Giant Land Snail *Archachatina marginata*. East African Wildlife Journal. 16: 85 – 95.

Bequaert, J.C. (1950). Studies in Achatinae, a group of AfricanLand Snail. Bulletin of Museum of Comparative Zoology at Havard College. 105: 1 – 216.

Bowman, J.C. (1977). Animals for Man. Edward Arnold, London, 69pp.

Chevalier, H. (1982). Facteurs de croissance chez des gesteropodes pulmones terrestres paleartiques en elevage. Haliotis. 12: 29 – 47.

Egonmwan, R.I. (1988). Reproductive Biology and growth of the Land Snail *Archachatina marginata* ovum and *Limicoleria flammea*. Ph.D. Thesis, University of Oxford, London, 186pp.

Hodasi, J.K.M. (1979). Preliminary studies on the feeding and burrowing habits of *Achatina achatina*. Ghana Journal of Science. 15: 193 – 199.

Oke, O.O. (1992). Studies on the land molluscs of South Western Nigeria. Ph.D. Thesis, University of Lagos, Nigeria. 242pp.

Owiny, M. (1974). Some aspects of the breeding biology of the Equatorial land Snail. *Limicolaria martensiana* (Archatinidae: Pulmonate). Journal of Zoology, London. 144: 361 – 382.

Schmidt-Nielsen, K. (1975). Animal Physiology: Adaptation and Environment. Cambridge University Press, London, 695pp.

Waldbaver, G.P. (1968). The consumption and utilization of food by insects. Advances in insect Physiology. 5: 229 – 288.

Yoloye, L.V. (1984). Molluscs for mankind. Inaugural Lecture. University of Ilorin, Ilorin, 21pp.