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Influence of Two Types of Food and Their Calcium Content on the Reproduction of the Snail (Achatina-Achatina) Linné, 1750) Raised In Captivity

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ABSTRACT

A study was carried out in the University of Nangui Abrogoua (Côte d'Ivoire) with the aim of evaluating their productive performances of the snail (achatina-achatina) in captivity. Juvenile snails of approximately one week old, with an average live weight of 0.33±0.023g and an average shell length of 0.09±0.06 cm were given two types of diets until sexual maturity. We used two diets vegetable (R_1 and R_2) and four concentrated diets(R_T,R_3,$R_4$and R_5)with variable calcium content (0.24,0.47,6.82,12.02,14.03 and 16.01% respectively) in order to compare the two types of diets and determine the calcium content that induced best biological performances. Results obtained showed that, with concentrated diets and rate calcium to 12.02%, A. achatina starts laying eggs from 12 months of age with an average weight of 96.78±16.32 g. It lays1 to70yellow or white eggs at depth up to 5.2 cm The best biological performances were obtained with concentrated diets.

Keywords: breeding, calcium, food, mollusc, reproduction.

INTRODUCTION

The breeding of snails is experiencing an increasing growth in sub-Saharan Africa. Species of giant African snails such as Achatinaand Archachatina types are the most preferred bush meat in West-Africa.

In Côted'Ivoire, researches related with a cheating culture have been focused on some species: Achatina achatina[1], Archachatina ventricosa [2], Achatinafulica[3], and now Archachatina marginata, a species which is more frequently consume din Ivory Coast [4].These researches proved that the biological performances of these animals were strongly related to diet. The concentrated diet has indeed strongly influenced their growth and sexual maturity. Moreover, [5],[6]and then[7]have shown that the leaves of certain plants were among the most common green feeds consumed by snails (A.achatina, A.fulica, and A .marginata) and helped them get better biological performances.

The choice of A.achatina (Linné, 1958) as biological model for our study is explained by the fact that, like other machines, studies were only based on young adults and there are very few information concerning its biological performances. This is actually an abundant snail in natural environment whose natural growth rates and relatively low reproduction constitutes an obstacle to the demand for natural stocks by populations [8].Thus; studying reproduction from specimens obtained in our breeding conditions could remedy this situation. Recent works on achatini culture reveal that a higher rate of calcium causes a higher weight gain and shell growth[9]. Being essential, this mineral appears to be crucial in the development of a concentrated food in the form of flour, and emphasize on calcium. Thus, this work aims at comparing the flour-based diet from the plant-based diet in order to firstly find the best diet, and secondly know the ideal calcium content for better biological performances.

MATERIALANDMETHODS

Experimental frame work

This study was conducted in the Center for Achatini culture at the University of Nangui Abrogoua (Abidjan, Côte d'Ivoire). The photo period was12h of day light and12h of darkness

Biological materials

Experiences initiated with young individuals having an average live weight of 0.33±0.023 gandan average shell length of 0.09±0.06 cm. They were fed adlibitum with cultivated green leaves of wild plants,andconcentratedfood.Theenclosuresusedconsistedofplastictubs with a square base having a volume of 8600cm^3.These tubs were equipped with lids of mosquito net type constituting ananti-leakage device. Their bottoms were covered witha4cmthickfinesandylittersterilized by heating. The implementation of incubating eggs to estimate their hatching rate was made in some polystyrene tubs either with the dimensions: 0.14x0.17x0.21m. The substrate used for made with the filling of coconut husks dried.

Effects of quality of the diet and calcium content on reproduction

The main objective of this study was to compare two types of diet; one plant-based diet and the other based on flour with known calcium levels. These various treatments were evaluated based on biological performance of the snails. Six diets were offered to the juveniles together with two vegetable diets and four concentrated diets. Diet R1 consisted of leaves,25% of each of four wild plants including Laporteaaestuans,Urticaceae;Phaulopsisfalcisepala, Acanthaceae; Palisotahirsuta, Commelinaceae and Cecropiapeltata, Moraceae. Diet R2 wasmadefrom25%of cultivated leaves composed of Caricapapaya, Caricaceae; Xanthosomamaffafa, Araceae; Lacticasativa, Asteraceae; and Brassicaoleracea, Brassicaceae [10] (Karamoko, 2009).Concentrated diets or flour-based feeds included R3,R4,R5,and RTdiffering with regard to calcium concentration (12.02, 14.03, 16.01 and 6.82%). Diet RT, has previously been characterized at the Central Laboratory for Animal Nutrition [11];[12]and was used as a control. The biochemical composition of different diets are shown in Table.1 and the characteristics of RT, R3, R4and R5 are shown inTable2.Priorto the trial, snails were kept under the constant starting conditions and densities of 50 embryos/m^2 or30embryos per tub. The animals were fed adlibitumonR1plants (0.24%), R2 (0.47%) and on concentrated RT (6.82%), R3 (12.02%) R4 (14.03%) and R5 (16.02%) under ambient conditions for 24 months.

Statistical analysis

The statistical processing of data was performed by means of a software program called STATISTICA version 7.1 and Microsoft Excel 2003. The average values of the various variables of reproduction were subjected to an analysis of variance (ANOVA) followed by a TUKEYHSD test with a threshold confidence level of 5%, 1% and 1.A correlation analysis was conducted between the variables for reproduction of snails and calcium rate in their diet.

RESULTS

Effect of quality diet on reproductive system

Animals subjected to diets laid at different stages (Table3).The firsteggs-layingwerereportedafter12.5months for animal’s fed on concentrated diet against 22.5 months for those fedon plant-based diet. At the end of the incubation period which was 13.93 days and16.34 days for the plant-based diet and concentrated diet, the average number of eggs per lying and the average number of embryos per laying are (32.5and146.04) against (156.04and164.76) respectively obtained as the plant-based diets and concentrated diets.

The TUKEYHSD test indicates a significant difference between the age of first egg-laying, the hatching rate, the average number of eggs, the average weight of eggs and the average number of embryos from various diets to various confidence thresholds

Effect of calcium rate on reproduction

A.achatina began laying eggs in an age equal or greater than12 months with an average weight of 96.78g.The average number of eggs-laying following the calcium content varies from1to 2 eggs-laying. She had layed in the substratum, an average number of eggs ranging from 133 to 682 with an average number of embryos ranging from 25 to 255.

At the end of the incubation period of which the durations varied between 14 and 17 days, the egg hatching rates of 37.39, 30.22 and 28.42% has been registered and a hatching rate of 59.03, 43.31 and 39.80 % in terms of percentage for fertile eggs, respectively for the species R3,R4andR5(Table4). Values of early embryonic mortality obtained are (17.59, 23.55and27.87%) and the late embryonic mortalities are (18.47,28.88 and 25%)respectively for the species R3, R3and R5. Statistical analysis indicates a significant difference between the total numbers of eggs lying, incubation durations and the hatching rates of various calcium concentrations ($p < 0.05$) (Table 5).

DISCUSSION

Significant variation in biological performance was demonstrated during this study. Variation in performance correlated with different diet types and calcium concentration. Snails are very sensitive to environmental conditions, as are most species. These nails fed plant- based diets (R1 and R2) were characterized by relatively low average size and growth rate, where as those fed the concentrated flour diets (R3, R4 and R5) had higher average size in the same trial period. It appears that the use of plants food like green embryos and fruits or tubers of certain plants, also according to[13],[12], [14]and[10] Karamoko (2009)have been shown to produce relatively low reproductive performance.

Impacts on reproductive performances were confirmed in our results. We observed a very large difference in biological performance between the two plant foods (R1 and R2) and food concentrated in the form of flour (R3, R4 and R5).The differences appear to be due to quality of the food and the age of breeding snails.

The age of A.achatina first egg-laying (12.5monthsofage) subject to the diets (R3 andR4, R5) respectively is shortened compared to the age range at maturity in the nature reported by[15]as(nearly23months of age). Sexual maturity was also achieving elaterin animals fed on vegetarian diets in captivity. This finding has significant implications for captive breeding of snails for human food consumption. Based on our results, we can optimize diet for maximal growth rates as well as for enhanced reproduction rates and younger ages in captive propagation.

There as on for this fast growth is a wealth of the diets concentrated in energy and nutrients (proteins, minerals and calcium) compared to the poor plant-based diets. Average number of clutch (or egg-laying)per diet, average number of eggs per clutch, big and small diameters of the eggs are higher than those previously obtained with plants by[16]and [1].The hatching rate obtained on concentrated diets(R3 and R4,R5) is better and higher than those of plant-based diets(R1and R2)respectively.

According to[17], giant African snails can out of any pathology slow down their growth and even interrupt it to aestivate.

So these dwarf snails affected by ales severe growth disorder scan however, assess to sexual maturity and can reproduce but later.

Our results also show that as the rate of calcium food increases, the average number of eggs per laying and egg size increase. This phenomenon would find its explanation in the fact that a large part of ingested calcium issued to make the shell eggs. The quality of the diet would therefore influence the acquisition of sexual maturity and reproduction.

CONCLUSION

This study showed that the reproduction of A.achatina is significantly influenced by the quality of the food and the calcium content of the food they eat. Relative to plant food, the concentrated food resulted in better performance.

Regimes R3, R4 and R5(12.02,14.02 and16.01% calcium, respectively) have helped improve the reproduction, as opposed to those plant-based diets. These diets reduce the reproductive cycle duration to about one year. Reproduction is therefore enhanced in terms of both egg-laying and hatching rates.

In order to fully assess the relative advantage and efficiency of the two diets, flour versus plant based, an economic cost benefit analysis is warranted. The cost of the flour-based diet will undoubtedly be somewhat higher, although flour still represents an in expensive commodity, and we feel that it is likely that the added cost of the concentrated diet versus leaves will be offset by the enhancements provided in terms of higher growth and reproductive rates, translating to shorter time required to reach harvestable size for large scale commercial applications as well as for subsistence and family scale farming.

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Table 1 . Chemical composition of vegetable and concentrated, or flour-based diet.

Ingredient	Plant-based	Flour-based
Sampleweight	41.11	41.38
Drymatter	88.48	92.05
Proteins	17.60	18.20
Totallipid	2.34	2.42
Minerals	18.4	29.56
Energycontent (cal/g)	2.76	2.72

Table2. Chemical composition of the six diets surveyed.

Diet	Weightofsample(g)	Drymatter	Protein	Totallipid	Mineralmatter	Calcium	CrudeEnergy(cal/g
R1	41.11	88.48	17.60	2.34	18.4	0.24	2.76
R2	43.04	90.66	17.70	2.35	19.38	0.47	2.72
RT	43.99	89.35	17.48	2.72	20.93	6.82	2.64
R3	44.50	91.10	18.36	2.50	36.07	12.02	2.79
R4	46.66	91.77	17.39	2.05	41.36	14.03	2.745
R5	46.66	93.07	17.48	2.34	45.59	16.01	2.78

Table3. Parameters of reproduction of Achatinaachatina according to the calcium rate

Diet	R1(0.24%)	R2(0.47%)	RT(6.82%)	R3(12.02%)	R4(14.03%)	R5(16.02%)
Age atfirst laying(month)	22^{b}	23^{b}	20^{b}	12^{a}	13^{a}	13^{a}
Mediannumberoflayingperdiet	1^{b}	1^{b}	1^{b}	2^{a}	2^{a}	2^{a}
Mediannumberofeggsperlaying	$48.34^{d}\pm21$	$159.43^{c}\pm23$	$133.53^{e}\pm18$	$682.52^{a}\pm24$	$450.76^{b}\pm23$	$380.21^{c}\pm20$
Mediannumberofjuvenils/laying	$32^{d}\pm5.43$	$33^{d}\pm6.21$	$25^{e}\pm4.18$	$255^{a}\pm12.65$	$136^{b}\pm10.63$	$108^{c}\pm9.32$
Totalrate ofhatching%	21.62^{d}	20.75^{c}	18.79^{d}	37.39^{a}	30.22^{b}	28.42^{b}
Durationofincubation(day)	$14.83^{b}\pm5.45$	$14.66^{b}\pm5.2$	$14.5^{b}\pm4.3$	$16.16^{a}\pm6.3$	$16.33^{a}\pm6.3$	$17.16^{a}\pm8.1$
Middleweightofanegg(g)	$0.34^{c}\pm0.02$	$0.34^{c}\pm0.02$	$0.35^{c}\pm0.02$	$0.49^{b}\pm0.03$	$0.52^{a}\pm0.04$	$0.54^{a}\pm0.05$
Maxeggdiameter(mm)	$4.10^{c}\pm1.23$	$4.17^{c}\pm1.11$	$4.71^{c}\pm1.56$	$5.2^{b}\pm1.74$	$5.5^{b}\pm1.88$	$6.2^{a}\pm2.12$
Smalldiameterofanegg(mm)	$2.80^{c}\pm0.89$	$2.82^{c}\pm0.95$	$3.87^{c}\pm1.32$	$4.15^{b}\pm1.56$	$4.3^{b}\pm1.78$	$5.2^{a}\pm2.48$

Median values of the same line indexed of the same letter are not statistically significant ($P<0.05$).

Table4. Parameters of reproduction of (Achatina-achatina) according to the calcium rate.

Diet	R1(0.24%)	R2(0.47%)	RT(6.82%)	R3(12.02%)	R4(14.03%)	R5(16.02%)
Age offirst laying(months)	22^{b}	23^{b}	20^{b}	12^{a}	13^{a}	13^{a}
Medianmassat reproduction(g)	83.90^{b}±11	89.47^{b}±13	94.49^{b}±14	96.78^{a}±16.	97.03^{a}±16.	98.38^{a}±17
Weight of the laying(g)	50.6^{d}±11.	53.8^{d}±11.	46.9^{d}±9.5	367.9^{a}±37.	233.5^{b}±28.	196.3^{c}±18.
Weighthatchlingsin%ofweightofeggs	20.59^{bc}	19.61^{bc}	17.57^{bc}	36.05^{a}	29.10^{b}	27.50^{b}
Rateoffecundity(%)	76.35^{ab}	71.06^{bc}	71.42^{bc}	88.12^{a}	82.66^{b}	81.31^{b}
Earlyembryonic mortalityrate(%)	18.91^{a}	22.01^{b}	30.07^{bc}	17.59^{a}	23.55^{b}	27.87^{bc}
Lateembryonicmortalityrate(%)	35.13^{ab}	28.30^{b}	22.55^{a}	18.47^{a}	28.88^{b}	25^{b}
Rateofhatchingineggs fertile%	21.2^{bc}	20.75^{bc}	18.79^{bc}	59.03^{a}	43.31^{b}	39.80^{b}
Mortalityrate ofthe adults(%)	14.15^{b}	17.54^{a}	18.78^{a}	11.87^{b}	12.74^{b}	13.41^{b}

The median values of the same line indexed of the same letter are not statistically different($P<0.05$).

Table 5 : matrix of correlation between the various parameters of reproduction of Achatinaachatina

Coefficients of correlation

Variables	Rate calcium	Food Ingestion	Number eggs	Weight eggs	Big diam. Eggs	Small diam eggs	During incubation.	Rate eclosion
Rate calcium	1							
Food Ingestion	0.75972	1						
Number eggs/laying	0.78025	0.67512	1					
Weight eggs	0.8343	0.82554	0.85195	1				
Big diameter eggs	0.9491	0.84756	0.83077	0.89801	1			
Small diameter eggs	0.95	0.79847	0.79954	0.84506	0.76378	1		
During incubation	0.87184	0.85992	0.8866	0.88916	0.87795	0.88682	1	
Rate exclusion	0.9954	0.7974	0.71676	0.89587	0.82209	0.8919	0.88	1