International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 15, No. 4, p. 555-562, 2019

RESEARCH PAPER OPEN ACCESS

The breeding of edible snails from Africa: Effects of diet quality and calcium levels on the meat yield of snails and the mineral composition of *Achatina achatina*

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Key words: Young snails, Diets, Green fodder, Concentrates

http://dx.doi.org/10.12692/ijb/15.4.555-562 Article published on October 30, 2019

Abstract

Very young snails of the species *Achatina achatina* (Linné) of 0.33 ± 0.23g live weight and 9.1 ± 0.06mm mean shell length were subjected to two types of diets. We have two wild and cultivated plant diets consisting of: *Laportea aestuans* (Urticaceae), *Phaulopsis falcisephala* (Acanthaceae), *Palisota hirsuta* (Commelinaceae), *Cecropia peltata* (Moraceae) for the R1 diet and *Carica papaya* (Caricaceae), *Xanthosoma mafaffa* (Araceae), *Lactiva sativa* (Asteraceae), *Brassica oleracea* (Brassicaceae) for diet R2 and four diets concentrated in the form of flour (R3, R4, R5 and RT) of variable calcium content (12.02%, 14.03%, 16.01% and 06.82%). These results reveal that animals fed R1 and R2 diets have high levels of carbon (C), silicon (Si) and aluminum (Al) (18.44 and 18.47), (4.31 and 2.10) (0.79 and 0.51) respectively. On the other hand, the animals fed on the concentrated diet are rich in 7 elements, in particular sodium, magnesium, phosphorus, sulfur, chlorine, potassium and chlorine.

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Introduction

The giant snail is highly valued in the African forest zone and is the main source of animal protein and income for many households (Brescia *et al*., 2002, Codjia *et al*., 2002, F.A.O., 1998). Snail flesh is eaten in West Africa and particularly in Ivory Coast by Ivorian populations. The portion of meat traditionally consumed by humans in West Africa accounts for about one-third of the live weight of the giant snail compared with almost half of the live weight for the uneaten shell and viscera (Sami *et al*., 2004; Otchoumou, 2005). Faced with rapid population growth and changes in eating habits, its consumption has become more important nowadays. Thus, a certain section of the population for whom the flesh of this animal was the subject of a taboo, she has crossed the wall of misconceptions and scientifically unfounded, to join the important camp of the usual consumers. However, almost all snails consumed and traded come from harvesting in forest areas (Adegbaju, 2007). As a result, the natural stock is seriously threatened because of the destruction of the biotope of these animals and the strong harvesting pressure due to the population's enthusiasm for this meat (Kouassi *et al*., 2008).The breeding of the different species of snails consumed and marketed is the alternative to continue to meet the needs of populations in this meat (N'da *et al*., 2004; Uboh *et al*., 2010.This necessarily involves the development of a food rich in nutrients and capable of inducing a good yield of snail meat. Among these nutrients, calcium is an essential element in the growth of these animals. To date, no detailed study has yet been conducted on the minimum content of this element for an adequate formulation capable of optimizing the yield of snail meat. Therefore, this work aims to study the effect of diet quality and calcium level on the meat yield and mineral composition of the *Achatina achatina* snail.

Materiel and methods

Experimental framework

This study was conducted at the Nangui Abrogoua University Achatiniculture Center (Abidjan, Ivory Coast). This center includes a building where breeding is under shelter and an outdoor experimentation area. The average monthly temperature and relative humidity in the livestock building were 26.7±1.4°C and 82.6±1.4%, respectively. The photoperiod was 12 hours of light and 12 hours of darkness.

Animals

800 very young snails of (snails aged one or two weeks) *Achatina achatina* (Fig. 1) average live weight 0.33 ± 0.23 average length of 9.1 ± 0.06mm were used. They are derived from high breeding stock in experimental facilities.

Fig. 1. *Achatina achatina* (snails aged one or two weeks).

Enclosures of breeding

The snails were breded in plastic vats length 0.66m, of width 0.6m and height 0.2m are a basic surface of approximately 0.4m² and a volume of 0.08m².These enclosures are equipped with lid of the mosquito net type constituting a device leak-preventer. Their bottom is covered with compost to a 4cm height thickness.

Diets

Six diets were proposed including two vegetable modes and four concentrated modes. The vegetable diets R1 and R2 respectively made up of 25% from wild sheets plants (*Laportea aestuans* (Urticaceae), *Phaulopsis falcisephala* (Acanthaceae), *Palisota Hirsuta* (Commelinaceae), *Cecropia feltata* (Moraceae)) and 25% of sheets cultivated (*Carica papaya* (Caricaceae), *Xanthosoma mafaffa* (Araceae), *Lactiva sativa* (Asteraceae), *Brassica oleracea* (Brassicaceae)) were proposed with the animals on the basis of work of inventories and food preferences (Karamoko, 2009). Concentrated diets (in the form of flour) R3, R4, R5, RT different by the calcium contents from (12.02%; 14.03%; 16.01% and 6.82%). the RT diet already studied (central Laboratory of animal nutrition) (Otchoumou *et al.*, 1989- 1990; Zongo *et al.*, 1990) were used as witness. The characteristics of RT, R3, R4 and R5 appear in table 1 and table 2.

Table 1. Components and compositions of the diets.

Sample weight	Dry matter	Total protein	Lipides	Mineral subtances	Calcium (cal/g)	Raw energie
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	2.74
R5 46.66	93.07	17.48	2.50	45.59	16.01	2.78

Table 2. Biochemical compositions of the four plants.

	Sample weight	Dry matter	Total protein	Lipides	Mineral subtances	Raw energie
Lactica sativa	45.12	88.42	22.28	1.26	1.1	4.195
Brassica oleracea	34.01	91.5	26.36	2.11	10.8	3.91
Laportea aestuans	48.84	94.13	32.22	4.37	23.71	3.644
Phaulopsis Falcisepala	28.20	93.47	25.52	3.51	21.85	3.329
Xanthosoma Mafafa	36.57	90.24	28.24	5.06	18.36	4.254
Carica papaya	56.47	92.48	27.69	4.08	13.58	3.588
Palisota hirsuta	49.24	81.08	24.28	3.45	10.48	2.57
Cecropia feltata	38.18	85.25	21.46	3.19	13.58	1.048

Results

Effects of diet quality on meat yield of snails Achatina achatina

The physical characteristics and body component weights of the snails collected at the end of the experiment according to the quality of the diet are presented in Table 3. The mean live weights of the snails collected on the different vegetable and concentrated diets are respectively 77.24g and 135.44g, for average shell lengths of 79mm and 154mm respectively. The average empty shell weight recorded on these different diets is 19.08g for the plant diet and 27.23g for the concentrated diet then the soft tissue of 58.09g and 108.21g respectively. The animals from the vegetable diet offer a quantity of consumable meat 35.29g less than those from the 66.91g concentrated diet and a quantity of uneaten viscera 22.8g and 41.3g respectively. The statistical comparison of the weight of the bodily components of these molluscs shows that on the different diets, the animals offer more soft tissue than shell. On the concentrated diet, the animals have a shell mass and soft tissues greater than those of the vegetable diets. It is also observed that the quantity of consumable tissues is greater than that of the vegetable diet. The statistical test mentions a significant difference between the weight of empty shells produced, soft tissues, foot and viscera on the types of diet.

Table 3. Weight of snails and weight of their bodily components by diet quality.

	Vegetable diet	Concentrated diet	Significance test
Shell length (mm)	79 ± 5.3	154 ± 3.08	**
Live weight (g) before euthanasia	77.24 ± 12,47	135.44 ± 21.48	**
Soft tissue weight (g)	58.09 ± 17.23	108.21 ± 18.89	**
Foot weight (g)	35.29 ± 10.59	66.91 ± 13.3	**
Viscera weight (g)	22.8 ± 10.61	41.3 ± 13.74	**

Effects of dietary calcium level on the meat yield of snails Achatina achatina

Physical characteristics and body component weights of snails collected at the end of the experiment based on calcium levels of R1 (0.24%), R2 (0.47%), RT (6.82%), R3 (12.02%), R4 (14.03%) and R5 (16.02%) are reported in Table 4. Mean live weights of collected snails were 71.4g; 78.14g, 98.52g, 181.01g, 176.7g, 173.01g, respectively. The proportions of shell relative to the rest of the body vary from 40.14% to 57.54%. The proportion of pedal mass (consumable flesh) varies from 33.33%

to 46.65%, the proportion of visceral mass varies from 7.69% to 24.25%. As for the total mass of flesh produced, it varies from 41.02% to 70.9%. We notice as the dietary calcium level increases; the proportion of the shell increases and that of the masses of pedal and visceral decreases. The total mass of flesh produced from concentrated diets is significantly higher than that of vegetarian diets. R3, R4 and R5 diets give the largest masses of flesh produced.

Table 4. Comparative analysis of the Weight of snails and their body components according to the food calcium content.

Diets	Food calcium	Live average weigth (g)	% of the live weights Cockle	Foot	Internal organs	Total flesh
R_1	0.24	71.45^{a}±11.04	29.14^{a}±11.85	46.65^{a}±8.51	24.25^{a}±8.78	70.9^{a}±17.85
R_2	0.47	78.14^{b}±10.47	35.88^{b}±5.54	45.79^{b}±6.12	18.33^{b}±7.54	64.12^{a}±11.14
R_T	6.82	98.52^{c}±8.15	45.22^{c}±6.85	37.39^{c}±09.60	17.39^{b}±5.65	54.78^{bc}±10.41
R_3	12.02	181.01^{bc}±23.41	53.59^{bc}±8.47	36.04^{bc}±5.86	10.37^{bc}±1.47	46.41^{ab}±14.12
R_4	14.03	176.7^{bc}±21.05	56.62^{bc}±8.10	34.90^{bc}±11.25	8.48^{ab}±2.47	43.38^{bc}±11.65
R_5	16.02	173.1^{bc}±17.36	58.98^{bc}±9.41	33.33^{bc}±11.41	7.69^{ab}±0.85	41.02^{bc}±11.47

The average values of the Nb : same column indexed of the same letters are statistically not different with $P < 0,05$.

Effects of the quality of the diet on the mineral composition of the flesh produced.

The results of the mineral analysis of the body cleared of the shell are reported in Table 5. The analysis of these results shows that the flesh is composed of macro-elements and trace elements. At the level of the 10 macro-elements identified, there are only 3 in which the animals subjected to the vegetable diet are rich. These results reveal that animals fed R1 and R2 diets have high levels of carbon (C), silicon (Si) and aluminum (Al) (18.44 and 18.47), (4.31 and 2.10) (0.79 and 0.51) respectively. On the other hand, the animals fed on the concentrated diet are rich in 7 elements, in particular sodium, magnesium, phosphorus, sulfur, chlorine, potassium and chlorine. With regard to the trace elements, of the 5 identified, the animals subjected to the plant diet R1 and R2 contain 2 elements including iron (Fe) and oxygen (O) for levels of (2.02 and 2.03), (66.93 and 69.50) respectively. In addition, while the flesh subjected to vegetable diets contains titanium (Ti), the animals subjected to the concentrated diets do not have any. As for the trace elements, the flesh subjected to the vegetable diets are very rich in iron and oxygen. The results of the comparative analysis of the mineral composition of the animals subjected to the two types of diets reveal that the animals subjected to the concentrated diet are richer in macro-elements in particular in Sodium (2.71), Magnesium (4.41) , in Phosphorus (8.46), Chlorine (2.84), Potassium (8.68) and Calcium (15.41) in contrast to the animals of the vegetable diet. On the other hand, the animals that consumed the plants are rich in trace elements, especially iron (0.66), copper (0.23) and oxygen (42.54). Moreover, the flesh of the animals subjected to the concentrated diet is rich in 7 macro-elements against 2 for that of the animals of the plant diet. The statistical analysis indicates a very significant difference between the following types of diets for minerals: Sodium, Magnesium, Aluminum, Silicon, Phosphorus, Potassium, Calcium and Oxygen.

Effects of the food calcium rate on the mineral composition of the produced flesh

The results of the mineral analysis of the shell-free body are reported in Table 6 and 7. On the macro-elements, we notice that sodium (Na), magnesium (Mg), phosphorus (P), sulfur (S), chlorine (Cl) potassium (K), and calcium (Ca) increases as calcium levels increase, carbon (C) and silicon (Si) decrease. Animals fed the low calcium diet R1 and R2 respectively (0.24 and 0.47) recorded high levels of carbon (C) 18.94 and silicon (Si) 4.31 with very low levels in sodium (Na) (0.16 and 0.22), magnesium (Mg) (0.15 and 0.19), aluminum (Al) (0.79 and 0.51), phosphorus (P) (0.39 and 0.44), sulfur (S) (0.15 and

0.12) and potassium (K) (0.11 and 0.15) respectively. Animals fed the high calcium diet R3, R4 and R5 respectively (12.03, 14.03 and 16.03) reported high levels of phosphorus (P) (8.41, 9.9 and 9, respectively). 22), potassium (K) (8.86, 9.19 and 9.78), magnesium (Mg) (3.66, 3.98 and 4.12), sodium (Na) (2.62 2.65 and 2.83) respectively. With regard to the trace elements, the animals fed at low calcium levels R1 and R2 respectively (0.24 and 0.47) give high levels of iron (2.02 and 2.03), copper (3.32 and 2.79) in oxygen (O) (66.93 and 69.50) whereas those fed with high calcium levels have low levels of iron and copper.

Table 5. Results of mineral matter proportionings of the snail flesh subjected according to the quality of the diet.

	Vegetal diet	Concentrated diet	Significant test
Carbon	18.38 ± 2.76	12.41 ± 2.76	*
Sodium	0.18 ± 0.04	2.71 ± 0.85	**
Magnesium	0.17 ± 0.05	4.41 ± 1.76	**
Aluminium	0,73 ± 0.03	0.21 ± 0.05	**
Silicon	3.41 ± 0.23	0.33 ± 0.03	**
Phosphorus	0.46 ± 0.07	8.46 ± 2.42	**
Sulfur	0.14 ± 0.02	0.91 ± 0.06	*
Chlorine	0.17 ± 0.06	2.84 ± 0.4	*
Potassium	0.13 ± 0.04	8.68 ± 2.3	**
Calcium	2.06 ± 0.03	15.41 ± 4.32	**
Iron	2.05 ± 0.6	0.66 ± 0.05	*
Copper	3.14 ± 1.43	0.23 ± 0.03	*
Zinc	0.15 ± 0.02	0.32 ± 0.06	*
Oxygen	68.20 ± 8.54	42.54 ± 12.65	**
Titanium	0.62 ± 0.03	-	*

Table 6. Principal macronutrients contained in the snail flesh according to food calcium contents.

	Macronutrients									
Variable	Carbon	Sodium	Magnesium	Aluminium	Silicon	Phosphorus	Sulfur	Chlorine	Potassium	Calcium
R_1 (0.24%)	18.94^a±1.64	0.16^a±0.06	0.15^a± 0.05	0.79^a±0.31	4.31^a± 1.33	0.39^a±0.11	0.15^a±0.01	0.06^a±0.03	0.11^b±0.02	2.15^c±2.07
R_2 (0.47%)	18.47^a±1.06	0.22^a±0.05	0.19^a± 0.03	0.51^a±0.24	2.10^a ±1.26	0.44^a±0.10	0.12^a±0.08	0.17^a±0.04	0.15^b±0.08	2.21^c±0.07
R_T (6.82%)	10.78^b ± 2.4	2.23^b±0.32	3.07^b± 0.48	0.45^a±0.04	0.34^b ±0.05	7.22^b±1.54	0.94^a±0.06	2.31^b±0.19	8.33^a±1.05	12.37^b±1.88
R_3(12.03%)	10.60^b±0.55	2.62^b±0.20	3.66^b± 0.06	0.29^b±0.07	0.33^b±0.26	8.41^b±0.30	0.84^a±0.16	2.79^b±0.40	8.86^a±0.58	13.37^b±0.98
R_4(14.03%)	7.40^c ±0.81	2.65^b±0.21	3.98^b± 0.21	0.28^b±0.15	0.33^b±0.18	9.19^b±0.65	0.83^a±0.05	2.86^b±0.28	9.19^a±0.60	16.54^a±0.83
R_5(16.02%)	7.38^c ±1.45	2.83^b±0.18	4.12^b± 0.09	0.18^b±0.09	0.32^b±0.16	9.22^b±0.82	0.81^a±0.16	3.01^b±0.24	9.78^a±1.39	17.43^a±0.91

Nb :The average values of the same column indexed of the same letters are not statistically different with the Test from Kruskal-Walis ($P < 0.05$)

Table 7. Principal trace elements contained in the snail flesh according to calcium contents.

	Trace Elements				
Variable	Iron	Copper	Zinc	Oxygen	Titanium
R_1 (0.24%)	2.02^a ± 0.04	3.32^a ± 1.57	0.06^a ± 0.03	66.93^a ± 2.07	0.10^a ± 0.07
R_2 (0.47%)	2.03^a ± 0.01	2.79^a ± 0.47	0.27^a ± 0.06	69.50^a ± 2.63	0.03^a ± 0.04
R_T (6.82%)	0.60^b ± 0.20	0.22^b ± 0.03	0.20^a ± 0.10	50.54^b ± 2.97	_
R_3 (12.03%)	0.68^b ± 0.10	0.33^b ± 0.06	0.25^a ± 0.06	45.45^b ± 1.93	_
R_4 (14.03%)	0.72^b ± 0.08	0.28^b ± 0.09	0.27^a ± 0.07	46.18^b ±1.12	_
R_5 (16.02%)	0.77^b ± 0.09	0.30^b ± 0.11	0.28^a ± 0.12	43.59^b ± 0.05	_

Nb :The average values of the same column indexed of the same letters are not statistically different with the Test from Kruskal-Walis ($P < 0.05$).

Discussion

Statistical analyzes showed that there was a significant difference ($P<0.05$) between plant-fed and concentrated-diet specimens with respect to the average proportions of various parts of the snail body. Independently of the diets, the visceral mass of the snails contained more energy, lipids and mineral matter than the pedal mass. Foot mass was richer in protein than visceral mass and snails in wild diets had a higher protein content than those from concentrated diets.

In Africa and particularly in Ivory Coast, snails are important for the amount of meat they provide and not for their gastronomic finesse (Zongo *et al.,* 1990). The pedal mass is the part of the body that is consumed (Aboua and Boka 1996). The results of this study should encourage the consumption of high snail meat and the use of shell and visceral mass. The results indicate that the shell of specimens subjected to concentrated diets represents more than half of the live weight of snail, while the masses of pedal and visceral represent on average one-third and one-sixth of the total weight, respectively.

These results are similar to those of Pacheco *et al.* (1998). The shell mass of the snails of the vegetable diets is 29.14g and 35.88g while that of the concentrated diets varies from 45.22g to 58.98g. These results are superior to those of Gomot (1998) who studied the proportions of the various parts of the body of Helix snails and reported that the shell of the high specimens ranged from 10.3 to 11.5% of the live weight of the Helix snails. Snail, while the shell of plant-dwelling individuals ranges from 17.5% to 22% of live weight.

This difference would be due to the quality of the diet and the nutrient richness especially the calcium. Visceral mass and shell can be used as a source of calcium and protein in animal feed (Risticet *et al*., 2000). It is noted that the live weight of animals increase as the level of dietary calcium increases. Results in agreement with those of Otchoumou *et al.* (2010) verified on three species of snails *Achatina achatina, Achatina fulica* and *Archachatina ventricosa*. The *Achatina* meat is very rich in protein, a result in agreement with those of Aboua (1990, 1995) who studied the chemical composition of *A. fulica* and showed that its flesh was very rich in protein. In addition, the pedal mass had a protein content ranging from 60.48% to 76.38% higher than those obtained by Otchoumou *et al.* (2010) for the three species studied (53.36 to 74.6 g). This result is slightly higher than the value (72g) reported by Aboua (1990).

The pedal mass contained more protein than the visceral mass because of the components of each diet. The pedal mass is mainly composed of contractile proteins (actin and myosin). Our results reveal that the pedal mass contains less lipids than the visceral mass. Snail meat is rightly recommended and recommended for low-fat diets (Saldanha *et al.*, 2001). The results of this study were slightly higher in the concentrated diet. In addition, the visceral mass was high in lipids and was more energetic compared to the pedal mass because lipids are highly energetic. These results could be explained by the type of diet used to feed the snails. The results of this study showed that the visceral mass is richer in mineral matter than the pedal mass. This shows that minerals absorbed by snails are transferred to internal organs where a storage threshold exists. This threshold differs according to the species of snail. The mineral composition of the snail flesh as presented in the tables has just corroborated the results obtained with the concentrated diets. Indeed, this wealth is due to its composition hence the term concentrate and the best nutritional characteristics offered by the feed provided to animals. Indeed, the food must provide energy elements, plastic elements and operating factors to ensure the maintenance of life (Pagot *et al.*, 1983). For their development and growth, molluscs and other species also need vitamins, minerals and trace elements. Snails are fed with compound feeds, made from a mixture of several raw materials, in fixed proportions to cover their needs and offer them optimal conditions for their growth. The minerals are usually classified in two groups: major minerals on the one hand or macroelements, including sodium, potassium, chlorine, calcium, phosphorus, magnesium and trace elements on the other hand, including iron, zinc, copper, manganese, iodine, selenium, chromium, molybdenum, fluorine, cobalt, silicon, vanadium, nickel, boron and arsenic. These elements intervene, at very low concentration, in innumerable metabolic processes (for example as constituents or activators of enzymes, regulators, stabilizers or co-carriers. Snails draw these elements both in their food and in the water. They deposit them selectively in the different tissues. Minerals are mostly stored in the skeleton, especially the vertebrae (65% minerals), but they are also found in the muscles (Lall and Parazo, 1995). According to these same authors, the most abundant mineral component of the flesh of fish and molluscs is potassium.

This essential intracellular action, whose metabolism is closely related to that of sodium, is essential for the functioning of a large number of enzymes, cellular metabolism, and the repolarization of nerve, cardiac and muscular membranes. It is also essential for the kidney, the regulation of aldosterone and blood pressure. Associated with calcium in the form of hydroxyapatite in the backbone of certain vertebrae, phosphorus is essential for the activation of many enzymes and the respiratory chain. The flesh of molluscs is very rich in iron that comes from plant diets as reported (Lall and Parazo, 1995).

Conclusion

The edible snails of Côte d'Ivoire are very rich in protein, minerals and energy. For this reason, they are collected by the forest peoples of Côte d'Ivoire. This study showed that the chemical quality of snails submitted to plant diets differs from those subject to concentrated diets. An improvement in the various parameters for rearing snails, and especially the diet components were able to improve the quality of the high snail meat. Thus the consumption of high snails is recommended in order to preserve wild snail biodiversity and to protect snail consumers against possible intoxication due to the use of pesticides and heavy metals.

Acknowledgements

The authors are grateful to the staff of pole of research livestock productions at Nangui Abrogoua university and Phd of our Laboratory who assisted in this study.

References

Aboua F, Boka K. 1996. Les escargots géants comestibles d'Afrique: quelques aspects physiques et préparation en Côte d'Ivoire. Nature et faune **12(4),** 2-9.

Aboua F. 1990. Chemical composition of *Achatina fulica*. Tropicultura **8(3),** 121-122.

Aboua F. 1995. Proximate analysis and mineral content of two giant African snails consumed in the Ivoiry Coast. Tropical Science **35(3),** 220-222.

Adegbaju SW. 2007. A guid to a successful poultry and snaillery business. Agro care series (I) 22-29

Brescia F, Chardonnet P, de Garine Wichatitsky M, Jori F. 2002. Les élevages non conventionnels. Mémento de l'agronome, CIRAD-GRET Paris. Http://www.doc-developpement-durable.org.

Cobinnah JR. 1994. Snail farming in West Africa. A practical guide CTA Technical Centre for Agricultural and Rural Cooperation (CTA).

Codjia JTC, Noumonvi RCG. 2002. Les escargots géants. Guide technique d'élevage n°2, Bureau pour l'échange et la distribution de l'information sur le mini-élevage. Http://www.fsagx.ac.b/bedm/product

FAO. 1998. La faune sauvage et la sécurité alimentaire en Afrique. Cahier F.A.O. Conservation **33,** Rome.

Géant africain Achatina achatina (Linné). Annales d'Ecologie, Université Nationale de C.I Tome XXI, 31-58.

Gomot A, Bruckert S, Gomot L, Combe JC. 1986. A contribution of the study of the beneficial effect of soil on the growth of *Helix aspersa*. Snail farming research. Association Nationale Elicicoltori **(1),** 76-83.

Karamoko M. 2009. Etude de la biologie, de l'écologie et du comportement d'un escargot terrestre d'intérêt économique, *Limicolaria flammea* (Muller, 1774), en milieu d'élevage. Thèse de doctorat unique. Université Cocody Abidjan **N°604/2009,** 166p.

Kouassi KD, Otchoumou A, Gnakri D. 2008. Le commerce des escargots (*Achatina achatina*), une activité lucrative en Côte d'Ivoire. Livestock Research for Rural Development, **Vol. 20** http:// www. Irrd. org/Irrd20/4/koua20058.htm.

Lall S, Parazo MP. 1995. Fish and Fishery Products. A. Ruiter ed. CAB International, Oxon (UK): 187-21.

N'da K, Otchoumou A, Koffi KJC. 2004. Alimentation à base de produits du papayer et maturation ovocytaire chez *Achatina fulica* (Bodich, 1820) EN Côte d'Ivoire. Tropicultura **22(4),** 168-172.

Otchoumou A, Dupont-NIvet, M, OCho AL, Dosso H. 2010. Body proportions and chemical composition of wild and reared edible snails of Ivory Coast, Italian Journal of Food Sciences **22(1),** 1120-1170.

Otchoumou A, Zongo D, Dosso H. 1989-1990. Contribution à l'étude de l'escargot

Pacheco P, Fatima-Martins M, De Battemarque V, Rodriguez PHM, Ghion E, Spers A. 1998. Diferentes fonts de calcio na dieta do escargot gigante africano (*Achatina fulica*) e su efeito no crescimento e rendimento de carcaca. Higiene Alimentar **12, 43**.

Ristic M, Sakae M, Kormanjos SD, Filipovic S. 2000. The investigation of the quality of snail inedible by products. Technologija Mesa **41, 163**.

Saldanha T, Gaspar A, Santana DM, Da N. 2001. Composicao centesimal da carne de escargot (*Achatina fulica*) criado em Iguape, SP. *Higiene* Alimentar **(15),** 69.

Uboh FE, Ebong PE, M'bi E. 2010. Cultural discrimination in the consumption of black snail (*Archachatina marginata*) and white snail (*Achatina achatina*) ; any scintific justification. Intenational Research Journal of Microbiology **1(1),** 013-17.

Zongo D, Coulibaly M, Diambra Oh, Adjiri E. 1990. Note sur l'élevage de l'escargot géant africain *Achatina achatina* (Linné). *Nature et Faune* **6(2),** 32-34.