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Effects of Dietary Calcium on the Organoleptic Qualities of an African Landsnails' Flesh

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Abstract: Young snails of *Achatina achatina* (Linné, 1750) of 0.33 ± 0.23 g of average live weight and 9.1 ± 0.06 mm average length of shell were subjected to two types of diet. Two diets contained wild and cultivated plants (R_1 and R_2) and four diets concentrated in flour forms (R_3, R_4, R_5 and R_T) of respectively variable calcium content (12.02%, 14.03%, 16.01% and 06.82%). The objective is to compare the organoleptic qualities of the snails' flesh emanating of the two types of food. The flesh of the concentrated diet are more tender (6.05), juicier (6.32) with an average aftertaste (5.8) while those of the vegetable diet are aromatized with an average of 6. The optimum calcium rates inducing the best tenderness (6.06), juiciness (6) are of 12.02% and of aftertaste (5.9) is diet containing 14.03% of calcium while the flavour (6.6) was obtained a rate of 0.24%.

Keywords: *Achatina achatina*, calcium, flavour, odor, savour, texture.

INTRODUCTION

Food takes a paramount place in biological performances of snail's breeding and its control must pass by a better knowledge of raw materials. Thus, for about ten years, many researchers have carried out research in order to develop ideal food in flour form able to ensure good ponderal productivity and a better valorisation of snails' flesh to solve the problems of protein deficit. The inventory and the appetability of the fodder consumed by snails were carried out through several investigations [6, 2]. Thus two types of diet were given to snails and the results of this study revealed that the breeding of snails can be improved with the use of food formulated in flour form. Indeed, the animals subjected to the concentrated diets showed the best performances of growth, reproduction and financial output compared to those subjected to the diets containing plants [13, 8, 1].

Beyond the biological performances generated by various food tested, one thing seems paramount:the organoleptic quality of the flesh of snails of breeding. Organoleptic qualities of a food are savour, the odor, the flavour, texture and appearance:all that can make it pleasant to eat or not. Indeed, pretexting a difference in taste between the livestock and those resulting from nature, the consumers seem to neglect snail of breeding to the profit of those collected in nature.They find wild snails more pleasant to eat than those from breeding.The less passion for snails of breeding has a harmful effect on the profitability of the breeding.

The purpose of this work is to compare the effects of two types of diet on the organoleptic qualities of the flesh of *Achatina achatina*, the specie of snail the most consumed in Côte d'Ivoire.

MATERIAL AND METHODS

The experimental farm of the Nangui Abrogoua (Côte d'Ivoire) was used as frame work of study for our work which started from July 2008 and ended in September 2010. 800 snails of the specie *Achatina achatina* with average weight of 0.33 ± 0.23 g and shelly average length of 9.1 ± 0.06 mm were used.

Food diet

Six food diets were proposed with the concentrated seed oysters including two vegetable modes and four diets.

The vegetable diets R_1 and R_2 respectively made up of 25% of wild sheets plants (*Laportea*

aestuans (Urticaceae), *Phaulopsis falcisepala* (Acanthaceae), *Palisota hirsuta* (Commelinaceae), *Cecropia peltata* (Moraceae)) and 25% of sheets cultivated (*Carica papaya* (Caricaceae), *Xanthosoma mafaffa* (Araceae), *Lactica sativa* (Asteraceae), *Brassica oleracea* (Brassicaceae)) were proposed to the animals base on the works of inventories and food preferences done by [6].

Concentrated diets (in flour form) R_3, R_4, R_5, R_T different by the calcium contents from (12.02%; 14.03%; 16.01% and 6.82%). Mode R_T already studied (central Laboratory of animal nutrition) were used like control. The contents of the diet are showed in table 1.

Table-1: Composition (g / 100 g) of the concentrated diets

	Corn	Cotton grain	Soya grain	Fish meal	Common wheat	Phosphate bicalcic	Vitamins	Carbonate calcium	Salt	Oligo-elements	Total
R_3	15	16	15		15	4	0,5	33,7	0,4	0,10	100
R_4	19	16	16		15	4	0,5	29	0,4	0,10	100
R_5	9,7	15,7	15,7		14,7	4	0,5	39,2	0,4	0,10	100
R_T	10	15,7	15,7	10	43,7	4	0,5	-	0,4	0,10	100

Snails' husbandry

The enclosures of breeding consist of boxes made of plastic in trapezoidal form at square base with 0.14 m height on a basic surface of 0.04 m^2 for a volume estimated to 56.10^{-4} m^3.

Organoleptic analyses of the snails' meat

At the end of 26 months of experiments, twenty-five snails were randomly taken in different batches. They were weighed and the length of the shell was measured, then after 24 hours of fasting, the snails are sacrificed and the flesh extracted from the shell. The sensory tests were carried on the snails feeding with different diet and those that have been harvested. With this intention, all the eviscerated animals obtained previously were used for the test of tasting according to the method of [9]. The various fleshes were cooked separately on hearths with standard gas in the same way and to season.

After cooking, the snails' flesh were cut out into pieces and tasted when slightly hot. Snails' meat pieces were identified using codes: A, B or C, according to the case to avoid the taster to know in which batch the snail is from. Tests relating to tenderness, the juiciness, the aftertaste, the flavour and the overall assessment of the snail meat were carried out. The meats are classified by categories according to the average of the notes obtained.

Constitution of the panel of tasters

The tasters consist of 15 people including 7 women and 8 men chosen randomly in the population. Their age varies between 25 and 40 years. These panellists or judges received explanations for a better comprehension of the test and were trained during two days.

Preparation and presentation of the samples

The snails must be well-cleaned and cut out into pieces. Onion, tomatoes and peppers are washed and put in a pan with the batch of snails and then, a little water is added and finally all is allowed to cook lovingly for 15 minutes. The condiments are taken back and crushed. The paste obtained after crushing the condiments is mixed with oil and salt is added. The snails are washed with the final paste and are placed in a mould. The mould is put in an oven at 110°C for 45 min. Experiments were carried out in an aired room away from all odour as well as audible and visual distractions.

Each judge received in a plate, samples of each piece of snails' meat above definite, coded with alphabetical numbers and after tasting filled a form to work out for this purpose effect and presented here after. After tasting the first piece of meat following the judge is allowed to wash his/her mouth with water and eat a slice of bread. Tasters do not communicate among them throughout this evaluation. All the samples are presented at the same time to the tasters in order to enable them to taste the meat twice if necessary.

Card-index notation

The criteria of notations are explained to the tasters before the beginning of the test. The notes to be allotted lie between 0 and 10. With this intention, each taster has a card (Figure 1) drawn up by [9] which is a scale going from 0 to 10 cm. Each centimetre corresponds to difference insensitivity. The taster is informed for this purpose marking by a cross on the line his evaluation of the organoleptic quality of the meat [15]. The distance from the origin (0) to the cross is measured. These various measurements are compiled for all the subjects to form the data to which will be applied the suitable statistical test (Statistica 7.0).

Statistical analysis

Programs STATISTICA version 7.1 and Microsoft Excel 2003 were used to make the various statistical analysis. The mineral compositions of the modes were compared using the test multiple comparisons of row (ANOVA) of Kruskal-Walis.

RESULTS

Effects of the quality of the diet on the organoleptic characteristics

The snails emanating from the six batches were appreciated for the tenderness, the juiciness, the aftertaste, the flavour of their meats and overall assessment by a panel of tasters (Table 2 and figure 2).

Tenderness

The average of the notes obtained is of 5.06 for the vegetable mode and 6.05 for the concentrated mode. These results suggest that the animals resulting from the vegetable mode are tenderer than those resulting from the concentrated mode. The statistical analysis reveals a significant difference between the two modes with the threshold of 5%.

Juiciness

For this factor, the average of the notes obtained is of 5.36 for the vegetable mode and 6.32 for the concentrated mode. These results suggest that the animals resulting from the concentrated modes are juicier than those emanating from the plants which present a neutral juiciness i.e. neither dryness nor juicy. The statistical analysis reveals a significant difference between the two modes with the threshold of 5%.

Aftertaste

The average of the notes obtained is of 4.46 for the vegetable mode and 5.8 for the concentrated mode. These results suggest that the animals resulting from the concentrated mode have or not an after-taste that those resulting from the vegetable mode. The statistical analysis reveals a significant difference between the two modes with the threshold of 5%.

Flavour

The average of the notes obtained on the level of the flavour is of 6 for the vegetable mode and 5.8 or the concentrated mode. These results suggest that the animals resulting from the vegetable mode are scented than those resulting from the concentrated mode. However the statistical analysis does not reveal any significant difference between the two modes with the threshold of 5%.

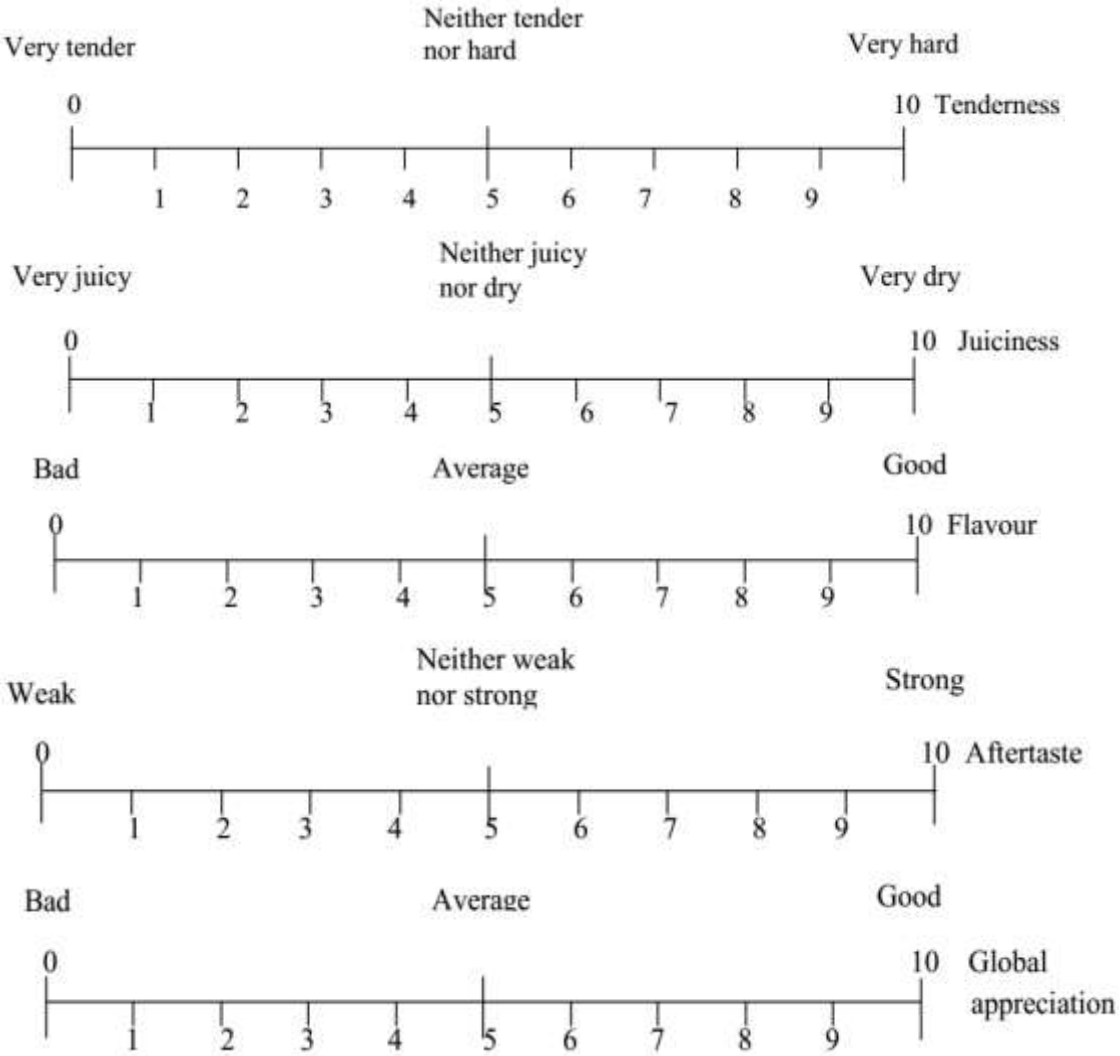

Fig-1: Scale of measurement of the organoleptic characteristics [9]

Table-2: Effects of the diet quality on the organoleptic characteristics

	Vegetable diets		Concentrated diets		
Variable	N	Mean value ± SD	N	Mean value ± SD	**Test of significativity**
Tenderness	15	5,06 ± 1,14[a]	15	6,05 ± 0,73[b]	*
Juiciness	15	5,37± 0,81[a]	15	6,32± 0,61[a]	*
Aftertaste	15	4,47 ± 0,81[b]	15	5,8 ± 0,87[a]	*
Flavour	15	6 ± 1,08[a]	15	5,85 ± 0,97[a]	*
Global appreciation	15	5,8 ± 1,14[a]	15	5,908 ± 1,01[a]	NS

*: significant difference with the threshold of 5%
NS : nonsignificant difference (p>0,05)
SD : standard deviation;

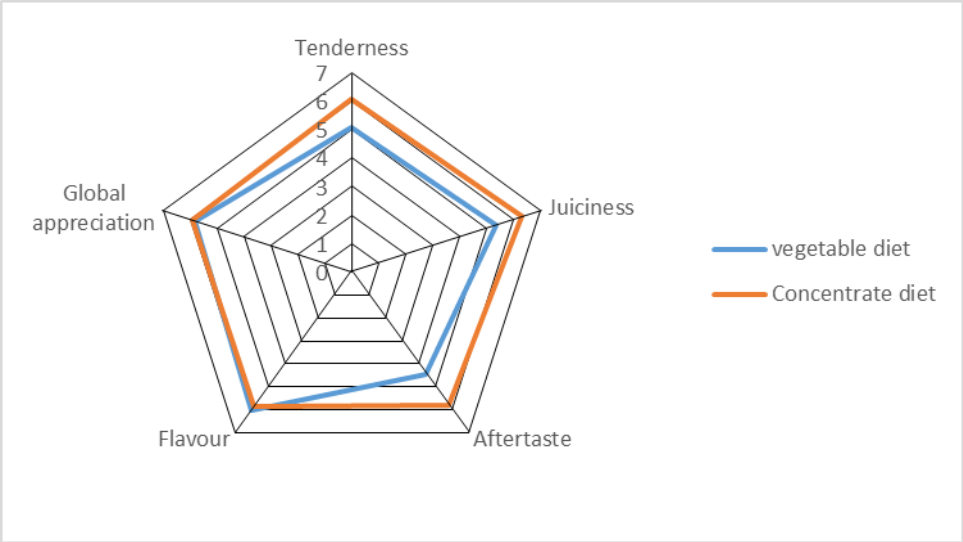

Fig-2: Radar representation of organoleptic qualities tested on the two categories of meat

Overall assessment

This factor which is the summation of all the precedents, records notes varying from 4 to 7 obtained on the vegetable mode and of the notes varying from 4.5 to 7.75 obtained on the concentrated mode. The average of the notes obtained is of 5.8 for the vegetable mode and5.9 for the concentrated mode. These results suggest that the animals resulting from the two modes were appreciated by the whole of the panellists. The statistical analysis does not reveal any significant difference between the two modes with the threshold of 5%.

Effects of dietary calcium on the organoleptic characteristics

The results emanating of the criteria of tenderness, juiciness, after-taste, flavour and overall assessment according to the calcium rate are summarized in table 3 and figure 3.

Table-3: Effects of dietary calcium on the organoleptic characteristics

Variable	N	**R_1 (0,24%)**	**R_2 (0,47%)**	**R_T (6,82%)**	**R_3 (12,02%)**	**R_4 (14,03%)**	**R_5 (16,02%)**
Tenderness	15	5,53 ±1,5[b]	5 ±1,7[b]	6,06 ±1,85[a]	6,4±1.8[a]	6,28 ±1,3[a]	6 ±1,35[a]
Juiciness	15	5,2 ±1,4[b]	5,2 ±1,3[b]	6 ±1,7[a]	6,4 ±1,5[a]	6,2 ±1,1[a]	6,7 ±1,2[a]
Aftertaste	15	4,53 ±1,5[b]	4,06 ±1,6[b]	5,8 ±1,4[a]	5,8 ±1,2[a]	5,9 ±1,6[a]	5,6 ±1,4[a]
Flavour	15	6,6 ±1,4[a]	6,1 ±1,6[a]	5,4 ±2,1[b]	4,8 ±2,2[b]	5,2 ±1,8[b]	5,2 ±1,5[b]
Global appreciation	15	5,6±1,3[a]	5,9±1,3[a]	6,6±1,7[a]	6,4±2,1[a]	5,3±2,3[a]	5,4±1,3[a]

a, b = Mean values with different superscripts in the same row are significantly (P<0.05) different.

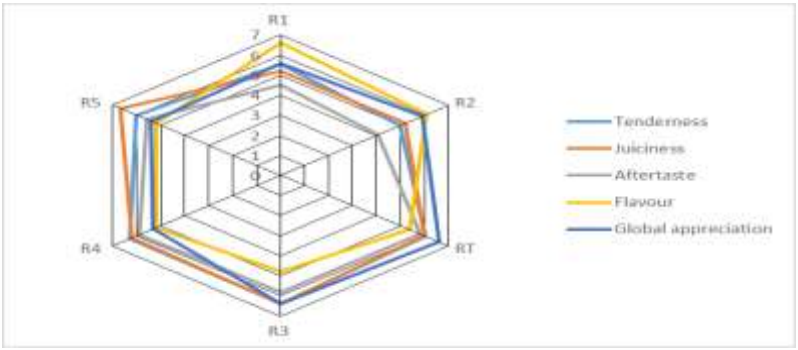

Fig-3: Results of the hedonic tests: effects of dietary calcium on the organoleptic characteristics

Tenderness

Tenderness is the aptitude of the meat for being crossed, torn or crushed more easily by the teeth. Tenderness was appreciated using the annotations which made it possible to classify these meat sin two categories according to the average of the notes obtained: the meats of snails of the modes R_2 and R_1 constitute category 1; they are respectively noted 5 ± 1.7 and 5.53±1.5. Category 2 is affected notes 6.06 ± 1.85; 6.4±1.8; 6.28 ±1.3 and 6 ±1.35 for the meats of snails of the modes R_T, R_3, R_4 and R_5. These values emanating of the various categories are statistically different with the threshold from 5%.

Juiciness

For this factor, the average of the marks obtained is 5.36 for the vegetable mode and 6.32 for the concentrated mode. These results suggest that the animals resulting from the concentrated diets are juicier than those emanating from the plants which present a neutral juiciness i.e. neither dryness. These values emanating of the various categories are statistically different with the threshold from 5%. The after-taste was appreciated using the annotations which made it possible to classify these meats in two categories according to the average of the notes obtained: the meats of snails of the modes R_T, R_3, R_4 and R_5, represented by the average constitute category 1; they are respectively noted (5.8 ± 1.4^a, $5.8 \pm 1,2^a$, $5.9 \pm 1,6^a$ and $5.6 \pm 1,4^a$) and those of the modes R_2 and R_1 represented by category 2, they are marked respectively (4.06 ± 1.6^b and 4.53 ± 1.5^b). The after-taste of the meat of snails of the concentrated modes is statistically different with the threshold 5% with those from the vegetable modes. In general, these snails do not present a major after-Taste though presenting different averages.

The flavour was appreciated using the annotations which made it possible to classify these meats in two categories: the snail meats of the modes, R_1 and R_2 presented by the best flavour constitute category 1; they are respectively marked (6.6 ± 1.4^b and 6.1 ± 1.6^b). Category 2 represented modes R_3, R_T, R_4 and R_5 are affected with marks of 4.8 ± 2.2^a, 5.4 ± 2.1^a 5.2 ± 1.8^a and 5.2 ± 1.5^a. These values are statistically different with the threshold 5% for the same letters.

Overall assessment

The overall assessment obtained using the annotations made it possible to classify these meats in two categories according to the averages of treatment: the meats of snails of the modes R_T, R_3 and R_2 constitute category 1; they are respectively marked (6.6 ± 1.7, 6.4 ± 2.1 and 5.9 ± 1.3). Category 2 is marked (5.3 ± 2.3, 5.4 ± 1.3 and 5.6 ± 1.3) for the meats of snails of the modes R_4, R_5 and R_1 respectively. Generally the results of the tests of acceptability show that the various fleshes resulting from the food modes are considered to be good. Thus, the various values are not statistically different with the threshold from 5%.

DISCUSSION

All meats, whether from breeding animals or birds, they have the same structure. They are composed, essentially, of muscle fibres, fat fabric (fatty) and conjunctive fabric (collagenous) [19]. The proportion of these various components, their colour and their texture can however vary. Consumers' choice for the meats with fast cooking let's suppose that within the sensory descriptors, the requirement relates firstly to the tenderness of the meat [3]. The organoleptic quality of fresh meats, often, is esteemed by its tenderness, its juiciness and its flavour [11]. These are the three descriptors that consumers appreciate the best. As regards to tenderness, there is a significant difference between the two batches (batch 1 and 2). The analysis of tenderness of our samples revealed that food diet affects the quality of the meat. This was probably due, on the one hand, to the difference recorded on the level of the growth (pedal mass) and on the other hand to the muscular activity since this same mass contains contractile proteins (actin and myosin). These results are in accordance with those reported by [10] who revealed that the compensation growth results in an increase in the profit of weight of the animals compared to the normal. Thus the reduction of the force of shearing of the meat under the effect of the compensation growth can be explained by the acceleration of the rate of proteins, likely to lead to a

new collagen synthesis [4].Collagen fibres are attached the ones to the others by chemical bonds of which the number varies according to the age and the exercise. The more dependent the fibres are firmly between them, the more them eat is hard. A reduction of the size of collagen fibres of the type I could also explain this improvement of tenderness under the effect of the compensation growth [5]. Lastly, the increase in tenderness could be connected to the increase in the proportion of glycolytic muscle fibres, with faster maturation, at the expense of the proportion of slow fibres [16].

In the same way according to works done by [23], foods, the control and methods of cookings can also influenced tenderness of the meat. But as far as our work is concerned, results showed no significant difference of tenderness caused by control in breeding and the methods of cookings could be established because those were the same ones for the various modes. But in our study, the food mode and the growth influenced the tenderness character. Average notes of the juicy character of the concentred diets are significant to those of the vegetable diets. The juiciness is more or less dry character of the meat in the course of consumption. This character is related to water released by meat when chewing and to the secretion of saliva activated by the lipids of the meat.

During firing, proteins contained in fibres coagulate, i.e. they are tightened. During this process, proteins expel water which they contain. To caricature, meat can be compared to a sponge mouthful of water, and heated with pressure put on the sponge [17]. The more the temperature of the meat rises, the more there is pressure on fibres, and thus of the juice which leaves the meat. That shows that the juiciness is related to the weights of the animal. Thus, animals of the concentrated modes having high weights that those of the vegetable modes are thus juicier. When the meat reaches a temperature interns approximately 70°C (160° F), the juice loss is accentuated, because at this temperature, the perimysium (collagenous which sheaths the fascicule of muscle fibres) contracts in its turn and puts additional pressure on the cells. A meat which reaches an internal temperature of 80° C (175° F) will have lost up to 30 to 35% of its water [18].

After-taste reveals a statistical difference between the fleshes of the two types in modes. Marks obtained bordering the average that shows that the food mode affects in a least degree the gustatory quality of the meat. The flavour was higher in the animals resulting from the vegetable diet to the detriment of those subjected to the concentrated diets. [11] think that the raw meat practically does not have odour, in fact reveals the various forms of cooking cause the development of the flavours starting from precursors (peptides, amino-acids, glycosides and lipids). Most flavours generated during methods of cookings, result from a set of reactions, whose principal ones are the hydrolysis, the oxidation and their actions known as of Maillard, these last including a whole complex whole of reactions [22]. The mechanism of the hydrolysis is common to proteins, lipids and glucoses.

This depends strongly on the culinary preparation and the activity of water. Oxidation requires as for it, the presence of oxygen, unsaturated lipids and temperature. The oxygen rate in the flesh of the plants being higher than that of the concentrates that would justify higher aromatic quality. Since the methods of cookings were the same ones for the various modes, the composition of the various modes are thus at the origin of this difference because the animals express only what they consume. The contents of lipids and proteins of the pedal masses having varied from one mode to another, it would be the same for their peptide component, amino-acids what would affect the flavour and the taste. According to [12], the flavour and flavour are due partly to the amino-acids and the fatty-acids which offer the food. These results are corroborated by [20] which stipulate that when a food is chewed in the oral cavity, from the odorous molecules release themselves from its structure and circulate in the back gorges. They arrive in the nasal cavity and stimulate the olfactive receivers. This retro-nasal way allows the perception of the flavour of the food which is responsible for 90% of the feeling of the taste.

Resulting from snails represented by category 1 was higher than that of category 2 this could be due to the taste, the flavour, the juiciness and the tenderness obtained on the level of these modes. Works done by [7, 21] confirm the aspect, the odour, the flavour, the texture; the crunchy biscuit are as many parameters which are involved in the appreciation of foods. However [23], also, found that tenderness was more important than the juicy character when it is a question of determining total gustatory quality. On this basis, the animals subjected to the concentrated modes having tenderness one more raised than those of the vegetable modes thus would be appreciated but the statistical analysis did not reveal any significant difference.

CONCLUSION

With the requirements of consumers in Côte d'Ivoire on the quality of wild snails' fleshes and its rather long growth, we were brought to produce snails which have characters of rapid growth and tasty meat like wild snails. For this purpose, zootechnical tests of performances were carried out by subjecting a concentrated diet to young snails comprising nutritive elements deprived of their usual vegetarian's diets. The organoleptic qualities of the meats of snails subjected to the concentrated diet are very closer to the meat of wild snails so much on the level of tenderness, flavour, the juiciness.

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