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Preliminary Study of the Physico-Chemical and Nutritional Composition of the Flesh of Giant Snails in Kinshasa (DRC)

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Abstract

The objective of this study is to determine the physicochemical composition and mineral content of the flesh of giant snails. Forty-six mature snails from the Baramoto market were analyzed. Morphological analysis identified two species: *Achatina balteata* and *Achatina weynsi*. Regarding nutrient and mineral salt composition, the results show that protein content is slightly higher in the flesh of the first species (78.7 ± 0.5%) compared to the second species (77.5 ± 0.5%). The fat content is low in both cases, but slightly higher in the second species (6.76 ± 0.27%) than in the first (5.9 ± 0.3%). On the other hand, ash content is higher in *Achatina weynsi* (15.2 ± 0.4%) than in *Achatina balteata* (13.6 ± 0.4%). Calcium is more abundant in the flesh of *Achatina balteata* (123.14 ± 3.7 mg/100 g) than in *Achatina weynsi* (115.44 ± 3.8 mg/100 g). Iron, copper, zinc, manganese, and iodine are present in small amounts in the flesh of both species, unlike other minerals such as potassium and magnesium, which are present in more substantial quantities. Thus, these two species represent a protein and micronutrient-rich food resource for human consumption. The low fat content makes the flesh of these two species an excellent dietary food.

Keywords: Snails; *Achatina balteata*; *Achatina weynsi*; Nutrient content

Introduction

Malnutrition is a serious public health issue that generally affects underdeveloped countries [1]. Out of 843 million people suffering from malnutrition, 798 million live in poor countries. Protein-energy malnutrition ranks first among nutritional disorders.

Widespread food shortages have led to persistent hunger and malnutrition, particularly among low-income populations in developing countries [2].

In the Democratic Republic of Congo, malnutrition causes significant productivity losses and irreversible losses in human capital. This contributes to a reduction in economic productivity by an estimated 3 to 8% of the Gross Domestic Product (GDP), which amounts to $478 per capita per year [3].

According to the National Institute of Statistics [4], 43% of the population in the DRC struggles to access animal protein, which is often unaffordable for low-income households. Hence, there is a need to consider alternative, affordable food sources available in nature, such as African giant snails.

Indeed, the giant snail is highly valued for the taste and quality of its meat. These characteristics make it a preferred animal in sub-Saharan Africa, where 20 million people-including one-third of preschool-aged children-suffer from malnutrition [5].

Giant snail meat is an excellent source of animal protein [6], which is often lacking in the diets of tropical countries [7]. Its protein content is 74.6% [8]. Moreover, it is very rich in mineral salts (iron, phosphorus, calcium, magnesium, etc.) and essential amino acids such as lysine, leucine, and phenylalanine [9,10]. On the other hand, it is very low in fat (3.4% compared to 11.5% in beef and 12% in chicken) [11].

For snails in the DRC, data on the physicochemical composition of their meat are nearly non-existent, unlike in some West African countries such as Benin [12,13], Côte d'Ivoire [9,14], Nigeria [10], and Togo [15]. In many rural communities in the DRC, snails are an important source of high-quality animal protein. They are consumed in several Congolese tribes, notably by the Ngbandi, Ngbaka, and Ngombe (in the former Equateur province), the Lokele and Topoke (in the former Oriental province) [16,17], and the Batembo and Barega in the Kivu region (Baluku, pers. comm.).

The aim of this study is to examine the physicochemical composition and mineral content of the meat of *Achatina balteata* and *Achatina weynsi* snails, in order to determine their nutritional value.

Materials and Methods

The study was carried out in the laboratory of the Faculty of Science and Technology, Department of Life Sciences, at the University of Kinshasa, where the snail samples were identified. The physicochemical composition and mineral content of the snail flesh, including dry matter, were determined at the Laboratory for the Analysis of Medicines and Food Products (LACOMEDA) of the Faculty of Pharmaceutical Sciences at the same university.

The biological material consisted of 40 mature snails purchased in 2021 from the Baramoto market in Kinshasa (DRC).

Identification of the snails

The purchased snails were identified using the methods recommended by Daget [18], Rowson [19], and Oke [20]. The criteria were based on the morphology, appearance and ornamentation of the shell, the shape of the apex, the presence or absence of a shell edge, the color and texture of the flesh, and the presence of a V-shaped, serrated fold at the end of the foot sole.

Sample preparation

The flesh of each live snail was extracted from the shell using a fork. After removing the hepatopancreas with a scalpel, the flesh was cut into small pieces and dried in a MEMMERT oven at 105°C for 24 hours. The pieces were then pounded in a mortar before analysis. All analyses were performed in triplicate.

Determination of total lipid content: The total lipid content was determined using the Soxhlet extraction method [21] from 5 g of sample.

Determination of crude protein content: Crude protein content was measured using the Kjeldahl method [22] from 0.1 g of each sample.

Determination of total ash content: The total ash content was determined by incineration of 5 g of dried sample in a muffle furnace [23].

Determination of mineral elements: Each mineral element was measured from 0.1 g of sample using an Inductively Coupled Plasma (ICP) analyzer, Sirop vison spectro model [24].

Statistical analysis

Statistical tests and data analyses were carried out using R software version 3.4.3 [25].

The data on the physicochemical composition of the snail flesh were first subjected to the Shapiro-Wilk test [26] to verify normality [27].

The comparison of mean values for mineral and organic composition was conducted using the Student's t-test [28] with a confidence level of 5% ($p<0.05$). Letters a, b, c, d, and e were assigned in the presentation of results to indicate differences among the studied factors.

Results

Systematic inventory of the snails

A total of 40 giant snails belonging to the family Achatinidae and the genus *Achatina* were identified, which included two species: *Achatina balteata* and *Achatina weynsi*.

Chemical composition and mineral content of snail flesh

The protein, fat, ash, and mineral salt contents of the flesh of *Achatina balteata* and Achatina weynsi, expressed per 100 g of dry matter, are presented in Tables 1 and 2.

Component	*Achatina balteata*	*Achatina weynsi*
Proteins (%)	78.7 ± 0.5^a	77.9 ± 0.4^a
Lipids (%)	5.9 ± 0.3^b	6.6 ± 0.2^b
Note: Columns marked with the same letter are not statistically different according to the student's t-test (p<0.05).		

Table 1: Protein and fat content in the flesh of *Achatina balteata* and *Achatina weynsi* snails (N=3).

From Table 1, the protein content appears slightly higher in the flesh of *Achatina balteata* than in that of *Achatina weynsi*. The first species is richer in protein than the second. In fact, the Student's t-test shows a significant difference in the average protein content between the two snail species ($t=3.33$; $p=0.01$).

As for the fat content, it seems higher in *Achatina weynsi* than in *Achatina balteata*. The flesh of the former contains more fat than that of the latter. According to the Student's t-test, the average lipid content in the first species is significantly higher compared to the second species ($t=5.375$; $p \leq 0.001$).

According to Table 2, ash content is higher in the flesh of *Achatina weynsi* compared to *Achatina balteata*. The quantity of ash is significantly greater in the former species. The Student's t-test confirms a very highly significant difference between the mean ash content of the two species ($t=6.70$; $p \leq 0.001$).

Minerals	*Achatina balteata*	*Achatina weynsi*
Ash (g)	13.6 ± 0.4^a	15.0 ± 0.3^a
Calcium (mg)	124.9 ± 3.15^b	116.1 ± 3.22^b
Potassium (mg)	285.9 ± 0.11^c	265.7 ± 4.07^c
Magnesium (mg)	347 ± 1.52^d	322.5 ± 3.11^d
Iron (mg)	4.8 ± 0.17^e	4.5 ± 1.01^e
Copper (mg)	0.5 ± 0.01^e	0.5 ± 0.08^e

Zinc (mg)	3 ± 0.24[e]	2.8 ± 0.15[e]
Manganese (mg)	1.6 ± 0.08[e]	1.5 ± 0.09[e]
Iodine (mg)	8.3 ± 1.04[e]	7.7 ± 1.28[e]
Note: Columns marked with the same letter are not statistically different according to the student's t-test (p<0.05).		

Table 2: Ash and mineral content in the flesh of *Achatina balteata* and *Achatina weynsi* snails (N=3).

Regarding calcium, *Achatina balteata* contains more than *Achatina weynsi*. The flesh of the first species is richer in calcium. The Student's t-test shows a significant difference between the calcium levels of the two species (t=3.24; p=0.01).

Potassium content in *Achatina balteata* is relatively higher than in *Achatina weynsi*. The first species contains a significantly greater amount of potassium (t=9.88; $p \leq 0.001$).

Magnesium content is also higher in *Achatina balteata* than in *Achatina weynsi*. The difference is statistically significant, with *Achatina balteata* showing a greater average magnesium level (t=14.2; $p \leq 0.001$).

As for iron, its content is slightly higher in the flesh of *Achatina balteata*, but the Student's t-test shows no significant difference between the two species (t=1.2; p=0.2).

Copper levels are nearly identical in both species, with no significant difference (t=0.4; p=0.69). Similarly, manganese content is nearly the same in both, with no significant difference noted (t=0.8; p=0.44).

Zinc is slightly more abundant in *Achatina balteata*, but statistical analysis shows no significant difference (t=1.2; p=0.26). The same applies to iodine: Although levels seem higher in *Achatina balteata*, the difference is not statistically significant (t=1.24; p=0.24).

Discussion

The flesh of *Achatina balteata* and *Achatina weynsi* snails does not have the same protein content, although both exceed 40% [8,29,30]. In fact, the protein content is slightly higher in the flesh of the first species (78.7 ± 0.5%) compared to the second species (77.5 ± 0.5%). These values are significantly higher than those reported for *Achatina fulica* [9] and *Archachatina marginata* [31].

As for fat content, it is low and varies between the two species. It appears to be higher in *Achatina weynsi* (6.76 ± 0.27%) than in *Achatina balteata* (5.9 ± 0.3%). These fat levels are considerably higher than those recorded by Zongo [11], who reported 3.4% in giant snails, compared to 11.5% in beef and 12% in chicken. These variations in content can be explained by the fact that they are different species, living in distinct natural environments where snails find a variety of food sources that are rich in energy, proteins, minerals, and vitamins due to the diverse vegetation [31].

This study also shows that ash content differs between the flesh of the two snail species. Specifically, ash content is higher in *Achatina weynsi* (15.2 ± 0.4%) than in *Achatina balteata* (13.6 ± 0.4%). These values are significantly greater than those reported by Aboua [9] and Kouadio [14].

Regarding minerals, calcium is more abundant in the flesh of *Achatina balteata* (123.14 ± 3.7 mg/100 g) than in *Achatina weynsi* (115.44 ± 3.8 mg/100 g). However, the calcium levels in both species are much lower than those observed in *Achatina fulica* (790 mg/100 g) and *Archachatina marginata* (1180 mg/100 g) [12]. This confirms that the studied species differ from those cited by the mentioned author.

In general, iron, copper, zinc, manganese, and iodine are present in low and statistically similar quantities in the flesh of both species. In contrast, minerals such as potassium and magnesium are present in relatively significant and statistically different amounts between the two species.

Conclusion

The preliminary study of the chemical composition and mineral content of giant snails has shown that their flesh is rich in proteins and micronutrients, and low in fat. As such, it represents an important food resource in the fight against hunger and malnutrition, which are widespread in the Congolese population. The low fat content of giant snail flesh makes it an excellent dietary food.

Therefore, to better promote and utilize this animal resource, further investigations across the country would be worthwhile.

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