

Mineral content of three spontaneous plants and study of the frequency of consumption of three sauces made from these plants

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Abstract

The aim of this study was to determine the mineral content of three spontaneous plants from the western part of Côte d'Ivoire. This work was carried out on these three spontaneous plants *Beilschmiedia mannii* (Sran sauce), *Sesamum radiatum* (Guile sauce), *Byttneria catalpifolia* (Zanhan sauce), and on their consumption frequencies in two rural and urban areas in the Tonkpi region. The experiments focused on analyzing the mineral content of the edible organs of these plants and determining the frequency of consumption of the sauces from which they derive. The results showed that these plants were relatively rich in mineral salts of high nutritional value. *Beilschmiedia mannii*, Iron (49.19 mg/100 g), Potassium (311.98 mg/100 g), Zinc (1.46 mg/100 g), Phosphorus (82.15 mg/100 g), Calcium (209.02 mg/100 g). *Sesamum radiatum* Iron (70, 17mg/100g), Potassium (149 mg/100g), Zinc (2.08 mg), Phosphorus (29.63 mg/100 g), Calcium (391.81 mg/100 g). *Byttneria catalpifolia*. Iron (15.09 mg/100 g), Potassium (35.90 mg/100 g), Zinc (0.016 mg/100g), Phosphorus (44.43 mg/100 g), Calcium (0.057 mg/100 g).

For consumption frequency, a cohort of 250 households divided into two rural and urban areas were carried out. The results showed a significant difference between the two areas. It appears from this study that the frequency of consumption of the three sauces made from these spontaneous plants was higher in rural areas than in urban areas. The highest consumption in both areas is the 42% Zanhan sauce, then comes the 34% Sran sauce and finally the 24% Guilé sauce.

Keywords: Minerals; Spontaneous Plants; Consumption Frequency; Tonkpi Region

1. Introduction

In recent years, there has been a change and globalization of food habits. This is the consequence of the demographic and epidemiological transition which is accompanied by major changes in lifestyles. These reflect a food transition which is characterized by a change in diets with the emergence of chronic non-communicable diseases such as obesity, arterial hypertension, dyslipidemia, type I and II diabetes, cardiovascular diseases, strokes and certain cancers [1]. The nutritional transition refers to the transition from a monotonous diet, but rich in starch and fiber, low in fat and a physically active life, to a more diversified diet, but rich in sugars, saturated animal fats and processed foods, low in fruits, vegetables and fiber to a sedentary lifestyle [2]. This phenomenon affects both developed and developing countries, but is accelerating in the latter, it takes hold while these countries are still affected by problems of malnutrition due to general or specific deficiencies (in nutrients) and by therefore face the double burden with problems of under and overnutrition, communicable and non-communicable diseases [3].

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African countries are not immune to the nutritional transition, there is a rapid increase in chronic diseases. Between 2010 and 2030 projections show a 98% increase in diabetes in sub-Saharan Africa, from 12.1 to 23.9 million cases. Since 2005, 32% of deaths from diseases are attributable to CVD [4].

Côte d'Ivoire, a predominantly agricultural country, is unfortunately not spared from malnutrition. Malnutrition and micronutrient deficiencies (iron, calcium, potassium, etc.) remain a major problem and represent a heavy burden for public health, due to the high mortality rate and the staggering costs generated by health care. Being associated. In the west of the country, the SMART report [5] established a prevalence of 37% of protein-energy malnutrition (PEM) in children. In addition, at the clinical level, the work of Rohner [6] has shown that more than 70% of children under 5 suffer from anemia in Côte d'Ivoire. All of these issues are largely the result of nutritional transition. This situation is probably due to the abandonment of the traditional diet in favor of a westernization of food. Indeed, a large part of traditional sauces are made from leafy vegetables or spontaneous plants rich in nutrients beneficial to human health such as mineral salts, vitamins and antioxidants. The abandonment or transformation of typical traditional sauces made from spontaneous plants constitutes a probable loss of essential nutrients [1,7]. In the west of Côte d'Ivoire, more precisely in the Tonkpi region, the Yacouba people use three spontaneous plants to make sauces. These are *Beilschmiedia mannii* (Sran), *Sesamum radiatum* (Guile) *Byttneria catalpifolia* (Zanhan). There is too little research on the nutritional value of these plants to encourage people to consume these plants through traditional sauces.

The main objective of this study is the nutritional enhancement of these three spontaneous plants in order to increase the frequency of consumption of the sauces from which they derive. In other words it will be:

- Determine the mineral salt content of *Beilschmiedia mannii* (Sran), *Sesamum radiatum* (Guilé) *Byttneria catalpifolia* (Zanhan).
- Determine the frequency of consumption of sauces derived from these three plants (Sran, Guilé and Zanhan).

2. Material and methods

2.1. Material Study site

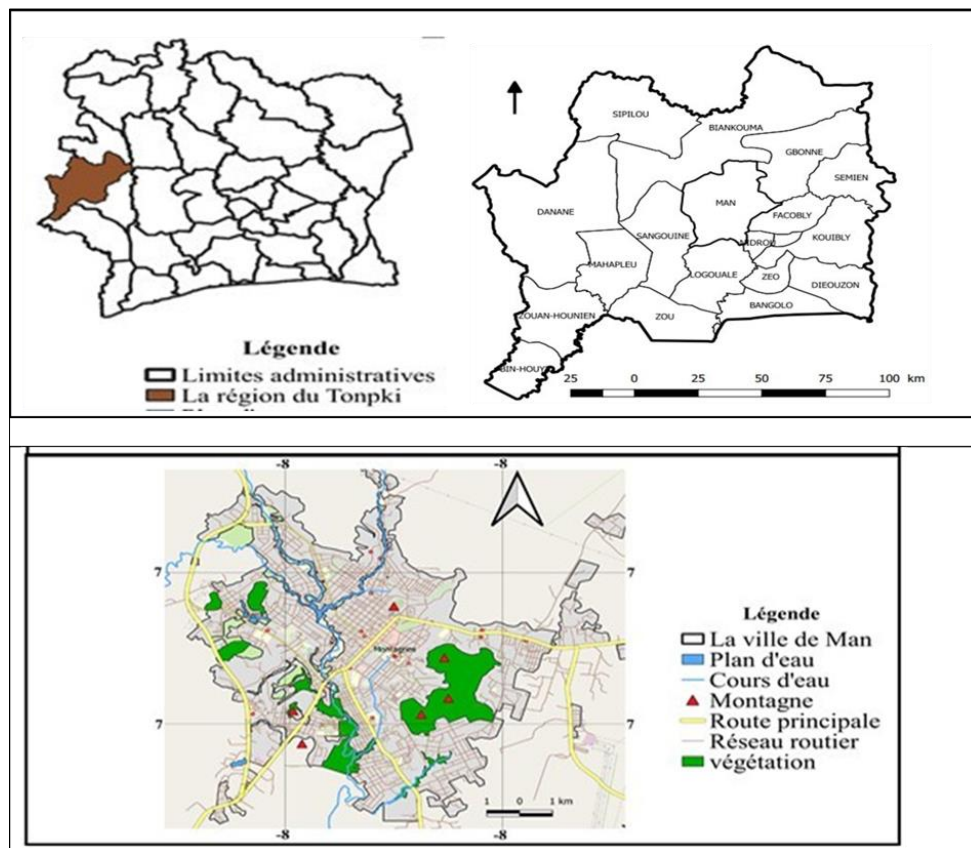


Figure 1 Map of the study area (Source: Google modified 2021)

This study was conducted in the Tonkpi Region, precisely in the Department of Man, in western Côte d'Ivoire. The Tonkpi region, located 600 km from Abidjan, inhabited by the Dan or Yacouba people. Man is the capital of the Tonkpi region and the capital of the Mountain District. The city of Man is called the “city of 18 Mountains” because of the many mountain ranges that surround it, so the city is inside 'a bowl. It is a city of 4140.7 km² with an estimated population of 188,704 inhabitants, according to the General Census of Population and Housing (GCPH) of 2014. It constitutes several neighborhoods and peripheral villages (Figure 1). Among these peripheral neighborhoods and villages, two neighborhoods of the city (Campus, Doyaguiné) and two peripheral villages (Kassiapleu, Guianlé) were selected for the surveys.

2.2. Plant material

The plant organs used in this study are: Dried seeds, fresh bark and dried leaves (Figure 2, 3, 4). The species chosen are sold in local markets in the Tonkpi Region located in western Côte d'Ivoire. Those are :

- *Beilschmiedia mannii*
- *Sesamum radiatum*
- *Byttneria catalpifolia*

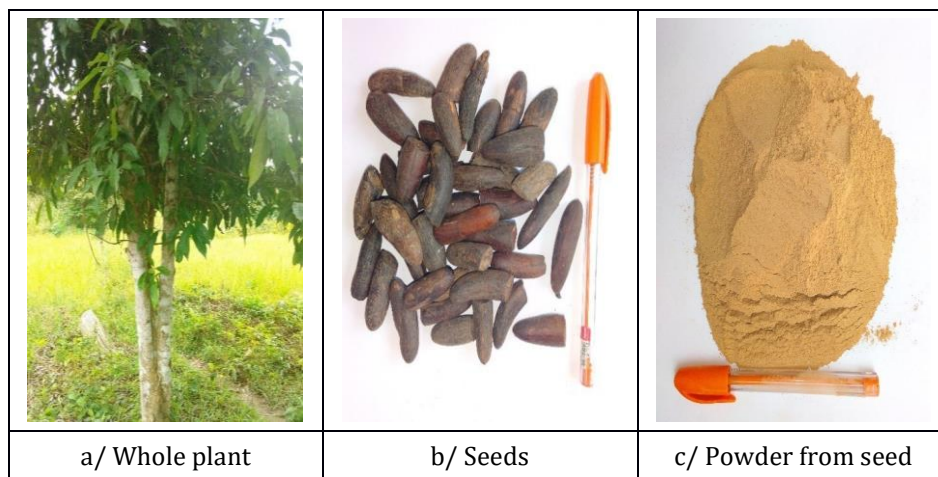


Figure 2 Photographie des différentes illustrations du sran (*Beilschmiedia mannii*)

- *Byttneria catalpifolia*

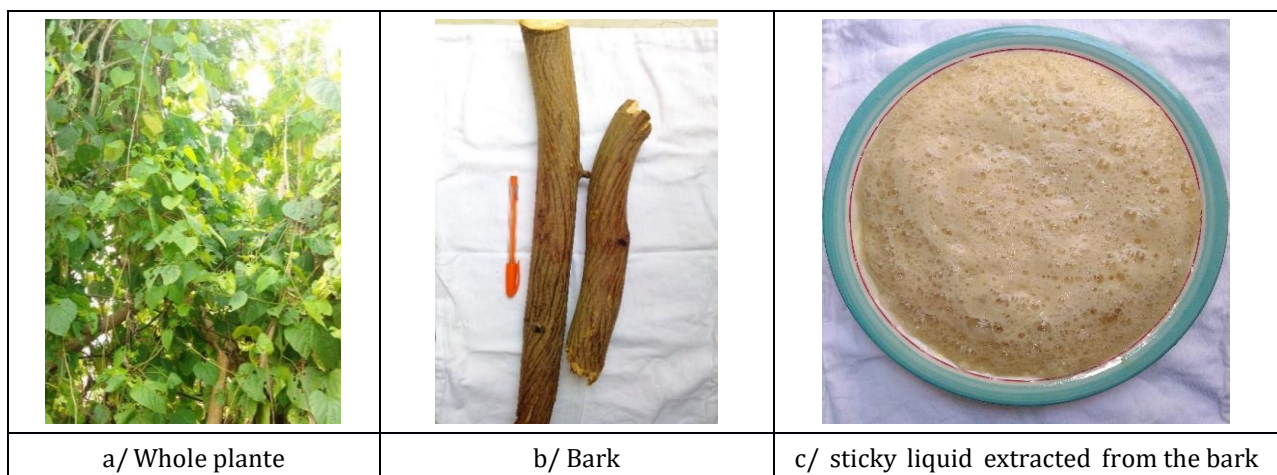


Figure 3 Illustrations of Zanhhan (*Byttneria catalpifolia*)

- *Sesamum radiatum*



Sauces: For this study, only the three sticky sauces made from plants were taken into account. It is:

Figure 4 Illustrations of Guilé (*Sesamum radiatum*)

- Zanhane sauce is a specialty of the Tonkpi region. It is a sauce made from a sticky liquid extracted from the bark. This sauce is generally eaten with cassava foutou, placali, and rice. It is highly appreciated and regularly consumed by the inhabitants of Tonkpi (Figure 4.a).
- The Sran sauce is also a specialty and is appreciated by the population. It is a sauce made from seeds cut into pieces, dried and reduced to powder, and is generally eaten with cassava foutou, placali, and rice. (Figure 4.b).
- The Guilé sauce, which is not a specialty of the population, is prepared from sun-dried leaves then made into powder, generally consumed with cassava foutou (Figure 4.c).

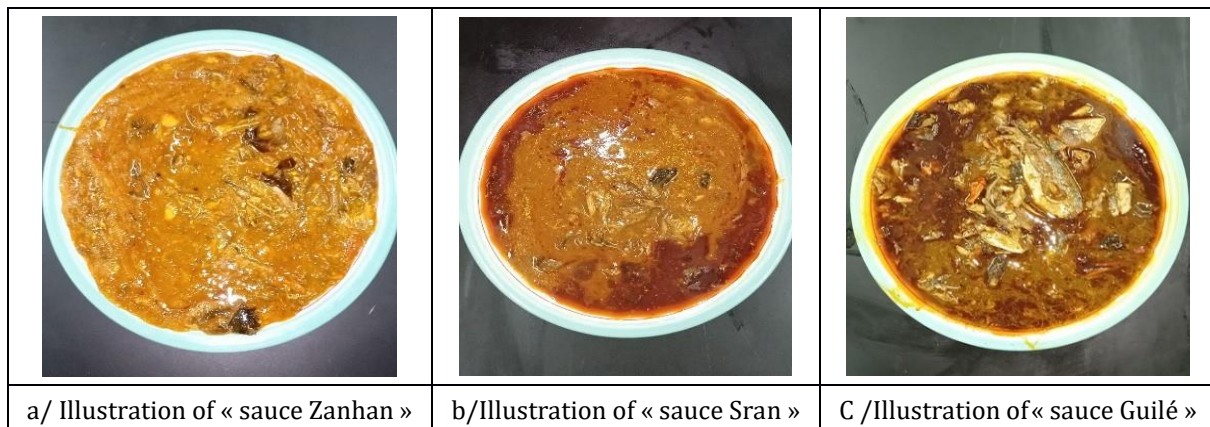


Figure 5 Illustration of sauces « Zanhane, Sran, Guilé »

2.3. Methodology

2.3.1. Conduct of the three sauces consumption frequency survey

This study is a cross-sectional survey. This type of survey was chosen because it was carried out on part of the population, for a period of two (2) months. The field work was characterized by a seed consumption survey of *Beilschmiedia mannii* called in the vernacular Sran, of *Sesamum radiatum* called in the vernacular Guilé and of *Byttneria catalpifolia* called in the vernacular Zanhane. The survey took place in urban areas of Manville (Campus district, Doyagouiné district) and in rural areas of two villages on the outskirts of Man (Guianlé, Kassiapleu) from January 10 to February 20, 2021. We interviewed 250 households proportionally distributed in each district of the city and the peripheral villages according to the number of households including 80 in Doyagouiné, 70 in the Campus, 50 in Guianlé and 50 in Kassiapleu. The investigation consists of meeting the investigator at his home. In each household, only one consumer was interviewed, designated by the person who usually takes care of the meals. The interviewee is submitted to the questionnaires which follow the chronology of the survey sheet and the answers are noted by the interviewer. The dialogue took place in the official language (French).

The main inclusion criteria are as follows:

- Reside in the neighborhoods and villages chosen at the time of the survey.
- Agree to answer the questionnaires

The non-inclusion criteria were as follows:

People residing in institutions, in a religious community or incarcerated (due to less freedom in the choice of food), as well as people who could not be interviewed because of a physical or mental disability. The number of people to be interviewed within each neighborhood and village was determined based on the population size of each neighborhood and village.

2.3.2. Determination of mineral content in the three spontaneous plants sampling

The sampling was carried out according to the different types of analyzes to be carried out on the product in the laboratory. The sample of the organs of *Beilschmiedia mannii* (seeds) and *Sesamum radiatum* (leaves) were taken in the form of powder sold on the market of the city of Man. After the samples were taken, the samples did not undergo any treatment and transparent sample bags were used for packaging. Samples are transported to the University of Man laboratory for mineral analysis and each sample has been stored at room temperature. The sample of the organ of *Byttneria catalpifolia* (barks) was taken in the form of fresh wood (vine) sold on the market of the city of Man. After sampling, the sample underwent treatment (Washing, Extraction of the sticky substance contained in the bark) and a 30ml pot was used for packaging. The sample was transported to the University of Man laboratory for mineral analysis and the sample was frozen at -18°C (Table 1).

Table 1 Sampling and sample storage mode

	The form taken from the market	Traitement	Packaging	Analyses	Storage
<i>Beilschmiedia mannii</i> (seed)	Powder	none	Transparent sample bags	Mineral	Ambient Temperature
<i>Sesamum radiatum</i> (leave)	Powder	none	Transparent sample bags	Mineral	Ambient Temperature
<i>Byttneria catalpifolia</i> (bark)	Bark	-Washing -Extraction of the sticky substance contained in the bark	30ml jars	Mineral	Freezing -18°C

2.3.3. Mineral dosage

The mineral salt content of each sample was determined by an X-ray fluorescence spectrometer, MESA-50 mode. The samples come in the form of powder and sticky liquid. During this assay, 2 grams (2g) of each sample was directly introduced into a sample holder covered by a plastic film a few microns thick, very transparent to X-rays. The sample to be analyzed is placed under a beam of X-rays. Under the effect of X-rays, the sample “enters into resonance” and itself re-emits X-rays specific to it, this is fluorescence. When we look at the energy spectrum of fluorescent X-rays, characteristic peaks of the elements present appear, we therefore know which elements we have, and the height of the peaks makes it possible to determine in what quantity (Jenkins, 1999).

2.4. Statistical analyzes or exploitation of results

Statistical analysis was performed using SPSS 16.0 Windows software. The processing of the data was done by an analysis of variance and the averages of the parameters (mineral content and frequency of consumption of the sauces).

3. Results

3.1. Mineral content of organs of plant species

Statistical analyzes showed significant difference in mineral content between the organs of the three species, *Byttneria catalpifolia*, *Beilschmiedia mannii*, *Sesamum radiatum* (Table II). The bark of *Byttneria catalpifolia* is characterized by a high content of phosphorus (44.43 mg/100 g), potassium (35.90 mg/100 g), iron (15.09 mg/100 g) and a very low zinc content (0.016 mg/100 g), calcium (0.057 mg/100 g).

The seeds of *Beilschmiedia mannii* have a high content of phosphorus (82.15 mg/100 g), potassium (311.98 mg/100g), calcium (209.02 mg/100 g), iron (49.19 mg/100g) and low zinc content (1.46 mg/100 g).

The leaves of *Sesamum radiatum* also have a high content of phosphorus (29.63 mg/100 g), potassium (149 mg/100 g), calcium (391.81 mg/100 g), iron (70.17 mg/100 g) and low zinc content (2.08 mg/100 g).

For the organs of the three species, the results showed that the seeds of *Beilschmiedia mannii* present a high phosphorus content (82.15 mg/100 g). In terms of potassium content, *Beilschmiedia mannii* largely dominates the other organs with a value of (311.98 mg/100 g). Thus for the calcium content the leaves of *Sesamum radiatum* dominate with a value of (391.81 mg/100 g). For the iron content the leaves of *Sesamum radiatum* also dominate with a value of (70.17 mg/100 g). But the organs of the three species reveal a very low zinc content. As well as calcium in the barks of *Byttneria catalpifolia* with a value of (0.057 mg/100 g).

Table 2 Mineral content of organs of plant species

		Phosphore (mg/100g)	Potassium (mg/100g)	Zinc (mg/100g)	Calcium (mg/100g)
Bark	<i>Byttneria catalpifolia</i>	44.43	35.90	0.016	0.057
Seed	<i>Beilschmiedia mannii</i>	82.15	311.98	1.46	209.02
Leave	<i>Sesamum radiatum</i>	29.63	149	2.08	391.81

3.2. Survey results

3.2.1. Frequency of sauce consumption

Overall consumption frequency of the three sauces

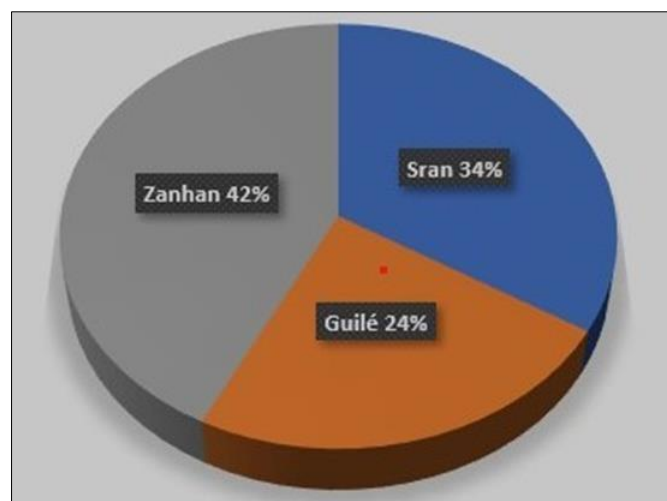


Figure 6 Overall consumption frequency of the three sauces in two rural areas and two urban areas in the Tonkpi region

Figure 6 presents the overall consumption frequency of the three sauces in two rural areas (Guianlé, Kassiapleu) and two urban areas (Dyagouiné, Campus) of the Tonkpi region. The results showed that the Zanhan sauce is the most consumed (42%), then comes the Sran sauce with a consumption frequency of 34% and finally the Guilé sauce whose consumption frequency is 24%.

Frequency of consumption of *Byttneria catalpifolia* (Zanhan)

The results obtained show a significant difference ($p > 0.05$) in the consumption of Zanhan sauce in rural and urban areas (Figure 7). Urban areas are thus characterized by a high consumption of Zanhan sauce, this frequency of consumption in rural areas is around 8% (Guianlé, Kassiapleu). The frequency of consumption of the sauce in urban area is less. It is about 7% (Campus, Doyagouiné).

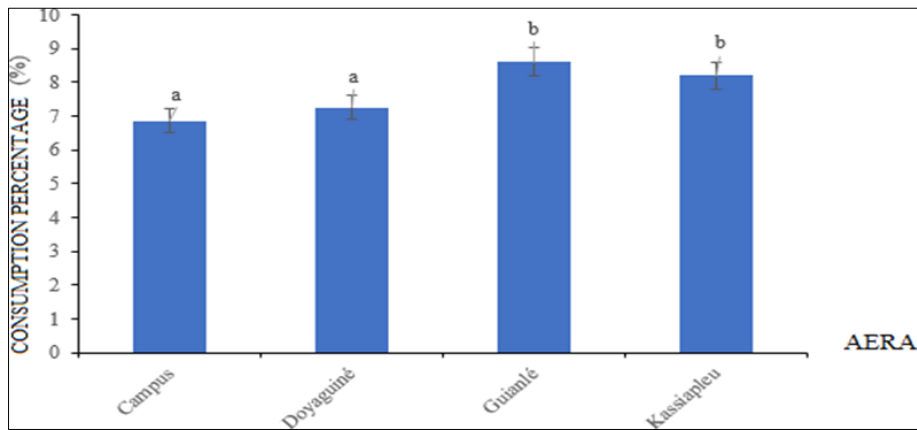
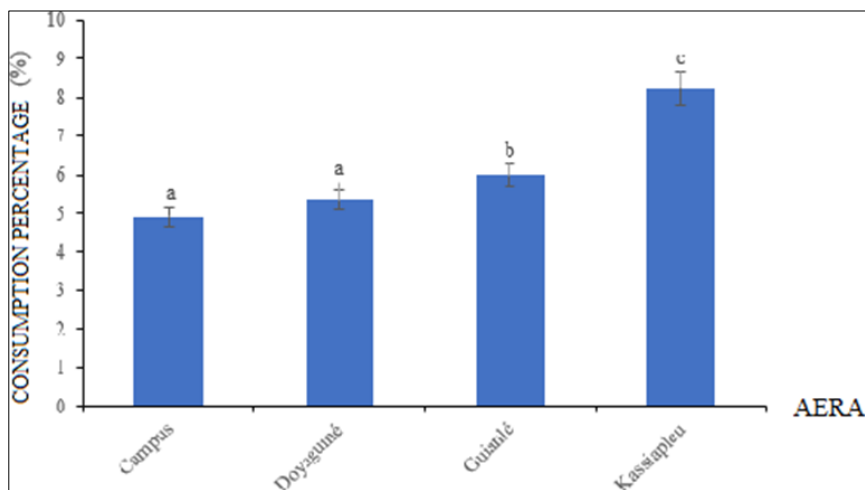


Figure 7 Frequency of consumption of Zanhan sauce in rural and urban areas

Frequency of consumption of *Beilschmiedia mannii* (Sran)

The frequency of consumption of Sran sauces differed significantly between urban and rural areas.



($p > 0.05$). The results showed that Sran sauce is less consumed in urban areas with a consumption frequency of about 5% on campus and in Doyagouiné. Thus the frequency consumed is higher in rural areas, 6% in Guianlé, 8% in Kassiapleu. (Figure 8)

Figure 8 Frequency of consumption of Sran sauce in rural and urban areas

Frequency of consumption of *Sesamum radiatum* (Guilé)

The results obtained from the frequency of consumption of Guilé sauce vary significantly between rural and urban areas ($p < 0.05$) in rural areas, the frequency of consumption of Guilé sauce is lower on Campus (3%) and in Doyagouiné (2%). On the other hand, the frequency of consumption of Guilé sauce is higher in rural areas with a consumption frequency of 6% in Guianlé and Kassiapleu (Figure 9).

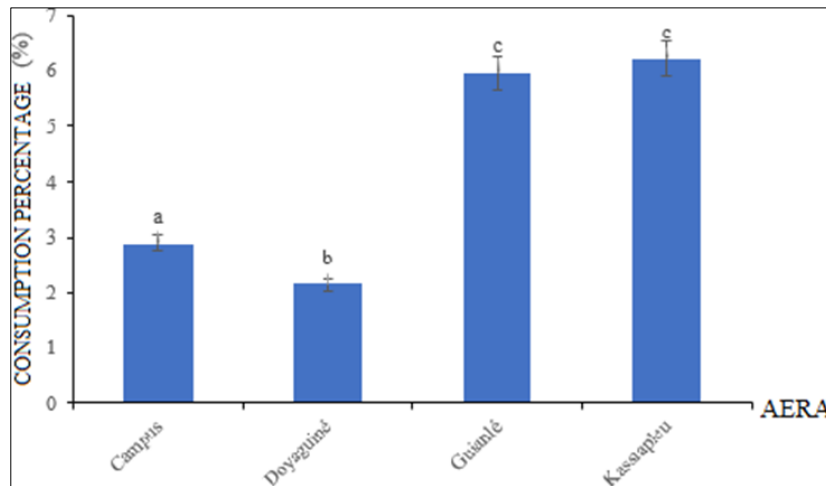


Figure 9 Frequency of consumption of Guilé sauce in rural and urban areas

4. Discussion

One of the specific objectives of this study was to determine the mineral content of three spontaneous plants *Beilschmiedia mannii* (Sran), *Sesamum radiatum* (Guilé), *Byttneria catalpifolia* (Zanhan). On this point, the results showed that these plants were relatively rich in mineral salts of great nutritional value.

The seeds of *Beilschmiedia mannii* contain a high content of phosphorus (82.15 mg/100g), potassium (311.98 mg/100 g), calcium (209.02 mg/100g), iron (49.19 mg/100g) and low zinc content (1.46 mg/100g). These results are different from those of Alexis *et al.* [8] which gives a relatively low potassium, iron content of the seeds of *Beilschmiedia mannii* potassium, (0.872% dm), iron (Fe (0.029% dm). Leung *et al.* (1968) [9] gives a calcium content of the seeds of *Beilschmiedia mannii* equal to Calcium: (0.258% dm), a value lower than that found in our calcium study (209.02 mg).

The leaves of *Sesamum radiatum* also have a high content of phosphorus (29.63 mg/100 g), potassium (149 mg/100g), calcium (391.81 mg/100g), iron (70.17 mg/100 g) and low zinc content (2.08 mg/100 g). These results are superior to previous work by Bedigian [10] Potassium (203 mg/100 g), Calcium (77 mg/100 g) and Iron (0.011 mg/100 g). Analysis of the bark of *Byttneria catalpifolia* is characterized by a high content of phosphorus (44.43 mg/100 g), potassium (35.90 mg/100 g), iron (15.09 mg/100g) and a very poor content of zinc (0.016 mg/100 g), calcium (0.057 mg/100 g). These values are different from those given by Juvencio [11] Iron (388.4mg/ 100g DM), zinc (15.4 mg/ 100 g DM).

This difference in results could be due to the method of analysis, but also to the origin of the seeds, leaves and bark, because seasonal variations influence the results of the physico-chemical composition of plant organs. It appears from the results obtained that the nutritional needs in mineral salts of the population can be met by the consumption of the organs of *Beilschmiedia mannii*, *Byttneria catalpifolia* and *Sesamum radiatum*. It is therefore important to make these species known.

In view of the above, we can say that these three plants are very good sources of minerals. However, the consumption of these plants is only done through sauces with a heterogeneous distribution of consumption as demonstrated by the second specific objective of this study. Thus, the frequencies of consumption of the three sauces overall differ from one sauce to another. Zanhan sauce is the most consumed in the two areas surveyed 42%, this rise in consumption could be due to the fact that this sauce has a high organoleptic quality and it is consumed practically with all local accompaniments.

A variation in the consumption of the three sauces was noted between different rural and urban areas. For the three sauces, the frequency of consumption is higher in rural areas than in urban areas. Similar results were obtained by Bthissam [12] who showed that there are significant differences between the diets of city dwellers and those of rural dwellers. In addition, Saliou [13] showed that the dual use (food and therapeutic) of *Moringa oleifera* is greater in rural areas ($p < 0.05$), i.e. 96.2% of households against 35.2% in urban areas. . This observation can be justified by the way of supply in rural and urban areas. The high consumption of wild plants in rural areas was strongly due to their physical availability.

In urban areas, purchasing is the main mode of supply, probably because of the scarcity and high cost of arable land. Most people in rural areas produce most of their raw materials themselves, the majority of them own land allowing them to do so, which is not the case in urban areas. In general, people living in the countryside have a traditional way of eating, based on fresh produce and dishes prepared and eaten at home. City dwellers see their way of eating changing and moving towards a westernized diet, with meals eaten more and more often outside and an increase in the consumption of industrialized products. These results also reflect and confirm the phenomenon of nutritional transition which is characterized by a neglect of traditional culinary dishes in urban areas [14].

5. Conclusion

In general, the mineral content analysis of the three spontaneous plants has shown that *Byttneria catalpifolia*, *Beilschmiedia mannii*, *Sesamum radiatum* have a high content of iron, phosphorus, potassium, calcium and a relatively high zinc content. In view of these results and taking into account the nutritional values of the organs of the plants analyzed, it is important to consume them for nutritional reasons. This could be useful for the proper functioning of the body. The consumption frequencies of the three sauces Zanhane, Sran and Guilé made from these spontaneous plants are higher in rural areas than in urban areas. The results of this survey made it possible to know the most consumed sauce in the two areas in the Tonkpi region. Overall, the most consumed sauce in the two areas surveyed is Zanhane sauce. But the results also showed that these sauces have a very high frequency of consumption in rural areas than in urban areas. It is of interest to consume them for nutritional reasons and also to reduce any deficiencies in mineral salts in the body. All this makes it possible to say that, today, in rural areas, these plants consumed are of great interest for the food security of the populations (almost daily consumption of these products). Data on the nutritional value of many of these plants are still lacking. They must be the subject of nutritional research in order to know their food values. Knowledge of the nutritional values of these products will contribute to a better awareness of the essential role that spontaneous food plants can play in order to be able to contribute to improving the well-being of local populations in terms of food.

Perspectives

In perspective, it would be possible to:

- Determine the macronutrients: (proteins, carbohydrates and lipids).
- Determine other micronutrients: (vitamins, antioxidants).
- Determine the impact of the time/temperature couple on the nutritional value of the three plants.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest.

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