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Challenges in Consumption of *Nymphaea lotus* Tubers during the Lean Season: Case of Ambato-Boeni District

RAZAFITSALAMA Victorien[1], RANDRIAMIALY Jean Dominique[2]
[1.] École Doctorale du Génie du Vivant et Modélisation
[2.] Faculté des Sciences, de Technologies et de l'Environnement- Université de Mahajanga

Abstract:- The shortage of rice stocks during the lean season pushes farmers to resort to the search for nutritional alternatives and substitutes. Also the objective of this work is to contribute to the fight against malnutrition and food insecurity, by promoting the natural plant genetic resources available in Madagascar. To do this, a preliminary investigation was carried out in the Ambato-Boeni District. It appears that the *Nymphaea lotus* tuber is frequently used in the preparation of different dishes such as *N.lotus* paste, ball and sauce. Biochemical analyzes and phytochemical screening were carried out. The results indicate that *Nymphaea lotus* tubers are rich in carbohydrates (88.59 ± 0.02% of dry matter) but the protein and lipid contents are relatively low, respectively 8.59 ± 0.04. % and 0.46 ± 0.03%. Among the different mineral elements analyzed, potassium holds first place and abounds up to 566.37 ± 0.04 mg per hundred grams of ash. Photochemical screening reveals that the *Nymphaea lotus* tuber contains different secondary metabolites including polysaccharides, flavonoids, tannins and finally polyphenols. The presence of these latter anti-nutritional and toxic factors leads to a reduction in edibility and/or digestibility of Nymphaea lotus starch without prior treatments such as soaking in water and cooking.

***Keywords*:-** *Nymphaea Lotus, Nutrition, Lean Period, Antinutritional Factors, Phytochemical Screening.*

I. INTRODUCTION

Madagascar is one of the countries most affected by the problem of malnutrition. The level of food insecurity, defined in relation to the percentage of the population not having enough to eat permanently or temporarily, is estimated at the national level at more than 50%, according to the national household survey in 2012 (INSTA, 2012).

Madagascar is classified among the countries with the highest rice consumption, the average consumption of rice per capita is around 142.5 kgs per year, approximately 10.8 kgs per month or 360 grams per day (REMESY. C et al 1992). Currently the problem is that rice production is decreasing from season to season and is becoming insufficient. It no longer covers the needs of the population. So every year Madagascar must import rice (INSTA, 2012). Around 12% of the populations (1.9 million people) are chronically food insecure, and almost half of the population faces seasonal food insecurity during the lean season (BNGRC, MTGRC, 2015). Given recent shocks, mainly poor rice harvests and rising food prices, households have switched to less expensive foods and reduced their rations as a coping mechanism (http://www. report/madagascar/contingency-plan-for-the-great-south-food-and-nutritional-insecurity).

As a result, during the lean season, many households supplement the basic food with substitute products to satisfy their nutritional needs, such as cassava, taro, potatoes and wild tubers which become a source of energy. Importance of rural families (AGBESSI H et al., 1987). Among wild tubers, *Nymphaea lotus* tubers hold an important place in the diet of certain farmers, as in the case of Ambato-Boeni District. The hypotheses to be verified in this study are the existence of important nutritional elements for the diet and the possible presence of antinutritional factors. Also with this in mind we have chosen the theme which is entitled: "CHALLENGES IN CONSUMPTION OF *Nymphaea lotus* TUBERS DURING THE LEAN SEASON : CASE OF AMBATO-BOENI DISTRICT"

The main objective of this study is to promote unconventional natural food resources such as *Nymphaea lotus.* The specific objectives resulting from this are the determination of macromolecules and micronutrients in the Nymphaea lotus tuber to highlight its nutritional value, qualitative analyzes of the different types of secondary metabolites, and the identification of antinutritional factors.

- *Study Site*

This research was carried out in the Ambato-boeni District of the Boeny region, more precisely in the following communes: Anjiajia, Andranofasika, Ankijabe, Ambato Ambarimay in the North-West part of Madagascar. The choice of this region was dictated by the strong geographical distribution of this plant and the consumption of this product by local residents. The collection of tuber samples was carried out at Tanambao in Vacille Lake, Ambato-Boeni District in a simple random manner. The characteristics studied are the biochemical parameters and phytochemical screening of the tubers. This is an analytical study.

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II. MATERIALS AND METHODS

A. Biochemical Analyzes of the Nymphaea lotus Tuber

For each analysis we opted for four repetitions. Proteins are nitrogenous nutrients, their raw content is determined from the nitrogen of ammonia, dosed according to the Kjedahl method.The sample is heat treated with hydrochloric acid. The mixture is then filtered. After being washed and dried, the residue is extracted with hexane (crude fats). The solvent is distilled and the residue is dried and weighed. The carbohydrate content is obtained by the difference between the crude ash, lipid, crude protein content and the water content of the sample. The determination of the different mineral elements is done by the atomic absorption spectrophotometer method from the ash obtained and finally the energy value according to Atwater. The search for secondary metabolites in samples consists of screening and testing for the presence of different chemical compounds, namely alkaloids, tannins, polyphenols, triterpenes, cyanogenic glycosides, saponosides, polysaccharides, flavonoids and leucoanthocyanins. by the method of FONG H. H. S et al., 1974.

III. RÉSULTS

A. Biochemical Composition of Nymphaea lotus Tuber

➢ *Water and Dry Matter Content*

The water content as well as that of the dry matter of *Nymphaea lotus* tuber is presented in table 04 below.

The *Nymphaea lotus* tuber has high water content: 46.24% water and the dry matter content is 53.75%.

Table 1: Water and Dry Matter Content of *N.lotus* Tuber

Constituents	Content in %
Eau Water	46,24 ± 0,00
Dry matter	53,75 ± 0,00

B. Macronutrient Content And Energy Value

The contents respectively of proteins, lipids, carbohydrates and tuber ash of *Nymphaea lotus* are: 8.59 ± 0.04%, 0.46 ± 0.03%, 88.59 ± 0.02% and 2.38 ± 0.03% DM and the energy value according to Atwater is 384.5 kcal.(Figure 1)

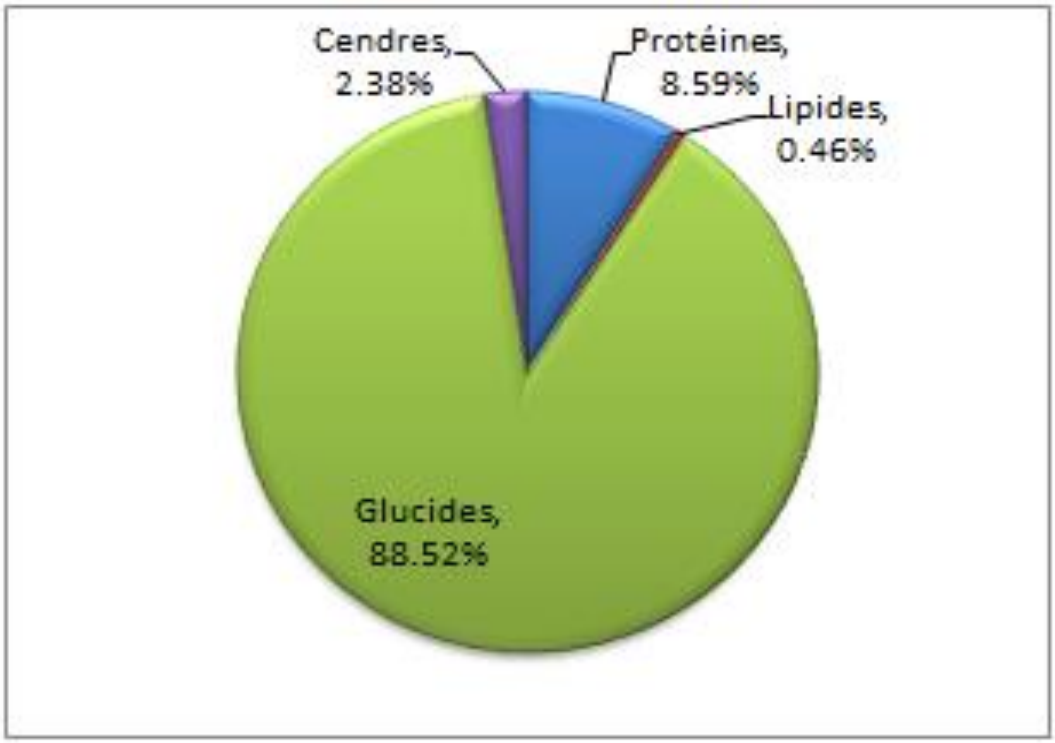

Fig 1 : Macronutrient Content of Nymphaea lotus Tuber in (%)

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C. Mineral Element Content

The element contents of *the N.lotus* tuber flour analyzed are shown in Table 2 below.

Table 2: Element Contents of Nymphaea lotus Tuber Flour Analyzed

Mineral elements	Units	Contents
Calcium	mg/100g	79,21 ± 0,05
Magnésium		96,77 ± 0,02
Fer		2,82 ± 0,04
Sodium		14,56 ± 0,01
Potassium		566,37 ± 0,04
Phosphore		261,56 ± 0,01

According to Table 2, the *N.lotus* tuber is an important source of potassium and phosphorus (566.37 ± 0.04 mg and 261.56 ± 0.01 mg of DM), It also contains significant quantities magnesium and calcium (96.77 ± 0.02 mg and 79.21 ± 0.05 mg per 100 g of DM). The iron and sodium contents are low (2.82 ± 0.02 mg and 14.56 ± 0.04 mg of DM).

D. Results of Phytochemical Screening

The phytochemical screening results carried out are summarized in Table 3 below

Table 3: Summary Table of Phytochemical Screenings Carried Out

Chemical Families	Results
Alcaloïdes	-
Flavonoïdes	+++
Leucoanthocyanes	-
Triterpènes	-
Hétérosides cyanogénetiques	-
Polysaccharides	+++
Saponosides	-
Tanins	++
Polyphenols	+

The signs (+) and (-) indicate the presence or absence of chemical compounds in the sample. The signs (++) and (+++) designate the abundance of these compounds:

(+) at trace level; (++) abundant; (+++) very abundant.

The phytochemical screening shows the absence of alkaloids, leucoanthocyanins, triterpenes, cyanogenic glycosides and saponosides. On the other hand, flavonoids and polysaccharides abound in the samples followed by tannins and polyphenols.

IV. DISCUSSION

Nymphaea lotus tuber has a high water content of 46%, so it does not keep for long due to the risk of mold development. It is a fragile food because the humidity level is very high (CHEFTEL et al 1977).

According to the results of biochemical analyses, the tuber of *Nymphaea lotus* is rich in carbohydrates (88.59 ± 0.02% DM). But it is low in terms of lipid and protein content (0.46 ± 0.03% and 8.59 ± 0.04% DM). The nutrient composition of the tuber studied is not balanced. Their exclusive consumption could then be the cause of

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malnutrition. Also the consumption of this tuber must then be accompanied by other foods rich in protein (MONDY et al 1977). After calculation, it turns out that this food has a high energy value (392.62 kcal) compared to cooked rice and raw cassava (129 kcal and 120kcal ("http://www.fao.org/docrep/t0207f /t0207f07.htm"). For our case, the carbohydrate and protein contents of the tuber studied (88.52% and 8.59% based on DM) are higher than those obtained by FRANÇOIS Malaisse (1938), (85% carbohydrate). and proteins 5.4% based on DM), but that of lipids (0.46 ± 0.03% of DM) is lower than that reported by the same author (lipid 2.8% of DM The foods studied). not being cultivated, these differences may be due to maturity or varieties of tuber as well as their pedoclimatic origins.

As for the mineral element contents of the *Nymphaea lotus* tuber, it results that potassium and phosphorus (566.37 ± 0.04 mg and 261.56 ± 0.01 mg per 100 g of DM) are the main substances there. encountered. However, we also note a significant quantity of magnesium and calcium (96.77 ± 0.02 mg and 79.21 ± 0.05 mg per 100 g of DM). These results show that in the elements contained in the tuber of Nymphaea lotus, their content in descending order is as follows: K > P > Mg > Ca > Na > Fe. This order gives an idea of the importance of the mineral elements in this tuber. These values found are far high compared to those of cooked rice with potassium contents of, those of phosphorus, magnesium and calcium respectively of 29.9 mg, 38 mg, 11.4 mg of DM and: 8, 17 mg dem dry. (http://pro.anses.fr/tableciqual/ (Consulted on 04.05.2016). Furthermore, the results of this study revealed that the potassium, magnesium and calcium contents of the tubers studied are very close compared to those taro and potato (approximately 514 mg of DM (RAYMONJDA CQUOT).

Concerning the secondary metabolites of Nymphaea lotus tuber, according to the phytochemical screening, we note the absence of alkaloids, leucoanthocyanins, triterpenes, cyanogenic glycosides and saponosides. However, it contains flavonoids, polyphenols, tannins, and polysaccharides.

In the presence of polyphenol oxidase, phenolic compounds are oxidized to quinones which condense to form colored compounds. This is enzymatic browning. This phenomenon could be the cause of the intense browning of *N.lotus* tubers when peeling them. Tannins are compounds responsible for the quality and organoleptic characteristics of foods: color, flavor, astringency and bitterness MOLE. S et al. (1987). Generally speaking, different methods exist to reduce and eliminate antinutritional factors in tubers. In particular biological and thermal processes to name only soaking and cooking (PURCHAS R.W. et al.,2003). However, in the majority of cases it has been observed that certain processes such as soaking lead to a significant variation in the mineral element content of the product (DUHAN A et al., 1989)

V. CONCLUSION

One of the main objectives of this work is to analyze the biochemical formation and traditional use of the *Nymphaea lotus* tuber in a human ration during the lean period to prevent malnutrition and food insecurity. Our results confirm that the N.lotus tuber is a good source of energy (392.62 kcal/100g of DM) and that with minimal processing these resources can easily be used in human nutrition. *Nymphaea lotus* tuber is rich in carbohydrates (88.52 ± 0.02% of DM) but poor in proteins (8.59 ± 0.04% of DM) and lipids (0.46 ± 0.03% of DM).). Combining this tuber with other protein-rich foods such as meat and milk in a meal can correct their deficit. These tubers have appreciable contents of potassium (566.37 ± 0.04 mg of DM) and phosphorus as well as significant contents of calcium and magnesium so it is an important source of minerals.

However, the presence of anti-nutritional factors such as tannins and polyphenols in tubers can reduce their nutritional value. Thus, in order to benefit from the optimal nutritional effects of tubers, it is necessary to partially eliminate these anti-nutritional factors through simple processes such as soaking before cooking. These processes improve the digestibility of tubers and the bioavailability of nutrients.These results confirm the idea that tubers are food resources that deserve to be valued in Madagascar in order to reduce the problem of malnutrition.

With a view to optimizing the research and analyzes undertaken in this work, we put forward some suggestions. First of all, it is appropriate to reconsider the dosage of vitamins in the product. Then, reliable tests must be done to confirm or refute the presence of oxalate and phytate in the product. In terms of processing, we can notably consider transforming the product into flour as well as significantly improving traditional techniques to develop the manufacturing technology of various dishes based on this product. And as it is a product that deserves to be popularized, it is recommended to continue the investigation into the consumption of this tuber in other regions.

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