

Mineral Elements in "Morinda Citrifolia" from Antsiranana I District, Madagascar

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Abstract— A large number of plants and fruits have been used for this purpose and have become preventive treatments or remedies against cancer, diabetes and various diseases when they exceed the capabilities of modern medicine, among these plants is "Noni". Nowadays, "Noni" is present everywhere: in medicines, in food supplements and even in cosmetic products such as shampoos. The goal of this study is to identify the mineral makeup of "Noni" that is consumed by the Malagasy people, notably in the northern region of the vast island. The analysis was carried out at the Laboratory of Nuclear and Environmental Physics (LPNPE) of the University of Antananarivo (Madagascar) using energy-dispersive X-ray fluorescence spectrometry (ED-XRF) as well as atomic absorption spectrometry (AAS) of the National Center for Research on the Environment (CNRE). These techniques made it possible to detect in the samples of "Noni" mineral elements such as potassium (K), calcium (Ca), chromium (Cr), manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), selenium (Se), bromine (Br), rubidium (Rb), strontium (Sr) and lead (Pb). The presence of these trace elements is essential, but their excess in the body can also lead to diseases. The "Noni" is particularly rich in minerals, and the leaves contain the highest concentration. This richness in elements in the plant could explain its therapeutic and medicinal virtues, although it does not fully account for its exceptional healing power.

Keywords— Noni, Mineral elements, Heavy metals, X fluorescence, Atomic absorption.

I. INTRODUCTION

In recent years, medicine using therapeutic plants has expanded considerably. Many plants and fruits have been used for this purpose and have become preventive treatments or remedies against cancer, diabetes and various diseases when they exceed the capabilities of modern medicine, among these plants is "Noni". Today, "Noni" is omnipresent: in medicines, in food supplements and even in cosmetic products such as shampoos. *Morinda Citrifolia* is a fruit with remarkable healing properties. It is a tropical tree, native to India and growing mainly in the Pacific islands.

Cultivated for more than 2500 years by the Polynesians, this plant is recognized for its medicinal virtues. However, this plant remains little studied by the scientific community. One can question its true virtues but also the potential risks associated with the consumption of the fruit of "Noni" or its derivatives. Many researches have already identified the active ingredients of "Noni", thanks to which we could discover the diseases that this plant can treat, but these properties of "Noni" can also be related to its mineralogical composition.

II. METHODOLOGY

A. Scope of the study

We examined various parts of the plant: the fruits, the leaves and the roots coming from the same tree, cultivated in ANTSIRANANA I. The analysis was carried out at the Laboratory of Nuclear Physics and Environmental Physics (LPNPE) of the University of Antananarivo (Madagascar) by

using energy-dispersive X-ray fluorescence spectrometry (ED-XRF) as well as atomic absorption spectrometry (AAS) from the National Center for Environmental Research (CNRE).

B. Presentation of the plant

The "Noni" (*Morinda Citrifolia*) is a plant native to Southeast Asia. It grows almost everywhere today. Used successfully for more than 2,000 years in Polynesia, China, India and elsewhere, the "Noni" was introduced by the inhabitants in the islands of the South Pacific, notably in Tahiti, in Hawaii, in Malaysia, and particularly thrives in unpolluted volcanic soils. Like Aloe Vera, kelp, papaya and other plants, "Noni" fruit extract has been proven to improve a wide range of health problems. For consumption, in America, fruit is mainly prepared as a food supplement in the form of juice. Although the fruit has a very bitter taste and an unpleasant smell, "Noni" juice is very pleasant to taste and smell thanks to the addition of natural grape and blueberry juices, a special blend developed by two eminent food chemists, Stephen Story and John Wadsworth [8]. The cultivation of "Noni" in Madagascar has been popularized since 2006 by the Tamatave Horticultural Technical Center, known as CTHT, as part of the "Banana" program, whose overall objective is the "Development of horticultural productions in the region of Tamatave (CTHT).

The CTHT provided training support on the cultivation of the following products: citrus, spices, various fruit trees, ornamental plants and oilseed plants. The 'Noni' culture is rapidly expanding. The areas concerned by this culture include the districts of Ambatondrazaka, Brickaville, Tamatave II,

Fénériver-Est and Vavatenina. The location of intervention plots is presented. It should be noted that this plant grows almost everywhere on the island (Analamanga Region, Menabe, Boeny). Recent data on the number of "Noni" plants grown in the Antsinanana region indicate that there are about 17,000 plants, two thirds of which are still growing, while one third is currently in production. When all these plants come into full production, with an average of 5 kg of "Noni" fruit per month and foot, the annual production of the region will exceed 1,000 tons of "Noni" fruit.

This represents a form of contract farming between two parties: the CHTT and the farmers, where the CHTT provides the plant material as well as technical training, while also guaranteeing the outlets via the CTCF. The latter is responsible for processing the fruits of 'Noni' into fermented juice [5]. The biological characteristics of Noni:

- Classification: phylogenetic
- Reign: Plantae
- Division: Magnoliophyta
- Class: Magnoliophyta
- Order: Rubiales
- Family: Rubiaceae
- Gender: Morinda
- Scientific name: Morinda Citrifolia
- Vernacular name: Noni

There are different varieties of "Noni", but the one we examined is part of the most common variety: the Morindacitrifolia var. citrifolia. It is a shrub measuring between 3 and 6 meters in height and having a lifespan of forty to fifty years. It retains its green foliage and blooms throughout the year (fig 1)



Fig. 1: Fruits mûrs de «Noni»



Fig. 2: Tree of «Noni »

C. Preparation of samples

We examined samples of leaves, roots and fruits from 'Noni'. These samples were taken from a same tree about five

(05) years old, native to the Menabe region (Morondava) but cultivated in Diégo Suarez. Before proceeding with the analysis of the samples, certain preparations were required. First of all, we weighed each type of sample (fruit, leaves and roots) to be able to later determine their water content.

D. Sample preparation for energy dispersive X-ray fluorescence (ED-XRF) analysis

In this analysis, we used a mass of 100g powder for each sample. The sample undergoes three (03) stages of preparation: first grinding, where the samples are ground using a silicified wood pestle. Then, sieving, which involves passing them through a 80µm sieve. The sieves are ready for the preparation of tablets. Finally, the pelletizing, which is a process allowing to transform the powder into cylindrical tablet by compression under a load of 22 tons.

E. Sample preparation for atomic absorption analysis

Before being analyzed, the sample must still undergo a series of preparations for mineralization. In order to proceed with the verification, we prepared three solutions for all the samples and repeated the measurements three times for each sample (fruits, leaves, root). To do this, we followed the following operating procedure. First of all, we weighed 5g of product in a platinum capsule previously calibrated with M1 mass. Then, we placed the capsule in an oven at 525° C until obtaining a white ash. After a night in the oven, we removed the capsule and put it in a desiccator to remove moisture.

We then weighed the capsule with its contents again. Subsequently, we added 50 ml of hydrochloric acid solution and brought this solution to a boil on the hot plate. After heating, we filtered the obtained solution. Finally, we took a volume of the solution and proceeded with dilution to obtain a final volume of 100ml to be analyzed. It should be noted that the solution needs to be diluted a further 10 times if a buffer is added, or 50 times if no buffer is added. If the concentration of the analyzed element exceeds the upper limit of the calibration range, a cascade dilution shall be performed. The volume of the added buffer must always represent one tenth of the dilution volume.

III. RESULTS

A. Analysis results by atomic absorption spectrometry.

The percentages of Sodium (Na), Potassium (K) and Calcium (Ca) present in the various parts of "Noni" are indicated in table 1.

TABLE 1: Fluctuation in concentration (n=5) of the "Noni" minerals examined.

Elements	Fruit	Leaves	Root
Sodium (Na)	0,12 %	0,36 %	0,21 %
Calcium (Ca)	1,46 %	2,87 %	2,15 %
Potassium (K)	1,7 %	0,96 %	1,0 %

B. X-Ray fluorescence results

For this analysis, the results (table 2) are directly provided by software installed on the computer.

TABLE 2: Variation in the concentration (n=5) of mineral elements from the analyzed Noni.

Elements	Fruit	Leaves	Root
Sodium	0,11 ± 0,02 %	0,41 ± 0,05 %	0,29 ± 0,03 %
Magnésium	0,25 ± 0,03 %	0,20 ± 0,02 %	0,27 ± 0,03 %
Phosphorus	0,2 ± 0,02 %	0,17 ± 0,02 %	0,08 ± 0,01 %
Potassium	1,94 ± 0,2 %	0,90 ± 0,1 %	0,93 ± 0,1 %
Calcium	1,35 ± 0,13 %	2,92 ± 0,3 %	2,15 ± 0,22 %
Manganese	38 ± 3,8 ‰	115 ± 11,5 ‰	37 ± 3,7 ‰
Iron	0,5 ± 0,1 %	0,8 ± 5 0,1 %	0,7 ± 0,1 %
Copper	8 ± 0,8 ‰	5 ± 0,5 ‰	5 ± 0,5 ‰
Zinc	17 ± 1,7 ‰	18 ± 1,8 ‰	24 ± 2,4 ‰
Arsenic	< LD	< LD	< LD
Cadmium	< LD	< LD	< LD
Lead	< LD	1,4 ‰	1,1 ‰

< LD: lower than the detection limit

This table presents the content of mineral elements (macro- and trace elements, as well as heavy metals) in three parts of a plant: fruit, leaf, and root. Here is a general interpretation of the data:

For the macro-elements: Fruits containing a high content of potassium and phosphorus. The leaves are rich in sodium and calcium. Magnesium is relatively stable. The leaf appears as a main site of mineral accumulation, probably due to its role in metabolic exchanges.

Trace elements: Manganese and Iron are highly concentrated in the leaves, which highlights their active role in photosynthesis. Zinc is more present in the roots, which indicates a role in soil absorption.

For heavy metals: No major problem of apparent toxicity. Lead present in small quantities outside the fruits, requiring monitoring according to local regulations if intended for consumption.

According to these results, 30% of the elements are in the fruit of «Noni», 39% in the leaves and 30% in the root. From this table, we can conclude that the leaves are the richest in mineral elements.

C. Contribution of the 'Noni' plant

'Noni' is currently recognised and consumed mainly in the form of juice. Although the leaves are the richest in minerals, it is the fruit that is most consumed by humans. In this section, we will examine the fruits to evaluate the contributions of "Noni" to consumption. We illustrate in figure 3, the proportion of each element present in the fruits of "Noni", in order to classify them into dominant elements and trace elements.

IV. DISCUSSIONS

According to our observations, the leaf of «Noni» appears as the most suitable for industrial use, because it constitutes the part richest in elements of the plant. However, after drying, the quantity of leaves is not large enough, which could pose a barrier to the industrialization of the product. That's why we recommend using fruits for any industrialization project.

Our research has highlighted the richness of "Noni" in minerals essential for humans. However, this research also led us to compare "Noni" with other fruits, which revealed to us that for certain nutrients there are other fruits or foods that are

richer than "Noni". For example, the concentration of phosphorus in soybeans is 0.58 % [9] and that of cow's milk is 1% [1], while the fruit of 'Noni' contains only 0.2%. Moreover, the potassium content of bananas varies between 1.2 and 3.0% [10], whereas that of the fruit of 'Noni' is only 1.94%. This remains significantly higher than that of the pineapple flesh and many vegetables, such as cauliflower and beans, which display a content of 0.3% [2].

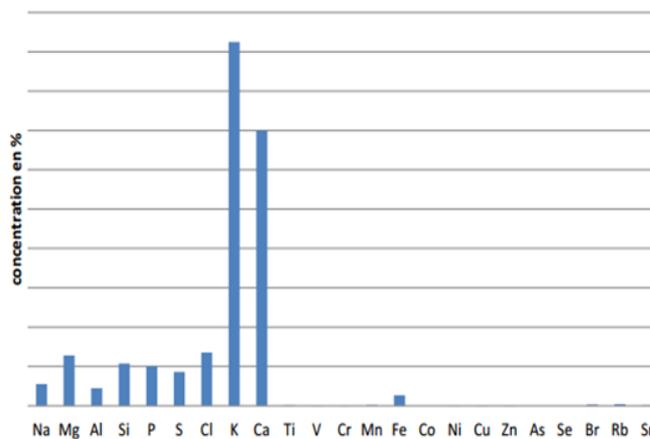


Fig. 3: Composition of a fruit of 'Noni'

The interest of 'Noni' lies in its ability to provide the organism with essential elements in significant quantities. Indeed, most foods do not contain major nutrients in adequate proportions. Thus, instead of consuming bananas for potassium or cow's milk for phosphorus, it would be just as wise to eat one or two fruits of «Noni». Polynesians have been using the juice of *Morinda citrifolia* ('Noni') as a traditional remedy for over 2000 years. However, the therapeutic mechanisms are still unknown [11]. Our study was based solely on fruits from the same tree, grown in the northern region of Madagascar. However, given that the composition of the plant depends mainly on the environment in which it develops and the elements it absorbs to grow, the analysis of other fruits from different plantations could lead to varied results. This is illustrated by the research of Basar, S. and Westendorf J. (2012) [3], who compared the mineral composition of various "Noni" plants from several countries in Iceland.

V. CONCLUSION

In this study, we carried out the analysis of mineral elements present in the "Noni" using the dispersive energy X-ray fluorescence method as well as atomic absorption. These techniques made it possible to identify in the samples of «Noni» mineral elements such as potassium (K), calcium (Ca), chromium (Cr), manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), selenium (Se), bromine (Br), rubidium (Rb), strontium (Sr) and lead (Pb). Although the presence of these trace elements is essential, their excess in the body can also lead to diseases. The results obtained highlight the presence of highly toxic elements such as bromine (Br), lead (Pb), chromium (Cr), cobalt (Co) and rubidium (Rb).

The presence of these toxic heavy metals is harmful to human health. However, we can affirm that there are no contraindications to the consumption of "Noni". Our measurements indicate that the leaf is the part richest in elements, followed by the fruit, then the root. The results of our research have demonstrated the beneficial effects of "Noni", which are attributed to both its mineral composition and the active compounds it contains. In conclusion, it is legitimate to ask whether the knowledge of the mineral composition of "Noni" could help improve scientific research with a view to developing new drugs based on "Noni".

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