

Decoction of the roots of *Tragia furialis boje* and the leaves of *Ravenala madagascariensis*, prepared using the method of Atomic Absorption Analysis

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Abstract - An herbal tea is a preparation made from a plant or mixture of plants, most often dried, by infusion, decoction, or maceration in water. The overall objective of this study is to determine the mineral content of the leaves and stems of *Ravenala madagascariensis* and the root of *Tragia furialis Bojer*, used in decoctions during pregnancy in northern Madagascar. The method used was Atomic Absorption Spectrometry. Samples were collected in the DIANA region, specifically in the Ambanja district. The samples used in the decoction analysis by Atomic Absorption Spectrometry also contained toxic elements such as lead ; undesirable elements such as aluminum, copper, iron, cobalt, and manganese; and the nutrient calcium. The concentration of elements found in the decoction of these plants was lower than the amounts ingested by pregnant women according to the standards set by the relevant authorities.

Keywords - Herbal tea, pregnancy, AAS, decoction.

I. INTRODUCTION

Women, especially during their first pregnancy, have many questions about the diet they should follow for the healthy development of their baby [1]. This is a period when they can, in the best interest of their child, adopt or resume better eating habits [2]. In Madagascar, in 2015, 26% of newborn deaths were due to the use of traditional medicine, particularly the use of herbal teas during pregnancy. According to the standards imposed by various entities, the plants used during pregnancy contain both nutrients and toxins. This is why we chose this topic entitled: Determination of major and trace elements in the decoction of *Tragia furialis* roots and *Ravenala Madagascaris* leaves using the Atomic Absorption Spectrometry method. We believe that a lack of knowledge about toxic elements and their effects on the health of pregnant women and intrauterine development leads them to frequently and abundantly consume herbal teas during pregnancy.

Atomic absorption spectrometry is an analytical technique that quantifies chemical elements in solution. Each element has a specific number of electrons associated with its nucleus. The normal and most stable orbital configuration of electrons is called the ground state. When energy is supplied to an atom, it absorbs it and adopts an electronic configuration called the excited state [3].

II. MATERIALS AND METHODS

Ten (10) fresh samples were collected from two (2) different locations in the northern region of Madagascar (Anivorano Nord and Joffre Ville). Anivorano Nord is located 75 km south of the regional capital, DIANA, on National Route 6. The sampling point is located at a latitude of 12°44' 49' 07" South and a longitude of 49°14' 29' 50" East. Joffre Ville is a small town located approximately 32 km south of Diego Suarez on the secondary road towards Montagne d'Ambre National Park. The

sampling point is located at a latitude of 12°12' 17' 07" South and a longitude of 49°07' 29' 50" East. These fresh samples were analyzed at the Madagascar laboratory, located in Antananarivo (the country's capital), for qualitative and quantitative analysis. Therefore, sample collection began on February 1, 2023, and ended on February 8, 2023.

Plant material

Tragia furialis Bojer also known by the vernacular name "ampsy" or "angilahy".



Figure 1: *Tragia furialis* Bojer

Ravenala madagascariensis is an endemic and emblematic tropical plant. There are five forms of *Ravenala*: malama, hiranirana, bemavo, horonorona, and menahirana. The *Ravenala madagascariensis* species is used for various purposes, including material, medicinal, and nutritional uses. The following section discusses basic concepts related to mineral elements.



Figure 1: *Ravenala madagascariensis*

Sample Preparation

The samples used in the analysis were prepared at home. The preparations were made on March 6, 2023.

From 5:11 PM to 5:41 PM, the first sample (*Tragia furialis* Bojer et *Ravenala Madagascariensis* to Joffre Ville) was taken and boiled in 1 liter of water at 150 degrees Celsius for 30 minutes.

The first result obtained was the decoction of *Ravenala Madagascariensis* and *Tragia furialis* Bojer and du Joffre Ville. The code for this sample is: MG 1803 IJ.

From 5:45 PM to 6:15 PM, the second sample (*Tragia furialis* Bojer and *Ravenala Madagascariensis* from Anivorano Nord) was taken following the same procedure as the first sample. The resulting decoction of *Ravenala Madagascariensis* and *Tragia furialis* Bojer et was coded MG 1810 IA. This preparation is similar to the herbal teas consumed by pregnant women in the northern region of Madagascar.

Figure 3 illustrates the two herbal tea decoctions.



Figure 3: Herbal tea decoctions

Analysis

After sample preparation, we proceed directly to the analysis using a graphic oven in the laboratory. Place approximately 5 ml of each sample (blank, material reference, and herbal tea decoction) to be analyzed in a small, clean cuvette. Place the six samples in a sampler: the blank sample is placed in slots 1 and 2, the RM (Material Reference) sample in slots 3 and 4, and the two decoctions in slots 5 and 6.

In Atomic Absorption Spectrometry, only 4 hollow lamps can be used because it consists of 4 lamps. Optimize the lamps to obtain good results. Program the analysis using the "Varian SpectrAA" software: Enter the data for the standards, blanks, reference materials, and samples into the program. Perform the qualitative analysis first before the quantitative analysis. Atomic Absorption Spectrometry is shown in its overview in Figure 4: the flame spectrometer (right) and the graphite furnace spectrometer (left), along with its accessories.



Figure 4: Atomic Absorption Spectrometry Chain

Results

The table below shows the respective mean (n=5) concentrations of mineral elements in the two analyzed decoctions.

Table 1: Variation in concentration (Mean \pm Standard deviation) of the two decoctions.

Elements	Decoction MG 1810 IA	Decoction MG1803 IJ
Lead ($\mu\text{g/l}$)	5,88 \pm 0,12	9,04 \pm 0,56
Copper ($\mu\text{g/l}$)	31,62 \pm 3,56	20,63 \pm 1,01
Cobalt ($\mu\text{g/l}$)	61,65 \pm 2,22	45,33 \pm 1,94
Manganese ($\mu\text{g/l}$)	1741,63 \pm 23,98	1215,50 \pm 26,54
Aluminum ($\mu\text{g/l}$)	1622,42 \pm 6,54	1215,12 \pm 7,56
Iron ($\mu\text{g/l}$)	869,61 \pm 7,89	2093,21 \pm 8,71
Calcium (mg/l)	22,84 \pm 1,14	26,35 \pm 1,89

This table shows us that both decoctions contain lead, a toxic element at low concentrations, but the concentration in the Joffre Ville decoction is higher than that in the Anivorano Nord decoction. They also contain calcium, a nutrient, at a very high concentration. Among the undesirable elements found in the decoction, manganese has the highest concentration, at 1741.63 $\mu\text{g/l}$ for the Anivorano decoction and 1215.502 $\mu\text{g/l}$ for the Joffre Ville decoction. During the analysis, other elements were found, such as zinc, nickel, cadmium, chromium, and arsenic, but their values were below the detection limit; this is why they are not listed in the table. We prove that in the decoction of the samples coming from Anivorano Nord, the nutrients are in greater quantity than these two other elements.

Discussion

These results reveal that the roots of *Tragia furialis* boje and the leaves of *Ravenala Madagascaris* and their decoctions are rich in nutrients with some undesirable and trace elements such as heavy metals.

Case of Lead

According to the results of the AAS, for the decoction of Anivorano the concentration is 5.88 ± 0.12 ug/l and for the decoction of Joffre ville is 9.04 ± 0.56 ug/l. A reduction in birth weight and a shortened pregnancy could also be linked to low lead exposure [4]. The World Health Organization (WHO) has set the maximum permissible lead concentration at 0.051 mg/l [5]. According to Decree No. 2004-635 of 15/06/04, traditional Malagasy medicine states that the acceptable standard for herbal tea is 0.05 mg/l [6].

Case of Copper

According to AAS results:

MG 1810 IA: 31.62 ± 3.56 µg/L

MG 1803 IJ: 20.63 ± 1.01 µg/L

Copper (Cu) is an essential trace element for the body, but as with all minerals, its delicate balance is crucial. It proves to be an excellent antioxidant, anti-infective, and anti-allergy agent when present in normal quantities in the body, where it helps combat the development of certain bacteria and viruses, as well as red blood cells. It also plays a role in skin protection by participating in melanin formation, in the metabolism of fats and carbohydrates, and in numerous hormonal syntheses, such as neurotransmitters. In addition to all these essential actions for the human body, copper facilitates the absorption of iron from our diet [7].

The European Food Safety Authority (EFSA), responsible for reviewing the reference intakes for nutrients, has defined adequate intakes for copper. These latest NRVs date from October 2015: Pregnant and breastfeeding women: 1.5 mg/day [8]. According to the Codex Alimentarius Commission on the Quantity of Nutrients in Dietary Supplements for Pregnant Women, copper consumption is between 0.5 and 1 mg/kg [9].

Cobalt Case

According to AAS, the results are as follows:

MG 1810 IA: 61.65 ± 2.22 µg/L

MG 1803 IJ: 45.33 ± 1.94 µg/L

Cobalt is a constituent of cobalamin, which participates in the production of red blood cells and

plays a major role in correcting potential anemias. The French Agency for Food Safety (AFSSA) has not established recommended daily allowances for cobalt because the requirements can be largely met through diet [10].

Case of Manganese

According to AAS, the results are as follows:

MG 1810 IA has a concentration of 1741.63 µg/L

MG 1803 IJ has a concentration of 1215.502 µg/L

Manganese has proven to be a powerful anti-allergic agent and may be used in the treatment of asthma and hay fever. Furthermore, it possesses antioxidant activity, helping to combat free radicals [11]. The EFSA, responsible for reviewing the reference intakes for nutrients, has defined an adequate intake of manganese. Its latest NRVs date from November 2013: Pregnant and breastfeeding women: 3 mg/day [8].

Aluminum Case

According to AAS results:

MG 1810 IA: 1622.42 µg/L

MG 1803 IJ: 1215.15 µg/L

A study also showed that a fraction of aluminum could cross the placental barrier and could therefore reach the fetus. However, given the new advances concerning the toxic effects of this metal [12], the EFSA re-evaluated this dose and established a new standard of 1 mg/kg of body weight per week. For a 60 kg adult, this represents 8.5 mg/kg per day [8].

Case of Iron

According to the AAS method: MG 1810 IA is 869.61 µg/L and MG 1803 IJ is 2093.21 µg/L.

It is an essential element for human survival (trace element). Iron is present in the hemoglobin of red blood cells, which transport oxygen to all cells. It is also present in myoglobin, a substance similar to hemoglobin, which helps muscles store oxygen. Iron is essential for the production of adenosine triphosphate, the primary source of bodily energy. It participates in several vital physiological processes, such as the regulation of cell growth and differentiation. Excess iron in the body can lead to myocardial infarction (blockage of the heart's arteries) and cardiovascular disorders [13]. The WHO

recommends a daily intake of 25–35 mg/kg per day [5]. The EFSA scientific group responsible for reviewing the reference intakes for nutrients has defined a reference intake for iron. These latest NRVs date from October 2015: Pregnant and breastfeeding women: 16 mg/day [8].

Case of Calcium

Our results show that the analysis according to AAS is: MG 1810 IA is 22.84 mg/l, MG 1803 IJ is 26.35 mg/l. Calcium is the most abundant metal in the body. It is mainly stored in bones. It contributes to the formation of bones, as well as teeth. Calcium also plays an essential role in blood clotting, maintaining blood pressure, and muscle contraction. Excess calcium causes the formation of kidney stones and an increased risk of cardiovascular disease. It is also involved in cellular exchange. Its blood level is extremely regulated to prevent variations that could be fatal to the body. Calcium also serves to regulate body pH; it is released from bones when there is an acidification of the internal environment caused by consumption of acidifying products and a low consumption of vegetables, which have an alkalizing effect [14].

The European Food Safety Authority (EFSA), responsible for reviewing the reference intakes for nutrients, has defined a reference intake for calcium. These latest RIs date from May 2015: Adults aged 25 and over (including pregnant and breastfeeding women): 950 mg/day. Adults aged 18 to 24 (including pregnant and breastfeeding women): 1000 mg/day [8].

III. CONCLUSION

In our study, we analyzed ten (10) plants of different origins: *Ravenala madagascariensis* (from Anivorano North and Joffre town) and *Tragia furialis* Bojer (from Anivorano North and Joffre town). These plants are used together in decoction by pregnant women in Northern Madagascar during pregnancy. They use them for their anti-edematous, hypotensive, antimalarial, and analgesic effects. Atomic Absorption Spectroscopy analysis also allowed us to quantify the chemical elements dissolved in our samples. According to the results, mineral elements

such as Calcium (Ca), Manganese (Mn), Iron (Fe), Cobalt (Co), Copper (Cu), Lead (Pb), and Aluminum (Al) were found in our samples. It was observed that the concentration in the herbal teas before decoction, whether fresh or dried, was higher than the concentration found using the AAS method. Calcium was the only nutrient found in the decoction. The quantities of toxic elements contained in the decoction were lower than the standards imposed for pregnant women.

However, excessive and long-term consumption of toxic elements could cause major health problems for the mother and the fetus or embryo. It is preferable for pregnant women to have regular prenatal consultations to receive the necessary care during their pregnancy. However, this does not preclude the consumption of decoctions, but they must be taken according to the standard. Midwives who provide herbal teas to pregnant women must have the necessary training to avoid giving incorrect dosages in order to preserve health and save maternal and fetal life.

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