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ANALYSIS OF MINERALS OF THERAPEUTIC INTEREST PRESENT IN THE ROOT POWDER OF CHRYSOPOGON NIGRITANUS (BLACK VETIVER)

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ABSTRACT

Chrysopogon nigritanus is a plant widely used traditionally for various purposes, particularly in traditional medicine for its various properties of pharmaceutical and cosmetic interest. From a scientific point of view, this plant has not been widely studied, particularly in the field of pharmacology. The aim of this work is to present the nutritional interest and composition in undesirable elements (pesticides) in the roots of *Chrysopogon nigritanus* based on screening for minerals and pesticides using successive energy-dispersive X-ray fluorescence and the Queschers method of standard NF EN 15662 for foods of plant origin in order to explore its mineral and pesticide composition. In this work, we presented the plant as well as the method and plant material used to perform the tests before announcing the screening results and their interpretation, which focused on the importance of minerals in the human system in order to scientifically demonstrate to users the nutritional value of *Chrysopogon nigritanus* roots in water and the absence of pesticides on them.

KEYWORDS: minerals, pesticides, screening, X-ray fluorescence, Queschers.

INTRODUCTION

Chrysopogon nigritanus is a plant widely used traditionally for various purposes, especially in traditional medicine for its various biological properties. Its roots are known and used in Senegal, as in other countries, especially in Africa, as a water purifier (antiseptic), giving it a taste and fragrance, as well as for its antibacterial properties. It has multiple therapeutic virtues, such as reducing gas and digestive disorders[1]; a decoction of rice water and vetiver roots (a staple dish in Senegal) soothes and relieves stress. Young women use vetiver root infusion to relieve menstrual cramps and after childbirth, and the infusion is used to cleanse the reproductive system. It is recognized as an effective purifying system for female parts subject to stress. The drink prepared from the root boiled in water is used to disinfect and eliminate pathogenic bacteria; the roots infused for a few hours are used for mild cases of diarrhea in nursing mothers and young infants.[1,2] This is why people use it as their everyday drink.

Minerals are essential to life. They play a role in many bodily functions (always in ionic form), such as water transport, nerve transmission, muscle contraction, and conduction. A lack of these nutrients can weaken the immune response and increase vulnerability to infections.[3] Unlike pesticides, which are chemicals that have harmful effects on humans, such as increased

disease, fertility problems, and increased risk of cancer if they exceed their non-toxic doses, exposure to minerals leads to the development of metabolic disorders.

Given the high consumption of *C. Nigritanus* roots, it was deemed necessary to study the composition of these two parameters in order to scientifically verify their nutritional value for consumers, but also to determine whether they pose any dangers related to chemical pesticides.

I. Presentation of the plant

The plant *Chrysopogon nigritanus* (Benth), better known by its taxonomic synonym *Vétiveria nigritana*, is a perennial grass species of the Poaceae family, monocotyledonous.[4] It grows in dense clumps, with short, simple rhizomes, upright, about 2.4 m high; it has large, open, spreading purple panicles composed of long, slender racemes, each with a thin stem and arranged in 8 to 10 whorls around a central axis. The leaves are erect or ascending, forming an acute angle with the stem, long and linear, tapering very gradually from the base to the fine, elongated tip. Initially folded, then unfolded or partially folded, they are glabrous, pale green, with the midrib recessed on the upper surface and protruding as a thin sharp line on the lower surface, the margins being finely toothed. The ligule has a vestigial membranous edge, with short hairs behind. Its sheath is hairless and strongly compressed, especially the sheaths with an acute keel at the base of the stem; pale yellow, shiny, and closely imbricate at the base.

The stems are coarse and pale yellow-green, cylindrical in their upper part and compressed in their lower part, with short, thick rhizomes. The roots are very coarse, bright yellow, sometimes growing from a short rhizome.[5] In addition to its use in traditional medicine, it is also used in ecology, cosmetics, and perfumery.

Image 1: the plant *C. Nigritanus.*

I. MATERIALS AND METHODS

1. Plant Material

The *Chrysopogon Nigritanus* sample was collected in October 2024 in the Dakar region, specifically in Hann Bel-Air. This locality is situated between 14°45' north latitude and 17°20' west longitude and covers an area of 42 km². It is part of the Grand Dakar arrondissement in the Dakar region, the capital of Senegal. It is home to the Hann Forest and Zoological Park, which in its ethnobotanical garden contains hundreds of identified plant species from diverse origins.

The harvested roots are cleaned and dried in the shade for a few days, then ground into powder using our electric grinder.

2. Mineral Screening Method

The analysis was carried out by energy-dispersive X-ray fluorescence. A mass of 1.2 g of the dried sample was taken and then mixed with 10% of its mass in HWC binding agent to ensure cohesion. The resulting mixture was compacted under a pressure of 20 tons to form a pellet, resulting in a total mass of 1.4 g, before being analyzed by energy-dispersive X-ray fluorescence.

3. Pesticide Screening Method

The QuEChERS method from the NF EN 15662 standard for plant-based foods, which is a versatile method for determining pesticide residues by GC-MS, was used with a detection limit: LOQ = 0.01 µg/kg.

II. RESULTS AND DISCUSSION

1. Results

The results of the mineral test are listed in the table below:

Table 1: list of minerals presents in *C. Nigritanus* roots and their concentrations.

Units	ppm (mg/Kg)
Mo	29,710
Pb	<LOD=0,001
Se	6,460
As	0,076
Hg	<LOD=0,001
Zn	6,186
Cu	8,077
Ni	0,615
Co	0,965
Fe	472,629
Mn	7,332
Cr	7,469
V	<LOD=0,001
Ti	25,977
Ca	389,049
K	530,132
S	58,879
Cd	<LOD=0,001
Mg	596,450
P	1078,560

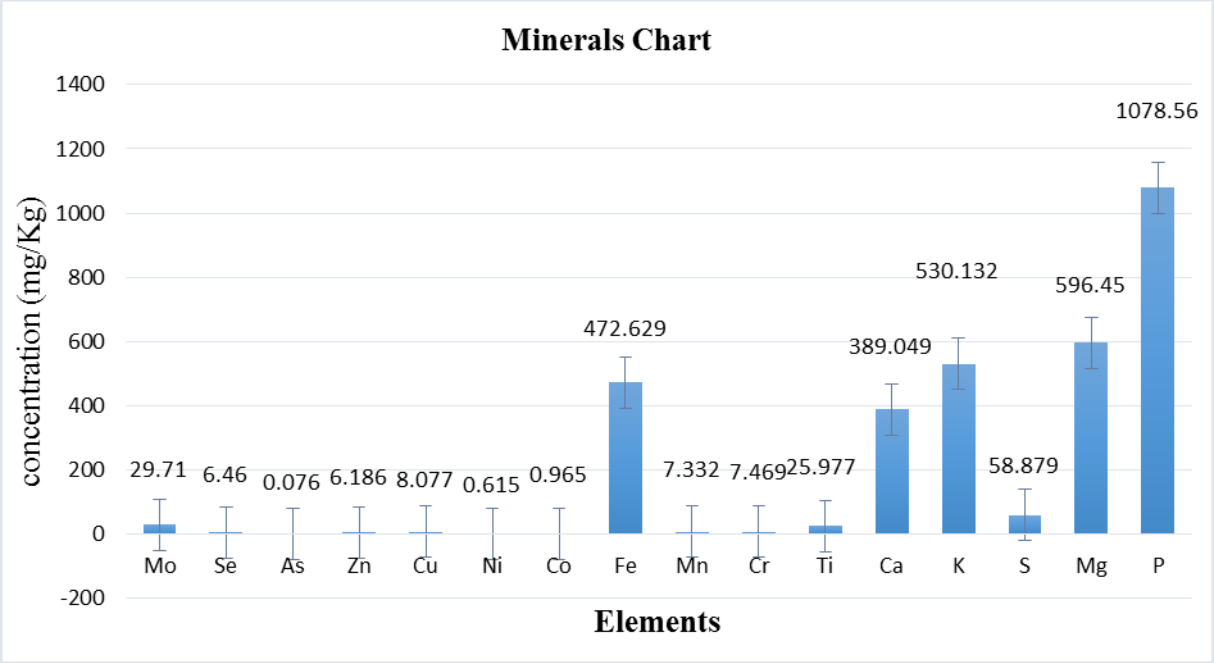

Figure 1: representative diagram of the minerals presents in the roots of *C. Nigritanus* and their concentrations.

The results of the pesticide screening are listed in the table below

Table 2: Pesticide screening in *C. Nigritanus* roots.

Order N°	Parameters	Results (µg/kg)[1,2]
1.	Dicofol	<LOQ
2.	Dimethoate	<LOQ
3.	Chlorpyrifos	<LOQ
4.	Methamidophos	<LOQ
5.	Malathion	<LOQ
6.	Lambda-Cyhalothrin	<LOQ
7.	Bifenthrin	<LOQ
8.	Lindane	<LOQ
9.	Trifluralin	<LOQ
10.	Propoxur	<LOQ
11.	Pirimiphos-methyl	<LOQ
12.	Dieldrin	<LOQ
13.	Endrin	<LOQ
14.	Heptachlor	<LOQ
15.	Deltamethrin	<LOQ
16.	Diazinon	<LOQ
17.	Endosulfan	<LOQ
18.	Aldrin	<LOQ
19.	DDT	<LOQ
20.	Profenofos	<LOQ
21.	Iprodione	<LOQ
22.	Bentazone	<LOQ
23.	Pendimethalin	<LOQ
24.	Cypermethrin	<LOQ
25.	Fenvalerate	<LOQ
26.	Esfenvalerate	<LOQ
27.	Permethrin	<LOQ
28.	Tetramethrin	<LOQ
29.	Chlorpyrifos-methyl	<LOQ
30.	Cyfluthrin	<LOQ

2. DISCUSSION

The analysis results on the sample of dried *C. Nigritanus* root powder show that it is rich in minerals, with the most abundant in these samples being phosphorus, magnesium, potassium, calcium, and iron.

Studies show that daily intakes of certain minerals are often below the recommended nutritional intake. To compensate for this mineral deficiency, it is recommended to prioritize consumption of foods and beverages rich in these elements rather than opting for medication supplements.[6] Adequate nutrition, including vitamins A, B, C, D, E, K, and certain minerals and trace elements such as zinc, sodium, potassium, calcium, copper, selenium, chloride, and phosphorus, can be beneficial in many infectious diseases. Many of these have antiviral effects, meaning they act against various species of respiratory viruses and can be used as adjunctive therapy with antiviral drugs.[7,8] However, the most common use of *C. nigritanus* roots in Africa, especially in Senegal, is to soak them in water that is drunk daily for a better taste but also for its purifying, antibacterial, and antiseptic properties, especially in women. According to our results, drinking this root water on a daily basis is beneficial due to its mineral content.

We have macroelements, which are needed in large quantities and include calcium, potassium, and magnesium. They are essential for functions such as bone mineralization and muscle contraction; trace elements, which are present in the body in trace amounts but are just as vital for good health. These include iron, zinc, selenium, manganese, copper, etc., which play key roles in various physiological processes. To demonstrate their importance, we will list some of their physiological roles.

❖ Phosphorus

It is the most abundant mineral in the sample with a concentration of 1078.560 ppm; phosphorus is an essential biological element[9] as it is necessary for cellular function. It is indispensable for this function because it allows the production and storage of energy in the form of phosphorylated compounds such as adenosine triphosphate.[10] According to the Food and Nutrition Board of the Institute of Medicine (USA), the recommended daily nutritional intake of phosphorus is 700 mg/day for healthy adults and up to 1250 mg/day for pregnant women.

❖ Magnesium

It is the second element in the sample with a concentration of 596.45 ppm; magnesium is one of the minerals whose deficiency can lead to several diseases.[11] It is essential for immune defenses and cardiovascular, digestive, neuromuscular, endocrine, osteoarticular, respiratory, and ocular activities, as well as carbohydrate, protein, lipid, and calcium-phosphorus metabolism. Magnesium is essential for supplying cells with energy.[12] Insufficient magnesium intake is associated with low bone mass and therefore skeletal fragility. It plays a role in increasing bone mineral density and reducing the number of fractures. It also has an impact on osteoporosis, which is defined as a decrease in bone mass leading to a reduction in the mechanical strength of the bone and thus an increased risk of fracture in postmenopausal women.[13]

❖ Potassium

It is the third most abundant mineral in our sample, with a concentration of 530.132 ppm. Potassium is an ion that is essential for cellular function. It determines the voltage and excitability of myocytes and the functioning of the heart, and is known as the heart's friend.[11,14] It is an active catalyst in our detoxification process; a potassium-rich diet can lower blood pressure in adolescents with high blood pressure.[15] Potassium deficiency, also known as hypokalemia, can lead to general weakness, widespread mineral deficiencies, muscle cramps, contractions or even muscle paralysis, and heart rhythm abnormalities.[16]

❖ Iron

It is present in significant quantities in our sample, with a concentration of 472.629 ppm. It is an essential metal for all organs, playing a structural and functional role for many proteins, particularly those involved in oxygen transport and storage, DNA synthesis, and electron transport.[17] Iron is essential for homeostasis, the physiological process that maintains a constant internal environment within the body to ensure its proper functioning, as it is an essential cofactor for various enzymes involved in essential metabolic reactions.[18] Given its importance for health and the fact that it is not synthesized by the body, intake must at least compensate for losses in order to prevent iron deficiency in the medium term.[17]

❖ Calcium

With a concentration of 389.049 ppm, calcium intake has an effect on the quality and quantity of bone matter.[19] Calcium supplementation or calcium fortification of food by pregnant women can lead to a slight reduction in preeclampsia or pregnancy loss.[20]

Calcium deficiency causes a lack of vitamin D, which plays an essential role in proper muscle, intestinal, and neurological function and bone mineralization. It leads to osteoporosis in women over 45 and can also cause heart rhythm abnormalities, cramps, tetany, brittle nails, eczema, etc.[11]

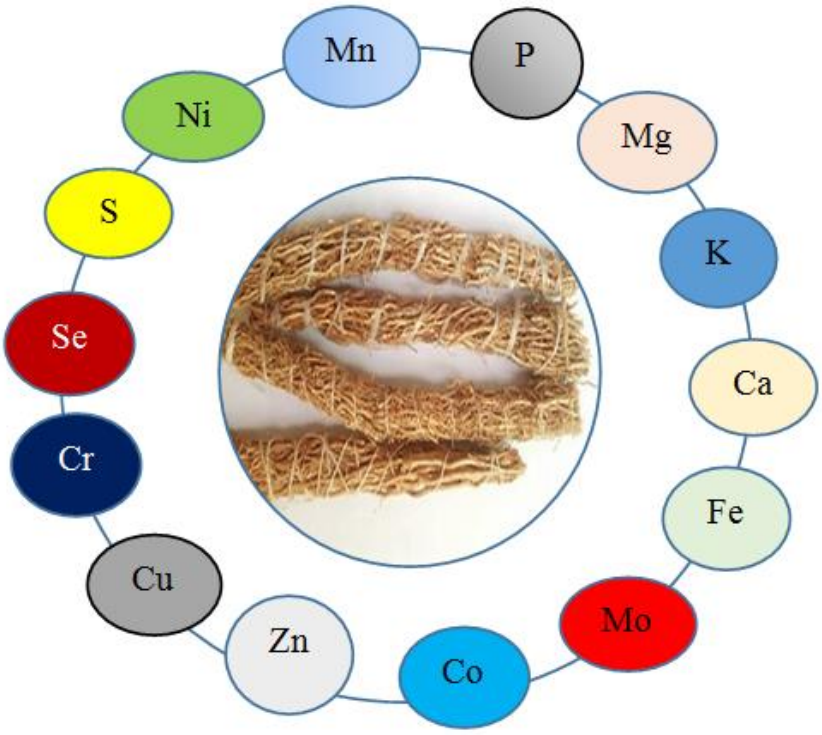

Figure 2: graphical summary of the nutritional contribution of *C. Nigritanus* roots.

Apart from the minerals whose concentrations are high in the sample of *C. nigritanus* root powder, the presence of other minerals with more or less significant concentrations is noted, such as sulfur and molybdenum, which are interesting trace elements essential for life. In humans, molybdenum acts as a cofactor for at least four enzymes: sulfite oxidase, xanthine oxidase, aldehyde oxidase, and the mitochondrial amidoxime-reducing component; the World Health Organization has established a slightly higher daily need for molybdenum of 100 to 300 mg/day for adults. As for sulfur compounds, they are found in all cells of the body and are essential for life. One of sulfur's most important roles is in protein production. It is necessary for detoxifying harmful toxins, forms part of the structure of vitamins B1 and B8, which support energy, skin, and the nervous system, and plays a role in healthy joint function.[21, 22] Selenium is also of fundamental importance to human health. It is an essential trace element and is the active center of many selenoproteins. It is mainly involved in antioxidant defense systems, thyroid metabolism, and immune function, and fights against aging and cellular degeneration.[23]

Zinc and copper are important trace elements involved in the body's biochemical and physiological functions and are essential to the human body. They catalyze enzymes, facilitate protein folding, and help regulate gene expression. Zinc deficiency can cause growth retardation, diarrhea, alopecia, glossitis, nail dystrophy, decreased immunity, visual and sexual difficulties, skin diseases, hair loss, and hypogonadism in men. It is effective in treating acne and in healing processes, due to its role in the synthesis of proteins such as collagen and keratin, and its effect on fibroblast proliferation. Cu is essential for the synthesis of neurotransmitters and is necessary for the inclusion of iron in the hemoglobin molecule. It has antiviral, anti-inflammatory, and anti-infectious properties in flu and rheumatic conditions.[24-26]

Elements such as cobalt (Co) and manganese (Mn) also play various roles in metabolic function, with Mn also acting in the production of neurotransmitters and the regulation of reproductive hormones.[27,28] Ni and Cr are involved in lipid metabolism, with Ni also playing a role in increasing hormonal activity and Cr in regulating glucose levels in cases of hyperglycemia.[29,30] Titanium (Ti) and arsenic (As) are among the non-essential trace elements in the human body.

In addition to these elements, others such as Pb, V, Cd, and Hg are also present in minute quantities. They are referred to as “trace elements.”

Given the nutritional richness of *C. Nigritanus* roots, we can confirm the benefits of consuming them on a daily basis, because despite their low content, trace elements are important in the physiological processes that regulate all of the body's vital functions.

For pesticide analysis, we use EU Regulation 396/2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin and the Codex Alimentarius on maximum residue limits for pesticides and maximum limits for extrinsic residues as a reference.

The results show that, for the 20 parameters studied, the concentrations are below the limit of quantification (LOQ), which is 0.01 µg/kg. This allows us to conclude that there are no pesticides present on the roots of *C. nigritanus* (Table 2). These results allow us to conclude that there are no pesticide-related hazards associated with the use of the plant's roots.

CONCLUSION

These results are only a first step in the search for nutrients of therapeutic interest and harmful elements that can affect the health of the *Chrysopogon Nigritanus* plant. They reveal an abundance of minerals in the roots of this plant, many of which are essential for the proper functioning of our body, and an absence of pesticides. These results are particularly interesting and encourage us to conduct further scientific studies on the various pharmaceutical uses of this plant, such as its antibacterial, anti-inflammatory, antiviral, and antifungal properties. We also plan to evaluate its toxicity and recommended doses in order to better promote this gem, which has a wide range of uses.

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