Preliminary Exploration of the Nutritional and Medicinal Value of *Vernonia amygdalina* (Bitter Leaf): Insights into Key Food Minerals and Their Health Benefits

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Abstract
The significance of a plant, including its medicinal and aromatic qualities as well as its possible health effects, largely depends on its unique chemical and nutritional makeup. *Vernonia amygdalina*, commonly known as bitter leaf, is known to contain vital secondary metabolites, many of which have been reported in scientific literature. The results obtained showed a nitrogen (N) and potassium (K) amount of 4.51% and 2.88% respectively; while manganese (Mn) and ferrous (Fe) are 307.52ppm and 100.94ppm respectively; in contrast to the least amount of 0.42% and 0.43%, obtained in phosphorus (P) and magnesium (Mg) respectively. The potential applications of *Vernonia amygdalina* are vast and significant. Its high potassium content is essential for maintaining optimal fluid balance within the body. Potassium is crucial for regulating muscular contractions, ensuring muscles operate effectively, and facilitating nerve signalling for seamless communication between the brain and the rest of the body. This mineral is key in controlling blood pressure, actively reducing the risks associated with hypertension. By managing water retention, *Vernonia amygdalina* effectively protects against the formation of kidney stones and plays a pivotal role in preventing osteoporosis. Nitrogen (N) forms an important component of protein synthesis, thus making its balance significant for the survival of the organism. This is so important in the sense that healthy adults who are neither gaining nor losing weight will maintain that the amount of Nitrogen consumed as protein in the diet equals the amount of Nitrogen losses in the body as a result of urine, faeces, etc.

Keywords: Food Minerals; *Vernonia amygdalina* (bitter leaf); Chemical Composition; Nutritional Analysis; Medicinal Plant

Introduction

Vernonia amygdalina, also commonly referred to as bitter leaf due to its characteristic bitter taste, which some try to remove before cooking in Nigeria (Edo *et al*., 2023). Some other African common names of bitter leaf include *grawa* (Amharic), *ewuro* (Yoruba), *etidot* (Ibibio), *onugbu* (Igbo), *ityuna* (Tiv), *oriwo* (Edo), *chusar-doki* (Hausa), *muluuza* (Luganda), *labwori* (Acholi), and *olusia* (Luo) (Adedapo *et al*., 2014). The plant is a member of the Asteraceae family and is a small shrub that grows in tropical and Sub-Saharan Africa, reaching a height of 2-5m. The leaves are also elliptical and can be up to 20 cm long. Its bark is rough. The leaves of this plant, being highly medicinal, are used in Nigeria as a green vegetable or as a spice in soups, especially in the popular bitter-leaf soup, where its antioxidant and other health-enhancing properties are well exhibited. Such vegetable preparation of bitter leaf is done in some quarters using freshly harvested leaves, which are macerated with either cold or hot water to reduce the bitterness of the leaves to a desirable level. The leaves are then added to other condiments for the soup, while the water extract may be taken as a tonic to prevent certain illnesses. The leaves can also be taken as an appetiser, while the water extract could be taken as a digestive tonic to aid in eliminating intestinal challenges, among other uses (Iwu, 2016). This manner of consumption is usually done by the female Hausas in their belief that it makes them more sexually attractive to their male counterparts. Moreso, in Northern Nigeria, bitter leaf is added to horse feed and other ruminant diets to provide a strengthening or fattening tonic called Chusar Doki in Hausa and also as a source of antibiotics for the animals (Dare, 2022; Meena *et al*., 2024). The leaves are also used in other countries, such as Ethiopia, as hops in preparing some types of local beer.

Also, due to its antibiotic and other properties, the leaves can widely be used for the treatment of fever and as a source of quinine substitute in Nigeria and some other African countries in the treatment of malaria. The younger shoots of the leaves are used in folk medicine as anthelmintic, antimalarial, laxative/purgative, enema, expectorant, worm expeller and fertility inducer in sub-fertile women (Ajayi *et al*., 2020; Hamda, 2022).

A lot of work has been done and is still ongoing on showcasing the medicinal uses and nutritional importance of bitter leaf. Work by Adedapo *et al*. (2014) revealed that phytochemical screening of the powdered leaves of *V. amygdalina* (bitter leaf) showed the presence of important bio-molecules such as alkaloids, tannin, flavonoids, saponin, anthraquinones and cardiac glycosides. The presence of these biological molecules tends to exhibit antioxidant and anti-inflammatory properties, as no mortality was recorded in any of the groups studied, including those in acute toxicity dosage, after the administration of its extract on the experimental animals.

Edo *et al*. (2023), in their review, explored the bioactive components and health benefits of bitter leaf. They noted that, among other health benefits, bitter leaf shows potential against various cancers, particularly breast cancer. They observed that further research is needed to understand its disease-fighting mechanisms and establish a safe dosage. Similarly, Achuba (2018) found in the study of the effects of bitter leaf extract on albino rats suffering from kidney damage caused by crude petroleum poisoning that the administration of the extracts was able to ameliorate the renal dysfunction induced by the contaminated diets. Degu *et al*. (2024), in their review, corroborated the presence of various phytochemicals in *V. amygdalina,* including flavonoids,

alkaloids, etc, and noted that the compounds are associated with several pharmacological activities such as antioxidant, antibacterial, anti-diabetic, anticancer, and anti-inflammatory effects.

The comprehensive review by Degu *et al.* (2024) revealed that there is a need for standardised approaches to better evaluate the medicinal uses of the plant. Given the need for better evaluation of the medicinal contents of *V. amygdalina*, this work aims to analyse the compositions of some important selected minerals present in it, which have significant health benefits. This is necessary for understanding the the disease-fighting mechanisms and establishing safe dosages.

Fig.1 Pictorial representation of *Vernonia amygdalina* (bitter leaf) with the flowers (picture taken at a home garden, Ibadan)

Materials and Methods

Sample preparation

Fresh leaves of *Vernonia amygdalina* were plucked from the parent, which had been established in the home garden setting for about a year. The collected leaves were immediately taken to the International Institute of Tropical Agriculture Analytical Laboratory in Ibadan for the analysis of important minerals.

Mineral Analysis

The method described by the Association of Official Analytical Chemists was employed for the analysis of the minerals. An aqua regia solution was prepared in a 2-litre volumetric flask as follows: 1.2 litres of distilled water were added to the flask, followed by the addition of 400 ml of concentrated hydrochloric acid and 133 ml of 70% nitric acid. The solution was diluted to 2 litres. 0.52 g of the powdered leafy samples, contained in clean ceramic crucibles, were placed in a cool muffle furnace, and the temperature was ramped to 500°C for 2 hours. The samples were allowed to remain at 500°C for an additional 2 hours before cooling down. They were later transferred to a desiccator. Each ashed sample was poured into a pre-labelled 50 ml centrifuge tube. The crucibles were rinsed with 5 mL of distilled water into the centrifuge tubes, followed by 5 mL of aqua regia solution. This process was repeated to achieve a total volume of 20 ml. The samples were then vortexed for thorough mixing before centrifuging for 10 minutes at 3000 rpm. The supernatants were decanted into clean vials, and micro-nutrient analyses for zinc, iron, copper, magnesium, phosphorus, and calcium were conducted using a flame atomic absorption spectrophotometer (AAS), model Acusys 211 from Buck Scientific, USA (AOAC, 2005; Jongrungruangchok *et al.*, 2010; Mongi, 2024; Nascimento *et al.*, 2025).

Results and Discussion

The present study evaluated the mineral composition of

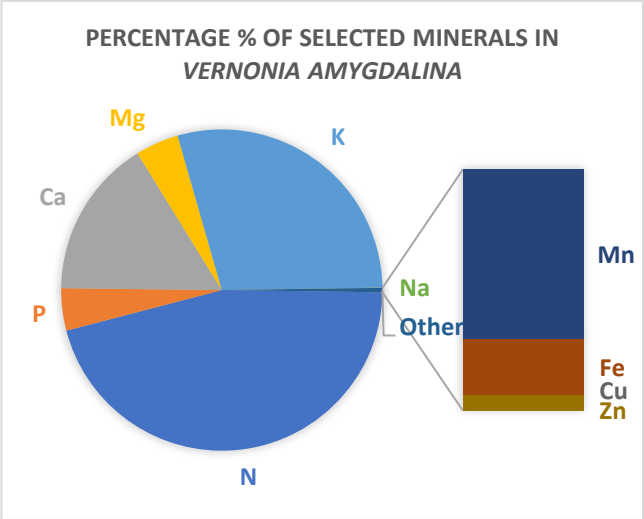

Fig. 2. Percentage (%) of selected minerals in *Vernonia amygdalina*

Vernonia amygdalina leaves, and the results (Figure 2) indicate that the plant contains appreciable levels of essential macro- and micro-nutrients. Major minerals included Nitrogen (4.51%), Phosphorus (0.42%), Calcium (1.58%), Magnesium (0.43%) and Potassium (2.88%), while trace minerals comprised Sodium (24.22 ppm), Manganese (307.52 ppm), Iron (100.94 ppm), Copper (1.31 ppm) and Zinc (27.50 ppm). The markedly elevated concentrations of Manganese and Iron are of particular significance. Fig. 2. Graph showing the mean percentages of selected food minerals in *Vernonia amygdalina.*

This study aimed to scientifically validate the nutritional and medicinal potential of *Vernonia amygdalina* (commonly known as Bitter Leaf), an endemic medicinal and aromatic plant (MAP) frequently consumed in sub-Saharan Africa. The findings highlight the urgent need to address the underutilisation of MAPs, which primarily results from a lack of public awareness about their significant health benefits rather than issues of affordability or availability. The high Manganese content (307.52 ppm) observed in this study is noteworthy, as Mn is a crucial cofactor for several metalloenzymes, especially mitochondrial manganese-superoxide dismutase (Mn-SOD), a key component of the cellular antioxidant defence system (Adedapo *et al.*, 2014). Adequate Mn intake supports free-radical detoxification and may contribute to reduced oxidative stress, a factor implicated in several chronic diseases (Achuba, 2018). However, the unusually high Mn concentration reported warrants further investigation to determine its source, bioavailability, and potential dietary implications. Also, these levels far surpass those found in many common cultivated vegetables. The high Mn content in *V. amygdalina* suggests that its consumption may significantly enhance the body's intrinsic free-radical detoxification capabilities, thereby acting as a powerful protector against oxidative stress, which is implicated in the pathology of numerous chronic diseases, including neurodegenerative disorders. The role of these elements in mitigating free radicals is particularly relevant, countering the description of them as "neuro-toxins" and instead emphasising their protective, neuro-supportive roles as anti-oxidant co-factors (Adedapo *et al.*, 2008).

The high Iron content (100.94 ppm) in *V. amygdalina* also underscores the plant's nutritional relevance. Iron is a key component of the heme structure in haemoglobin

and myoglobin, which is essential for the efficient transport and storage of oxygen throughout the circulatory system and muscle tissues (Anderson and Frazer, 2009). This efficient transport is vital for all metabolic processes. A diet deficient in bioavailable iron leads to anaemia, a condition that severely compromises oxidative energy production and results in reduced work performance and acidosis (AOAC, 1990; Binquryan *et al*., 2024; Obeagu, 2025).

Furthermore, the study reiterates the profound systemic consequences of chronic iron deficiency, including an impaired thermoregulatory capacity due to reduced synthesis and activity of the heme-dependent enzyme thyroid peroxidase. In vulnerable populations such as infants and children, low iron status is directly correlated with detrimental, long-lasting effects on growth and intellectual development, often manifesting as impaired growth and reduced intelligence quotient scores (Atoyebi *et al*., 2023A; Korczak *et al*., 2024). Additionally, Iron-deficiency anaemia remains highly prevalent in sub-Saharan Africa, and plant-based sources with appreciable Fe content represent valuable dietary resources, particularly where access to animal-source foods is limited (Atoyebi *et al*., 2023B; Korczak *et al*., 2024). However, plant-derived non-heme iron has variable bioavailability due to interactions with antinutritional factors such as phytates and polyphenols (Johansson, 2022; Freitas *et al*., 2025). The substantial concentration of Fe in *V. amygdalina* thus presents a readily accessible dietary strategy to mitigate Iron Deficiency Anaemia (IDA), particularly in populations where access to diverse animal-source foods is limited.

The macronutrient profile also suggests nutritional relevance with high concentrations of the macronutrients Nitrogen (N) and Potassium (K). The Nitrogen content (4.51%) reflects the plant's protein potential and aligns with earlier reports indicating that *V. amygdalina* can contribute to dietary protein intake. Dietary nitrogen is essential for all protein synthesis processes, which are crucial for maintaining structural integrity, enzymatic function, and immune response (Wu *et al*., 2022; Corsetti *et al*., 2024). The presence of this level of nitrogen underscores the plant's potential to contribute significantly to the dietary protein needs of consumers. Crucially, the maintenance of a complete nitrogen homeostasis is the benchmark for health in non-growing adults. Regular consumption of this plant contributes essential amino acids necessary for maintaining this delicate balance between protein synthesis and catabolism (Atoyebi *et al*., 2023A).

Potassium (2.88%) is an essential intracellular cation widely found in plant-based foods. Its main physiological role is maintaining the sodium-potassium balance, which controls fluid regulation, nerve signal transmission, and neuromuscular function (Abate *et al*., 2024; Saed *et al*., 2025). This ion gradient is carefully regulated, with potassium excretion acting as a counter-regulatory mechanism to sodium retention to prevent cellular toxicity. Diets high in potassium, typical of plant-based foods, are linked to improved blood pressure regulation (Edo *et al*., 2023). Research, including the Dietary Approaches to Stop Hypertension (DASH) study, has shown that diets rich in bioavailable potassium are very effective in lowering systemic blood pressure in hypertensive individuals (Edo *et al*., 2023). However, caution is necessary to maintain intracellular balance; while dietary intake is beneficial, excessively high intracellular concentrations compared to the extracellular matrix can cause hypokalaemia, emphasising the importance of balanced nutrient intake.

The mineral composition analysis of *Vernonia amygdalina* provides robust scientific support for its inclusion in the human diet, validating its traditional use and nutritional significance. The high levels of Iron and Manganese are particularly relevant to public health efforts aimed at reducing oxidative stress and combating prevalent micronutrient deficiencies. At the same time, the Potassium and Nitrogen content contribute fundamentally to cardiovascular and metabolic health, respectively. These results confirm that the beneficial health-enhancing abilities of MAPs are often scientifically grounded. Variations in mineral composition of *V. amygdalina* across studies have been documented, likely due to environmental factors, soil nutrient composition, plant maturity, seasonal variation, and differences in analytical techniques (Pol *et al*., 2024). The relatively high Mn content in this study may reflect local soil enrichment or physiological uptake mechanisms and therefore requires validation through multi-site and seasonal sampling (Asadi *et al*., 2025). Processing methods traditionally applied to *V. amygdalina* leaves, such as washing, maceration, blanching, and drying, could alter its mineral content and bioavailability (Uchegbu *et al*., 2023). Thus, future research should consider both raw and processed forms of the leaves to reflect real-world consumption patterns better. Research should also focus on determining the bioavailability and specific form (speciation) of these minerals, as well as conducting human intervention trials to quantify the therapeutic potential of *V. amygdalina* in clinical settings, thereby bridging the knowledge gap that currently limits its optimal utilisation.

Conclusion

It has been observed in the uses of *Vernonia amygdalina* that so many individuals, including so-called herbalists and naturopathic doctors, often recommend the *Vernonia amygdalina* aqueous extracts for the treatment of emesis, nausea, diabetes, loss of appetite-induced anorexia, dysentery and some other gastrointestinal tract problems and infections in their patients. Furthermore, *Vernonia amygdalina* is well known as a very potent medicinal plant with diverse uses, including the treatment of diabetes, fever reduction, and, recently, a non-pharmaceutical solution to persistent fever, headache, joint pain, and any other type of pain that could be associated with the central nervous system. This is the reason why *Vernonia amygdalina* is often found in many domestic gardens and home settings and has become very popular and an important part of the women's cuisine in this part of the world and Asia, due to its antioxidant, anti-inflammatory and antinociceptive properties.

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