COMPARATIVE STUDY OF MINERAL PROFILES IN *DIOSCOREA* SPECIES

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Abstract:

The research study examines the Dioscorea species, commonly known as yams, within the Dioscoreaceae family, which includes about 600 species found in various tropical regions. These tubers are significant for their carbohydrate content and various bioactive compounds with potential medicinal properties, including diosgenin, which is linked to numerous health benefits. The study emphasizes the need for further pharmacological research to validate the ethnomedicinal uses of Dioscorea species, which are traditionally used to treat a variety of ailments. The research also highlights the importance of mineral analysis in three species: Dioscorea bulbifera, D. esculenta, and D. alata, utilizing atomic absorption spectroscopy for precise mineral content determination. Results indicate varying levels of essential minerals among the species, suggesting their nutritional importance. The conclusion advocates for incorporating these yams into daily diets due to their rich mineral content and potential health benefits, while also calling for conservation efforts due to the decline of these plants in the wild.

Keywords*: Nutrient uptake potential*

Introduction

A total of 600 species of *Dioscorea*, or "yams," are the subject of this study. These plants are native to a wide variety of habitats, including the South Pacific, Africa, the Caribbean, and South America. Vitamins, lipids, and proteins are all present in these tubers, which also happen to be an important source of carbohydrates. *Dioscorea, Stenomeris, Tacca* and *Trichopus* are notable genera that belong to this family of perennial herbs, which is mostly found in tropical zones. Economically significant *Dioscorea* species include genuine yams because of their nutritional value and the steroidal saponins they produce, which are utilized in pharmaceuticals. Diosgenin is one of many bioactive chemicals found in *Dioscorea*; it has antioxidant and anti-inflammatory characteristics. There is a pressing need for additional pharmacological investigations to confirm the species' ethnomedicinal potential, given its historic use in treating a variety of diseases. The focus of the study is mineralogy of three species of *Dioscorea* using atomic spectroscopy to determine mineral levels precisely: *D. bulbifera, D. esculenta*, and *D. alata.* Cordate leaves and vivid green pigmentation distinguish *D. bulbifera* from *D. alata,* which is easily distinguished by its growth pattern and tuber form. *D. esculenta* is known for its climbing habit and nutritional richness. The research is focused on improving our knowledge of the therapeutic uses and raising awareness about how to include *Dioscorea* species in our meals. The goal is to support traditional knowledge and get more people involved in farming. With these findings, we hope to strengthen the existing body of knowledge about *Dioscorea* and the ways it may improve human health and nutrition.

Review of literature:

Dioscorea species, commonly known as yams, are a diversified group of perennials belonging to the Dioscoreaceae family. They are widely distributed in tropical and subtropical regions, notably Africa, Asia and the Americas. With more than 600 species, *Dioscorea* presents a range of forms and characteristics, which makes them important in various ecological contexts (NGO NGWE *et al.,* 2015; Bhattaccharjee et al., 2011).

Ecologically, *Dioscorea* species play an important role in their habitats. They contribute to the structure and function of the ecosystems in which they develop. The vineyards and the tubers of yams help to prevent soil erosion, to maintain the integrity of the soil and to promote biodiversity (NGO NGWE *et al.,* 2015). In many regions, these plants support a variety of organizations by providing food and housing. In addition, they are an integral part of sustainable agriculture because they are often cultivated in intercalary systems. This cultivation practice improves soil fertility and encourages ecological interactions that benefit various cultures (Darkwa *et al.,* 2020). *Dioscorea* species can improve soil health by contributing to organic matter through their decomposing leaves and roots, which enriches the soil with nutrients.

Current culture practices of *Dioscorea* species emphasize their potential in improving agricultural resilience, in the face of climate change. These plants can tolerate unfavorable conditions, such as drought and poor soil quality, which makes them adapted to cultivation in less favorable environments. Research suggests that the incorporation of yams in agricultural systems can help secure food sources, especially in regions faced with climatic uncertainty (Nazir *et al.,* 2021). The emphasis on sustainable agricultural practices, such as organic farming and agroforestry, is vital to maintain ecological balance and ensure the longevity of the culture of *Dioscorea*.

Economically, *Dioscorea* species are very significant. The main economic product derived from these factories is the Ignonne, which are staple food in many countries and play a crucial role in local diets. The production of yam contributes to the possibilities of food security and employment in rural communities (Do Nascimento *et al.,* 2021). In addition, *Dioscorea* species are a source of diosgenin, a phytoestrogen used in the production of steroid hormones and various drugs. This adds a layer of economic importance because the extraction and treatment of diosgenin have become lucrative industries (Azeteh *et al.,* 2019).

In addition to their economic uses, *Dioscorea* species have notable health benefits. They are rich in carbohydrates, vitamins and minerals, making it a precious part of a balanced diet (Padhan & Panda, 2020). The nutritional value of yams supports various health functions, including digestive health and energy provision. In addition, traditional medicine practices have recognized the medicinal properties of *Dioscorea* species to treat conditions such as inflammation, diabetes and reproductive health problems (Ojımelukwe *et al.,* 2021). The various applications of Dioscore in the promotion of health and nutrition still highlight their meaning in modern food contexts.

Overall, *Dioscorea* species illustrate how agricultural practices can be improved sustainable while meeting economic and health needs in local communities. Their various roles in ecosystems, agriculture and medicine highlight their importance in traditional practices and contemporary agricultural systems., The species of *Dioscorea*, commonly known as ignorant, have significant roles in traditional medicine in various cultures. For example, in African communities, especially such as opposite and winged. *Dioscorea* are used to treat disorders such as diarrhea, respiratory issues and fever (Kumar *et al.,* 2017). In the same way, in Asian traditions, *Dioscorea* has been incorporated into treatments for conditions such as fatigue and hormonal imbalances. The traditional use of *Dioscorea* spp. It illustrates their importance not only as food sources, but also as full components of cultural health practices.

The benefits for the health of the species of hospitality are largely attributed to their rich phytochemical components. These include steroid saponins, flavonoids and polyphenols, who have shown that they exhibit anti-inflammatory, antioxidant and immune enhancement properties (Adomėnienė and Venskutonis, 2022). For example, the saponins found in *Dioscorea* are known to lower cholesterol levels, highlighting their potential in promoting heart health. These characteristics not only validate their traditional uses, but also open - end paths for their inclusion in modern dietary recommendations (Salehi *et al.,* 2019).

Despite their promising benefits for health and cultural meaning, the species *Dioscorea* face significant challenges, in terms of conservation and sustainable use. Many species are threatened due to the loss of habitat, review and competition from more cultivated crops. In the regions in which *Dioscorea* is underutilized, as parts of the South-Est Asia, there is an urgent necessity of conservation efforts to protect these precious plants (Ikiriza *et al.,* 2019). In addition, traditional knowledge of *Dioscorea* is at risk of being lost while the younger generations move towards more modern lifestyles and practices (Jahan et al., 2019). Therefore, it is urgent to document and protect this knowledge by promoting sustainable agricultural practices.

Progress in biotechnology promises cultivation and improvement of discorean species. Research has shown successful propagation techniques, including tissue culture, which could help increase yields and guarantee the availability of these plants (Wang *et al.,* 2025). In addition, biotechnological approaches can be exploited to improve disease resistance and nutritional value, making not only a basic food culture but also a potential superfood. There is also a significant research opportunity on the metabolic paths of *Dioscorea*, which could lead to the discovery of additional compounds of health benefits (Chandrasekara and Josheph Kumar, 2016).

The integration of the conservation of biodiversity with economic development is crucial for the sustainable practices surrounding *Dioscorea* and other traditional crops. The initiatives that support local farmers can help maintain different cultivation systems by guaranteeing the health benefits associated with *Dioscorea* SPP. They are optimized (Das *et al.,* 2013; Waris *et al.,* 2021). By promoting both conservation and economic development, communities can improve food safety, preserve traditional knowledge and promote benefits for the health of *Dioscorea* species for future generations.

MATERIALS AND METHODS

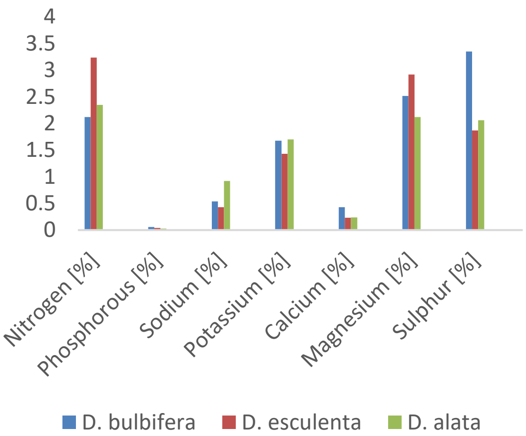
Fruits of *Dioscorea bulbifera*, *D. esculenta* and *D. alta* (white) were collected from the research region. To prevent surface contamination, the sample fruits were rinsed and cleansed with distilled water. The outer coating was meticulously removed using a knife after the yam fruit was sliced into fine segments. After curing at room temperature, the samples were subjected to oven drying. The dry samples were morter-and-pestled and subsequently graded into a fine powder. The powdered sample was contained in hermetic plastic containers designated as A, B, and C. The minerals were analyzed at the KASTURI AGROTECH Mineral Analysis Laboratory in Sangli. AAS was used to measure mineral contents (Nitrogen, Phosphorous, Sodium, Potassium, Calcium, Magnesium, Sulphur, Boron, Zinc, Ferrous, Copper, Manganese, Molybdenum).

Results and discussion:

The state of mineral nutrients may indicate adaptability and luxuriant growth of chosen Dioscoreaceae species. Nitrate is the primary nitrogen source that plants can access in soil [Beevers and Hagemen 1968]. *D. bulbifera, D. esculenta* and *D. alata* have a total nitrate content of 70.38%, 19.82%, and 58.65%, respectively. *D. bulbifera* exhibits a higher nitrate level than *D. esculenta* and *D. alata*. Nitrogen is the most critical mineral for plant growth. It is essential for the synthesis of organic molecules. The overall proliferation of the plant is indicated by the total nitrogen concentration [Gallacher and Sprent 1978]. Amino acids and amides are produced from the nitrogen that is assimilated. Amino acids are the fundamental unit of DNA, which is the structural and functional unit of life.

The findings of the current investigation are shown in Table No. 1 as well as Figures 1 and 2. The nitrogen concentration in *D. esculenta* is 3.24%, which is higher than that of *D. bulbifera* and *D. alata*, which have nitrogen contents of 2.12% and 2.35%, respectively, as indicated by the table. Phosphorus is also essential for the nutrition of plants. It is a critical component of APM, ADP, ATP, and NADP. It is involved in the transmission mechanism of plants. *D. bulbifera* has a phosphorus content of 0.06%, which is higher than that of *D. esculenta* and *D. alata*, both of which have a phosphorus content of 0.04%, as indicated by the table. Plants require sodium; however, it is utilized in negligible quantities. Na regulates the osmotic pressure in plant cells, resulting in an increase in water utilization. Occasionally, Na ions can replace K ions in specific metabolic and osmoregulatory duties, enabling varying degrees of interchangeability between the two elements. Compared to D. esculenta and *D. bulbifera*, which have concentrations of 0.435% and 0.54%, *D. alata* has a higher sodium concentration of 0.92%. The growth and development of plant roots are substantially influenced by potassium [Jung et al. (2009)]. The transport of water, nutrients, and carbohydrates within plant tissues is associated with potassium. In plants, potassium is involved in enzyme activation, which affects the synthesis of ATP, carbohydrates, and protein. Potassium increases the production of plants by improving root development and drought resistance. *D. alata* exhibits a potassium concentration of 1.70%, which is higher than that of *D. bulbifera* (1.68%) and *D. esculenta* (1.43%). Calcium is essential for the construction and fortification of cell walls and membranes, which safeguards them from adversities such as drought, pests, and moisture. It promotes the development of roots, which is responsible for the assimilation of water and other essential nutrients. The results suggest that the calcium content in *D. bulbifera* is 0.43% (43 mg/100g) higher than that of the other two species, *D. esculenta* and *D. alata*, which contain 0.23% and 0.24%, respectively.

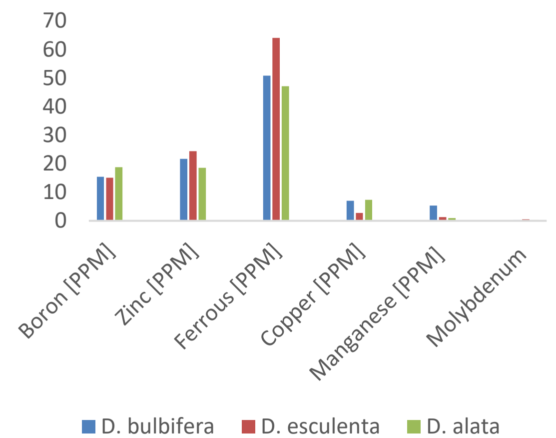
Fig.1 Macro elements(%) present in *Dioscorea species*



Epstein (1972) identified 2% Mg on a dry weight basis as a critical value in plants. Magnesium is an essential mineral for vegetation. It is an essential component that is situated in the nucleus of chlorophyll. It is a component of all green vegetation and is indispensable for the process of photosynthesis. It functions as an enzyme and aids in the breathing process. It also serves a critical role in the aggregation of ribosomal particles. Leaf chlorosis may be the consequence of inadequate magnesium levels. The magnesium content of *D. bulbifera*, *D. esculenta*, and *D. alata* is comparable, with values of 2.52%, 2.92%, and 2.12%, respectively.

Magnesium is an essential nutrient for a wide variety of critical physiological and biochemical functions in plants (M. Ishfaq 2022). Marschner (1986) asserts that it is directly involved in the production of fatty acids as a component of the biotin enzyme. The Institute of Medicine (IOM) (2004) Food and Nutrition Board advised a daily manganese (Mn) intake of 1.8 to 2.3 mg. In comparison to D. alata, which has a lower content (0.92 PPM), the tubers of *D. bulbirera* (5.28 PPM) and D. esculenta (1.27 PPM) contain a higher manganese content. Sulfur is present in low quantities, although the presence of sulfur varies among distinct plants. The present study suggests that *D. bulbifera* has a considerably higher sulfur content (3.355%) than *D. esculenta* (1.87%) and D. alata (2.06%). Numerous sulfur-containing compounds have been directly and indirectly linked to the defense of plants against microbial diseases (Hell 1997). The Dioscreaceae species have the potential to serve as biocontrol agents against microbial infections. Inhibited cell expansion, meristematic death, and diminished fecundity are the results of boron deficiency in plants, which impairs both vegetative and reproductive growth (Marschner, 1995). Nevertheless, it is essential in small quantities. The optimal boron concentration in the foliage of the majority of crops is between 20 and 100 ppm; however, the requirements for boron vary among other crops (Plank, 1999). It is essential for the regulation of plant hormones. *D. bulbifera, D. eaculenta,* and *D. alata* do not exhibit any Boron deficiency, as evidenced by their concentrations of 15.39 PPM, 15.09 PPM, and 18.82 PPM, respectively. Zinc (Zn) is an essential component of plants, as it is involved in a variety of essential cellular functions, such as enzyme activation, metabolic and physiological processes, and ion homeostasis (Yang *et al.,* 2020; Alsafran *et al*., 2022). Zinc deficiency disrupts the basic metabolic processes of plants, leading to stunted growth and leaf chlorosis. This can impede nutrient assimilation and, in the end, result in zinc insufficiency in the human diet (Li *et al.,* 2013). Zinc's critical role in the activation and stabilization of metalloenzymes is a significant factor in the interactions between plants and pathogens (Fones and Preston, 2012). The results suggest that *D. esculenta* [24.34] demonstrates a higher level of resistance to infections than *D. bulbifera* [21.66 PPM] and *D. alata* [18.53 PPM].

Fig.2 Micro elements(ppm) present in *Dioscorea species*



Machold and Stephan (1969) state that iron is involved in the production of common chlorophyll precursors. The chloroplast stroma contains phytoferritin, a form of iron storage that can hold approximately 5,000 atoms of Fe^{3+}. According to Marschner (1986). The metabolic activities that nearly all living things rely on, including DNA synthesis, respiration, and photosynthesis, make iron a vital micronutrient. Because the oxidized ferric form of iron is poorly soluble in aerobic settings, it ranks as the third most limiting nutrient for plant growth and metabolism (Zuo and Zhang, 2011; Samaranayke *et al.,* 2012). Many crop plants suffer from iron insufficiency, a nutritional condition that lowers nutritional quality and yields. Compared to *D. bulbifera* [50.79PPM] and *D. alata* [47.12PPM], the results show that *D. esculenta* has a high ferrous concentration of 63.98 PPM.

Copper (Cu) is a trace element that is indispensable for the proper growth and development of vegetation. It is actively involved in a variety of biological processes, such as protein transport, cell wall metabolism, respiration/photosynthesis electron transfer, and hormone signal transduction, and functions as the active site for multiple enzymes while acting as a cofactor [Guang Chen et al., 2022]. It, along with another trace element that is acknowledged for its importance in photosynthesis, is indispensable for reproductive growth. It is associated with enzymes that are involved in the redox processes of photosynthesis (Haehnel, 1984). D. alata (7.36 PPM) has a higher concentration of copper than *D. bulbifera* (6.99 PPM) and D. esculenta (2.70 PPM), as indicated by the data.

Magnesium is an essential nutrient for a wide variety of critical physiological and biochemical functions in plants [M. Ishfaq 2022]. Marschner (1986) asserts that it is directly involved in the production of fatty acids as a component of the biotin enzyme. The Institute of Medicine (IOM) (2004) Food and Nutrition Board advised a daily manganese (Mn) intake of 1.8 to 2.3 mg. In comparison to D. alata, which has a lower content (0.92 PPM), the tubers of *D. bulbirera* (5.28 PPM) and D. esculenta (1.27 PPM) contain a higher manganese content.

Arnon and Stout (1939) demonstrated the importance of molybdenum in plant growth by conducting experiments on hydroponically cultivated tomatoes. Human tooth enamel contains molybdenum, which may help prevent its degradation. Curzon and companions (1971). Molybdenum is an essential component of two enzymes that catalyze the conversion of nitrate into nitrite, a hazardous nitrogen form, and subsequently into ammonia. Ammonia is subsequently used in the synthesis of amino acids in plants. It is necessary for symbiotic nitrogen-fixing microorganisms in legumes to assimilate ambient nitrogen. Molybdenum is employed by plants to convert inorganic phosphorus into organic forms within the organism. The table indicates that *D. bulbifera, D. esculenta* and *D. alata* are present at concentrations of 0.28, 0.46, and 0.32, respectively.

Members of the Dioscoreaceae family possess negligible amounts of ash. *D. bulbifera* has an ash value of 1.6%, while D. esculenta and D. alata have an ash content of approximately 0.5% and 0.4%, respectively.

SR. NO	PARAMETER	*D. bulbifera*	*D. esculenta*	*D. alata*
1.	Nitrate [%]	70.38	19.82	58.65
2.	Nitrogen [%]	2.12	3.24	2.35
3.	Phosphorous [%]	0.06	0.04	0.03
4.	Sodium [%]	0.54	0.43	0.92
5.	Potassium [%]	1.68	1.43	1.70
6.	Calcium [%]	0.43	0.23	0.24
7.	Magnesium [%]	2.52	2.92	2.12
8.	Sulphur [%]	3.35	1.87	2.06
9.	Boron [PPM]	15.39	15.09	18.82
10	Zinc [PPM]	21.66	24.34	18.53
11	Ferrous [PPM]	50.79	63.98	47.12
12	Copper [PPM]	6.99	2.70	7.36
13	Manganese [PPM]	5.28	1.27	0.92
14	Molybdenum	0.28	0.46	0.32
15	Ash [%]	1.6	0.5	0.4

Table 1. Mineral uptake potential in *D. bulbifera, D. esculenta, and D. alata* yam fruit.

Summary and Conclusion:

Dioscoreaceae species, especially *D. bulbifera, D. esculenta*, and *D. alata*, show signs of adaptation and growth potential based on their mineral nutrient content. The nitrogen concentration of *D. esculenta* is 3.24%, that of *D. alata* is 2.35%, and that of *D. bulbifera* is 2.12%. Nitrogen is essential for plant development. The phosphorus levels in *D. bulbifera* are the highest at 0.06%. D. alata had the greatest sodium contents at 0.92% and the highest potassium concentrations at 1.70%. The percentage of calcium in *D. bulbifera* is the highest, at 0.43%. While all species have a relatively similar magnesium content, *D. esculenta* has a little higher at 2.92%. In comparison to *D. alata* (0.92 PPM), manganese levels in *D. bulbifera* are 5.28 PPM. The sulfur content in *D. bulbifera* is 3.355% greater as well. The highest level of infection resistance was observed in *D. esculenta*, which had a zinc content of 24.34 PPM. *D. alata* has the highest concentration of copper (7.36 PPM), whereas *D. esculenta* has the highest concentration of iron (63.98 PPM). In terms of molybdenum concentrations, *D. bulbifera* has 0.28 percent, *D. esculenta* 0.46 percent, and *D. alata* 0.32 percent. The ash content of all species is extremely low, with *D. bulbifera* being the lowest at 1.6%.

Based on the data, we can conclude that the *Dioscorea* species has a good mineral presence. The study's findings indicate that *Dioscorea* species are an effective dietary supplement due to their high mineral content.

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