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Comparative Study on the Phytochemical Screening and Chemical Composition of *Chrysophyllum albidum and Anacardium occidentale* Leaves Cultivated in South-western Nigeria

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Abstract:
Using standard methods, the proximate composition, phytochemical screening, and mineral analyses were carried out on Chrysophyllum albidum and Anacardium occidentale leaves. The results of proximate composition showed that Anacardium occidentale leaves contain a significantly higher amount of crude protein (13.95%), crude fat (8.96%), crude fiber (14.97%), ash content (3.48%) and carbohydrate content (43.84%) compared to the respective values of 7.37%, 3.54%, 2.97%. 2.02% and 32.56% for Chrysophyllum albidum. However, the moisture content of Chrysophyllum albidum was higher than Anacardium occidentale. The phytochemicals detected in the ethanolic leaf extracts of Chrysophyllum albidum were flavonoids, alkaloids, steroids, cardiac glycoside, tannins, triterpenoid, saponin, and reducing sugar. However, triterpenoids and cardiac glycosides were absent in Anacardium occidentale leaves. The concentrations of all mineral elements were high, with Calcium having the highest concentration of all minerals in both leaves. As a result, the findings suggest that both leaves could serve as a source of highly nutritious feed and phytomedicine. Given the plant's diverse ethnopharmacological uses in various parts of the world, they are of nutritional, clinical, and veterinary importance.

Keywords: *Leaves, mineral analysis, phytochemical screening, phytomedicine, proximate composition*

1. Introduction

In recent years, there has been a gradual resurgence of interest in medicinal plant use in developing countries, owing to reports that herbal medicines are safe and have no negative side effects, especially when compared to synthetic drugs [1]. As a result, looking for new drugs with better and cheaper plant-based alternatives is a natural choice [1]. These plants have medicinal value because they contain chemical substances that have a specific physiological action on the

human body. These plants are also known to have been consumed by individuals as leafy vegetables, as they are a valuable component of the African diet in general and West Africa in particular [1]. Apart from adding variety to the menu, they may be the easiest food to obtain in a survival situation, and their inclusion in the diet can benefit good nutrition. They have been discovered to contain macro and micronutrients like vitamins, minerals, fiber, amino acids, protein, and carbohydrates. Mineral content, such as potassium (K), sodium (Na), magnesium (Mg), and Phosphorus (P), is one of the most important contributions of edible leafy plants [2]. The African star apple, Chrysophyllum albidum, is found in the South-Western part of Nigeria. They are wild plants belonging to the Sapotaceae family, which includes up to 800 species. Their trees grow 10 to 20 meters tall, with round, pear-shaped, or sub-spherical-shaped fruits measuring up to 3 cm in diameter. The small flowers are 3 to 8 mm in diameter, and the oval, greenish (above), and golden pubescent (below) leaves are 3 to 15 cm long [3]. Anacardium occidentale (cashew) is native to Brazil and can be found in the Caatinga, Cerrado, and Amazonian biomes. The cashew tree is now widely planted worldwide, particularly in Brazil, Vietnam, India, Nigeria, Indonesia, the Philippines, Benin, Guinea-Bissau, and the Ivory Coast. It is a member of the Anacardiaceae family, with approximately 22 species in the genus Anacardium; Anacardium occidentale is used commercially. The cashew tree is an evergreen tree that grows to a height of 8–15 meters. The nut, a brown, reniform achene composed of the pericarp (shell) and the almond, is the true fruit of the cashew tree [4]. This study aims to compare Chrysophyllum albidum and Anacardium occidentale leaves to determine selected nutritional and phytochemical properties.

2. Materials and Method

2.1. Collection and Preparation of Samples

Chrysophyllum albidum and Anacardium occidentale leaves were collected from the Federal University of Agriculture's Horticulture Department in Abeokuta, Nigeria. The leaves were separated from their stalk, air-dried at room temperature, then pulverized to powder form after drying using a mortar and pestle. Aliquot portions of the powdered leaves were weighed and used for the proximate analysis.

2.1.1. Chemicals and Reagents

Materials used include beakers, filter paper, a hot plate, a 100 mL conical flask, a measuring cylinder, a fume cupboard, an analytical weighing balance, and a funnel. Concentrated HNO3, concentrated HCI, and Distilled water were the reagents used and were of analytical grade.

2.1.2. Extraction of the Plant Leaves

Ethanolic extract of the plant leaves was prepared by soaking 100g of the dry powdered plant leaves in 1000ml of absolute ethanol at room temperature for 48 hours (for thorough extraction). After that, the extract was filtered twice, first through Whatman filter paper No. 42 (125mm) and then through cotton wool in a funnel. The extract was then concentrated to one-tenth its original volume using a rotary evaporator with a water bath set at 60°C and then freeze-dried. The dried residue (crude extract) was then kept at 4 degrees Celsius. For phytochemical screening, aliquot portions of the crude plant extract residue were weighed and used [5].

2.1.3. Sample Digestion

In a dry 100 mL conical flask, 1 g of each dried leave sample variety was weighed using an analytical weighing balance. In a fume cupboard, 10 mL of concentrated Nitric acid and 10 mL of Hydrochloric acid were added to the weighed leave sample, and the flask was placed on a hotplate and heated for one hour. The solution became clear, indicating that the sample had been digested. The sample was filtered through filter paper into a 100 mL volumetric flask and made up to the mark with distilled water after cooling. Mineral analysis was performed on an aliquot portion of the digested sample [6].

2.2. Proximate Composition

The powdered leaves were used for the proximate analysis. The contents of dry matter, moisture, ash, crude fat, crude protein (Nitrogen x 6.25), and crude fiber were determined using the Association of Official Analytical Chemists' standard methods (AOAC, 2000). The net difference between the other nutrients and the total percentage composition was used to calculate carbohydrate content. The moisture content was determined by drying 2 g of fresh sample in an oven at 105 °C for 24 hours till a constant weight was achieved. The ash content was determined by incinerating a 2 g sample at 550 °C for 3 hours in a muffle furnace. From a 2 g sample, crude lipid (CL) was extracted using the Soxhlet Method for 8 hours with n-hexane. The nitrogen (N) content was calculated using the micro-Kjeldahl method, and crude protein (CP) content was calculated by multiplying the N % by 6.25. To determine crude fibre content, a 2 g sample was treated with 1.25 % (W/V) H2SO4 and 1.25 % (W/V) NaOH [7].

2.3. Phytochemical Screening

Phytochemical screening was performed using standard procedures [8], [9], [10], [11], [12], [13], [14]

2.3.1. Test for Saponins

In a test tube, 0.5 g of extract was mixed with 5 mL distilled water and vigorously shaken until a stable, persistent froth formed. The frothing was combined with three drops of olive oil and vigorously shaken, with the formation of an emulsion observed [8].

2.3.2. Test for Triterpenoids

Chloroform of 1 mL was used to dissolve 0.5 g of the extract. After that, 2 ml of concentrated H2SO4 was added, followed by 1 ml of acetic anhydride. The presence of triterpenoids is indicated by the formation of a reddish-violet color [9].

2.3.3. Test for Tannins

In separate test tubes, 2 mL of the extract/fraction were diluted with distilled water, and 2–3 drops of a 5 % ferric chloride (FeCl3) solution were added. A green–tannin was indicated by the black or blue coloration [10].

2.3.4. Test for Reducing Sugar (Fehling's Test)

The extract was dissolved in 5 mL distilled water and then filtered, hydrolyzed with dilute HCl, neutralized with alkali (NaOH), and heated with Fehling's A and B solutions. The presence of reducing sugars was indicated by the formation of red precipitate [11].

2.3.5. Test for Anthraquinones

A 0.5 g of the extract was boiled in 10 mL H2SO4 and filtered while it was still hot. The filtrates were shaken with 5 mL chloroform, then pipette the chloroform layer into another test tube and add 1 mL dilute ammonia. Color changes in the resulting solution were observed [12].

2.3.6. Test for Steroids

The extract was dissolved in 10 mL chloroform, and an equal volume of concentrated H2SO4 was added to the test tubes by the sides. The presence of steroids is indicated by a reddish upper layer and a yellowish sulfuric acid layer with green fluorescence [11].

2.3.7. Test for Cardiac Glycosides (Keller-Killiani Test)

A 2 mL glacial acetic acid solution containing one drop of ferric chloride solution was added to 0.5 g of extract dissolved in 5 mL water. 1 mL of concentrated H2SO4 was used as a base. The presence of deoxy sugar characteristics of cardenolides was indicated by a brown ring at the interface. A violet ring may appear beneath the brown ring, while a greenish ring may form just above the brown ring in the acetic acid layer and gradually spread throughout this layer [13].

2.3.8. Test for Flavonoids

A piece of magnesium ribbon was added to 4 mg/mL extracts and fractions, followed by drop-wise additions of concentrated HCl. Flavones were detected when the color changed from orange to red; flavonoids were detected when the color changed from red to crimson [14].

2.3.9. Test for Alkaloids

About 2–3 drops of Dragendoff's reagent were added to 0.1 mL of the extract and fractions in a test tube. The presence of alkaloids was indicated by an orange-red precipitate with turbidity [14].

2.4. Mineral Analysis

After simple digestion using the double acid digestion method, Minerals analysis was performed. A standard flame emission photometer was used to determine sodium (Na) and potassium (K) using NaCl and KCl as standards [15].

3. Result and Discussions

3.1. Proximate Analysis

3.1.1. Crude Protein

Chrysophyllum albidum leaves have a crude protein content of 7.37 %, which is lower than reports by [16] (7.45%) on Chrysophyllum albidum leaves. At the same time, Anacardium occidentale's protein content of 13.95 % is also lower than reports on Anacardium occidentale leaves (14.65%) [17]. In this study, Anacardium occidentale leaves have a high protein content than Chrysophyllum albidum leaves, indicating that they are necessary for animal growth and increased milk production. Plant protein is a food nutrient that is especially important for the poor in developing countries like Nigeria. Proteins are a type of macromolecule that can be used as an alternative energy source when other energy sources are scarce [18]. Food protein is required to produce vital hormones, important brain chemicals, antibodies, digestive enzymes, and essential elements for DNA synthesis. Some proteins play a role in structural support, while others play a role in bodily movement or germ defense [19]. Food protein is required to produce vital hormones, important brain

chemicals, antibodies, digestive enzymes, and essential elements for DNA synthesis. Some proteins play a role in structural support, while others play a role in bodily movement or germ defense [20].

3.1.2. Crude Fat

Chrysophyllum albidum leaves have a higher fat content (3.54%) compared to reports by [16] (3.42%) on Chrysophyllum albidum leaves. In comparison, the crude fat on Anacardium occidentale leaves (8.96%) has a low-fat content compared to [17] on Anacardium occidentale leaves (10.81%). However, the leaves of Anacardium occidentale (8.96%) in this study have a high crude fat content than the leaves of Chrysophyllum albidum (3.54%), indicating that Anacardium occidentale has a higher energy value when there are more fats in the animal leaves [21].

3.1.3. Crude Fibre

The leaves of Anacardium occidentale contained a crude fiber value of 14.97%, which is lower compared to the value reported by [17] 16.45%. Whereas reports by [16] on Chrysophyllum albidum leaves (3.42%) are higher than the fiber content on Chrysophyllum albidum leaves 2.97% from this study. The crude fiber of Anacardium occidentale 14.97% contains a significantly higher amount of crude fiber than Chrysophyllum albidum leaves (2.97%), which implies that Anacardium occidentale leaf contains a high amount of fiber that aids nutrient absorption and promotes regular bowel movements. It also demonstrates that they can aid in the proper functioning of the digestive system [21]. Fiber aids and speeds up the excretion of waste and toxins from the body, preventing them from sitting in the intestine or bowel for an extended period, which can lead to a build-up and various diseases [22]. The leaves' high crude fiber content may also contribute to their hepatoprotective properties and utility in the treatment of diabetes and hypercholesterolemia. Fibre also adds bulk to the diet and prevents the overconsumption of starchy foods, potentially protecting against metabolic diseases like hypercholesterolemia and diabetes [23].

3.1.4. Ash Content

Anacardium occidentale leaves ash value (3.48%) compares favorably with the value reported by [17] (3.70%). The ash value of Chrysophyllum albidum (2.02%) leaves also compare favorably with the value of Chrysophyllum albidum reported by [16] (2.18%). The mineral content preserved in the plant leaf is reflected in the ash content of the plant material. According to the findings, the leaves may contain nutritionally significant elements. The ash value of Anacardium occidentale leaves (3.48%) is higher than that of Chrysophyllum albidum leaves (2.02 %) [24].

3.1.5. Carbohydrate Content (%)

The carbohydrate content of Chrysophyllum albidum is 32.56 % is lower than that of Anacardium occidentale leaves (43.84%). The carbohydrate content of both leaves is lower than reported values for sweet potato leaves (82.8%) and Corchorus tridens (75.0%) [25]. Carbohydrates are known to be necessary for the survival of plants and animals and for providing raw materials for various industries [26]. Plant-produced carbohydrates, along with protein and fat, are one of food's three main energy sources. The process of respiration, a chemical reaction between glucose and oxygen that produces energy, carbon dioxide, and water, releases energy stored as carbohydrates when animals eat plants. Animal cells also use glucose to make other substances that are required for growth [27].

3.1.6. Moisture Content

The moisture content of Anacardium occidentale leaves (39.72%) is comparatively low compared to Chrysophyllum albidum (45.48%). However, they are both high compared to values reported for Annona muricata leaves (11.1%) [28]. The low moisture content of Anacardium occidentale leaves is known to prevent microbial growth and spoilage [29].

Parameters (%)	Chrysophyllum albidum	Anacardium occidentale
Crude Protein	7.37	13.95
Crude Fat	3.54	8.96
Crude Fibre	2.97	14.97
Ash Content	2.02	3.48
Carbohydrate Content	32.56	43.84
Moisture Content	45.48	39.72

Table 1: Proximate Analysis of Chrysophyllum Albidum and Anarcadium occidentale Powdered Leaves Powdered Leaves

3.2. Phytochemical Screening

The phytochemical screening of Chrysophyllum albidum and Anacardium occidentale ethanolic leaf extracts revealed that they all contain secondary metabolites, such as flavonoids, tannins, and alkaloids. Steroids, Saponins, and Reducing Sugar were also discovered in the leaves. Anacardium occidentale leaves did not contain triterpenoids, anthraquinones, or cardiac glycosides, and Chrysophyllum albidum leaves did not contain anthraquinones. Flavonoids and phenolics have been reported to be free radical scavengers that prevent oxidative cell damage and have potent anticancer properties [30]. They may also trigger mechanisms that affect cancer cells and inhibit tumor invasion. Their ability to neutralize and quench free radicals could explain these activities. Tannins have been shown to be effective in treating

inflamed or ulcerated tissues and cancer prevention. Alkaloids are plant-derived chemicals that act as predator and parasite repellents. This is likely what gives these agents their antimicrobial properties. Aponins are thought to react with cancer cells' cholesterol-rich membranes, limiting their growth and viability. Saponins could coagulate and precipitate red blood cells [31].

Phytochemicals	Chrysophyllum Albidum	Anacardium Occidentale
Flavonoids	+ve	+ve
Saponins	+ve	+ve
Tannins	+ve	+ve
Steroids	+ve	+ve
Alkaloids	+ve	+ve
Triterpenoids	+ve	-ve
Anthraquinone	-ve	-ve
Reducing Sugar	+ve	+ve
Cardiac glycosides	+ve	-ve

Table 2: Phytochemical Screening of Chrysophyllum albidum and Anarcadium occidentale Leaf Extract
Where +Ve = Present, -Ve =Absent

3.3. Mineral Analysis

The composition of soils is responsible for the presence and quantity of various minerals in plants. It also depends on the plant's ability to retain these micronutrients selectively. Mineral concentrations and their presence are, therefore, attributed to the type of plant and its surroundings [32]. Minerals play an essential role in plant and animal biological functions. Minerals are primarily responsible for plants' medicinal and toxic properties.

Table 2 shows mineral analysis results on Chrysophyllum albidum and Anacardium occidentale. The results show that the leaves contain significant amounts of Calcium (Ca), Potassium (K), Magnesium (Mg), and Sodium (Na), with Calcium having the highest concentration of all minerals in both Anacardium occidentale and Chysophyllum albidum. Calcium is essential for the absorption of dietary Vitamin B and the activation of lipase. It is also involved in the synthesis of the neurotransmitter acetylcholine. Calcium supplementation helps to reduce blood pressure [33]. Magnesium and potassium play roles in enzyme synthesis, enzyme activation as a cofactor, biological structure promoters, and physiological function [34]. The leaves could not detect elements such as chromium (Cr) and lead (Pb), which is good because lead is toxic to the body and is known to be non-essential. Pollution from industrial activities may be to blame for the availability of these micronutrients in plants. On the other hand, chromium prevents diabetes from interfering with insulin production and function. All other minerals found in the leaves play a role in the physiological and biochemical processes in the leaves [35].

Minerals	Chrysophyllum Albidum	Anacardium Occidentale
Ca	694±27.92	768±5.78
Mg	132±45.38	114±1.84
K	364±24.96	640±21.27
Na	127.09± 17.69	168±24.06
Cr	ND	ND
Pb	ND	ND

Table 3: Mineral Composition of Chrysophyllum albidum and Anarcadium occidentale Powdered Leaves
Values Are Means ± SD for 3 Determinations

4. Conclusion

Finally, the above analytical data revealed that the leaves of Chrysophyllum albidum and Anacardium occidentale are potentially good sources of carbohydrates and protein, as well as being high in minerals like Ca, Na, and Mg. The leaves are also high in phytochemicals, making their consumption extremely beneficial to one's health. However, more research is needed to determine the bioavailability of the nutrients. Their physicochemical properties must also be assessed to determine the edible and industrial uses of the leaves.

5. References

i. Ji, H. F., Li, X. J., & Zhang, H. Y. (2009). Natural products and drug discovery: can thousands of years of ancient medical knowledge lead us to new and powerful drug combinations in the fight against cancer and dementia? EMBO reports, 10(3), 194-200.
ii. Dina, K., & Dina, R. (2015). Raw Food Nutrition Handbook, the: An Essential Guide to Understanding Raw Food Diets. Healthy Living Publications.
iii. Emudainohwo, J. & Earnest, Erhirhie & Moke, Emuesiri & Edje, K.E., (2015). A Comprehensive Review on Ethno-Medicine, Phytochemistry and Ethnopharmacology of Chrysophyllum albidum. Journal of Advances in Medical and Pharmaceutical Sciences. 3. 147-154. 10.9734/JAMPS/2015/18641.

iv. de Andrade, I. M., de Oliveira Nascimento, J. D. A., de Sousa, M. V., dos Santos, J. O., & Mayo, S. J. (2019). A morphometric study of the restinga ecotype of Anacardium occidentale (Anacardiaceae): wild coastal cashew populations from Piauí, Northeast Brazil. Feddes Repertorium, 130(2), 89-116.
v. Akinwunmi, O. A., Adekeye, D. K., & Olagboye, S. A. (2020). Phytochemical quantification, in vitro antioxidant and antidiabetic potentials of methanol and dichloromethane extracts of Triclisia subcordata (Oliv) leaves. Trends in Phytochemical Research, 4(1), 17-24.
vi. González, E., Gómez-Caravaca, A. M., Giménez, B., Cebrián, R., Maqueda, M., Martínez-Férez, A., ... & Robert, P. (2019). Evolution of the phenolic compounds profile of olive leaf extract encapsulated by spray-drying during in vitro gastrointestinal digestion. Food Chemistry, 279, 40-48.
vii. Ahmad, F., Sulaiman, M. R., Saimon, W., Yee, C. F., & Matanjun, P. (2016). Proximate compositions and total phenolic contents of selected edible seaweed from Semporna, Sabah, Malaysia. Borneo science.
viii. Edeoga, H. O., Okwu, D. E., & Mbaebie, B. O. (2005). Phytochemical constituents of some Nigerian medicinal plants. African journal of biotechnology, 4(7), 685-688.
ix. Velavan, S. (2015). Phytochemical techniques-a review. World Journal of Science and Research, 1(2), 80-91.
x. Shittu, O. K., & Abubakar, A. N. (2014). Evaluation of Phytochemicals, Proximate, Minerals, and Anti-nutritional composition of Yam peel, Maize chaff, and Bean coat.
xi. Usunomena, U., & Ngozi, O. P. (2016). Phytochemical analysis and proximate composition of Vernonia amygdalina. Int. J. Sci. World, 4, 11-14.
xii. Ajayi, I. A., Ajibade, O., & Oderinde, R. A. (2011). Preliminary phytochemical analysis of some plant seeds. Res J Chem Sci, 1(3), 58-62.
xiii. Ayoola, G. A., Coker, H. A., Adesegun, S. A., Adepoju-Bello, A. A., Obaweya, K., Ezennia, E. C., & Atangbayila, T. O. (2008). Phytochemical screening and antioxidant activities of some selected medicinal plants used for malaria therapy in South-western Nigeria. Tropical Journal of Pharmaceutical Research, 7(3), 1019-1024.
xiv. Yusha'u, M., Hamza, M. M., & Abdullahi, N. (2021). Antibacterial activity of Adansonia digitata stem bark extracts on some clinical bacterial isolates. International Journal of Biomedical and Health Sciences, 6(3).
xv. USMAN, H. (2013). Nutritional and anti-nutritional analysis of the seed and seed oil of Citrullus Ecirrhosis (wild melon).
xvi. Omoboyowa, D. A., Amadi, U. B., & Aja, O. A. (2016). Comparative evaluation of chemical Profile of Chrysophyllum albidum seed cotyledon and leaf. Journal of medicinal plants studies, 4(4), 203-207.
xvii. Oloruntola, O. D. (2021). Proximate, phytochemical, mineral composition, and antioxidant activity of Anacardium occidentale L. leaf powder. DYSONA-Life Science, 2(4), 39-49.
xviii. James, O., & Emmanuel, U. C. (2011). Comparative studies on the protein and mineral composition of some selected Nigerian vegetables. African Journal of Food Science, 5(1), 22-25.
xix. Gropper, S. S., & Smith, J. L. (2012). Advanced nutrition and human metabolism. Cengage Learning.
xx. Fallah, A., Mohammad-Hasani, A., & Colagar, A. H. (2018). Zinc is an essential element for male fertility: a review of Zn roles in men's health, germination, sperm quality, and fertilization. Journal of reproduction & infertility, 19(2), 69.
xxi. Adebayo, S. E., Orhevba, B. A., Adeoye, P. A., Musa, J. J., & Fase, O. J. (2012). Solvent extraction and characterization of oil from African Star Apple (Chysophyllumalbidum).
xxii. Adeyeye, A., Ayodele, O. D., Akinnuoye, G. A., & Sulaiman, W. (2018). Proximate composition and fatty acid profiles of two edible leafy vegetables in Nigeria. American Journal of Food, Nutrition, and Health, 3(2), 51-55.
xxiii. Yeap, S. K., Ho, W. Y., Beh, B. K., San Liang, W., Ky, H., Yousr, A. H. N., & Alitheen, N. B. (2010). Vernonia amygdalina, an ethnoveterinary and ethnomedical-used green vegetable with multiple bioactivities. Journal of medicinal plants research, 4(25), 2787-2812.
xxiv. Roe, D. J. (1994). Some ecophysiological aspects of cashew (Anacardium occidentale L) with emphasis on possible flower manipulation in Maputaland (Doctoral dissertation).
xxv. Princwill-Ogbonna, I. L., Ogbonna, P. C., & Ogujiofor, I. B. (2019). Proximate composition, vitamin, mineral, and biologically active compounds levels in leaves of Mangifera indica (Mango), Persea americana (Avocado pea), and Annona muricata (Soursop). Journal of Applied Sciences and Environmental Management, 23(1), 65-74.
xxvi. Jeyavishnu, K., Thulasidharan, D., Shereen, M. F., & Arumugam, A. (2021). Increased revenue with high value-added products from cashew apple (Anacardium occidentale L.)—addressing global challenges. Food and Bioprocess Technology, 14(6), 985-1012.
xxvii. Mauseth, J. D. (2014). Botany: an introduction to plant biology. Jones & Bartlett Publishers.
xxviii. Usunomena, U., Okolie, N. P., Anyanwu, G. O., & Egharevba, E. M. (2015). Phytochemical screening and proximate composition of Annona muricata leaves.
xxix. Arekemase, M. O., Adams, A. I., Ibrahim, T. O., Babashola, K. D., & Ahmed, M. I. (2019). The efficacy of extracts of the leaf and bark of cashew plant (Anacardium occidentale) on bacterial isolates isolated from banana (Musa paradisica). Niger. J. Microbiol, 33(2), 4821-4828.
xxx. Ghasemzadeh, A., & Ghasemzadeh, N. (2011). Flavonoids and phenolic acids: Role and biochemical activity in plants and humans. Journal of medicinal plants research, 5(31), 6697-6703.
xxxi. Usunobun, U., & Egharebva, E. (2014). Phytochemical analysis, proximate and mineral composition, and in vitro antioxidant activities in Telfairia occidentalis aqueous leaf extract. Journal of Basic and Applied Sciences, 1(1), 74-87.

xxxii. Nazar, R., Iqbal, N., Masood, A., Khan, M. I. R., Syeed, S., & Khan, N. A. (2012). Cadmium toxicity in plants and role of mineral nutrients in its alleviation.
xxxiii. Perveen, K., Bokhari, N. A., Siddique, I., Siddiqui, I., & Soliman, D. A. (2012). Mineral analysis of Phoenix dactylifera L. leaves by inductively coupled plasma optical emission spectroscopy. African Journal of Pharmacy and Pharmacology, 6(39), 2782-2786.
xxxiv. Pandey, N. (2018). Role of plant nutrients in plant growth and physiology. In Plant nutrients and abiotic stress tolerance (pp. 51-93). Springer, Singapore.
xxxv. Khan, A., & Safdar, M. (2003). Role of diet, nutrients, spices, and natural products in diabetes mellitus. Pakistan journal of nutrition, 2, 1-12.