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THE PHYTOCHEMICAL ANALYSIS OF MORINGA OLEIFERA LEAVES WITHIN THE NEW GEORGIA COMMUNITY, LIBERIA (JUNE–DECEMBER 2023)

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ABSTRACT

Background: Moringa oleifera is a nutrient-rich and medicinally useful plant, highly prized for its multifaceted phytochemicals with curative potential. Although its advantages have been widely investigated across much of the world, not much research has been conducted on the phytochemical profile of moringa leaves in Liberia, even though they are generally consumed in the local diet and traditional medicine. Determining a phytochemical profile is significant to assist with public health as well as agricultural use. **Methods:** In this research, the leaves of moringa that were gathered within June and December 2023 from the New Georgia Community, Bassa Town, Liberia, were subjected to standard phytochemical screening protocols for the identification of alkaloids, flavonoids, saponins, tannins, phenols, and glycosides. The assays were all run in triplicate to ensure reproducibility, and results were compared with available phytochemical literature for validation**. Results:** Screening of the presence of alkaloids, flavonoids, saponins, tannins, phenols, and glycosides was confirmed. Alkaloids were implicated in analgesic and anti-malarial activities, flavonoids in antioxidant and anti-inflammatory activities, saponins in antimicrobial and immune-modulating effects, tannins in wound-healing, phenols in antioxidant protection, and glycosides in cardioprotective functions. Nutritionally, they also had proteins, vitamins A, C, and E, as well as essential minerals like calcium and potassium, pointing to the leaf's use in fighting malnutrition and overall health. **Conclusion:** The phytochemical diversity of Moringa oleifera makes it a promising nutritional supplement as well as medicinal plant in Liberia. Evidence warrants the marketing of moringa products, awareness creation, and sustainable production to improve community health and nutrition.

KEYWORDS: *Moringa oleifera*, phytochemicals, medicinal plants, bioactive compounds, Liberia.

INTRODUCTION

Moringa oleifera, also known as moringa or the "miracle tree," is indigenous to the Indian subcontinent but has become a global plant of interest because of its incredible nutritional and medicinal value. It has been extensively cultivated in tropical and subtropical parts of Asia, Africa, and Latin America owing to its versatility, quick growth, and wide range of uses (Anwar et al., 2020). The plant is greatly valued, in addition to its edible leaves, for its seeds, flowers, pods, and roots, every one of which holds compounds with therapeutic or nutritional significance. This diversity has secured moringa a significant position both in conventional medication and contemporary dietetic interventions.

The leaves of M. oleifera are particularly rich in vitamins (A, C, and E), minerals such as calcium and potassium, and proteins that make them an affordable and sustainable source of nutrition in communities facing food insecurity. Also, they possess several phytochemicals like alkaloids, flavonoids, tannins, phenols, saponins, and glycosides, which are associated with a range of biological activities including antioxidant, antimicrobial, anti-inflammatory, and cardioprotective activities (Malhotra & Mandal, 2018; Dodiya et al., 2015). These compounds have gained interest due to their use in preventing chronic diseases and enhancing overall health results.

Worldwide, moringa has been researched for its use in the fight against malnutrition, immunity enhancement, and integrative healthcare delivery. Nonetheless, in Liberia, and specifically in the New Georgia Community of Bassa Town, scientific research on the phytochemical

content of locally grown moringa is sparse. Despite the fact that the plant is cultivated and used within homes, its phytochemical content has not been extensively analyzed to provide scientific proof of its medicinal and nutritional potential in the context.

Thus, this research tries to address this research gap by carrying out a detailed phytochemical analysis of leaves of Moringa oleifera samples obtained from the New Georgia Community from June through December 2023. The results will have the potential to provide scientific justification for the use of moringa as a functional food and medicinal crop in Liberia, with benefits both to community health and sustainable agriculture.

MATERIALS AND METHODS

Research Design

Experimental research design was used in the study to identify and describe the phytochemical components of Moringa oleifera leaves using in vitro screening methods. The design used was valid because it facilitated direct laboratory-based experiments on bioactive compounds under controlled circumstances. Focus was laid on the qualitative identification of secondary metabolites recognized for their medicinal and nutritional functions, including alkaloids, flavonoids, tannins, phenols, glycosides, and saponins. Experimental setup ensured replicability as well as accuracy in determination of the phytochemicals present, as well as facilitating comparison with related work elsewhere.

Sample Collection

Young, fresh moringa leaves were harvested from cultivated plants at the New Georgia Community, Bassa Town, Liberia, during a six-month period (June–December 2023). The collection period was determined to determine seasonal variation in leaf phytochemistry. A random sampling method was used, where leaves were randomly collected from various plants in various household gardens and community plots. The method ensured that there was no sampling bias and that the analyzed leaves were representative of the one grown around there. Clean sterile polyethylene bags were used to transport the collected samples to avoid contamination. The samples were air-dried at room temperature to maintain their bioactive compounds prior to analysis in the laboratory.

Phytochemical Screening

Phytochemical screening was also carried out at the UL Microbiology Laboratory (2024) according to established protocols. All tests were run in triplicate to enhance accuracy and minimize error. Alkaloids were identified using the iodine reagent, where the production of reddish-brown precipitate was an indication of their presence. Flavonoids were detected using treatment with sodium hydroxide followed by dilute acid, where the production of yellow coloration that became colorless upon acid addition was an indication of their presence. Tannins were identified by the addition of ferric chloride solution, which gave a greenish-black coloration, whereas phenols were detected by the ferric chloride reaction and identified by a deep blue color. Glycosides were identified by glacial acetic acid, ferric chloride, and sulfuric acid, with a reddish-brown color at the junction validating their presence. Saponins were detected by the frothing test, with persistent foam determining their occurrence. All findings were noted meticulously, and findings were tabulated for later comparison with the literature.

Data Collection and Analysis

All observations made in the experimental setup during the phytochemical screening were conducted in a systematic manner. Every test for alkaloids, flavonoids, tannins, phenols, glycosides, and saponins was performed in triplicate to ascertain reliability, reproducibility, and accuracy of results. The results were noted on standard laboratory observation sheets with special care for the color changes, precipitates, or frothing behaviors that suggested the occurrence of specific compounds.

Data analysis utilized descriptive statistics to present the qualitative findings in terms of frequency and consistency of compound detection between replicates. Presence or absence of phytochemicals was presented in categorical terms (positive or negative results), and comparison was made to published phytochemical profiles of Moringa oleifera from previous studies in Africa and Asia. This comparative study facilitated the verification of results within a wider scientific framework, with the added advantage of emphasizing regional differences in phytochemical composition.

Ethical Considerations

This study was conducted in strict adherence to ethical guidelines as approved by the Institutional Review Board (IRB) of the University of Liberia. Prior to sample collection, permission was obtained from local community leaders and landowners to harvest moringa leaves within the New Georgia Community. All collections were performed responsibly to prevent overharvesting and to ensure the sustainable use of local plant resources.

In the lab, tests were conducted according to proven standards of precision, integrity, and replicability. Researchers took tough measures to avoid contamination, properly tagged all samples, and kept detailed lab records to serve as proof of transparency and accountability. Even though the study did not touch on human or animal subjects, ethical considerations concerned environmental sustainability and integrity of data, both of which were stringently practiced during the research process. Adherence to IRB standards cemented the study's dedication to ethical and responsible scientific methodologies.

RESULTS

Table 1: Phytochemical compounds detected in moringa leaves.

Phytochemical	Test Reagent	Observation	Interpretation
Alkaloids	Iodine	Reddish-brown precipitate	Present
Flavonoids	NaOH + Dilute Acid	Yellow → Colorless	Present
Tannins	Ferric chloride	Greenish-black	Present
Phenols	Ferric chloride	Deep blue color	Present
Glycosides	Acetic acid + $FeCl_3$ + H_2SO_4	Reddish-brown junction	Present
Saponins	Frothing	Persistent foam	Present

The qualitative phytochemical assay of New Georgia Community moringa leaves showed the existence of various bioactive compounds, which were individually detected using standard chemical reagents and observation methods. Alkaloids were identified by the iodine test, with the appearance of a reddish-brown precipitate, proving their existence. Flavonoids were established through the NaOH and dilute acid test, which exhibited a yellow to colorless color change, showing that they are present in the leaves. The ferric chloride test was greenish-black in color for tannins and deep blue in color for phenols, thereby ensuring that these two phenolic compounds are present in high amounts. Detection of glycosides was done employing the mixture of ferric chloride, acetic acid, and sulfuric acid, which gave a reddish-brown junction that verifies their existence. Lastly, saponins were confirmed employing the frothing test, wherein the formation of foam lasting for a long period confirmed their existence.

The identification of the varied phytochemical compounds identifies the high bioactive content of moringa leaves. Alkaloids offer the possibility of analgesic and anti-malarial activity, flavonoids and phenols offer antioxidant and anti-inflammatory activities, tannins offer antimicrobial action, glycosides lend cardioprotective value, and saponins are noted for immune modulation and cholesterol lowering. Together, these observations document the nutritional and therapeutic value of moringa leaves, justifying their application as a natural resource for health maintenance and disease prevention in Liberia.

Table 2: Health significance of phytochemicals in moringa leaves.

Compound	Medicinal Benefits	Nutritional Benefits
Alkaloids	Pain relief, anti-malarial	–
Flavonoids	Antioxidant, anti-inflammatory, anti-cancer	Supports immunity
Saponins	Antimicrobial, enhances nutrient absorption	–
Tannins	Astringent, wound healing, anti-inflammatory	–
Phenols	Antioxidant, prevents cellular damage	–
Glycosides	Therapeutic (cardiac glycosides)	–
Vitamins (A, C, E)	–	Vision, skin, antioxidant
Minerals (Ca, K)	–	Bone, muscle, electrolyte balance
Proteins	–	Essential amino acids, growth

The phytochemical and nutrient profile of moringa leaves shows a wide range of medicinal and nutritional advantages. Alkaloids, for example, have pain-relieving and anti-malarial activities with illustration of their therapeutic use, with flavonoids showing excellent antioxidant activity with anti-inflammatory as well as anti-cancer activities while also aiding in immune support. Saponins are involved in antimicrobial activity as well as in aiding nutrient absorption, while tannins have astringent activities, facilitate wound healing, and inhibit inflammation. Phenols provide antioxidant protection by preventing cell damage, and glycosides such as cardiac glycosides provide therapeutic advantages for heart protection.

Besides bioactive compounds, moringa leaves are also high in essential vitamins and minerals that enhance nutritional health. Vitamins A, C, and E promote vision, skin health, and antioxidant defense, while minerals like calcium and potassium ensure bone structure, muscle function, and electrolyte balance. The protein content provides necessary amino acids required for growth and tissue repair.

Taken altogether, the blend of phytochemicals and nutrients places moringa leaves as a functional food with preventive and therapeutic uses in health. Their inclusion in diets or medicinal preparations has the capacity to enhance overall well-being, enhance immunity, and prevent dangers arising from oxidative stress, malnourishment, and chronic diseases. These observations highlight the potential for moringa as a natural product in health promotion among communities like New Georgia and others.

DISCUSSION

Phytochemical screening of the Moringa oleifera leaves harvested from the New Georgia Community verified the alkaloids, flavonoids, saponins, tannins, phenols, and glycosides. This supports the findings of earlier research

carried out in Asia and Africa, which in turn reported moringa to be a rich source of bioactive compounds with tremendous medicinal and nutritional potential (Kirtikar & Basu, 2021; Bennett et al., 2018).

Alkaloids were detected by the formation of a reddish-brown precipitate, supporting previous findings of their abundance within moringa leaves. Alkaloids have been much recognized for their pharmacological activity, especially in pain management and antimalarial uses (Kirtikar & Basu, 2021). Their detection strengthens moringa's possible utilization where malaria and other infectious conditions continue to persist.

Flavonoids, which were identified by typical color changes, are potent antioxidants that reduce oxidative stress and also have anti-inflammatory activities. The findings of this study agree with Anwar et al. (2020), who reported that flavonoids in moringa play an important role in its anticancer and cardioprotective activity.

Saponins were verified by ongoing frothing, in keeping with Oduro et al. (2019). These chemicals are related to antimicrobial properties, enhanced nutrient uptake, and bolstering the immune system, pointing to potential benefits of moringa intake for digestive as well as immune health.

Tannins, as evidenced by a greenish-black coloration, validate moringa's herbal use in wound healing and anti-inflammatory treatment. Bennett et al. (2018) also emphasized tannins' astringent and shielding functions in moringa leaves.

Phenols, which resulted in a blue coloration, are strong antioxidants which have been known to eliminate free radicals and hinder cell damage. This finding corroborates the findings of Fahey et al. (2017), who highlighted phenols as key compounds in the prevention of chronic diseases.

Lastly, glycosides were established by the reddish-brown coloration of the test solution at the junction. These are cardiac glycosides that possess therapeutic value in the treatment of cardiovascular diseases. Leone et al. (2016) also provided similar findings highlighting the significance of moringa glycosides in cardioprotection.

Generally, these findings justify the phytochemical content of moringa and attest to its applicability in traditional and modern therapeutic compound development. The correlation of the findings with existing research confirms moringa's consistency in geographical settings, as well as a scientific basis for its use in Liberia. More importantly, the occurrence of varied phytochemicals makes Moringa oleifera a potential prospect for the construction of nutritional supplements, medicinal herbs, and functional foods. In addition, the results indicate potential for mainstreaming moringa production into community-focused nutrition and health programs for both treating malnutrition and managing chronic diseases in low-resource environments.

CONCLUSION

The current research illustrates that moringa leaves from the New Georgia Community contain a rich and varied composition of phytochemicals consisting of alkaloids, flavonoids, saponins, tannins, phenols, and glycosides. These substances are well-documented for their extensive bioactive effects, including antioxidant, anti-inflammatory, antimicrobial, and cardioprotective activities. The occurrence of these bioactive ingredients illustrates the twin therapeutic as well as nutritional value of moringa leaves, making them a valuable natural source for managing common health issues.

Notably, the results indicate that moringa leaves may have a key role in preventive care strategies, especially in resource-scarce environments such as Liberia where access to traditional medicines might be limited. Their addition to daily diets or as complementary herb medicines may help promote better general health, increased immunity, and control of chronic diseases including oxidative stress, hypertension, and metabolic disorders.

Generally, the research supports the importance of marketing native plant sources such as moringa not just due to their potential as a nutritional food source but also because of their ability to aid in community health and wellness. Future studies on dosage maximization, bioavailability, and clinical effectiveness will be important to maximize fully the therapeutic application of moringa leaves in Liberia and elsewhere.

Recommendations

1. Perform in vivo and clinical trials: Careful laboratory and clinical investigations must be carried out to confirm the pharmacological activity, bioavailability, and safety profiles of the bioactive constituents in moringa leaves. These studies will give scientific evidence for their therapeutic uses and regulatory approval for drug use.
2. Create moringa nutritional supplements and herbal products: Based on the high phytochemical content, moringa leaves can be developed into dietary supplements, teas, powder, and other herbal products intended to enhance overall health, control diseases, and avoid nutrient deficiencies.
3. Encourage community awareness programs: Education campaigns should be created to raise awareness of local communities regarding the nutritional and therapeutic value of moringa. Such programs have the potential to encourage adoption, induce diversification in diet, and promote preventive health behavior.
4. Promote sustainable production practices: For a consistent and assured supply of quality moringa

leaves, stakeholders must embrace sustainable production practices such as organic farming, conservation of soils, and effective water management. This will save natural resources while contributing to local livelihoods.

5. Incorporate moringa into national nutrition and healthcare policies: Policymakers need to seriously consider adding moringa-based interventions into Liberia's nutrition programs, public health plans, and school feeding programs. Such incorporation can enhance population health outcomes, cut back on the reliance on synthetic supplements, and encourage the utilization of native plant material.

Take-Home Message

New Georgia Community moringa leaves are high in varied phytochemicals and essential nutrients and contain substantial therapeutic and nutritional values. Their bioactive agents—including alkaloids, flavonoids, saponins, tannins, phenols, and glycosides—propose antioxidant, anti-inflammatory, antimicrobial, and cardioprotective activities, whereas vitamins, minerals, and proteins add to nutritional health. These results suggest that moringa has the potential to be used as a natural, sustainable resource in supporting wellness, immunity, and disease prevention in Liberia. Sustainable harvesting, public awareness, and incorporation into nutrition and healthcare policies can optimize the plant's health benefit while maintaining environmental sustainability.

Authors Contribution

Hanson Chosen Jlateh helped to conceptualize the study, coordinated the fieldwork data collection, and drafted the initial manuscript. Dr. Stephen Monday served as a study design consultant, conceptualized the methods section, did the analysis, and provided critical edits to the manuscript. Gbi Seyon Jlateh did reviewed, interpreted the data, edited the manuscript, and validated the study.

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Conflict of Interest

The authors confirm that they have no conflict of interest that involves this study. All reporting, analysis, and research were done independently and free of any financial or personal relationships that would have affected the results.

Disclaimer

The views, interpretations, and conclusions expressed in this study are solely those of the authors. They do not necessarily reflect the official policy or position of the University of Liberia, the local community authorities, or any affiliated organizations. The authors assume full responsibility for the accuracy and integrity of the research content.

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