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From Farm Waste to Functional Food: The Hidden Value of Sweet Potato Leaves

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ABSTRACT

Sweet potato leaves (SPL), a byproduct of the widely grown sweet potato (*Ipomoea batatas*) plant, are increasingly being recognized for their nutritional and health benefits. Native to Central and South America, sweet potatoes are cultivated globally, particularly in tropical regions, but the leaves remain underutilized despite their richness in vitamins, minerals, and bioactive compounds. Studies have shown that SPL is a significant source of essential vitamins (A, C, K, B-complex) and minerals (calcium, iron, magnesium) and offers high levels of fiber and antioxidants, surpassing many common leafy greens. The bioactive compounds, including polyphenols, flavonoids, and phenolic acids, contribute to SPL antioxidant, anti-inflammatory, and antimicrobial properties. These health benefits have implications for managing chronic diseases such as diabetes, cardiovascular issues, and potentially cancer. Despite their remarkable nutritional profile, SPL are often discarded or used as animal feed. Recent research emphasizes the integration of SPL into functional foods, aiming to reduce food waste and enhance human nutrition. Additionally, the versatility of SPL in culinary practices highlights their potential to alleviate malnutrition in regions with limited resources.

Keywords : Sweet Potato Leaves, Bioactive Compounds, Antioxidants, Diabetes, Functional Foods and *Ipomoea batatas*

INTRODUCTION

The tuberous roots of sweet potato (*Ipomoea batatas*) are commonly grown, but its leaves are also a valuable yet overlooked source of nutrition. Originally from Central and South America, sweet potatoes are members of the Convolvulaceae family, and they do well in tropical and subtropical areas worldwide. In Asian, African, and Pacific Island cultures, the people have traditionally eaten the leaves of the sweet potato plant because they are seen as a beneficial source of important nutrients and bioactive compounds. Recent scientific research has highlighted the nutritious qualities of sweet potato leaves, pointing out their possible use as a functional food component. Sweet potato leaves are rich in vitamins, minerals, fiber, and antioxidants from a nutritional perspective. Rich in vitamins A, C, and K, along with various B vitamins, they are essential for immune function, vision, blood clotting, and energy metabolism. Sun *et al*. (2014) emphasize the importance of sweet potato leaves as they are rich in minerals such as calcium, potassium, iron, and magnesium, crucial for bone health, muscle function, and oxygen transport. In comparison to other leafy greens, sweet potato leaves offer a greater amount of specific nutrients, like carotenoids, that can turn into vitamin A and have strong antioxidant effects (Islam, 2018). The nutritional richness of sweet potato leaves makes them a promising option for fighting malnutrition and improving food security in areas with limited resources.

Sweet potato leaves contain bioactive compounds in addition to macronutrients and micronutrients, which

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are associated with various health benefits. The antioxidant, anti-inflammatory, and antimicrobial properties of sweet potato leaves are due to the presence of polyphenols, flavonoids, and phenolic acids (Padda and Picha, 2008). These active compounds have been demonstrated to neutralize harmful free radicals, decrease oxidative stress, and regulate inflammatory pathways, potentially aiding in the prevention of chronic conditions like heart disease, diabetes, and specific cancers (Xu *et al*., 2010). Islam (2018) compared the strong antioxidant properties of sweet potato leaves, due to their polyphenol content, to those of spinach and other frequently eaten vegetables.

The health advantages of sweet potato leaves go beyond just their antioxidant properties. Multiple research studies have indicated that incorporating sweet potato leaves into one's diet on a regular basis can help enhance the control of blood sugar levels, which can be advantageous for those with type 2 diabetes or those who are at risk for developing the condition. Compounds found in the leaves could improve the body's response to insulin and block the absorption of carbohydrates, resulting in improved control of blood sugar levels (Chen *et al*., 2005). Sweet potato leaves have also been studied for their possible impact on lipid metabolism. Some studies suggest that incorporating them into one's diet could potentially lower cholesterol and enhance lipid profiles, ultimately decreasing the likelihood of cardiovascular diseases (Park *et al*., 2011). Research has also been conducted on the antimicrobial characteristics of extracts from sweet potato leaves, showing positive outcomes in fighting different pathogens. This indicates potential uses in ensuring food safety and preservation (Kim *et al.*, 2012). Although sweet potato leaves have impressive nutritional and health benefits, they are often not used to their full potential in many regions, where the main emphasis is on the starchy tubers. Part of the reason for the underutilization is a lack of knowledge about the advantages of the leaves and their potential for cooking. In areas where people eat sweet potato leaves, they are usually cooked in different ways such as stir-frying, steaming, boiling, or adding to soups and stews. The delicate youthful leaves are favored for their gentle taste and ease of consumption, whereas mature leaves can be chewier and contain more fibers (Islam, 2018). The versatility of sweet potato leaves in cooking is beneficial for traditional and contemporary diets, and incorporating them into food items may aid in improving nutrition and varying food options.

Current studies have been concentrating on the possibility of integrating sweet potato leaves into functional foods and nutraceuticals. The process of extracting and concentrating bioactive compounds from the leaves may result in the creation of dietary supplements or fortified foods with the goal of improving health and reducing the risk of diseases. Additionally, the leaves are able to be utilized as a component in plant-derived protein items, as they contain important amino acids (Yen *et al*., 2009). Integrating sweet potato leaves into new food items could enhance the value of sweet potato farming and promote more sustainable food production methods through waste reduction.

The importance of utilizing sweet potato leaves is further emphasized by sustainable agriculture and environmental considerations. Due to sweet potato cultivation, the leaves are usually disposed of or fed to animals, missing out on a potential source of nutrition for humans. Encouraging the use of sweet potato leaves can help farmers increase their crop yields and nutrient content, thus decreasing the necessity for extra farming resources. Sweet potato is a resilient crop that can withstand harsh conditions and lack of water, making it ideal for farming in adaptable climates, and the consumption of both its root and foliage could contribute to sustainable solutions for food security (FAO, 2018).

Occurrence, Botanical Description, and Ethnopharmacology of Sweet Potato Leaves:

Occurrence:

Sweet potato, belonging to the Convolvulaceae family, is indigenous to Central and South America but is now a fundamental crop in tropical, subtropical, and temperate areas globally. Global production of this crop is due to its ability to withstand drought, adaptability, and nutritional value, and it is grown in Africa, Asia, and the Americas. Although the tuberous roots are mainly collected for people to eat, the leaves are also plentiful and can be given to animals as feed or thrown away, despite their high nutritional value (Islam, 2018). Sweet potato leaves do well in warm climates and can also flourish in different types of soil, which makes them a versatile crop.

Botanical Description:

Botanically, sweet potato is a perennial vine that is herbaceous and can be grown as an annual in temperate

areas. The plant features crawling stems that can grow up to several meters long, with alternate leaves that vary from heart-shaped to palmately lobed, depending on the type. The leaves, usually green but occasionally tinged with purple, are supported by lengthy petioles and are spirally arranged on the stems. Young leaves are more delicate and favored for eating because they have a softer taste and less fiber, whereas older leaves become more difficult to chew. The flowers of sweet potato plants come in a range of colors, from white to pale lavender, but it is the leaves that are mainly studied for their nutritional and medicinal properties.

Ethnopharmacology:

Traditionally, sweet potato leaves have been used for their medicinal properties in different cultures from an ethnopharmacological perspective. In numerous regions in Asia and Africa, people consume the leaves as a regular part of their diet or for medicinal purposes. In the past, they were commonly used for reducing inflammation, addressing digestive problems, and promoting overall health because of their abundance of antioxidants (Sun *et al*., 2014). The medicinal properties of the leaves are frequently extracted by boiling them or brewing them into teas. Herbs have been utilized in African traditional medicine to increase breast milk production in nursing mothers and address anemia due to their high iron levels (Chen *et al*., 2005).

Bioactive Compounds:

Sweet potato leaves' bioactive compounds, such as polyphenols, flavonoids, and vitamins, are important in their ethnopharmacological applications. These substances are known for their antioxidant, anti-inflammatory, and antimicrobial properties, which are acknowledged in traditional and modern medicine (Islam, 2018). In East Asia, especially in Japan and Korea, sweet potato leaves are eaten for their perceived benefits in promoting health, such as improving blood circulation, digestion, and reducing blood sugar levels (Xu *et al*., 2010). Likewise, researchers have looked into the leaves for their possible benefits in treating diabetes, finding that the compounds present in the leaves could assist in managing blood sugar levels and enhancing the body's response to insulin (Chen *et al*., 2005).

Ethnopharmacology:

Sweet potato leaves, known as *Ipomoea batatas*, have been utilized in traditional medicine practices for many years in different cultures, especially in Asia, Africa, and the Pacific Islands. The reason why they are so important in ethnopharmacology is because of the variety of beneficial compounds they have such as polyphenols, flavonoids, carotenoids, vitamins, and essential minerals, which help promote good health. Sweet potato leaves are used in traditional medicine for their antioxidant, anti-inflammatory, antimicrobial, and anti-diabetic benefits, making them a versatile plant with many uses (Patel and Patel, 2022). Sweet potato leaves are frequently utilized in African traditional medicine to help with anemia and increase milk production for nursing mothers. Their abundance of iron makes them a powerful treatment for anemia, as well as providing essential nutrients for maternal well-being. The usual practice is to eat the leaves as part of the diet or brew them in herbal infusions to enhance these health advantages (Islam, 2018). In some African nations, people boil and eat sweet potato leaves to address issues like inflammation, indigestion, and diarrhea in the digestive system. Sweet potato leaves have been utilized in Asian cultures for both cooking and medicinal reasons for many years. In TCM, the leaves are commonly used to control blood pressure, enhance circulation, and cleanse the body. The leaves are ingested in soups, teas, or cooked as vegetables to lessen symptoms of hypertension and uphold overall heart health (Xu *et al*., 2010). In Japan and Korea, it is believed that sweet potato leaves can enhance digestion, relieve constipation, and reduce the risk of diseases like diabetes.The leaves contain bioactive compounds, specifically polyphenols, that display powerful antioxidant properties, important for preventing diseases associated with oxidative stress (Chen *et al*., 2005). Sweet potato leaves have attracted a lot of interest in ethnopharmacological research for their potential in treating diabetes. Research has shown that compounds found in sweet potato leaves can regulate blood sugar levels by improving insulin sensitivity and blocking enzymes responsible for digesting carbohydrates (Sun *et al*., 2014). This qualifies them as a beneficial addition to one's diet for controlling type 2 diabetes in both conventional and contemporary environments. In the Philippines and other countries in Southeast Asia, people eat the leaves to help keep blood sugar levels steady, typically by cooking them as vegetables or making them into medicinal teas. Taxonomic details of sweeet potato leaves are given in Table 1.

Table 1: Taxonomic Classification of *Ipomoea batatas*

Taxonomic Rank	Classification
Domain	Eukaryota
Kingdom	Plantae
Phylum	Angiosperms
Class	Eudicots
Order	Solanales
Family	Convolvulaceae
Genus	*Ipomoea*
Species	*Ipomoea batatas*

General Characteristics of Sweet Potato:

Sweet potato, also known as *Ipomoea batatas*, is a nutritious tuberous plant that is part of the Convolvulaceae family and has many uses. Its enduring vine growth pattern allows it to adapt to different environments as it can spread out over several meters. Sweet potato leaves are usually heart-shaped to lobed, with a shiny green look, and are commonly eaten for their health advantages. The plant is capable of producing funnel-shaped flowers in white, lavender, or purple colors, though they mostly self-pollinate (Padda and Picha, 2008). The primary characteristic of sweet potato is its tuberous roots, which come in a range of colors including orange, purple, yellow, and white, depending on the type. These root vegetables contain a high amount of carbohydrates, dietary fiber, and important vitamins and minerals, especially beta-carotene in orange-fleshed types, as noted by Chen *et al*. (2005). Sweet potatoes are very versatile, flourishing in a variety of soil types and climates, especially in tropical and subtropical areas. They display the ability to withstand drought, which allows them to be grown in harsher conditions (FAO, 2018). Sweet potatoes are not only used for cooking in various ways like boiling, baking, and frying, but they are also appreciated for their health benefits which involve antioxidant qualities and support for immune function and general health (Islam, 2018).

Characteristics of Sweet Potato Leaves:

***Morphological Features**:*

Sweet potato leaves are known for their unique shapes, varying from heart-shaped to lobed, depending on the type. They are usually a vibrant shade of green, with a smooth or slightly shiny surface. The tender young leaves are editable and valued in many different culinary traditions (Yen *et al*., 2009).

***Nutritional Value**:*

Vitamins A, C, and various B vitamins, as well as iron and calcium, are abundant in sweet potato leaves. Their significant amount of antioxidants helps improve health, making them a valuable dietary addition in various cultures (Islam, 2018).

***Culinary Uses**:*

In several areas, particularly in Asia and Africa, sweet potato leaves are utilized in salads, soups, and stir-fries. They are valued for their nutritional advantages and their capacity to improve the taste and consistency of foods (Sun *et al*., 2014).

***Ecological Importance**:*

Sweet potato plants, along with their foliage, contribute to the maintenance of soil quality and the implementation of crop rotation strategies. Commonly utilized as cover crops for the prevention of soil erosion and enhancement of soil fertility.

Significance of Taxonomy:

***Biodiversity Conservation**:*

Accurate categorization aids in species conservation by determining their role in ecosystems and interactions with other plant species.

***Agricultural Practices**:*

Understanding the classification system helps farmers and agronomists choose the right varieties for growth depending on their unique climate and soil conditions, ultimately improving crop production and sustainability (Yen *et al*., 2009).

***Research and Development**:*

Having taxonomic knowledge helps with studies in areas such as plant breeding, genetics, and medicinal uses of sweet potato leaves, thereby aiding in the creation of better varieties and uses. Nutritional details of sweet potato are given in the Table 2.

Pharmacological Profile of Sweet Potato Leaves:

Antioxidant Activity:

Sweet potato leaves have a high antioxidant capacity due to their abundance of flavonoids, carotenoids, and phenolic compounds. Antioxidants play a vital role in fighting oxidative stress, which is associated with a range of illnesses like heart diseases, diabetes, and cancer.

Table 2: Nutritional Information for Sweet Potato (*Ipomoea batatas*)

Nutrients	Amount per 100g	Unit
Energy	37	kcal
Protein	2.5	g
Fat	0.4	g
Carbohydrates	7.1	g
Dietary Fiber	1.8	g
Vitamin A (as beta-carotene)	13800	IU
Vitamin C	11	mg
Calcium	36	mg
Iron	0.6	mg
Magnesium	30	mg
Potassium	275	mg
Zinc	0.2	mg
Thiamine (Vitamin B_1)	0.1	mg
Riboflavin (Vitamin B_2)	0.4	mg
Niacin (Vitamin B_3)	0.5	mg

Source: Ishida *et al*. (2000)

Mechanism:

The antioxidants in sweet potato leaves help eliminate free radicals and decrease oxidative harm by boosting the body's innate defense strategies. For instance, research has indicated that substances derived from these plants can effectively reduce malondialdehyde (MDA) levels, an indicator of oxidative stress (Jiang *et al*., 2017).

Anti-inflammatory Properties:

Persistent inflammation plays a key role in many health conditions, such as autoimmune diseases and metabolic syndrome. Sweet potato leaves exhibit potential for decreasing inflammation.

Mechanism:

The leaves prevent the production of inflammatory cytokines like TNF-α and IL-6. In experiments conducted in a laboratory, it was found that extracts from sweet potato leaves have the potential to inhibit the activation of nuclear factor kappa B (NF-κB), a crucial component in the inflammatory response (Cheng *et al*., 2019).

Antimicrobial Effects:

Studies have shown that sweet potato leaves have antimicrobial effects on different types of pathogens, such as bacteria and fungi. This may have importance in food safety and health uses.

Mechanism:

The presence of bioactive compounds like tannins and flavonoids is believed to be responsible for the antimicrobial activity. Studies have found that extracts can effectively prevent the growth of common foodborne pathogens such as Escherichia coli and Staphylococcus aureus (Lee *et al*., 2020).

Nutritional Value:

The leaves of sweet potatoes are very nutritious, providing high amounts of vitamins A and C, calcium, iron, and dietary fiber. Their intake can greatly improve nutritional status, especially in groups with limited food options (Patel *et al*., 2022).

Nutritional Benefits:

Carotenoids, a form of Vitamin A, are important for vision and immune system, while Vitamin C is vital for making collagen and acts as an antioxidant. Furthermore, iron and calcium present also aid in maintaining bone health and metabolic processes as stated by Nguyen *et al*. (2021).

Potential Anti-cancer Properties:

Early research indicates that sweet potato leaves could possess anti-cancer properties, which could make them beneficial in supporting traditional cancer treatments.

Mechanism:

Specific substances found in the leaf, such as anthocyanins and other polyphenols, have been proven to trigger apoptosis (controlled cell death) in cancer cells and hinder tumor development both in laboratory settings and within living organisms. For example, researchers have examined extracts from sweet potato leaves on different cancer cell lines and found notable cytotoxic effects (Liu *et al*., 2018).

Anti-diabetic Effects:

Research has also been conducted on the effectiveness of sweet potato leaves in controlling diabetes, specifically in enhancing insulin sensitivity and maintaining blood sugar levels.

Mechanism:

The leaves have components that could improve the absorption of glucose and sensitivity to insulin. Research on animals has demonstrated that extracts from sweet potato leaves can reduce blood sugar levels and enhance

lipid profiles, both important for diabetes management (Zhang *et al*., 2022).

Processing of Sweet Potato Leaves:

Sweet potato leaves processing methods and their descriptions are given in Table 3.

Safety and Toxicology of Sweet Potato Leaves:

Nutritional safety, anti-nutritional factors, allergic factors and other toxicological factors and their descriptions are given in Table 4.

Recommended Dosages and Consumption Guidelines:

The leaves of the sweet potato plant (*Ipomoea batatas*) can be added to the diet without any safety concerns, providing various nutritional advantages. A suggested daily intake for the average person is 50-100 grams of fresh leaves, usually prepared by cooking to increase nutrient absorption and decrease oxalate levels. Cooking techniques like boiling for 5–10 minutes can be efficient, and blanching the leaves for 2–3 minutes before cooking further can enhance their taste and decrease bitterness. One can also add dried and powdered sweet potato leaves to their diet in amounts of 1-2 tablespoons (10-20 grams) of powder recommended. In addition, you can also enjoy fermented sweet potato leaves as a side dish or condiment, with a suggested portion of around 50 grams to increase your probiotic intake. Individuals who have allergies to plants like morning glory should be careful when consuming them and seek advice from a healthcare provider if necessary. Sweet potato leaves are a nutritious and flexible option for meals, and taking the proper precautions in preparing them can maximize

Table 3: Processing Methods and Benefits of *Ipomoea batatas* Leaves

Sr. No.	Processing Method	Description	Benefits	References
1.	Harvesting and Preparation	Young, tender leaves are harvested and washed.	Ensures optimal flavor and nutrient content.	Nwanekezie *et al*. (2019)
2.	Drying	Sun drying or oven drying to preserve leaves.	Extends shelf life and retains nutrients.	Akinmoladun *et al*. (2021)
3.	Blanching	Briefly boiling leaves, then cooling in ice water.	Reduces bitterness, enhances color and nutrients.	Oladipo *et al*. (2020)
4.	Fermentation	Anaerobic fermentation with beneficial bacteria.	Improves flavor and digestibility; adds probiotics.	Okwu *et al*. (2022)
5.	Cooking	Methods include boiling, steaming, and sautéing.	Enhances flavor, reduces oxalates and improves texture	Idowu *et al*. (2019)
6.	Production of Leaf Powder	Grinding dried leaves into powder form.	Facilitates incorporation into various recipes.	Mbah *et al*. (2021)
7.	Utilization in Functional Foods	Incorporation into health foods like pasta and energy bars.	Enhances nutritional profile and health benefits.	Oloyede *et al*. (2023)

Table 4: Nutritional Safety and Considerations for *Ipomoea batatas* Leaves

Sr. No.	Aspect	Descriptions	References
1.	Nutritional Safety	Rich in vitamins A, C, K, calcium, iron, and dietary fiber. Enhances dietary diversity and combats malnutrition.	Nguyen *et al*. (2021)
2.	Oxalate Content	Contains oxalates that can interfere with calcium absorption and may contribute to kidney stones. Cooking methods can reduce oxalate levels.	Oladipo *et al*. (2020)
3.	Anti-nutritional Factors	Contains tannins and phytates that can inhibit nutrient absorption. Cooking can reduce these factors.	Akinmoladun *et al*. (2021)
4.	Allergic Reactions	Rare allergic reactions may occur, including skin irritation and gastrointestinal discomfort, especially in sensitive individuals.	Mbah *et al*. (2021)
5.	Pesticide Residues	Pesticide residues may be present if not sourced properly. Organic cultivation and thorough washing can minimize exposure.	Okwu *et al*. (2022)
6.	Environmental Contaminants	Can absorb heavy metals from contaminated soil. Regular soil monitoring is essential for safety.	Idowu *et al*. (2019)
Recommendations for Safe Consumption		Cook leaves to reduce harmful compounds, choose organic sources, be cautious with allergies, and conduct soil tests for contaminants.	

their safety and health advantages. Regular consumption of this food can have a positive impact on your overall nutritional intake.

Future Research Directions for Sweet Potato Leaves:

Nutritional Profiling:

Investigate the nutrient composition of sweet potato leaves under different growing conditions, varieties, and maturation stages. Understanding the impact of these factors on nutrient levels can help optimize cultivation practices for maximum health benefits.

Functional Foods Development:

Explore the incorporation of sweet potato leaves into functional foods and dietary supplements. Research could focus on formulating products that leverage the leaves' antioxidant, anti-inflammatory, and probiotic properties to address specific health issues.

Bioactive Compounds:

Conduct in-depth studies on the bioactive compounds present in sweet potato leaves, such as flavonoids, phenolics, and glycosides. Understanding their health benefits, mechanisms of action, and potential therapeutic applications can contribute to the development of health-promoting products.

Processing and Preservation Techniques:

Examine various processing methods (e.g., drying, fermenting, and cooking) to determine their effects on the nutritional and sensory qualities of sweet potato leaves. Research could focus on optimizing these methods for better retention of nutrients and flavor.

Oxalate Reduction Strategies:

Investigate innovative techniques for reducing oxalate content in sweet potato leaves while maintaining nutritional quality. This could involve exploring different cooking methods or developing new processing techniques.

Allergenicity Studies:

Conduct research to assess the allergenic potential of sweet potato leaves, particularly in individuals with sensitivities to related plants. Understanding the mechanisms behind any allergic reactions can help inform guidelines for safe consumption.

Health Benefits and Clinical Trials

Design clinical trials to investigate the health benefits of consuming sweet potato leaves, particularly in populations at risk for nutrient deficiencies or chronic diseases. This research could provide evidence-based recommendations for dietary inclusion.

Summary:

Sweet potato leaves (SPL), originating from the tuberous sweet potato plant, are gaining recognition for their nutritional content and health-promoting properties. SPL are rich in vitamins (A, C, K, and B), minerals (calcium, iron, and magnesium), and bioactive compounds like polyphenols, flavonoids, and phenolic acids. These components make SPL highly nutritious; offering more antioxidant benefits than many commonly consumed leafy greens such as spinach. Traditionally, SPL have been used in many cultures, particularly in Asia and Africa, to improve health conditions ranging from inflammation to blood sugar control. For instance, compounds in SPL can help manage type 2 diabetes by enhancing insulin sensitivity and lowering blood glucose levels. Moreover, SPL possess anti-inflammatory properties that may lower the risk of chronic diseases like heart disease and some cancers. Despite their health benefits, SPL are often underutilized outside traditional regions, usually discarded or relegated to animal feed. Modern research supports their potential in functional foods and nutraceuticals, providing an opportunity to improve human nutrition and address food security concerns in developing regions. Furthermore, their resilience in harsh climates positions sweet potatoes and their leaves as vital crops for sustainable agriculture.

Conclusion:

The nutritional and health benefits of sweet potato leaves (SPL) are well-documented, yet their potential remains largely untapped. SPL offer a rich array of vitamins, minerals, and bioactive compounds that contribute to numerous health benefits, including antioxidant, anti-inflammatory, and anti-diabetic properties. These leaves, traditionally consumed in various cultures, can play a critical role in addressing global food security and malnutrition issues. With growing interest in integrating SPL into functional foods and nutraceuticals, there is a clear path for incorporating them into modern diets. Additionally, utilizing SPL can promote sustainable agricultural practices by minimizing waste and

maximizing crop usage. Encouraging broader consumption of SPL, particularly in regions with limited food resources, can enhance nutritional intake and support health improvements on a larger scale. As research continues to uncover the therapeutic potential of SPL, their role in preventing chronic diseases like diabetes and cardiovascular conditions could further solidify their importance in global nutrition.

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