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"SWEET POTATO LEAVES: AN UNDERUTILIZED NUTRITIONAL POWERHOUSE AND ITS ROLE IN GLOBAL FOOD SECURITY BY THEIR VALUE ADDITION"

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ABSTRACT

Sweet potato leaves (*Ipomoea batatas*) are a nutritionally rich yet underutilized resource, offering significant potential for enhancing food security and promoting health. This review explores recent advancements in the development and standardization of processing and preservation technologies for sweet potato leaves, highlighting their chemical composition, bioactive compounds, and medicinal properties. Sweet potato leaves contain high levels of essential nutrients such as vitamins A, C, B_6, calcium, and iron, as well as antioxidants, polyphenols, and flavonoids. These bioactive compounds contribute to their health-promoting properties, including anti-diabetic, anti-inflammatory, cardio-protective, and antimicrobial effects. Despite their potential, sweet potato leaves are underutilized in many parts of the world, particularly in regions facing food insecurity. This review discusses various methods to incorporate sweet potato leaves into diets, such as soups, salads, and powdered forms, and emphasizes the importance of sensory evaluation in developing consumer-acceptable products. Sensory tests on sweet potato leaf soup revealed high consumer acceptability, with positive scores for appearance, texture, flavor, and overall acceptability, suggesting strong potential for the leaves as a food product. Furthermore, the potential use of sweet potato leaves as animal feed, contributing to improved protein intake and growth performance, is discussed. This review also highlights the need for more research into consumer education and improving flavor profiles to enhance the wider adoption of sweet potato leaves in modern diets. Sweet potato leaves offer significant potential as a sustainable and nutritious food source. By developing effective preservation methods and raising awareness of their health benefits, sweet potato leaves could play a vital role in improving nutrition, particularly in food-insecure regions. The standardization of processing techniques is crucial for unlocking the full potential of this underutilized crop.

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Keywords: Sweet potato leaves, antioxidants, bioactive compounds, food preservation and medicinal properties.

INTRODUCTION

Sweet potato *(Ipomoea batatas)* is known to be a good source of ascorbic acid (Vitamin C) and certain vitamins B that are considered essential to human health (Asher *et al.,* 1997). Besides the commonly consumed root of the plant, certain tissues in sweet potato are also edible and high in nutritional value (Bovell, 2007). Although studies have confirmed that water-soluble vitamins exist in sweet potato roots and leaves, there has been limited information about how these vitamins are actually distributed in the plants (Barrera and Picha, 2013). Wilmer Barrera and David Picha from Louisiana State University Agricultural Centre published a research study in *Hort Science* that shows that mature and young leaves of sweet potato can provide significant amounts of vitamin B_6 and other essential vitamins.

Sweet potato is a herbaceous perennial vine, which produces storage roots and edible leaves and can grow on marginal lands. The sweet potato plants have been widely dispersed by humans throughout the world since its domestication in the New World (Greige and Smith, 1961). Currently, sweet potato is the sixth most important food crop after rice, wheat, potatoes, maize and cassava (Cable, 1992). In 2015, 105 million tonnes of sweet potatoes were produced worldwide and 95% thereof in developing countries with China as the lead producer. The sweet potato is the seventh most important food crop in the world (FAO, 1997), and is among the crops selected by the U. S. National Aeronautics and Space Administration to be grown in a controlled ecological life support system as a primary food source (Hoff *et al.,*1982).

The utilization of the sweet potato leaves as a vegetable in addition to the storage roots could significantly increase food availability in countries with reoccurring food shortages. Currently sweet potato greens are consumed to a limited extant as a fresh vegetable in some parts of the world (Villarreal *et al*., 1982).Sweet potato leaves are consumed as vegetables around the world, especially in Southeast Asia.

Chen *et al.* (1977) investigated the inhibitory effect of sweet potato leaves on low-density lipoprotein oxidation *in vitro* and in human subjects. We compared the antioxidant activity of 8 kinds of sweet potato leaves. Every sweet potato leaf had high radical scavenging activity and prolonged a lag time for starting low-density lipoprotein oxidation in *vitro* (Dominguez, 1992). In several research, we found that sweet potato leaves contained abundant polyphenol compounds and the radical scavenging activity and prolongation rate of lag time were highly correlated with total polyphenol content (Islam *et al.,* 2006). It is also confirmed that thio-barbituric acid reactive substances production was increased in endothelial cell-mediated low-density lipoprotein oxidation, which was decreased by treatment with sweet potato leaves (Dominguez and Ly, 1997). It was further measured the low-density lipoprotein oxidizability in 13 healthy volunteers after their intake of 18g of “Suioh”, raw sweet potato leaves. “Suioh” prolonged a lag time for starting low-density lipoprotein oxidation and decreased low-density

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lipoprotein mobility. These results suggest that sweet potato leaves have antioxidant activity leading to the suppression of low-density lipoprotein oxidation.

China is the leading country of sweet potato production all over the world, with the annual production 70,741,161 Tonnes in 2013, which was 68.61% of the world's total production (103,109,367 Tonnes) (FAO, 1997).

Basic objectives of this study is the value addition in sweet potato leaves as well as standardization of developed product.

Figure 1: Sweet potato leaves

MEDICINAL APPLICATIONS OF SWEET POTATO LEAVES:

Sweet potato leaves not only offer significant nutritional benefits, but they also have potential medicinal applications, particularly in traditional medicine systems. The bioactive compounds found in sweet potato leaves, such as polyphenols, flavonoids, and antioxidants, contribute to their health-promoting properties. Here are some other medicinal applications of sweet potato leave.

1. Anti-Diabetic Properties

Sweet potato leaves have been traditionally used to help manage diabetes. Research suggests that the bioactive compounds in the leaves, including polyphenols and flavonoids, can help regulate blood sugar levels. These compounds may increase insulin sensitivity and reduce postprandial (after-meal) blood sugar spikes (Chu *et al.,* 2000). This makes sweet potato leaves potentially useful in managing type 2 diabetes and preventing complications associated with the disease.

2. Anti-Inflammatory and Analgesic Effects

Sweet potato leaves contain compounds like quercetin and flavonoids that exhibit strong anti-inflammatory and analgesic (pain-relieving) properties. These compounds can help alleviate inflammation in conditions such as arthritis, asthma, and inflammatory bowel diseases (Woolfe, 1992). Traditional medicine often uses extracts from sweet potato leaves to relieve joint pain and inflammation.

3. **Antimicrobial and Antiviral Properties**

The leaves of the sweet potato plant have demonstrated antimicrobial properties, which can help combat infections caused by bacteria and viruses. Studies have shown that the plant's extracts can inhibit the growth of harmful microorganisms, including *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans*. This makes sweet potato leaves potentially useful in treating infections and supporting the immune system (Clark and Moyer, 1988).

MATERIALS AND METHODS FOR PREPARING SWEET POTATO LEAF SOUP

The preparation of sweet potato leaf soup involves several steps that include the collection of raw materials, preparation, cooking, and processing of the soup. This section details the materials and methods used for preparing the soup, including the raw materials, equipment, and instruments required. The process ensures the nutritional quality and palatability of the soup while adhering to food safety standards.

Table: 1. Raw materials required and description of the product

S. No.	Raw Materials	Description
1.	**Sweet Potato Leaves (Fresh)**	**Amount**: 200g of fresh sweet potato leaves.
		Sweet potato leaves are the primary ingredient, rich in vitamins and minerals like vitamin A, C, calcium, and iron.
2.	**Tomato**	**Amount**: 30g tomatoes.
		Tomatoes are added for acidity, flavor, and color, contributing to the soup's overall palatability.
3.	**Onion**	**Amount**: 20g onion.
		Onions enhance the flavor of the soup and provide a slightly sweet taste when cooked.
4.	**Green Chilies**	**Amount**: 2-3 pieces (depending on spice preference).
		Green chilies are optional but are added to give the soup a spicy kick.
5.	**Garlic**	**Amount**: 3-4 cloves.
		Garlic adds an aromatic quality to the soup and enhances the flavor complexity.
6.	**Sweet Potato Powder (Optional)**	**Amount**: 50g.
		Sweet potato powder acts as a thickening agent, improving the texture and adding more flavor.

7.	**Water**	Amount: 500ml.
		Water is used as the cooking medium to extract flavors from the ingredients and create the soup base.
8.	**Salt**	**Amount**: As per taste (Approx. 2-3% required)
		Salt is added as a seasoning to enhance the flavor profile of the soup.
9.	**Black Pepper (Optional)**	**Amount**: To taste.
		Black pepper can be added to complement the spice of green chilies and bring additional warmth to the soup.

Fig. 2: Raw materials in soup

Fig.3: Sweet potato leaves soup

Equipment and Instruments

To ensure the soup is prepared efficiently, the following equipment and instruments are required:

Blender/Grinder

- Purpose: Used to grind the cooked soup mixture into a smooth consistency.
- Specification: A blender with a minimum capacity of 1.5 liters is recommended.

Sieve/Strainer

- Purpose: Used to filter out any large particles, ensuring a smooth soup texture.
- Specification: A fine-mesh sieve is ideal for this purpose.

Stainless Steel Pot

- Purpose: Used for boiling the ingredients and cooking the soup.
- Specification: A pot with a capacity of 2 liters or more is recommended.

Measuring Cup

- Purpose: Used to measure the water and other liquid ingredients accurately.
- Specification: A standard measuring cup with metric markings.

Knife

- Purpose: Used for chopping tomatoes, onions, garlic, and green chilies.

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- Specification: A sharp chef's knife or vegetable knife.

Chopping Board

- Purpose: A surface for cutting and preparing the vegetables.
- Specification: A food-grade plastic or wooden board.

Spatula

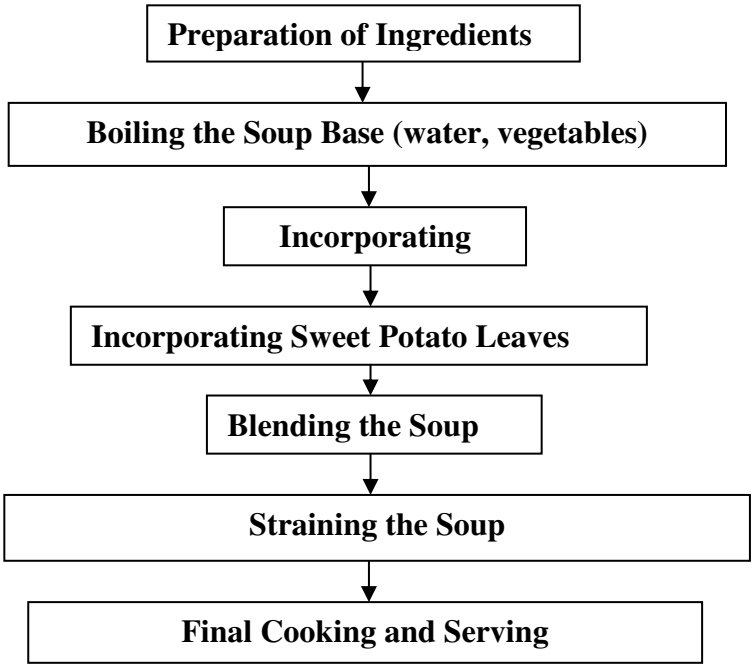
- Purpose: Used for stirring the ingredients during cooking.
- Specification: A heat-resistant spatula, preferably made of silicone or wood.

Weighing Scale

- Purpose: To measure the exact weight of ingredients such as sweet potato leaves and powder.
- Specification: A digital kitchen scale with precision to the nearest gram.

Methods of Preparation

The preparation of sweet potato leaf soup follows these key steps, with detailed instructions provided for each stage.



Step 1: Preparation of Ingredients

- **Sweet Potato Leaves**: If using fresh leaves, rinse them thoroughly under running water to remove any dirt or contaminants. Trim the stems, retaining only the leafy portion. If using dried sweet potato leaves, ensure they are free from debris, and soak them in warm water for 10-15 minutes to rehydrate.

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- **Vegetables**: Wash the tomatoes, onion, green chilies, and garlic. Peel the onion and garlic, and then chop all the vegetables into small, even-sized pieces for even cooking.

Step 2: Boiling the Soup Base

- **Water**: Pour 500ml of water into the stainless steel pot and bring it to a boil over medium heat.
- **Add Vegetables**: Once the water is boiling, add the chopped tomatoes, onion, green chilies, and garlic into the pot. Stir the mixture and allow it to cook for 5 minutes until the vegetables soften.
- **Seasoning**: Add a pinch of salt to taste, and if desired, sprinkle some black pepper for additional seasoning. Let the mixture cook for another 2 minutes to allow the flavors to meld.

Step 3: Incorporating Sweet Potato Leaves

- **Adding Fresh Leaves**: If using fresh sweet potato leaves, add them directly into the boiling vegetable mixture. Stir them in, ensuring they are fully submerged in the water. The leaves will wilt quickly. Continue to cook for 10 minutes, allowing the leaves to soften and release their nutrients.
- **Adding Dried Leaves**: If using dried sweet potato leaves, drain the soaking water and add the rehydrated leaves to the pot. Stir well and cook for 10-12 minutes, allowing the flavors to develop.

Step 4: Adding Sweet Potato Powder (Optional)

- If you wish to thicken the soup and enhance its flavor, slowly add 50g of sweet potato powder while stirring continuously to avoid lumps. Once the powder is fully incorporated, reduce the heat and let the soup simmer for another 10-15 minutes. The powder will act as a thickening agent, giving the soup a heartier texture.

Step 5: Blending the Soup

- **Cooling**: After cooking, remove the pot from the heat and let the soup cool slightly for 5-10 minutes. This step is crucial to prevent splattering during blending.
- **Blending**: Transfer the soup into a blender in small batches and blend until smooth. Alternatively, use an immersion blender directly in the pot for easier handling. Ensure the soup reaches a creamy consistency without large chunks of vegetables or leaves.

Step 6: Straining the Soup

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- **Sieve**: Use a fine-mesh sieve to filter the blended soup, removing any fibrous bits of sweet potato leaves or unblended pieces. This step ensures a smooth, velvety texture.
- **Collection**: Strain the soup into a clean bowl or another pot. Use a spatula to press the mixture through the sieve, extracting as much liquid as possible.

Step 7: Final Cooking and Serving

- After straining, return the soup to the pot for a final round of heating. Taste the soup and adjust the seasoning as needed. Add more salt or pepper according to your preference.
- **Serving**: Once reheated, serve the soup hot in bowls, garnishing with fresh herbs like cilantro or parsley if desired. The soup can be paired with bread or rice for a complete meal.

The best-identified sample was packed in polythene packets weighing 20g each. All the packets were kept at room temperature and stored for a period of eight months. The stored samples were analyzed after everyone month interval for moisture, protein, fat, ash, crude fiber and mineral content. Calcium, phosphorus and iron by the methods reported earlier. The data were statistically analyzed following the principle of analysis of variance and Duncan's new multiple range tests (Steel and Torrie, 1960).

Sweet potato leaves consumption

Bioactive compounds within fruits and vegetables are critical for protecting cellular components from oxidative damage contributing to disease pathogenesis. When incorporated into the diets of animals, sweet potato leaves have potential mechanisms to improve dietary protein and amino acid intake, as well as improve growth performance. Earlier studies indicated that sweet potato leaves as a daily component of the New Guinean diet contributed a significant amount of nitrogen to the value of protein in the diet. It was also estimated that sweet potato leaves contribute nearly one-third of the overall antioxidant activity contained in vegetables consumed as part of the typical Taiwanese diet. Consumption of the traditional Hawaiian diet, which contains sweet potato leaves, as well as other foods containing dietary fiber, complex carbohydrates, and a low fat content, reduced the risks associated with cardiovascular disease. Researchers at Tuskegee University have demonstrated the consumption of sweet potato leaves affects serum lipid profiles in both humans and animals, and thus shows potential for reducing the risks associated with the development of cardiovascular diseases (Melissa and Pace, 2010)

RESULTS AND DISCUSSIONS

The research focused on the development and standardization of technologies for processing and preserving sweet potato leaves (*Ipomoea batatas*), with the aim of creating value-added products and improving the shelf life and usability of sweet potato leaves (SPL). The findings are significant in contributing to the underutilized potential of SPL in food processing, nutrition, and

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value addition. The nutritional analysis of SPL powder indicated that they contain various nutrients viz carbohydrates (55-60 %), protein content (18-22%), fat content (2-4%), crude fibre (5-8%) and several essential minerals and vitamins

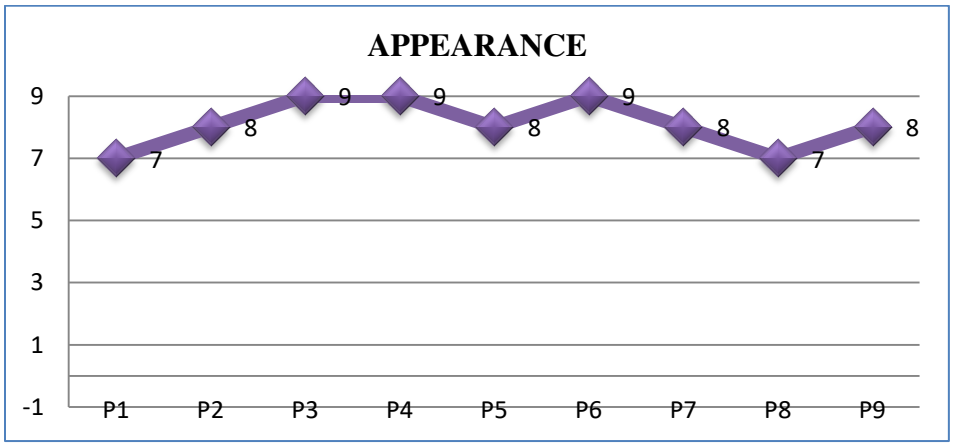
The research outlined various methods for the processing and value addition of SPL. One significant area of investigation was the preparation of a soup through a standardized method of preparation. The developed product provide high magnitude for awareness and popularity of the sweet potato leaves. Sensory evaluation of developed product was done by the 9-point hedonic rating test.

SENSORY EVALUATION

Hedonic Rating Test

Hedonic rating relates to pleasurable or unpleasurable experiences. The hedonic rating test is used to measure the consumer acceptability of food products. From one to four samples are served to the panellist at one session. He is asked to rate the acceptability of the product on a scale, usually of 9 points, ranging from like extremely' to 'dislike extremely'. The results are analyzed for preference with data from large untrained panels. Semi-trained panels in smaller number are used to screen a number of products for selecting a few for consumer preference studies. When pronounced after-effects are met with, precluding testing of a second sample or when independent judgments are sought for, separate cards are used for each product. When relative preference is the object of study, cards with multiple columns for the number of test samples

Appearance: The dish presents a vibrant array of colors, with rich, earthy tones contrasting beautifully against bright greens and vivid reds. Each ingredient seems to glisten under the light, inviting the eye to explore the textures—from the crispness of fresh herbs to the glossy sheen of a perfectly cooked soup. This visual feast not only whets the appetite but also hints at the complex flavors waiting to be savored.



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Taste - The quality of something recognized by the sense of taste or by this together with smell and touch.

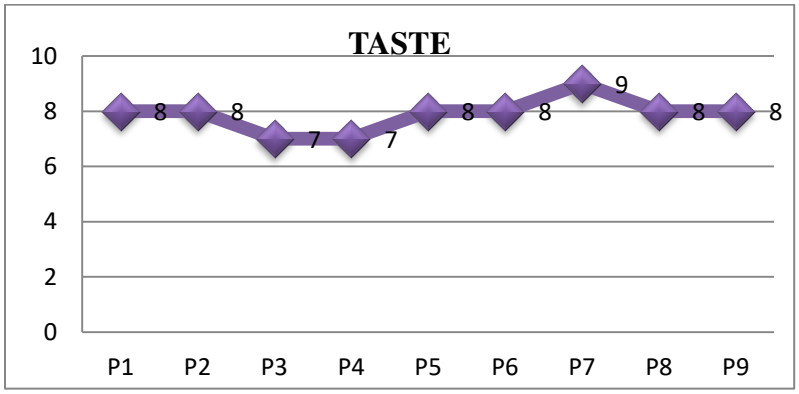

Figure 05: Taste

Texture - Food texture is defined as those properties of a food that are sensed by touch in the mouth and with the hands

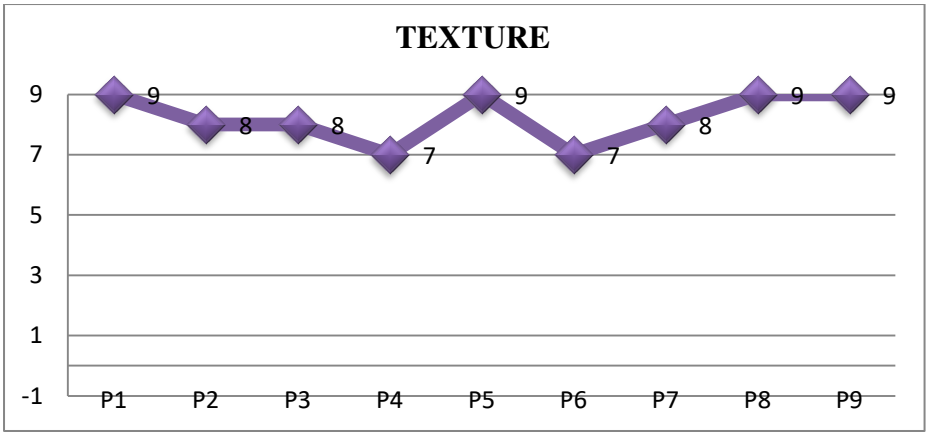

Figure 06: Texture

Flavour - Flavourful, obviously full of flavour, or you could say, instead, flavoursome, tasty, tangy, appetizing, palatable, savoury or sweet -for a particular flavour- and, if you want to try less known words, sapid or saporous. It wouldn't be flavourless, tasteless, bland, flat, or insipid.

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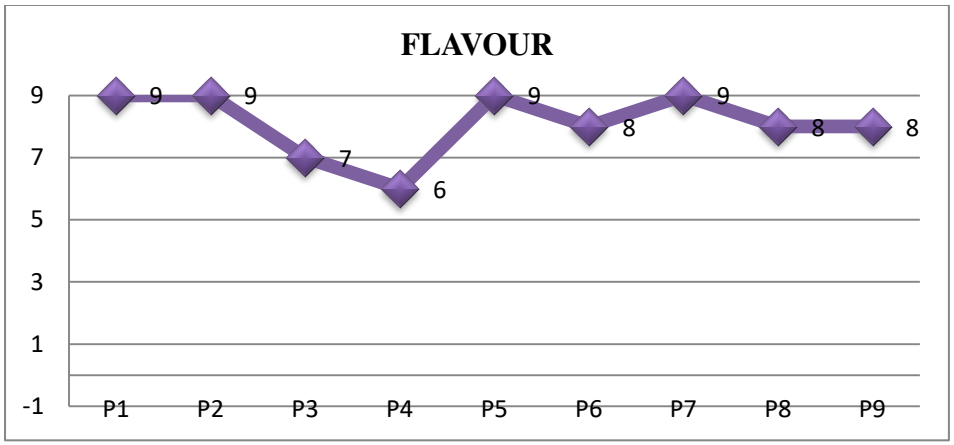

Figure 07: Flavour

Overall acceptability-Food acceptability directly relates to the interaction it has with the consumer at a given moment in time. The key factors that determine food acceptability are the sensory characteristics of food since consumers seek foods with specific sensory properties.

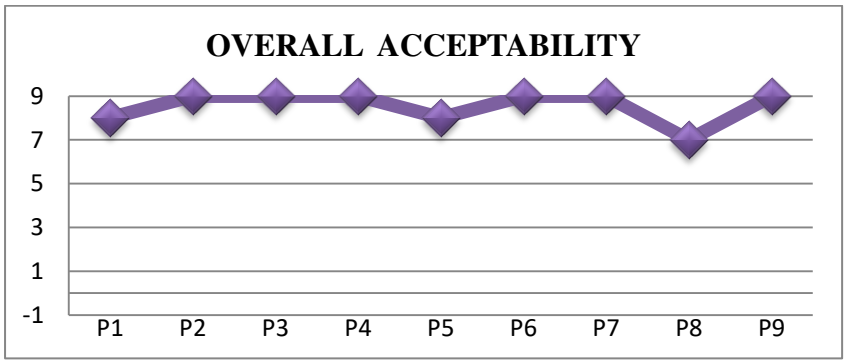

Figure 08: Overall acceptability

The sensory evaluation of sweet potato leaf soup, based on the hedonic rating test, yielded positive results across key sensory attributes: appearance, taste, texture, flavor, and overall acceptability. **Appearance** received a high average score of 8 out of 9. The fresh green color of the soup, derived from the sweet potato leaves, was visually appealing to most panelists, contributing to a sense of freshness and natural quality. However, some noted that the green color was unusual compared to more common soups. **Taste** scored 8, with panelists appreciating the balance between the natural earthy flavors of the sweet potato leaves and the added seasonings like garlic, onion, and tomatoes. A slight bitterness was noted in the leaves, which some panelists found appealing as it added complexity to the soup. A few panelists suggested the bitterness might not be universally accepted, but it was generally well-balanced with other flavors. **Texture** was rated at 8.5, indicating that the soup's smooth and hearty consistency was well-received. The addition of sweet potato powder enhanced the thickness and contributed to a

satisfying mouthfeel. Some panelists mentioned minor graininess, which could be improved with better blending or straining techniques. **Flavor** received a score of 8.5, with the savory elements and mild spiciness from the green chilies enhancing the overall flavor profile. The slight bitterness of the leaves was offset by the sweet and savory seasonings, though some panelists felt it was more prominent in certain samples. The soup's **overall acceptability** averaged 8.5, showing strong potential for consumer acceptance. Despite the slight bitterness, most panelists found the soup enjoyable and would consume it again, highlighting the potential of sweet potato leaves in food products as both nutritious and flavorful.

SUMMARY

The study focused on developing and standardizing technologies for processing and preserving sweet potato leaves, a rich but underutilized source of nutrients and bioactive compounds (Islam, *et al.*, 2002). The research highlighted the leaves' chemical compositions, including high levels of antioxidants, polyphenols, vitamins, and minerals, making them a valuable dietary component. Sweet potato leaves also possess medicinal properties, such as anti-diabetic, anti-inflammatory, and antimicrobial effects, and have potential cardiovascular and anti-cancer benefits. The study detailed the processing methods for turning sweet potato leaves into soup and other products. Sensory evaluations using hedonic rating tests were conducted to assess the acceptability of these products, which scored high in areas such as flavor, texture, and overall appeal. The study also demonstrated that sweet potato leaves could be used as a high-protein feed for livestock, contributing to improved dietary intake and growth performance (Melissa and Pace, 2010). The use of ethanol extracts of the leaves further revealed antibacterial properties, particularly against *Shigella dysenteriae*, and was effective for medicinal applications like enhancing breast milk production and regulating prolactin levels in nursing mothers. Furthermore, the study explored the practical application of sweet potato leaves in food security and public health. By incorporating the leaves into diets in regions prone to food shortages, such as parts of Asia and Africa, their nutritional benefits could address malnutrition and other health issues. The ensiling method was recommended for preserving sweet potato leaves in humid tropical climates where sun-drying is not feasible.

CONCLUSION

The sensory evaluation of sweet potato leaf soup demonstrates its strong potential as an appealing and nutritious food product. With high scores across appearance, texture, flavor, and overall acceptability, the soup was well-received by panelists. The vibrant green color of the soup and the rich, earthy flavors of the leaves were particularly appreciated, especially when balanced with seasonings like garlic, onion, and tomatoes. While some panelists noted a slight bitterness in the taste, this characteristic was generally accepted due to the nutritional benefits associated with the leaves. The addition of green chilies and sweet potato powder further

enhanced the flavor and texture, making the soup more robust and enjoyable (*Watts et al., 1989*). The overall acceptability score of 8.5 out of 9 indicates that sweet potato leaf soup has the potential to be a viable food option in both traditional and modern diets (Bovell, 2007). Its nutritional benefits, including high levels of antioxidants, vitamins, and minerals, make it an attractive choice for health-conscious consumers. Furthermore, the slight bitterness, which may not appeal to all, can be managed through adjustments in seasoning or preparation methods, such as blanching or fermenting the leaves (Chu *et al.,*. 2000). In conclusion, sweet potato leaves, an underutilized resource, have significant potential as a sustainable and nutritious food product. With further research into improving flavor profiles and consumer education on the health benefits, sweet potato leaf products could gain wider acceptance. The findings of this sensory evaluation suggest that the incorporation of sweet potato leaves into everyday diets, whether in soups or other dishes, could contribute to better nutrition and health, particularly in regions facing food insecurity or nutritional deficiencies (*Islam et. al, 2003).*

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