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Formulation and Development of a Functional Fermented Beverage from Guava Leaves

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***Abstract*:** There has been more interest in making functional drinks in the last several years because more people are looking for natural and health-promoting items. Guava leaves were chosen for the beverage's development because of their therapeutic effects on the human body (antibacterial, anti-inflammatory, anti-diabetic), their high polyphenol, flavonoid, and antioxidant content. Guava leaves can be transformed into a novel fermented herbal drink, integrating traditional herbal uses with contemporary nutraceutical applications, which is the first step toward developing a novel beverage. The aim of this research is to develop a functional beverage while utilizing an underused product with various health benefits. This natural, health-driven novel beverage adheres to global consumer demands for inclusive, sustainable and nutrient-dense drinking options and provides artisanal and commercial sectors with a scalable solution to sustainable global demands for economic equity, environmental efficacy and health.

Key words: *Guava leaves, Therapeutic effects, Herbal beverage, Herbal drink, Functional beverage,*

I. INTRODUCTION

The critical role that foods and beverages play in both preventing and treating disease has gained more attention recently. Because functional foods offer health benefits beyond their basic nutritional purposes, their production and consumption have become increasingly important. Due to their ease of use, capacity to meet consumer demands for container contents, size, shape, and appearance, and ease of distribution and storage for products that are shelf-stable and refrigerated, beverages are currently the most active functional food category.

(Corbo., et al 2014). People want such products because they are learning more about nutrition, health, and environmental sustainability. This initiative pushes beverage companies to come up with new ways to make drinks that suit a variety of nutritional needs while also addressing social issues like food waste.

Natural foods and drinks are currently gaining huge popularity among customers all over the world. Limiting sugar and sweeteners in beverages is an effort to reduce obesity and enhance health. Fermented dairy products and non-dairy beverages are popular substitutes for carbonated artificial beverages in several nations (Irkin., et al 2019).

Guava leaves are often thrown away during fruit processing, but they contain various bioactive compounds, including flavonoids, tannins, saponins, terpenoids, and different polyphenols. These compounds have strong antioxidant, anti-inflammatory, and antimicrobial properties. Extracts from the leaves can inhibit the growth of food-borne pathogens like Staphylococcus aureus, E.coli, Shigella spp., and Clostridium spp. This suggests that guava leaves could serve as a natural preservative to improve the microbial stability and shelf life of food products. (Abd El-Aziz., et al 2025).

II. LITERATURE REVIEW

Nutritional and Medicinal Value of Guava Leaves

Guava tree parts, including fruit, stem, bark, leaves, and roots, are frequently used to cure diabetes, diarrhea, stomach aches, and other illnesses. Since people rarely consume guava leaves and their health advantages are not well recognized, they are regarded as one of the non-traditional dietary items. Guava leaves and other plant parts, which are abundant in flavonoids, tannins, and other chemicals, have been demonstrated to have antibacterial, antioxidant, anti-diabetic, and anti-inflammatory properties (Khanna., et al 2025).

Guava leaves have been used for a long time in traditional diets and folk medicine. Their healing properties have been well documented in pharmacological and biochemical studies. The leaves are rich in various phytochemicals, including alkaloids, flavonoids, polyphenolic compounds, terpenoids, saponins, tannins, carbohydrates, lipids, and essential oils, as well as different glycosides and amino acids. These compounds serve as important secondary metabolites, playing a key role in the plant's biological and medicinal effects. (Bulugahapitiya., et al 2021).

Anti-diabetic property of guava leaves

Diabetes mellitus is a long-term metabolic disorder marked by consistently high blood glucose levels. This condition may arise from insufficient insulin production by pancreatic β-cells or from reduced sensitivity of body tissues to insulin. Ongoing high blood sugar is associated with increased production of reactive oxygen species, weakened antioxidant defense, and disturbances in lipid metabolism. These factors together lead to oxidative stress. Oxidative stress is crucial in the progression of diabetes and the development of its long-term complications through gradual cellular damage. Guava leaves have been utilized in various cultures for their health benefits, particularly in the management of metabolic disorders. Studies show that extracts from guava leaves can lower blood sugar and lipid levels due to their high amounts of phenolic compounds and flavonoids, although these levels can change with the seasons. Different parts of the guava plant—like the leaves, fruits, peel, pulp, seeds, and bark—have shown potential for regulating blood sugar and improving lipid profiles in research and clinical studies (Díaz-de-Cerio et al., 2016). Moreover, flavonoids are recognized as important active compounds that contribute to the blood sugar-lowering effects seen in many medicinal plants (Singh et al., 2013).

As a traditional treatment for diabetes, people in Asian countries like Taiwan and Japan boil guava leaves (*Psidium guajava* L.) in water and drink the extract. The current study aimed to find the active ingredient and explore how aqueous guava leaf extract improved glucose absorption in rat clone 9 hepatocytes. To separate the extract into fractions with different polarities, researchers eluted it using MeOH-H2O solutions through Diaion, Sephadex, and MCI-gel columns. They assessed the hypo glycemic effect of these fractions using the uptake test of 2-[1-14C] deoxy-D-glucose in rat clone 9 hepatocytes. High-performance liquid chromatography (HPLC) and nuclear magnetic resonance studies helped identify the active ingredient. The findings indicated that phenolics constitute the primary component of the extract, that the high polarity fractions of the guava leaf extract facilitate glucose absorption in rat clone 9 hepatocytes, and that quercetin is the most active ingredient (Cheng., et al 2009).

Importance of Functional beverages

Functional and medicinal beverages are goods that make claims about health benefits like enhanced heart function, cerebral clarity, or immune system strength. They were created to satisfy the rising demand for "healthy" meals because they are convenient and can avoid illnesses. With the help of these drinks, nutrients or other substances—like flavonoids, certain amino acids, antioxidants, or phytonutrients—can be easily accessed and consumed (Dini., et al 2019).Nowadays, consumers are shifting from synthetic to plant-based functional beverages.

The WHO's guidelines emphasizing the benefits of functional beverages for improved nutrient delivery and preventative health have led to an increase in their demand worldwide. Products with established nutritional profiles and high bioavailability of bioactive substances are given priority by contemporary customers. Ready-to-drink beverages are the functional food segment with the fastest market development because of their convenience and specific advantages. Using just 1 g of sugar per 500 mL, this study created a unique fermented guava leaf drink that is completely digested by natural lactic acid bacteria and contains probiotics (>10 CFU/mL), plant-derived phenolics, and no glycemic impact (GL <1). It is better than traditional functional beverages for managing diabetes and PCOD on a regular basis since it contains

important bioactives such quercetin, gallic acid, vitamins, and organic acids (Gupta., et al 2023).

Customers are more concerned about their health and want beverages that provide excellent delivery of certain nutrients and bioactive compounds, like probiotics, omega-3 fatty acids, fibre, vitamins, minerals, antioxidants, and prebiotics, in addition to being a good source of energy. The current trading is being superimposed by nutritionally sound and nutraceutical-enriched beverages to highlight their demand in both domestic and foreign markets (Giri., et al 2023).

Importance of fermentation

Fermentation started as a way to preserve food. Over time, fermented products have become important parts of human diets due to their nutritional and functional benefits. Eating fermented foods regularly is linked to better gut health and overall well-being. These benefits come from the actions of fermenting microorganisms. They change raw ingredients into bioactive compounds that affect gut microbial balance, support the intestinal lining, and regulate immune function. Additionally, viable microbes temporarily enter the digestive tract. They can suppress harmful organisms and encourage anti-inflammatory responses. Therefore, choosing the right raw materials and specific microbial strains for fermentation is crucial to achieving the desired benefits in fermented foods. (Tajmousavilangerudi., et al 2025).

Humans have been using microbial fermentation, a common metabolic process, for thousands of years. Fermented food makes up almost one-third of the world's food supply, which naturally has a significant impact on both local and global economies. With the yeast (*Saccharomyces cerevisiae)* being one of the earliest domesticated organisms, fermentation has a particularly long history in the baking and brewing of alcoholic beverages. Although domesticated yeast strains have been employed by brewers the most, it is becoming more and more obvious that wild yeast strains are significant sources of features needed for industrial fermentations, such as brewing. Novel metabolic capacities, like the capacity to ferment complex carbohydrates in wort or create new taste compounds, are due to the ease of genotyping, phenotyping, and isolation of wild yeast strains (Scholes., et al 2021).

Stevia as a Natural Bioactive and Sweetener

Stevia is known for its strong natural sweetness. The leaves have no calories and are much sweeter than sucrose because they contain steviol glycosides, especially stevioside. This diterpenoid compound gives Stevia its sweet flavor. Since stevioside adds sweetness without affecting blood glucose levels, many people use it as a natural sugar substitute (Arumugam., et al 2020).
The food industry frequently uses stevia rebaudiana (SR) because of its steviol glycoside content, which makes it an appropriate calorie-free sweetener. These glycosides and the extracts from SR also exhibit pharmacological and therapeutic qualities, such as antibacterial, antihypertensive, anti-diabetic, antioxidant, and anticancer, according to both in vitro and in vivo investigations (Carrera-Lanestosa., et al 2017).
Stevioside and rebaudiosides are steviol diterpene glycosides that are utilized as sweeteners in the food industry and are the primary chemicals that give stevia preparations their sweetness. Stevia leaves are a rich source of biologically active molecules that are good for human health in addition to their sweet properties. For many years, traditional medicine in Brazil and Paraguay has utilized stevia not only as a sweetener but also as a medication to treat diabetes and hyperglycemia (Peteliuk., et al 2021).

Stevia and other herbal sweeteners are gaining popularity as healthy substitutes for sugars and artificial sweeteners. Stevia can be utilized to treat tissue diseases connected to oxidative stress because of its anti-inflammatory and antioxidant qualities. Stevia was used to lessen tissue damage in different body organs following ischemia and metabolic stressors. The primary source of glycosides in stevia, steviol, is what gives the herb its sweet flavour. The digestive tract is unable to break down or absorb the large amounts of diterpene glycosides found in stevia. As a result, stevia sweetener consumption does not affect blood glucose levels. Stevia is 200 times sweeter than conventional sugar and has no calories, making it harmless, non-toxic, and non-mutagenic in contrast to low-calorie synthetic sweeteners. It has been observed that consuming 2 mg/kg/bw of stevia daily is safe, particularly for individuals with diabetes (Ajami., et al 2020).

CONCLUSION

Functional beverages have become quite popular in the food and health sectors. They offer extra nutritional and health benefits beyond basic nutrition. These drinks usually contain bioactive ingredients like antioxidants, vitamins, minerals, probiotics, and different plant extracts that help improve wellness and prevent disease. These components help support bodily functions and can help prevent various diseases related to lifestyle choices. Guava-based drinks are particularly promising as functional beverages due to their high levels of flavonoids, tannins, and phenolic compounds,. This research aims to create a functional fermented beverage using stevia, a healthy sugar alternative, and guava leaves as the main ingredient. According to the study, the antibacterial, anti-diabetic, and antioxidant properties of guava leaves make them a helpful addition to the beverage. Fermentation can enhance the product's flavour and also make it more stable and safe for storage. This beverage can be consumed by health-conscious individuals, especially those with PCOD and diabetes. By offering vital information regarding the creation, enhancement, and possible health advantages of herbal-fermented beverages, the findings should aid in the development of novel functional drinks in the food business.

The proposed fermentation herbal beverage has promising potential for further research and development. Microbial and bioactive profiles, formulation and fermentation conditions, and sensory evaluation may be the focus of future research. After a product is created, research on shelf life and customer acceptability can also be conducted. The increasing demand for natural, functional, and low-sugar beverages suggests that this formulation could become a sustainable, health-promoting beverage for consumers with diabetes, PCOD, and other health-conscious conditions.

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