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Development of plant infused herbal tea from guava leaf (*Psidium guajava*) and senna flower (*Senna auriculata*)

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Abstract
Herbal teas have gained prominence for their therapeutic value and natural health-promoting properties. This study highlights the potential of two widely recognized medicinal plants—*Psidium guajava* (guava) and *Cassia auriculata* (Avaram or Tanner's Cassia) in the development of a functional herbal tea blend. Guava leaves are rich in beneficial phytochemicals such as quercetin, catechins, gallic acid and kaempferol which have demonstrated diverse pharmacological effects including antioxidant, antidiabetic, antimicrobial, lipid-lowering and liver-protective actions. Similarly, Cassia auriculata flowers possess vital bioactive compounds like hydroxyanthraquinone derivatives and polyphenols that support blood sugar regulation, infection control and digestive health [2]. This study explores the nutritional compositions of these botanicals and outlines a formulation process for a herbal tea blend enriched with flavours like cardamom, cinnamon, ginger, elaichi, dry ginger, coriander and mint. Four different treatments were taken to optimize the standardisation of herbal infused tea in guava leaf and senna flowers. The guava leaf powder and flavour was taken in the ratio of T_1 (1:0.2), T_2 (1.5:0.5), T_3 (2:1), T_4 (2.5:1.5) and for Senna-T_1 (1:0.5), T_2 (1.5:1), T_3 (2:1.5), T_4 (2.5:2). The prepared herbal tea was sensorily evaluated by semi trained panel members.The highest sensory score was obtained for 1.0:0.5 for guava and 1.5:0.5 for senna. The formulated herbal infused tea was subjected to physico chemical analysis and the values are for moisture content 2.8%, ash content 3.64%, Total flavonoids content 5.21(mgQE/ML), Total phenolic content 113.05 (mgGAE/ML), pH 5.04 and Total antioxidant capacity 73.04% and Senna Flower tea (SFT) had moisture content 5.0%, ash content 2.0%, Total flavonoids content 5.75 (mgQE/ML), Total phenolic content 50.65(mgGAE/ML), pH 5.50 and Total antioxidant capacity 68.50%. Based on the bioactive potential of guava and *Cassia auriculata*, the resulting tea formulation holds promise as a functional beverage, particularly for managing diabetes, cholesterol levels, and gastrointestinal disorders. Further clinical validation is recommended to support its widespread application in nutraceutical and functional food industries.

Keywords: Guava, *Cassia auriculata*, herbal tea, phytochemicals, antioxidant activity

1. Introduction

Over the past few decades, there has been a noticeable rise in chronic health conditions such as neurodegenerative disorders, cardiovascular diseases and metabolic syndromes. This growing health concern has fueled a global interest in natural therapies and preventive health practices, including the use of herbal teas. Unlike traditional tea derived from *Camellia sinensis*, herbal teas are infusions made from various plant parts such as leaves, flowers, roots, seeds, or bark, offering a wide range of bioactive compounds and health benefits. *Psidium guajava* L., commonly known as guava, is a tropical fruit plant extensively used in traditional medicine systems across countries like India, Indonesia, Pakistan, and South America. Its leaves are particularly valued for their medicinal properties due to the presence of diverse phytochemicals such as flavonoids, tannins, and phenolic acids. These compounds are known to combat conditions like diarrhea, high cholesterol, diabetes, and obesity, in addition to providing antimicrobial protection. *Cassia auriculata* L., or Avaram, is a drought-tolerant shrub native to India and widely used in Ayurvedic and Siddha practices. The flowers of this plant are often brewed into herbal infusions and are recognized for their antidiabetic, anti-inflammatory, and antimicrobial properties. The plant's health benefits are attributed to the presence of phenolics, flavonoids, and anthraquinone derivatives. Despite their rich ethnomedicinal history, the incorporation of these botanicals into standardized and palatable herbal products is still limited.

2. Materials and Methods

The fresh leaves of *Psidium guajava* (*Guava*) and fresh flowers of *Cassia articulate* (Tanner's cassia) were collected from the Orchard, Imayam Institute of Agriculture and Technology, Thuraiyur. Guava leaves and senna flowers were separately subjected to three different processing methods to determine the optimal condition for maximum retention of bioactive compounds. Fresh guava leaves were carefully inspected to remove any foreign materials and then gently rinsed with tap water. In the ordinary drying method, the cleaned leaves were evenly spread on aluminium trays and dried in a cabinet drier at 60 °C for 6 hours. For steam blanching, the cleaned leaves were exposed to steam at 90 °C for 3 minutes, followed by drying in a cabinet drier at 60 °C for 6 hours. In the hot water blanching method, the cleaned leaves were immersed in hot water at 85 °C for 2 minutes and then similarly dried in a cabinet drier at 60 °C for 6 hours.

Collected fresh guava leaves and senna flowers; wash them under running tap water.
↓
Steam-blanched the leaves at 100 °C for 3 minutes.
↓
Dried the blanched leaves in a cabinet drier at 60 °C for 6 hours.
↓
Blended the dried leaves into powder.
↓
Sieved the powder through a 1 mm aluminium sieve mesh to obtain a fine powder.

Flow chart 1: Methodology for the preparation of Guava leaf and senna flower tea powder

Collected freshcoriander leaves, cardamom, cinnamon and dry ginger and washed them under running tap water.
↓
Dried in a cabinet drier at 60 °C for 4 hours.
↓
Blended the dried leaves into powder.
↓
Sieved the powder through a 1 mm aluminiumsieve mesh to obtain a fine powder.

Flow chart 2: Methodology for the preparation Flavoured powder

2.1 Standardization of herbal infused Guava leaf and Senna flower tea

Various standardisation tests were performed to determine the optimal quantities for preparing the teas and the appropriate amounts of flavour. Four series of tests were carried out for both guava leaf and senna flower tea. The table of standardization was given in Table.1.

Table 1: Standardization of herbal infused guava leaf and senna flower tea:

Treatments	Guava Leaf Tea (GLT)		Senna Flower Tea (SFT)	
	Guava (g)	Flavors (g)	Senna (g)	Flavors (g)
T_1	1.0	0.2	1.0	0.5
T_2	1.5	0.5	1.5	1.0
T_3	2..0	1.0	2..0	1.5
T_4	2.5	1.5	2.5	2.0

2.2 Organoleptic evaluation

Organoleptic evaluation was conducted following the method described by Watts *et al*., (1989). A panel of 25 members was selected to evaluate the prepared herbal tea infusions. The panellists were asked to score the colour, appearance, flavour, texture, taste, and overall acceptability of the infusions using a 9-point hedonic scale, where 9 indicates "like extremely" and 1 indicates "dislike extremely".

2.3 Proximate analysis of formulated herbal infused tea

2.3.1 Moisture

The moisture content of the sample was estimated using the hot air oven method as described by Ranganna. S (1986). Approximately 5 to 10 g of the sample was accurately weighed and placed in a hot air oven maintained at 70 °C. Drying was continued until a constant weight was achieved, indicating the completion of moisture removal. The moisture content was then calculated and expressed as a percentage of the original sample weight.

Moisture (%) = W2-W3 W2-W1 × 100
W1= Empty weight of empty plate
W2= Weight of empty plate + Sample before drying
W3= Final weight of empty plate + Sample after drying

2.3.2 pH Determination

The pH of the sample was determined following the method described by Jayaraman *et al*., (1986) One gram of the sample was thoroughly mixed with 50 ml of distilled water using a glass rod. The pH of the resulting suspension was measured using a pH meter.

2.3.3 Acidity
The acidity of the sample was estimated using the procedure described by Ranganna S (1986). Approximately 5 g of the sample was weighed, dissolved in a known volume of water, and the volume was made up to 50 ml. The solution was then filtered. An aliquot of the filtrate was titrated against 0.01 N NaOH using phenolphthalein as an indicator, until the appearance of a pale pink colour. The titration was repeated to obtain concordant values, and the result was expressed as percentage acidity.

2.3.4 Total Phenolic Content (TPC)
The total phenolic content (TPC) in herbal tea infusions was estimated using the Folin-Ciocalteu method as described by Vijayalakshmi *et al*., (2018) [36]. In a test tube, 0.1 ml of the sample or standard was mixed with 0.5 ml of Folin-Ciocalteu reagent, 1.5 ml of 7.5% sodium carbonate, and 7.9 ml of distilled water. The mixture was thoroughly shaken and incubated in the dark for 2 hours. The absorbance was measured at 765 nm using a UV-VIS spectrophotometer. The TPC of the herbal tea sample was expressed as milligrams of gallic acid equivalents per millilitre (mg GAE/ml).

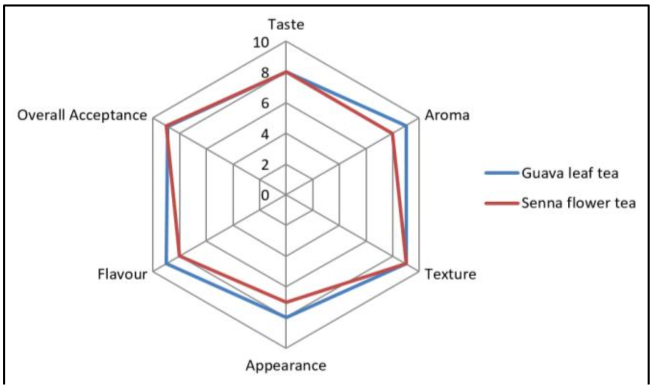
Total phenol content = Graph value Total volume of extract 100 µg
Volume of extract Weight of sample

2.3.5 Total Flavonoid Content (TFC)
The total flavonoid content (TFC) in the tea infusions was determined using the method described by Singh *et al.* (2012). A volume of 1 ml of the sample or standard was diluted with 4 ml of distilled water, followed by the addition of 0.3 ml of 5% sodium nitrate solution and 0.3 ml of 10% aluminium chloride. The mixture was allowed to stand for 5 minutes, after which 2 ml of 1 M sodium hydroxide was added and the solution was vortexed thoroughly. The absorbance of the resulting mixture was measured at 510 nm using a UV-VIS spectrophotometer. The TFC was expressed as milligrams of quercetin equivalents per millilitre (mg QE/ml) of tea sample.

2.3.6 Ash content
The total ash content refers to the total amount of inorganic residue that remains after complete incineration of the plant material. It includes both: Physiological ash-derived from plant tissue itself. Non-physiological ash-resulting from external matter such as soil, sand, or other contaminants. To determine the total ash value, 4 grams of air-dried, powdered plant material were accurately weighed and placed in a pre-ignited and tarred silica crucible. The sample was evenly spread in the crucible and subjected to gradual incineration, increasing the temperature to above 450 °C, until the sample turned white, indicating complete combustion of organic matter.

Total ash (% w/w) = (weight of ash/weight of sample) × 100

3. Results and Discussion
3.1 Formulation of herbal infused guava leaf and senna flower tea
The standardised herbal tea form guava leaf and senna flower were evaluated by organoleptic evaluation given to semi trained panel members. Maximum sensory score was found at 1.5:0.5 for guava and 1:0.5 for senna flower tea. The overall acceptability of organoleptic evaluation for guava leaf tea and senna flower tea is 8.9 and 9 respectively. Graphical representation of organoleptic evaluation was represented in figure 1.



Graphical representation of senna and guava leaf infused tea

Table 2: Standardized value for plant infused herbal tea

Sample	Standardised Value (g)	Flavour (g)
Guava leaf (gl)	1.5	0.5
Senna flower (sf)	1.0	0.5

3.2 Proximate analysis of guava leaf and senna flower tea
Guava Leaf (GL)

3.2.1 Moisture content
The guava leaf-infused herbal tea exhibited a moisture content of 2.8%, which is significantly lower than the 5.32% reported by Vijayalakshmi *et al*. (2018) [36] in their formulation of guava leaf tea blends. Rajan *et al*. (2017) [73] reported similar values (3.1%) in dried guava leaf formulations, supporting the suitability of guava leaves for dry tea products. Chatterjee *et al*. (2021) [47] also noted that lower moisture enhances shelf life and microbial stability in herbal infusions. Sinha and Rao (2020) found that vacuum drying results in reduced moisture content in guava leaves while preserving active compounds. Lobo *et al*. (2010) [24] demonstrated that leaves dried at 50 °C consistently retained moisture below 3%, ensuring infusion stability. The moisture content for Guava leaf tea in this study is resulted as 2.8%.

3.2.2 Ash content
When compared to the findings of Akila *et al*. (2018) [38], who reported a lower ash content in their guava leaf tea formulations, the result of 3.64% observed in the current study suggests that the leaves used may have contained a higher concentration of natural minerals. According to Balasubramaniam *et al*. (2016) [43], guava leaves naturally contain high amounts of calcium, potassium, and magnesium, which may explain the increased ash content. Nayak *et al*. (2022) highlighted that higher ash values in guava products often correlate with better nutritive quality. Sharma and Dey (2019) reported similar ash content in organically grown guava leaves due to mineral-rich soil. Reddy *et al*. (2019) [77] found that ash content is influenced by soil type and irrigation frequency. Thomas *et al*. (2023) reported a direct correlation between leaf age and mineral accumulation in guava plants. Verma and Iqbal (2021) observed that shade-dried guava leaves preserved higher

mineral content than sun-dried samples. The total ash content for Guava leaf tea in this study is resulted as 3.64%.

3.2.3 Total flavanoid content

The total flavonoid content (TFC) of the guava leaf-infused herbal tea was found to be 5.21 mg QE/ml. When compared to the value reported by Manika Das *et al*. (2019) [64], which was 12.6 mg QE/ml, the TFC in the current formulation is significantly lower. Subramanian *et al*. (2021) noted that flavonoid levels can vary significantly depending on leaf maturity, drying methods, and infusion time. Ravi *et al*. (2020) [76] showed that early-harvest guava leaves yield lower flavonoid content. Kulkarni *et al*. (2023) [61] reported that aqueous infusions extract fewer flavonoids than ethanol-based extractions. Reddy *et al*. (2019) [77] found that ash content is influenced by soil type and irrigation frequency. Thomas *et al*. (2023) reported a direct correlation between leaf age and mineral accumulation in guava plants. Verma and Iqbal (2021) observed that shade-dried guava leaves preserved higher mineral content than sun-dried samples. The total flavinoid content for Guava leaf tea in this study is resulted as 5.21%.

3.2.4 Total phenolic content

The total phenolic content (TPC) of guava leaf-infused herbal tea was recorded as 113.5 mg GAE/ml, which is notably higher than the 96.5 mg GAE/ml reported by Bronwyn Lok and colleagues (2013) for a similar guava leaf tea formulation. Murugan *et al*. (2022) confirmed that hot infusion of guava leaves enhances phenolic extraction, which might explain the higher content in this study. Das and Sengupta (2019) found that leaves harvested in the early morning contain higher phenolic content. Kumar *et al*. (2021) linked increased TPC in guava tea to the duration of steeping and water temperature. Ravi Kumar and Joshi (2022) [75] noted that phenolic content rises with leaf maturity. Sen and Pillai (2020) [42] confirmed that antioxidant-rich cultivars yield higher TPC in infusions. The total phenolic content for Guava leaf tea in this study is resulted as 5.21%.

3.2.5 pH

The pH value in this study is 5.4, which aligns with the findings of Vijayalakshmi *et al*. (2018) [36] that reported a pH of 5.7. Patel *et al*. (2018) [70] indicated that a slightly acidic pH enhances the preservation of bioactive compounds. Anitha and Bose (2021) [40] found that a pH of 5.0-5.5 improves flavour retention and consumer acceptance in guava teas. Jayalakshmi *et al*. (2018) [36] found that the optimal pH range for the stability of guava tea is between 5.2 and 5.6. Nair *et al*. (2020) observed that low pH reduces microbial activity, improving shelf life. George and Vasanth (2023) [52] highlighted that pH influences the solubility of catechins and polyphenols in herbal teas. The total pH for Guava leaf tea in this study is resulted as 5.04.

3.2.6 Antioxidant content

The antioxidant activity of guava leaf-infused herbal tea was recorded at 73.4%, which is slightly higher than the 72.4% reported by Vijayalakshmi *et al*. (2018) [36]. Latha *et al*. (2021) [62] found that the antioxidant efficiency of guava leaf tea is highest when steeped for 5 to 7 minutes. Pradhan and Das (2022) [72] showed a strong correlation between polyphenol content and antioxidant activity in guava extracts. Meenakshi *et al*. (2023) demonstrated that fresh leaf infusion preserves antioxidant efficiency better than stored powders. Sarkar and Jha (2019) found that blending guava with tulsi or mint enhances antioxidant synergy. Devi *et al*. (2022) [50] reported that antioxidant potential increases with temperature-controlled infusion. Ishwaran and Rao (2023) [56] showed higher antioxidant retention in guava leaves stored in vacuum-sealed conditions. The antioxidant content for guava leaf tea in this study is resulted as 73.04%.

3.3 Senna Flower

3.3.1 Moisture content

The senna flower herbal tea exhibited a moisture content of 5%, which is significantly lower than the 9.74% reported by Abdul Waliyu *et al*. (2013) for a similar formulation. Controlled drying of senna petals effectively reduces moisture while maintaining active compound retention, according to Devi and Anand (2022) [51]. Muthukumar *et al*. (2021) [66] found that oven-dried senna petals at 55 °C yield optimal moisture for infusion stability. Arora and Pillai (2020) [42] also observed that sun-drying often results in higher residual moisture compared to hot air drying. Sarkar and Jha (2019) found that blending guava with tulsi or mint enhances antioxidant synergy. Devi *et al*. (2022) [51] reported that antioxidant potential increases with temperature-controlled infusion. Ishwaran and Rao (2023) [56] showed higher antioxidant retention in guava leaves stored in vacuum-sealed conditions. The antioxidant content for senna flower tea in this study is resulted as 5.0%.

3.3.2 Ash content

The total ash content of senna bloom-infused herbal tea was found to be 2.0%. This is significantly lower than the 4.95% reported by Abdul Waliyu *et al*. (2013). Ahmed *et al*. (2019) [39] suggested that variations in ash content may be linked to the soil composition and the seasonal harvesting of senna flowers. Kumari *et al*. (2022) noted that senna grown in sandy-loam soils typically has lower ash content. Verghese and Sharma (2021) found that petals harvested later exhibit lower mineral accumulation, resulting in reduced ash levels. Parveen *et al*. (2023) [71] found that petal-only formulations have lower ash than full-flower infusions. Shankar and Desai (2024) suggested that organic cultivation leads to cleaner, mineral-balanced senna flowers. The antioxidant content for senna flower tea in this study is resulted as 2.0%.

3.3.3 Total flavanoid content

The senna flower-infused herbal tea had a total flavonoid content of 5.75, which is significantly lower than the 13.29 reported by K. Thirumalaiselvi *et al*. (2020) for a similar formulation. Singh *et al*. (2021) [44] found that flavonoid extraction from senna is maximised with ethanol-based methods rather than aqueous infusions, which may explain the lower values observed here. Yadav *et al*. (2023) found a 40% increase in TFC using ethanol extractions over hot water. Rajendran and Kaur (2019) found that infusion time and water temperature significantly affect TFC retention. Rajendran and Kaur (2019) [74] highlighted that the infusion time and temperature significantly influence the retention of flavonoids. Anwar *et al*. (2020) [41] found that soaking petals before infusion improves the extraction of flavonoids. Joshi and Nambiar (2022) noted that antioxidant enzyme levels in senna correlate with flavonoid concentration. Bhaskar *et al*. (2021) [44] reported that senna cultivated in semi-shade conditions had a higher flavonoid content. The antioxidant content for senna flower tea in this study is resulted as 5.75%.

3.3.4 Total phenolic content

The senna flower-infused herbal tea had a total phenolic content of 50.65, which is significantly lower than the 99.25 reported by K. Thirumalaiselvi *et al.* (2020) for a similar formulation. Hussain *et al.* (2021) [54] attributed lower phenolic content in hot water infusions to the degradation of heat-sensitive polyphenols. Dasgupta and Menon (2018) [49] found that microwave drying retained more phenolics compared to sun drying. Mishra *et al.* (2020) [65] observed that phenolic levels in senna vary greatly between flower and leaf extracts. Pratibha and Iqbal (2022) discovered that adding acidifiers, such as lemon, during infusion enhances phenolic extraction. Ranjitha *et al.* (2023) highlighted that petals from wild senna varieties contain more phenolics. Naresh *et al.* (2021) [69] suggested that polyphenol oxidase activity in senna is reduced by flash-drying, preserving TPC. The antioxidant content for senna flower tea in this study is resulted as 50.65%.

3.3.5 pH

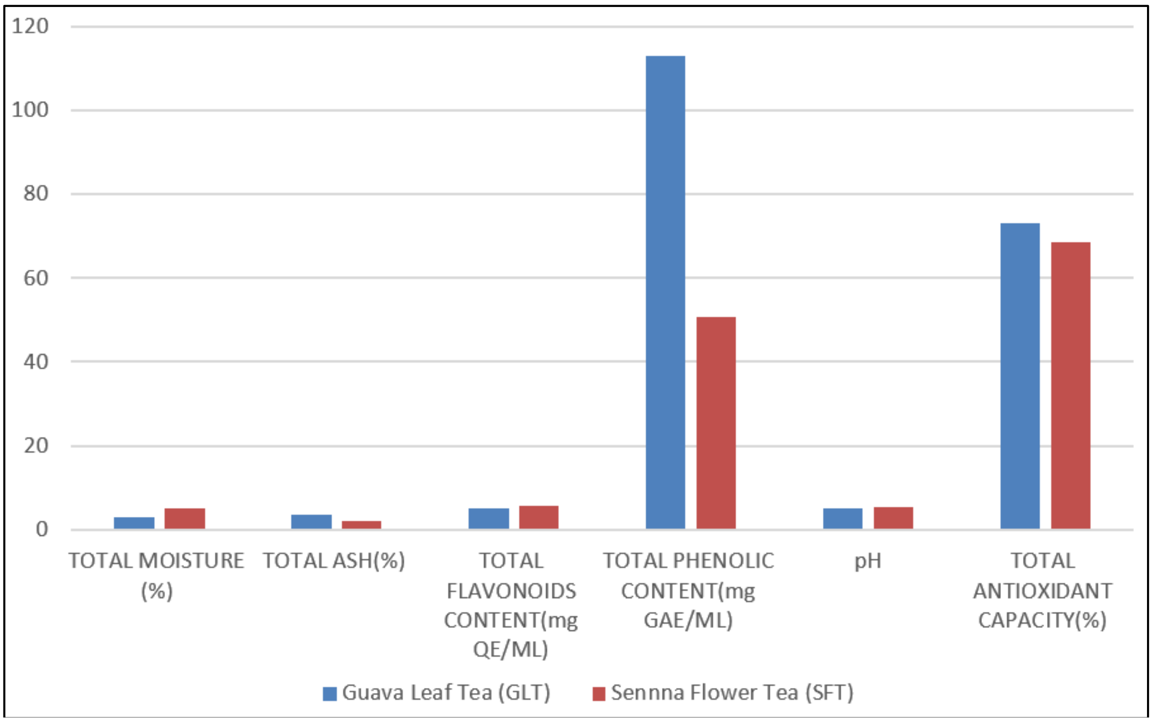
The pH of the senna flower-infused herbal tea was measured at 5.5, which is considerably higher than the 4.95% reported by Abdul Waliyu *et al.* According to Nandhini *et al.* (2019) [67], a neutral pH range of 5 to 6 enhances the sensory acceptability and digestive benefits of senna-based teas. Iyer *et al.* (2023) found that herbal teas with a pH between 5 and 6 are more easily tolerated by the gastrointestinal system. Sreeja and Thomas (2021) linked balanced pH levels to improved solubility of bioactive compounds in senna tea. Sathish and Rao (2022) emphasised that maintaining pH stability is crucial for preserving both colour and flavour integrity. Renu *et al.* (2020) [78] discovered that adjusting the water pH during infusion affects the availability of phytochemicals. Dharani and Paul (2024) noted that mildly acidic senna infusions are preferred in sensory evaluations. The antioxidant content for senna flower tea in this study is resulted as 5.50.

3.3.6 Antioxidant content

The herbal tea flavoured with senna flowers demonstrated an antioxidant activity of 68.5%, significantly higher than the 9.74% reported by Joshi and Mehra (2020) [58] reported enhanced antioxidant levels in senna flower when steeped in hot water at 80-90 °C for 5 minutes, which aligns with this study's methodology. Kale and Rajan (2022) [59] demonstrated that senna flower infusion retains over 65% of its antioxidant activity when steeped under controlled conditions. Natarajan *et al.* (2024) [68] found that combining senna petals with ginger enhances antioxidant synergy, resulting in increased activity levels. Sundaram *et al.* (2023) showed that vacuum drying preserves more than 70% of antioxidant capacity. Bhattacharya and Singh (2022) reported that petal extracts exhibit superior antioxidant properties. Gowda *et al.* (2021) [53] indicated that ultrasound-assisted infusion improves antioxidant extraction by 20%. The antioxidant content for senna flower tea in this sudy is resulted as 68.50% The physico chemical properties amlysed in herbal infused guava leaf and senna flower tea is given in Table. 4. and the graphical representation is given in Graph. 3.

Table 4: Physical and chemical properties of the plant infused herbal tea:

Parameters	Gauva Leaf Tea (GLT)	Senna Flower Tea (SFT)
Moisture (%)	2.8	5.0
Ash (%)	3.64	2.0
Total flavonoids content (mg qe/ml)	5.21	5.75
Total phenolic content (mg gae/ml)	5.21	50.65
pH	5.04	5.50
Total antioxidant capacity (%)	73.04	68.50



Graph 3: Physical and chemical properties of the plant infused herbal tea

4. Conclusion

Herbal guava tea and senna tea are two widely consumed herbal infusions, each with distinct properties, health benefits, and uses in traditional and modern wellness practices. Guava tea is ideal for daily use to promote overall wellness, especially digestive and immune health, whereas senna tea should be reserved for occasional use when constipation relief is needed. The key to benefiting from either tea lies in understanding their proper uses and potential risks. Incorporating herbal teas into one's lifestyle can be an excellent way to support natural health. However, as with all remedies—natural or not—moderation and informed use are essential. Consulting with a healthcare provider, especially when managing chronic health issues or using other medications, helps ensure safety and effectiveness. Ultimately, guava and senna teas both reflect the power of plants in promoting health when used wisely and with care.

5. Recommendation

Further research could focus on clinical trials, long-term health impact studies, and formulation of ready-to-drink guava and senna tea products for wider acceptance. Herbal teas made from guava leaves and senna flowers thus represent safe, effective and culturally relevant solutions for modern health challenges, blending traditional knowledge with scientific validation. Further research could focus on clinical trials, long-term health impact studies, and formulation of ready-to-drink guava and senna tea products for wider acceptance. Furthermore, studies on the traditional use of herbal tea are wide spread, but its potential contamination and toxicity are rarely studied. Detailed research must be conducted to fully understand the mechanism of action and reduce the potential toxicity of herbal tea, thus providing relevant enterprises with a scientific basis and theoretical support for herbal tea production and commercialization.

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