(ISSN: 0973-7049(P))

The Bioscan
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES

21(3): S.I (3), 1005-1014, 2026 www.thebioscan.com

Process Optimization And Quality Evaluation Of Surangi Flower Tea Bags Infused With Lemon Peel And Mint Leaves

[1]Akanksha Ankush Bhosale, [2]Gurunath Mote, [3]Kumar Chakre

[1,2,3]Department of Food Technology school of Engineering and technology, D.Y.Patil Agriculture and technical university, Talsande, Kolhapur

Corresponding Author
Akanksha Ankush Bhosale,
[3]Department of Food Technology school of Engineering and technology, D.Y.Patil Agriculture and technical university, Talsande, Kolhapur

DOI: https://doi.org/10.63001/tbs.2026.v21.i03.S.I(3).pp1005-1014

KEYWORDS: Mammea suriga; Surangi flower tea; Herbal tea; Antioxidant activity; Phenolic compounds; Flavonoids; HPLC; Functional beverages.

Received on: 15-07-2026

Accepted on: 02-08-2026

Published on: 11-08-2026

ABSTRACT

This current study was designed and developed to formulate a new herbal tea using Surangi Flower (Mammea Suriga) dried (flowers), added with lemon peel and mint leaves. This research was conducted to develop formulation and evaluate sensory characteristics, physical and chemical characteristics, phytochemical composition, and antioxidant activity, and chromatographic profiling of herbal tea. Five different formulations of herbal tea were made by altering the sizes of components (Surangi Flower, lemon peel, and mint leaves); however, the control sample was commercial tea (Camellia Sinensis). The sensory evaluation results show the highest acceptability for formulation T4 containing 80% Surangi flower, 10% lemon peel, and 10% mint leaves.According to results of phytochemical analyses, both powdered Surangi flower and brewed Surangi tea contain high amounts of antioxidant activity, phenolic and flavonoid content. HPLC analysis showed that the powdered Surangi flower and brewed Surangi tea contain the three major bioactive compounds — gallic acid, chlorogenic acid and quercetin. Brewed Surangi tea contains greater amounts of these three bioactive compounds than conventionally brewed teas. The amount of bioactive compounds remaining in the finished product of Surangi tea is significantly influenced by the temperature at which it is brewed. Surangi tea brewed at 80 deg C has greater amounts of antioxidant activity than Surangi tea brewed at 100 deg C. All the physical and chemical characteristics of the herbal teas created have desirable properties and chemical composition, as they have all been demonstrated to remain in acceptable ranges for both storage stability and consumer acceptance based on moisture content, total solids, ash content and pH.The study highlights the functional and therapeutic potential of Surangi flower tea as a natural antioxidant-rich beverage and supports its application in nutraceutical and functional food development.

INTRODUCTION

Herbal tea has gained considerable global popularity due to its numerous health-promoting properties and its role as a functional beverage. Unlike conventional tea prepared from Camellia sinensis, herbal tea is produced from various plant materials such as flowers, leaves, fruits, seeds, bark, and roots, and is naturally caffeine-free. Herbal infusions are rich sources of bioactive phytochemicals, including flavonoids, tannins, phenolic acids, alkaloids, terpenoids, and essential oils, which contribute to their antioxidant, antimicrobial, anti-inflammatory, and therapeutic properties (Craig, 1999; McKay & Blumberg, 2007). Regular consumption of herbal tea has been associated with improved immune function, reduced oxidative stress, enhanced digestive health, and protection against chronic diseases due to the synergistic effects of these phytochemicals (Shahidi & Ambigaipalan, 2015).

The growing consumer preference for natural, plant-based functional foods and beverages has further accelerated the demand for herbal tea products. Increasing awareness regarding the adverse health effects associated with synthetic food additives and artificial ingredients has encouraged the development of beverages enriched with medicinal herbs possessing both nutritional and therapeutic benefits (Granato et al., 2020). Consequently, there is increasing interest in identifying underutilized medicinal plants that can serve as novel ingredients for functional beverage formulations.

Mammea suriga Kosterm, also widely referred to as Surangi or Mammea longifolia, is a species of the plant that is indigenous to its location and has properties that make it a medicinal plant. It belongs to Calophyllaceae family and is found in the Western Ghats of the country India. Surangi buds are known in traditional medicine for how it is used in the treatment of medical conditions like dyspepsia, migraine headaches, bleeding as well as different skin diseases and inflammations (Kirtikar & Basu, 2006). Chemically, Surangi flowers have been found to possess various bioactive compounds such as flavonoids, coumarins, xanthones, tannins, alkaloids and essential oils which exhibit different medicinal properties like antioxidant, antimicrobial, etc (Nadkarni, 2009; Khandelwal, 2008). Although these beneficial properties of Surangi flowers have been documented, they remain to be utilized as functional food and herbal beverage ingredient.

Mint, the scientific name of which is Mentha arvensis L., is recognized as one of the best plants due to its quality aroma, taste and medicinal benefits (Eisner et al., 2015). This material

contains flavonoids, phenolics, menthol, menthone, and rosmarinic acid in addition to many essential oils which aid in attaining the antimicrobial and antioxidant characteristics (Singh et al., 2010). The lemon peel (Citrus limon L.) also boasts vitamin C, flavonoids, pectin, limonene, and a large number of other components that give it antimicrobial and antioxidant abilities as well (Ghasemi et al., 2009).These plants might be used in herbal tea so that consumers would take pleasure from taste and aroma of the drinks and benefit from their positive characteristics.

Given the rise in popularity of functional herbal drinks and the healing properties of lesser-known medicinal plants, Surangi flowers can serve as a valuable material when making herbal tea. Thanks to their exceptional floral scent, great phytochemistry, and traditional value, these flowers can serve as a perfect ingredient for novel functional drinks, which prompted the author to carry out the current research. The research focused on the development of herbal tea from dried Surangi flowers plus mint and lemon peel and was carried out to study the plant's phytochemical content, physicochemical features, antioxidant properties, and sensory characteristics of the beverage created.The findings are expected to provide scientific evidence supporting the utilization of Surangi flowers as a valuable functional ingredient for herbal beverage production.

2. MATERIALS AND METHODS

2.1 Sample Procurement

From the local markets of vegurla and talasande raw materials like Surangi flower(Mammea suriga), mature lemons (Citrus limon), and mint leaves (Mentha arvensis) were procured. Based on freshness, fragrance, absence of physical damage, and overall quality fresh flowers and leaves were selected. For the control sample Camellia sinensis tea was purchased from the local market.

2.2 Materials

2.2.1 Raw Materials

For the preparation of herbal tea dried Surangi flowers (Mammea suriga), dried lemon peel powder (Citrus limon), and dried mint leaves (Mentha arvensis) are used as a raw material. Surangi flower were collected freshly during the flowering season and shade dried.

2.2.2 Chemicals and Equipment

All chemicals and laboratory equipment used for physicochemical and phytochemical analyses were obtained from the Department of Food Science and Technology, D.Y. Patil Agriculture and Technical University, Talsande, Kolhapur. Analytical-grade reagents were used throughout the study.

2.2.3 Packaging Materials

Filter paper tea bags and airtight glass containers were used for packaging and storage of the prepared herbal tea samples. It helps to protect from moisture gain and tea bags helps in equal distribution of the tea.

2.2.4 Preparation of Herbal Tea Samples

Preparation of Surangi Flower Powder

Freshly collected Surangi flowers were cleaned thoroughly to remove dust and foreign matter. The flowers were shade-dried under well-ventilated conditions until they became dry and brittle. The dry flowers were ground in a mechanical grinder and sieved through a 20 mesh sieve to obtain uniformity. For future use the powder was stored in air-tight containers.

Preparation of Lemon Peel Powder

Ripe lemons got washed properly and peeled by human hand. After peeling, peels were chopped to small pieces and shade dried at ambient conditions until completely dried. The shades of peels were made powdered through a grinder and a 20 sieving was done to get fine powder. The powder was packed in airtight containers for further use.

Preparation of Mint Leaf Powder

The fresh mint leaves were sorted, washed, and shade dried under well-ventilated conditions. After they became completely dry, the leaves were ground and passed through a 20 mesh sieve. The powder was then stored in air-tight containers for future utilizations.

Formulation of Surangi Herbal Tea

Five different formulations of herbal tea were created by altering the ratio of Surangi flowers powder, lemon peel powder, and mint leaves powder. The T1 tea formulation had 100% Surangi flowers powder and was the control Hispanic tea. The treatments T2 to T5 had different ratios of lemon peel powder and mint leaves powder for tea preparation. The treatment T0 was commercially obtained from the tea plant Camellia sinensis and used in the study as reference control.

Table 1. Formulation of Surangi Herbal Tea Samples

Ingredients (%)	T0	T1	T2	T3	T4	T5
Camellia sinensis Tea	100	0	0	0	0	0
Surangi Flower	0	100	80	80	80	60
Lemon Peel	0	0	20	0	10	20
Mint Leaves	0	0	0	20	10	20

Processing of Surangi Herbal Tea

The preparation of herbal tea followed the sequence:

Collection of Raw Materials → Cleaning → Shade Drying → Grinding → Sieving (20-mesh) → Formulation → Packaging → Chemical Analysis → Data Collection

The preparation of the tea blend involved the right mixing and measuring of the different components with the aim of producing a quality powder. The process that followed included filling tea bags that weighed 2 grams with the powder and storing them in airtight glass containers to ensure quality was preserved.

2.2.5 Analysis of raw material and product

A) Physicochemical Analysis

Moisture and ash contents were determined according to FSSAI Methods 04A.001:2021 and 04A.004:2021, respectively. Moisture was measured by hot air oven drying at 103 ± 2°C, while ash content was determined by incineration in a muffle furnace at

(ISSN: 0973-7049(P))

The Bioscan AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES 21(3): S.I (3), 1005-1014, 2026 www.thebioscan.com

550 ± 10°C. The pH of tea infusion (2 g tea in 100 mL distilled water brewed at 80°C for 5 min) was measured using a calibrated digital pH meter following IS 4706. Total soluble solids (TSS) were determined using a digital refractometer and expressed as °Brix.

B) Phytochemical Analysis

a) Determination of Antioxidant Activity (DPPH Assay)

Antioxidant activity was determined using the DPPH radical scavenging assay. One gram of Surangi flower powder was extracted with 20 mL of 70% methanol by sonication for 2 h 30 min, followed by centrifugation (6000–8000 rpm, 15 min) and filtration. Different concentrations (5–25%) of the extract were prepared. One millilitre of each extract was mixed with 3 mL of 0.1 mM DPPH solution and 6 mL methanol, incubated in the dark for 30 min, and absorbance was measured at 517 nm using a UV-Visible spectrophotometer. Methanol served as the blank, while ascorbic acid was used as the standard. The percentage antioxidant activity was calculated as:

% Antioxidant Activity = [(Ac − As)/Ac] × 100

Where:

Ac = Absorbance of control

As = Absorbance of sample

b) Determination of Total Antioxidant Activity (Phosphomolybdenum Assay)

Total antioxidant activity was determined using the phosphomolybdenum assay. Sample extracts or ascorbic acid standard were mixed with phosphomolybdenum reagent, incubated at 95°C for 90 min, cooled to room temperature, and absorbance was recorded at 695 nm. Antioxidant activity was calculated using the following equation:

% Antioxidant Activity = [(At − Ac) − AAC]/(At − Ac) × 100

Where:

At = Absorbance of test sample

Ac = Absorbance of control

AAC = Absorbance of assay control

c) Determination of Total Flavonoid Content (TFC)

Total flavonoid content was estimated by the aluminium chloride colorimetric method using quercetin as the standard. Sample extract was reacted sequentially with sodium nitrite, aluminium chloride, and sodium hydroxide, and the absorbance was measured at 510 nm against a reagent blank. Total flavonoid content was calculated from the quercetin calibration curve and expressed as mg quercetin equivalent per gram of sample (mg QE/g).

Calibration equation:

Y = mX + c

C = (As − c)/m

TFC (mg QE/g) = (C × V × DF)/(1000 × W)

Where:

C = Concentration from calibration curve (µg/mL)V = Volume of extract (mL)

DF = Dilution factor

W = Weight of sample (g)

d) Determination of Total Phenolic Content (TPC)

Total phenolic content was determined using the Folin–Ciocalteu method with gallic acid as the standard. Sample extract was mixed with Folin–Ciocalteu reagent and sodium carbonate solution, incubated at room temperature for 30 min, and absorbance was measured at 765 nm. Total phenolic content was calculated from the gallic acid calibration curve and expressed as mg gallic acid equivalent per gram of sample (mg GAE/g).

Calibration equation:

A = mC + b

C = (A − b)/m

TPC (mg GAE/g) = (C × V × DF)/(1000 × M)

Where:

C = Concentration from calibration curve (µg/mL)

V = Volume of extract (mL)

DF = Dilution factor

M = Mass of sample (g)

e) HPLC Analysis

The phenolic compounds of Surangi herbal tea were analyzed using the Ultimate 3000 UHPLC system manufactured by Thermo Fisher Scientific. The analytical equipment consisted of a UV-Visible spectrophotometer, and the analysis was performed on the RP-C18 column. The mobile phase consisted of water with 0.1% formic acid and organic solvents such as methanol and acetonitrile. The mobile solvents were passed through 0.45 µm membrane filter and degassed using supersonication. The sample of Surangi herbal tea was first extracted in methanol and then passed through a 0.45 µm syringe filter. The standard solutions included gallic acid, catechin, chlorogenic acid, and many other compounds to prepare the calibration curves. The volume of 10 µL of each sample was injected for the chromatographic separation to occur at the rate of 1 mL per minute. The separation was performed at the wavelengths of 254, 280, and 320 nm, respectively, and the predicted peaks were identified using retention time and quantified from calibration curves.

f) Sensory Evaluation

A sensory evaluation was performed by a panel of semi-trained individuals. Tea infusions prepared from each formulation were tested for colour, flavour, appearance, taste, texture, and overall acceptability using a nine-point Hedonic scale ranging from 1 (“dislike extremely”) to 9 (“like extremely”).

RESULTS AND DISCUSSION

4.1 Phytochemical Analysis of Surangi Flower

4.1.1 Antioxidant Activity of Surangi Flower

The antioxidant activity of Surangi flower was evaluated using the DPPH radical scavenging assay. The results obtained for methanolic extract and brewed samples are presented in Table 4.1. Antioxidant activity increased with increasing concentration in all samples, indicating a concentration-dependent radical scavenging effect.

The methanolic extract of Surangi flower exhibited the highest antioxidant activity, reaching 87.1% at 80 mg/mL concentration. Brewing at 80°C also showed substantial antioxidant activity (85.0%), whereas brewing at 100°C resulted in comparatively lower activity (80.0%). The reduction in antioxidant activity at higher brewing temperature may be attributed to thermal degradation of heat-sensitive phenolic and flavonoid compounds.

The high antioxidant potential observed in Surangi flowers suggests the presence of bioactive phytochemicals capable of neutralizing free radicals and reducing oxidative stress. Similar observations have been reported for several herbal teas rich in phenolic compounds.

Table 4.1.1.1 Antioxidant activity of Surangi flower extract at different concentrations

Concentrations	AA%

5 mg/ml	60.1%
10 mg/ml	75.2%
20 mg/ml	80.7%
40 mg/ml	84.9%
80 mg/ml	87.1%

•Brewing at 80oC:
A total of 2 g of the powdered herbal tea sample was added to 100 mL of distilled water preheated to 80°C. The mixture was brewed at 80 ± 2°C for the specified extraction time, after which the infusion was filtered through Whatman No. 1 filter paper. The filtrate was allowed to cool to room temperature and was subsequently used for physicochemical, phytochemical, antioxidant, and sensory analyses.

Concentrations	AA%
5 mg/ml	76.4%
10 mg/ml	77.7%
20 mg/ml	79.1%
40 mg/ml	83.8%
80 mg/ml	85%

Table no. 4.1.1.2 Result of Anti-oxidant activity of Surangi powder brewing at 80oC

- Brewing at 100oC:

In this process we have taken 2gm powder sample in 100ml water and brewed at 100oC.

Concentrations	AA%
5 mg/ml	50.5%
10 mg/ml	54.1%
20 mg/ml	67%
40 mg/ml	72.9%
80 mg/ml	80%

Table no. 4.1.1.3 Result of Anti-oxidant activity of Surangi powder brewing at 100oC

4.1.2 Total Flavonoid Content

Flavonoids are among the major groups of phytochemicals responsible for antioxidant and health-promoting properties of herbal products. The total flavonoid content (TFC) of Surangi flower powder and brewed samples is presented in Table 4.2.

The results indicated that Surangi flower powder possessed the highest flavonoid content, while a gradual reduction was observed after brewing. Brewing at 80°C retained more flavonoids than brewing at 100°C. This decrease may be attributed to thermal degradation and oxidation of flavonoid compounds at elevated temperatures.

The retention of substantial amounts of flavonoids after brewing indicates that Surangi tea can serve as a valuable dietary source of natural antioxidants.

Table

4.1.2.1 Total flavonoid content of Surangi flower powder and brewed samples

Sample in Different forms	TFC
Surangi Powder	90.56 ± 0.48 mg QE/g
Brewing at 80°C	79.24 ± 2.45 mg QE/g

Brewing at 100°C	72.31 ± 3.56 mg QE/g

4.1.3 Total Phenolic Content

Sample in Different forms	TPC
Surangi Powder	96.29 ± 4.23 mg GAE/g
Brewing at 80°C	80.94 ± 2.33 mg GAE/g
Brewing at 100°C	74.76 ± 4.63 mg GAE/g

Table 4.3. Total phenolic content of Surangi flower powder and brewed samples

Phenolic compounds are important contributors to antioxidant activity and functional properties of herbal teas. The total phenolic
content (TPC) of Surangi flower powder and brewed samples is presented in Table 4.3.
Surangi flower powder exhibited the highest phenolic content (96.28 ± 4.23 mg GAE/g), followed by samples brewed at 80°C (80.94 ± 2.33 mg GAE/g) and 100°C (74.76 ± 4.63 mg GAE/g). The reduction in TPC with increasing brewing temperature suggests degradation of phenolic compounds due to prolonged heat exposure.
The high phenolic content observed in Surangi flower indicates its potential as a rich source of natural antioxidants. Since phenolic compounds are known for their free radical scavenging ability, the results support the antioxidant activity observed in the DPPH assay.

4.2 Evaluation of Surangi Herbal Tea
4.2.1 Sensory Evaluation
A 9-point hedonic test was employed for the evaluation of sensory properties of Surangi herbal tea. The results of the experiment are presented in the table 4.4.
Among the various formulations, T4 (80% Surangi flower, 10% lemon peel, and 10% mint leaves) was rated as the best for all different parameters such as appearance scoring (8.00), aroma (7.90), flavor (8.12), after taste (8.17), mouthfeel (7.92) and overall acceptability (8.00). This was due to getting the right proportion of Surangi flower, lemon peel, and mint leaves.
It must be pointed out that the high flavor profile of T4 is determined by the presence of the citrus flavor in lemon peel and refreshing flavor of mint leaves.

Table 4.4. Sensory evaluation scores of Surangi herbal tea formulations

Treatments / Parameters	T_0	T_1	T_2	T_3	T_4	T_5
Appearance (Colour)	6.50	6.67	7.58	7.83	**8.00**	7.25
Aroma (Odor)	6.90	6.92	7.28	7.66	**7.90**	7.58
Taste (Flavour)	7.34	7.18	7.38	7.67	**8.12**	7.50
Aftertaste	7.40	7.20	7.34	7.92	**8.17**	7.33
Mouthfeel	7.20	6.83	7.22	7.83	**7.92**	7.75
Overall Acceptability	7.40	7.20	7.50	7.92	**8.00**	7.42
Average	7.12	7.00	7.38	7.80	**8.02**	7.47

4.2.2 Physicochemical Characteristics of Optimized Surangi Tea
The table 4.5 covers the physicochemical characteristics of the optimized Surangi tea (T4).
The moisture amount of the tea is 8%, showing enough stability during the storage process and lower chances of spoilage by microorganisms. The content of ashes in the tea is 17.5%, which means that there exist some minerals in the extracts made of Surangi flower, lemon peel, and mint leaves. The pH of the beverage is 4.6, which points on the weak acidity of the infusion and on the positive nature of this fact in relation to the quality of taste and stability of the beverage.
The amount of total soluble solids, which equals 16.3 °Brix means that there are various soluble phytochemicals, flavor compounds, and bioactive substances in tea.

Table 4.5. Physicochemical properties of optimized Surangi herbal tea

Parameter	Result
Moisture (%)	8
Total Ash (%)	17.5
pH	4.6
Total soluble solids	16.3

4.2.3 Antioxidant Activity of Optimized Surangi Tea

Phosphomolybdenum method was utilized for detecting the total antioxidant activity of Surangi herbal tea regarding its ideal concentration in the formulation. The data indicated that antioxidant properties were elevated with the increase in the concentration of Surangi herbal tea from 92.5% to 97.9%. This peak of 97.9% of antioxidant properties was obtained at a concentration of 310 µg GAE and indicates the definitive strong reductive ability of Surangi herbal tea extract. Great antioxidant activity is supported by the finding of 34.9 mg GAE IC_{50} indicating remarkable antioxidant properties of the formulation. The significant level of antioxidant activity is explained by the strong synergy of natural phenolic and flavonoid components in the Surangi flower, lemon peel, and mint leaves, which are well-known to inhibit the process of oxidation thereby protecting living organisms from free radical damage.

Table 4.6. Total antioxidant activity of optimized Surangi herbal tea

Equivalent (µg GAE)	Antioxidant Activity (%)
62 µg	92.5 %
124 µg	96.7 %
186 µg	97.5 %
248 µg	97.8 %
310 µg	97.9 %

4.2.4 Total Flavonoid Content of Optimized Surangi Tea

The Surangi herbal tea in its optimal state contained a little less than 100 mg QE/g of the total weight in flavonoids. Flavonoids are known to be an essential group of plant-based compounds that exhibit antioxidant and anti-inflammatory properties.

It is a concrete proof of the high degree of antioxidant capacity of the tea and shows that it has prospects of being developed into a functional drink.

Table 4.7. Total flavonoid content of optimized Surangi herbal tea

Parameter	Result
Total Flavonoid content	100 mg QE/g

4.2.5 Total Phenolic Content of Optimized Surangi Tea

The level of phenolic substances measured in the optimized Surangi tea is quantified at 125 mg GAE/g. Phenolic substances represent one of main classes of plant-related bioactive substances contributing to antioxidant and health beneficial properties.

The essential amount of phenolic substances established in the current study suggests that Surangi tea can serve as a source of antioxidants with natural origin acting against free radicals and oxidative stress diseases.

Table 4.8. Total phenolic content of optimized Surangi herbal tea

Parameter	Result
Total Phenolic content	125 mg GAE/g

4.2.6 HPLC Characterization of Surangi Herbal Tea

Researchers have performed high-performance liquid chromatography research in order to discover the major phenolic substitutions in Surangi tea and compare it to traditional tea derived from Camellia Sinensis.

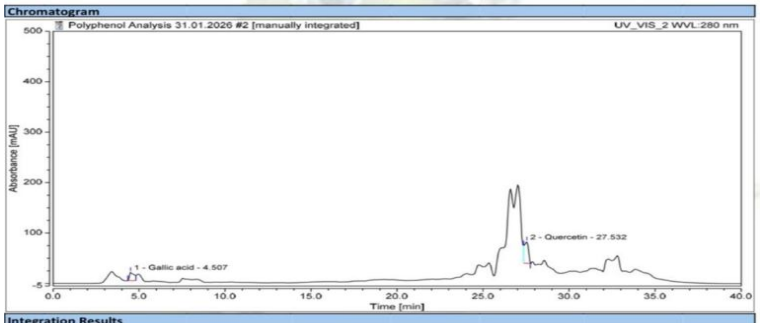
The results of the high-performance liquid chromatography tests show that Surangi tea contains three of the components that can be called bioactive, which are chlorogenic acid, gallic acid and quercetin. Out of the three, quercetin is found to be the one in which concentration is maximum (380.9 mg per 100 g), gallic acid comes next (201.8 mg/100 g) and chlorogenic acid is the least (35.3 mg/100 g).

Surangi tea shows much higher presence of the mentioned phenolic compounds when compared to Camellia sinensis tea, thus proving better content in phytochemicals and antioxidant activity for Surangi tea.

It is quercetin and gallic acid that are responsible for promoting health of Surangi tea and contributing into antioxidant action. The proof of the presence of these compounds comes from HPLC chromatographs where they show up as distinct peaks.

- HPLC Chromatogram of Surangi Tea Sample at 280 nm

HPLC Chromatogram of Surangi Tea Sample at 280 nm



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount
1	Gallic acid	4.507	5.222	16.495	30.29	27.96	n.a.
2	Quercetin	27.532	12.018	42.500	69.71	72.04	n.a.
Total:			17.240	58.995	100.00	100.00	

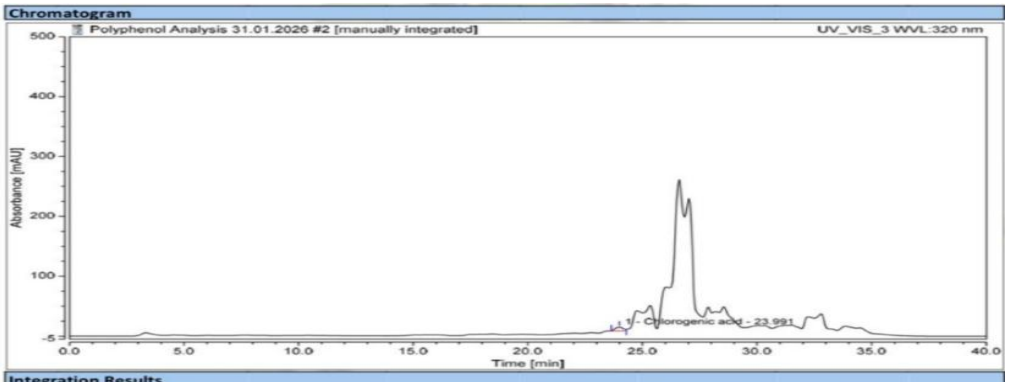
Figure no . 1 HPLC Chromatogram of Surangi Tea Sample at 280 nm

When we look at the chromatogram produced from our Surangi tea sample using 280 nm as the wavelength, we can see there are peaks from both gallic acid and quercetin. Furthermore, it can be seen that quercetin peak had a larger area compared to gallic acid and a peak intensity that is also larger relative to gallic acid, demonstrating a higher relative abundance for quercetin in the Surangi tea sample than for gallic acid. In addition, the peak intensity for quercetin indicates a greater concentration of flavonoids in the Surangi tea sample compared to any other beverage tested and therefore contributing to the overall antioxidant activity of the Surangi tea sample.

Analysis using HPLC method of Surangi flower tea demonstrated the existence of useful flavonoids in much higher concentration than those present in the tea made from the leaves of Camellia sinensis. The flavonoid that has the highest abundance in Surangi tea is quercetin, which is found at an amount of 380.9 mg per 100 g of the tea. The second flavonoid with the second largest amount of 201.8 mg is gallic acid. The last flavonoid on the list is chlorogenic acid with a value of 35.3 mg per 100 grams. Surprisingly, when compared to the values of these flavonoids in Surangi tea, the amounts in the control tea were way smaller similar to its quercetin concentration which accounted for only 72.5 mg per 100 grams. Both gallic acid and chlorogenic acid were present in even smaller amounts of 50.5 mg and 6.4 mg per 100 g respectively. Both p-coumaric acid and catechin were below the detection limit (BDL <0.01 mg/100 g) in both samples. The higher concentration of bioactive phenolic compounds in Surangi tea suggests its superior antioxidant potential and supports its use as a functional herbal beverage with potential health-promoting properties.

- HPLC Chromatogram of Surangi Tea Sample at 320 nm

At 320 nm, it was noticeable via the chromatogram that chlorogenic acid was present based on the identifiable retention peak. There was good resolution in the separation of the various phenolic compounds located within the sample. The retention peaks seen on both Surangi tea chromatograms indicated that these bioactive phenolic constituents were present and that they were in abundance.



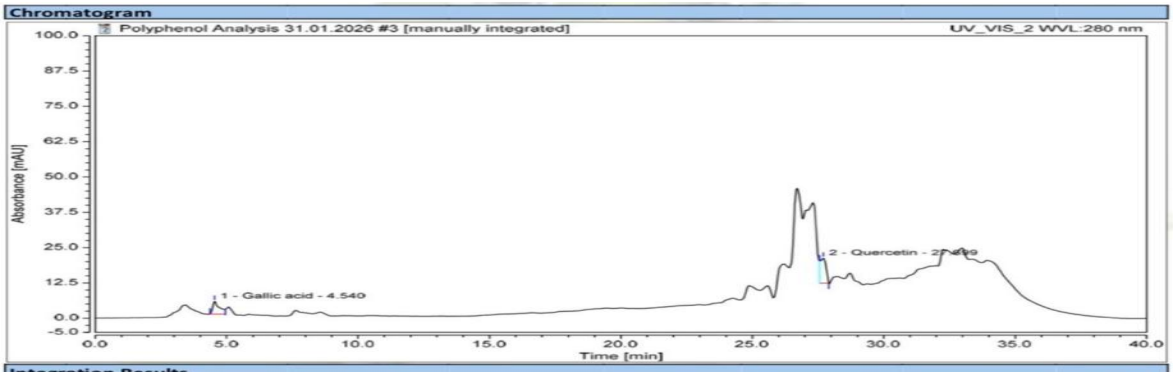
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount
1	Chlorogenic acid	23.991	2.546	6.124	100.00	100.00	n.a.
Total:			2.546	6.124	100.00	100.00	

Figure no. 2 HPLC Chromatogram of Surangi Tea Sample at 320 nm

- HPLC Chromatogram of Control Tea Sample at 280 nm

The control Camellia sinensis tea sample's chromatogram at 280 nm showed comparatively lower peak intensity (i.e., smaller peak area) for both gallic acid and quercetin relative to that of Surangi tea. The smaller peak area associated with the control tea sample implies that there are lower concentrations of phenolic and flavonoid compounds in the control sample.



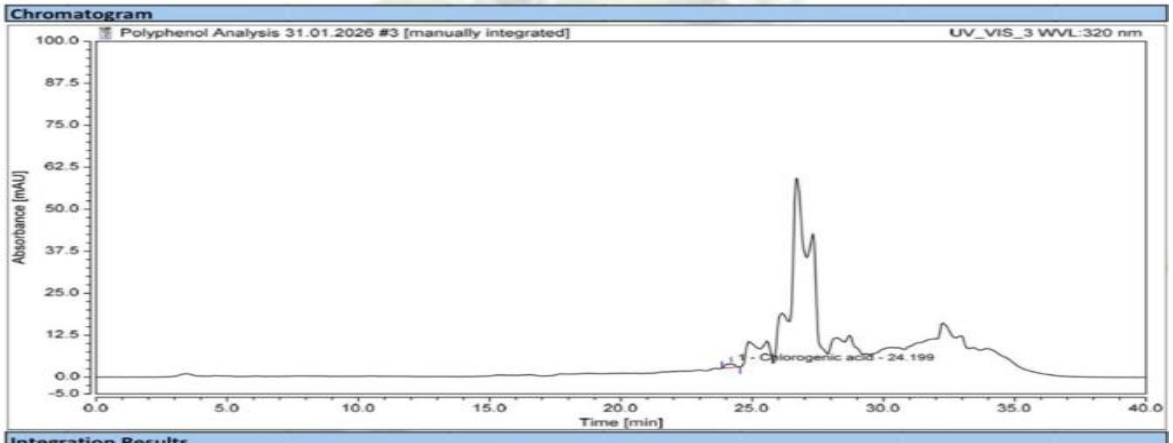
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount
1	Gallic acid	4.540	1.306	4.484	36.34	33.60	n.a.
2	Quercetin	27.699	2.288	8.859	63.66	66.40	n.a.
Total:			3.593	13.343	100.00	100.00	

Figure no. 3 HPLC Chromatogram of Control Tea Sample at 280 nm

- HPLC Chromatogram of Control Tea Sample at 320 nm

Chromatographic analysis of a control sample of tea at 320 nm revealed the presence of chlorogenic acid; however, it had comparatively lower levels than Surangi tea (as denoted by fewer, less intense peaks on the chromatogram). With this analysis, the control sample had a comparatively lower concentration of phytochemicals than Surangi tea.



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount
1	Chlorogenic acid	24.199	0.459	1.074	100.00	100.00	n.a.
Total:			0.459	1.074	100.00	100.00	

Figure no. 4 HPLC Chromatogram of Control Tea Sample at 320 nm

In summary, the data show that the Surangi tea formulation has greater concentrations of many phenolic compounds than its control Camellia sinensis tea sample, as evidenced by the fact that the chromatographic peak intensity, as well as the chromatographic peak area, correlate strongly with the quantitative HPLC data for quercetin, gallic acid, and chlorogenic acid.The chromatographic profiles corroborated the quantitative HPLC data and demonstrated that Surangi tea contains significantly higher levels of phenolic and flavonoid compounds than conventional tea, thereby supporting its potential application as a functional herbal beverage

CONCLUSION

The present study demonstrated that Surangi flower (Mammea suriga) can be effectively utilized for the development of a functional herbal tea. The tea exhibited good physicochemical properties, high antioxidant activity, and appreciable levels of phenolic and flavonoid compounds. The process of brewing at 80°C allowed more bioactive compounds to be retained

compared to brewing at 100°C. In terms of sensory evaluation, the formulation T4 was selected as the best option (80% Surangi flower + 10% lemon peel + 10% mint). Additionally, the HPLC analysis has confirmed the presence of crucial bioactive compounds such as quercetin, gallic acid and chlorogenic acid, thus emphasizing the Surangi tea as an herbal beverage with natural antioxidant properties.

Recommendations

It is highly recommended that more research be done to determine the shelf life and stability of Surangi herbal tea in relation to its storage. Also, clinical and in vivo research can be conducted for successfully confirming the health-related benefits of Surangi tea. Furthermore, Surangi tea has the potential to be commercialized, thus making it a highly valued functional beverage that will not only enable the utilization of underutilized medicinal plants for human health improvement but also contribute to promoting entrepreneurship in rural areas.

REFERENCE

1. Maurya, A., Sharma, R., Yadav, H., Mandal, D., & Shukla, A. C. (2024). Mentha spp.: A miraculous plant with pharmaceutical uses. In A. C. Shukla, S. Facknath, D. Mandal, & B. Montanari (Eds.), Advances in medicinal and aromatic plants: Production, processing, and pharmaceutics (Vol. 2). Apple Academic Press.
2. Abdullah, R., Zaheer, S., Kaleem, A., Iqtedar, M., Aftab, M., & Saleem, F. (2023). Formulation of herbal tea using Cymbopogon citratus, Foeniculum vulgare, and Murraya koenigii and its anti-obesity potential. Journal of King Saud University – Science, 35, 102734.
3. An, H., Liu, J., Chen, Y., Huang, Y., Chen, J., Liu, Z., Li, S., & Huang, J. (2023). Characterization of key volatile compounds in jasmine tea infusion with different amount of flowers. Food Chemistry: X, 19, 100750.
4. Dhage, S. R., Shirke, G. D., Kadam, J. H., & Pinjarkar, M. S. (2023). Studies in qualitative changes in surangi (Mammea suriga) flowers during storage. The Pharma Innovation Journal, 12(6),3075–3079.
5. Fatimah, A. I. F., Ristianingrum, A., & Lidya, L. (2022). Sensory properties and antioxidant activity of chrysanthemum flower tea bags with lemon peels and mint leaves. E3S Web of Conferences, 348, 00026.
6. Sofiah, S., Aswan, A., Yunanto, I., Ramayanti, C., Amelia, P. D., & Utami, A. N. (2022). Making herbal tea from a mixture of butterfly pea flower (Clitoria ternatea) and ginger powder (Zingiber officinale) by using dryin method according to Indonesian National Standards (SNI). Atlantis Highlights in Engineering, 9, 107–115.
7. Suksathan, R., Rachkeeree, A., Puangpradab, R., Kantadoung, K., & Sommano, S. R. (2021). Phytochemical and nutritional compositions and antioxidant properties of wild edible flowers as sources of new tea formulations. NFS Journal, 24, 15–25.
8. Raj, D., Shah, M. S., & Sharma, D. (2021). Mint – A versatile medicinal herb. In International Book Series on Medicinal and Aromatic Plants.
9. Kumar, A., Kaur, J., & Singh, B. (2020). Nutritional composition and functional properties of lemon (Citrus limon) peel powder. Journal of Food Science and Nutrition, 7(3), 1021–1027.
10. Devi, K. M., Singh, N. I., Devi, S. B., & Singh, M. S. (2018). Proximate analysis and nutritive value of dried pudina (Mentha arvensis) leaf powder. International Journal of Current Microbiology and Applied Sciences, 7(3), 756–761.
11. Rachkeeree, A., et al. (2018). Microbial quality and safety of traditional herbal teas in Thailand. Journal of Ethnopharmacology, 213, 44–50.
12. Shastri S. L., Krishna V., Ravishnakar B., Vinay Kumar N. M., & Chethan Kumara G. P. (2017). Antioxidant and hepatoprotective potential of Mammea suriga aqueous extract against CCl_4-induced hepatotoxicity in rat models. World Journal of Pharmaceutical Research, 6(6), 1396–1409.
13. Shastri S. L., Krishna V., Kumar R. S., & Ramu V. (2016). Phytochemical analysis, antibacterial property and molecular docking studies of Mammea suriga Kosterm. World Journal of Pharmaceutical Sciences.
14. Paul S., et al. (2015). Microbial quality assessment of black tea marketed in India. Journal of Food Safety and Hygiene.
15. Poojary, M. M., Vishnumurthy, K. A., & Adhikarin, A. V. (2015). Extraction, characterization and biological studies of phytochemicals from Mammea suriga. Journal of Pharmaceutical Analysis, 5(3), 182–189.
16. Singh, R., Shushni, M. A. M., & Belkheir, A. (2015). Antibacterial and antioxidant activities of Mentha piperita L. Arabian Journal of Chemistry, 8(3), 322–328.
17. Owuamanam, C. I., et al. (2014). Microbial assessment of herbal teas from different vendors. African Journal of Microbiology Research.
18. González-Molina, E., Domínguez-Perles, R., Moreno, D. A., & García-Viguera, C. (2010). Natural bioactive compounds of Citrus limon for food and health. Journal of Pharmaceutical and Biomedical Analysis,51(2),327–345.
19. Pitt, J. I., & Hocking, A. D. (2009). Fungi and Food Spoilage (3rd ed.). Springer.
20. Downes, F. P., & Ito, K. (2001). Compendium of Methods for the Microbiological Examination of Foods (4th ed.). American Public Health Association.
21. Craig, W. J. (1999). Health-promoting properties of common herbs. The American Journal of Clinical Nutrition, 70(3), 491S–499S.
22. Ghasemi, K., Ghasemi, Y., & Ebrahimzadeh, M. A. (2009). Antioxidant activity, phenol and flavonoid contents of 13 citrus species peels and tissues. Pakistan Journal of Pharmaceutical Sciences, 22(3), 277–281.
23. Granato, D., Barba, F. J., Kovačević, D. B., Lorenzo, J. M., Cruz, A. G., & Putnik, P. (2020). Functional foods: Product development, technological trends, efficacy testing, and safety. Annual Review of Food Science and Technology, 11, 93–118.
24. Khandelwal, K. R. (2008). Practical pharmacognosy: Techniques and experiments (19th ed.). Nirali Prakashan.
25. Kirtikar, K. R., & Basu, B. D. (2006). Indian medicinal plants (2nd ed.). International Book Distributors.
26. McKay, D. L., & Blumberg, J. B. (2007). A review of the bioactivity and potential health benefits of chamomile

tea (Matricaria recutita L.). Phytotherapy Research, 20(7), 519–530.

27. Nadkarni, K. M. (2009). Indian materia medica (Vol. 1). Popular Prakashan.
28. Shahidi, F., & Ambigaipalan, P. (2015). Phenolics and polyphenolics in foods, beverages and spices: Antioxidant activity and health effects—A review. Journal of Functional Foods, 18, 820–897.
29. Singh, R., Shushni, M. A. M., & Belkheir, A. (2011). Antibacterial and antioxidant activities of Mentha piperita L. Arabian Journal of Chemistry, 8(3), 322–328.