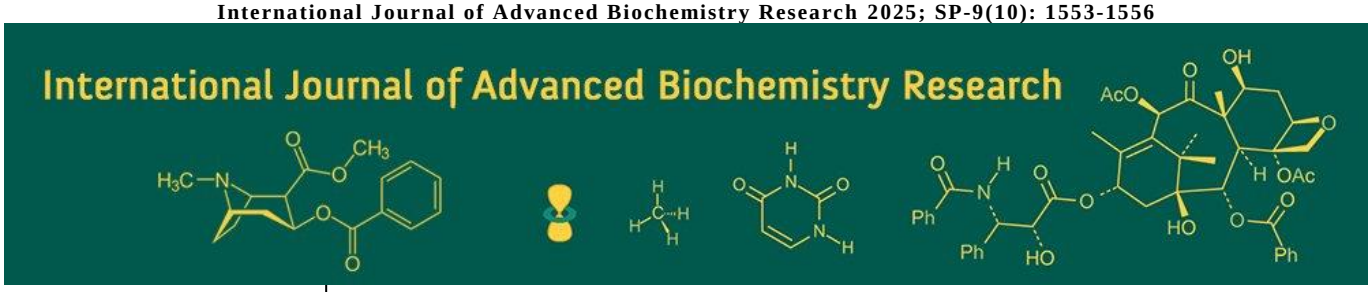


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# Development and quality assessment of herbal tea bag

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**Abstract**
The popularity and consumption of herbal teas has witnessed a significant uptick nowadays, propelled by shifting consumer attitudes toward holistic health and natural remedies. The present study focuses on the formulation and quality assessment of a novel herbal tea incorporating lemongrass, mint, tulsi, cinnamon and turmeric cultivated under agriphotovoltaic system. The assessment includes a complete examination of proximate compositions, mineral analysis and assessing antioxidant property. Proximate analysis of the selected herbal tea bag included moisture (6.35%), protein (6.60%), fat (4.91%), ash (6.27%), carbohydrate (61.15%), and crude fibre (14.78%) depicting ample variation with proximate content of the control herbal tea bag which contained only lemongrass. The mineral composition of selected herbal tea bag showed ample variations (mg/100 g) in potassium (+276.16), calcium (+63.11), iron (+5.54), sodium (+0.77) and zinc (-0.33). The antioxidant composition of selected herbal tea bag includes total phenolic content (58.16 mg GAE/g), total flavonoid content (25.07 mg QE/g) and total antioxidant capacity (0.664 mg AAE/g). Nutritional analysis of the final formulation indicates this herbal tea bag can be positioned as a nutritious, eco-friendly option, appealing to health-conscious consumers who seek organic and natural remedies as part of their daily wellness routine.

**Keywords:** Herbal tea, holistic, antioxidants, nutritious, organic and health benefits

## Introduction
Herbal tea is the form of an infusion of dried plant parts (leaves, flowers, seeds, roots and barks). They are mostly popular because of their fragrance, antioxidant properties and therapeutic applications. In recent years, the herbal tea market has grown significantly, influenced by changing consumer preferences favoring health and wellness (Okpiaifo *et al.*, 2023; Puri *et al.*, 2022) [10, 13]. This increased consumption reflects a shift toward holistic health approaches and natural remedies. The COVID-19 pandemic has also spurred demand for herbal teas, as many seek drinks that boost immunity and reduce stress (Abd Wahab *et al.*, 2023) [4].

Lemongrass (*Cymbopogon citrates*) contains alkaloids, flavonoids, saponins, quinones, and tannins, which provide antibacterial, antioxidant, pain relief, cough and cold remedy, stomach acid reduction, and aromatherapy benefits. (Patel and Metha, 2006) [12] evaluated antioxidant compounds in lemongrass and found that dried lemongrass contained higher levels of phenols and flavonoids compared to fresh lemongrass, suggesting that dried lemongrass has greater antioxidant potential.

Holy basil or Tulsi (*Ocimum tenuiflorum* L.) is a highly valued medicinal herb with antioxidant and antimicrobial properties attributed to its phenolic and aromatic compounds. The main phenolics in basil include phenolic acids and flavonol glycosides (Lee and Scagel, 2010) [9]. Tulsi contains a significant amount of antioxidants that help combat free radicals, support vision, boost the immune system, enhance stamina, and regulate blood sugar levels (Lakshmi *et al.*, 2015) [8].

Mint (*Mentha piperita* L.) leaves are rich in numerous antioxidant vitamins and phytonutrients, including vitamin A, beta carotene, vitamins C, K, and E, folates, riboflavin and pyridoxine, as well as minerals such as potassium, calcium, iron, manganese, and magnesium (Straumite *et al.*, 2015) [16]. The leaves provide a refreshing effect and a distinct aroma due to the abundance of menthol compounds. Mint has pharmaceutical uses including symptomatic relief of digestive issues, expectorant and antitussive effects in respiratory disorders.

Cinnamon (*Cinnamomum burmanni* L.) contained cinnamaldehyde, a key compound contributing to its sensory qualities by masking off-flavors. It contains beneficial compounds including cinnamate, cinnamic acid, and essential oils, and offers health benefits such as anti-inflammatory, antitermitic, nematicidal, mosquito larvicidal, insecticidal, antimycotic, and anticancer properties (Kirana and Sunarharum, 2020) [7].

India produces nearly the entire world's Turmeric (*Curcuma longa* L.) crop and consumes about 80% of it. Due to its superior qualities, Indian turmeric is regarded as the best globally. The active compound curcumin in turmeric has been shown to stimulate bile production by the gallbladder. It is also a potent antioxidant, helping to neutralize harmful free radicals. It has been used to treat a wide range of health issues, from aiding weight loss in individuals with metabolic disorders to alleviating arthritis and joint pain, while also boosting immunity and offering cardiovascular protection (Gupta *et al.*, 2020) [6].

## Materials and Methods

Raw materials such as lemongrass, tulsi, mint and cinnamon were procured from the local market in Parbhani, Maharashtra. The fresh rhizomes of turmeric (*Curcuma longa*) variety *Salem* grown under photovoltaic system were taken to conduct research work, while chemicals and reagents were acquired from the laboratory at the Department of Food Science and Nutrition, College of Community Science, Department of Food Process Technology, College of Food Technology, VNMKV, Parbhani (MS).

For the formulation of herbal tea bag, the amounts of ingredients were calculated on dry weight basis. The raw materials were cleaned and dried (separately) and then stored in an air tight container, followed by taking in required amount as per the formulations given in Table 1 and mixing together in the tea bag as per formulation and then storing in an airtight container.

**Table 1:** Formulation of Herbal tea (g/100 g)

| Ingredients | Control | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
|---|---|---|---|---|---|
| Lemongrass | 100 | 65 | 60 | 55 | 50 |
| Turmeric | - | 05 | 10 | 15 | 20 |
| Mint | - | 10 | 10 | 10 | 10 |
| Tulsi | - | 10 | 10 | 10 | 10 |
| Cinnamon | - | 10 | 10 | 10 | 10 |

**Table 2:** Standardized formulation for preparation of Herbal tea

| Ingredients | % |
|---|---|
| Lemongrass | 55 |
| Turmeric | 15 |
| Tulsi | 10 |
| Mint | 10 |
| Cinnamon | 10 |

Table 2 shows the standardized formulation of herbal tea bag which has been selected according to the organoleptic evaluation followed by nutritional analysis of the treatment among four samples prepared by altering ratios of raw materials, containing 55 g, 15 g, 10 g, 10 g, 10 g (/100 g) of lemongrass, turmeric, tulsi, mint and cinnamon respectively.

Developing herbal tea required inclusion of all raw materials. It started by sorting and cleaning the raw materials. The lemongrass leaves were dried using cabinet drying at 45 °C for 7 hrs and crushed, tulsi and mint were shade dried at ambient temperature for 24hrs and crushed. Turmeric from the four samples was selected based on organoleptic analysis as well as nutrition composition and coarsely ground, followed by grinding cinnamon coarsely. Then the raw ingredients were mixed at the prescribed ratio as per table and sieved as per the particle size of herbal tea (30-40 mm) and then stored in an airtight container. The tea was thoroughly combined, resulting in an ideal mixture. The tea bags were then filled with 2 grams of herbal tea and top was tightly tied with strings to prevent leaks and the bags were labeled. The procedure for preparing herbal tea bag is given in Figure 1.

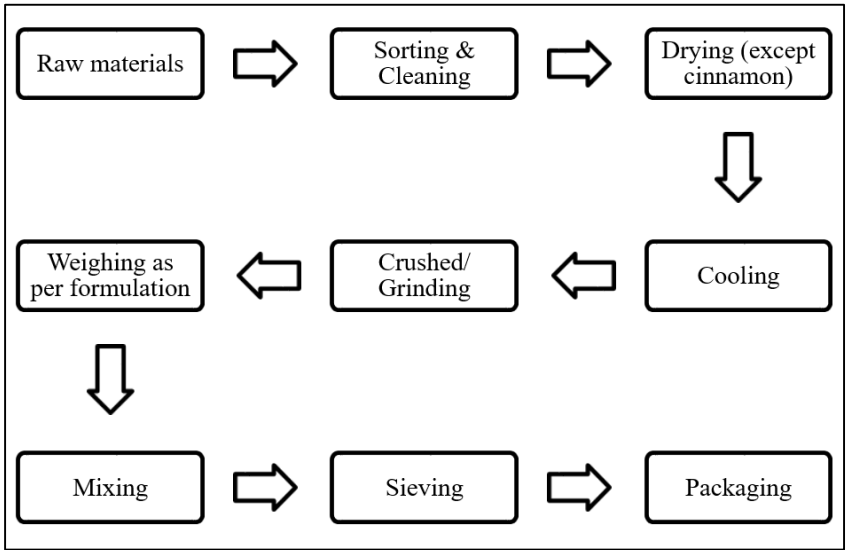


**Fig 1:** Flow chart for preparation of herbal tea

## Proximate analysis

### Moisture estimation

Moisture content was determined by AOAC, 2000 method. 2 g of the sample weighed in a pre-weighed Petri dish, which was then dried at 130±3 °C for 3 hr. After drying, the Petri dish was cooled in a desiccator and weighed. This drying, cooling and weighing process was repeated every 30 min until the weight difference between two consecutive measurements was less than 1 mg.

**Protein estimation**
The protein estimation was done according to AOAC 954.01-2010. The nitrogen content of the sample was measured using the Kjeldahl method with Pelican Kel plus equipment. The crude protein was subsequently calculated by multiplying the nitrogen content by a factor of 6.25.

**Fat estimation**
Fat content in the bran samples was determined by AOAC 922.06-2007 method. Fat content in the FMB was estimated in Soxhlet apparatus as crude ether extracted method using moisture-free samples. The solvent was evaporated and the remaining fat residue was weighed.

**Fiber estimation**
The crude fiber content was estimated according to the method given by AOAC 962.09-2007. Crude fiber in the sample was measured by using samples that were free of moisture and fat. Crude fiber is estimated by boiling a 2 g of bran sample with dilute acid and alkali to replicate the digestive processes. The fiber, which remains undissolved, is collected by filtration. The residue is then dried, weighed and ashed to remove any mineral contamination.

**Mineral analysis**
The measurement of the mineral content in the herbal tea bag, including calcium, iron, and other elements, was done in accordance with the standardized methods described in (Ranganna, 1986) [14] through acid digestion of the ash following its initial weighing. A quantity of 5 ml of 5 N HCl was introduced to the ash, allowed to cool, transferred into a 100 ml volumetric flask, and adjusted to the mark with distilled water. Subsequently, the mineral contents were determined using the atomic absorption spectrometric technique.

**Total Phenolic Content (TPC)**
The Total Phenolic Content (TPC) of the herbal tea was determined using the Folin-Ciocalteu colorimetric method, with slight modifications as necessary. Briefly, an aliquot of the sample extract (usually 0.5-1.0 mL) was mixed with 2.5 mL of 10% (v/v) Folin-Ciocalteu reagent and allowed to react for 3-5 minutes at room temperature. Subsequently, 2.0 mL of 7.5% (w/v) sodium carbonate solution was added to the mixture, and the reaction was allowed to proceed in the dark for 30-60 minutes. The absorbance was then measured at 760 nm using a UV-Visible spectrophotometer. Gallic acid was used as the standard for constructing the calibration curve, and the results were expressed as milligrams of gallic acid equivalents per gram of dry weight (mg GAE/g DW) of the sample.

**Total Flavonoid Content (TFC)**
The Total Flavonoid Content (TFC) was estimated using the aluminum chloride ($AlCl_3$) colorimetric assay. In this method, 0.5 mL of sample extract was mixed with 0.1 mL of 10% (w/v) aluminum chloride, 0.1 mL of 1 M potassium acetate, and 4.3 mL of distilled water. The reaction mixture was incubated at room temperature for 30 minutes, after which the absorbance was measured at 415 nm using a UV-Visible spectrophotometer. Quercetin was used as the standard reference compound, and a calibration curve was plotted to quantify the flavonoid content. The results were expressed as milligrams of quercetin equivalents per gram of dry weight (mg QE/g DW) of the sample.

**Total Antioxidant Capacity (TAC)**
The Total Antioxidant Capacity (TAC) was assessed using the phosphomolybdenum method, which is based on the reduction of Mo (VI) to Mo (V) by the antioxidants present in the sample under acidic conditions. For the assay, 0.3 mL of sample extract was added to 3 mL of reagent solution containing 0.6 M sulfuric acid, 28 mM sodium phosphate, and 4 mM ammonium molybdate. The mixture was incubated in a water bath at 95 °C for 90 minutes. After cooling to room temperature, the absorbance was measured at 695 nm against a blank. Ascorbic acid was used to prepare the standard curve, and the antioxidant capacity was expressed as milligrams of ascorbic acid equivalents per gram of dry weight (mg AAE/g DW) of the sample.

**Statistical analysis**
The data collected underwent organization, tabulation, and statistical analysis. The sample analyses were conducted in triplicate. Analysis of variance was performed using the standard ANOVA procedure. The data obtained for different treatments were recorded and statistically analyzed using CRD (complete randomized design), following the method outlined by (Panse and sukathme, 1954) [11] to determine significance levels. The analysis of variance indicated significance at the $p<0.05$ level.

**Results and Discussion**

**Table 3:** Proximate composition of herbal tea

| Parameter (%) | Control | Selected Sample ($T_3$) |
|---|---|---|
| Moisture | 6.40±0.32 | 6.35±0.07 |
| Crude Protein | 7.70±0.39 | 6.60±0.21 |
| Crude Fat | 2.30±0.23 | 4.91±0.13 |
| Ash | 4.20±0.22 | 6.27±0.18 |
| Carbohydrate | 63.65±1.58 | 61.15±0.82 |
| Crude fiber | 15.80±0.58 | 14.78±0.30 |

*Results are mean ± S.D of three determinations

Table 3 shows moisture content of the control and selected sample was estimated to be 6.40% and 6.35% respectively. It indicates that drying of herbs resulted in reduction of moisture. The protein, carbohydrates, fat, fiber and ash of control tea were 7.70%, 63.65%, 2.30%, 15.80% and 4.20% respectively, the corresponding values of accepted tea sample for above tabulated nutrients were 6.60, 61.15%, 4.9%, 14.78%, and 6.27%. From the results it was concluded that selected sample of herbal tea contained protein, fat, fiber and ash in significant amount. The results inferred that the developed herbal tea has significant nutrient content as of control tea.

**Table 4:** Mineral composition of herbal tea

| Parameter (mg/100 g) | Control | Selected Sample ($T_3$) |
|---|---|---|
| Calcium (Ca) | 34.40±1.20 | 97.51±1.30 |
| Iron (Fe) | 7.80±0.30 | 13.34±0.55 |
| Sodium (Na) | 23.47±1.24 | 24.24±0.75 |
| Zinc (Zn) | 4.48±0.18 | 4.15±0.15 |
| Potassium (K) | 52.58±1.35 | 328.74±0.75 |

*Results are mean ± S.D of three determinations

Table 4 shows the calcium, iron, sodium, zinc and potassium content of control tea were 34.40 mg/100 g, 7.80 mg/100 g, 23.47 mg/100 g, 4.48 mg/100 g and 52.58

mg/100 g respectively. The corresponding values for selected herbal tea for above tabulated nutrients were 97.51 mg/100 g, 13.34 mg/100 g, 21.24 mg/100 g, 4.15 mg/100 g and 328.74 mg/100 g. The study showed that herbal tea was good sources of calcium, iron, Sodium and potassium since it contained various herbs along with turmeric grown under photovoltaic system (Sharangi *et al.*, 2022) [15].

**Table 5:** Antioxidant composition of herbal tea

| Parameter | Control | Selected Sample ($T_3$) |
|---|---|---|
| Total phenolic content (mg GAE/g) | 38.77±2.74 | 58.16±3.13 |
| Total flavonoid content (mg QE/g) | 21.14±2.50 | 25.07±2.37 |
| Total antioxidant capacity (mg AAE/g) | 0.23±0.042 | 0.664±0.084 |

*Results are mean ± S.D of three determinations

Table 5 shows the total phenolic content, total flavonoid content and total antioxidant capacity of control tea were 38.77 mg GAE/g, 21.14 mg QE/g, and 0.23 mg AAE/g respectively. The corresponding values of selected herbal tea for above tabulated composition were 58.16 mg GAE/g, 25.07 mg QE/g and 0.664 mg AAE/g. The results inferred that the developed herbal tea with incorporation of several herbs along with photovoltaically grown turmeric is a good source of antioxidants, contributing to various health benefits upon consuming (Chandrasekara and Shahidi, 2018) [5].

## Conclusion

The study of developed herbal tea demonstrated the enrichment of potassium, calcium, iron, sodium, total phenolic content, total flavonoid content and total antioxidant capacity. The organoleptically accepted herbal tea ($T_3$) was found to contain significantly higher amount of mineral composition, antioxidants and phytochemicals, which is beneficial to reduce oxidative stress of the body, heart health, neural health and combat mineral deficiencies. People nowadays are shifting towards healthy and mindful consumption preferring organic beverages which can be made as home remedies. The inclusion of various herbs and spices along with lemongrass enhanced the organoleptic qualities, mineral composition and antioxidant properties of the product. Quantity attributes of selected herbal tea ($T_3$) can be stored for 2 months in ambient condition packed with aluminium laminated paper bags as primary packaging and tin boxes as secondary packaging.

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