**Evaluation, consumer acceptability and cost economics of flavour blended mulberry herbal tea**

**Abstract:**

Mulberry (Morus spp.) leaves are renowned for their potent antioxidant activity and associated health benefits, making them an attractive base for functional beverages. In this study, a ready-to-drink, flavour-enhanced mulberry herbal tea was developed using 4 g of mulberry leaf powder along with 0.6 g each of ginger, cumin (jeera), and mint (pudina) per serving. These ingredients were selected to improve both flavour and functional value. The formulation was standardized and evaluated by a semi-trained sensory panel (n = 21) using a 20‑point hedonic scale assessing appearance, aroma, bouquet, body, astringency, flavour, and overall acceptability. The optimized formulation (T2) achieved the highest sensory score (14.73), significantly outperforming the control across all attributes (p < 0.05), indicating the effectiveness of the chosen blend in enhancing sensory quality.

Further consumer testing with 120 participants confirmed high acceptability, with positive ratings for colour (93.3%), flavour (92.5%), taste (89.2%), freshness (90.8%), nutrition (87.5%), and convenience (86.7%). Cost analysis revealed production expenses of ₹76.34 per 100 g, notably lower than the ₹155/100 g benchmark for conventional green tea, demonstrating strong economic viability. Overall, the results show that the optimized mulberry herbal tea offers an appealing, health-oriented alternative with superior sensory characteristics and competitive production costs, supporting its potential for successful commercialization in the functional beverage market.

**Key words**: Functional beverage, flavour blended, sensory evaluation, hedonic scale, consumer acceptability, cost economics,

**Introduction:**

Tea is a favourite drink that is consumed by all ages. In worldwide, the total consumption of tea is higher than the consumption of other drink such as soft drink, coffee, and alcoholic beverages (Agustina, 2015). Types of tea that is widely consumed in Indonesia is tea in the packaging and tea leaves. According to data from the Association of Light Beverage Industry (ASRIM) in Agustina (2015), the amount of packaged tea consumption in Indonesia at 2014 reaches 2 billion liters or 1.07 pounds (0.5 kg) of tea leaves per person annually. The data shows that the tea in the packaging becomes the second highest ready-drink consumed after mineral water.

According to Winarti (2010), tea is a drink made by brewing leaves, leaf shoots, or stem of tea plants (*camellia sinesis*) dried with hot water. The term 'tea' is also defined as beverages made by brewing dried fruits, spices or other medicinal plants (Winarti, 2010: 201). One of the ingredients that can be used as tea is mulberry leaves. According to Frank & Orwell (2013), mulberry leaves have a very powerful antioxidant effect. As an effort to improve quality mulberry leaves tea color, this study adds food coloring into mulberry tea. Sappan wood is one of the natural red dye. The red color that comes out the sappan wood comes from brazilin, one of the flavonoid compounds (Nirmal *et al*, 2015). In addition to the dye, the addition of sappan wood is also conducted in order to increase the content of antioxidants in mulberry leaf tea drinks. The use of a combination of antioxidants has been shown to increase antioxidant activity compared to when used separately.

The utilization of mulberry leaves as tea in a ready-to drink packaging is one of the innovation to get the benefits in terms of health as well as to fulfill consumers need in practical mode consumption. In addition to product innovation, another thing to plan in order to achieve marketing goals is the implementation of marketing strategies based on the marketing mix, a combination of product, pricing, promotional activities, and distribution systems that are at the core of the company's marketing system (Swastha & Sukotjo, 2002). The four variables are the determinants of the success rate of the company marketing strategy.

The use of mulberry leaves in ready-to-drink tea is an innovative way to deliver health benefits while meeting consumer demand for convenient products. Beyond product innovation, effective marketing strategies based on the marketing mix—product, price, promotion, and distribution—are essential to achieve marketing goals (Swastha & Sukotjo, 2002). The product mix, which includes aspects like quality, brand, and packaging, is the first and crucial element to plan, as it attracts customer interest and meets their needs (Kotler & Armstrong, 2001). It also plays a key role in shaping customer preferences and differentiating the product from competitors.

According to our latest research, the global Mulberry Hard Tea market size reached USD 1.14 billion in 2024, demonstrating robust momentum driven by evolving consumer preferences and innovation in the beverage sector. The market is anticipated to expand at a CAGR of 8.2% during the forecast period, projecting the market to attain a value of USD 2.18 billion by 2033. This steady growth is primarily fueled by the increasing demand for novel, health-oriented alcoholic and non-alcoholic beverages, as well as the premiumization trend in the global drinks industry.

**II Material and Methods:**

In this chapter, the material and methods adopted for various experiments in the present study “Development of Mulberry Herbal Tea with Different Flavours” was carried out at the Department of Sericulture, UAS, GKVK, Bengaluru in collaboration with Department of food science and nutrition, CoA, UAS, GKVK, Bengaluru during the year 2023-2024. This paper deals with the methods and approaches followed to accomplish the best accepted flavoured mulberry herbal tea with consumer acceptability and working out the economics of the best accepted flavoured mulberry herbal tea.

**Procurement of raw material**

The fresh, tender mulberry leaves (V1or Victory-1) were collected from the Mulberry Garden, Department of Sericulture, University of Agricultural Sciences, GKVK, Bangaluru, located in the Northern part of Bangalore between Latitude; 13⁰05’ North and Longitude: 77⁰34’ East Altitude: 924 m (above mean sea level), land area: 1380 acres. The maximum and minimum temperature was about 29.6 and 18.5 ⁰C, respectively.

**Processing of mulberry leaves for preparation of mulberry herbal tea with different flavours**

Generally, the tender mulberry leaves were harvested from the top of the branches in the early morning and immediately transferred into a zip-pouch for moisture retention.The collected mulberry leaves were manually separated and the leaves were washed in tap water to remove extraneous matter and spread those leaves on a clean cloth. The mulberry leaves were dried in the shade until they became crisp. Then dried leaves were ground into small pieces and stored.

**Flavour blended mulberry herbal tea**

Flavour blended mulberry herbal tea was prepared with three best accepted flavors ginger, *jeera*(cumin) and *pudina*(mint) and using mulberry tea powder 4g constant in all treatments, combination of ginger, *jeera* and *pudina* at 0.4, 0.6 and 0.8g, respectively and compared with control for sensory parameters (Table: 1)

**Table 1: Formulation for flavour blended mulberry herbal tea**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sl.No.** | **Ingredients (g)** | **I** | **II** | **III** | **Control** |
| **1** | Ginger | 0.4 | 0.6 | 0.8 | - |
| **2** | *Jeera* | 0.4 | 0.6 | 0.8 | - |
| **3** | *Pudina* | 0.4 | 0.6 | 0.8 | - |
| **4** | Mulberry leaf | 4 | 4 | 4 | 4 |
| **5** | Water | 250ml | 250ml | 250ml | 250ml |
| **4** | Honey | 3ml | 3ml | 3ml | 3ml |

**Results and Discussion:**

**Sensory evaluation of flavour blended mulberry herbal tea**

The mulberry herbal tea was prepared by using mulberry leaf tea powder with 4g and ginger, *pudina*(mint) and *jeera*(cumin) (blended) with 0.4g, 0.6g and 0.8g respectively. Products were subjected to sensory evaluation by 21 semi trained panel members using 20-point hedonic scale and the results are presented in (Table 1)

The tea with 4g mulberry leaf tea powder and 0.6g of ginger, *pudina*(mint) and *jeera(cumin)* powder each was the best accepted among formulations attributed with higher composite sensory score for all the sensory attributes to the other level of incorporation with mean score of 1.74,1.74, 1.77, 1.76, 0.97, 0.91, 1.42, 1.12, 1.89, 1.38 and 14.73 and control had 1.69, 1.76, 1.21, 1.26, 0.83, 0.97, 1.27, 0.51, 0.99, 1.09 and 11.61 for appearance, colour, aroma, bouquet, acidity, sweetness, body, astringency, flavour, quality and overall acceptability respectively expect sweetness and colour which had high score in control (Table 2, Fig. 1)

There was significant difference between the variations flavour blended mulberry herbal tea for sensory attributes like appearance, colour, aroma, bouquet, body, astringency, quality and overall acceptability, whereas, acidity and sweetness showed a non-significant difference at 5 per cent level of significance among the variations.

Ubashana*et al*. (2020) combined moringa, amla, ginger, celery, and sweet basil to create a herbal tea based on curry leaves. The combination of 50% curry leaves, 20% amla, 10% moringa and dry ginger, and 50% celery and sweet basil had the best overall acceptance, according to an organoleptic study This suggests that curry leaf- based herbal tea could serve as an alternative to commercial green tea with diverse health benefits.

**Table 2:** **Mean sensory scores of flavour blended mulberry herbal tea**

|  |  |
| --- | --- |
| **Treatments** | **SENSORY PARAMETERS** |
| **Appearances** | **Colour** | **Aroma** | **Bouquet** | **Acidity** | **Sweetness** | **Body** | **Astringency** | **Flavour** | **Quality** | **OAA** |
| **Control** | 1.69±0.46 | 1.76±0.43 | 1.21±0.46 | 1.26±0.43 | 0.83±0.35 | 0.97±0.40 | 1.27±0.48 | 0.51±0.19 | 0.99±0.20 | 1.09±0.24 | 11.61±3.68 |
| **T1** | 1.73±0.38 | 1.74±0.35 | 1.50±0.46 | 1.49±0.38 | 0.96±0.15 | 0.96±0.15 | 1.10±0.20 | 0.85±0.21 | 1.16±0.26 | 1.01±0.06 | 12.57±2.89 |
| **T2** | 1.74±0.26 | 1.74±0.25 | 1.77±0.27 | 1.76±0.31 | 0.97±0.40 | 0.91±0.19 | 1.42±0.21 | 1.12±0.36 | 1.89±0.14 | 1.38±0.39 | 14.73±2.5 |
| **T3** | 1.04±0.22 | 0.90±0.18 | 1.08±0.29 | 0.93±1.55 | 0.71±0.40 | 0.75±0.37 | 0.85±0.22 | 0.53±0.26 | 0.99±0.06 | 1.01±0.06 | 8.33±1.16 |
| **F value** | \* | \* | \* | \* | NS | NS | \* | \* | \* | \* | \* |
| **Sem**± | 0.08 | 0.07 | 0.08 | 0.07 | 0.08 | 0.06 | 0.06 | 0.06 | 0.04 | 0.05 | 0.62 |
| **CD at 5%** | 0.21 | 0.20 | 0.24 | 0.21 | - | - | 0.18 | 0.17 | 0.11 | 0.14 | 1.73 |

\*Significance, **NS**- Non significant at 5 per cent level, **Control** – Mulberry leaf tea powder (4g), **T1**- Mulberry leaf tea powder 4g + 0.4g ginger, *pudina* and *jeera* respectively, **T2**- Mulberry leaves powder 4g + 0.6 ginger, *pudina* and *jeera* respectively, **T3** - Mulberry leaves powder 4g + 0.8g ginger, *pudina* and *jeera* respectively

The results revealed that 0.6g of ginger, *pudina*(mint) and *jeera*(cumin) (T2) incorporation to mulberry tea scored higher than control expect colour and sweetness. Ginger likely contributes a warm, spicy aroma and flavour, jeera adds a subtle earthy and nutty profile, and pudina provides a refreshing and cooling effect. These combined flavours and aromas may lead to a more balanced and appealing sensory profile, making T2 more preferable to the control in terms of taste and aroma, even though the differences are not statistically significant.



**Control** – Mulberry leaf tea powder (4g), **T1**- Mulberry leaves powder 4g + 0.4g ginger, *pudina* and *jeera* respectively, **T2** - Mulberry leaves powder 4g + 0.6 ginger, *pudina* and *jeera* respectively, **T3** - Mulberry leaves powder 4g + 0.8g ginger, *pudina* and *jeera* respectively

**Fig 1: Mean sensory scores for overall acceptability of flavour blended mulberry herbal blended tea**

**Consumer acceptability of flavour blended mulberry herbal tea**

Consumer preference and sensory quality are valuable and crucial for product development and quality assurance. Consumer-focused food product development should be taken into account as a strategy for creating a competitive edge, ensuring long-term business success in the market place and averting unfavourable changes to the acceptability and quality of the product.A new product should only be introduced if it is accepted by consumers; otherwise, it should be rejected. (Table 3 and Fig.2).

The data shows that consumers are generally satisfied with a wide range of product features. Of these, colour and flavour are the most popular, with acceptance percentages of (93.33 %) and (92.50 %), respectively. This shows that most customers are satisfied with the product's flavour and look, with only a less percentage indicating partial or no approval. Additionally, (89.16 %) of customers strongly approve taste, while a slightly greater number somewhat accept it, indicating that taste is generally well-liked even though some consumers feel it might be improved. Freshness is highly valued, as seen by the product's (90.83 %) acceptance rating, which indicates that most customers believe it to be fresh. (Table 3 and Fig.2).

**Table 3: Consumer acceptability of best accepted flavour blended mulberry herbal tea**

**(n=120)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Statement** | **Accepted** | **Partially accepted** | **Not accepted** |
| n | % | n | % | n | % |
| **Colour** | 112 | 93.33 | 6 | 5.00 | 2 | 1.67 |
| **Flavour** | 111 | 92.50 | 8 | 6.67 | 1 | 0.83 |
| **Taste** | 107 | 89.16 | 13 | 10.83 | 0 | 0.00 |
| **Nutrition** | 105 | 87.50 | 14 | 11.66 | 1 | 0.83 |
| **Freshness** | 109 | 90.83 | 9 | 7.50 | 2 | 1.67 |
| **Convenience** | 104 | 86.67 | 12 | 10.00 | 4 | 3.33 |



**Fig 2**: **Consumer acceptability of best accepted flavour blended mulberry herbal tea**

The nutrition of the product had an acceptance score of (87.50 %), indicating that while most customers are happy with its nutritional content, some people believe it might be improved. Finally, (86.67 %) of respondents agreed with the statement "convenience," indicating that while many people find the product convenient to use, others may find it less so. Colour and flavour provide the highest levels of satisfaction, while there are opportunities to improve taste, nutrition, and convenience to further enhance overall consumer satisfaction. This may be due to consumers’ accustomed habit of drinking regular tea.

Lee *et al*. (2010) found that green tea preferences vary by country: Korean consumers preferred green teas with green flavors and moderate bitterness, U.S. consumers favored teas with brown, fruity, or sweet aromas, and Thai consumers liked fruity flavors with no green taste. Across all regions, teas with high bitterness were generally disliked.

 **Cost economics of flavoured blended mulberry herbal tea**

The cost of production of flavour blended mulberry herbal tea was calaculated per 100ml. Overhead charges at 30 per cent of expenditure on manufacturing which includes labour cost, depreciation cost on machinery, equipments, building *etc*. Premium charges @ 10% and profit at 30 per cent was included. (Table 4).

**Table 4**: **Cost economics of flavoured mulberry herbal tea (Per 100g)**

|  |  |  |
| --- | --- | --- |
| **Ingredients** | **Quantity used (g)** | **Cost (₹)** |
| Mulberry leaves powder | 69 | 5 |
| Ginger powder | 10.3 | 10.3 |
| Jeera powder | 10.3 | 1.65 |
| Pudina powder | 10.3 | 25 |
| Total | 100 | 41.95 |
| Overhead charges @ (30 %) | - | 12.58 |
| Premium charges @10 per cent | - | 4.19 |
| Profit (30 %) | - | 17.62 |
| Cost product |  | 76.34 |

 The cost estimation of developed flavour blended mulberry herbal tea was 76.43 per 100gram which was lesser that available green tea per 100 grams where it has 155 rupees.

Similar findings were reported in a study by Ramya and Chandrashekar (2020) on the development of pakoda using mulberry leaves. The production cost of the most accepted mulberry leaf pakoda (5 percent inclusion) and the control (without mulberry leaves) was calculated. The cost of raw materials was ₹5.66 for the control and ₹5.87 for the pakoda with mulberry leaves. Production costs were ₹1.69 for the control and ₹1.76 for the best-accepted formulation. The selling price per 100 g was ₹11.22 for the best-accepted pakoda and ₹10.81 for the control, respectively.

Vaibhavi, (2019) estimated the cost of 100ml mango ginger green tea was Rs.13, whereas the cost of mango ginger mouth freshener was Rs.36. The cost of Mango ginger juice was 9.00/100ml.

**Conclusion:**

The study effectively created a flavor-enhanced, ready-to-drink mulberry herbal tea that offers cost-effectiveness, significant sensory appeal, and functional health advantages. In several aspects, the optimized formulation—which included 4 g of mulberry powder and 0.6 g of ginger, cumin, and mint—was considerably favored over the control and obtained the highest sensory ratings (p < 0.05). Detailed consumer testing showed broad acceptance, with more than 89% of respondents approving in key categories including convenience, flavor, and freshness. With an affordable production cost of ₹76.34 per 100 g, the product offers a competitive edge over traditional green tea, which costs ₹155 per 100 g. These results demonstrate the blend’s potential for commercialization in the functional drinks market as a tasty, affordable, and health-conscious herbal beverage.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE):**

Author(s) hereby declares that NO generative AI technologies such as large language models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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