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Formulation and Sensory Evaluation of a Herbal Tea Using Pomegranate Peel

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Abstract

This study evaluates the sensory attributes and physicochemical properties of pomegranate peel-based herbal tea formulations to determine the most acceptable blend. Sensory evaluation was conducted with a semi-trained panel (n=36) using a 9-point hedonic scale to assess aroma, brew colour, taste, astringency, aftertaste, and overall acceptability across five formulations. Statistical analysis using the Friedman test indicated significant differences in sensory acceptability among formulations ($p < 0.001$). Formulation 567, containing a blend of pomegranate peel powder (PPP), lemongrass powder (LP), ginger powder (GP), and cinnamon powder (CP), exhibited the highest acceptability. In addition, a comparison was made between herbal teas prepared using pomegranate peel powder and those made with coarse pomegranate peel to identify the differences and determine which is most preferred. The findings suggest that formulation 567 offers an optimal balance of sensory qualities, supporting its potential for commercial herbal tea development. This study contributes valuable insights into the utilisation of pomegranate peel waste in functional beverage formulations.

Keywords: Formulation acceptability, herbal tea, pomegranate peel, sensory evaluation

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Introduction

The global popularity of herbal teas has grown significantly in recent years, driven by increased health awareness, lifestyle changes, and consumer interest in functional beverages. Unlike traditional teas derived from *Camellia sinensis*, herbal teas consist of various plant parts such as seeds, bark, fruits, and roots from different herbs, and are valued for their flavour and therapeutic benefits (Ravi Kumar, 2014). Herbal tea is defined as an aqueous infusion prepared by steeping herbal plants in hot or cold water for a specific duration to extract health-promoting phytochemicals. Pomegranate (*Punica granatum*), known for its nutritional and medicinal value, has gained attention for the high antioxidant content of its peel, a by-product usually discarded by the food industry. Pomegranate peel, rich in polyphenols, flavonoids, and tannins, possess notable antioxidant, antibacterial, anti-inflammatory, and antidiabetic properties (Singh et al., 2024a; Venkitasamy et al., 2019). Its phenolic content, measured at 249.4 mg/g, is markedly higher than that of the pulp (24.4 mg/g), making it a promising functional ingredient. Despite growing evidence of its health benefits, limited research in Sri Lanka has explored the development of palatable herbal tea using pomegranate peel—particularly from the local "Nimali" variety. Existing products typically include flavoured black teas or plain dried peel, which can be unappealing due to bitterness. This study aims to evaluate five pomegranate peel herbal tea formulations with varying ingredients and powder textures to determine the most acceptable blend based on sensory attributes and pH-induced colour changes. The objectives of this study are: (1) to assess sensory preferences of the formulations and (2) to identify the formulation with the highest overall acceptability.

Materials and Methods

Raw Materials

Pomegranate peel powder (PPP) from the "Nimali" variety was provided by the Mathakadara, a Sri Lankan supplier and stored under sterillzied conditions. Lemongrass powder (LP) and ginger powder (GP) were sourced from Umandawa and Ran Ketha (Aroma Products brand). Cinnamon sticks were purchased locally (Matale), cleaned, and ground hygienically. Empty drawstring tea bags were ordered via the online platform Daraz (China).

Formulations and Sample Preparation

Table 1: *Formulations developed by using pomegranate peel powder along with herbs and spices*

Name of the sample	Pomegranate peel powder(g)	Lemongrass Powder (g)	Cinnamon Powder (g)	Ginger Powder (g)
123	2.5	-	-	**-**
234	2	0.5	-	**-**
345	2	-	0.5	**-**
456	2	-	-	**0.5**
567	**2**	**0.5**	**0.5**	**0.5**

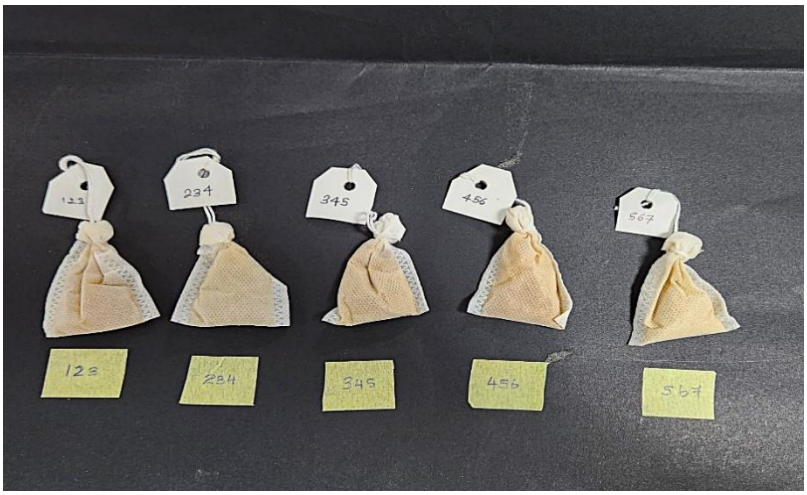

Figure 1: *Herbal tea formulation(123, 234, 345, 456, and 567) in tea bags, with pomegranate peel powder as the main component, combined with various herbs and spices.*

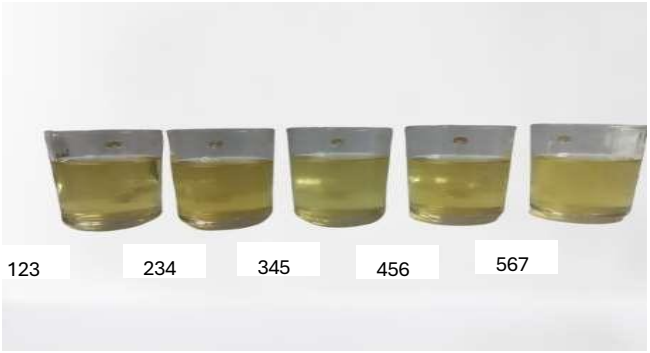

Figure 2: *Visual appearance of the five-pomegranate peel herbal tea formulations (123, 234, 345, 456, and 567) presented for sensory evaluation.*

Five herbal tea formulations (coded 123, 234, 345, 456, 567) were prepared using pomegranate peel powder (PPP) combined with lemongrass powder (LP), ginger powder (GP), and cinnamon powder (CP) in varying proportions. Additionally, two pomegranate peel samples, fine powder (123) and coarse powder (678), were compared for sensory evaluation (Table 1). From each formulation, a 10 g blend was prepared under aseptic conditions, manually mixed, and 2.5 g of each was packed into tea bags. In preparation of the herbal tea, each tea bag (2.5 g) was steeped in 100 mL of boiling water for 3 minutes. The resulting infusions were used for sensory evaluation.

Ethical Clearance

Ethical approval for the sensory evaluation was granted by the Ethics Review Committee of the Faculty of Humanities and Sciences, Sri Lanka Institute of Information Technology (SLIIT), under reference number 2024-07-1.

Sensory Evaluation

A semi-trained panel of 36 participants evaluated the formulations using a 9-point hedonic scale. The panel was provided with ballot papers to evaluate attributes such as aroma, brew colour, brew taste, astringency,

aftertaste, and overall acceptability. During the sensory evaluation, participants were given water and plain crackers to cleanse their palates between tasting each herbal tea formulation. Sensory testing was conducted in triplicate, and the Friedman test was applied to analyse the mean attribute scores.

Statistical Analysis

The mean and standard deviation of the sensory evaluation results were calculated for each attribute and overall acceptability. The non-parametric Friedman test was performed using Minitab to identify the most preferred formulation among the five. Pairwise comparisons were conducted where p-values were below 0.05, indicating a significant difference and leading to rejection of the null hypothesis. Radar and bar charts were created in Microsoft Excel to visually represent the sensory data.

Results

Sensory Evaluation of Herbal Tea Formulations

Visual and sensory comparison of Pomegranate Peel Fine Powder Herbal Tea (Sample 123) and Pomegranate Peel Coarse Powder herbal Tea (Sample 678)

Two tea samples were prepared using 2.5 g each of fine and coarse PPP, steeped separately in 100 mL of boiling water. Differences in brew appearance and sensory were observed.

The results present the sensory evaluation of the formulated herbal teas, assessed for attributes including aroma, brew colour, taste, astringency, aftertaste, and overall acceptability. Table 2 displays the descriptive statistical analysis of sensory evaluation for all herbal tea formulations. The Friedman test revealed significant differences in acceptability across samples ($p < 0.001$).

Table 2: *Descriptive statistical analysis of sensory evaluation for all herbal tea formulations.*

Variable	Formulations	Mean	StDev	Minimum	Maximum	Median
Aroma Average	Form123	4.685	1.299	2	7	**4.667**
	Form234	5.667	1.345	3	8	**5.667**
	Form345	6.472	1.037	3.667	8.667	**6.333**
	Form456	7.287	1.018	5	9	**7.5**
	Form567	6.926	0.902	5	8.333	**7**
Colour Average	Form123	5.731	1.192	3.333	8	**5.833**
	Form234	6.019	1.267	3.333	8.333	**6**
	Form345	5.815	1.164	2.667	8.667	**6**
	Form456	6.5	1.091	4.333	9	**6.667**
	Form567	6.148	1.049	4	8.333	**6.333**
Taste Average	Form123	5.213	1.357	2.667	8	**5.333**
	Form234	5.528	1.351	2.667	8	**5.5**
	Form345	6.176	1.246	4	9	**6.167**
	Form456	6.648	1.345	3.333	9	**7**
	Form567	6.722	1.231	4	9	**6.667**
Astringency Average	Form123	5.139	1.379	2.667	8.667	**5.167**

	Form234	5.565	1.311	3	7.667	**5.667**
	Form345	5.861	1.346	3	9	**5.833**
	Form456	6.204	1.36	2.333	9	**6.5**
	Form567	6.231	1.287	3.667	9	**6.333**
Aftertaste Average	Form123	5.352	1.497	2.333	8.333	**5.667**
	Form234	5.611	1.246	3	8	**5.667**
	Form345	5.991	1.36	3.667	8.333	**5.667**
	Form456	6.481	1.44	2.667	8.667	**6.667**
	Form567	6.574	1.228	4	9	**6.667**
Overall acceptability Average	Form123	5.444	1.277	3	7.667	**5.5**
	Form234	5.852	1.363	3	7.667	**6**
	Form345	6.324	1.233	4	8.667	**6.333**
	Form456	**6.875**	**1.317**	**3.333**	**9**	**7**

Figure 3 Presents the mean overall acceptability scores for formulations 123, 234, 345, 456, and 567, with formulation 567 receiving the highest score (6.935) followed by formulation 456 (6.875).

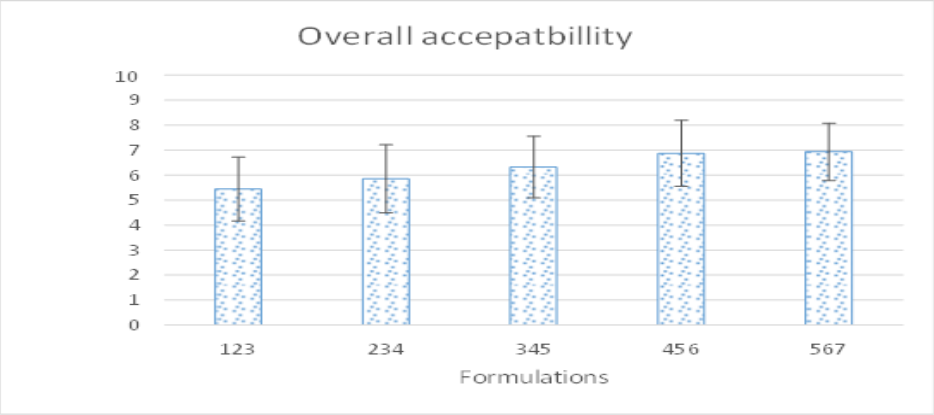

Figure 3: *Bar chart displaying the mean values ± standard deviation (SD) of overall acceptability for formulations 123, 234, 345, 456, and 567.*

Figure 4 illustrates the sensory attributes of each herbal tea formulation sample in a radar chart, showing formulation 123 had the lowest preference with the smallest enclosed area across attributes, indicating low acceptability primarily due to lack of aroma and weak flavour.

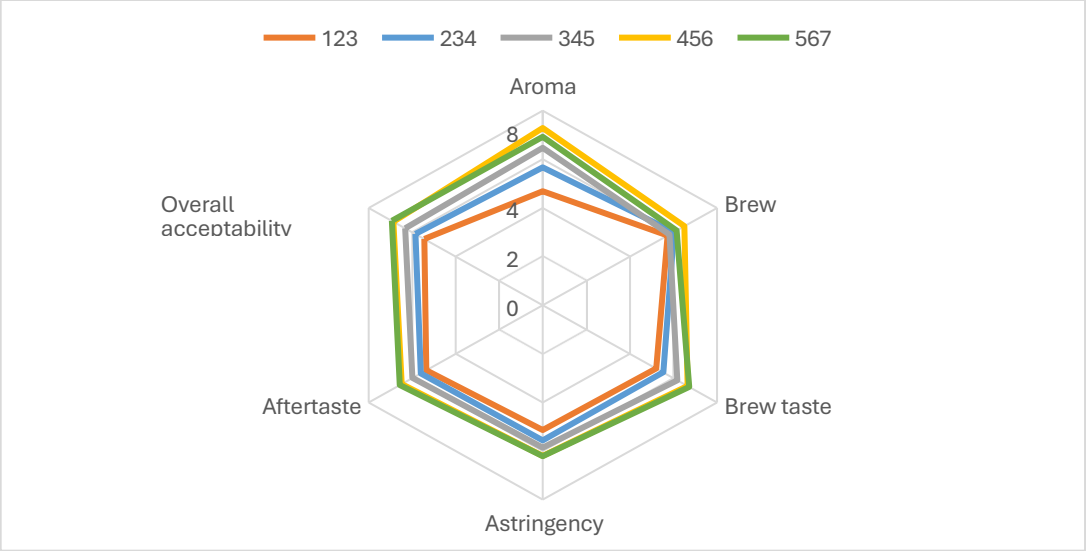

Figure 4: *Radar chart displaying the sensory evaluation attributes mean values scores for all formulations.*

Visual and sensory comparison of Pomegranate Peel Fine Powder Herbal Tea (Sample 123) and Pomegranate Peel Coarse Powder Herbal Tea (Sample 678)

Figure 5 compares samples 123 (fine powder) and 678 (coarse powder) herbal tea formulations.

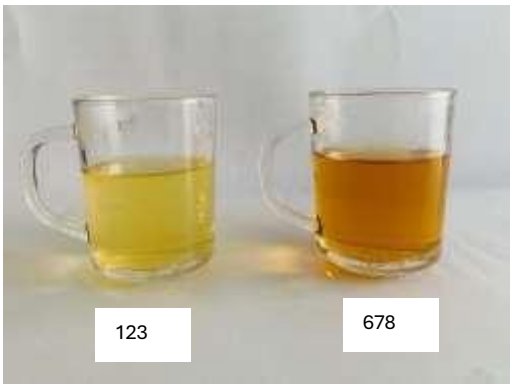

Figure 5: *Comparison of pomegranate peel powder pomegranate herbal tea (sample 123) and pomegranate peel coarse powder herbal tea (sample 678).*

Discussion

Previous studies have explored antioxidant-rich herbal teas using pomegranate peel, with one study targeting the Indian market. In that study, dried pomegranate peels were ground into coarse powder and combined with spices (cinnamon, cardamom, and ginger) in varying amounts (2 g, 3 g, and 5 g) for twelve formulations. Sensory evaluation indicated that cardamom was the preferred spice, followed by ginger and

cinnamon (Singh et al, 2024). In contrast, the present study found that formulations combining all ingredients were preferred by most participants, with cinnamon-only formulations ranked second, highlighting differences in panel preferences between studies.

The sensory evaluation results according to Table 2, the mean overall acceptability scores for the formulations were: 123 (5.444), 234 (5.852), 345 (6.324), 456 (6.875), and 567 (6.935). Friedman test analysis showed a significant difference ($p < 0.001$) across all samples. Among the five formulations, 567 achieved the highest score (6.935), closely followed by 456 (6.875). Although the difference between 567 and 456 was statistically significant ($p < 0.05$), the higher overall acceptability score indicates that formulation 567 was preferred by more participants.

Figure 4 shows that formulation 234 (PPP and LP) had a larger area for brew colour than formulations 123 and 345, with a significant difference from 345 ($p = 0.003$). Formulation 456 (PPP and CP) displayed the largest areas in aroma and brew colour, indicating that cinnamon enhanced its sensory profile ($p < 0.001$). The graph also highlights formulation 567, which covered the greatest area across most attributes, confirming it was the most preferred overall.

According to Figure 5, the pomegranate peel fine powder herbal tea (sample 123) produced a light-yellow brew with a mild taste, no aroma, less astringency, and a bitter aftertaste. In contrast, the coarse peel herbal tea (sample 678) yielded a more appealing light-brown colour, mild aroma, favourable astringency, and improved aftertaste. The observed differences suggest that the coarse peel (sample 678) retains more tannins than the fine powder (sample 123), resulting in a deeper colour and stronger flavour when infused.

Conclusion

Pomegranate peel, often discarded as waste, contains higher antioxidant levels than the pulp and is rich in bioactive compounds. This study formulated and evaluated five herbal tea blends combining pomegranate peel with lemongrass, ginger, and cinnamon. Sensory evaluation with 36 participants showed significant differences ($P < 0.05$) among formulations, with blend 567 (PPP, LP, GP, CP) scoring highest in overall acceptability (6.935) and blend 123 scoring lowest (5.444). Formulation 456 excelled in aroma and brew colour due to cinnamon, but was slightly less preferred than 567. This study demonstrates that pomegranate peel can be effectively used to develop herbal teas with appealing flavours, offering potential for the creation of functional beverages rather than being discarded as a byproduct.

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