Sensory optimisation of lemongrass (*Cymbopogon citratus*) and pandan (*Pandanus amarylifolius* Roxb.) herbal tea on several brewing techniques

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**Abstract.** Conservatively, tea is an aromatic beverage made from dried leaves of tea plant (*Camellia sinensis*). However, lemongrass (*Cymbopogon citratus*) and pandan leaves (*Pandanus amarylifolius* Roxb.) can also be processed as herbal tea to develop their functional properties. This current study aims to investigate the sensory profiles of the herbal tea as well as to determine the optimum techniques for hot, iced and hot+ice brewings. Spectrum Descriptive Analysis method was conducted by involving 12 trained panelists to develop sensory vocabularies. Meanwhile, the sensory optimization was conducted by Just about Right (JAR) method involving 106 consumer respondents. The Spectrum data shows that 4 out of 12 sensory attributes, including sweet, astringency, lemongrass flavor, and pandan flavor; were significantly affected by different brewing techniques (p-values <0.05). Through Penalty analysis on JAR data, it shows that sweet and pandan flavor were optimum for hot brewing. Meanwhile, the sweet and astringency were optimum for cold brewing. Under current set up, there is no optimum attributes was obtained for hot+ice brew technique. Considering their functional properties, the cold brewed herbal tea shows the most superior among the samples tested as it shows the highest total sugar content, total phenolic compound, and antioxidant activity (p-values<0.05).

1. **Introduction**

Tea is the most widely consumed drink in the world aside from water. Conservatively, tea is defined as an aromatic beverage made from dried leaves of tea plant (*Camellia sinensis*). However, the current definition of tea has been covering not only for dried leaves of tea plant but also including dried herbs, fruits, seeds, flowers, leaves, skins or roots from medical plants. The non-*Camellia sinensis* tea is popular as herbal tea. Lemongrass (*Cymbopogon citratus*) and Pandan (*Pandanus amarylifolius* Roxb.) are herbal plants that can be processed into herbal tea to develop their functional properties.

Quality attributes such as color, flavor and aroma in tea can also be influenced by brewing techniques, including the temperature and time used to brew tea [1]. Brewing technique is the process of separating one or more components using water solvents. The higher extraction efficiency obtained by the high temperature of water. While brewing at low temperatures can protect molecules from degradation. Moreover, the longer the brewing time, the flavor of the tea will come out optimally and
the color will get thicker [2]. Tea brewing technique is useful in maximizing antioxidant activities. The brewing process serves to maintain the quality of tea by avoid the degradation of its functional properties.

This current study aims to fulfill market needs and introduce the characteristics of product to consumers through investigate the sensory profiles of the herbal tea as well as to determine the optimum techniques for hot, iced and hot+ice brewings. Spectrum Descriptive Analysis method was conducted by involving trained panelists to develop sensory vocabularies. Meanwhile, the sensory optimization was conducted by Just-About-Right (JAR) scales.

2. Materials and Method
2.1. Materials
The materials were used in this study consist of lemongrass and pandan leaves. While water were used as palate cleansers according to the recommendation from [3] that mineral water can clean the palate for various products. The purpose of using palate cleansers was to avoid carry-over effect and adaptation to sensory stimuli.

2.2. Methods
The methods used in this study were Spectrum Descriptive Analysis and Just-About-Right (JAR) scales. The Spectrum Descriptive analysis provides information on the perceived sensory attributes and the levels or intensities of each attribute. A spectrum panel is trained for the evaluation [4]. In this study, spectrum method was conducted by involving 12 trained panelists to develop sensory vocabularies. Meanwhile, Just-About-Right (JAR) scales measure the appropriateness of the level of specific attribute and are used to determine the optimum levels of attributes in a product [5]. The sensory optimization was conducted by JAR scale involving 106 consumer respondents.

The Spectrum data was further analysed by ANOVA General Linier Model (GLM) in Minitab 17 software with 95% confidence interval with 2 factors, brewing techniques (hot, cold, hot+ice brewings) and 12 trained panelists. Meanwhile, the JAR data was further evaluated by Penalty Analysis on XLSTAT. The schematic description of the brewing techniques in this study can be seen in the Table 1.

| Brewing Techniques | Leaves (g) | Temperature (°C) | Time (min) | Water (mL) | Ice (g)* |
|--------------------|------------|------------------|------------|------------|----------|
| Hot Brew           | 1.5        | 95               | 5          | 250        | -        |
| Cold Brew          | 1.5        | 4                | 720        | 250        | -        |
| Hot + Ice Brew     | 1.5        | 80               | 5          | 150        | 100      |

Notes: * added after brewing

3. Results and Discussion
3.1. Panelists response to significantly different attributes of lemongrass and pandan herbal tea
The determination of significantly different attributes from Spectrum Descriptive Analysis method was made using General Linear Model (GLM) in Minitab 17 software with 95% confidence interval. The meaning of significantly different was the value of p-value less than 0.05 and denoted by different notation. These significantly different attributes can be interpreted as the panelists can detect the
difference in the intensity of the sensory attributes of the difference brewing techniques. The following attributes were significantly different can be seen in Table 2.

**Table 2. The influence brewing techniques on sensory attributes of lemongrass and pandan herbal tea**

| Attributes        | p-value | Brewing Techniques | Mean (±SD) | Grouping |
|-------------------|---------|--------------------|------------|----------|
| **Sweetness**     | 0.024   | Hot + ice brew     | 2.30±0.30  | A        |
|                   |         | Hot brew           | 1.88±0.53  | A        |
|                   |         | Cold brew          | 0.98±0.06  | B        |
| **Astringency**   | 0.001   | Cold brew          | 6.04±0.06  | A        |
|                   |         | Hot + ice brew     | 4.63±0.06  | B        |
|                   |         | Hot brew           | 3.13±0.06  | C        |
| **Lemongrass Flavor** | 0.000 | Hot brew           | 5.92±1.41  | A        |
|                   |         | Hot + ice brew     | 5.42±0.23  | A        |
|                   |         | Cold brew          | 2.45±0.30  | B        |
| **Pandan Flavor** | 0.000   | Hot brew           | 7.29±0.18  | A        |
|                   |         | Hot + ice brew     | 6.92±0.94  | A        |
|                   |         | Cold brew          | 2.67±0.94  | B        |

Based on Table 2, there were 4 sensory attributes that significantly different (p-value, 0.05) include sweetness, astringency, lemongrass flavor and pandan flavor. Based on mean values, the hot + ice brewing technique had the highest intensity in sweetness. Both of lemongrass and pandan contain main components that affect the flavor of tea infusion, they were citral and 2-Acetyl-1-Pyroline (2AP). Those are well extracted in high temperature solvents compared to low temperatures [6]. Citral and 2AP give a distinctive flavor of infusion that affects the impression of sweetness [7]. In the cold brewing techniques, lemongrass flavor and pandan flavor were not felt significantly by panelists’ senses, thus affecting the assessment of sweetness intensity. In the hot brewing technique, the temperature that was too high can lead to the evaporation of volatile components and oxidation of flavor components as well as caused off-flavor [8].

In astringency, cold brewing techniques showed the highest intensity. The phenol content of food product can contribute to the presence of astringency mouthfeel, dry sensation or constriction in certain areas of the oral cavity or tongue. It is known that in lemongrass and pandan contain phenolic content that cause astringent in tea infusion [9]. The higher migration of bioactive compounds to solvent due to the longer extraction time caused high intensity of astringency in cold brewing techniques. Low temperatures also protect molecules from degradation [10]. Meanwhile, high temperatures can lead to destruction of a molecule that causes oxidation, epimeration and polymerization [8]. However, the hot+ice brewing technique can limit the occurrence of these reactions, providing protection against bioactive compounds by stopping contact with high temperatures. Based on the results of chemical analysis, the highest DPPH free radical inhibition was obtained in cold brewing technique (79.8%), followed by hot + ice brewing technique (75.2%). Whereas the lowest DPPH free radical inhibition was found in hot brewing technique (69.05%). This is because the antioxidant compounds can be well extracted depending on the type of antioxidant and the temperature of the solvent used [11].

### 3.2. Optimisation of lemongrass and pandan herbal tea sensory attributes

In order to conduct penalty analysis, the consumers’ overall liking ratings and ratings on the JAR attributes are required. The penalties are plotted against the percentage of the consumers giving each response. The mean drops were calculated for the “too much” and “too little” levels. According to Iserlyska et al. [12], it shows how many points of liking were lost for having a product “too much” or
“too little” for a consumer. The penalty is a weighted difference between the means. Attributes impacting 20% or more of respondents and causing a drop of 1 point or more are included in the critical corner. A critical corner is usually set to highlight those attributes that are having the greatest negative impact on liking.

Figure 1(A) represents the mean drops plotted against the percentages of panellists giving responses on each sensory attribute of hot brewing technique. According to penalty analysis data, the sweetness attribute shows a non-significant penalty result, although the mean drop for the "too little" level shows a significant effect ($\alpha = 0.05$). This is because the level of "too much" is less than 20% so that the overall penalty is not significant. The analysis penalty used an absolute threshold (threshold) of 20% which shows the minimum limit of the percentage of consumers in assessing the intensity of attributes to describe the product characteristics at the ideal level [13]. In astringency attributes, the two mean drops also cannot be analysed because the level of "too much" is less than 20% so it only shows the mean drop for the "too little" level that is not significant. However, the overall result of the penalty shows a significant difference. This shows that astringency has an effect on decreased consumer preferences, but this test is not enough to detect the mean drop level (too little / too much) that has an effect [12]. In the lemongrass flavor, the overall penalty shows a significant difference even though the two mean drops are not significant. This indicates that lemongrass flavor influences the decreasing in consumer preferences, but this test is not enough to detect the mean drop level (too little / too much) that influences. In pandan flavor the overall test showed insignificant results.

Figure 1(B) represents the mean drops plotted against the percentages of panellists giving responses on each sensory attribute of cold brewing technique. According to penalty analysis data, the sweetness attribute shows a non-significant penalty result, although the mean drop for the "too little" level shows a significant effect ($\alpha = 0.05$). This is because the level of "too much" is less than 20% so that the overall penalty is not significant. In the astringency attribute the overall test results are not significant. In the lemongrass flavor, the overall penalty shows a significant difference even though the two mean drops are not significant. This indicates that lemongrass flavor influences the decreasing in consumer preferences, but this test is not enough to detect the mean drop level (too little / too much) that influences. In the pandan flavor attribute, the "too little" level indicates a significant mean drop compared to "too much". The overall penalty shows a significant difference, meaning that the pandan flavor with a "too little" level affects the decreasing in consumer preference.

Figure 1(C) represents the mean drops plotted against the percentages of panellists giving responses on each sensory attribute of hot+ice brewing technique. According to penalty analysis data, it is known that all attributes have a significant penalty. In the sweetness attribute, the penalty result shows a not significant difference, even though the mean drop for the "too little" level shows a significant effect ($\alpha = 0.05$). This is caused by the level of "too much" is less than 20% so that the overall penalty is not significant. In astringency attributes, the two mean drops also cannot be analysed because the level of "too much" is less than 20% so it only shows the mean drop for the "too little" level that is not significant. However, the overall result of the penalty shows a significant difference. This shows that astringency has an effect on decreasing consumer preferences, but this test is not enough to detect the mean drop level (too little / too much) that has an effect. The lemongrass flavor attribute shows a non-significant penalty result, even though the mean drop for the "too little" level shows a significant effect. This is caused by the level of "too much" is less than 20% so that the overall penalty is not significant. In the pandan flavor attribute, the "too little" level shows a significant mean drop, while "too much" indicates an insignificant mean drop. The overall penalty shows a significant difference, meaning that the pandan flavor with a "too little" level affects the decreasing in consumer preferences.
Figure 1. Mean drops plot of hot brewing technique (A), cold brewing technique (B), hot-ice brewing technique (C)
4. Conclusions

This current study aims to investigate the sensory profiles of the herbal tea as well as to determine the optimum techniques for hot, cold and hot+ice brewings. From Spectrum data, it shows that there are 4 out of 12 sensory attributes which were significantly affected by different brewing techniques (p-values <0.05). Those include, sweet, astringency, lemongrass flavor, and pandan flavor. Through Penalty analysis on JAR data, it shows that sweet and pandan flavor were optimum for hot brewing. Meanwhile, the sweet and astringency were optimum for cold brewing. Under current set up, there is no optimum attributes was obtained for hot+ice brew technique. Considering the functionality, the cold brewed herbal tea shows the most superior properties among the samples tested as it shows the highest total sugar content, total phenolic compound, and antioxidant activity (p-values<0.05).

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