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SENSORY EVALUATION OF LEMONGRASS BEVERAGE MIXED WITH AGARWOOD INFUSION USING 9-POINT HEDONIC SCALE

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Abstract

Lemongrass and agarwood are potential forest herbal tea products which need to be further explored based on research and development schemes. The purpose of this research is to conduct a sensory evaluation using a 9-point hedonic scale and different statistical approaches on mixed lemongrass beverages and agarwood infusion. Four treatments are used in this research including: L_1 = Lemongrass concentration 0.1% w/v, L_2 = Lemongrass concentration 0.2% w/v, L_3 = Lemongrass concentration 0.3 % w/v, L_4 = Lemongrass concentration 0.4% w/v. This research used 4 different statistical approaches including Kruskal-Wallis, Freidman Test, ANOVA-CRD, and ANOVA-RBCD. Sensory evaluation was conducted using a 9-point hedonic scale using 30 trained respondents on 4 parameters including appearance, aroma, taste and bitterness. The results show that all statistical approaches give sensitive analysis for P-value measurement except for the Freidman Test. Appearance is the only parameter with a significant p-value in all statistical approaches. Different treatments show different maximum hedonic score values on different parameters, and they are significantly different based on DMRT results. However, based on the area of the spider web chart, L2 has the largest impact on hedonic score value compared to other treatments. It could be concluded that Treatment L2 (lemongrass concentration of 0.2% w/v) has the highest hedonic evaluation score which shows that this is the effective concentration to produce beverage products with good acceptability.

Keywords*: Agarwood, Lemongrass, Sensory evaluation*

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INTRODUCTION

Lemongrass beverage is an herbal tea product made from the infusion of Cymbopogon citratus leaves. *C. citratus* usually being utilized for its stem as a cooking spice ingredient. Thus the utilization of this species leaves could be classified as product diversification. Several studies show that lemongrass beverages could be a potential source of functional beverages (Putra et al., 2023; Santoso et al., 2021). Excellent antioxidant and antimicrobial activity are the factors responsible for its role as a functional beverage (Ranajah et al., 2022). The photochemistry and pharmacological activities of *C. citratus* also become the main driver for more research and development of the beverage from this species (Oladeji et al., 2019).

Research and development of lemongrass beverages mostly were focused on the mixture of ingredients to create unique herbal beverage flavours. Lemongrass beverage can be mixed with several herbal ingredients to develop herbal tea products including ginger (Dzigbor et al., 2024), lime (Kieling et al., 2019), berry (Aragon & Jao-jao, 2023), parqueting (Joshua et al., 2023), roselle

(Suseno et al., 2022), lipia and ganoderma (Dzah, 2015). Herbal material that has excellent medicinal activity and can give beneficial health effects should be chosen as a Mixture ingredient of lemongrass beverage (Wangiyana, 2020). One of the potential ingredients that need to be further explored as a mixture of lemongrass beverages is agarwood infusion (Wangiyana et al., 2019). This mixture can be classified as forest herbal tea that has a very good potency to be more promoted in Indonesia (Wangiyana & Triandini, 2023)

A mixture of lemongrass beverage and agarwood infusion can be a potential novel herbal beverage with medicinal effect (Wangiyana et al., 2020). This novel herbal beverage can be further developed by conducting a sensory evaluation to measure consumer preference (Alagendran et al., 2019; Baharudin et al., 2023). Quantification of sensory evaluation can be conducted to improve the accuracy and precision. This can be done by applying a hedonic scale (Lim, 2011; Wangiyana & Triandini, 2022).

The hedonic scale for sensory evaluation can be improved to further development of the mix lemongrass and agarwood beverages. Most research sensory evaluations in Indonesia use a 5-point hedonic scale for the quantification (Adrianar et al., 2015; Larasati & Issutarti, 2017; Batubara & Pratiwi, 2018; Wangiyana et al., 2021a; Triandini and Wangiyana, 2022). Meanwhile, most sensory evaluations conducted by international researchers are 9-point hedonic scales. Sensory evaluation with a 9-point hedonic scale has a broader range scale than 5- a point hedonic scale, which can give more sensitivity to the measurement (Feng & O'Mahony, 2017; Yang & Lee, 2018; Wangiyana et al., 2022a; Wichchukit & O'Mahony, 2022). Furthermore, data analysis using a 9-point hedonic scale can also be improved using different statistical methods which can give robust analysis (Wangiyana et al., 2024).

The purpose of this research is to conduct a sensory evaluation using a 9-point hedonic scale and different statistical approaches on mixed lemongrass beverage and agarwood infusion.

METHODS

a. Research Material

This research used agarwood leaves and lemongrass leaves taken from the agroforestry plantation on Kekait Puncang, North Lombok (Wangiyana et al., 2022b). Chemical compounds for carbohydrate, protein, and lipid analysis including $CuSO_4$, K_2SO_4, NaOH, HCl, and H_3BO_3 (Merck). Disposable polypropylene glass and questionnaire for sensory evaluation. This research used instruments including grinding machine (Miyako BL-22 PLY), tea filter (Lionstar), electric stove (Eastern Electric), analytical digital scale (Jadever), electric oven (Olike), and thermometer.

b. Experimental Design

This research uses 4 treatments of different lemongrass concentrations according to Table 1. Each treatment has 30 replications which is equal to respondents who are given the hedonic score for the sensory evaluation.

Table 1. Treatment of different lemongrass concentration

L_1	Lemongrass concentration of 0.1% w/v
L_2	Lemongrass concentration of 0.2% w/v
L_3	Lemongrass concentration of 0.3% w/v
L_4	Lemongrass concentration of 0.4% w/v

c. Procedure

1) Raw material selection

Lemongrass and agarwood were selected based on two criteria. Firstly, the plant's raw material should not infected by bacteria, fungi, or insects. Secondly, the plant's raw material should not have chlorosis and necrosis symptoms (Wangiyana et al., 2021b).

2) Lemongrass and agarwood leaves preparation

Lemongrass leaves were dried using an oven (Olike) until the biomass was 10% of the initial weight. Dried lemongrass then were ground using a grinding machine (Miyako BL-22 PLY) to produce ground leaves with a particle sizes of 1 mm to 2 mm. The same procedure was applied to agarwood leaves as raw material for agarwood infusion (Wangiyana 2018).

3) Lemongrass beverage mixed agarwood infusion

Ground lemongrass particles with concentration according to the experimental design (Table 1) were heated using an electric stove (Eastern Electric). The heating was conducted using agarwood infusion as a solvent with a temperature of 70^{o}C for 5 minutes. The lemongrass beverage then was filtered using a tea filter (Wangiyana et al., 2021c).

4) Proximate analysis

Proximate analysis was conducted following INS 01-2891-1992 standards. The thermogravimetric test was used to determine the total water content. The drying ash method by furnace combustion was used to determine the total ash content. The Soxhlation method was used to measure the total fat content. The Kjehdahl technique was used to calculate the total protein content. Carbohydrate content is estimated based on calculations (Eden & Rumambarsari, 2020):

$$\%C = 100\% - (\%P + \%L + \%A + \%W)$$

%C = Total Carbohydrate
% P = Total Protein
% L = Total Lipid
% A = Total Ash
%W = Total Water

5) Sensory evaluation

A nine-point hedonic scale was used for sensory evaluation, which can be divided into verbal and numerical (table 2). The hedonic scale that most clearly conveys the respondent's degree of preference is the verbal hedonic scale. For statistical analysis, the verbal hedonic scale is converted to a numerical hedonic scale (Xia et al., 2021).

Thirty individuals, ranging in age from twenty to twenty-four, were selected to participate in this study. The 9-point hedonic scale training participants are food sensory responders from Universitas Pendidikan Mandalika (Wangiyana et al., 2023a). All respondents gave an evaluation in four parameters, including appearance, aroma, taste, and bitterness.

Table 2. Verbal hedonic scale and numerical hedonic scale

Verbal Hedonic Scale	Numerical Hedonic Scale
Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

d. Data Analysis

Data analysis is conducted using descriptive and inductive statistical approaches. The numerical score of each treatment was analysed descriptively in the form of a spider web diagram. Inductive statistics is performed using different statistical approaches, including the Kruskal-Wallis test, Freidman test, ANOVA-CRD (Analysis of Variance – Completely Randomised Design), and ANOVA-RCBD (Analysis of Variance – Randomized Complete Block Design) (Table 3). Duncan Multiple Range Test (DMRT) α 0.05 was also conducted to examine the treatment effect on the

numerical hedonic scale of each parameter. All data analyses were performed using co-stat for Windows (Triandini et al., 2024)

Table 3. Summary of statistical method approaches in this research

Statistical Approach	Assumption	Linear model	Description
Kurskal-Wallis	Lemongrass beverage and respondents are homogenous	$H = \frac{12}{N(N+1)}\sum_{i=1}\frac{R_i^2}{n_i} - 3(N+1)$	Ri = ranking in the column N = Total Number of Sample ni = Number of treatments
Freidman Test	Respondents are heterogeneous (become group)	$X^2 = \frac{12}{bt(t+1)}\sum r^2 - 3b(t+1)$	b = Number of Group t = Number of Treatments r = Number of rankings
ANOVA CRD	Normal distribution of numeric scale and respondents are homogenous	$Y_{ij} = \mu + \tau_i + \varepsilon_{ij}$	Y_{ij} = An observation μ = The Experimental Mean T_i = The Treatments Effect ε_{ij} = The Experimental Error
ANOVA RCBD	Normal distribution of numeric scale and respondents are heterogeneous (become block)	$Y_{ij} = \mu + \tau_i + \beta_j + \varepsilon_{ij}$	Y_{ij} = An observation μ = The Experimental Mean T_i = The Treatments Effect B_j = The Block Effect ε_{ij} = The Experimental Error

RESULT AND DISCUSSION

Proximate analysis is one of the essential assays needed for food and beverage product development (Taleat et al., 2023). This assay shows that lemongrass beverage mixed with agarwood infusion was dominated by water content (Figure 1). Carbohydrate and protein content shows that this beverage has a proximate profile similar to a typical herbal tea beverage (Washed et al., 2019). Furthermore, there is no lipid detected from this beverage product.

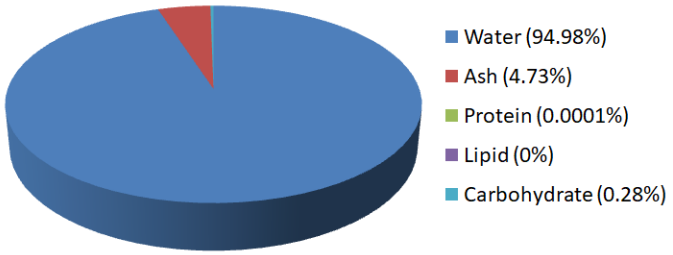

Figure 1. Proximate analysis result of lemongrass beverage mixed agarwood infusion

The different statistical approach shows slightly different P-value which determine the significance degree of the treatment. P-value is an essential parameter in statistical approach comparison (Andrade, 2019). This value shows that only the taste parameter has significant hedonic score evaluation on all statistical approaches. Freidman test on all parameters has a significantly different results which shows that this statistical approach is less sensitive compared to others. Recent studies that use different statistical approaches for sensory evaluation also show similar results (Triandini et al., 2024).

Table 4. P-value comparison of the different statistical approaches

Statistical Approach	P-value			
	Appearance	Aroma	Taste	Bitterness
Kruskal-Wallis	0.091 ^{ns}	0.2435 ^{ns}	0.0182 *	0.1325 ^{ns}
Freidman Test	0.00001 ***	0.00001 ***	0.00001 ***	0.00001 ***
ANOVA-CRD	0.022 *	0.1924 ^{ns}	0.027 *	0.184 ^{ns}
ANOVA-RCBD	0.0038 *	0.1412 ^{ns}	0.0011 **	0.0533 ^{ns}

Note: ns = non-significant (P value is more than 0.05), * = significant (P value is 0.01 – 0.05), ** = highly significant (P value is 0.001 – 0.01), *** very highly significant (P value is less than 0.001)

DMRT analysis shows that different treatment has different significant result on different parameter (Table 5). DMRT can be a sensitive analysis to compare the mean value of sensory evaluation results (Wulandari et al., 2022). L_2 treatment has the highest hedonic score value significantly different to other treatments on appearance parameters. Meanwhile, L_1 treatment has the highest hedonic score value and is significantly different to other treatments on taste parameters. On the bitterness parameter, the L_4 treatment has the highest hedonic score value. All treatment has no significant difference in hedonic value on aroma parameters.

Table 5. DMRT analysis based on LSD and error value

Treatment	Mean ± Error			
	Appearance	Aroma	Taste	Bitterness
L_1	6.60 ± 0.20 ^{ab}	5.33 ± 0.26 ^{a}	5.73 ± 0.21 ^{a}	4.17 ± 0.36 ^{b}
L_2	6.96 ± 0.14 ^{a}	5.87 ± 0.18 ^{a}	5.30 ± 0.29 ^{ab}	4.40 ± 0.37 ^{ab}
L_3	6.00 ± 0.30 ^{c}	5.13 ± 0.38 ^{a}	5.00 ± 0.30 ^{bc}	4.50 ± 0.34 ^{ab}
L_4	6.20 ± 0.27 ^{bc}	5.10 ± 0.27 ^{a}	4.57 ± 0.29 ^{c}	5.20 ± 0.32 ^{a}
LSD 0.05	0.55	0.73	0.67	0.76

Note: Different mean values followed by the same letters are significantly different ($p<0.05$). L_1 = Lemongrass concentration 0.1% w/v, L_2 = Lemongrass concentration 0.2% w/v, L_3 = Lemongrass concentration 0.3 % w/v, L_4 = Lemongrass concentration 0.4% w/v.

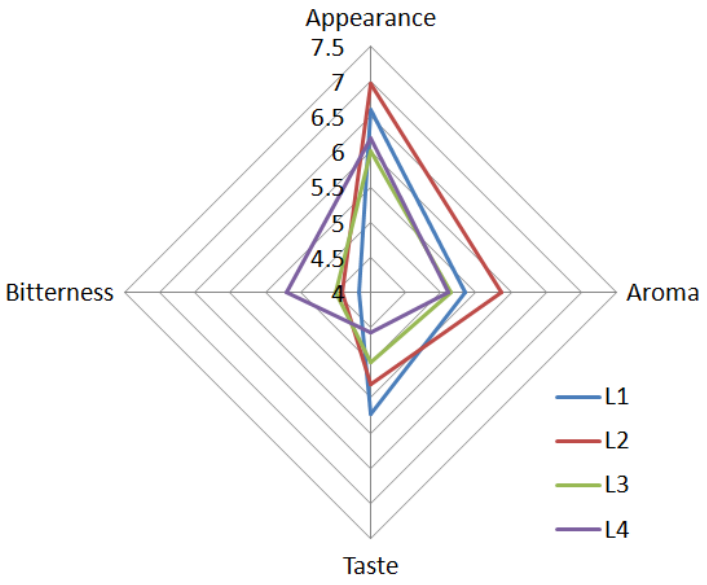

Figure 2. Spider web analysis of treatment hedonic score on each parameter. (L1 = Lemongrass concentration 0.1% w/v, L2 = Lemongrass concentration 0.2% w/v, L3 = Lemongrass concentration 0.3 % w/v, L4 = Lemongrass concentration 0.4% w/v)

Spider web analysis shows that all treatments have slightly different maximum hedonic score values on different parameters (Figure 2). This analysis also shows that respondents give different evaluation scores on different parameters which makes the unique profile of each treatment. However, based on the chart area value, L_2 (Lemongrass concentration of 0.2% w/v) can be considered as a treatment that has the highest evaluation score from the respondents. This result also shows the effective concentration of herbal beverage ingredients for further product development (Suna et al., 2019).

Sensory evaluation using different statistical approaches shows that lemongrass beverage mixed with agarwood infusion has a hedonic score higher than the threshold value. This result shows the potency of this beverage product to be further developed as a potential forest herbal tea from Lombok Island, Indonesia (Wangiyana et al., 2023b). Marketplace research on a larger scale should be conducted to measure the impact of this beverage product at the industrial scale.

CONCLUSION

The potency of lemongrass beverage mixed with agarwood infusion is confirmed based on sensory evaluation using different statistical methods. Treatment L_2 (lemongrass concentration of 0.2% w/v) has the highest hedonic evaluation score which shows that this is the effective concentration to produce beverage products with good acceptability.

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