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# Sensory Quality Analysis of Herbal Beverages with Sweetener Proportions

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***Abstract:*** *Consumer acceptance of rhizome-based herbal beverages is often limited by bitterness and strong spice aroma. This experimental study evaluated the effect of palm sugar : granulated sugar proportions (300:200 g, 400:100 g, 500:0 g per 500 g total sweetener) on sensory quality and the nutritional composition of a multi-rhizome herbal drink (ginger, turmeric, temulawak, lempuyang, and black pepper). Thirty-five panelists assessed color, aroma, taste, aftertaste, and overall preference using a 5-point hedonic scale. Sensory data were analyzed by one-way ANOVA followed by Duncan's post-hoc test (α = 0.05). Nutritional analysis of the selected best formulation (400:100) used standard laboratory methods (Weibull for fat, Kjeldahl for protein, Luff–Schoorl for carbohydrates and sugars, and Atwater calculations for energy). Results indicated that sweetener proportion significantly affected color ($p < 0.001$), while aroma, taste, aftertaste, and overall preference did not differ significantly between treatments ($p > 0.05$). The 400 g palm sugar : 100 g granulated sugar formulation achieved the most balanced sensory profile and production efficiency, with measured nutritional values of 0.42% fat, 0.86% protein, 9.18% carbohydrate, 8.90% total sugar, and 43.96 kcal per 100 mL. This formulation shows potential as a consumer-acceptable, low-calorie functional herbal beverage. Further research is recommended on shelf life, antioxidant activity, and larger-scale consumer acceptance testing.*

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## Introduction

Healthy lifestyles are becoming increasingly popular and are widely promoted through social media, one example being the consumption of herbal drinks. Herbal drinks are extracted from natural ingredients such as rhizomes, leaves, flowers, or stems that have physiological benefits for the body. The ingredients are generally derived from medicinal plants (TOGA), which have long been used in traditional medicine in Indonesia. These products are available in various forms and are known to have health benefits, such as improving immunity and appetite (Estiasih et al., 2025; Witoyo et al., 2025).

Despite their benefits, consumer acceptance of herbal drinks remains low due to their bitter taste and strong aroma. This is evident in bitter drinks made from sambiloto *(Andrographis paniculata)* and brotowali *(Tinospora crispa),* necessitating the addition of ingredients such as turmeric, galangal, and lemongrass to reduce the bitterness. Therefore, improving sensory quality is a crucial aspect in the development of herbal drinks (Anjani et al., 2024; Witoyo et al., 2025).

Previous research has generally developed herbal drinks made from ginger and turmeric with conventional sweeteners and focused on improving immunity, acidity, sediment stability, and shelf life (Ivanti et al., 2022; Nabilah et al., 2021; Sihombing, 2021). To date, no formulation has been found that specifically combines digestive improvement and appetite enhancement in a single product, necessitating the development of a formula with improved sensory qualities (Sakapani et al., 2026).

This study used ginger *(Zingiber officinale var. officinarum)*, turmeric *(Curcuma longa)*, temulawak *(Curcuma xanthorrizha)*, lempuyang *(Zingiber zerumbet)*, and black pepper *(Piper ningrum L.)* because of their potential to support digestive health and stimulate appetite (Astawan, 2020; Rahman et al., 2024). A combination of palm sugar and refined sugar was used as the sweetener. Palm sugar was selected because it produces a desirable brown color and distinctive caramel-like aroma that enhance the sensory quality of herbal beverages, whereas brown sugar was not used because it tends to impart a bitter taste and an aroma that may mask the characteristic flavor of the spices (Suryani et al., 2025). Refined sugar was included because of its neutral taste, higher sweetness, and lower cost. The combination of these two sweeteners was chosen because it has been shown to improve the color, aroma, taste, and overall consumer acceptability of herbal beverages (Ivanti et al., 2022; Sakapani et al., 2026; Suryani et al., 2025).

This study aims to analyze the effect of palm sugar and granulated sugar proportions on the sensory quality of herbal beverages and determine the optimal nutritional content of the product. The research's urgency lies in developing a herbal beverage formulation that is more acceptable to consumers. The novelty lies in the use of a combination of rhizomes, which support digestive health and increase appetite, with a combination of palm sugar and granulated sugar as a sensory enhancement strategy (Ivanti et al., 2022; Nabilah et al., 2021; Sakapani et al., 2026; Sihombing, 2021).

## Research Methods

This research is an experimental study using a quantitative approach aimed at analyzing the effect of palm sugar and granulated sugar ratios on the sensory quality of rhizome-based herbal drinks. The study was conducted at the Faculty of Vocational Studies, Surabaya State University, starting in October 2025. The treatment formulation was based on pre-experimental results, which


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referenced previous research.

### Treatment Design and Raw Materials

The treatment was designed using three proportions of palm sugar and granulated sugar, totaling 500 grams: 300;200, 400;100, and 500;0, determined based on the results of two pre-experimental stages. The research procedure began with a pre-experiment to determine the spice formulation and sweetener proportions based on previous research (Nabilah et al., 2021; Sihombing, 2021). The standard recipe ingredients for the spices used presented in Table 1 below.

**Table 1 Composition of Herbal Beverage Ingredients**

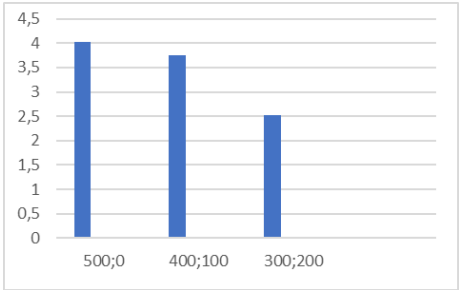
| Raw materials | Qty Formula 1 | Qty Formula 2 | Qty Formula 3 |
|---|---|---|---|
| Palm sugar | 300 g | 400 g | 500 g |
| Granulated sugar | 200 g | 100 g | 0 g |
| Tumeric | 130 g | 130 g | 130 g |
| Ginger | 30 g | 30 g | 30 g |
| Temulawak | 80 g | 80 g | 80 g |
| Lempuyang | 50 g | 50 g | 50 g |
| Black peppercorns | 60 pcs | 60 pcs | 60 pcs |
| Water | 1 L | 1 L | 1 L |

After being cleaned and pureed, the spices were boiled for 4 minutes, then boiled again at 60–100°C for 10 minutes before being cooled and filtered. The sugar syrup was prepared by dissolving palm sugar and granulated sugar in proportions determined by the treatment in 500 ml of water at ±90°C, then cooled and filtered. The spice decoction was mixed with the sugar syrup and water in a 3:3:3 ratio. The sample codes used were 678 (300; 200), 469 (400; 100), and 173 (500; 0). The research instrument consisted of a sensory test sheet with a numeric scale of 1-5 to assess color, aroma, flavor, aftertaste, and overall preference.

Each panelist will be given mineral water to cleanse their palate between sample evaluations, ensuring impartiality in the assessment. Data were analyzed using SPSS through a one-way ANOVA, followed by a Duncan test if significant differences were found ($p<0.05$). The best products were then tested for nutritional content using the Weibull, Kjeldahl, Luff-Schoorl, and Atwater systems.

## Results and Discussion

### Beverage Sensory Test Results




**Picture 1 Average Color Result**

The 300:200 treatment obtained the lowest color score (2.51), while the 400:100 and 500:0 treatments obtained scores of 3.74 and 4.03, respectively. These results indicate that the higher the proportion of palm sugar, the darker the color of the drink. Differences in assessments may also be influenced by the panelists' visual conditions and lighting (Rahayu et al., 2019).

The lighter color in the 300:200 treatment was due to the use of more granulated sugar, while the 400:100 and 500:0 treatments produced a darker color due to the higher palm sugar content. These results align with Ratnasari et al. (2022) and Suryani et al. (2025) who stated that the addition of palm sugar increases the intensity of the brown color in the product.


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**Table 2 Color Statistics Calculation**

ANOVA

warna

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 45.314 | 2 | 22.657 | 28.046 | <,001 |
| Within Groups | 82.400 | 102 | .808 | | |
| Total | 127.714 | 104 | | | |

Based on Table 2, the results of the one-way ANOVA test show a calculated f-value of 28.046 with a significance level lower (0.001) than the f-table (<0.05). Therefore, it can be concluded that the addition of sweetener proportions to herbal drinks has a significant effect. Furthermore, to determine the differences in each sweetener addition on color, a further Duncan test was conducted.

**Table 3 Duncan's Test on Color Attributes**

warna

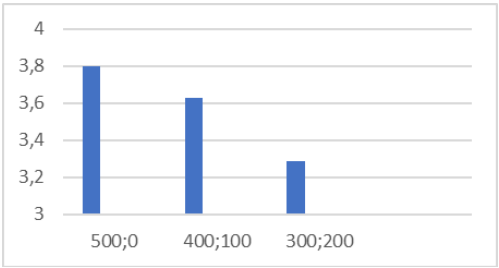
Duncan[a]

| | | Subset for alpha = 0.05 | |
|---|---|---|---|
| perlakuan | N | 1 | 2 |
| 300;200 | 35 | 2.51 | |
| 400;100 | 35 | | 3.74 |
| 500;0 | 35 | | 4.03 |
| Sig. | | 1.000 | .187 |

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 35.000.

Based on the Duncan test in Table 3, the 400;100 treatment and the 500;0 treatment are in subset two, while the 300;200 treatment is in subset one, meaning there is a significant difference in the color sensory attributes according to the panelists.




**Picture 2 Average Aroma Results**

The 300:200, 400:100, and 500:0 treatments each achieved aroma scores of 3.28, 3.62, and 3.80, respectively. All three treatments were considered to have a slightly sharp spice aroma, showing no significant differences.

The slightly sharp aroma of spices is influenced by the caramelized aroma of palm sugar formed during the caramelization process. The higher the sugar content, the stronger the resulting aroma, which can dominate the spice aroma (Suryani et al., 2025; Syamsul et al., 2023). Aroma also plays a crucial role in shaping panelist acceptance because it is closely related to taste perception (Rahayu et al., 2019; Syamsul et al., 2023).

**Table 4 Aroma Statistics Calculation**

ANOVA

aroma

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 4.800 | 2 | 2.400 | 2.693 | .073 |
| Within Groups | 90.914 | 102 | .891 | | |
| Total | 95.714 | 104 | | | |

Based on Table 4, the ANOVA test results show a calculated f value of 2.693 with a significance level greater (0.73) than the f table (<0.05). Therefore, it can be said that adding a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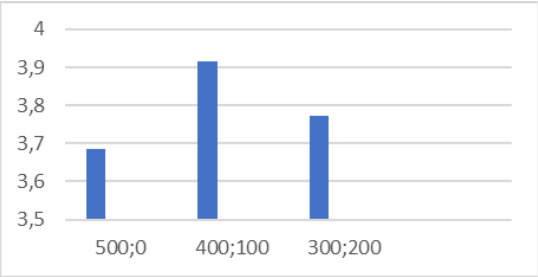
proportion of sweetener to herbal drinks does not affect the aroma.




**Picture 3 Average Taste Results**

The sensory attribute values for the 300:200, 400:100, and 500:0 treatments were 3.68, 3.68, and 3.91, respectively. All three treatments were considered to have a slightly more dominant spicy flavor than sweet, thus showing no significant differences. The similarity in assessments was also influenced by the good taste of the panelists (Rahayu et al., 2019; Ratnasari et al., 2022).

These results were influenced by the use of the same spice composition in each treatment and the small difference in the proportions of palm sugar and granulated sugar. The combination of the two types of sugar still managed to provide a balanced flavor in the herbal drink (Suryani et al., 2025).

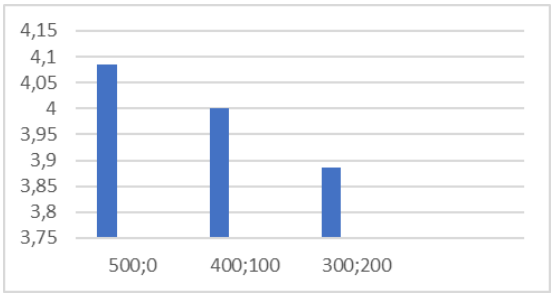
**Table 5 Taste Statistics Calculation**

ANOVA

rasa

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | .933 | 2 | .467 | .431 | .651 |
| Within Groups | 110.457 | 102 | 1.083 | | |
| Total | 111.390 | 104 | | | |

Based on the table above, the results show a calculated f-value of 0.432, with a significance level greater (0.651) than the f-table (<0.05). Therefore, it is concluded that adding sweetener to herbal drinks does not affect the taste. The panelists considered the taste to be the same.




**Picture 4 Average Aftertaste Results**

The aftertaste values for the 300:200, 400:100, and 500:0 treatments were 3.88, 4.00, and 4.08, respectively. All three treatments showed nearly identical ratings, indicating that the panelists were quite accepting of the beverage, as it left a slight spicy and sweet aftertaste.

These results are influenced by the balanced composition of spices, sweeteners, and mineral water. Mineral water plays a role in controlling the release of flavor compounds so that sweetness and bitterness are not excessive, while also influencing the final sensation and shelf life of the product (Ma et al., 2024; Rahayu et al., 2019; Syamsul et al., 2023). The use of the same formula (3:3:3) in all treatments also resulted in relatively similar aftertastes perceived by panelists.

**Table 6 Aftertaste Statistics Calculation**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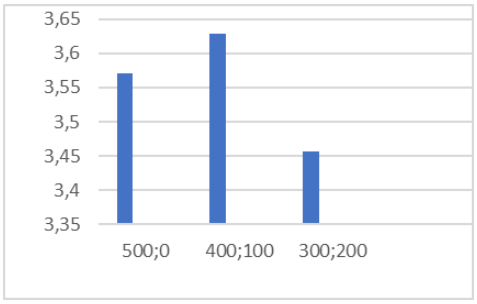
**ANOVA**

aftertaste

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | .705 | 2 | .352 | .381 | .684 |
| Within Groups | 94.286 | 102 | .924 | | |
| Total | 94.990 | 104 | | | |

Based on Table 6, the ANOVA test results show a calculated f value of 0.381 with a significance level greater (0.684) than the f table (<0.05). Therefore, it can be said that the addition of the proportion of sweetener to the herbal drink did not have an effect, meaning that the panelists tended not to perceive any significant differences in the three treatments.




**Picture 5 Overall Average Likeability Results**

Based on Figure 5, the 300:200, 400:100, and 500:0 treatments obtained overall preference scores of 3.45, 3.62, and 3.57, respectively. All three treatments were in the liking category and showed relatively similar values. This is suspected because all samples used the same formula ratio, namely 3:3:3 (spices:sweetener:mineral water), so that color differences due to the sweetener proportion did not affect the overall level of panelist preference.

Next, a One-Way ANOVA test was conducted to determine the effect of the sweetener proportion on the sensory quality of herbal drinks.

**Table 7 Overall Likeability Statistics Calculation**

**ANOVA**

kesukaan

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | .533 | 2 | .267 | .210 | .811 |
| Within Groups | 129.429 | 102 | 1.269 | | |
| Total | 129.962 | 104 | | | |

Based on Table 7, the ANOVA test results show a calculated f-value of 0.210 with a significance level greater (0.811) than the f-table (<0.05). Therefore, it can be concluded that adding a proportion of sweetener to herbal drinks does not affect overall preference.

## Discussion

Sensory testing on herbal beverage products with the addition of sweetener proportions with criteria reviewed from color, aroma, taste, aftertaste, and overall preference. Average value of sensory attributes of herbal drinks presented in Table 8 below

**Table 8 Average Value of Sensory Attributes of Herbal Drinks**

| Treatment | Color | Aroma | Flavor | Aftertaste | Favorites |
|---|---|---|---|---|---|
| 300;200 | 2.51 [a] | 3.28 [a] | 3.77 [a] | 3.88 [a] | 3.45 [a] |
| 400;100 | 3.74 [a] | 3.62 [a] | 3.91 [a] | 4 [a] | 3.62 [a] |
| 500;0 | 4.02 [b] | 3.8 [a] | 3.68 [a] | 4.08 [a] | 3.57 [a] |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The results of the three treatments are presented in Table 9 below.

**Table 9 Final Results of Sweetener Treatment in Beverages**

| Sensory attributes | Treatment 300;200 | Treatment 400;100 | Treatment 500;0 |
|---|---|---|---|
| Color | Visual quality is less appealing, orange and brown colors are separate | The color is more even with less sediment. | Having the highest score, the color of the drink is even without sediment. |
| Aroma | The aroma of the legit is more intense than the spices. | The sweet and spicy aroma was clearly visible. | A burning aroma appears, and the caramelization aroma of the palm sugar is more pronounced than the spices. |
| Flavor | The taste is too sweet. | The taste is just right and balanced. | The taste is quite balanced, with the caramel flavor being more dominant. |
| Aftertaste | Leaving a sweet taste on the tongue, less acceptable. | Leaving a spicy and sweet taste on the tongue, it is acceptable. | Leaving a sweet and spicy taste on the tongue, acceptable |
| Favorites | Less favored by panelists | Panelists' favorite | Quite liked by the panelists. |

The 400:100 treatment was determined to be the best product not only due to sensory considerations but also to production cost efficiency. This treatment proportion achieved the right flavor, resulting in a stable sensory attribute, an attractive dark brown color with minimal sediment, a well-balanced aroma between spices and sweetener, and a more pronounced sweet and bitter flavor without either one dominating.

From an industrial perspective, the 400 gram palm sugar and 100 gram granulated sugar treatment is considered more flexible, as it does not exhibit excessive or extreme differences in any one sensory attribute, unlike the previous two treatments. This can make it easier for producers if there is a slight increase or decrease in the sweetener composition. This treatment is also more adaptive to fluctuations in raw material prices in the market. Thus, producers can maintain product quality consistency in the eyes of consumers while maintaining optimal production cost stability for the company.

**Nutritional Content of Drinks**

Nutritional content was determined based on the 400:100 sample treatment. The parameters tested for this treatment were total sugar and calories (carbohydrates, fat, and protein) presented in Table10 below.

**Table 10 Nutritional Content of Herbal Drinks**

| No. | Parameter | Unit | Test Results | Method |
|---|---|---|---|---|
| 1 | Fat | % | 0.42 | Weibull |
| 2 | Protein | % | 0.86 | Kjeldahl |
| 3 | Carbohydrate | % | 9.18 | Luff-Schrool |
| 4 | Total sugar | % | 8.90 | Luff-Schrool |
| 5 | Calories | kcal | 43.96 | Calculation |

**1. Fat**


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Fat is an essential component of the body and can be found in everyday foods. Fat is divided into two types: saturated fat and unsaturated fat. Saturated fat can be found in red meat and dairy products, while unsaturated fat can be found in plant products, avocados, and fish. Biologically, fat provides energy to the body. It also functions to protect vital organs and maintain a stable body temperature (Asyah et al., 2026).

The amount of fat in this herbal drink is relatively small, if 0.42% when converted into kcal, using the international energy conversion standard (atwater system) then 0.42% × 100 ml = 0.42 g, then 0.42 × 9 kcal = 3.78 kcal. The fat in the drink is less than 9 kcal, which is not a large amount on the body, so this herbal drink is classified as a low-fat drink. The low fat content is because herbal drinks only use rhizome plants, where rhizomes have more water content and macromolecules such as vitamins. It is different if the drink contains grains with a high fat content (Roberts & Flaherman, 2022; Sudiarto et al., 2022).

**2. Protein**

Protein is divided into two types: plant protein and animal protein. Protein functions include building and repairing body cells, increasing muscle mass, and so on. High-protein sources can be found in beef, nuts, chicken, tofu, and tempeh. Plant protein has a limited amino acid variation compared to animal protein. Consuming plant protein is closely linked to a healthier diet, with a lower risk of disease and long-term benefits. Plant protein is widely consumed in developing communities because it is more affordable and economical. One use is as an herbal drink (Hasbani et al., 2026).

The test results show that the protein content of the herbal drink is 1g. Based on the Atwater system, 1g of protein equals 4 kcal. If 0.86% is converted into kcal, then 0.86% × 100 ml = 0.86 g, then 0.86 × 4 kcal = 3.44 kcal. Because this drink is a functional drink, the presence of protein in the herbal drink helps balance the nutrition in the drink, so that the drink does not only contain sugar as a source of energy. The low protein content is due to the raw materials containing more macromolecules such as water. Other effects can be caused by improper handling during the process, such as excessive heating which can cause protein denaturation (Roberts & Flaherman, 2022; Soesilowati et al., 2023).

**3. Carbohydrate**

Carbohydrates can be found in flour, rice, corn, and grains. This content can determine the sensory characteristics of foods, such as texture, flavor, and color (Fitri & Fitriana, 2020).

The test results show that the carbohydrates contained in herbal drinks are 9.18% if converted into kcal then 9.18% × 100 ml = 9.18 g then 9.18 × 4kcal = 36.72 kcal, with a carbohydrate content of 36.72 kcal this drink will provide immediate energy to the body when feeling weak. The amount of carbohydrates is influenced by the sugar in the drink, so, the more added sugar, the higher the carbohydrate content. However, it should be noted that this drink contains lempuyang which can cause bloating, so herbal drinks can be drunk after meals (Roberts & Flaherman, 2022; Senen et al., 2025).

**4. Total sugar**

The two forms of carbohydrates used for energy are blood glucose and muscle glycogen. Glucose is broken down in the body to be absorbed as energy by cells and tissues. Glucose can also be stored as an energy reserve within cells as glycogen (Alawi & Ray, 2019).

Total sugar is a derivative of total carbohydrates, meaning that sugar and carbohydrates are both related to each other. The test results show that total sugar is 8.90%, so 9.18% of this spiced drink is dominated by sugar from almost all carbohydrates, with 0.28 grams being another component that was not tested. The more sugar content used, the more energy reserves in the body, the higher the carbohydrate content (Roberts & Flaherman, 2022; Senen et al., 2025).

**5. Calories**


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Calories represent the amount of energy contained in a food product and are an essential component for the life of every living being. The number of calories needed is determined by considering gender, height, age, weight, physical condition, and activity level. Test results show that the total energy content of herbal drinks is 43.96 kcal per 100 ml of drink. This figure is obtained by adding the weight of fat, protein, and carbohydrates. Most calories are obtained from three macronutrients: fat, protein, and carbohydrates. Calories themselves are calculated using several alternative methods, one of the simplest is the Atwater system method, namely, 4 kcal/gram for carbohydrates, 4 kcal/gram for protein, and 9 kcal/gram for fat (Anjani et al., 2024; Roberts & Flaherman, 2022).

This herbal beverage contains all three micronutrients. The presence of sugar contributes to the highest carbohydrate content, contributing as a primary energy source to support metabolism and maintain body balance. While these substances contribute energy, their presence is lower because the drink uses rhizomes as its raw material, keeping total calorie intake to a minimum. Men generally require approximately 2,000-3,000 calories daily, while women require approximately 1,600-2,400 calories. This indicates that the herbal beverage studied falls into the low-calorie category (Anjani et al., 2024; Sudiarto et al., 2022).

## Conclusion and Recommendation

This study showed that the proportion of palm sugar and granulated sugar significantly influenced the sensory attributes of color, but did not significantly influence aroma, taste, aftertaste, and overall preference. The treatment of 400 g palm sugar and 100 g granulated sugar was chosen as the best formulation because it produced an attractive color, balanced spicy and sweet aroma, a more harmonious taste, and an aftertaste that was acceptable to panelists while still considering production cost efficiency. The results of the nutritional analysis also showed that the product contained relatively low amounts of fat, protein, carbohydrates, total sugar, and energy, making it a potential alternative for functional herbal drinks.

This study still has limitations because it only used three variations of sweetener proportions, involved 35 panelists, and assessed sensory aspects and nutritional content without testing the product's shelf life or functional activity. Therefore, further research is recommended to develop more diverse formulation variations, involve a larger number of panelists, and conduct tests on product stability, shelf life, antioxidant activity, and effectiveness on digestive health. Practically, the results of this study can serve as a reference for food industry players in developing herbal drinks made from rhizomes with good sensory quality, efficient production costs, and have the potential to be more widely accepted by consumers.

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