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FORMULATION OF LEMONGRASS (*Cymbopogon Nardus*) AND CITRIC ACID ON THE CHARACTERISTICS OF TELANG FLOWER DRINK (*Clitoria Ternatea*) AS A READY TO SERVE FUNCTIONAL DRINK

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Abstract

This research explores the formulation of a ready-to-serve (RTS) beverage utilizing butterfly pea flower (Clitoria ternatea) combined with lemongrass (Cymbopogon nardus) and citric acid to enhance both sensory qualities and antioxidant properties. The study aims to identify the optimal concentrations of lemongrass and citric acid that yield the best sensory attributes and health benefits. A randomized complete block design was employed, featuring two factors: the first factor being the lemongrass concentration (15, 20, and 25 grams) and the second factor the citric acid concentration (0.2, 0.4, and 0.6 grams), resulting in a total of 27 experimental combinations. The researchers utilized two-way ANOVA to analyze the chemical data, followed by Tukey's test to identify significant differences among treatments. Additionally, sensory evaluations were conducted using Friedman's method. The optimal formulation, identified as S3A3 (25 grams of lemongrass and 0.6 grams of citric acid), exhibited an antioxidant activity of 5.80 ppm, a pH of 3.5, a color a value of 3.5, and a color rating of 4.38 (liked). Furthermore, it received a taste score of 4.26 (liked) and an aroma score of 4.26 (liked). These findings indicate that the S3A3 formulation not only aligns with consumer preferences but also provides substantial health benefits, positioning it as a competitive option in the functional beverage market.*

Keywords: *Ready-to-serve Beverage, butterfly pea flower, lemongrass, antioxidant*

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INTRODUCTION

Butterfly pea flower, also known as butterfly pea or blue pea, is a climbing plant commonly found in Indonesia. This flower is characterized by its single petals in various shades of purple, blue, pink, and white (Budiasih, 2017). Its popularity stems not only from its visual appeal but also from its bioactive compounds beneficial to health, particularly as a crucial role in combating free radicals, which are implicated in various degenerative diseases such as cancer, diabetes mellitus, and coronary heart disease (Giri *et al.*, 2023; Pinto & Vilela, 2021). Due to its accessibility and numerous benefits, butterfly pea is highly potential for processing into ready to serve (RTS) functional beverages.

Ready-to-serve functional beverages are health-beneficial drinks that are ready to consume. They are liquid and packaged in individual containers, ready to be consumed

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directly without heating, mixing, or dilution (Paudel, 2022). Packaging also varies, from bottles, box packages containing powder or granules, to sachets like tea bags (Benyathiar *et al.*, 2022). This convenience makes butterfly pea beverages in RTS form an attractive option for modern consumers seeking healthy and practical drinks. Butterfly pea RTS beverages are already quite popular in the market, but there is still room for innovation to enhance their appeal and market value.

Butterfly pea beverages contain various essential nutrients, including vitamin C, vitamin E, and fiber (Evangelista & Surya, 2024). However, the natural taste of butterfly pea may not be appealing to some individuals. Therefore, a proper formulation is needed to enhance the flavor and enrich its health benefits. This research explores the potential of lemongrass and citric acid as flavor enhancers and nutritional value improvers in butterfly pea RTS beverages. Lemongrass is chosen for its characteristic fresh aroma that can balance the taste of butterfly pea (Gosavi & Swami, 2024) while citric acid, in addition to providing a refreshing sour taste, also possesses antioxidant properties (Oboh & Imafidon, 2018).

Previous research by Utami & Fauziah (2024) has shown promising results with the addition of lemon juice to butterfly pea beverages. This study successfully produced a beverage with high antioxidant activity. This finding indicates that the addition of certain natural ingredients can significantly enhance the antioxidant potential of butterfly pea beverages. Based on this finding, this research aims to explore the combination of lemongrass and citric acid as an alternative to improve the flavor profile and antioxidant activity of butterfly pea RTS beverages. Thus, it is hoped that a functional beverage can be produced that is not only delicious and refreshing but also rich in health benefits for consumers. This research aims to analyze the physicochemical characteristics (color reader, pH, ash content, and antioxidant levels) and organoleptic characteristics (color, taste, and aroma) of the formulated beverage, with the objective of determining its overall quality and health benefits.

MATERIALS AND METHODS

The materials used in this study include butterfly pea flowers sourced from Dusun Sengon Agung, Purwosari, Pasuruan Regency, granulated sugar, lemongrass, citric acid, and water. For the antioxidant analysis, the following materials were utilized: 1,1-diphenyl-2-picrylhydrazyl (DPPH) from Sigma Aldrich, USA, analytical grade ethanol, hydrochloric acid (HCl), petroleum benzene from Merck, distilled water, and 0.01 N iodine solution.

Preparation of Butterfly Pea Flower RTS Beverage

The method employed in this study for the preparation of the butterfly pea flower beverage involves varying the concentration of butterfly pea flower with lemongrass and citric acid. The experimental design used is a factorial Randomized Block Design (RBD) consisting of two factors, each with three levels.

- First Factor: Concentration of lemongrass (S)
  S1: 15 grams
  S2: 20 grams
  S3: 25 grams
- Second Factor: Concentration of citric acid (A)
  A1: 0.2 grams
  A2: 0.4 grams
  A3: 0.6 grams

The weighing process is conducted to measure the percentage of each ingredient used. The butterfly pea flowers and lemongrass are thoroughly washed with running water to remove contaminants from their outer surfaces. After washing, the lemongrass is cut to expedite the drying process in the oven and to fit into tea

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bags. The butterfly pea flowers and lemongrass are then oven-dried at a temperature of 50-60ºC for 1-2 hours or until completely dry (Gunawan et al., 2024). Before drying, line the oven tray with parchment paper to prevent sticking and contamination, ensuring that the food maintains its quality and is easy to remove after drying. Once dried, the butterfly pea flowers and lemongrass are mixed and packed into tea bags. Before packaging, mix the butterfly pea flowers and lemongrass thoroughly with a spoon, then place them into the tea bags, adding citric acid. Seal the tea bags tightly.

Data Analysis

The physical analysis includes color testing using a Color Reader, while the chemical analysis involves measuring pH with a pH meter and assessing antioxidant activity using the DPPH method. In the study of butterfly pea flower beverages, the physicochemical properties were analyzed using Analysis of Variance (ANOVA) with a confidence level of 95% (α=0.05). If significant differences are found, the next step is to apply Tukey's test with the assistance of Minitab software.

The organoleptic evaluation of the butterfly pea flower beverage is conducted using the Friedman test with a 5% significance level. The data is analyzed statistically using Excel calculations to determine the best treatment in physicochemical and organoleptic analysis, employing the De Garmo Effectiveness Index test modified by Susrini (2003).

RESULTS AND DISCUSSION

Antioxidant Activity

The antioxidant activity of the ready-to-serve (RTS) butterfly pea flower beverage was evaluated through various treatments involving different concentrations of lemongrass and citric acid. The results, as shown in Table 1, indicate that the antioxidant activity, measured by IC_{50} values, varies significantly across different formulations. The treatment with 25 grams lemongrass and 0.6 grams citric acid (S3A3) exhibited the highest antioxidant activity with an IC_{50} value of 5.80 ppm, suggesting a potent ability to neutralize free radicals. This finding aligns with previous studies that highlight the synergistic effect of combining natural antioxidants to enhance overall activity.

Table 1. Average Antioxidant Activity of RTS Butterfly Pea Flower Drink

Formulation	Lemongrass (gram)	Citric Acid (gram)	IC_{50} (ppm)
S1A1	15	0.2	60.80 ± 0.73^{a}
S1A2	15	0.4	25.85 ± 0.80^{ab}
S1A3	15	0.6	18.05 ± 0.31^{ab}
S2A1	20	0.2	8.65 ± 0.28^{b}
S2A2	20	0.4	7.15 ± 0.40^{b}
S2A3	20	0.6	6.95 ± 0.38^{b}
S3A1	25	0.2	6.95 ± 0.75^{b}
S3A2	25	0.4	6.80 ± 0.29^{b}
S3A3	25	0.6	5.80 ± 0.90^{b}

Note: The letters in the statistical results indicate significant differences among the treatments; treatments sharing the same letter are not significantly different

The observed trend in antioxidant activity can be attributed to the individual and combined effects of lemongrass and citric acid. Lemongrass is known for its high content of

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phenolic compounds (Tazi *et al.*, 2024), which contribute to its antioxidant properties. Citric acid, on the other hand, not only enhances the flavor profile but also acts as a chelating agent (Sing *et al.*, 2022), stabilizing the antioxidant compounds present in the beverage (Laura *et al.*, 2024). The combination of these two ingredients likely results in a more effective scavenging of free radicals, as evidenced by the lower IC_{50} values in treatments with higher concentrations of both components.

The implications of these findings are significant for the development of functional beverages. The enhanced antioxidant activity observed in the RTS butterfly pea flower beverage suggests its potential as a health-promoting drink. By optimizing the concentrations of lemongrass and citric acid, manufacturers can create a beverage that not only appeals to consumers' taste preferences but also offers substantial health benefits. This study provides a foundation for further research into the formulation of antioxidant-rich beverages, emphasizing the importance of ingredient synergy in maximizing health benefits.

pH Analysis

The pH values of the ready-to-serve (RTS) butterfly pea flower beverage were measured across various treatments, as shown in Table 2. The results indicate that the pH ranged from 3.50 to 4.20, with the highest pH observed in the treatment with 15 grams of lemongrass and 0.2 grams of citric acid (S1A1). This pH level is indicative of a slightly acidic beverage, which is consistent with the natural acidity of butterfly pea flowers and the addition of citric acid. The presence of citric acid is known to enhance the flavor profile of beverages while also contributing to their preservation by inhibiting microbial growth (Vilas-Boas *et al.*, 2022).

The observed variations in pH among the different treatments can be attributed to the concentrations of lemongrass and citric acid used. Higher concentrations of citric acid generally lead to lower pH values, as seen in treatments S3A3 and S3A2, which exhibited the lowest pH levels of 3.50 and 3.85, respectively.

Table 2. Average pH of RTS Butterfly Pea Flower Drink

Formulation	Lemongrass (gram)	Citric Acid (gram)	pH
S1A1	15	0.2	4.20 ± 0.07^{ab}
S1A2	15	0.4	4.10 ± 0.05^{a}
S1A3	15	0.6	4.00 ± 0.2^{a}
S2A1	20	0.2	4.15 ± 0.05^{b}
S2A2	20	0.4	4.10 ± 0.05^{b}
S2A3	20	0.6	4.09 ± 0.2^{b}
S3A1	25	0.2	4.00 ± 0.1^{c}
S3A2	25	0.4	3.85 ± 0.1^{d}
S3A3	25	0.6	3.50 ± 0.9^{c}

Note: The letters in the statistical results indicate significant differences among the treatments; treatments sharing the same letter are not significantly different

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This trend aligns with the established understanding that organic acids, such as citric acid, play a crucial role in determining the acidity of food and beverages (Shi *et al.*, 2022). The acidic environment not only affects the taste but also enhances the antioxidant properties of the beverage, as lower pH levels can improve the stability of antioxidant compounds (Tazi *et al.*, 2024).

The implications of these pH findings are significant for the formulation of functional beverages. A pH range of 3.50 to 4.20 is optimal for consumer acceptance, as it provides a refreshing taste while ensuring the beverage remains safe for consumption (Helilusiatiningsih *et al.*, 2024). Additionally, the slightly acidic nature of the RTS butterfly pea flower beverage may enhance its health benefits, as acidic environments are known to promote better absorption of certain nutrients. Future research could explore the relationship between pH and the sensory attributes of the beverage, further optimizing formulations for both health benefits and consumer preferences.

Color Analysis

The color analysis of the ready to serve (RTS) butterfly pea flower beverage was conducted using a color reader, focusing specifically on the a* value, which indicates the red-green component of the color spectrum (). As presented in Table 3, the a* values ranged from 4.42 to 5.83, with the highest value recorded in the treatment with 25 grams of lemongrass and 0.6 grams of citric acid (S3A3). This increase in the a* value suggests a more pronounced red hue, which can be attributed to the interaction between the anthocyanins present in the butterfly pea flowers and the citric acid, enhancing the overall color intensity of the beverage (Laia *et al.*, 2023; Utami & Fauziah, 2024).

Table 3. Average Color of RTS Butterfly Pea Flower Drink

Formulation	Lemongrass (gram)	Citric Acid (gram)	Brightness a*
S1A1	15	0.2	4.20 ± 0.07^{ab}
S1A2	15	0.4	4.10 ± 0.05^{a}
S1A3	15	0.6	4.00 ± 0.2^{a}
S2A1	20	0.2	4.15 ± 0.05^{b}
S2A2	20	0.4	4.10 ± 0.05^{b}
S2A3	20	0.6	4.09 ± 0.2^{b}
S3A1	25	0.2	4.00 ± 0.1^{c}
S3A2	25	0.4	3.85 ± 0.1^{d}
S3A3	25	0.6	3.50 ± 0.9^{c}

Note: The letters in the statistical results indicate significant differences among the treatments; treatments sharing the same letter are not significantly different

The observation that only the a* value was measured, rather than L* (lightness) or b* (yellow-blue), is significant. The focus on a* allows for a more detailed understanding of the beverage's color profile, particularly in terms of its appeal to consumers. The anthocyanins in butterfly pea flowers are known for their vibrant colors, and the addition of citric acid can further influence the color by altering the pH, which affects the stability and expression of these pigments (Handayani *et al.*, 2024). This relationship underscores the importance of ingredient selection in beverage formulation, as

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it directly impacts not only the aesthetic qualities but also consumer perception and acceptance.

Furthermore, the results highlight the potential for optimizing color attributes in functional beverages. A visually appealing product is crucial for market success, and the enhancement of the red hue through careful formulation can attract consumers seeking both health benefits and sensory enjoyment (Sasongko *et al.*, 2024). Future studies could explore the relationship between color intensity and consumer preferences, as well as the stability of color over time, to ensure that the final product remains attractive throughout its shelf life.

Sensory Evaluation

Sensory evaluation is a critical component in the development of food and beverage products, as it directly impacts consumer acceptance and market success. In this study, the sensory attributes of the ready-to-serve (RTS) butterfly pea flower beverage were assessed, focusing on color, taste, and aroma. The results from Figures 1, 2, and 3 demonstrate that the beverage received favorable ratings across all sensory dimensions, indicating its potential appeal to consumers.

Color

As shown in Figure 1, the color of the RTS butterfly pea flower beverage was highly rated by the panelists, particularly for the formulation containing 25 grams of lemongrass and 0.6 grams of citric acid (S3A3). The vibrant hue of the beverage is primarily attributed to the anthocyanins found in butterfly pea flowers, which are renowned for their striking blue and purple colors. The addition of citric acid not only enhances the visual appeal but also stabilizes these pigments, resulting in a more attractive product (Handayani *et al.*, 2024). Research indicates that color is a significant factor in consumer perception, as it can evoke emotional responses and influence the perceived quality and flavor of beverage.

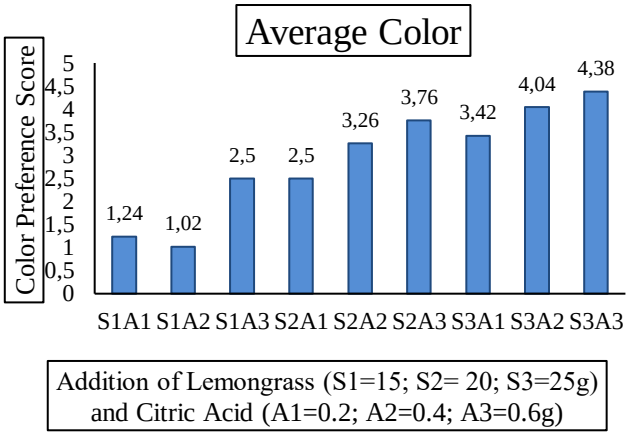

Fig 1. Sensory Preference Level of RTS Butterfly Pea Flower Drink Color

The implications of these findings are substantial for product development. A visually appealing beverage can enhance consumer interest and encourage trial, which is crucial in a competitive market (Sasongko *et al.*, 2024). The vibrant color of the RTS butterfly pea flower beverage may also be marketed as a natural and healthy option, appealing to health-conscious consumers seeking visually striking drinks.

Taste

In terms of taste, as depicted in Figure 2, the formulations with higher concentrations of lemongrass were preferred by the panelists, providing a refreshing and well-balanced flavor profile. The combination of lemongrass and citric acid created a harmonious blend of tangy and sweet notes (Sucitra & Rahmawati, 2022), which resonated well with consumer preferences. This finding aligns with existing literature that emphasizes the importance of flavor balance in beverage formulation, as it can significantly affect overall consumer satisfaction.

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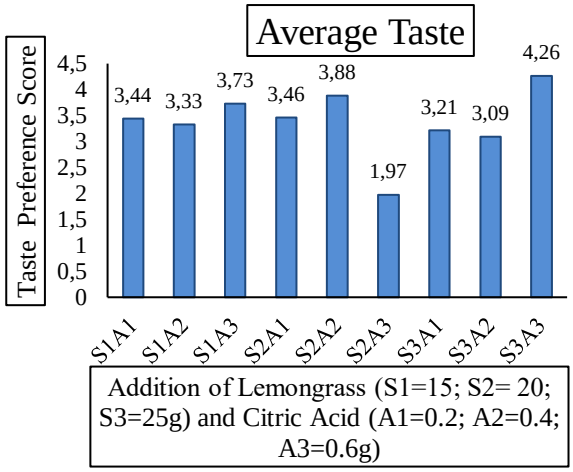

Fig 2. Sensory Preference Level of RTS Butterfly Pea Flower Drink Taste

The implications of the taste evaluation suggest that optimizing flavor profiles can lead to higher consumer acceptance and repeat purchases. By focusing on the balance of flavors, manufacturers can create a product that not only satisfies taste preferences but also stands out in the marketplace, potentially leading to increased sales and brand loyalty.

Aroma

The aroma evaluation, illustrated in Figure 3, revealed that the RTS beverage was well-received, with lemongrass contributing significantly to its fragrant profile. Aroma plays a vital role in flavor perception, and studies have shown that a pleasant aroma can enhance the overall drinking experience (Morrin & Tepper, 2021). The aromatic compounds released from lemongrass not only improve the sensory appeal of the beverage but also create a positive association for consumers (Joshua *et al.*, 2023), making it an essential aspect of product development.

The implications of the aroma findings indicate that enhancing the aromatic qualities of beverages can significantly influence consumer preferences. A pleasant aroma can attract consumers and enhance their overall experience, leading to positive word-of-mouth and increased marketability. By emphasizing the aromatic aspects of the RTS butterfly pea flower beverage, producers can effectively position their product as a premium offering in the health beverage segment.

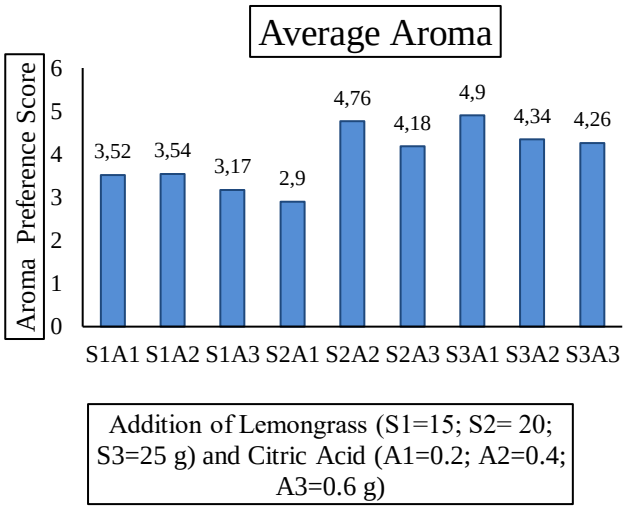

Fig 3. Sensory Preference Level of RTS Butterfly Pea Flower Drink Aroma

Best Treatment

Identifying the optimal treatment in beverage formulation is crucial for maximizing both sensory appeal and health benefits. In this study, the best treatment for the ready-to-serve (RTS) butterfly pea flower beverage was determined based on the data presented in Figures 4 and 5.

The findings from Figure 4 highlight that the S3A3 formulation exhibited the highest antioxidant activity, as evidenced by its low IC_{50} value. This suggests that the combination of lemongrass and citric acid not only enhances the flavor and aroma but also significantly boosts the health-promoting properties of the beverage. Previous research has shown that both lemongrass and citric acid possess antioxidant properties, which can synergistically work together to provide enhanced protection against

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oxidative stress. The incorporation of these ingredients in the RTS beverage not only improves its nutritional profile but also positions it as a functional drink that appeals to health-conscious consumers.

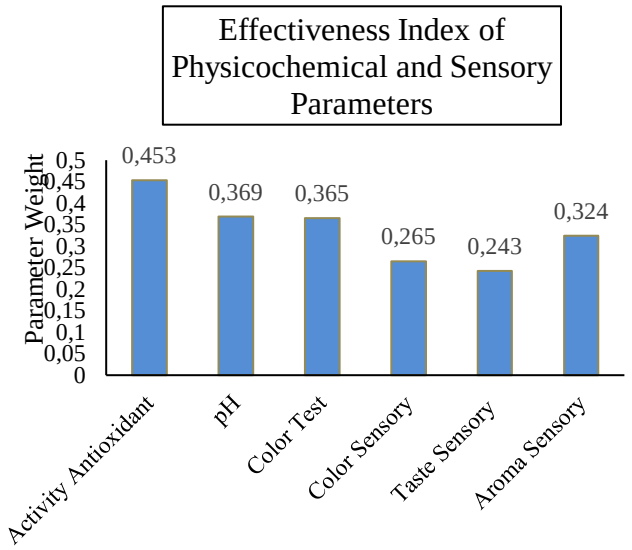

Fig 4. RTS Butterfly Pea Flower Drink Test Parameter Weight

Furthermore, Figure 5 illustrates the sensory evaluation results, where the S3A3 formulation received the highest scores for color, taste, and aroma.

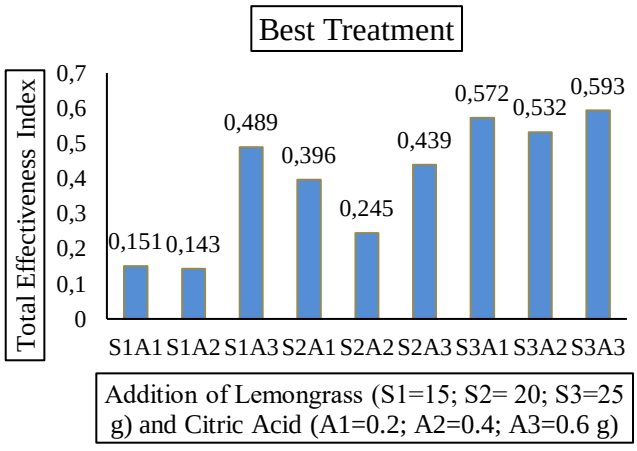

Fig 5. Weight of RTS Butterfly Pea Flower Drink Treatment

This indicates that the optimal treatment not only excels in antioxidant capacity but also offers a pleasing sensory experience. The positive reception of this formulation can be attributed to the harmonious balance of flavors and the vibrant color, which are essential factors in consumer acceptance. Literature supports the notion that a well-balanced flavor profile, combined with appealing visual attributes, can significantly enhance consumer satisfaction and encourage repeat purchases. Thus, the S3A3 formulation stands out as a promising candidate for commercial production, catering to the growing demand for functional beverages that are both enjoyable and beneficial to health. The results indicate that the formulation containing 25 grams of lemongrass and 0.6 grams of citric acid (S3A3) emerged as the most favorable option, demonstrating superior antioxidant activity and sensory attributes compared to other treatments.

Conclusion

Based on the study's findings, it can be concluded that the concentration of lemongrass and citric acid significantly influences the antioxidant activity, sensory attributes, and overall acceptability of the ready-to-serve (RTS) butterfly pea flower beverage. The optimal formulation, identified as S3A3 (25 grams of lemongrass and 0.6 grams of citric acid), demonstrated remarkable results with an antioxidant activity of 5.80 ppm, pH 3.5, color a* 3.5, and a color rating of 4.38 a taste score of 4.26, and aroma score of 4.26. The S3A3 formulation not only meets the sensory preferences of consumers but also provides substantial health benefits, making it a suitable option for the growing market of functional beverages. The results indicate that this formulation aligns with consumer expectations for both taste and health, positioning it as a competitive product in the beverage industry.

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