Effects of Withering Duration and Drying Conditions on the Just-About-Right Sensory Profile of Batu City Rose Tea (*Rosa hybrida*)

Igoy Bimo[1*], *Rendra* Lebdoyono[1], *Aji* Ramadhani[1], *Diwyacitta* Putri[1], *Raida* Ifadah[1], Anggun Maharani[1], *Dego* Ali[2], *Hanif* Ahmi[3], *Aisyah* Kamiliyah[4*], *Sakinah* Abida[5]

[1]Food Technology and Agricultural Product Study Program, Faculty of Food Security, Universitas Negeri Surabaya, Surabaya 60286, East Java, Indonesia.
[2]Food Science and Biotechnology Department, Faculty of Agricultural Technology, Universitas Brawijaya, Malang City 65145, East Java, Indonesia.
[3]Engineering Faculty, Universitas Negeri Surabaya, Surabaya 60231, East Java, Indonesia.
[4]Faculty of Vocational Study, Universitas Negeri Surabaya, Surabaya 60231, East Java, Indonesia.
[5]Biotechnology Study Program, Faculty of Mathematics and Natural Sciences, Universitas Negeri Malang, Malang 65145, Indonesia

Abstract. This study investigated the effect of withering duration, drying temperature, and drying time on the sensory characteristics of rose tea (*Rosa hybrida*) using the Just-About-Right (JAR) method. A randomized complete block design with a 3 × 2 × 3 factorial arrangement was applied, consisting of withering durations (4, 12, and 16 hours), drying temperatures (60°C and 80°C), and drying times (1, 2, and 3 hours). Sensory evaluation was conducted by 50 untrained panellists to assess color, aroma, taste, flavor, and astringent sensation. JAR data were analyzed using a one-sample proportion test with a theoretical proportion of 0.333. The results showed that processing conditions significantly influenced the sensory profiles of rose tea. Shorter withering duration (4 hours) combined with higher drying temperature (80°C) consistently produced significantly higher JAR proportions across multiple attributes, including floral aroma, fresh aroma, taste attributes (sweet, sour, and bitter), as well as floral flavor and astringent sensation. In contrast, longer withering durations tended to either intensify certain attributes excessively at 60°C or reduce sensory balance at 80°C. The findings indicate that optimizing processing parameters, particularly shorter withering and higher drying temperature, is essential to achieve balanced and consumer-preferred sensory profiles in rose tea.

1 Introduction

Rose tea derived from *Rosa hybrida* petals has attracted growing interest as a functional beverage due to its appealing sensory characteristics and potential health benefits [1,2]. Its richness in bioactive compounds, including phenolics, flavonoids, and volatile aromatics, contributes not only to antioxidant activity but also to its distinctive color, aroma, and taste. These sensory attributes are critical for consumer acceptance, particularly in functional beverages where product efficacy must be supported by pleasant sensory experiences.

* Corresponding author : igoybimo@unesa.ac.id

However, the expression of these qualities is highly dependent on post-harvest processing, which can significantly alter the stability and formation of key compounds.

Among the main processing steps, withering and drying play a crucial role in determining the final sensory profile of rose tea. Withering duration influences enzymatic activity and biochemical transformations such as oxidation and precursor development, which affect both pigment stability and aroma formation. Meanwhile, drying temperature and duration drive moisture removal and accelerate chemical reactions, including thermal degradation and Maillard reactions, that shape flavor, color, and aroma [3]. Despite the importance of these processes, limited studies have focused on optimizing processing parameters specifically for rose tea to achieve a well-balanced and desirable sensory profile.

To address this gap, consumer-oriented sensory evaluation methods are essential. The Just-About-Right (JAR) approach is widely applied to assess whether specific sensory attributes reach the optimal intensity preferred by consumers [4]. Unlike conventional hedonic tests, JAR provides more detailed insights by identifying whether attributes are perceived as too weak, too strong, or ideal. Therefore, this study aims to evaluate the effects of withering duration, drying temperature, and drying time on the JAR sensory profiles of rose tea produced in Batu, Malang, to support the optimization of processing conditions to achieve balanced, consumer-preferred sensory characteristics.

2 Materials and Methods

The equipment used to produce the rose tea samples included an oven for drying to reduce moisture content. For brewing, the tools consisted of a gooseneck electric kettle, a weighing scale, spoons, glass cups, plastic cups, and measuring cylinders. Rose flowers were harvested at the fully bloomed stage to ensure uniform maturity among samples. The flower material consisted of red, white, and yellow rose petals in a standardized 1:1:1 (w/w) proportion, corresponding to 30 g of each color in each 90 g sample batch. Furthermore, all tea infusions were prepared under standardized brewing conditions by steeping dried rose flowers in mineral water at 90°C for 3 minutes using a 1:100 (g) sample-to-water ratio. Moisture content was not directly measured during the study; instead, the moisture condition of the samples was controlled indirectly through the predefined drying temperature and drying duration treatments. The flowers were harvested during March-April 2025 and obtained from farmers in Batu City, East Java, Indonesia.

2.1 Rose Tea Production Protocols

The experiment used a Randomized Complete Block Design (RCBD) with a 3x2x3 treatment structure. The treatments included different withering times (4, 12, and 16 hours), drying temperatures (60°C and 80°C) as the block, and drying durations (1, 2, and 3 hours). All treatments were randomly arranged within each block to reduce the influence of environmental variations during rose processing. For preparation, the samples were brewed in an Edelmann electric kettle and then cooled to room temperature before evaluation. The dried rose flowers were steeped at 90°C for 3 minutes using a 1:100 ratio (sample weight in grams to mineral water mL) to ensure optimal extraction of bioactive compounds while avoiding excessive bitterness. The replication of drying factors was done twice.

2.2 Sensory Evaluation Using the JAR Method

Ethical approval for this rose tea consumption study was obtained from the Malang State Health Polytechnic with permission number No. DP.04.03/F.XXI.31/0882/2024. Sensory evaluation was conducted using the Just-About-Right (JAR) method to assess the characteristics of local rose tea from Batu. Each panellist evaluated each sample once. The JAR values, which are shown at 7-scale, represent the proportion of panellists who selected JAR [5]. The scale ranged from 1 ("much too weak") to 7 ("much too strong"), with 4 representing the ideal intensity ("just about right"). For example, if 25 out of 50 panelists rated a sample as JAR, the value is expressed as 0.50. A Google Form was utilised to record the panellist responses. We also acknowledge the potential for sensory fatigue when evaluating 18 samples. To minimize this effect, the samples were presented in a randomized order, panellists were provided with drinking water for palate cleansing between samples, and resting time was allowed during the evaluation session.

A total of 50 untrained panellists with a single-session consumer test in Surabaya City participated in the study. Eighteen samples were tested, divided into two sessions, with nine samples in each session. Each sample was served in a 15 mL portion using plastic cups. The JAR results were used to determine how well each sample matched the panelists' ideal preferences based on attributes such as sweetness, bitterness, sourness, sweet aroma, sour aroma, floral aroma, astringency, floral flavor, as well as brown and red color.

2.1 Statistic Analysis

JAR data analysis was conducted using Minitab 22 with the 1-Proportion Test. This test is used to determine the proportion of a particular sensory attribute that corresponds to the "ideal" level based on panellist data. The one-proportion test was intentionally selected because JAR analysis is based on the proportion of panellists identifying an attribute as "just-about-right," whereas ANOVA evaluates differences among mean scores and does not directly determine the optimal JAR level. In the analysis of JAR data using a 7-point scale, category simplification is performed by collapsing the intensity levels into three main groups to facilitate statistical interpretation. Scores of 1 to 3 are classified as *low*, a score of 4 represents *just about right* (JAR), and scores of 5 to 7 are categorized as *high*. With this grouping approach, subsequent proportion analysis is based on the assumption of an equal distribution across the three categories, resulting in a theoretical proportion (p_0) of 0.333. This method enables the application of a one-sample proportion test to determine whether the distribution of panellists' responses for the evaluated attribute significantly deviates from a balanced or random condition.

3 Results

3.1 Color Characteristics of Rose Tea

The color attributes of rose tea Table 1 Supplementary File (https://bit.ly/SuppFile1JAR) were significantly influenced by drying temperature and time. At 60°C, red color was optimal under longer withering (16 hours) and shorter drying (1 hour) (0.54*), while yellow color increased with extended drying, peaking at 16 hours withering and 3 hours drying (0.61*), indicating pigment transformation. At 80°C, the yellow color became more dominant and frequently reached significant levels, especially after 4 hours of withering and 2–3 hours of drying (0.62*). This suggests that higher temperatures accelerate anthocyanin degradation and favor yellow pigments, whereas red color becomes less stable.

3.2 Aroma Attributes of Rose Tea

Aroma characteristics, as shown in Table 1 Supplementary File**,** were strongly influenced by withering and drying conditions. At 60°C, floral aroma was most prominent under short withering (4 hours) and longer drying (2–3 hours) (up to 0.54*), while fresh aroma peaked at moderate withering (12 hours) with short drying (1 hour), indicating better preservation of fresh volatiles under milder conditions. At 80°C, aroma intensity increased, especially under short withering (4 hours), where floral and fresh notes consistently reached significant levels (0.55*–0.61*). However, longer withering (12 hours) reduced aroma, likely due to volatilization or degradation

3.3 Taste Attributes of Rose Tea

Taste attributes, as shown in Table 1 Supplementary File**,** varied with processing intensity. At 60°C, significant responses were observed under longer withering and drying, particularly at 12 hours of withering and 3 hours drying, where sweet (0.65*), sour (0.68*), and bitter (0.60*) all reached significant levels, indicating intensified but potentially less balanced taste. At 80°C, taste was more balanced under short withering (4 hours), with all attributes consistently exceeding JAR levels across drying times. In contrast, longer withering (12–16 hours) reduced taste significance, likely due to compound degradation. Overall, short withering combined with high drying temperature provides optimal taste balance.

3.4 Flavor and Mouthfeel of Rose Tea

Flavor and mouthfeel attributes, as shown in Table 1 Supplementary File**,** represented by floral flavor and astringent sensation JAR, showed patterns similar to aroma and taste. At 60°C, significant values were limited and mainly observed under longer processing (12 hours withering and 3 hours drying; 0.55*–0.57*), indicating enhanced but potentially excessive flavor and astringency. At 80°C, the most consistent results occurred under short withering (4 hours), with values ranging from 0.58* to 0.65* across drying times. Longer withering reduced significance, suggesting an imbalance. Overall, short withering combined with higher drying temperature provides better flavor–mouthfeel balance.

4 Discussions

The color and aroma profiles of rose tea are strongly influenced by processing conditions through their effects on pigment stability and volatile compound retention [6]. Anthocyanins, the primary pigments responsible for the characteristic red coloration of rose petals, are highly susceptible to thermal degradation and oxidative reactions. During prolonged withering and high-temperature drying, anthocyanins may undergo hydrolysis, oxidation, and conversion to colorless or yellow-brown degradation products, resulting in reduced redness and increased yellowish hues [7]. Similar reductions in anthocyanin stability during thermal processing have been reported in herbal and flower-based teas, where elevated temperatures accelerate pigment breakdown and non-enzymatic browning reactions [8]. Conversely, moderate drying conditions may facilitate cellular disruption and pigment release while minimizing excessive degradation, thereby preserving desirable color attributes.

The aroma profile is largely determined by volatile terpenoids and aromatic alcohols such as geraniol, citronellol, and phenylethyl alcohol. Short withering periods combined with controlled drying can enhance the liberation of these compounds from glycosidically bound precursors, increasing floral aroma intensity. However, prolonged processing or excessive thermal exposure may promote volatilization, oxidation, and degradation of these aromaactive compounds, leading to losses in fresh and sweet floral notes. Similar trends have been observed in the processing of jasmine, chrysanthemum, and other floral teas, where aroma quality decreases as volatile retention declines under intensive drying conditions.

Taste perception is closely associated with changes in phenolic composition during processing. Extended withering promotes enzymatic oxidation of phenolic compounds through polyphenol oxidase activity, producing quinones and polymerized phenolics that contribute to bitterness and astringency. Thermal treatments further influence these reactions by modifying enzyme activity and altering phenolic structures. While moderate heating may inactivate oxidative enzymes and limit excessive astringency, prolonged drying can concentrate non-volatile phenolics and intensify bitter sensations [9]. These findings are consistent with previous studies reporting that processing-induced phenolic oxidation is a major determinant of flavor development in tea and herbal infusions [10]. Therefore, the sensory characteristics observed in the present study likely result from the combined effects of anthocyanin degradation, volatile compound retention, phenolic oxidation, and temperature-dependent chemical transformations occurring during withering and drying.

5 Conclusion

The sensory characteristics of rose tea were significantly influenced by withering duration, drying temperature, and drying time, as assessed using the Just-About-Right (JAR) method. Among the evaluated treatments, 4 h of withering combined with drying at 80°C produced the most desirable sensory profile, achieving the highest JAR proportions for color, aroma, taste, and mouthfeel. These findings indicate that a short withering period followed by relatively high-temperature drying can effectively preserve and enhance consumer-preferred sensory attributes in rose tea. From a practical perspective, this processing combination may serve as a useful guideline for rose tea manufacturers seeking to improve product quality and consumer acceptance. Future studies should investigate the physicochemical mechanisms underlying these sensory responses, particularly changes in anthocyanins, phenolic compounds, and volatile constituents, as well as evaluate consumer acceptance using larger and more diverse panel populations.

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References

1. I. Bimo, D. Ali, W. Sunarharum, S. Widjanarko, N. Mu’awannah, C. Athirah, N. Jatmiko, M. Pranita, Rose tea for lowering blood pressure and alleviating stress: Sensory analysis and *in silico* investigations. Cogent Food Agric. **11**, 2592346 (2025). https://doi.org/10.1080/23311932.2025.2592346
2. I.A. Bimo, D.Y. Ali, W.B. Sunarharum, N. Mu’awannah, C.E. Athirah, N.S. Jatmiko, et al., The effects of drying temperature and duration on rose tea chemical and sensory profiles as a functional beverage. Adv. Food Sci. Sustain. Agric. Agroind. Eng. **8**, 411–422 (2025). https://doi.org/10.21776/ub.afssaae.2025.008.01.3
3. Y. Geng, Mechanism and examples of Maillard reaction. Int. J. Food Sci. Agric. **8,** 54–58 (2024). https://doi.org/10.26855/ijfsa.2024.03.008
4. K. Fibrianto, I.A. Bimo, A.M. Sofa, A. Putri, D. Amelia, O.R. Lalilika, et al., Validations of sensory overall acceptability optimizations on response surface methodology through just-about-right technique for coffee-leaf tea at different brewing methods. Adv. Food Sci. Sustain. Agric. Agroind. Eng. **7**, 20–28 (2024). https://doi.org/10.21776/ub.afssaae.2024.007.01.3

5. R. Surya, D.A. Kumalawati, F. Tedjakusuma, D. Subali, A. Santini, F. Nurkolis, Profiling of consumer perception and acceptance of indigenous *jamu* beverages. Beverages **12**, 46 (2026). https://doi.org/10.3390/beverages12040046
6. Y. Xuan, J. Ren, Z. Chen, D. Shi, Integrated transcriptome and metabolome analyses provide molecular insights into the transition of flower color in the rose cultivar 'Juicy Terrazza'. BMC Plant Biol. **25**, 883 (2025). https://doi.org/10.1186/s12870-025-06794-2
7. X. Su, G. Liu, M. Zheng, X. Li, K. Song, D. Shi, Integrating the dual functionality of plant tannins for natural hair dyeing: A critical review on mechanisms, sustainability and formulation innovation. Color. Technol. **142**, 177–195 (2026). https://doi.org/10.1111/cote.70030
8. Z.-W. Zhou, Q.-Y. Wu, Y. Yang, Q.-C. Hu, Z.-J. Wu, H.-Q. Huang, et al., The dynamic change in fatty acids during the postharvest process of oolong tea production. Molecules **27**, 4298 (2022). https://doi.org/10.3390/molecules27134298
9. C.R. Balcázar-Zumaeta, K. Reyna-Gonzales, D.I. Diaz, A.J. Pajuelo-Muñoz, A.F. Iliquin-Chavez, I. Yoplac, et al., Optimizing roasting time and temperature to enhance the physicochemical properties and retention of bioactive compounds of three *Coffea arabica* subvarieties. Appl. Food Res. **5**, 100987 (2025). https://doi.org/10.1016/j.afres.2025.100987
10. Y. Du, H. Zhang, D.O. Rothenberg, K. Zhang, Y. Lin, K. Jin, et al., Multiomics correlation analysis on the mechanism of flavor substance formation during the processing of "Huanong 53" black tea. LWT **214**, 117086 (2024). https://doi.org/10.1016/j.lwt.2024.117086