**Research Article**

# Privileges of Food Dehydrator-Based Processing in Egg Tea Drinks Production and Qualities

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**Abstract** | Egg tea is a traditional Indonesian drink made from free-range chicken or duck egg yolk, and brewed tea. Egg tea drinks are preferred because of their taste and are thought to provide health benefits. We aimed to determine some instant egg tea drinks qualities, such as the antioxidant, physicochemical, and sensory properties using a food dehydrator that can maintain antioxidant, nutritional, and sensory properties. We employed an *in-vivo* trial with a completely randomized design consisting of five treatments and four replicates. The egg tea was dried using a food dehydrator at 60°C for five different drying times (2, 3, 4, 5, and 6 h). The parameters evaluated were antioxidant activity, energy value, moisture, protein, fat, ash content, solubility, color (L*, a*, b*), and sensory evaluation of hedonic preferences and qualities. The results revealed that different drying times showed significant differences (P<0.05) in antioxidant activity, energy value, protein, fat, ash, moisture content, color (L*, a*, b*), and sensory properties, except for color attributes in the hedonic preference test. The longer the drying time, the lower the antioxidant activity, moisture content, solubility, and color values (a* and b*) and the higher the energy value, protein, fat, ash content, brightness (L*), and hedonic preferences and quality.

**Keywords** | Antioxidant activity, Drying, Egg tea drink, Food dehydrator, Sensory evaluation

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## INTRODUCTION

Eggs are a source of protein at a lower price than meat and milk, have highly digestible protein, and contain all amino acids required by the body. One type of egg with higher nutritional value is duck eggs. Duck eggs have several advantages over poultry eggs, mainly because they have a higher composition of polyunsaturated fatty acids as well as a better ratio of omega 6 and omega 3 fatty acids and essential amino acids (Al-Obaidi and Al-Shadeedi, 2016). Despite these benefits, duck egg consumption is not as widespread as that for chicken eggs. One of the traditional Indonesian drinks that uses duck eggs, especially egg yolks, as the raw material is egg tea. Traditionally, egg tea is a mixture of free-range chicken or duck egg yolk and sugar, which is beaten with a bunch of coconut sticks until frothy, followed by the addition of sweetened condensed milk, brewed tea and lime juice to reduce the fishy odor.

Duck egg yolk contains 41.7% moisture, 2.8% ash, 17.4% protein, and 32.4% fat (Mazanowski *et al*., 2005). The high content of fat, fat-soluble vitamins, and phospholipids, including lecithin, which is an emulsifying agent from egg yolks, causes egg tea to have more specific, distinctive, and preferred taste characteristics. Tea is not only a refreshing and delicious drink, but also has many health benefits, including antioxidant, cardiovascular protection, anticancer, and antimicrobial activities (Zhang *et al*., 2019).

In addition, tea contains various bioactive compounds including alkaloids, free amino acids, peptides, polyphenols, pigments, polysaccharides, and volatile compounds (Lin *et al*., 2021). Therefore, egg tea is one of the traditional drinks consumed to increase energy, maintain eye health, and meet the body's vitamin intake needs. As tea is preferred for consumption, innovation is needed to produce egg tea drinks in the form of instant powders. Choosing the correct drying technique is necessary to maintain the nutritional content of instant egg tea. Both high heating temperatures and long heating times can reduce the nutrient and antioxidant content of instant egg tea. Instant egg tea prepared using a spray dryer (150°C inlet and 58°C outlet) decreased the protein digestibility of egg tea with an increase in the amount of tea used (Yenrina *et al*., 2016).

Drying using a food dehydrator can maintain the nutritional content and taste of egg tea because the temperature can be regulated. Research on drying whole eggs into powder using a dehydrator at 62.8°C is better than commercial ones using a spray dryer (Daramola-Oluwatuyi *et al*., 2021). Thus, we aimed to determine the antioxidant activity, energy value, physicochemical, and sensory properties of instant egg tea drinks using a food dehydrator that might maintain antioxidant levels, nutritional content, and consumer acceptance.

## MATERIALS AND METHODS

### Materials

This study used 150 of 1-day-old Bayang duck eggs obtained from the UPT Faculty of Animal Science, Universitas Andalas (Padang, Indonesia). Black tea was obtained from a black tea manufacturer (Kadjoe Aro Tea, Padang, Indonesia). Other ingredients were used, including maltodextrin, sugar, citric acid, and vanilla powder, all of which were of food-grade quality obtained from local chemical stores (Padang, Indonesia).

### Preparation of instant egg tea

Egg tea was prepared based on Patent number S00202211553 (2022), consisting of extracting black tea, shaking egg yolks, and mixing with other ingredients. The tea extraction process used black tea brewed in hot water at 90°C for 5 min. Subsequently, the tea extract was filtered and the liquid tea extract was used. Homogenized egg yolks were added to the other ingredients and beaten using a hand mixer (Philips HR-1538, China) for 10 min until foam was formed. The mixture was brewed again with hot water (85-90°C). After that, the drying treatment was carried out using a food dehydrator (Kris LT-18, Indonesia) at 60°C with five levels of drying time (2, 3, 4, 5, and 6 h). The instant egg tea formulations are referred to as Patent number S00202211553.

### Antioxidant activity

The di-phenyl-picryl-hydroxyl (DPPH) assay method was used to assess antioxidant activity. About 1 mL of each sample was combined with 1 mL of methanol (Merck, Germany) solution containing 80 ppm DPPH. The liquid was mixed and incubated in the dark for 30 min. A spectrophotometer (Shimadzu UV-1800, Japan) with an absorbance reading of 517 nm was used for measurements. Methanol was utilized as a control (Huang *et al*., 2006).

### Energy value

Energy value measurement was based on the AOAC Method (2005). About 1 g of each sample in pellet form was combusted using an adiabatic oxygen bomb calorimeter (IKA C200, USA), which had a wire inside and was filled with 30 atm/bar oxygen. The initial temperature was recorded and the sample was fired until the temperature increased. The final temperature readings were recorded when the temperature increased and then decreased.

### Proximate composition

The proximate composition was analyzed following the AOAC (2005) procedures. The moisture content was analyzed using an oven, fat content using the Soxhlet extraction, protein content using the Kjeldahl, and ash content using the dry ashing methods.

### Solubility

Solubility was determined following Jouki *et al*. (2021) with slight modifications. Each sample of egg tea powder (5 g) was mixed with water (50 mL) and stirred for 1 min. The mixture was then incubated at 29°C/ 30 min before being centrifuged (Oregon LC-04S, China) at 4000 rpm for 15 min. The supernatant was then placed into a previously weighed container and dried at 103°C. The solubility percentage was obtained by dividing the dry supernatant weight by the initial sample weight. The color test was performed using a Colorimeter (Hunter Lab Color Flex EZ, Germany) according to the Mir *et al*. (2023) method. The test was performed using the Hunter codes L*, a*, and b*, where L* represents brightness, a* represents redness, and b* represents yellowness.

### Sensory evaluation

Hedonic preferences and quality scoring evaluations were performed by 50 untrained panelists following Lawless and Heymann (2010). Hedonic preferences were measured using five hedonic scales: 1 (Strongly dislike), 2 (Dislike), 3 (Neutral), 4 (Like), and 5 (Strongly like) for color, taste, aroma, and texture attributes. The sensory quality was assessed using seven scores for color, taste, aroma, and texture. The color scale included 1 (White to cream), 2 (Light cream), 3 (Cream), 4 (Brownish cream), 5 (Light brown), 6 (Brown), and 7 (Dark brown). The taste scale included 1 (Strongly bland), 2 (Bland), 3 (Slightly bland), 4 (Neutral), 5 (Slightly sweet), 6 (Sweet), and 7 (Strongly sweet). The aroma scale included 1 (Strongly eggy), 2 (Eggy), 3 (Slightly eggy), 4 (Neutral), 5 (Slightly creamy), 6 (Creamy), and 7 (Strongly creamy). The texture scale included 1 (Strongly watery), 2 (Watery), 3 (Slightly watery), 4 (Neutral), 5 (Slightly thick), 6 (Thick), and 7 (Strongly thick). Samples were prepared by brewing egg tea powder (10 g) in 125 mL of water at 80°C and through mixing.

### Data analysis

All analyses were performed in four replication. Data were analyzed using the SPSS software (version 16.0, SPSS Inc., USA). Duncan's multiple range test was used to assess the significance of the differences with 5% level of probability.

## RESULTS AND DISCUSSION

### Antioxidant activity

As shown in Figure 1, the results showed that there was a significant ($P<0.05$) effect of drying time on the antioxidant activity of instant egg tea. The highest antioxidant activity was found in the 2 h drying and the lowest in the 6 h drying. In the present study, a decrease in antioxidant activity was observed with a longer drying process. Drying for 2 h resulted in the highest antioxidant activity, owing to the lowest drying time and vice versa.

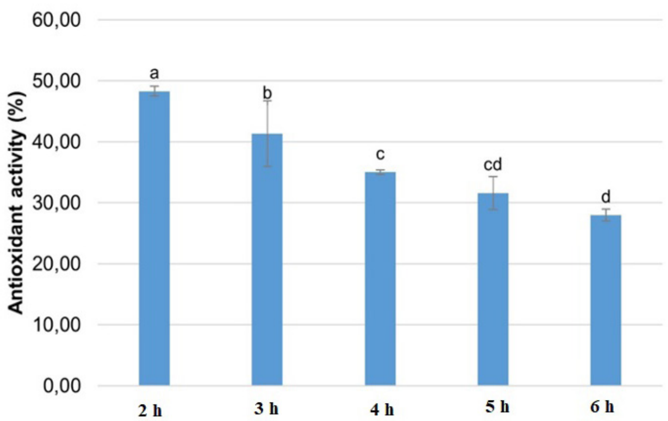


**Figure 1:** Antioxidant activity of instant egg tea powder. Superscripts with letters (a, b, c, d) show significantly different ($P<0.05$).

The decrease in antioxidant activity was influenced by antioxidant compounds which can be damaged by heat during drying. The main antioxidant activity of instant egg tea originates from tea as the raw material. Antioxidant activity is found at high levels in fresh tea but decreases during the processing stage (Kamiloglu *et al*., 2016). This is because antioxidant activity is influenced by phenolic compounds, which are thermolabile and cause damage to antioxidants when exposed to heat during drying (Mahmoudi *et al*., 2016). Drying using hot air at 60°C resulted in a decrease in the total phenol content and antioxidant activity of *Coreopsis tinctoria* flower tea (Miao *et al*., 2022).

Drying causes the degradation of polyphenolic compounds owing to the use of high temperatures for a long time (Tsurunaga *et al*., 2022). Other studies have reported that the main compounds in black tea that act as antioxidants are catechins, oxy-aromatic acid, flavonols, theaflavins, theagalins, thearubigins, pigments such as chlorophyll and carotene, and alkaloids (Yashin *et al*., 2015). In addition to high temperatures, differences in drying methods can affect polyphenol components, particularly catechins and their derivatives (Qu *et al*., 2019). On the other hand, the use of maltodextrin in beverage formulations also affects antioxidant activity, which can maintain the DPPH radical scavenging activity during drying (Nguyen *et al*., 2023).

### Proximate composition and energy value

The moisture, protein, fat, ash content, and energy values of instant egg tea drinks are shown in Table 1. Statistical analysis showed that different drying times had a significant ($P<0.05$) effect on all parameters. In the present study, the longer the drying time resulting in lower moisture content of instant egg tea. Drying for 2 h resulted in a significant ($P<0.05$) difference from drying for 5 and 6 h, but was not significantly different from 3 and 4 h of drying in the moisture content of instant egg tea drink powder. Many studies have reported that a lower moisture content is affected by temperature and drying time (Koç *et al*., 2011; Rannou *et al*., 2015; Yemmireddy *et al*., 2013). The drying time applied to instant egg tea using a food dehydrator produced egg tea powder with low moisture content. This is because the food dehydrator drying system can

**Table 1:** Proximate composition and energy value of instant egg tea powder.

| Drying time (hour) | Moisture (%) | Protein (%) | Lipid (%) | Ash (%) | Energy (kcal/g) |
|---|---|---|---|---|---|
| 2 | $2.91±0.26^{a}$ | $12.18±0.15^{e}$ | $9.57±5.20^{b}$ | $1.18±0.03^{c}$ | $4.50±0.1^{a}$ |
| 3 | $2.79±0.24^{a}$ | $14.52±0.25^{d}$ | $12.70±0.67^{ab}$ | $1.15±0.10^{c}$ | $4.56±0.05^{b}$ |
| 4 | $2.53±0.11^{ab}$ | $15.71±0.17^{c}$ | $13.92±0.70^{a}$ | $1.49±0.03^{b}$ | $4.66±0.14^{c}$ |
| 5 | $2.23±0.19^{bc}$ | $16.73±0.17^{b}$ | $13.39±0.77^{a}$ | $1.61±0.03^{b}$ | $4.69±0.04^{cd}$ |
| 6 | $2.07±0.47^{c}$ | $17.45±0.14^{a}$ | $15.32±0.59^{a}$ | $1.79±0.19^{a}$ | $4.83±0.07^{d}$ |

*Superscripts with letters (a, b, c, d) that are different in the treatment, show significantly different ($P<0.05$).

stabilize heat throughout the surface with even heat distribution, so that the water molecules in the dried egg tea evaporate properly. The moisture content of instant egg tea drink powder meets the regulatory requirements based on Regulation no. 01-4320-1996 of the National Standardization Agency of Indonesia, where the powder drink category has a maximum moisture content of 3%. Moisture content is an important parameter for drying products, serving for product storage stability (Dantas *et al*., 2018).

In terms of protein and fat content, the results showed a significant (P<0.05) difference in protein content for each drying time treatment. Different aspects of the fat content, drying for 4 to 6 h, produced a fat content that was not significantly different. Overall, the protein and fat content in this study increased with the length of drying time, which following Park and Kim (2023) and Mikami *et al*. (2021), the more evaporated water molecules cause an increase in protein and fat content of materials. This may be related to an increase in the total solid content of the material. The protein and fat contents in this study were much lower than those in egg yolk powder reported by Gu *et al*. (2021) (30.89% and 58.26%, respectively). This may be due to the use of other ingredients, such as tea extract, sugar, and maltodextrin, in the instant egg tea formulation. The average ash content of instant egg tea drink powder at different drying times showed a significant (P<0.05) effect between different drying times of instant egg tea. Based on Regulation no. 01-4320-1996 from the National Standardization Agency of Indonesia, instant powder drinks have a maximum ash content of 1.5%, therefore only drying treatments for 2, 3, and 4 h meet these requirements.

Regarding the energy value of instant egg tea drink powder, the difference in drying time showed a significant (P<0.05) effect on the energy value of instant egg tea. The energy value of the 2 h drying time was not significantly different from those of the 3 and 4 h drying times, but was significantly (P<0.05) different from those of the 5 and 6 h drying times. In this study, the energy value of instant egg tea drink powder increased with longer drying time. This was because of the higher levels of protein, fat, and carbohydrates in instant egg tea drink powder. The energy value is closely related to the fat, carbohydrate, and protein contents of the ingredients. A high-fat content in a food or drink will provide a high energy value. However, if it has a high moisture content, it can reduce the energy value of food or drinks, even though it still has a high-fat content (Rolls, 2009). Based on the results, the increase in energy value of instant egg tea was in line with the increase in fat content and decrease in moisture content of instant egg tea drink powder, and it was found that the energy value of instant egg tea with 6 h of drying time had the highest energy value (4.83 ± 0.15 kcal/g) and was consistent with the fat and protein content of the treatment.

Egg yolks provide calories of around 3.2 kcal/g (Iannotti *et al*., 2014), while in this study the energy value ranged from 4.5 -4.8 kcal/g. The energy value of instant egg tea in this study was derived not only from egg yolks but also from other ingredients, such as sugar.

## Solubility

Based on Table 2, it can be seen that the average solubility of instant egg tea with different drying times had a significant (P<0.05) effect except for drying 4 and 5 h. The decrease in solubility with drying time could be due to the characteristics of the powder of the resulting product, which was drier and took longer to undergo wetting to dissolve in water. The solubility of instant powders depends on the drying method and ingredients added (Hariadi *et al*., 2023; Shittu and Lawal, 2007). Egg yolk powder itself has poor solubility properties owing to its high-fat content, which ranges from 12-14% (Anton, 2013; Su *et al*., 2020). The longer the drying time for instant egg tea powder, the lower the solubility. The effect of drying time on solubility showed that longer egg tea powder was exposed to the heat of drying, which resulted in the evaporation of moisture and increased the concentrations of protein, fat, and ash.

**Table 2:** The solubility value of instant egg tea powder.

| Drying time (hour) | Solubility (%) |
|---|---|
| 2 | 73.40±0.37$^{a}$ |
| 3 | 72.11±0.07$^{b}$ |
| 4 | 71.50±0.16$^{c}$ |
| 5 | 71.27±0.19$^{c}$ |
| 6 | 70.66±0.26$^{d}$ |

*Superscripts with letters (a, b, c, d) that are different in the treatment, show significantly different (P<0.05).

**Table 3:** Average values of Lightness (L*), redness (a*) and yellowness (b*) of instant egg tea drink powder.

| Drying time (hour) | Lightness (L*) | Redness (a*) | Yellowness (b*) |
|---|---|---|---|
| 2 | 51.38±0.78$^{e}$ | 16.56±0.84$^{a}$ | 40.16±0.48$^{a}$ |
| 3 | 52.12±0.09$^{d}$ | 14.91±0.29$^{b}$ | 39.06±0.10$^{b}$ |
| 4 | 53.90±0.06$^{c}$ | 16.60±0.05$^{a}$ | 38.34±0.40$^{c}$ |
| 5 | 59.57±0.23$^{b}$ | 14.25±0.31$^{b}$ | 37.76±0.27$^{c}$ |
| 6 | 60.71±0.24$^{a}$ | 13.28±0.73$^{c}$ | 34.63±0.35$^{d}$ |

*Superscripts with letters (a, b, c, d) that are different in the treatment, show significantly different (P<0.05).

## Color (L*, a*, b*)

The color analysis of the instant egg tea drink powder is shown in Table 3. The L*, a*, and b* values of instant egg tea were significantly (P<0.05) affected by drying time. As long as drying was performed on instant egg tea powder, the higher the L* value, the lower the a* and b* values, indicating that a longer drying time resulted in a brighter color but lowered the redness and yellowness values of instant egg tea powder. Egg yolk is one of the main ingredients of instant egg tea and has been reported by Gu *et al*. (2021) to have L*, a*, and b* values of 82.2 ± 0.45, 9.3 ± 0.06, and 51.55 ± 0.48, respectively.

Visually, the resulting instant egg tea appears brown owing to the formation of a browning reaction due to drying heat. Browning reactions can occur because of the long heating time during the drying process of egg tea (Wang *et al*., 2022), therefore, heating time is a factor that causes the browning reaction.

### Sensory evaluation

The hedonic preferences and sensory quality results for the sensory properties of instant egg tea powder assessed on 50 untrained panelists are shown in a spider web diagram (Figures 2 and 3). The difference in drying time showed a significant ($P<0.05$) difference in taste, aroma, texture, and overall attributes, but did not show a significant difference in color. A longer drying time gave the aroma and overall preference for panelists tended to prefer. For taste and texture attributes, increasing the drying time up to 5 h gave a value that tended to be preferred by panelists, but then decreased at 6 h drying time. Regarding the sensory qualities of instant egg tea, drying time had a significant ($P<0.05$) effect on the attributes of color, taste, aroma, and texture.

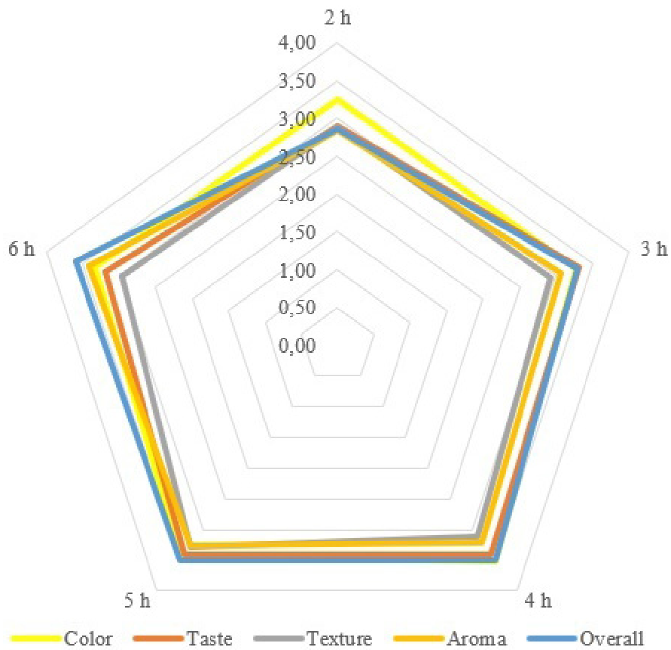


**Figure 2:** Hedonic evaluation of instant egg tea powder.

The insignificant effect on the color of instant egg tea powder in the hedonic evaluation correlated with the drying treatment received for each sample, which was due to the same brownish color effect for each treatment. The sensory quality results also showed that instant egg tea had a brownish cream to light brown color. This brownish color was dominated by the color of the tea solution, which was used in the same amount; therefore, it did not affect the color. Theaflavins, thearubigins, and theabrownins are important components that provide color and taste to black tea liquor, which produces bright, red, and dark colors (Wang *et al*., 2022).

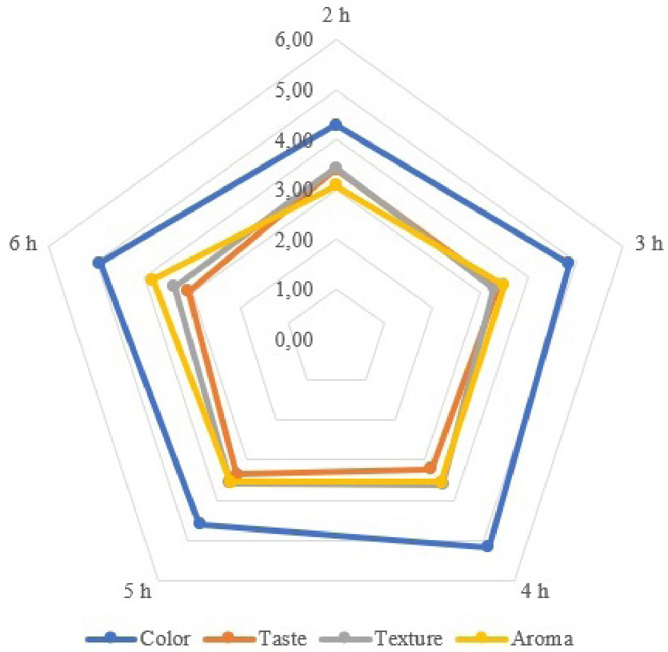


**Figure 3:** Sensory qualities of instant egg tea powder.

The taste of instant egg tea powder is related to the aroma formed during drying, which is caused by the Maillard reaction. The drying process increases the odor and flavor changes caused by the Maillard reaction (Xiang *et al*., 2021). However, the low preference for hedonic value for the taste attribute may be related to the low-fat content of instant egg tea powder. A salted egg oven temperature study found that high moisture content in salted eggs resulted in decreased fat solids, which reduced the taste of salted eggs (Novia *et al*., 2011). This is also indicated by the sensory quality results, which indicate a slightly bland taste.

The drying time could not remove the egg aroma and was shown by the slight eggy results in sensory quality evaluation. However, the lack of a creamy tea aroma may be caused by the evaporation of the volatile content in the tea over the duration of drying (Wang *et al*., 2022). The missing tea aroma content in powdered egg tea production is the result of a lack of volatile content due to the long drying time, therefore the egg odor is not covered. The increase in texture value along with the drying time of egg tea was related to the solubility of the instant powder when dissolved, which had an average of 70% and was preferred by panelists based on its sensory quality.

## CONCLUSIONS AND RECOMMENDATIONS

Preparing instant egg tea powder using a food dehydrator with different drying times has a significant effect on antioxidant activity, proximate composition, energy value, solubility, color (L*, a*, b*), and sensory evaluation. A longer drying time can increase protein, fat, ash, energy value, and brightness (L*), while decreasing antioxidant activity, moisture content, solubility, and a* and b* values. The stability of instant egg tea powder during storage remains unknown. Therefore, it will be necessary in further studies to test the stability of instant egg tea powder to determine product quality during storage.

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## NOVELTY STATEMENT

This study introduces a novel approach for the preparation of instant egg tea drinks by utilizing a food dehydrator to investigate the impact of different drying times on instant egg tea drink qualities and provides valuable insights for optimizing the quality of egg tea, highlighting the nuanced relationship between processing duration and beverage characteristics. This contributes to advancements in the production of this traditional Indonesian drink.

## AUTHOR'S CONTRIBUTION

The authors collaboratively engaged in executing experimental trials, conducted statistical analyses, and played essential roles in composing and revising the manuscript.

### Conflict of interests

The authors have declared no conflict of interest.

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