Andaliman spice coffee as functional drink

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Keywords:

Coffee
Andaliman
Antioxidant
Acid
Sensory

Article history:

Received 21.09.2024
Received in revised form 19.12.2024
Accepted 31.12.2024

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DOI:
10.24263/2310-1008-2024-12-2-8

Abstract

Introduction. To increase the health benefits of traditional foods, it is advisable to add spices to them. The aim of this study was to fortify coffee with Andaliman powder, evaluate the changes in antioxidant activity, total dissolved solids, and total acid content of fortified coffee, and evaluate its sensory properties.

Materials and methods. Ground Robusta coffee and Andaliman powder were the main materials in the study. DPPH method was used to determine antioxidant activity; content of total dissolved solid was measured using a refractometer; content of total acid by the titration method; sensory properties by a scoring method by testing quality attributes such as color, aroma, taste, and overall.

Results and discussion. The treatment given was 10 g of robusta coffee powder and 15 g of palm sugar with the addition of 0% (P0), 5% (P1), 10% (P2), and 15% (P3) of andaliman spice powder. The data from the antioxidant activity test were analyzed descriptively, the total dissolved solids and total acid test data were analyzed using Analysis of Variance (ANOVA) with a significant level of 5%, and the data from the sensory test was analysed by the Kruskal Wallis nonparametric test with a significant level of 5%.

Along with the increased of added of Andaliman powder to ground Robusta coffee from 0 to 15%, antioxidant activity of Andaliman spice coffee has increased 66.66 to 75.03 %, content of the total dissolved solids increased from 12.12%Brix to 12.41%Brix, content of total acids from 0.13% to 0.25%, showing a real difference ($p \leq 0.05$).

The addition of andaliman powder does not change the color of the coffee brew, but the aroma produced in the coffee brew is the typical aroma of Andaliman. The level of acceptance of the panelists to the product as a whole is influenced by the color, aroma, and taste. The overall test showed that P2 was preferred by the panellists, this is because P2 has a strong coffee color, a strong andaliman aroma, and a bitter taste that is not too dominant.

Conclusion. The addition of andaliman powder to coffee increased its antioxidant activity, content of total dissolved solids and total acids. The best option for Andaliman spice coffee as a functional drink is coffee with 10% andaliman powder added.

Introduction

Indonesia is a country with abundant and diverse natural resources. Among the agricultural crops grown in Indonesia, coffee production is an extremely important and plays a significant role in agrobusiness. Indonesia was the fifth largest coffee producer in 2023 after Brazil, Vietnam, Colombia, and Ethiopia, producing 8.15 million of 60 kg bags that consisted 5% % of Global Production (USDA, 2023).

Coffee is one of the beverage products that is very popular with the public because it can have the effect of relieving drowsiness, giving a delicious sensation, soothing, relieving stress and improving focus. There are two types of coffee currently cultivated in Indonesia, namely Robusta coffee and Arabica coffee. The production of Robusta coffee reached 80.4% or more than 601,000 tons and the production of Arabica coffee reached 19.6% or more than 147,000 tons (Yuhendra and Pebrian, 2023). Coffee beans contain chemical compounds such as caffeine, chlorogenic acid, carbohydrates, fats, organic acids, amino acids, and volatile compounds (Mahriani et al., 2020; Stabnikova and Paredes-Lopez, 2024). Chlorogenic acid ($C_{16}H_{18}O_9$), the main phenolic component in coffee, and caffeine ($C_8H_{10}N_4O_2$) are considered to be the major components, giving coffee of its beneficial effects.

Generally, coffee beans are processed into powder and brewed with hot water and added sugar as a sweetener. However, processed coffee products are still not fully usable by the community, so it is necessary to innovate or develop processed products. Spiced coffee is one of the innovation opportunities, because spiced coffee has many benefits and can be used as a functional drink.

Addition of spices in form of powder or extracts in preparation of different traditional food products is well known trend having the aim to improve their health value (Aminzare et al., 2015; Khareba et al., 2021; Kochubei-Lytvynenko et al., 2022; Stabnikova et al., 2021).

Functional beverages are beverages that contain nutrients and have physiological properties that are beneficial to the human health (Batubara and Pratiwi, 2018). Spiced coffee, a mixture of coffee powder and spice powder, can be one such functional beverages. Spices added to coffee are natural ingredients that contain bioactive compounds that are essential for well-being (Hanif et al., 2020). Innovation in the preparation of spiced coffee aims to produce new flavours and aromas, enrich the properties of coffee, and impart health benefits to it (Junianda et al., 2023). Andaliman is one of the spices that can give a unique flavor and aroma to coffee and may provide health benefits when consuming this fortified beverage.

Andaliman (*Zanthoxylum acanthopodium* DC), also known as Batak peppercorn, is one of the typical spices of North Sumatra that is often used as a spice for Batak cuisine in food processing. Andaliman contains antioxidant compounds, such as phytosterols, carotene, tannins, alkaloids, and flavonoids that can act as free radical scavengers (Adrian et al., 2023). Andaliman spice is useful for nourishing the body, has a warming effect, can be used in traditional medicine for fever and stomach pain, and can relieve mild illnesses such as stomach colic, coughs, flu, and fever (Silalahi et al., 2018; Turnip et al., 2024).

In addition, andaliman is also useful as a medicinal plant, antibacterial and has an attrition oil content. Product development is needed in order to improve product quality, so that the products produced have a selling value and there is an improvement in product quality. Robusta coffee with the addition of andaliman spice powder can be one of the alternative products that can maintain the distinctive taste and aroma of coffee and provide functional benefits for the body. The purpose of the research conducted is to produce spice coffee innovations and determine the antioxidant activity, total dissolved solids, total acid, and sensory activity in coffee with the addition of andaliman spice as a functional drink. The

benefit of this study is to provide information about the addition of spices to coffee and increase the functional value of spice coffee products that can have health effects.

Materials and methods

Materials

The material used in this study is ground robusta coffee with the brand Pure Coffee Powder from Humbang Hasundutan Regency, North Sumatra. Andaliman powder with a healthy palm brand and palm sugar with the Dari Bumi brand were obtained from Shopee.

Methods

Making Andaliman spice coffee

Coffee with spices "Andaliman" was prepared as follows: 150 ml of mineral water was boiled, cooled to 90 °C, and 10 g of coffee powder "Robusta" was added, to which "Andaliman" powder was previously added in the amount of 0% (P0), 5% (P1), 10% (P2) and 15% (P3), as well as 15 g of palm sugar.

Antioxidant activity test

The antioxidant activity of spice coffee was determined according to (Rabani and Fitriani, 2022). Antioxidant activity testing was carried out by the 2,2-diphenyl-2-picrylhydrazyl (DPPH) method. 0.05 mM DPPH solution was prepared by dissolving 15.8 mg of DPPH with 100 ml of methanol as a raw solution. 1 ml of the solution is mixed with a sample of 2 ml. Blanks were made by adding 1 ml of DPPH 0.05 mM with 4 ml of methanol p.a. The solution was homogenized and left for 30 minutes in a dark room or place. The test was carried out using a UV-Vis spectrophotometer with a wavelength of 520 nm.

Total dissolved solids test

The total dissolved solids (TDS) test refers to (Bayu et al., 2017). TDS was measured using refractometer. The sample was taken as much as one drop and dripped onto a prism refractometer that has been calibrated using sterile aquades and wiped with a soft cloth. Then the refractometer was directed at the light source. The value indicated on the refractometer indicated the amount of TDS in the sample in degrees Brix.

Total acid test

The total acid test by the titration method is an analysis of the large amount of acid contained in a solution. Total acid testing refers to (Kasim et al., 2020). The total acid test begins with filtering using filter paper, then continues the dilution process, especially so that the color of the tested sample is not too dark. Dilution is carried out by dissolving 10 ml of sample solution on a 100 ml measuring flask and adding with aquades until it reaches the miniscus line. Then the solution is taken in the amount of 10 ml and put into the erlenmeyer. 1% PP (*Phenolphtelain*) solution is added as many as 2 drops to the sample solution and titrated by slowly opening the valve on the burette so that the 0.1 N NaOH alkaline solution is mixed with the sample, then waited until it changes color to reddish. The required NaOH

volume is recorded. The percentage of total acid content is calculated using the following formula:

$$Total\ acid\ (\%) = \frac{\text{Volume titran} \times \text{N} \times \text{P} \times \text{Mr Acid}}{\text{Volume sampel} \times 1000} \times 100\%$$

where N is normality of titran,
P is a dilution multiplier factor,
Mr. Acid is a molecular weight of acid (g/mol) (chlorogenic acid = 354)

Sensory test

Sensory testing refers to modified research (Nurhayati, 2017), which is carried out using a scoring method by testing quality attributes such as color, aroma, taste, and overall. The test was carried out by 25 semi-trained panelists with samples brewed using hot water and placed in containers that have been given codes. Then the panelists will fill out the test format sheet by providing an assessment in the form of checklist marks on the available table columns. The color test was carried out on an assessment scale consisting of 4 levels, namely: (1) light, (2) slightly dark, (3) dark, (4) very dark. The testing of aroma parameters was carried out on an assessment scale consisting of 4 levels, namely (1) not typical of andaliman, (2) somewhat typical of andaliman, (3) typical of andaliman, (4) very typical of andaliman. The taste parameter test was carried out with an assessment scale consisting of 4 levels, namely (1) not bitter, (2) slightly bitter, (3) bitter, (4) very bitter. The overall parameter testing was carried out on an assessment scale consisting of 4 levels, namely (1) very disliked, (2) disliked, (3) liked, (4) strongly liked.

Data analysis

The data from the antioxidant activity test results were analyzed descriptively. The total dissolved solids and total acid content test data were analyzed using Analysis of Variance (ANOVA) with a significant level of 5% and will be continued with the Duncan Multiple Range Test (DMRT) if there is a real effect between treatments ($p \leq 0.05$). The data from the sensory test results were analyzed by the Kruskal Wallis nonparametric test with a significant level of 5% followed by Mann-Whitney if there was a real influence between treatments ($p \leq 0.05$). All data was analysed using the SPSS for Windows 26.0 application.

Results and discussions

Antioxidant activity

The data displayed is a test of 4 treatments, namely P0 (0%) without the addition of andaliman, P1 with the addition of 5% (0.5 g) of andaliman powder, P2 with the addition of 10% (1 g) of andaliman powder), and P3 with the addition of 15% (1.5 g) of andaliman powder (Table 1).

Table 1

Andaliman spice coffee antioxidant activity

Sample	Andaliman powder (%)	Inhibition (%)
P0	0	69.66±0.35[a]
P1	5	71.04±0.35[a]
P2	10	71.85±0.27[b]
P3	15	75.03±1.77[c]

Note:
Data displayed in average form ± standard deviation;
Different lowercase superscripts show real differences ($p \leq 0.05$)

Antioxidant activity of Andaliman spice coffee has increased along with the increased addition of andaliman. The highest antioxidant activity was observed for P3 with the addition of andaliman by 15% (1.5 g), which was 75.03%, while the lowest antioxidant activity was produced at P0 without the addition of andaliman, which was 69.66%. This happens because the Andalim spice (*Zanthoxylum acanthopodium*) contains active compounds such as alkalis, tannins, flavonoids, terpenoids, saponins, and phenols that can act as antioxidants. Andaliman fruit contains active compounds of anticocidiants with an IC50 value of 66.91 bpj/ppm (Winarti et al., 2018). Coffee has antioxidants obtained from polyphenol compounds (chlorogenic acid and caffeine) as well as melanoidin (Liczbinski and Bukowska, 2022). In addition, the addition of palm sugar to coffee can also increase antioxidant levels in spice coffee derived from melanoidin compounds (South et al., 2020).

Total dissolved solids

Content of total dissolved solids in Andaliman spice coffee samples is shown in Table 2.

Table 2

Total dissolved solids content in Andaliman spice coffee

Sample	Andaliman powder (%)	Total dissolved solids (%Brix)
P0	0	12.12 ± 0.08[a]
P1	5	12.24 ± 0.05[b]
P2	10	12.38 ± 0.08[c]
P3	15	12.42 ± 0.08[c]

Note:
Data displayed in average form ± standard deviation;
Different lowercase superscripts show real differences ($p \leq 0.05$)

Based on Table 2, the total dissolved solids in P0 have an average of 12.12 %Brix, in P1 have an average of 12.24 %Brix, in P2 have an average of 12.38 %Brix, and in P3 have an average of 12.42 %Brix. The highest total dissolved solids of spice coffee were found in P3, which was 12.42 %Brix, while the lowest was found in P0, which was 12.12 %Brix. The total dissolved solids test in each treatment has increased not too high. However, the more

andaliman powder is added to coffee, the more the total value of dissolved solids tends to increase. Total dissolved solids is a measure of substances that can be dissolved in water (organic and inorganic substances) (Nurhayati, 2017). Coffee contains sucrose, chlorogenic acid, caffeine, and organic acids such as lactic acid, citric acid, and malic acid, which can increase the total dissolved solids. Andaliman contains several compounds that can be dissolved in water, namely flavonoids, tannins and saponins (Salim, 2024). In addition, the addition of palm sugar to spice coffee brewing affects the total dissolved solids produced because sugar contains sucrose and reduced sugars such as glucose and fructose (Purba et al., 2021).

Total acid content

Total acid content in Andaliman spice coffee is shown in Table 3.

Table 3

Total acid content in Andaliman spice coffee

Sample	Andaliman powder (%)	Total acid (%)
P0	0	0.49 ± 0.19^{a}
P1	5	0.57 ± 0.19^{ab}
P2	10	0.84 ± 0.19^{bc}
P3	15	1.00 ± 0.30^{c}

Note:
Data displayed in average form ± standard deviation;
Different lowercase superscripts show real differences ($p \leq 0.05$)

Based on Table 3, it was obtained that the total acid yield in P0 had an average of 0.49%, in P1 it had an average of 0.57%, in P2 it had an average of 0.84%, and in P3 it had an average of 1.00%. The highest total dissolved solids of spice coffee are found in P3, which is 1.00% while the lowest is found in P0, which is 0.49%. The data on the results of the total acid test in each treatment experienced a not too high increase. However, the more andaliman powder is added to coffee, the more the total acid value tends to increase. According to Kasim et al. (2024) Total titrated acid is the number of acid components contained in a solution. Andaliman has an acid content that can affect the total acid of spice coffee products, namely ascorbic acid or vitamin C (Wira et al., 2024). Andaliman also contains phenolic acids (polyphenols, phenols) and carboxylic acids which have acidic properties and are also aromatic acid compounds. Coffee contains chlorogenic acid, oxalic acid, lactic acid, acetic acid, citric acid, and formic acid. In addition, palm sugar also contains organic acids such as acetic acid, lactic acid, malic acid, and ascorbic acid (Suharto et al., 2021).

Sensory evaluation

Based on the results of sensory testing with the Kruskal Wallis test, it was shown that the addition of andaliman powder to coffee for color parameters had no real effect ($p \geq 0.05$), while for aroma, taste and overall parameters had a real effect ($p \leq 0.05$) (Table 4).

Table 4

Andaliman spice coffee sensory test

Sample	Andaliman powder (%)	Color	Aroma	Taste	Overall
P0	0	3.00±0.87	1.44±0.71^{a}	212±0.88^{a}	2.96±1.01^{a}
P1	5	2.76±0.88	2.20±0.82^{b}	2.56±0.82^{ab}	2.40±0.76^{b}
P2	10	2.9±0.81	2.68±0.85^{c}	2.64±0.91^{b}	3.00±0.71^{a}
P3	15	3.00±0.82	3.08±1.08^{cd}	2.96 ± 0.89^{b}	2.52±1.00^{ab}

Note: Data displayed in average form ± standard deviation

The color in the Andaliman coffee brew is dominated by the dark (black) color of the coffee and the addition of andaliman powder does not change the color of the coffee brew. The aroma produced in the coffee brew is the typical aroma of Andaliman. This happens because andaliman is a plant that contains aromatic compounds. The aroma of Andaliman comes from essential oils as well as linalool and limonene compounds (Meutia et al., 2015). The brewing coffee has a bitter taste. Coffee has a distinctive bitter taste that comes from chlorogenic acid and caffeine while andaliman has a bitter and spicy taste similar to orange and can stimulate the secretion of saliva (saliva) derived from the content of essential oils (Permana et al., 2021). The level of acceptance of the panelists to the product as a whole is influenced by the color, aroma, and taste. The overall test showed that P2 was preferred by the panellists, this is because P2 has a strong coffee color, a strong andaliman aroma, and a bitter taste that is not too dominant.

Conclusions

Based on the results of the study, it can be concluded that the addition of andaliman powder has an effect on antioxidant activity, total dissolved solids, and total acid content. The best option for andaliman spice coffee as a functional drink is coffee with 10% andaliman powder added.

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Cite:

UFJ Style

Manullang B.M., Pramono Y.B., Kamil R.Z. (2024), Andaliman spice coffee as functional drink, *Ukrainian Journal of Food Science*, 12(2), pp. 175–183, https://doi.org/10.24263/2310-1008-2024-12-2-8

APA Style

Manullang, B.M., Pramono, Y.B., & Kamil, R.Z. (2024). Andaliman spice coffee as functional drink. *Ukrainian Journal of Food Science*, *12*(2), 175–183. https://doi.org/10.24263/2310-1008-2024-12-2-8