

Physicochemical, Sensory, and LCMS Profiles of Cascara Tea combined with Dayak Onion and Stevia

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ABSTRACT

The increasing utilization of coffee husk waste has opened up new opportunities for the development of innovative beverages by processing it into cascara tea. Cascara and its brew have the potential to be natural antioxidants because they contain secondary metabolites such as polyphenols. This study aims to examine the development, quality characteristics, and sensory properties of herbal tea based on a combination of cascara, Dayak onion bulbs, and stevia formulations, as well as to obtain the optimal formulation combination and identify the chemical compound profile using LCMS. This study used a completely randomized design analyzed statistically using Analysis of Variance (ANOVA) and followed by Duncan's New Multiple Range Test (DNMRT). Differences in the concentrations of Dayak onion and stevia affected the characteristics of water content, ash content, pH value, polyphenol content, and hedonic tests of color, aroma, and taste in cascara tea combined with Dayak onion and stevia. The optimal formulation was found in formula D (60% cascara: 20% Dayak onion: 20% stevia). The results of compound profile identification in the optimal formula using LCMS included anthranilic acid, DL-Tryptophan, chlorogenic acid, quercetin, rutin, and trans-resveratrol. The addition of stevia improved the aroma and taste of the tea infusion, with a hedonic aroma score of 3.48 (normal/acceptable) and a taste score of 3.65 (liked).

Key words: Antioxidant activity; coffee skin utilization; innovative beverage formulations; LCMS profile; sensory evaluation.

1 INTRODUCTION

Coffee is one of the world's leading commodities in terms of revenue, second only to petroleum, and is consumed by about one-third of the world's population (International Coffee Organization - ICO, 2019). Indonesia is the fourth largest coffee producer in the world after Brazil, Vietnam, and Colombia. According to data from the Indonesian Central Statistics Agency, total national coffee production in 2024 will reach 807,580 tons. High coffee production will increase the amount of coffee husks left over from coffee processing. Coffee husks are often considered to be of no economic value, so they are often discarded or simply used as compost. However, coffee husks contain bioactive compounds that have the potential to be used in value-added products.

In recent years, the nutraceutical potential of coffee husks has gained scientific attention. Coffee husks not only contain five major nutrient groups, namely protein, carbohydrates, lipids, minerals, and dietary fiber, but also exhibit significant antioxidant activity (Neves et al., 2019). In-depth biochemical characterization indicates that this antioxidant activity mainly comes from the presence of various phenolic compounds, including flavonoids and other polyphenols (Cangussu et al., 2021). Among these bioactive compounds, chlorogenic acid and anthocyanins are two of the most widely studied phytochemicals and have been reported to have various beneficial effects on human health, particularly in relation to their antioxidant properties (Naveed et al., 2018).

One of the most popular uses lately is processing coffee husks into innovative beverages, namely cascara tea, which is refreshing and beneficial for the body. Cascara tea can be combined with various other plants, one of which is Dayak onion bulbs. Hasni et al. (2022) conducted research combining cascara with Dayak onion bulbs and found the best treatment based on consumer assessment to be the K3 formulation: 60% cascara and 40% Dayak onion. Dayak onion bulbs are reported to contain flavonoids and have the potential to be used as a hypertension medication. Flavonoid compounds can reduce cholesterol levels, prevent blood vessel blockages, and improve blood circulation so that blood flows normally (Setyawan, 2019). Additionally, the active compounds of flavonoids, alkaloids, and glycosides in Dayak onion also play a role in anti-diabetes by controlling blood sugar levels and optimizing pancreatic function (Hasni et al., 2019).

Hidayat et al. (2018) processed Dayak onion into tea and tested the panelists level of liking for the Dayak onion tea, obtaining a score of 2.4 (tending to dislike) due to its bitter taste. Dayak onion bulbs are reported to be useful for preventing and alleviating complaints caused by degenerative diseases, but their bitter taste causes consumers to dislike the brew made from Dayak onion bulbs. The cascara and Dayak onion tea formulation can be combined with stevia leaves (*Stevia rebaudiana* L.), which contain *glycoside* compounds that provide sweetness without producing calories. The main *glycoside* components in stevia plants are *stevioside* and *rebaudioside*, which are formed from a combination of different sugar molecules. The most commercially used

glycoside is stevioside, which has a sweetness level 250–300 times higher than regular sugar. In addition, stevia leaves also contain various nutrients, including protein, fiber, carbohydrates, phosphorus, potassium, calcium, magnesium, sodium, iron, vitamin A, vitamin C, and oil (Buchori, 2007).

This study will examine the quality characteristics of herbal tea based on a combination of cascara, Dayak onion bulbs, and stevia formulations. Tea quality is assessed based on its brew, both sensorily and in terms of its chemical compounds (Hasni et al., 2022). In addition, this study aims to obtain the optimal formulation combination and identify the chemical compound profile using LCMS, where LCMS (Liquid Chromatography Mass Spectrometer) is a high-accuracy analysis technique used for qualitative and quantitative analysis and can provide information in the identification of a metabolite (Sumartini, Ikrawan & Muntaha, 2020). Chromatography is a method of separating analytes contained in a liquid or gas mobile phase, which is then passed through a stationary phase. Each component of the sample elutes from the stationary phase at a specific retention time. When the components pass through the detector, the signal is recorded and plotted in the form of a chromatogram (Manini, Andreoli & Niessen, 2004).

2 MATERIAL AND METODS

2.1 Materials and Tools

The main raw materials used in this study were cascara from Arabica coffee husks and Dayak onions from Sialaman Village, South Tapanuli Regency, as well as commercial dried stevia from Seduh Tea and Tisane, Bekasi. Other materials used were tea bags and water. The chemicals used for the chemical tests were quercetin, ethanol, AlCl_3 , $\text{CH}_3\text{COO-Na}$, gallic acid, methanol, Follin-Ciocalteu reagent, acetonitrile, 0.1% Na_2CO_3 formic acid, and DPPH (2,2-diphenyl-1-picrylhydrazyl). The sensory test material used was mineral water.

The tools used in this study were porcelain dishes, spoons, 60-mesh sieves, basins, blenders, knives, label paper, beaker glasses, analytical scales, buckets, pulpers, pH meters, filter, gas stove, electric stove, glass, test tube, micropipette, watch glass, spatula, 50 mm funnel pipette, 10 ml measuring flask, 100 ml measuring flask, oven, furnace, Taffware Ultrasonic 40 KHz ultrasonic bath, Whatman No. 42 filter paper, Agilent Technologies Cary 8454 UV-Vis spectrophotometer, Shimadzu LCMS 9050, sensory test code paper, and sensory test evaluation forms.

2.2 Methods

2.2.1 Research Design

This study used a completely randomized design (CRD) with 6 treatments and 3 replicates, resulting in 18 experimental

units. The percentage of cascara used was 60%, referring to the best treatment from the study by Hasni et al. (2022). The treatments for the different percentages of Dayak onion and stevia were as follows: A = 40%:0%, B = 30%:10%, C = 25%:15%, D = 20%:20%, E = 15%:25%, F = 10%:30% (Hasni et al., 2022). The data obtained were statistically analyzed using analysis of variance (ANOVA), and if the F-test result was significant, it was followed by Duncan's Multiple Range Test (DMRT) at a 5% level.

2.2.2 Preparation of Cascara Powder

The cascara production process refers to the research by Muzaifa et al. (2019), in which the coffee fruit skin used was fresh, newly harvested, ripe coffee fruit characterized by its red color. The coffee fruit was ground using a pulper machine to separate the fruit skin from the coffee beans. The coffee skin was placed in plastic and fermented anaerobically for 12 hours. Anaerobic fermentation is carried out to encourage the formation of organic acids such as chlorogenic acid, oxalic acid, formic acid, acetic acid, and citric acid, which play a role in increasing and decreasing the pH and giving a sour taste to cascara tea (Oktaviani et al., 2020). The skins are then rinsed with clean water and drained, then dried in the sun for approximately 4 days, characterized by their brittleness. They are then ground with a blender and filtered using a 60mesh sieve.

2.2.3 Preparation of Dayak Onion Powder

The process of making Dayak onion powder refers to the research of Duweini and Tribaditia (2017), for the initial stage, the separation between the stems and bulbs of Dayak onions is carried out. The bulbs that have been separated are peeled off the outer skin then washed thoroughly with running water and drained. Furthermore, the Dayak onion bulbs are thinly sliced. This is to facilitate the drying process. Drying is done by sunlight for ± 2 days (Saragih, Hanif & Emmawati, 2019). Furthermore, the dried bulbs were pollinated using a blender and sieved with a size of 60 mesh.

2.2.4 Preparation of Stevia Powder

The stevia leaf raw material is obtained in a dry state, so the drying stage of stevia to reduce moisture content can be skipped. Stevia is first sorted from twigs, gravel, blackened leaves and other impurities. Then the stevia leaves are blended and filtered using a 60mesh sieve.

2.2.5 Formulation of Tea Bags

The process of making a combination of cascara powder, Dayak onion, and stevia is packaged in a tea bag (paper tea bag). Each is weighed according to the treatment with a total weight of 5 grams (Septiwi, Ratnasari & Handayani, 2019). Then it is sealed by tying the tea bag string tightly. The weight of each cascara tea component can be seen in Table 1.

Table 1: Formulation of cascara, Dayak onion, and stevia herbal tea bags.

Treatment	Cascara		Dayak onion		Stevia		Total weight of tea bags (g)
	%	g	%	g	%	g	
A	60	3	40	2	0	0	5
B	60	3	30	1.5	10	0.5	5
C	60	3	25	1.25	15	0.75	5
D	60	3	20	1	20	1	5
E	60	3	15	0.75	25	1.25	5
F	60	3	10	0.5	30	1.5	5

2.3 Tea Product Analysis

The parameters observed include moisture content, ash content (BSN, 2013) SNI 3836:2013, pH value (Bawinto, Mongi & Kaseger, 2015), polyphenol content (BSN, 2013) SNI 3836:2013, and organoleptic test. The organoleptic test conducted on cascara herbal tea bags, combined with Dayak onion and stevia, was a hedonic test (preference test) covering taste, color, and aroma (BSN, 2006) SNI 01-2346-2006). The hedonic test was conducted by 30 untrained panelists of both genders and aged at least 25 years old. In this test, panelists were asked to enter a partitioned testing room to minimize distractions between panelists. The testing room temperature was cool and comfortable, ranging from 22-26°C, with good and neutral lighting. The tea samples were served at 5 ml and warm. The samples were randomly coded using three combinations of numbers. The test was conducted based on the level of preference, or a numerical scale with a score of 1-5, where (1) was very dislike, (2) dislike, (3) somewhat like, (4) like, and (5) very like. The panelists were asked to cleanse their taste buds with the mineral water provided, wait for 30 seconds, and then taste the next sample. The data obtained was statistically analyzed using ANOVA.

Determining the optimal formulation for cascara tea combined with Dayak onion and stevia was done using the ranking test method. Parameter weighting in the ranking test is performed by calculating the value of each parameter as the average of each treatment, then normalizing the data to standardize the scale across parameters. Each parameter is assigned a weight based on its level of importance. The total score is then calculated, and the treatment with the highest score is designated as the best treatment (Rafiyanti et al., 2018; Novia et al., 2023). The ranking test conducted in this study was based on the sorting of chemical analysis test assessments such as water content, ash content, pH, and polyphenol content, as well as organoleptic tests on cascara tea combined with Dayak onion and stevia.

Next, the optimal formula results were used to identify chemical compound profiles using LCMS. LCMS analysis was performed using a Shimadzu LCMS 9050 instrument. Separation was performed on a Kinetex 2.6 μ m C18A LC

column (100 mm x 2.1 mm). The mobile phase flow rate was 0.3 ml/min with an injection volume of 5 μ L, gradient 0-2 min 10% (A); 2-7 min 10-50% (A); 7-12 minutes 50% (A); 12-15 minutes 50-10% (A), Eluent Acetonitrile (A) and Aquadest + 0.1% Formic Acid (B) with positive ionization mode. Next, the optimal treatment was analyzed for antioxidant activity (IC₅₀) (Rahmi, 2017), total bacterial count (SNI 3836: 2013), and lead contamination (SNI 3836: 2013). Each test parameter was repeated three times. The antioxidant, TPC, and Pb analyses were replicated three times.

3 RESULT

3.1 Physicochemical Characteristics of Cascara Tea combined with Dayak Onion and Stevia

Observations made on cascara tea combined with Dayak onion and stevia included moisture content, ash content, pH value, and polyphenol content, as shown in Table 2. The moisture content obtained from cascara herbal tea combined with Dayak onion and stevia based on the results of this study ranged from 6.98% - 7.77% with an average of $7.30 \pm 0.30\%$. The tea drying process was carried out to reduce the moisture content in the material to improve the durability of the tea product.

Ash content in cascara tea combined with Dayak onion and stevia ranged from 4.10 - 7.73% with an average of $5.98 \pm 1.16\%$. in Table 2. the lowest ash content of herbal tea bags was found in formula A = 60:40:0 (cascara: Dayak onion: stevia), which was 4.10%, while formula F = 60:10:30 (cascara: Dayak onion: stevia) had the highest ash content, which was 7.73%. The 5% DNMR test showed a significant difference between treatments.

The pH value obtained in cascara herbal tea combined with Dayak onion and stevia ranged from 4.44 - 5.16 with an average of 4.82 ± 0.26 . Acidity or pH is used to indicate the level of acidity or alkalinity of the resulting tea brew.

Polyphenol measurement was performed by measuring the absorbance of cascara tea extract combined with Dayak onion and stevia mixed with 10% Folin ciocalteu reagent and sodium carbonate at a wavelength of 765 nm. The observation of

polyphenol content in cascara herbal tea combined with Dayak onion and stevia ranged from 4.98 - 11.84%, as shown in Table 2. The highest polyphenol content was found in formula D, which was 11.84%, and the lowest was found in formula A, which was 4.98%. As the concentration of stevia increases and the concentration of Dayak onion decreases in the formulation, the polyphenol content becomes higher. Polyphenols can inhibit, prevent, and reduce oxidation by free radicals (Febriana, Tamrin & Faradillah, 2019).

3.2 Organoleptic Testing of Cascara Tea combined with Dayak Onion and Stevia

The organoleptic test conducted on herbal tea from cascara, Dayak onion, and stevia was a hedonic test

(preference test). Table 3 and Figure 1 show the results of the organoleptic test and the overall acceptance level of the cascara tea formulation combined with Dayak onion and stevia by untrained panelists. Based on color and taste, formula D was the most preferred by the panelists, while based on aroma, formula F was the most preferred. Formula F, which contained the least proportion of Dayak onion, was the least preferred formula in terms of color, because the color of the tea brew produced was paler than the other formulas, as shown in Figure 2. Overall, based on the hedonic organoleptic test, formula D (60:20:20) was the most preferred formula by the panelists, and formula A (60:40:0) was the least preferred cascara herbal tea formula combined with Dayak onion and stevia by the panelists.

Table 2: Observation of Water Content, Ash Content, pH Value, and Polyphenol Content of Cascara Tea Combined with Dayak Onion and Stevia.

Treatment (%) (Cascara : Dayak Onion : Stevia)	Parameter $\pm$ SD			
	Moisture Content (%)	Ash Content (%)	pH Value	Polyphenols Content (%)
A= 60: 40: 0	6.98 $\pm$ 0.19 ^a	4.10 $\pm$ 0.17 ^a	5.16 $\pm$ 0.20 ^d	4.98 $\pm$ 0.08 ^a
B= 60: 30: 10	7.04 $\pm$ 0.07 ^a	5.60 $\pm$ 0.35 ^b	5.04 $\pm$ 0.12 ^{cd}	7.38 $\pm$ 0.02 ^b
C= 60: 25: 15	7.15 $\pm$ 0.19 ^{ab}	5.83 $\pm$ 0.06 ^b	4.89 $\pm$ 0.06 ^{bc}	8.08 $\pm$ 0.13 ^c
D= 60: 20: 20	7.38 $\pm$ 0.15 ^{bc}	5.93 $\pm$ 0.12 ^b	4.73 $\pm$ 0.06 ^b	9.19 $\pm$ 0.06 ^d
E= 60: 15: 25	7.52 $\pm$ 0.13 ^{cd}	6.67 $\pm$ 0.58 ^c	4.66 $\pm$ 0.06 ^{ab}	10.46 $\pm$ 0.01 ^c
F= 60: 10: 30	7.77 $\pm$ 0.11 ^d	7.73 $\pm$ 0.46 ^d	4.44 $\pm$ 0.22 ^a	11.84 $\pm$ 0.00 ^f

Note: Numbers in the same row followed by the same lowercase letter are not significantly different according to DNMRT at the 5% level. SD = Standard Deviation.

Table 3: Average Hedonic Organoleptic Test of Cascara Tea Combined with Dayak Onion and Stevia.

Treatment (%) (Cascara : Dayak Onion : Stevia)	Color $\pm$ SD	Aroma $\pm$ SD	Taste $\pm$ SD
A= 60: 40: 0	3.49 $\pm$ 0.15 ^{bc}	2.71 $\pm$ 0.15 ^a	2.42 $\pm$ 0.24 ^a
B= 60: 30: 10	3.75 $\pm$ 0.21 ^d	2.80 $\pm$ 0.13 ^{ab}	2.65 $\pm$ 0.22 ^{ab}
C= 60: 25: 15	3.61 $\pm$ 0.09 ^{cd}	2.99 $\pm$ 0.06 ^b	2.96 $\pm$ 0.39 ^{bc}
D= 60: 20: 20	4.09 $\pm$ 0.07 ^c	3.48 $\pm$ 0.09 ^c	3.65 $\pm$ 0.28 ^d
E= 60: 15: 25	3.29 $\pm$ 0.04 ^b	3.62 $\pm$ 0.19 ^{cd}	3.28 $\pm$ 0.22 ^{cd}
F= 60: 10: 30	2.87 $\pm$ 0.20 ^a	3.75 $\pm$ 0.14 ^d	3.30 $\pm$ 0.17 ^{cd}
CV	4.02 %	4.16%	6.57%

Note: The numbers in the same row followed by the same lowercase letter are not significantly different according to DNMRT at the 5% level. SD = Standard Deviation. CV = Coefficient of Variation. Panelist preference scores: 1 = strongly dislike, 2 = dislike, 3 = neutral/somewhat like, 4 = like, 5 = strongly like.

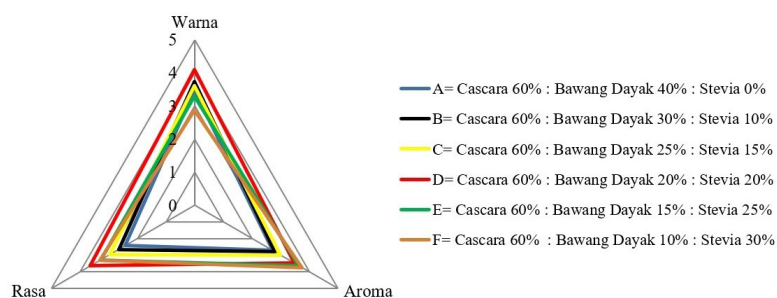


Figure 1: Radar Chart of Sensory Evaluation of Cascara Tea combined with Dayak Onion and Stevia.

3.3 Optimal Formula

The optimal formula was determined based on a ranking test. Ranking tests are conducted by sorting samples based on predefined attributes or intensity levels, taking into account the degree of preference and the importance of a particular parameter in the product, by selecting the best options or eliminating the lowest-scoring ones. The ranking test was conducted based on the sorting of observations of moisture content, ash content, pH, and polyphenol content based on quality characteristics in accordance with SNI 3836:2013, as well as a hedonic organoleptic test covering color, aroma, and taste in cascara herbal tea combined with Dayak onion and stevia. The best formula obtained from the ranking test results was formula D (60:20:20) (cascara: Dayak onion: stevia). The best formula was tested for chemical compound detection using LCMS, antioxidant testing, total plate count contamination testing, and lead metal contamination testing.

3.4 Observation of Optimal Formula (LCMS, Antioxidants, Total Plate Count, Lead (Pb) Contamination)

The optimal formula D was further analyzed to determine the molecular weight and suspected characteristic compounds contained therein using LCMS qualitatively. The LCMS chromatogram and the profiles of the identified and selected compounds based on retention time, compound weight, and ion fragmentation can be observed in Figure 3 and Table 4. These compounds were selected based on retention time compatibility, m/z values, and signal intensity, which reflect the relative abundance of each component in the mixture. These results indicate that the cascara tea formulation with Dayak onion and stevia contains various metabolites, mainly from the organic acid, phenolate, flavonoid, and alkaloid groups, which form the chemical basis for the innovative characteristics of the product. The main compounds identified include anthranilic acid, DL-Tryptophan, 2,3-dihydroxybenzoic acid, 3-hydroxycoumarin, aspirin, chlorogenic acid, caffeine, quercetin, rutin, vestitol, and trans-resveratrol.

The antioxidant activity of the optimal formula D was measured at 255.60 ± 0.49 ppm, as shown in Table 5. The antioxidant capacity of tea products from cascara, Dayak onion, and stevia was tested using the DPPH (1,1-diphenyl-

2-picrylhydrazil) free radical scavenging method, expressed as the IC_{50} (Inhibition Concentration 50) value. The IC_{50} (Inhibition Concentration) value was determined after obtaining the absorbance value and % inhibition against DPPH, followed by determining the regression equation $Y = ax+b$. Then, the Y value was substituted with 50 in the equation, and the X value obtained was the IC_{50} value. The equation can be seen in Figure 4. Formula D was tested using a UV-Vis spectrophotometer at a wavelength of 516 nm with an incubation time of 30 minutes in a dark room.

Microbial contamination (total plate count) in formula D was 9.5×10^1 colonies/g, as shown in Table 5. In the study by Sinulingga et al. (2021), the total plate count of tea obtained from the average repetition was 3.3×10^4 colonies/g. The total number of colonies is one of the important parameters in microbiological contamination analysis used to evaluate the cleanliness, safety, and microbiological quality of a product.

Lead (Pb) contamination in cascara tea combined with Dayak onion and stevia in a formula of D= 60:20:20 was detected at 0.02 mg/kg, as shown in Table 5. This value indicates that the lead contamination in the product is at a very low level, reflecting that the raw materials, processing, drying, and brewing stages do not contribute significantly to increased Pb contamination.

4 DISCUSSION

4.1 Moisture Content of Cascara Tea combined with Dayak Onion and Stevia

Table 2 shows that the highest moisture content was found in formula F at $7.77 \pm 0.11\% \pm 0.19$ and the lowest in formula A at $6.98\% \pm 0.19$. The increase in moisture content in tea is in line with the increase in the proportion of stevia in the formulation. The more stevia is added, the higher the moisture content of the tea produced. Bahar et al. (2025) stated that high moisture content in food can cause damage to food due to internal and external microbial activity (external destructive microbes). Based on Table 2, all water content treatments are still below the safe limit, meaning that this herbal tea bag meets the SNI 3836:2013 standard for the quality of dry tea products in packaging.

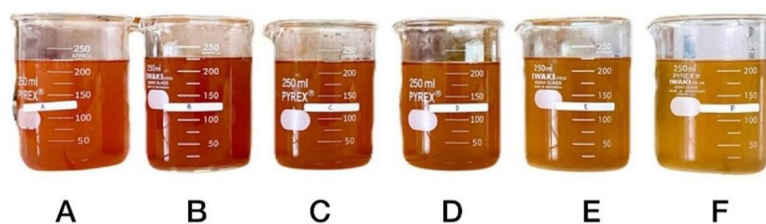


Figure 2: Color Infusion of Cascara Tea combined with Dayak Onion and Stevia. A= 60%: 40%: 0%; B= 60%: 30%: 10%; C= 60%: 25%: 15%; D= 60%: 20%: 20%; E= 60%: 15%: 25%; F= 60%: 10%: 30%.

4.2 Ash Content of Cascara Tea combined with Dayak Onion and Stevia

Table 2 shows that the difference in the concentration of Dayak onion and stevia in cascara tea has a significant effect on ash content ($P < 0.05$). The increase in ash content is in line with the increase in the proportion of stevia in the formulation. In line with the results of Siagian et al. (2020), the average total ash content of tin leaf tea with the addition of stevia leaves continued to increase. In addition, Akbar et al. (2019), in their research, found that stevia leaves contain various minerals such as potassium, calcium, and magnesium, which contribute to an increase in ash content. The ash content values of all treatments were still in the range of 4.10-7.73%, which is normal for packaged dried herbal tea products, namely a maximum of 8% according to Indonesian National Standard 3836:2013.

4.3 pH Value of Cascara Tea combined with Dayak Onion and Stevia

The effect of different concentrations of Dayak onion and stevia formulations on tea brewing can be seen in Table 2. The higher the concentration of Dayak onion, the higher the pH value produced. This is in line with the research by Hasni et al. (2022), where increasing concentrations of Dayak onion, namely 20, 40, 60, 80, and 100%, resulted in higher pH values ranging from 4.24 - 5.35. In addition, the higher the concentration of stevia given, the lower the pH value or the higher the acidity of the tea infusion. This is suspected because although it is known to be sweet, it contains phenolic compounds and organic acids that can lower the pH value of the solution. According to Shivanna et al. (2013), the types of phenolic compounds that are organic acids in stevia powder include dicaffeoylquinic acid, 3,4-dimethoxycinnamic acid, and caffeic acid.

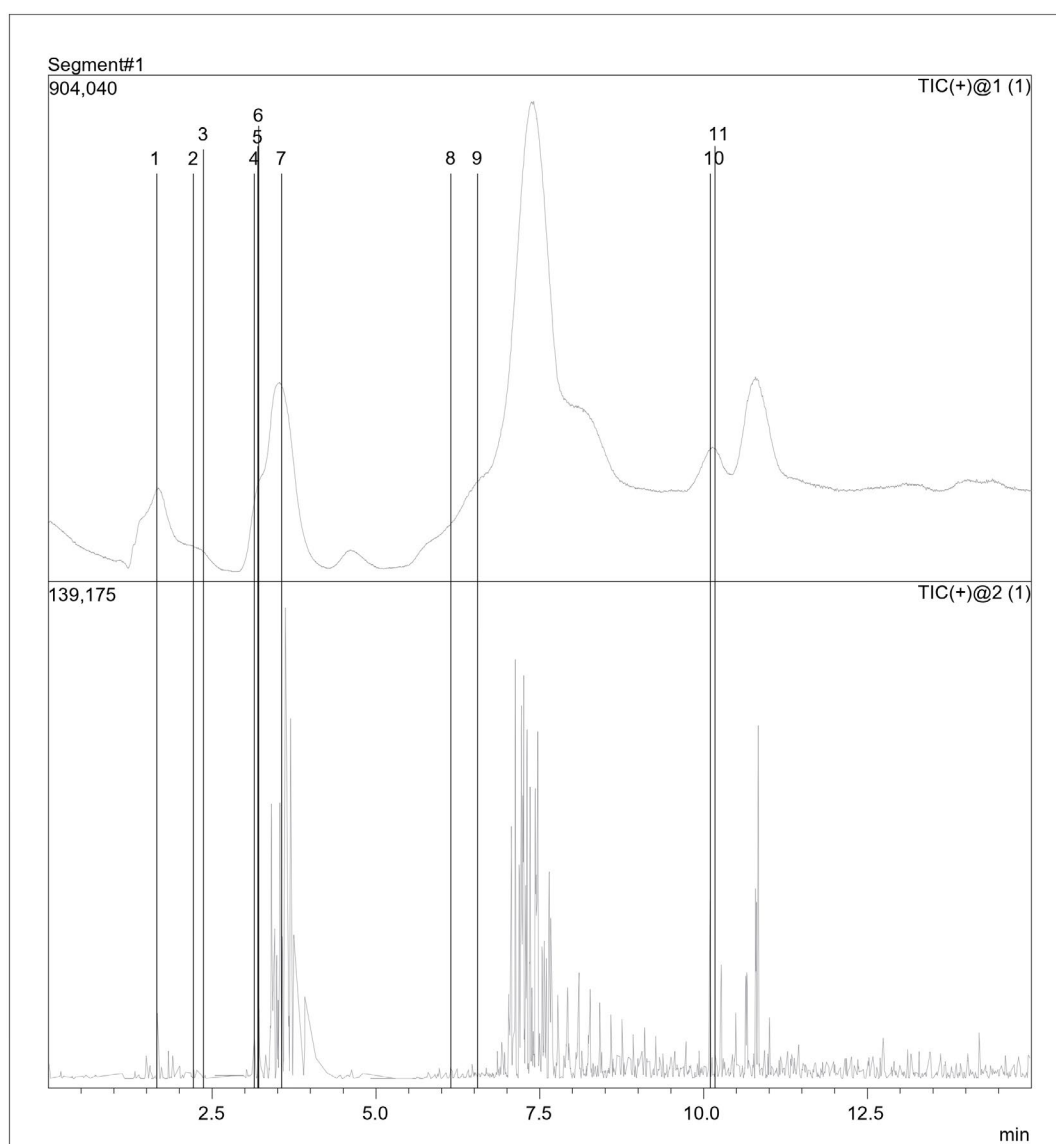


Figure 3: LCMS Chromatogram Graph of of Cascara Tea combined with Dayak Onion and Stevia (Positive).

Table 4: Profile of Compounds Detected in LC-MS Analysis of Cascara Tea combined with Dayak Onion and Stevia Positive Ionization Mode.

Peak Num-ber	Retention time (minute)	Molecular mass (g/mol)	[M+H] ⁺ (m/z)	Fragment ions (m/z)	Molecular formula	Compound
1	1.664	137.04768	138.0547	94.06481 92.04902 80.04918 79.04126 78.03352 77.03798 65.03800 51.02231	C ₇ H ₇ NO ₂	Anthranilic acid
2	2.222	204.08988	205.0973	146.05971 143.07225 130.06458 118.06480 115.05400 91.05405	C ₁₁ H ₁₂ N ₂ O ₂	DL-Tryptophan
3	2.371	154.02661	155.0337	65.03793	C ₇ H ₆ O ₄	2,3-Dihydroxybenzoic acid
4	3.145	162.03169	163.0388	135.04440 117.03313 89.03809 77.03815 63.02291	C ₉ H ₆ O ₃	3 hydroxycoumarin
5	3.199	180.04226	181.0496	163.03915 145.02823 135.04397 117.03333 107.04802 89.03802 77.03833 63.02298	C ₉ H ₈ O ₄	Aspirin
6	3.218	354.09508	355.1024	163.03891 145.02812 135.04366 117.03302 107.04879	C ₁₆ H ₁₈ O ₉	Chlorogenic acid
7	3.572	194.08038	195.0876	195.08755 138.06593 123.04246 110.07094 109.03942 97.03908 83.05984 69.04413 67.02833	C ₈ H ₁₀ N ₄ O ₂	Caffeine
8	6.514	302.04265	303.0500	303.05033 229.05027 153.01819	C ₁₅ H ₁₀ O ₇	Quercetin
9	6.550	610.15339	611.1610	303.04968 287.05547	C ₂₇ H ₃₀ O ₁₆	Rutin
10	10.103	272.10486	273.1119	229.08590 211.07521 201.09089 197.05934 169.06444 168.05676 158.07222 141.06936 128.06174 127.05390 115.05384 105.03266 77.03831	C ₁₆ H ₁₆ O ₄	Vestitol

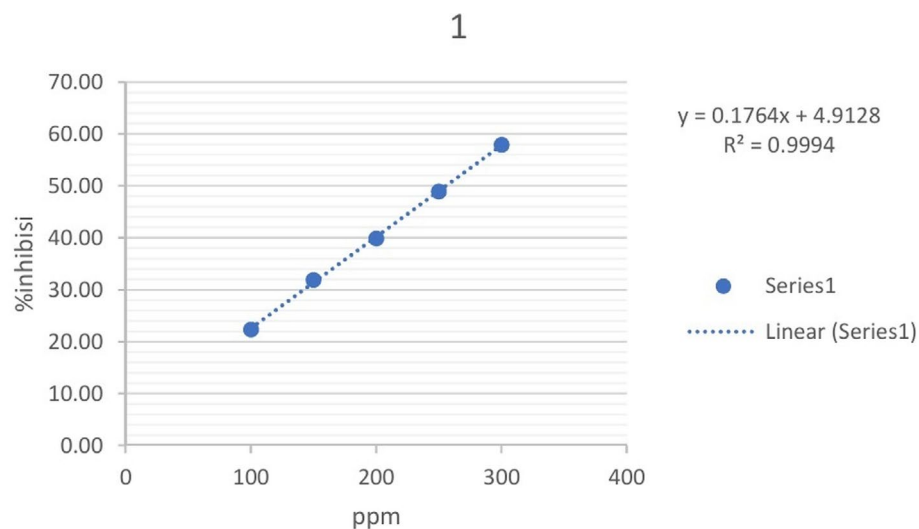
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Table 4: Continue.

Peak Num-ber	Retention time (minute)	Molecular mass (g/mol)	[M+H] ⁺ (m/z)	Fragment ions (m/z)	Molecular formula	Compound
11	10.175	228.07864	229.0857	214.06323 197.05891 197.05891 168.05743 158.07236 141.06919 139.05411 128.06293 115.05393 77.03809	C ₁₄ H ₁₂ O ₃	Trans-resveratrol

Table 5: Antioxidants, Total Plate Count, and Lead (Pb) in Cascara Tea combined with Dayak Onion and Stevia.

Analysis	Formula D (Cascara 60%: Bawang Dayak 20%: Stevia 20%)
Antioxidant IC ₅₀ (ppm)	255.60
Total Plate Count (TPC) (Colony/g)	9.5 x 10 ¹
Lead contamination (Pb) (mg/kg)	0.02

**Figure 4:** Antioxidant Analysis Calibration Curve.

In addition, the fermentation process in coffee skin processing also affects the pH value of tea brew, generally lowering the pH to a more acidic level. Puspangingrum et al. (2020) in their research stated that high lactic acid bacteria activity in fermented coffee skin will produce higher organic acid content, thereby lowering the pH. Conversely, the pH increases due to a decrease in the acid content of the coffee husks, accompanied by a decrease in lactic acid bacteria activity. The organic acids produced are chlorogenic acid, oxalic acid, formic acid, acetic acid, and citric acid. One of the acids that plays an important role in increasing and decreasing the pH is chlorogenic acid. The pH value of the tea brew in this study ranged from 4.44 - 5.16, which is classified as a mildly acidic brew. Herbal tea with a pH ranging from 4 - 6 is still

considered safe for consumption because it is not too acidic or too alkaline and can help maintain digestive tract stability (Rosdy et al., 2023).

4.4 Polyphenol Content of Cascara Tea Combined with Dayak Onion and Stevia

The polyphenol content observed in Table 2 increased with the addition of stevia and decreased with the addition of Dayak onion, with a range of 4.98–11.84%. The results of a study by Ariva et al. (2020) on the measurement of polyphenol levels in cascara extract with different drying temperatures ranged from 10.46 - 13.60%. The increase in polyphenol levels in this study can be attributed to the contribution of polyphenols from the three ingredients used in the manufacture

of herbal tea, which is rich in bioactive compounds. Cascara, Dayak onion, and stevia tea contain polyphenol compounds such as chlorogenic acid, gallic acid, rutin, antranilic acid, DL-Tryptophan, catechin, tannin, quercetin, and other polyphenol compounds.

Cascara contains phenolic compounds such as chlorogenic acid, which acts as a natural antioxidant (Muzaifa et al., 2019). According to Fitriani et al. (2021) in their research, Dayak onion contains flavonoids and phenolics such as rutin and quercetin. Apart from the composition of raw materials, the drying process can also cause a decrease in active substances in a material. The decrease in polyphenol content is caused by enzymatic oxidation during drying, resulting in the oxidation and reduction of polyphenols. Heating during drying serves to inactivate the polyphenol oxidase enzyme so that the damage to polyphenol compounds is minimized. However, if the temperature exceeds the optimum temperature, the stability of the polyphenol compounds in the material will be disrupted and cause a decrease in polyphenol content (Ariva et al., 2020).

4.5 Organoleptic Testing of Cascara Tea combined with Dayak Onion and Stevia

The hedonic test conducted included color, aroma, and taste of tea beverages made from cascara, Dayak onion, and stevia. Color is one of the most important physical parameters in food ingredients. Consumer preference for food products is also determined by the color of the food. The quality assessment of food ingredients is highly dependent on several factors such as taste, color, texture, and nutritional value. The colors produced from the hedonic test ranged from 2.87 - 4.09 (neutral to like). Formulation F, with the lowest concentration of Dayak onion and the highest concentration of stevia, received the lowest color rating from the panelists because the color of the tea brew produced was lighter and paler than the other formulations. This was due to the compounds found in stevia leaves. According to Desy, Siagian, and Bintoro (2020), the presence of glycosides, flavonoids, and rutin in stevia leaves gives a yellow color to the brewed tea made from tin leaves with the addition of stevia leaves.

In formulations B and C, the percentage of Dayak onion tends to be higher than stevia, resulting in a darker reddish-brown tea infusion. The red color in this tea infusion comes from Dayak onion bulbs, which contain anthocyanins, a natural pigment that is a subclass of flavonoids (Cahyadi et al., 2018). Based on organoleptic testing of color parameters, panelists showed a higher preference for herbal tea infusions made from cascara, Dayak onion, and stevia with a brownish color, as this color was considered to resemble the characteristic color of tea from *Camellia sinensis*, thus providing a more familiar and appealing visual impression.

The assessment shows that the panelists highest level of preference for the aroma of herbal tea bags was found in formulation F= 60: 10: 30 (cascara: Dayak onion: stevia) with a score of 3.75 (like). Meanwhile, the lowest level of panelist preference was found in the formulation A= 60: 40: 0 (cascara: Dayak onion: stevia) with a score of 2.87 (average/acceptable). The results of the hedonic aroma test showed that the higher the proportion of stevia in the herbal tea bag mixture, the higher the panelists liking score for the aroma, which was significantly and statistically different from treatments A, C, D, and F. This indicates that stevia not only functions as a natural sweetener but also contributes to the aroma characteristics of herbal tea bags. Conversely, high concentrations of Dayak onion can produce an aroma that is less preferred by panelists due to its strong, slightly pungent, or unfamiliar aromatic characteristics. The aroma intensity of Dayak onion is considered stronger than that of stevia and cascara due to its herbal aroma, which is similar to the grassy aroma of Dayak onion. The grassy aroma is caused by the presence of aromatic aldehyde compounds, which are derived from the aldehyde-ketone compounds found in Dayak onion (Suroto and Eldha, 2007). Based on organoleptic testing of aroma parameters, panelists preferred herbal tea bags with a sweet, non-grassy herbal aroma.

The panelists gave the highest rating for the taste of tea brewed from formulation D = 60:20:20 (cascara: Dayak onion: stevia) with a score of 3.65 (like). The panelists level of liking was low for formulation A= 60: 40: 0 (cascara: Dayak onion: stevia) with a score of 2.42 (dislike). Formulations without added stevia were less liked by the panelists because the resulting taste tended to be sour to bitter. The more stevia added and the less Dayak onion added, the more the tea brew was liked by the panelists. However, in treatments E and F, as the stevia concentration increased, the panelists' liking level was lower than in treatment D. This was because the brew tasted too sweet, giving an aftertaste that was not liked by the panelists. Stevioside in stevia leaves can contribute to a bitter taste. Although stevioside is a natural sweetener in stevia, excessive amounts can cause a bitter taste. Stevia leaves have a sweetness range of approximately 200 - 300 times sweeter than sucrose or cane sugar (Cahyani et al., 2022). Based on organoleptic testing of taste parameters, panelists preferred tea infusions made from cascara, Dayak onion, and stevia with a balanced combination of sour, astringent, and sweet flavors.

The organoleptic score recapitulation is the overall result of the panelists preference for cascara tea combined with Dayak onion and stevia, presented in a radar chart in Figure 2. This is intended to facilitate reading and viewing the panelists preference for the product. In Figure 2, it is evident that the formula most preferred by the panelists according to the sensory recapitulation is formula D (60% cascara: 20% Dayak onion: 20% stevia).

4.6 LCMS Profile from the Optimal Formula

The results of qualitative identification using Liquid Chromatography Mass Spectrometry (LCMS) on herbal tea infusions from cascara, Dayak onion, and stevia showed the detection of bioactive compounds in positive ion mode. In the chromatogram in Figure 3 and Table 4, the profiles of the identified and selected compounds based on retention time, compound weight, and ion fragmentation showed 11 compound peaks. The identified compounds include anthranilic acid, DL-tryptophan, 2,3-dihydroxybenzoic acid, 3-hydroxycoumarin, aspirin, chlorogenic acid, caffeine, quercetin, rutin, vestitol, and trans-resveratrol.

The initial peak of the chromatogram was dominated by anthranilic acid, detected at a retention time of 1.664 minutes with a molecular mass of 137.04768 g/mol, followed by DL-tryptophan at a retention time of 2.222 minutes with a molecular mass of 204.08988 g/mol. These two compounds are derivatives of aromatic amino acids that are relatively polar and are mainly associated with the presence of cascara as the main ingredient. Coffee husks are known to be rich in organic acids and amino acid metabolite compounds, the content of which can increase during the fermentation and drying process, explaining the appearance of these compounds in the early phase of the chromatogram.

Further retention times identified 2,3-dihydroxybenzoic acid (154.02661 g/mol) and 3-hydroxycoumarin (162.03169 g/mol), which belong to the group of simple phenols resulting from the metabolism of phenylpropanoids (Garcia-Diez *et al.*, 2024). Simple phenols are generally easily extracted in hot water and frequently appear in herbal infusions, so their presence in these formulations enriches the antioxidant profile of the infusions even though their individual activity is lower than that of complex flavonoids such as quercetin or rutin.

Aspirin compounds were detected at a retention time of 3.107 minutes with a molecular mass of 180.04226 g/mol. The identification of aspirin compounds in herbal tea combinations is thought to be due to false positives caused by the phenomenon of isomerism, namely the presence of natural compounds that have the exact same molecular weight (m/z) as aspirin. It is thought that caffeic acid has the same chemical formula as aspirin. In addition, Dayak onions are rich in naphthoquinone and coumarin compounds, which have very similar masses, so the LCMS device detects and displays the name aspirin based on the match in the database.

Chlorogenic acid was identified at a retention time of 3.218 minutes with a molecular mass of 354.09508 g/mol and is one of the main phenolic compounds characteristic of cascara and coffee by-products. This compound is an ester between caffeic acid and quinic acid, and is often reported as a chemical marker of cascara. In line with the report by Liang *et al.* (2025), the dominance of chlorogenic acid is not

only related to its antioxidant capacity, but also plays a role in creating the soft sour taste and fresh impression that are characteristic of cascara based drinks.

Caffeine was detected at a retention time of 3.572 minutes with a molecular mass of 195.08760 g/mol. As an alkaloid from the methylxanthine group that is naturally found in coffee, tea, and cocoa, the presence of caffeine in this brew directly reflects the contribution of cascara as the main raw material (Widya, 2024). Although its abundance is relatively lower than chlorogenic acid, caffeine still plays an important role in forming a mild bitter taste and providing a stimulant effect that distinguishes cascara tea from non-caffeinated herbal drinks.

At a longer retention time, the flavonoid compounds quercetin (302.04265 g/mol) and rutin (610.15300 g/mol) were identified. Quercetin as an aglycone is known to have antioxidant activity, while rutin as a glycoside form is more stable and more soluble in water (Jan *et al.*, 2022).

From a sensory perspective, flavonoids generally impart a bitter and astringent taste, but in this formulation, these characteristics can be reduced by the addition of stevia so that they do not dominate the final flavor profile. Vestitol was detected at a retention time of 10.103 minutes with a molecular mass of 272.08921 g/mol. This compound is an isoflavonoid that is rarely reported in conventional herbal tea products, and its presence indicates the unique contribution of Dayak onion to the complexity of the formulation's metabolite profile. Isoflavonoids are known to have various biological activities, including antioxidant and anti-inflammatory potential (Hasni *et al.*, 2019).

The trans-resveratrol compound was detected with a molecular mass of 228.07865 g/mol and is thought to originate from Dayak onion, which is known to contain various secondary polyphenols. Trans-resveratrol is a polyphenolic stilbenoid that plays a role in antioxidant activity through free radical scavenging mechanisms and strengthening the cell's defense system against oxidative stress (Faisal *et al.*, 2024).

4.7 Antioxidant Activity of the Optimal Formula

Table 5 shows that the antioxidant capacity of herbal tea products in this package is very weak, at 255.60 ppm. Antioxidant classification is divided into several categories: very strong if the value is <50 ppm, strong between 50-100 ppm, moderate between 100-150 ppm, weak between 150-200 ppm, and very weak if >200 ppm (Molyneux, 2004). Based on research by Saragih, Hanif and Emmawati (2019), 3 g of dried Dayak onion tea brewed with 150 ml of boiling water produced antioxidant activity of 263.27 ppm, whereby the processing method used to make this tea also affects the antioxidant activity content. Antioxidant compounds, especially flavonoids, are easily damaged, with the main cause of damage being the heating process. This was also stated by

Muawanah et al. (2012), where the heating method used in the product can also affect the nutritional value and antioxidant capacity due to heat-induced cell damage.

Polyphenol-rich samples often do not show stronger DPPH IC_{50} activity because antioxidant activity depends on the type and structure of specific polyphenols, not just their total content. Low IC_{50} values (strong activity) require polyphenols with ortho-hydroxy groups that readily donate hydrogen to DPPH radicals, such as quercetin or chlorogenic acid, while polymeric polyphenols like tannins or proanthocyanidins are less reactive despite their high content (Mangiwa et al., 2023). Additionally, Azkiyah et al. (2025), in their study, mentioned that the chemical structure determines the efficiency of glycosylated polyphenols or those with long side chains, which inhibit steric interactions with DPPH, resulting in a higher IC_{50} (weak activity).

4.8 Total Plate Count of the Optimal Formula

Total plate count observations show that the number of microbial colonies in tea is 9.5×10^1 colonies/g, which is well below the maximum microbial contamination limit set in SNI 3836:2013 for packaged dry tea, which is 3×10^3 colonies/g. This low number of microbes indicates that herbal tea products have good microbiological quality. One of the factors that influence the low total plate count microbial contamination in this herbal tea bag is the content of natural antimicrobial compounds in ingredients such as Dayak onion, which is known to have antibacterial activity where phenolic compounds, flavonoids, and saponins in Dayak onion play a role in inhibiting bacterial growth (Warsiti et al., 2013). Fauziati and Sampepana (2017), stated that Dayak onion extract contains the active compound 3,4-dimethoxy-6-formyl-2,2-bipyridine, which functions as an antibacterial agent. In addition, cascara also has antibacterial activity due to the presence of caffeine and melanoidin compounds (Duangjai, 2016). According to Sinulingga et al. (2021), stevia contains various phytochemicals such as alkaloids, flavonoids, terpenoids, rebaudiosides, riboflavin, steviol, stevioside, and thiamine, which are widely known as antimicrobials, including antibacterial and antifungal agents.

4.9 Lead Contamination (Pb) of the Optimal Formula

The lead (Pb) content in formula D was 0.02 mg/kg, which is well below the maximum Pb contamination limit set in Indonesian National Standard 3836:2013, which is 2.0 mg/kg. These results are also in line with the research by Ababneh and Abu-Sbeih (2025), who analyzed the toxic element content in commercial herbal tea infusions and reported that the Pb concentration in various brands of herbal tea ranged from $<6.67 \times 10^{-4}$ to 3.24×10^{-2} mg/kg, which is an absolutely very

low value and far below the maximum limit recommended by the World Health Organization (WHO, 2011). Although Pb in the study was reported as one of the elements with the highest contribution to estimated daily intake compared to other heavy metals, the estimated daily intake (EDI) and target hazard quotient (THQ) values remained below the health risk threshold. Thus, the presence of Pb at low levels as detected in this study is not expected to pose a significant health risk. However, given the toxic nature of lead and its ability to accumulate in the body with long-term exposure, monitoring heavy metal contamination remains an important aspect in the development and quality control of herbal tea products.

5 CONCLUSIONS

Differences in Dayak onion and stevia concentrations significantly affected the physicochemical and sensory characteristics of cascara herbal tea. The optimal formulation based on Indonesian National Standard 3836:2013 using the ranking test method is treatment D=60:20:20 (cascara:Dayak onion:stevia), with 7.38% moisture, 5.93% ash, pH 4.73, 9.19% polyphenols, and the highest sensory acceptance. LCMS identified 11 bioactive compounds, including anthranilic acid, chlorogenic acid, quercetin, caffeine, vestitol, and trans-resveratrol. Antioxidant activity (IC_{50} 255.60 ppm), total plate count 9.5×10^1 colonies/g, and Pb 0.02 mg/kg.

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7 AUTHORS CONTRIBUTION

Conceptual idea: Kasim, A.; Kasim, F.; Harahap, R. M. R.; Methodology design: Kasim, A.; Kasim, F.; Harahap, R. M. R.; Data collection: Harahap, R. M. R.; Data analysis and interpretation: Harahap, R. M. R.; and Writing and editing: Kasim, A.; Kasim, F.; Harahap, R.M.R.

8 DATA AVAILABILITY STATEMENT

Data available upon request to authors.

9 REFERENCES

Ababneh, F. A., & Abu-Sbeih, K. A. (2025). Analysis and health risk assessment of toxic elements in traditional herbal tea infusions. *Open Chemistry*, 23(1):20250134.

- Akbar, C. I. et al. (2019). Teh rambut jagung dengan penambahan daun stevia sebagai alternatif minuman fungsional bagi penderita diabetes melitus tipe 2. *Jurnal Aplikasi Teknologi Pangan*, 8(2):67-73.
- Ariva, A. N. et al. (2020). The effect of drying temperature on the quality of cascara tea from arabica coffee husks (*Coffea arabica*). *Jurnal Teknologi dan Industri Pertanian Indonesia*, 12(1):21-28.
- Azkiyah, L. et al. (2025). Evaluasi aktivitas antioksidan dan karakteristik sensori tea infusion berbasis cascara dengan penambahan jahe, lemon, dan daun mint. *Agroteknika*, 8(4):776-790.
- Bahar, A. et al. (2025). Phytochemical analysis of herbal tea bags based on drying temperature. *Amerta Nutrition*, 9(1):119-127.
- Bawinto, A. S., Mongi, E., & dan Kaseger, B. E. (2015). Analysis of moisture content, pH, organoleptic properties, and mold in smoked tuna products in girian bawah village, bitung City, North Sulawesi. *Jurnal Media Teknologi Hasil Perikanan*, 3(2):55-65.
- Buchori, L. (2007). Pembuatan gula non karsinogenik non kalori dari daun stevia. *Jurnal UNDIP*, 11(2):57-60.
- Cahyadi, W. et al. (2018). The effect of concentration on the characteristics of stevia sugar and the addition of ascorbic acid on the characteristics of dayak onion cocktail (*Eleutherine palmifolia*). *Pasundan Food Technology Journal*, 5(2):154-163.
- Cahyani, S. A. N. et al. (2022). The effect of adding stevia leaf extract (*Stevia rebaudiana*) on the chemical and organoleptic characteristics of instant herbal medicine. *Jurnal Teknologi Pangan dan Ilmu Pertanian (JIPANG)*, 4(2):1-7.
- Cangussu, L. B. et al. (2021). Chemical characterization of coffee husks, a by-product of *Coffea arabica* production. *Foods*, 10(12):3125.
- Desy, I., Siagian, N., & dan Bintoro, V. P. (2020). Physical, chemical, and organoleptic characteristics of tin leaf tea bags with added stevia leaves (*Stevia rebaudiana*) as sweetener. *Jurnal Teknologi Pangan*, 4(1):23-29.
- Duangjai, A. (2016). Comparison of antioxidant, antimicrobial activities and chemical profiles of three coffee (*Coffea arabica* L.) Pulp Aqueous Extracts. *Integrative Medicine Research*, 5(4):324-331.
- Duweini, M., & Tribaditia, R. (2017). Penentuan formulasi optimum pembuatan minuman fungsional dari bunga rosella (*Hibiscus sabdariffa* L.) dengan penambahan bawang dayak (*Eleutherine palmifolia* (L) MERR.) menggunakan metode RSM (Response Surface Method)". *Agroscience*, 7(2):234-248.
- Faisal, Z. et al. (2024). Exploring the multimodal health-promoting properties of resveratrol: A comprehensive review. *Food Science and Nutrition*, 12(4):2240-2258.
- Saputra, S. H., & Fauziati, dan Sampepana, E. S. F. (2017). *Teknologi penanganan pasca panen umbi bawang tiwai dan aplikasi di industri*. Balai Riset dan Standardisasi Industri Samarinda. Samarinda. [https://bspjisamarinda.kemenperin.go.id/download/proceeding/2017_semnas1/Hal_302-307_Ok.pdf].
- Febriana, E., Tamrin, & Faradillah, R. F. (2019). Analisis kadar polifenol dan aktivitas antioksidan yang terdapat pada ekstrak buah: Studi kepustakaan. *Jurnal Komponen Ilmu-Ilmu Teknologi Pangan*, 8(1):1-16.
- Fitriani, S. N. et al. (2021). Kandungan fitokimia dan aktivitas antioksidan ekstrak bawang Dayak (*Eleutherine palmifolia* (L.) Merr.). *Jurnal Teknologi Pertanian*, 22(2):97-104.
- Garcia-Diez, E. et al. (2024). Epicatechin and colonic metabolite 2,3-dihydroxybenzoic acid, alone or in combination with metformin, protect cardiomyocytes from high glucose/high palmitic acid-induced damage by regulating redox status, apoptosis and autophagy. *Food & Function*, 15(5):2536-2549.
- Hasni, D. et al. (2022). Pengaruh formulasi kulit buah kopi arabika dan umbi bawang dayak terhadap mutu seduhan minuman herbal carcara. *Jurnal Tanaman Industri dan Penyegar*, 9(2):57.
- Hasni, Y. et al. (2019). The effect of ethanolic extract of dayak onion (*Eleutherine palmifolia* (L) Merr) tuber on blood glucose and insulin level of streptozotocin-induced diabetic wistar rat. *Asian Journal of Pharmaceutical Research and Development*, 7(4):38-42.
- Hidayat, M. R. et al. (2018). Pengaruh formulasi ukuran partikel dan suhu pengeringan terhadap aktivitas antioksidan teh herbal celup bawang dayak (*Eleutherine palmifolia* (L.) Merr.). *Ziraa'ah Majalah Ilmiah Pertanian*, 43(3):283-292.
- International Coffee Organization - ICO. (2019). *World Coffee Production*.
- Jan, R. et al. (2022). Bioactivity and therapeutic potential of kaempferol and quercetin: New insights for plant and human health. *Plants*, 11(19):2623.
- Liang, N. et al. (2025). Phenolic acid composition of coffee cascara in connection with antioxidant capacity: A geographic assessment. *Antioxidants*, 14(5):502.

- Mangiwa, S. et al. (2023). Analisis mutu fisik dan kimia serta uji aktivitas antioksidan teh cascara dari kulit kopi arabika (*Coffea arabica* L.). *Jurnal Biologi Papua*, 15(1):78-87.
- Manini, P., Andreoli, R., & Niessen, W. M. A. (2004). Liquid chromatography–mass spectrometry in occupational toxicology: A novel approach to the study of biotransformation of industrial chemicals. *Journal of Chromatography A*, 1058(1-2):21-37.
- Molyneux, P. (2004). The use of the stable free radical diphenylpicryl-hydrazyl (DPPH) for estimating antioxidant activity. *Songklanakarin Journal of Science Technology*, 26(2):211-216.
- Muawanah A. et al. (2012). Penggunaan bunga kecombrang (*Etlingera elatior*) dalam proses pembuatan permen jelly. *Jurnal Kimia Valensi*, 2(4):4-8.
- Muthia, R. et al. (2023). Characterization and determination of total phenol levels of ethanolic extract of bawang dayak bulbs (*Eleutherine bulbosa* urb.) based on variation in growing time of plants. *Jurnal Ilmiah Farmasi*, 8(2):83-93.
- Muzaifa, M. et al. (2019). Kajian pengaruh perlakuan pulp dan lama penyeduhan terhadap mutu kimia teh cascara. *Jurnal Teknologi Pertanian Andalas*, 23(2):136-142.
- National Standardization Agency of Indonesia- BSN. (2013). *Indonesian National Standard: Packaged Dried Tea (SNI 3836:2013)*. BSN.
- National Standardization Agency of Indonesia- BSN. (2014). *Indonesian National Standard: Balck Tea Bags (SNI 3753-2014)*. BSN.
- National Standardization Agency of Indonesia- BSN. (2006). *Indonesian National Standard: Organoleptic or Sensory Testing Instructions (SNI 01-2346-200))*. BSN.
- Naveed, M. et al. (2018). Chlorogenic acid (CGA): A pharmacological review and call for further research. *Biomedicine & Pharmacotherapy*, 97:67-74.
- Neves, J. V. G. das. et al. (2019). Total phenolic content and primary antioxidant capacity of aqueous extracts of coffee husk: Chemical evaluation and beverage development. *Food Science and Technology*, 39:348-353.
- Novia, R. et al. (2023). Karakteristik organoleptik produk RUTF (Ready to use Therapeutic Food) Berbentuk Bar untuk Mengatasi Masalah Malnutrisi Akut Berat pada Balita. *Jurnal Ilmu Gizi Indonesia (JIGZI)*, 4(1):1-6.
- Oktaviani, L. et al. (2020). Fermentation of coffee pulp using indigenous lactic acid bacteria with simultaneous aeration to produce cascara with a high antioxidant activity. *Heliyon*, 6(7):e04462.
- Rafiyanti, C. V. et al. (2018). Studi pembuatan es krim nabati dengan variasi sumber karbohidrat dan konsentrasi lesitin sebagai emulsifier. *Jurnal Ilmiah Mahasiswa Pertanian*, 3(3):486-496
- Rahmi, H. (2017). Review: Aktivitas antioksidan dari berbagai sumber buah-buahan di Indonesia. *Jurnal Agrotek Indonesia*, 2(1):34-38.
- Rosdy, N. M. M. et al. (2023). *Erosive potential and sugar content of popular beverages: A double whammy for dentition*. *International Journal of Dentistry*, 2023, 9924186.
- Septiwi, R. E., Ratnasari, D., & Handayani, R. P. (2019). Production of salam leaf tea bags (*Syzygium polyanthum*) with the addition of red ginger rhizome (*Zingiber officinale* Rosc. Var. *Rubrum*) for health. *Journal of Holistic and Health Sciences*, 3(1):46-53.
- Setyawan, A. B. (2019). The effectiveness of dayak onion tea in lowering blood pressure in hypertensive patients. seminar Ilmiah Nasional Teknologi, Sains, dan Sosial Humaniora (SINTESA), 2(1):245-259.
- Siagian, I. D. N., Bintoro, V. P., & Nurwantoro. (2020). Karakteristik fisik, kimia dan organoleptik teh celup daun tin dengan penambahan daun stevia (*Stevia rebaudiana* Bertoni) sebagai pemanis. *Jurnal Teknologi Pangan*, 4(1):23-29.
- Sinulingga, S. E. et al. (2021). Inovasi Pembuatan Teh Herbal dari Jantung Pisang dengan Tambahan Daun Stevia sebagai Pemanis Alami. *Jurnal Bios Logos*, 11(2):148-154.
- Shivanna, N. et al. (2013). Antioxidant, anti-diabetic and renal protective properties of *Stevia rebaudiana*. *Journal of Diabetes and Its Complications*, 27(2):103-113.
- Sumartini., Ikrawan, Y., & Muntaha, F. M. (2020). Analisis bunga telang (*Clitoria ternatea*) dengan variasi Ph metode liquid chromatograph-tandem mass spectrometry (LC-MS/MS). *Pasundan Food Technology Journal*, 7(2):70-77.
- Suroto, H. S., & Eldha, S. 2007. Analisa Kandungan Kimia dan Pemanfaatan Bawang Tiwai untuk Bahan Baku Industri. *Jurnal Riset Teknologi Industri*, 1(2):22-27.
- Wasiti, W. et al. (2018). Uji Aktivitas antibakteri ekstrak etanol bawang dayak (*Eleutherine palmifolia* (L.) Merr) terhadap Bakteri *Staphylococcus aureus*. *Jurnal Farmasi Indonesia*, 15(2):75-82.

World Health Organization - WHO. (2011). *Lead in drinking-water: Background document for Development of WHO Guidelines for Drinking-Water Quality*. World Health

Organization 27p. Available in: <https://cdn.who.int/media/docs/default-source/wash-documents/wash-chemicals/lead-background-feb17.pdf?sfvrsn=fc50727b_4>