

Formulation of Takokak Leaf Powder (*Solanum torvum* Swartz.) with Cinnamon and Palm Sugar as a Herbal Drink

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Abstract: Public health is increasingly becoming a major concern, especially in efforts to prevent disease through healthier and more natural consumption patterns. Herbal drinks have become one of the most widely developed alternatives because of their health benefits. Various medicinal plants have been traditionally used in folk medicine, including takokak leaves (*Solanum torvum* Swartz.), cinnamon (*Cinnamomum* spp.), and palm sugar (*Arenga pinnata*). Takokak leaves are known to contain bioactive compounds with potential antioxidant properties, while cinnamon and palm sugar contribute to enhancing palatability while enriching bioactive compounds. This study aims to formulate takokak leaf powder (*Solanum torvum* Swartz.) with cinnamon and palm sugar as a herbal beverage and evaluate its functional potential. This study is an experimental study with a completely randomized design (CRD) comprising six treatment combinations and one control. The results showed that the addition of cinnamon and palm sugar to the takokak leaf herbal beverage significantly affected the levels of flavonoids, phenols, tannins, and IC₅₀. Flavonoid levels ranged from 6.38 to 9.71 mg/100g, phenolic content ranged from 4.67 to 6.49 mg/100g, tannin content ranged from 3.74 to 7.19 mg/100g, and IC₅₀ values ranged from 19,293.34 to 42,290.50 ppm. The results also showed that all positive treatments contained alkaloid and saponin compounds. Based on the hedonic sensory test results, treatment P1 (2% cinnamon and 3% palm sugar) received the highest preference score compared to other treatments based on the parameters of color, aroma, taste, viscosity, and overall acceptance. These findings indicate the potential of takokak herbal beverage formulations as a source of natural antioxidants that are sensorially acceptable. Further research is recommended to evaluate takokak leaf herbal beverages with the addition of cinnamon and palm sugar in vitro and in vivo.

Keywords: Antioxidants; Cinnamon; Herbal Drinks; Palm Sugar; Takokak Leaf Powder.

Introduction

Public health is increasingly becoming a major concern, especially in efforts to prevent disease through healthier and more natural consumption patterns. Herbal drinks have become one of the most widely developed alternatives because of their health benefits. Various medicinal plants have been traditionally used in folk medicine, including takokak leaves (*Solanum torvum* Swartz.), cinnamon (*Cinnamomum* spp.), and palm sugar (*Arenga pinnata*). Takokak leaves are known to contain bioactive compounds such as flavonoids, alkaloids, tannins, and saponins, which have potential as antioxidants, anti-inflammatory agents, and antihypertensive agents [1]. However, the use of fresh takokak leaves has limitations in terms of shelf life and taste. Therefore, innovation in the form of powdered formulations is needed to make it more practical and appealing to consumers.

One of the attempts to enhance the palatability and health benefits of takokak leaf powder is by adding cinnamon and palm sugar. Cinnamon is a spice that has long been used as a traditional medicine due to its active compounds such as cinnamaldehyde, eugenol, and coumarin, which have antidiabetic and antimicrobial effects and can improve body metabolism [2]. Additionally, cinnamon can enhance the aroma and taste of herbal beverage formulations [3]. Meanwhile, palm sugar not only

serves as a natural sweetener but also contains minerals and bioactive compounds that provide additional health benefits, such as boosting energy and strengthening the immune system [4].

The processing of takokak leaves into herbal powder formulated with cinnamon and palm sugar aims to create a more practical product with better taste while retaining its health benefits. Proper formulation is crucial to ensure that the bioactive compounds in the ingredients remain intact during processing. Therefore, this study will examine the physical and chemical characteristics of the resulting powder, including the main phytochemical content that plays a role in its biological activity.

In addition to health aspects, the formulation of this herbal drink powder also has great economic potential. Products based on natural ingredients are increasingly in demand by the public as awareness of healthy lifestyles increases. With the right formulation, this herbal beverage can become a value-added product that can be further developed for the commercial market, both on an industrial scale and as an innovative home-based product.

This study aims to formulate takokak leaf powder with cinnamon and palm sugar as a herbal beverage and analyze the phytochemical content in the product. The specific objectives of this study are to develop a takokak leaf powder formulation as a herbal beverage that retains its efficacy based on traditional use in ethnomedicine, analyze

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the phytochemical compound content in takokak leaf powder to identify the presence of active compounds involved in traditional medicine, and evaluate consumer preference for the herbal beverage formulation. The urgency of this research lies in its contribution as a foundation for the development of herbal products based on natural ingredients that are more practical, nutritious, and beneficial for public health.

Research Methods

This study is an experimental study. The research design used is a completely randomized design with treatments varying in cinnamon and palm sugar concentrations. The experiment was conducted three times, resulting in 21 experimental units.

Table 1. Research Treatment Combinations

No	Combination	Cinnamon : Brown Sugar
1	P0	Control (0%:0%)
2	P1	2% : 3%
3	P2	2% : 6%
4	P3	2% : 9%
5	P4	4% : 3%
6	P5	4% : 6%
7	P6	4% : 9%

Product Making

Washing leaves is carried out to remove physical, chemical, and biological contaminants from the surface of the leaves. Washing is done using clean water. The leaves that have been washed clean are dried in the oven at 50 °C for 6 hours. The dried leaves are grinded into powder. Takokak leaf powder is mixed with cinnamon and palm sugar according to the treatment.

Flavonoid Analysis

0.1 g of concentrated sample extract was dissolved in 10 mL of methanol and then divided into four test tubes. The first tube was used as a control tube, the second tube was added with Mg powder, and the third tube was added with concentrated HCl, then heated in a water bath for 15 minutes, and the color of each tube was compared with the control tube. If the precipitate changes color to brown when Mg powder and amyl alcohol (C₅H₁₁OH) are added, and the precipitate changes color to dark red when HCl is added, then the sample is positive for flavonoids [17].

Phenol and Tannin Analysis

In the tannin/phenolic test, FeCl₃ reagent is added to the extract, causing a color change to dark green, indicating that the sample contains tannin/phenolic compounds [17].

Saponin Analysis

In the saponin test, a certain amount of extract is placed in a test tube, then 10 mL of hot water is added, cooled, and vigorously shaken for 10 seconds. The result is positive for saponins because foam forms to a height of 1 cm

for at least 10 minutes, and upon adding 1 drop of 2 N HCl, the foam does not disappear [17]

Alkaloid Analysis

The alkaloid test was performed using Mayer's reagent, Bouchardat's reagent, and Dragendorff's reagent. The concentrated extract reacted with Mayer's reagent, causing a color change and the formation of a white precipitate. When Bouchardat's reagent was added, a brownish-black precipitate formed, and when Dragendorff's reagent was added, an orange-yellow precipitate formed [17].

IC₅₀ Analysis

The IC₅₀ test using the DPPH method was performed by dissolving samples of takokak leaf powder, cinnamon, and palm sugar in methanol at various concentrations (10, 25, 50, 100, and 200 µg/mL). A 0.1 M DPPH solution was prepared in methanol and stored in the dark for 30 minutes. One milliliter of the sample solution was mixed with 1 mL of DPPH solution, shaken, and incubated in the dark for 30 minutes at room temperature. The absorbance of the solution was measured at a wavelength of 517 nm using a UV-Vis spectrophotometer, with a negative control consisting of DPPH solution without the sample [18]. The percentage of inhibition was calculated using the formula:

$$\% \text{ Inhibition} = \left(\frac{A. \text{Control} - A. \text{Sample}}{A. \text{Control}} \right) \times 100$$

The IC₅₀ value was obtained from a linear regression graph between sample concentration and inhibition percentage, with IC₅₀ indicating the concentration required to inhibit 50% of DPPH radicals. The smaller the IC₅₀ value, the stronger the antioxidant activity [18].

Hedonic Sensory Test

The hedonic sensory test was conducted by involving panellists to assess their preference for the product based on several attributes, namely color, aroma, taste, viscosity, and overall acceptance. The test was conducted with 20 untrained panellists aged 18-30 years. Sensory testing is carried out by taking into consideration the ethical aspect, which is that panellists participate in a transparent manner after being informed about the purpose and methodology of the study (informed consent). The samples are advised to be consumed carefully and to be aware of any potential allergies. Panellists have the right to refuse or discontinue participation at any time, and panellist data is kept confidential [19, 20].

Herbal beverage samples were prepared according to the formulation, then served in clean containers and randomly coded. Panellists were asked to taste each sample and rate it on a hedonic scale of 1–5, where lower numbers indicate dislike and higher numbers indicate preference. The test results were statistically analyzed to determine consumer acceptance of the tested formulation [21].

Data Analysis

The data obtained were statistically analyzed using Analysis of Variance (ANOVA), and if the results were

significantly different at $p \leq 0.05$, the analysis was continued with Duncan's multiple range test to examine the differences between treatments.

Results and Discussion

Flavonoids, Phenols, Tannins, and IC₅₀

Quantitative analysis was performed on flavonoids, phenols, tannins, and IC₅₀ parameters from seven samples

consisting of one control and six formulations of takokak leaf powder with cinnamon and palm sugar. The average results of the flavonoid, phenol, tannin, and IC₅₀ tests are presented in Table 2. The test data were then analyzed using the ANOVA method to determine significant differences between herbal drink formulations in terms of the parameters tested. The ANOVA test results are presented in Table 3.

Table 2. Mean \pm SD of Quantitative Phytochemical Test Results and Antioxidant Activity

Treatment	Flavonoids (mg/100g)	Phenols (mg/100g)	Tannins (mg/100g)	IC ₅₀ (ppm)
P0	6.81 \pm 0.002	4.67 \pm 0.001	3.74 \pm 0.002	42,290.50 \pm 0.014
P1	6.38 \pm 0.002	5.66 \pm 0.002	4.19 \pm 0.002	33,733.95 \pm 0.015
P2	7.84 \pm 0.001	5.77 \pm 0.002	5.07 \pm 0.001	33,612.95 \pm 0.012
P3	8.70 \pm 0.003	5.98 \pm 0.002	5.19 \pm 0.003	33,401.38 \pm 0.010
P4	9.04 \pm 0.002	6.15 \pm 0.003	5.95 \pm 0.003	33,089.15 \pm 0.011
P5	9.16 \pm 0.004	6.37 \pm 0.002	6.85 \pm 0.003	32,536.70 \pm 0.012
P6	9.71 \pm 0.002	6.49 \pm 0.003	7.19 \pm 0.003	19,293.34 \pm 0.017

Table 3. ANOVA Test Results

		Sum of Squares	df	Mean Square	F	Sig.
Flavonoid	Between Groups	28.521	6	4.754	9.787E5	.000
	Within Groups	.000	14	.000		
	Total	28.522	20			
Fenol	Between Groups	6.661	6	1.110	2.355E5	.000
	Within Groups	.000	14	.000		
	Total	6.661	20			
Tanin	Between Groups	29.823	6	4.970	9.404E5	.000
	Within Groups	.000	14	.000		
	Total	29.823	20			
IC ₅₀	Between Groups	8.225E8	6	1.371E8	7.801E11	.000
	Within Groups	.002	14	.000		
	Total	8.225E8	20			

Based on Table 3, it was found that the flavonoid content between treatments differed significantly ($p < 0.05$). The flavonoid content in the samples obtained ranged from 6.38 to 9.71 mg/100 g. In general, the addition of cinnamon and palm sugar can increase the flavonoid content of takokak leaf powder herbal drinks. The highest flavonoid content was obtained in sample P6 with a flavonoid content of 9.71 mg/100g.

The phenol results showed that the phenol content differed significantly between treatments ($p < 0.05$). The phenol content in the samples ranged from 4.67 to 6.49 mg/100g. In general, the addition of cinnamon and palm sugar can increase the phenol content of herbal powdered takokak leaf drinks. The highest phenol content was found in sample P6, at 6.49 mg/100g.

The tannin results showed that the tannin levels between treatments differed significantly ($p < 0.05$). The tannin content in the samples obtained ranged from 3.74 to 7.19 mg/100g. In general, the addition of cinnamon and palm sugar can increase the tannin levels in herbal

powdered takokak leaf drinks. The highest tannin content was obtained in sample P6, at 7.19 mg/100g.

The IC₅₀ results showed that IC₅₀ levels differed significantly between treatments ($p < 0.05$). The IC₅₀ values of the samples obtained ranged from 42,290.50 to 19,293.34 ppm. In general, the addition of cinnamon and palm sugar can reduce the IC₅₀ value of the herbal tea made from takokak leaf powder. The lowest IC₅₀ value was obtained in sample P6 with the highest addition of cinnamon and palm sugar (4%:9%), with a flavonoid content of 19,293.34 ppm.

Saponins and Alkaloids

Qualitative analysis was conducted for the saponin and alkaloid test parameters. This analysis aimed to determine the presence of saponin and alkaloid compounds in seven samples consisting of one control and six takokak leaf powder formulations with cinnamon and palm sugar. The results of the qualitative saponin and alkaloid tests are presented in Table 4.

Table 4. Qualitative Test Results of Saponins and Alkaloids

Treatment	Saponins (+ / -)	Alkaloids (+ / -)
P0	Positive (+)	Positive (+)
P1	Positive (+)	Positive (+)
P2	Positive (+)	Positive (+)
P3	Positive (+)	Positive (+)
P4	Positive (+)	Positive (+)
P5	Positive (+)	Positive (+)
P6	Positive (+)	Positive (+)

Qualitative testing for saponins showed that all samples from P0 to P6 were positive for saponins. In line with the saponin test results, alkaloid compounds were also consistently detected in all herbal beverage samples.

Sensory Testing

Sensory testing was conducted to determine consumer preference for various formulations of herbal beverages made from takokak leaves with the addition of cinnamon and palm sugar. The evaluation was based on five sensory parameters: color, aroma, taste, viscosity, and overall rating. The evaluation used a hedonic scale of 1–5, where a score of 1 indicated very dislike, a score of 2 indicated dislike, a score of 3 indicated somewhat like, a score of 4 indicated like, and a score of 5 indicated very like.

This test involved 20 untrained panellists as respondents to obtain a general overview of product acceptance. The results of the sensory testing are presented in Table 5.

Table 5. Mean Sensory Scores of Takokak Herbal Drink with Cinnamon and Palm Sugar

Treatment	Color	Aroma	Taste	Viscosity	Overall	Overall Average
P0	3.95	2.50	2.50	3.75	3.50	3.23
P1	4.55	3.85	4.60	4.40	4.45	4.37
P2	3.75	3.85	4.50	3.80	4.35	4.05
P3	2.75	3.50	4.10	3.50	3.35	3.43
P4	4.45	3.55	3.70	4.10	4.25	4.00
P5	2.85	3.55	4.10	4.15	3.75	3.67
P6	2.55	3.20	4.30	4.00	3.55	3.52

Description: 1= Strongly dislike; 2= Dislike; 3= Somewhat dislike; 4= Like; 5= Very like

Based on the sensory test results in Table 5, the average color score in the sensory test ranged from 2.55 to 4.55, the average aroma score ranged from 2.50 to 3.85, the average taste score ranged from 2.50 to 4.60, the average viscosity score ranged from 3.50 to 4.40, and the average overall score ranged from 3.35 to 4.45. The formulation with the highest overall score was P1, with an average overall score of 4.37.

Flavonoids are antioxidants derived from plant secondary metabolites and act as free radical scavengers [22]. The highest flavonoid content was found in sample P6 with the highest addition of cinnamon and palm sugar (4%:9%), with a flavonoid content of 9.71 mg/100g. The high flavonoid content in formulation P6 correlates with the raw material content. Takokak leaves are known to contain various bioactive compounds, including flavonoids, which are known to have pharmacological effects [8]. The increase in flavonoid content with the addition of cinnamon and palm sugar indicates that both ingredients positively contribute to the flavonoid compound content. Palm sugar is known to have a high flavonoid content of 22.15–43.19 ppm, while cinnamon extract contains a total flavonoid content of 60.546% EK [23, 24].

Phenols

Phenols are secondary metabolites in plants composed of aromatic rings with one or more hydroxyl groups [25]. The highest phenol content was found in sample P6 with the highest addition of cinnamon and palm sugar (4%:9%), amounting to 6.49 mg/100g. The high phenol content in formulation P6 correlates with the phenol content in the raw materials, including tekokak leaves, cinnamon, and palm sugar. Tekokak leaves are

known to have a higher phenol content than other parts, at 40.28 mg/g [26]. Cinnamon extract is known to have high phenolic compounds, reaching 75.685% EAG, thereby increasing the total phenol content of the formulation [24].

Tannins

Tannins are compounds composed of complex polyphenols, consisting of C, H, and O elements with large and heavy molecules [27]. The highest tannin content was obtained in sample P6 with the highest addition of cinnamon and palm sugar (4%:9%), amounting to 7.19 mg/100g. The high tannin content in formulation P6 correlates with the tannin content in the raw materials. Tannins are known to be abundant in plant parts such as leaves and bark, including takokak leaves and cinnamon bark [28]. Tannins are one of the secondary metabolites found in takokak leaves [29]. Cinnamon is also known to be a plant rich in bioactive compounds, one of which is tannins [24].

Saponins

Saponins are one type of secondary metabolite compound belonging to the glycoside and sterol groups found in plants and have numerous health benefits [30]. Qualitative testing for saponins showed that all samples from P0 to P6 were positive for saponins. The presence of saponins in herbal beverages originates from the bioactive compounds in takokak. Takokak is known to contain secondary metabolites such as flavonoids, alkaloids, saponins, triterpenoids, steroids, tannins, and glycosides [28]. The positive saponin test results are also attributed to the addition of cinnamon. Cinnamon extract is known

to contain antibacterial compounds, including saponins, tannins, alkaloids, quinones, and triterpenoids [31].

Alkaloids

Alkaloids are natural secondary metabolites found in plants and animals. These compounds have a cyclic structure containing one or more nitrogen atoms, which give them their characteristic properties [32]. Consistent with the saponin test results, alkaloid compounds were also detected in all herbal beverage samples from P0 to P6. The presence of alkaloids in herbal beverages stems from the bioactive compounds in takokak. Takokak is known to contain secondary metabolites such as flavonoids, alkaloids, saponins, triterpenoids, steroids, tannins, and glycosides [28]. The positive alkaloid test results were also due to the addition of cinnamon. Cinnamon extract is known to contain antibacterial compounds, including saponins, tannins, alkaloids, quinones, and triterpenoids [31].

IC₅₀

The IC₅₀ (Inhibition Concentration) value represents the concentration of the sample solution required to inhibit 50% of DPPH free radicals. A smaller IC₅₀ value indicates stronger antioxidant activity in neutralizing free radicals [33]. The IC₅₀ values of the samples ranged from 42,290.50 to 19,293.34 ppm. The IC₅₀ values of the samples showed a clear decreasing trend as the addition of cinnamon and palm sugar increased. The results show that the highest antioxidant activity was obtained in sample P6. This proves that the addition of cinnamon and palm sugar can enhance the antioxidant activity of the product. This antioxidant activity is derived from the antioxidant compounds present in all raw materials. Takokak is known to contain secondary metabolites that act as antioxidants [28]. Cinnamon also contains various bioactive compounds, such as cinnamaldehyde, eugenol, and coumarin, which have important pharmacological effects, including antioxidant effects. Cinnamon extract is known to have an IC₅₀ of 1.939 µl/ml [24].

Sensory Testing

The hedonic scale is an effective and simple method for assessing how much consumers like a product overall and is considered the most informative form of evaluation from the consumer's perspective [34]. Based on the sensory test results, formulation P1 obtained the highest score based on the overall average of sensory parameters compared to other formulations.

In terms of taste, P1 achieved the highest score (4.60), indicating that takokak leaf powder produced the most acceptable taste for panellists with the addition of 2% cinnamon and 3% brown sugar. The proper balance of ingredients in the formulation enhances panellist preference, while the addition of overly dominant ingredients can reduce preference [35]. In terms of aroma, formulations P1 and P2 had the same score of 3.83. This indicates that the mixture of cinnamon and palm sugar aroma at the concentrations in P1 and P2 is most

acceptable to consumers and does not overly dominate the product.

In terms of color, P1 also has the highest value (4.55), indicating that the product color in that formulation is considered most appealing by the panellists. In terms of viscosity, the highest value is also obtained by P1 with a score of 4.40, indicating that consumers prefer herbal beverages with a viscosity that is not too thick. In line with the other parameters, the highest overall acceptance score was obtained by P1 (4.45). Overall, these results indicate that the P1 formulation is the most preferred by panellists in terms of taste, aroma, color, viscosity, and overall acceptance.

Conclusion

The results of the study indicate that the addition of cinnamon and palm sugar to takokak leaf herbal drinks has a significant effect on flavonoid, phenol, tannin, and IC₅₀ levels. Flavonoid levels ranged from 6.38 to 9.71 mg/100g, phenolic content ranged from 4.67 to 6.49 mg/100g, tannin content ranged from 3.74 to 7.19 mg/100g, and IC₅₀ values ranged from 19,293.34 to 42,290.50 ppm. The study also showed that all positive treatments contained alkaloid and saponin compounds. Based on sensory test results, treatment P1 (2% cinnamon and 3% palm sugar) received the highest preference score compared to other treatments based on color, aroma, taste, viscosity, and overall acceptance parameters.

Author's Contribution

A A. Bulan Ginitri: as the principal researcher, research implementer, and data collector; Ida Ayu Mirah Agung: as data collector and data analyst.

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