International Journal on Food, Agriculture, and Natural Resources
Volume 04, Issue 03, Page 32-36
ISSN: 2722-4066
http://www.fanres.org

Original Paper

Acceptability and Antioxidant Activities of Jelly Drink Ginger (*Zingiber officinale* R.), Curcuma (*Curcuma xanthorriza* R.) and Turmeric (*Curcuma longa* L.) Extract as A Healthy Drink Alternative for People with Hypercholesterolemia

Ika Rosita Rahmawati [1*], *Asrul Bahar*[2]
1) *Departement of Nutrition, Surabaya State University, Surabaya, 60231, Indonesia*
*) *Corresponding Author: ika.19053@mhs.unesa.ac.id*

Received: 15 February 2023; Revised: 12 August 2023; Accepted: 15 August 2023
DOI: *https://doi.org/10.46676/ij-fanres.v4i3.159*

***Abstract*—This study aims to (1) determine the acceptability of ginger, curcuma and turmeric extract jelly drinks as an alternative healthy drink for people with hypercholesterolemia;(2) Knowing the best formula for ginger, curcuma and turmeric extract jelly drinks from the results of antioxidant activity tests. This study is an experimental study using a RAL design with 1 factor, namely the ratio of ginger, curcuma and turmeric extract (1:1:1, 2:1:1, 1:2:1, and 1:1:2). Data from hedonic test results and antioxidant activity tests were analyzed using 1-factor ANOVA test and continued with Duncan test with confidence intervals <0.05. The results of the hedonic test statistical analysis showed that the proportions of ginger, curcuma and turmeric extracts had no effect on the aroma, color, taste and thickness of the jelly drink. While the results of the statistical analysis of the antioxidant activity test showed that the proportions of ginger, curcuma and turmeric extracts had an effect on the antioxidant activity of the jelly drink. The best formula is ginger, curcuma and turmeric extract jelly drink (1:2:1) with the largest antioxidant activity of 77.52%.**

***Keywords*—Jelly drink, Ginger, Curcuma, Turmeric, Hypercholesterolemia**

I. INTRODUCTION

Heart disease or cardiovascular disease (CVD) is the main cause of death in the world. WHO estimates that 17.9 million people died from CVD in 2019, representing 32% of all deaths in the world [1]. The prevalence of heart disease based on a doctor's diagnosis in Indonesia is 1.5% [2]. There are several risk factors for coronary heart disease including smoking, hypertension, obesity, and cholesterol [3]. An increase in blood cholesterol levels beyond normal limits is usually called hypercholesterolemia.

One alternative non-pharmacological therapy to reduce total cholesterol levels in the blood is to consume foods with antioxidants [4]. Antioxidants play a role in reducing cholesterol levels by preventing the oxidation of fatty acids caused by free radicals. According to [5], when oxidation of fatty acids occurs, cholesterol will easily pass through the artery walls resulting in an increase in the amount of cholesterol in the blood. Antioxidants donate less electrons to free radicals to stabilize free radicals [6]. Sources of antioxidants can be obtained from herbal plants.

Ginger (Zingiber *officinale* R.) is a herbal plant with high antioxidant activity [33]. The antioxidant activity of ginger is obtained from the compounds gingerol, shaogaol, and gingeron. In addition, the antioxidant activity of ginger is higher than the antioxidant activity of vitamin E [7]. Emprit ginger oleoresin content is lower than red ginger but higher than elephant ginger [8]. Oleoresin is a component that plays a role in giving ginger a spicy taste. Therefore, this type of ginger is used as an ingredient for making jelly drinks.

Curcuma (Curcuma *xanthorriza* R.) and turmeric (Curcuma *longa* L.) also have high antioxidant activity obtained from the active component, namely curcuminoids [34]. The curcuminoid component gives the rhizome a yellow color to the two spices. [9], stated that curcuma has antioxidant content obtained from the active components contained in its rhizomes including, curcumin, demethoxycurcumin, and bisdemethoxycurcumin [10].

The use of ginger, curcuma and turmeric spices in the community is generally in the form of traditional herbal drinks. In addition, the jelly drink circulating in the community is generally made from fruit juice and has minimal nutritional value. Ginger, curcuma and turmeric extract jelly drink is an alternative healthy drink innovation for people with hypercholesterolemia. The addition of extracts of ginger, curcuma and turmeric in various proportions serves to add variety of flavors and increase functional value and is expected to produce good physicochemical characteristics of the jelly drink. Based on the description above, it is necessary to conduct research on acceptability based on indicators of aroma, color, taste and viscosity as well as antioxidant activity of ginger, curcuma and turmeric extract jelly drink as an alternative healthy drink for people with hypercholesterolemia.

II. Material and Methods

A. Materials

The materials used in this study were emprit ginger, curcuma and turmeric rhizomes from the Jambangan market in Surabaya, Indonesia, carrageenan and sugar.

B. Equipment

The equipment used in making jelly drinks includes blender, oven, digital scale, knive, basin, filter, pan, stove, gas, refrigerator, ladle, spoon, measuring cup and glove.

C. Reasearch Design

This study used a completely randomized design (CRD) with 1 factor, namely the proportion of ginger, curcuma and turmeric extracts (1:1:1, 2:1:1, 1:2:1 and 1:1:2). Details of the research design are presented in Table 1.

The data obtained were processed using 1-factor ANOVA test followed by Duncan test to show a significant effect with confidence intervals set at $p<0.05$. This study used antioxidant activity test to determine the best treatment.

TABLE I. Research design

Treatment	The proportion of Ginger, Curcuma, and Turmeric Extracts		
	Ginger Extract	Curcuma Extract	Turmeric Extract
F1	1	1	1
F2	2	1	1
F3	1	2	1
F4	1	1	2

Description: F1 = ginger extract: curcuma extract: turmeric extract (1:1:1); F2 = ginger extract: curcuma extract: turmeric extract (2:1:1); F3 = ginger extract: curcuma extract: turmeric extract (1:2:1); F4 = ginger extract: curcuma extract: turmeric extract (1:1:2)

D. Procedure

i. Production of ginger, curcuma, and turmeric extracts

Extract making begins with sorting or selecting good quality spices. After that, the skin of the spices is removed and weighed, then the spices are cut into small and thin pieces. Then, the spices are dried using an oven for ± 2 hours at a temperature of 50-60°C. After drying, the spices were blended with a mixture of water using a water and spice ratio of 1:3 and then filtered to obtain the extract.

ii. Production of jelly drink

Jelly drink was made by preparing and weighing the ingredients including the proportion of extracts of ginger, curcuma and turmeric based on treatment (1:1:1, 2:1:1, 1:2:1 and 1:1:2), 20% sugar and 0.3% carrageenan. The process of making jelly drinks consists of mixing, boiling and cooling. The mixed ingredients are ginger extract, curcuma extract, turmeric extract, sugar and carrageenan. After the ingredients have been mixed, it is continued with the boiling process until it boils at a temperature of 90-100°C. After boiling, the jelly drink is poured into a plastic cup and cooled at room temperature until the steam disappears and then a lid is placed on the cup. The next process is cooling in the refrigerator with a temperature of 1-4°C for 24 hours to form a gel in the jelly drink.

E. Analysis Method

The level of panelists' preference for jelly drinks was observed using the hedonic test. In the hedonic test, the panelists gave responses about the product being tested with 6 scale levels: strongly dislike (1), dislike (2), somewhat dislike (3), somewhat like (4), like (5) and like very much (6). Data were analyzed using 1-factor ANOVA test if the results of 1-factor ANOVA test show a real treatment effect, then Duncan test is performed. The best treatment is based on the antioxidant activity test. This research has been approved by the Health Research Ethics Commission of the Faculty of Dentistry, Airlangga University with ethics reference number 317/HRECC.FODM/VI/2022.

III. Result and Discussion

A. The level of preference for jelly drinks with extracts of ginger, curcuma and turmeric

i. Aroma

The results of the 1-factor ANOVA test showed that the proportions of ginger, curcuma and turmeric extracts does not have a significant effect on jelly drink aroma. This is because the calculated F value is 1.533 and a significance level of 0.207 (above $\alpha = 0.05$) so that the hypothesis which states the effect of the proportions of extracts of ginger, curcuma, and turmeric on the organoleptic properties of the aroma of jelly drink is rejected.

TABLE II. The result of the level of favorability of the aroma of jelly drink

Component	The Result of The Level of Favorability			
	1:1:1	***2:1:1***	***1:2:1***	***1:1:2***
Aroma	4.50^{a}±0.91	4.46^{a}±0.91	4.64^{a}±0.99	4.24^{a}± 0.98

Note: a,b = similar letter notation means no significant difference at the Duncan test level has a value of 5%.

Table 2 presents the analysis result of the aroma test of jelly drink obtained on means ranging from 4.24 to 4.64 (somewhat like to like). The highest mean was found in the 1:2:1 treatment with a value of 4.64, while the lowest mean for aroma was found in the 1:1:2 treatment with a value of 4.24.

Curcuma contains 6-10% essential oil, while the essential oil content of ginger and turmeric is 3.5% [9]-[11]. Essential oils are volatile components that determine the characteristics of spices, especially aroma [12]. The content of essential oils in curcuma extract is more than the other main ingredients, so the aroma of ginger, curcuma, and turmeric jelly drinks is dominated by the sharp aroma of curcuma, while the aroma of ginger and turmeric is masked by the aroma of curcuma which causes the evaluation of the aroma of jelly drink is not much different.

Research conducted by [13] stated that the aroma of the tamarind turmeric jelly drink was influenced by the main ingredients used such as turmeric and tamarind. While, research [14] found that the addition of ginger and curcuma rhizomes to kombucha rhizomes did not have a significant effect on the panelists' assessment of the aroma of kombucha rhizomes.

ii. Color

The results of the 1-factor ANOVA test showed that the proportions of ginger, curcuma and turmeric extracts does not have a significant effect on jelly drink color. This is because the calculated F value is 0.370 and a significance level of 0.775 (above $\alpha = 0.05$) so that the hypothesis which states the effect of the proportions of extracts of ginger, curcuma, and turmeric on the organoleptic properties of the color of the jelly drink is rejected.

TABLE III. THE RESULT OF THE LEVEL OF FAVORABILITY OF THE COLOR OF JELLY DRINK

Component	The Result of The Level of Favorability			
	1:1:1	***2:1:1***	***1:2:1***	***1:1:2***
Color	$4.48^{a}\pm1.13$	$4.36^{a}\pm1.12$	$4.58^{a}\pm1.01$	$4.52^{a}\pm 1.05$

Note: a,b = similar letter notation means no significant difference at the Duncan test level has a value of 5%.

Table 3 presents the analysis result of the color test of jelly drink obtained on means ranging from 4.36 to 4.58 (somewhat like to like). The highest mean was found in the 1:2:1 treatment with a value of 4.58, while the lowest mean for color was found in the 2:1:1 treatment with a value of 4.36.

The yellow color produced in turmeric and curcuma is a curcuminoid [15]. Curcuminoids are phenolic compounds with the main content of yellow curcumin found in rhizomes such as turmeric and curcuma [16]. The addition of ginger extract tends to increase the yellow color caused by the presence of oleoresin compounds which are yellow to dark brown in ginger rhizome [17].

The above statement is in line with research conducted by [17], which stated that the addition of ginger extract in different proportions to the white turmeric instant drink did not affect the color of the white turmeric instant drink, due to the yellow color of curcumin in the white turmeric and the yellow to dark brown color by oleoresin in ginger. Meanwhile, based on research conducted by [18], stated that the color of jelly drink was not significantly different between treatments because the color level of the jelly drink produced had almost the same color between treatments, thus causing difficulties for the panelists to determine which treatment is most preferred.

iii. Taste

The results of the 1-factor ANOVA test showed that the proportions of ginger, curcuma and turmeric extracts does not have a significant effect on jelly drink taste. This is because the calculated F value is 0.878 and a significance level of 0.453 (above $\alpha = 0.05$) so that the hypothesis which states the effect of the proportions of extracts of ginger, curcuma, and turmeric on the organoleptic properties of the taste of the jelly drink is rejected.

TABLE IV. THE RESULT OF THE LEVEL OF FAVORABILITY OF THE TASTE OF JELLY DRINK

Component	The Result of The Level of Favorability			
	1:1:1	***2:1:1***	***1:2:1***	***1:1:2***
Taste	$4.20^{a}\pm1.23$	$3.94^{a}\pm1.20$	$4.34^{a}\pm1.26$	$4.10^{a}\pm 1.39$

Note: a,b = similar letter notation means no significant difference at the Duncan test level has a value of 5%.

Table 4 presents the analysis result of the taste test of jelly drink obtained on means ranging from 3,94 up to 4.34 (somewhat like to like). The highest mean was found in the 1:2:1 treatment with a value of 4.34, while the lowest mean for color was found in the 2:1:1 treatment with a value of 3.94.

Curcuma extract has a slightly spicy bitter taste with a bitter aftertaste [18][19], the bitter taste in curcuma is caused by the presence of starch fraction, essential oil, and curcuminoid which are extracted a lot [21]. Ginger has a spicy taste obtained from its main constituent, namely oleoresin which consists of a gingerol component [22]. Meanwhile, turmeric extract has a distinctive taste including bitter, spicy and tart due to the curcumin content [23]. Thus the addition of extracts of ginger, curcuma, and turmeric in different proportions did not affect the change in taste of the ginger, curcuma, and turmeric jelly drinks.

This statement is in line with research conducted by [21], on herbal drinks with the treatment of red ginger : white turmeric and red ginger : curcuma obtained in the taste preference test had no significant effect, with averages ranging from 3.10 (somewhat like) to 3.50 (somewhat like).

iv. Viscosity

The results of the 1-factor ANOVA test showed that the proportions of ginger, curcuma and turmeric extracts does not have a significant effect on jelly drink viscosity. This is because the calculated F value is 1.545 and the significant level is 0.204 (above $\alpha = 0.05$) so that the hypothesis which states the effect of the proportions of extracts of ginger, curcuma, and turmeric on the organoleptic properties of the viscosity of the jelly drink is rejected.

TABLE V. THE RESULT OF THE LEVEL OF FAVORABILITY OF THE VISCOSITY OF JELLY DRINK

Component	The Result of The Level of Favorability			
	1:1:1	***2:1:1***	***1:2:1***	***1:1:2***
Viscosity	$4.92^{a}\pm0.78$	$4.62^{a}\pm0.97$	$4.88^{a}\pm0.87$	$4.64^{a}\pm 0.94$

Note: a,b = similar letter notation means no significant difference at the Duncan test level has a value of 5%.

Table 5 presents the analysis result of the viscosity test of jelly drink obtained on means ranging from 4.62 to 4.92 (Somewhat like to like). The highest mean was found in the 1:1:1 treatment with a value of 4.92, while the lowest mean for color was found in the 2:1:1 treatment with a value of 4.62.

The proportions of ingredients and water in the production of extracts of ginger, curcuma and turmeric are the same, namely 1:3 (ingredient: water). And the proportion of carrageenan in the manufacture of jelly drink is the same at 0.3%. Carrageenan is the result of red seaweed extract, which is not assimilated by the human body, only contains fiber, but provides unique functional characteristics that can be used as a gelling agent [24]. So that the addition of extracts of ginger, curcuma, and turmeric in different proportions did not affect changes in the taste of ginger, curcuma and turmeric jelly drinks.

This statement is in line with research conducted by [25], that the viscosity of starfruit jelly drink is affected by the treatment of the proportion of starfruit : water and differences in carrageenan concentrations. Meanwhile, based on research conducted by [26], stated that the addition of curcuma extract with different proportions does not have a significant effect on jelly drink viscosity.

B. Chemical Test of Ginger, Curcuma and Turmeric Extract Jelly Drink

i. Antioxidant Activity

The results of the 1-factor ANOVA test showed that the proportions of ginger, curcuma and turmeric extracts does have a significant effect on jelly drink antioxidant activity. This is because the calculated F value is 24.387 and the significant level is 0.005 (below $\alpha = 0.05$) so that the hypothesis which states the effect of the proportions of extracts of ginger, curcuma, and turmeric on the antioxidant activity of jelly drink is accepted. To find out the differences in the antioxidant activity of ginger, curcuma, and turmeric extract jelly drinks, further tests must be carried out using Duncan test.

TABLE VI. ANTIOXIDANT ACTIVITY RESULTS OF GINGER, CURCUMA, AND TURMERIC JELLY DRINKS

Component	The Result of The Level of Favorability			
	1:1:1	*2:1:1*	*1:2:1*	*1:1:2*
Antioxidant Activity (%)	$53.33^{a}\pm1.73$	$67.98^{b}\pm0.25$	$77.52^{c}\pm1.39$	$69.83^{bc}\pm5.34$

Note: a,b = similar letter notation means no significant difference at the Duncan test level has a value of 5%.

Table 6 presents the analysis result of the antioxidant activity of jelly drink obtained on means ranging from 53.33% to 77.52%. The highest mean was found in the 1:2:1 treatment with a value of 77.52%, while the lowest mean for antioxidant activity was found in the 1:1:1 treatment with a value of 53.33%.

The best jelly drink product in terms of antioxidant activity is known based on the results of Duncan's further test by looking at the highest subset average value. It was concluded that the 1:2:1 treatment was the best product formula with an average value of 77.52%. The greater the proportion of curcuma extract used, the higher the antioxidant activity of the jelly drink. This is related to the antioxidant activity found in curcuma more than in ginger and turmeric.

This statement is in line with research conducted by [27], that instant curcuma has higher antioxidant activity compared to instant turmeric with an average of 82.72% in instant curcuma and instant turmeric with an average of 76.67% with a ratio of powder and ethanol 1: 9 due to high levels of curcumin and demethoxy curcumin in curcuma.

Consuming spices is one of the nutritional therapies that can be carried out in patients with hypercholesterolemia which is reported to affect the reduction of cholesterol levels [28]. The antioxidant effect on volatile, non-volatile compounds, flavonoids, and polyphenols can prevent the presence of free radicals in the body [28]. In conditions of hypercholesterolemia there is an increase in the amount of reactive oxygen (ROS), and the presence of excess free radicals causes degenerative diseases such as heart disease, hypertension, and cancer [29]. Ginger contains flavonoids and polyphenols which are antioxidant compounds that can prevent cell damage caused by free radicals. Curcuma extract contains curcuminoids which function as antioxidants [8]. Meanwhile, turmeric contains the active substance curcumin which prevents fat peroxidation to protect the body from several degenerative diseases [30]. Thus, presenting a jelly drink with extracts of ginger, curcuma and turmeric which are high in antioxidants, have an effect on hypercholesterolemia sufferers by reducing free radicals in the body, thereby preventing degenerative diseases, one of which is heart disease.

IV. CONCLUSION

The proportions of ginger, curcuma and turmeric extracts did not affect the acceptability of the jelly drink which included aroma, color, taste and viscosity. Meanwhile, the proportion of extracts of ginger, curcuma, and turmeric had an effect on the antioxidant activity of the jelly drink. The best formula is ginger, curcuma and turmeric extract jelly drinks 1:2:1 with the highest antioxidant activity of 77.52%.

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