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The Effect of the Use of Jackfruit Juice (Artocarpus heterophyllus) in the Making of Cendol on Physical Properties and Sensory Quality

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Abstract
This study aims to analyze the effect of the use of jackfruit juice (Artocarpus heterophyllus) in the manufacture of cendol on physical properties and sensory quality. The background of this study is based on the high use of synthetic dyes in cendol which is risky to health. Jackfruit juice was chosen because it contains natural pigments of carotenoids that can function as a coloring as well as add to the distinctive aroma and taste of the fruit. This research was conducted at the Food Processing Laboratory and the Food Materials Engineering and Analysis Laboratory, Culinary Education Study Program, Faculty of Engineering, State University of Jakarta. The study used an experimental method with a Complete Random Design (RAL), consisting of three treatments of jackfruit juice concentration (50%, 60%, and 70%). The physical trait test included color and elasticity, while the sensory quality test included color, aroma, taste, surface texture and elasticity using hedonic methods by somewhat trained panelists. The results of the statistical hypothesis test with the Anova test showed that the use of jackfruit juice did not have a significant effect on physical properties, namely the color test with a range of 30.78 – 33.00 and the elasticity test with a range of 9.83 – 15.5. The sensory quality statistical hypothesis test with the Kruskall Wallis test showed that the use of jackfruit juice had a significant effect on the color aspect and there was a real difference which was continued by the Tuckey's Test with the best percentage of 70% while other aspects namely taste, aroma, surface texture and chewiness there were no significant real differences. The conclusion of this study is that jackfruit juice can be used as a natural dye and flavor that significantly improves the physical and sensory quality of cendol.
Keywords: *Cendol, jackfruit juice, natural dyes, sensory quality, physical properties.*

INTRODUCTION

Cendol is generally green in color, made from extracts of *suji* leaves and *pandan* leaves. The *cendol* dough is given food coloring and *suji* leaf water to make it look more attractive, while the aroma of *pandan* leaves also enhances flavor enjoyment (Zuhdiyah et al., 2024). According to *Permenkes RI* No. 772/Menkes/Per/IX/1998, coloring agents are additives used to enhance or change the color of food. There are two types of dyes: natural dyes (derived from plants, vegetables, and fruits) and synthetic dyes (generally derived from chemical substances). The chemical content in food coloring is safe to consume in certain amounts; however, coloring agents that are unsuitable or unsafe pose health risks (Zuhdiyah et al., 2024). In making *cendol*, most vendors use synthetic dyes that are unsafe for consumption, resulting in brightly colored *cendol* that attracts consumers. The dye used often contains Rhodamine B, a substance derived from textile dyes, whose use in processed food products is prohibited. According to the Decree of the Director General of *POM* No. 00386/C/SK/II/90, which amends the attachment of *Permenkes* No. 239/Men.Kes/PER/V/85, certain dyes are declared hazardous to health (PISTANTY, 2012).

Due to the importance of coloring in processed foods, it is recommended that consumers choose natural dyes, which are safer to consume and contain beneficial health components

(Ampatzoglou et al., 2022; Fitriani & Zahrulianingdyah, 2022; La Quintana & Paucar-Menacho, 2020; Ren & Zhou, 2021; Zhang et al., 2021). Natural dyes are found in fruits, vegetables, and plants. One fruit with the potential as a source of natural dye is jackfruit. Jackfruit contains carotenoid pigments natural pigments responsible for reddish-yellow coloration and the carotene content increases with ripeness (Anaya-Esparza et al., 2018; Chhotaray & Priyadarshini, 2022; Gupta et al., 2023; Jadhav et al., 2021; S et al., 2022). Therefore, jackfruit can be used as a natural coloring in processed foods, particularly in the form of fruit juice. Beyond its coloring function, jackfruit juice adds nutritional value to *cendol*, particularly potassium, which supports heart health, electrolyte fluid balance, and blood pressure regulation (Biworo et al., 2015; Saha, 2016; Santana Andrade et al., 2022).

Previous research by Zuhdiyah et al. (2024) highlighted the widespread use of synthetic dyes in food products such as *cendol*, which often contain harmful substances like Rhodamine B, and emphasized the importance of substituting them with natural dyes to improve food safety. However, that study was limited to discussing the dangers of synthetic dyes without empirically testing natural alternatives in food product formulations. Meanwhile, a study by Ranasinghe et al. (2019) demonstrated that jackfruit contains carotenoid pigments with potential as natural dyes but did not explore their practical application in traditional food products like *cendol*. These studies leave a research gap regarding the applicative effectiveness of jackfruit as a natural dye that is safe, nutritious, and sensory-preferred. Therefore, this study aims to fill that gap by empirically testing the effect of jackfruit juice on the physical properties (color, texture, viscosity) and sensory quality (color, taste, aroma, and overall liking) of *cendol*. This research seeks to provide scientific evidence that jackfruit juice can serve as an innovative substitute for synthetic dyes in traditional foods enhancing food safety, nutritional value, and consumer appeal—while also tapping into the local economic potential of jackfruit.

METHOD

This study is an experimental study using a *Complete Random Design (RAL)*. The treatment consisted of three percentages of jackfruit juice: 50%, 60%, and 70%. The research was conducted at the Food Processing Laboratory and the Food Engineering and Analysis Laboratory, Culinary Education Study Program, State University of Jakarta. The physical properties analyzed included color measured using the Adobe Photoshop CS6 application—and elasticity, measured using a texture analyzer. Sensory quality was evaluated through hedonic tests assessing color, aroma, taste, surface texture, and elasticity, involving 45 moderately trained panelists. Data on physical traits were analyzed using one-way *ANOVA*, while sensory quality data were analyzed using the *Kruskal-Wallis* test, followed by *Tukey's* post-hoc test.

RESULTS AND DISCUSSION

Color Test Hypothesis Results

The color test was carried out with the CIE parameter L*a*b* and then analyzed using the application *Adobe Photoshop* CS6. Each product treatment was taken using a Fujifilm XT 4

camera in the sun three times. The measured parameter is L* = *Lightness*/Brightness; a* = red-green horizontal axis; b* = yellow-blue vertical axis.

Data from the measurement results of the color test of cendol products showed that the use of jackfruit juice with 50% treatment produced the lowest average of 30.78. The use of jackfruit juice with 60% treatment is enough to get a high average value of 33.00. Meanwhile, the use of 70% treated jackfruit juice produced the highest average of 33.33. The data from the hypothesis test on the cendol color test using jackfruit juice are presented as follows:

Table 1. Hypothesis Test

SK	Db	JK	KT	Calculation	Ftable
Treatment	2	34,741	17,37	0,027	3,403
Error	24	15333,6	638,898		
Total	**26**	**15368,3**	**656,268**		

Based on the results of the calculation of the one-way anova test, it was obtained that the value of $F_{was\ calculated} < F_{table}$, so that the null hypothesis (H_0) was accepted and the alternative hypothesis (H_1) was rejected. This shows that the variation in the percentage of jackfruit juice does not have a significant influence on the color level in the cendol use of jackfruit juice.

Hypothesis Results of Elasticity Test

The chewiness test is an objective test that aims to determine the quality of cendol products with the use of jackfruit juice based on the level of chewiness. This measurement uses *a texture analyzer*.

The chewiness test showed that the use of jackfruit juice with 50% treatment had the highest average value of 15.5. Meanwhile, the use of jackfruit juice with a treatment of 60% has a slightly lower average value of 14.5. The lowest average score was 9.83 in the 70% treatment. The results of hypothesis testing the elasticity test variables are presented in the following table:

Table 2. Hypothesis Test

SK	Db	JK	KT	Calculation	Ftable
Treatment	2	38,222	19,111	0,488	5,143
Error	6	234,833	39,139		
Total	8	273,056	58,25		

Referring to the data of the test table of the decision of the elasticity test, it was obtained that the value of $F_{was\ calculated} < F_{table}$, so that the null hypothesis (H_0) was accepted and the alternative hypothesis (H_1) was rejected. Thus, the percentage of jackfruit juice did not have a significant effect on the purity test in cendol using jackfruit juice.

Sensory Quality Test Hypothesis Test Results

Sensory quality testing was carried out to obtain cendol quality assessment data with the use of jackfruit juice based on three treatments, namely 70%, 60%, and 50%. The organoleptic

assessment includes five aspects of product quality assessment, the results of which are described in the following section:

Color Aspect

Table 3. Hypothesis Test

Rating Scale	Score	Percentage of Fruit Juice					
		70%		60%		50%	
		n	%	n	%	n	%
Yellow	5	6	40	0	0	0	0
Slightly Yellow	4	8	53,33	5	33,33	4	26,67
Less Yellow	3	1	6,66	10	66,67	8	53,33
Not Yellow	2	0	0	0	0	3	20
Very Not Yellow	1	0	0	0	0	0	0
Sum		**15**	**100**	**15**	**100**	**15**	**100**
Mean		**4,33**		**3,33**		**3,07**	

Based on the average value of the panelists' assessment results, it can be concluded that cendol with a percentage of jackfruit juice of 50% and 60% is categorized as having a color intensity that is less yellow close to a bit yellow. Meanwhile, cendol with a percentage of jackfruit juice of 70% has an intensity of yellow color close to slightly yellow to less yellow.

The results of hypothesis testing using the Kruskal-wallis test, it is known that the value of X^2 is calculated more than the value of X^2 table. This shows that H_0 is accepted and H_1 is rejected so that the conclusion that can be drawn is that there is an influence of the percentage of jackfruit juice on the aspect of the color of cendol using jackfruit juice. Therefore, to find out the difference in each treatment or which treatment is different, this test is continued with a follow-up test. The results of the advanced test calculation with the Tuckey test can be seen in the following table:

Table 4. Tuckey test

The Difference of Each Treatment	Result	Decision
|A-B|=|4.33-3.33|=1	1 > 0.17	Real differences
|A-C|=|4.33-3.07|=1.26	1.26 > 0.17	Real differences
|B-C|=|3.33-3.07|=0.26	0.26 > 0.17	Real differences

Information:

A = Cendol consumption of jackfruit juice 70%

B = Cendol use of jackfruit juice 60%

C = Cendol use of jackfruit juice 50%

Referring to the table of the calculation results of the Tuckey's test, A > B, A > C, and B > C. Therefore, it can be concluded that A, namely cendol, the use of 70% jackfruit juice is the best treatment in the aspect of cendol color.

Taste Aspect

Table 5. Tuckey test

Rating Scale	Score	Percentage of Fruit Juice					
		70%		60%		50%	
		n	%	n	%	n	%
It Feels Like It	5	5	33,33	2	13,33	2	13,33
It feels a bit like that.	4	4	26,67	5	33,33	7	46,67
Less Than Enough	3	4	26,67	6	40	4	26,67
It doesn't feel like that	2	2	13,33	2	13,33	2	13,33
It doesn't feel so bad	1	0	0	0	0	0	0
Sum		**15**	**100**	**15**	**100**	**15**	**100**
Mean		**3,8**		**3,467**		**3,6**	

Based on all the data obtained, it can be concluded that the highest taste quality is found in cendol with a percentage of jackfruit juice of 70% which is classified in the jackfruit flavor assessment scale. Meanwhile, cendol with a percentage of jackfruit juice of 60% and 50% showed a relatively lower taste quality, namely tasting on the scale of the assessment of less jackfruit flavor towards a slightly jackfruit flavor.

In line with the results of hypothesis testing through the kruskall wallis method, it is known that the value of X^2 table is higher than the value of X^2 calculated. These findings indicate that the zero hypothesis (H_0) is accepted, while the alternative hypothesis (H_1) is rejected. Thus, the results of the analysis showed that there was no significant influence between treatment groups on the taste aspect.

Aroma Aspect

Table 6. Tuckey test

Rating Scale	Score	Percentage of Fruit Juice					
		70%		60%		50%	
		n	%	n	%	n	%
Smelling Like A Tree	5	12	80	11	73,33	14	93,33
A bit of a smell like that	4	2	13,33	4	26,67	1	6,67
Less Than Enough	3	1	6,67	0	0	0	0
It doesn't smell like a snake	2	0	0	0	0	0	0
Very Unscented Jackfruit	1	0	0	0	0	0	0
Sum		**15**	**100**	**15**	**100**	**15**	**100**
Mean		**4,73**		**4,73**		**4,93**	

Based on the average score obtained, it can be concluded that the majority of panelists assessed cendol with a percentage of jackfruit juice of 50% in all three percentages having aroma quality with a jackfruit-flavored assessment aspect.

Analyzing the results of hypothesis testing using the Kruskall Wallis analysis method, a lower value of X^2 calculation was obtained compared to the value of X^2 tables. This shows that the

null hypothesis (H_0) is accepted, while the alternative hypothesis (H_1) is rejected. Thus, it can be concluded that the percentage of jackfruit juice used does not have a significant influence on the sensory quality of the aroma aspect.

Surface Texture Aspect

Table 7. Tuckey test

Rating Scale	Score	Percentage of Fruit Juice					
		70%		60%		50%	
		n	%	n	%	n	%
Soft	5	6	40	5	33,33	9	60
Somewhat subtle	4	5	33,33	5	33,33	4	26,67
Less Refined	3	4	26,67	4	26,67	2	13,33
Not Smooth	2	0	0	1	6,67	0	0
Very Unrefined	1	0	0	0	0	0	0
Sum		**15**	**100**	**15**	**100**	**15**	100
Mean		**4,13**		**3,93**		**4,46**	

Looking at the overall average of the panelists' assessments, it can be concluded that the surface texture aspect of cendol with a percentage of jackfruit juice of 70% and 50% obtained the same assessment aspect, which is rather smooth to smooth. Meanwhile, cendol with a percentage of 60% jackfruit juice shows a surface texture in the assessment aspect that is not smooth to close to somewhat smooth.

Judging from the results of the hypothesis test on the texture aspect, it is known that the value of X^2 calculation does not exceed the value of X^2 of the table. Thus, the decision taken is to accept the null hypothesis (H_0) and reject the alternative hypothesis (H_1). This decision indicates that the percentage of jackfruit juice used did not have a significant effect on the sensory quality of surface texture between treatment groups.

Elasticity Aspect

Table 8. Tuckey test

Rating Scale	Score	Percentage of Fruit Juice					
		70%		60%		50%	
		n	%	n	%	n	%
Supple	5	4	26,67	3	20	3	20
Slightly chewy	4	9	60	5	33,33	8	53,33
Less Chewy	3	2	13,33	6	40	4	26,67
Not Chewy	2	0	0	1	6,67	0	0
Highly Chewy	1	0	0	0	0	0	0
Sum		**15**	**100**	**15**	**100**	**15**	**100**
Mean		**4,13**		**3,67**		**3,93**	

Overall, the chewiness aspect of cendol with a percentage of jackfruit juice of 60% and 50% in the assessment aspect of slightly chewy is close to chewy and cendol with a percentage of jackfruit juice of 70% is assessed as chewy on average.

Based on the results of the analysis of the Kruskall Wallis test that has been carried out, it was obtained that the value of X^2 is calculated to be smaller than the X^2 table, which indicates that the null hypothesis (H_0) is accepted, while the altrative hypothesis (H_1) is rejected. Thus, it can be concluded that the percentage of jackfruit juice does not have a significant influence on the sensory quality of the chewiness of cendol.

CONCLUSION

The use of jackfruit juice in making *cendol* does not have a significant effect on the physical properties of color and suppleness. However, in the sensory aspect, jackfruit juice has a significant effect on the color, particularly at the 70% concentration, which imparts a strong yellow to slightly yellow hue. Thus, jackfruit juice can be used as a natural alternative for coloring and flavoring in the innovation of traditional beverage products, making them healthier and more visually appealing.

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