The effect of various sweeteners on the physical, chemical, and organoleptic characteristics of ginger leaf extract syrup

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FULL PAPER

The effect of various sweeteners on the physical, chemical, and organoleptic characteristics of ginger leaf extract syrup

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Abstract

The ginger leaf is an underutilized component of the ginger plant that contains antioxidant chemicals in the form of terpenoids, phenols, and flavonoids, making it effective as a free radical inhibitor. To improve the advantages of ginger leaves, it may be utilized as a food supplement product in the form of syrup as an alternative in product development. The purpose of this study was to determine the effect of sweeteners on the physical properties (viscosity), chemical properties (pH, total phenol, and antioxidant activity), and organoleptic properties of ginger leaf extract syrup (SEDJ), as well as the optimal type of sweetener to generate the most favoured syrup. With five repeats, this study employed a range of sweeteners, including T_1 (sorbitol), T_2 (sucrose), T_3 (HFS), and T_4 (honey). The results revealed that sweetener usage in SEDJ had a significant influence ($p<0.05$) on the pH, viscosity, and organoleptic properties of ginger leaf extract. Based on the highest level of panellist preference, SEDJ with honey sweetener is the best treatment that is nutritious as an antioxidant.

1. Introduction

The ginger plant (*Zingiber officinale*) is one of the biopharma plants of the rhizome group, and its availability is very copious in Indonesia. The demand for ginger rhizomes is expected to rise by 2.91%, annually, thus, of course, will also produce a lot of waste from ginger farmlands, i.e. leaves. The component of the ginger leaf that contains antioxidants that are beneficial to health has not been effectively utilized (Sivasothy *et al*., 2012). Earlier studies reported that the antioxidant content of ginger leaves was rather high at 291±18 mg GAE/100 g of the wet base with the highest antioxidant compounds including flavonoids and phenols (Chan *et al*., 2011). The antioxidant content of ginger leaf extract can effectively reduce cell viability in colorectal cancer cells and human breast cancer cells (Susanti *et al*., 2017). Examining the function of ginger leaf extract content, it may be utilized as an alternative for producing functional goods, one of which is as a dietary supplement or food supplement, particularly for health.

Food supplements as an alternative form of health food in the form of capsules, tablets, powders, or liquids whose health effects are usually associated with the cumulative effects of bioactive compounds in them (Pereira *et al*., 2013). Food supplements in capsule form are widely circulated in the community and are not preferred. Therefore, it is essential to create supplement products that are preferred and easy to consume, one of which is syrup.

The syrup was chosen because the formulation is relatively preferred, has a sweet taste, and is more easily absorbed by the body than capsules or tablets (Prawesty *et al*., 2017). Typically, syrup preparations are processed to include additional ingredients such as sweeteners and thickeners (Goldfein and Slavin, 2015). Natural sweeteners that are commonly found on the market include sorbitol, sucrose, high fructose syrup (HFS), and honey. Each type of sweetener has distinct properties and contents. The syrup is typically made with sorbitol or sucrose, which leaves a bitter aftertaste at the back of the

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tongue. As a result, extensive research on various types of sweeteners is required.

The purpose of this study was to determine the effect of sweetener use on viscosity, pH value, total phenol, antioxidant activity, and organoleptic SEDJ, as well as the optimal type of sweetener to produce the most preferred syrup. SEDJ has the prospect to be a new functional syrup product for wellness.

2. Materials and methods

2.1 Ginger leaf extract preparation

The maceration method is used to obtain ginger leaf extract. Ginger leaf powder was macerated with 80% of methanol in a 1:10 ratio. The powder is soaked in 80% methanol for 72 hrs and shaken every 6 hrs during the first maceration. After 24 hrs, the macerate is filtered with filter paper. After that, the macerate was soaked again with 80% methanol for 24 hrs while being shaken out, and then it was filtered. The total macerates obtained were evaporated using a rotary vacuum evaporator until a viscous extract was produced (Susanti *et al.*, 2017).

2.2 Ginger leaf extract syrup preparation

First, 3% of ginger leaf extract was weighed for each treatment. By diluting before producing syrup, the value of sugar water content is equivalent to 29.85%. The liquid was homogenized after being mixed with 0.5% CMC and 0.3% citric acid. The ginger leaf extract is created by combining 11% propylene glycol with 3% extract and then stirred until homogenous. The ginger leaf extract solution is mixed until homogenous. After that, SEDJ is placed in a container and evaluated for pH, viscosity, total phenol, antioxidant activity, and organoleptic activity.

2.3 Physical and chemical characterization of ginger leaf extract syrup

2.3.1 Viscosity

Viscosity was measured using the Ostwald pipe method (Raju *et al.,* 2020). The viscosity was tested by calculating the syrup with a pycnometer. The next test was to measure the aquadest flow time using 10 mL of distilled water drawn into the Ostwald pipe until the mark is at the top. The sinking aquadest's time is counted until the mark reaches the bottom. The flow time of syrup samples is measured using the same method in the next test.

2.3.2 pH value

The pH value of the sample was measured using a pH meter that was standardized with a buffer solution of pH 4.0 and pH 7.0 (AOAC, 2013).

2.3.3 Total phenol

Total phenol was analyzed by a UV-Vis Spectrophotometer at a wavelength of 765 nm (Yasser *et al.,* 2020). SEDJ was weighed at 0.3 mL and then dissolved to 10 mL with methanol: water (1:1). A total of 0.2 mL of syrup solution was pipetted, followed by 15.8 mL of water and 1 mL of Folin-Ciocalteu reagent. The solution was then permitted to stand for 8 mins before adding 3 mL of 20% Na_2CO_3 to the mixture. The solution was then left to remain for 2 hrs at room temperature before the absorption was measured.

2.3.4 Antioxidant activity

Antioxidant activity measurement refers to 2,2-diphenyl-1-picrylhydrazyl (DPPH). Sample testing was carried out by means of 50, 100, 150, and 200 μL pipettes using a micropipette. Each sample was placed in a test tube and DPPH M 3.8 mL was added to the vortex. For 30 mins, the sample is placed in a dark environment. A UV-Vis spectrophotometer was used to test the sample's absorbance at 515 nm (Kasote *et al.,* 2019). The value of antioxidant activity (IC_{50}) of each sample concentration is determined according to the quadratic equation y = a + bx. The value of x is the concentration, and the value of y is the absorbance of the sample (Cai *et al.,* 2019).

2.4 Organoleptic characterization of ginger leaf extract syrup

The organoleptic of SEDJ was tested by the ranking test method followed by a hedonic test with twenty-five panellists. The ranking test was conducted according to Salleh *et al.* (2020) by evaluating the sample code column by sorting ranks from 1 to 4. Criteria with rank 1 show the highest intensity while ranking 4 shows the lowest intensity. The hedonic test is carried out according to Singh *et al.* (2018) on the preference for colour, taste, aroma, thickness, and overall SEDJ. The scale of the score used is 1-4, which means dislike-like.

2.5 Statistical analysis

Data on the results of testing total phenol and antioxidant activity were analysed descriptively. Analysis of the data from the results of the viscosity test and pH of SEDJ is the Analysis of Variance (ANOVA) test with a significance level of 5%, and if there is a significant effect, then a further test is performed using the Duncan Multiple Range Test (DMRT) tests. The organoleptic test parameters were analysed using non-parametric Kruskall-Wallis with a significance level of 5%, and if there was an effect, followed by the Mann-Whiteney test. All data analysis was calculated with the help of the SPSS 16.0 for the Windows computer

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program.

3. Results and discussion

3.1 Physical properties of ginger leaf extract syrup

Physical properties evaluated on SEDJ consist of the amount of viscosity, dissolved solids and pH levels. Viscosity is an important parameter for syrup products because it can influence the product's microbial stability (Hamzeloo-Moghadam *et al.,* 2015). According to Table 1, the results obtained from this study on syrup viscosity utilizing sweeteners have a significant effect ($p<0.05$). SEDJ T_1 produces the highest viscosity, whereas SEDJ T_2 produces the lowest viscosity. The quantity of solids added differentially by sweets determines the variance in viscosity. The more sweetener added, the greater the viscosity value of the syrup. This is in accordance with the opinion of Amiri *et al.* (2014) that varying the amount of added sugar results in a variable viscosity value. Viscosity has a direct proportional connection to the total amount of dissolved solids. The high total dissolved solids, followed by the duration of heating time, will increase the thickness of the syrup owing to concentration, resulting in a longer syrup flow time (Mayasari *et al.,* 2020). Because of the tight connection between particles, syrup viscosity might arise. The greater the connection between particles, the higher the viscosity. The syrup has a high viscosity due to the existence of hydrogen bonds between hydroxyl (OH) groups in sugar molecules and water molecules (Häkkinen and Abbott, 2019).

Table 1 shows the findings of research on pH levels of SEDJ with various sweetener types. According to this study, the use of sweeteners had a significant ($p<0.05$) influence on the pH of syrup. The pH value of SEDJ differs because the pH value of the sweetener as a raw ingredient differs before it is combined with other raw materials. The hydroxyl group influences the pH of the sweetener, which causes it to be acidic. The hydroxyl group in sugar will attract particles (OH-) or negatively charged particles around the sugar, increasing the H+ in the syrup. A number of organic acids in honey, such as citric acid and cinnamic acid, might impact the low pH of honey (Pauliuc and Oroian, 2020). The pH of syrup does not yet have a fixed standard, however, the pH value of SEDJ is compatible with Farahnaky *et al.* (2018) statement that decent syrup owns a pH value between 3-6.

3.2 Chemical properties of ginger leaf extract syrup

Chemical properties evaluated on SEDJ consist of total phenol and antioxidant activity. According to Figure 1, the total value of phenol in SEDJ ranges from 0.868 to 1.350 mg/mL. The higher the value generated, the higher the overall phenol content of the syrup. It can be inferred from Figure 1 that the total phenol value of SEDJ T_3 is the highest. The reaction between the Folin-Ciocalteu reagent and the phenol is responsible for the elevated phenol value. Folin-Ciocalteu reagents can react with additional reducing agents, such as sugar and ascorbic acid, in addition to measuring total phenol levels (Everette *et al.,* 2010). The hydroxyl group found in reducing carbohydrates such as fructose reduces Folin -Ciocaleu reagents, resulting in an increase in total phenol concentration. The low total phenol value in SEDJ T1 is because sorbitol sweeteners are artificial sweeteners that do not include reducing sugars but rather polyhydric alcohols (Al Humaid, 2018). The difference in total phenol value is related to the use of reducing sugars such as fructose and honey to generate components of melanoidin or melanin compounds, which are included in phenolic compounds formed during the heating process as a result of the Maillard reaction (Wang *et al.,* 2013).

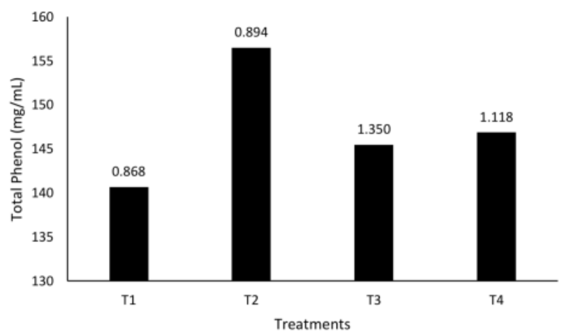

Figure 1. Effect of various sweetener on total phenol SEDJ. Treatment T_1: sorbitol; T_2: sucrose; T_3: HFS; T_4: honey

The IC_{50} value, which represents the concentration of an antioxidant in suppressing free radicals by 50%, reflects the value of antioxidant activity in SEDJ. According to the results in Figure 2, the value of the antioxidant activity is categorized as insufficient.

Table 1. Viscosity dan pH value of SEDJ

Parameters	Samples			
	T_1	T_2	T_3	T_4
Viscosity (cPs)	274.35±0.85^a	209.45±1.23^d	237.82±1.93^c	254.93±0.76^b
pH Value	4.14±0.09^a	4.27±0.25^a	3.95±0.09^{ab}	4.09±0.18^b

Values are presented as mean±SD. Values with different superscripts within the same column are significantly different ($p<0.05$). Treatment T_1: sorbitol; T_2: sucrose; T_3: HFS; T_4: honey

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According to Figure 2, SEDJ with T_1 treatment has the greatest antioxidant activity value compared to SEDJ with other treatments because of sorbitol sweeteners as an efficient humectant, which is 140.64 ppm. Large concentrations of sorbitol sweeteners improve their potential as a humectant that binds water in the material and reduces the loss of active chemicals in syrup, particularly antioxidants (Thalerngnawachart and Duangmal, 2016). The antioxidant activity in SEDJ with honey sweetener is lower than in SEDJ with sorbitol and HFS sweeteners, which is expected because the honey used is factory packaged honey, which has a lower antioxidant content than pure honey from bees.

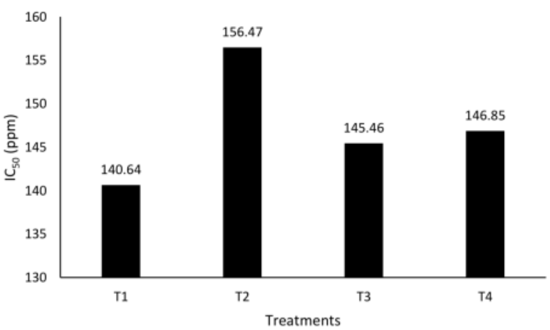

Figure 2. Effect of various sweetener on antioxidant activity SEDJ. Treatment T_1: sorbitol; T_2: sucrose; T_3: HFS; T_4: honey

According to Figure 2, SEDJ T_1 has the highest antioxidant activity, whereas SEDJ T_1 has the lowest total phenol value, according to Figure 1. This observation demonstrates that antioxidant chemicals are not proportional to total phenol. Not just polyphenols are considered to be antioxidant molecules that have a function in syrup. According to the findings of Ghasemzadeh *et al.* (2010), ginger leaves contain a variety of antioxidant chemicals, 56% of which include terpenoids, flavonoids, and polyphenols. According to Sivasothy *et al.* (2011), many of the terpene chemicals identified in red ginger leaf extract are 47.1% sesquiterpenoids and 42.6% monoterpenoids. These compounds can act as a group of antioxidants that affect the measurement of antioxidant status. Thus, antioxidant activity is not always related to total phenol but is the result of a combination of interactions of various antioxidant compounds in the SEDJ.

3.3 Organoleptic and Hedonic properties of ginger leaf extract syrup

According to Table 2, the addition of sweeteners has a substantial ($p<0.05$) influence on the colour of SEDJ products. Panellists favour the brownest colour, as demonstrated by SEDJ T_4. SEDJ T_2 has the lowest brown colour intensity because sucrose is a non-reducing sugar that does not participate in the Maillard reaction but only in the caramelization reaction, which results in brighter colours. Because it contains reducing sugars that can undergo Maillard and caramelization processes, SEDJ with honey and fructose sweetener has a browner colour intensity. The brown colour is rather thick greenish derived from the raw material of ginger leaf extract which is formed due to the presence of flavonoid and coprophilic pigments (Maitimu *et al*., 2013).

Based on the sensory test results in Table 2, the panellists were unable to distinguish the aroma of a leaf extract from each treatment. The syrup aroma is thought to be due to the content of volatile and aromatic compounds produced from terpenoid compounds derived from ginger leaves. This is supported by the opinion of Steinhaus (2015), which reported that aromatic compounds in leaf extracts have different aromas derived from terpenoid compounds in them. Based on the results of the statistical analysis, the panellists were unable to distinguish ($p> 0.05$) the level of SEDJ thickness. Based on Table 2, the highest level of SEDJ viscosity was found in SEDJ T_1, while the lowest viscosity level was in SEDJ T_2. The greater the amount of added sweetener solids shows increasing levels of viscosity. Viscosity has a relationship that is directly proportional to the total amount of dissolved solids (Nadooshan *et al*., 2018).

According to Table 3, there is a significant impact ($p<0.05$) on the usage of sweeteners on SEDJ's preference overall. SEDJ T_4 is the most favoured syrup among panellists, but SEDJ T_2 is not. It demonstrates that when the amount of sweetness grows, as well as the panellists' overall preference. The addition of sweeteners to SEDJ had a substantial influence on its sweetness ($p<0.05$). The sweetness intensity of SEDJ with the

Table 2. Organoleptic properties SEDJ

Organoleptic Attributes	Treatment				Score Interpretation of 1-4
	T_1	T_2	T_3	T_4	
Colour	1.68±0.802[a]	3.24±1.128	2.80±0.816	1.60±0.627[a]	(darkbrown - lightbrown)
Aroma	2.40±1.555	2.36±0.907	2.36±0.952	2.92±1.352	(leaf typical - no leaf typical)
Taste	3.32±0.980[a]	3.28±0.714[a]	1.96±0.889[b]	2.80±1.207[b]	(sweet - bitter)
Viscosity	2.16±1.248	2.84±1.248	2.80±0.764	2.76±0.779	(thick - watery)

Values are presented as mean±SD. Values with different superscripts within the same column are significantly different ($p<0.05$). Treatment T_1: sorbitol; T_2: sucrose; T_3: HFS; T_4: honey

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Table 3. Hedonic value of SEDJ

Organoleptic Attributes	Treatment			
	T_1	T_2	T_3	T_4
Colour	3.44±0.507	3.24±0.436	3.40±0.577	3.48±0.510
Aroma	3.04±0.790	3.16±0.746	2.84±0.624	3.40±1.764
Taste	$2.76±0.663^{a}$	$2.96±0.676^{a}$	$3.40±0.707^{b}$	$3.40±1.707^{b}$
Viscosity	3.00±1.248	2.96±1.248	3.24±0.764	3.04±0.779
Overall	$2.72±0.891^{ab}$	$2.68±0.690^{ac}$	$3.08±0.812^{bcd}$	$3.24±0.723^{d}$

Values are presented as mean±SD. Values with different superscripts within the same column are significantly different ($p<0.05$). Treatment T_1: sorbitol; T_2: sucrose; T_3: HFS; T_4: honey

treatment of T_3 and T_4 cannot be differentiated by the panellists based on Table 2 because the sweetness of the second sweetener is almost the same degree of sweetness. HFS has 1.7 times the sweetness of cane sugar (Chattopadhyay *et al.,* 2014; Helstad, 2019), whereas honey has 1.5 times the sweetness of cane sugar (National Honey Board, 2007). While SEDJ T_1, specifically sorbitol sweetener, has the lowest sweet taste intensity since it has a lower sweetness level of 60%, or 0.5 to 0.7 times when compared to sucrose (Chattopadhyay *et al.,* 2014). The highest sweetness level was preferred by panellists. This is presumably because the sweet taste that can cover the bitter taste derived from ginger leaf extract is flavonoids (Saad *et al.,* 2014).

4. Conclusion

The use of varied sweeteners influences viscosity, pH, and organoleptic colours and tastes. The most optimum SEDJ is ginger leaf extract syrup with honey sweetener treatment as it is the most favoured SEDJ by panellists and is beneficial as an antioxidant.

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