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The Effect of Maltose-Sucrose Weight Ratio in Lozenges of Bajakah Root Ethanolic Extract (*Spatholobus littoralis* Hassk.) on Their Flavonoid Total Release, Physical, and Sensory Properties

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Bajakah root; lozenges; physical properties; flavonoids total; sensory test.

ABSTRACT. Bajakah root ethanol extracts contain flavonoids, phenolics, and tannins as antioxidants that can inhibit tumor growth. However, consuming the pure extract as a supplement has an unpleasant odor and taste. Providing the extract as lozenges may give better taste, control the release of active substances, be absorbed in the oral mucosa, and avoid first-pass metabolism. Sucrose and corn syrup are the main components of lozenge fillers. This study evaluates the combination of maltose-sucrose on physicochemical properties, drug release, and taste acceptance. Bajakah roots were macerated in 50% ethanol (1:5 w/v) for three days, and the filtrate was evaporated. The extract contained 2.18% and 9.03% of flavonoids and tannins, respectively. The high proportion of sucrose increased hardness, sweet taste, pungent aroma, and better release of active substances, but did not affect the disintegration time. The maltose-sucrose weight ratio of 1:1 was selected because it met the requirements for lozenges based on the Indonesian Pharmacopoeia Edition VI, having characteristics of a weight of 250 ± 9.93 mg; hardness of 9.30±2.08 kg; dissolution time of 10.48 ± 4.26 minutes; and released 80% of active substances for 60 minutes. In addition, this formula is stable in storage and is most preferred by respondents.

INTRODUCTION

Bajakah root is one of Kalimantan's endemic plants, which the Dayak people use as a traditional medicine to maintain stamina and cure diseases (Hasna *et al*., 2021). Bajakah root is a medicinal plant from the *Fabaceae* family that grows on woody trees from the *Phaseoleae* genus. Bajakah roots are efficacious in curing diseases such as diarrhea, aches and pains, dysentery, wounds, and are even used as a cancer medicine (Nastiti and Nugraha, 2022). Putra *et al*. (2023) reported that Bajakah roots contain active substances of phenolic compounds, flavonoids, tannins, and saponins. On the other hand, Ayuchecaria *et al*. (2022) explored that Bajakah Tampala extracts contained phenolic levels of 12.33 mg GAE/g. According to Zhang *et al*. (2015), more than 200 secondary metabolites are included in Bajakah root genus *Uncaria*, some of which are phenolics, indole alkaloids, triterpenes, flavonoids, and phenylpropanoids. Bajakah root ethanolic extract has potent antioxidant activity with an IC_{50} value of 8.25 µg/mL (Mahfudh *et al*., 2024). In addition, Hamzah *et al*. (2022) reported an in vivo study showing that Bajakah root extract with a concentration of 400 mg/kg BW has a 15% inhibition rate in diabetes. At a dose of 500 mg/kg BW, Bajakah root extract can inhibit the bacteria *Streptococcus mutants*, *Staphylococcus spp*, *Pseudomonas aeruginosa*, *Candida albicans*, and *Enterobacteriaceae* (Hamzah *et al*., 2022). A dose of 5 mg/mL delivered for three days can relieve gastritis (Rousdy and Wardoyo, 2023), and a 50 mg/mL dose delivered for 14 days can inhibit tumor weight and volume (Alhawaris, 2023). Research conducted by Sari *et al*. (2023) carried out maceration on Bajakah roots (*Spatholobus littoralis* Haskk) with 96%, 70%, and 50% ethanol solvent. This research found that 50% ethanol solvent yielded an extract with a high percentage of 6%. In addition, several compounds, such as flavonoids and tannins, have better solubility in ethanol-containing water. Therefore, 50%

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ethanol was chosen as the solvent for this research. compounds, such as flavonoids and tannins, have better solubility in ethanol-containing water. Therefore, 50% ethanol was chosen as the solvent for this research.

People usually consume Bajakah roots by boiling them. However, decoction is considered less practical, efficient, and uniform in dosage, so its efficacy cannot be guaranteed. Patients did not accept the extract's bitter taste and aroma, so a lozenge drug delivery system was developed to overcome this problem. Hard lozenges or hard candy are sugar-based lozenges with a specific dosage. They are made by melting the ingredients and pouring them into a mold until the mass becomes solid and hard at room temperature (Mursyid and Dahlia, 2018). Hard lozenges are currently being developed in the herbal pharmaceutical industry because of several advantages, including their practicality for formulation and the fact that they can mask the unpleasant taste of the drug, increase patient compliance, control the release of active substances, absorption in the oral mucosa, and avoid first-pass metabolism (Mursyid and Dahlia, 2018; Ermawati *et al*., 2023). Hard lozenges require several ingredients: active ingredients, a lozenge base, pH adjusting, and flavoring agent.

Sucrose and corn syrup are sugars commonly combined as essential ingredients in hard lozenge formulations. Sucrose can function as a filler and binder. In addition, sucrose is cheap, a source of caramel formation, and has a preservative function at concentrations higher than 60%. In hard candy formulations, sucrose levels >70% will increase the tendency of hard candy to become grainy and quickly form crystals (Allen, 1998). However, the hard candy will be sticky and mushy if only sucrose is used. Stickiness occurs due to the increased water content in the candy. This can be overcome by adding maltose as a mixture of sucrose, which is expected to increase the viscosity of the candy so that it is not sticky and mushy and reduces the migration of carbohydrate molecules (Aidoo *et al*., 2014). Sucrose and maltose will combine to formulate Bajakah root ethanolic extract hard lozenges, which function as sweeteners and binding agents. However, an incorrect ratio of sucrose and maltose causes problems such as grainy (crystallized).

Based on previous research conducted by Aidoo *et al*. (2014), the ratio of sucrose to lactose syrup obtained a formula with good characteristics, namely a formula with a ratio of 50:50% and an active substance concentration of 2%. In this study, the combination of sucrose-maltose as a base for hard lozenges is evaluated, including its effect on the physicochemical properties of the preparation, the active substance release profile, and the sensory response test. We tried to find the best filler combination to formulate Bajakah root extract lozenges that fulfill the required physicochemical properties of hard lozenges based on the Indonesian Pharmacopeia 6th Ed.

RESEARCH METHODS

Materials: Bajakah root (Palangkaraya, Central Kalimantan), citric acid (Weifang Winsign Industry Co., Ltd., China), taro flavor powder (PT. Matcha Muda Manggala, Indonesia), and distilled water (Saba Kimia, Indonesia), Quercetin standard (Sigma Aldrich, German), Tannic acid standard (Sigma Aldrich, German), D (+)-Sucrose (USP-NF, pharma grade, AppliChem), Maltose (NF Grade, Lab Alley), Food grade Ethanol (Lab Alley). Instrumen: Analytical balance (KERN: ABS 220-4, Germany), hot plate (IKA C-MAG, Germany), magnetic stirrer (Cole Parmer, Canada), moisture analyzer (Ohaus, USA), oven (Memmert, Germany), dissolution apparatus type 2 (RC-6, China), spectrophotometer UV-Vis (Genesys 150 Thermo Scientific, USA), hardness tester (Tianjin Guoming Medicinal Equipment Co., Ltd, China).

Sample Preparation

Bajakah root determination was conducted at the Biology Laboratory, Faculty of Mathematics and Natural Sciences, UNS. Plant identification was carried out by comparing the specimens with descriptions in the literature based on morphological and taxonomic characteristics. Bajakah roots were macerated with 50% ethanol solvent in a ratio of 1:5, where 1 kg of Bajakah roots was put in a maceration chamber, then 5 liters of 50% ethanol were added; the extraction process took 72 hours; every 24 hours, it was stirred. After 72 hours, the precipitate was filtered, and a filtrate was produced, then evaporated at 40 – 50 °C until thickened. The thick extract of Bajakah root was calculated for yield and water content (Ermawati *et al*., 2023).

Detection of Active Ingredients Concentration

Quantitative Analysis of Flavonoid

A 0.5 mL aliquot of quercetin solution (100 ppm) was mixed with 0.5 mL of 10% $AlCl_3$ and 4 mL of 5% acetic acid, and the mixture was incubated for 30 minutes. The absorbance of the resulting solution was recorded using a UV-Vis spectrophotometer within the wavelength range of 370 – 450 nm. A stock solution of quercetin

(1000 ppm) was serially diluted to obtain concentrations of 20, 40, 60, 80, and 100 ppm. From each concentration, 0.5 mL was taken and reacted with 0.5 mL of 10% $AlCl_3$ and 4 mL of 5% acetic acid, followed by incubation for 30 minutes. Absorbance was then measured at the maximum wavelength obtained. For the sample analysis, 50 mg of the dried extract was weighed, dissolved in 10 mL of 96% ethanol, and filtered. From this solution, 0.5 mL was taken and mixed with 0.5 mL of 10% $AlCl_3$ and 4 mL of 5% acetic acid. The absorbance was measured at 510 nm, the maximum wavelength was determined using UV-Vis spectrophotometry, and the measurements were repeated three times (Patil and Pike, 1995).

Quantitative analysis of Tannin

Fifteen milligrams of Bajakah root ethanolic extract was extracted with 10 mL of diethyl ether for 20 hours. The extract was then filtered, and the remaining diethyl ether was evaporated. Approximately 10 mL of distilled water was added to the extract, and 1.0 mL of the sample solution was mixed with 0.1 mL of Folin Ciocalteu reagent and mixed homogeneously using a vortex for 5 minutes. A 20% sodium carbonate solution (2 mL) was added and continuously mixed using a vortex for 5 minutes. The distilled water (10 mL) was then added to the solution and diluted ten times. After incubation for 30 minutes at room temperature, the absorbance of the final solution was then measured at λ 760 nm (Chanwitheesuk *et al*., 2005). The standard tannic acid (10 mg) was mixed with 10 mL of Folin Ciocalteu reagent and mixed homogeneously for 5 minutes using a vortex. A sodium carbonate solution (20%) was added until the total volume reached 100 mL. A serial dilution with the concentrations of 6, 12, 18, 24, and 30 % (v/v) was prepared to make a standard curve. Their absorbance was then read at wavelength 760 nm after incubation for 30 minutes at room temperature (Harbertson *et al*., 2008).

Bajakah Root Ethanolic Extract Hard Lozenges Formula

The compositions of the components in various formulas are presented in Table 1. The maltose was first heated at 165 °C until melted, then sucrose was added while stirring until homogeneous. Once homogeneous, the mixture was cooled, and the other components, such as citric acid, Bajakah root ethanolic extract, and flavor, were added while stirring until homogeneous and put in a mold. One formula with a total weight of 122.5 grams produced 49 hard lozenges, so each lozenges weighed 250 mg (Ermawati *et al*., 2023).

Table 1. The formula of Bajakah root ethanolic extract *lozenges* using a variation of maltose-sucrose.

Ingredients	Weight (grams)			
	Formula 1	Formula 2	Formula 3	Function
Bajakah root ethanolic extract	0.005	0.005	0.005	Active substance
Maltose	80	60	40	Filler and binder
Sucrose	40	60	80	Filler and binder
Citric acid	0.5	0.5	0.5	pH adjusting
Taro flavor	2.0	2.0	2.0	Flavoring agent

Physical Properties of Bajakah Hard Lozenges

The organoleptic testing of Bajakah root water extract effervescent granules includes shape, color, taste, and aroma. A total of 20 lozenges were weighed, and the average weight of each lozenge was calculated. There should be no more than two lozenges whose weight deviates from the average weight specified in column A and no tablet that deviates more than the average weight specified in column B (Table 2). A total of six tablets of each formula were taken randomly and tested with a hardness tester. The scale on the hardness tester was read when the tablet was broken, and the average value was calculated (Farmakope Indonesia, 2021). Six hard lozenge tablets were put in the basket in the disintegration tester, and their disintegration time was evaluated. After the tester device was turned on within 15 minutes, the disintegration time was assessed as the time required for a tablet to disintegrate without residue (Artanti *et al*., 2021).

Table 2. The weight deviation requirement of tablets.

The average weight of tablets	Average weight deviation (%)	
	Column A	Column B
≤ 25 mg	15%	30%
25-150 mg	10%	20%
151- 300 mg	7.5%	15%
>300 mg	5%	10%

Stability Test

The stability test of the hard lozenges was carried out for 24 hours by storing them at room temperature. The hard lozenges were evaluated for hardness, color, and odor at 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, and 24 hours. The tablets from each formula were placed in amber glass containers and stored for two weeks at cool (8 – 15 °C), room (15 – 30 °C), and warm (30 – 40 °C) temperatures. The observed changes in the physicochemical properties of the gummy candies included hardness, color, and texture. The hard lozenges were stored in a plastic clip and protected from sunlight. Evaluate the level of hardness or durability of the preparation by pressing the hard lozenges (Ermawati *et al*., 2020).

Ethical Clearance

This study was granted research permission and ethical feasibility from the Health Research Ethics Committee of Dr. RSUD. Moewardi with Number 813/III/HREC/2024. This ethical clearance was applied at the Regional General Hospital (RSUD) Dr. Moewardi, at Jalan Kolonel Sutarto No. 132, Jebres, Surakarta, Central Java, Indonesia. This submission was required to survey the acceptance of the taste and organoleptic properties of Bajakah root ethanolic extract hard lozenge products by 20 respondents (Wulandari *et al*., 2019).

Sensory Test

A total of 20 participants who had provided informed consent were selected to take part in this study. Samples were given to the participants to assess using the provided rating scale. The participants were asked to rate the taste, aroma, and texture of gummy candy on a scale ranging from 1 to 4, with a score of 4, 3, 2, and 1 indicating "very like", "like", "not like", and "dislike", respectively (Badan Standar Nasional Indonesia, 2008).

Dissolution test of Lozenges

The quercetin stock solution was prepared in 0.1, 1.5, 3.0, 4.5, and 6.0 mL using a micropipette and dissolved with phosphate buffer to 10 mL. To make a standard curve, the absorbance of the series solution was measured at 372 nm. A dissolution study was conducted using the paddle method at 50 rpm in 500 mL of phosphate buffer with a pH of 6.8. Samples were collected at 5-minute intervals for 60 minutes and promptly replaced with an equal volume of fresh buffer for analysis using a UV-VIS spectrophotometer. The chamber was filled with 500 mL of phosphate buffer with a pH of 6.8 and heated to 37 °C. Bajakah root Lozenges were placed into the chamber and rotated at 50 rpm. Samples of 10 mL were withdrawn using a syringe at intervals of 0, 2, 5, 10, 15, 20, 30, 45, and 60 minutes. Each withdrawn sample was replaced with 10 mL of fresh buffer solution. The absorbance of the samples was measured using a UV–VIS spectrophotometer at a maximum wavelength of 372 nm. The total flavonoid content was calculated from the standard curve of quercetin in buffer solution (Williams, 2004).

Data Analysis

The results of the physicochemical properties test were subjected to statistical analysis employing the One-Way ANOVA test in IBM Statistics 21 to ascertain the existence of significant differences among the three formulas in each assessment. To determine normality, the Shapiro-Wilk test was conducted, and after detecting the differences by the One-Way ANOVA, the Post Hoc test was carried out using the Tukey HSD method at a significance level of less than 0.05. The percentage value of each formula in the taste acceptance test was also computed.

RESULTS AND DISCUSSION

The determination results with document number 054/UN27.9.6.4/Lab/2023 stated that the raw material of Bajakah roots used in this study was *Spatholobus littoralis* Hassk. This species of Bajakah root is suspected to be the type of Bajakah widely traded and considered an anti-cancer drug by the people on the Island of Borneo. Not all kinds of Bajakah root can be used for medicinal purposes. There are at least about 200 types of it. Some of them are even poisonous and dangerous if consumed. Three types of Bajakah are commonly used for health, including Bajakah Lamei for treating diarrhea, curing cancer, healing wounds, and preventing heart disease, Bajakah Tampala (*Spatholobus littoralis* Hassk) for healing wounds, and Bajakah Kalawit (*Uncaria gambir* Roxb) for preventing heart disease.

The water content of the thick extract fulfills the requirement if the value ranges between 5 – 30% (Voight and Davis, 2000). Due to enzymatic activity, the percentage of water content that does not meet quality

requirements will cause an extract to be contaminated and decompose active compounds easily. The percentage of the water content of Bajakah root ethanol extract is 12%. The yield value of an extract is related to the large amount of bioactive content contained in the plant extract (Dewatisari *et al*., 2018). The yield is calculated by comparing the weight of the thick extract (g) with the weight of the raw material multiplied by 100%. The yield can be considered satisfactory or suitable if the value exceeds 10% (Farmakope Herbal Indonesia, 2008).

The organoleptic result of Bajakah root ethanolic extract is a thick reddish-brown extract with a typical aroma of Bajakah roots and a bitter taste. Based on the research results, Bajakah root ethanolic extract has a total flavonoid and tannin content of 2.18% and 9.03% (w/w), respectively. These quantitative numbers were estimated using standard curves provided in Figures (S1 and S2) and Tables (S1 and S2) in Supplementary Information (SI).

Physical Properties Test

Sucrose is the main ingredient in hard lozenge formulation. Sucrose can be a crystallization agent in the final product if it undergoes dispersion (Miller and Hartel, 2015). The higher the amount of sucrose used, the greater the potential to form crystals, so that the weight uniformity of the hard lozenge is inconsistent. The results of the evaluation of tablet weight uniformity obtained met the requirements for each formula, where two tablets deviated in column A (5%), and none of the tablets deviated in column B (10%). Based on the normality and homogeneity test results, a significant value of > 0.05 was obtained, so it can be concluded that the weight uniformity evaluation results are normally and homogeneously distributed (Ermawati *et al*., 2024). A one-way ANOVA test was carried out to determine the effect of variations in the sucrose-maltose based on the weight uniformity of Bajakah root ethanolic extract hard lozenges. The test results show that a significant value of 0.00 (< 0.05) was obtained, so the variations in the sucrose-maltose base affect the weight uniformity of hard lozenges. The statistical analysis of weight uniformity is provided in Table S3.

The lozenges are intended to dissolve or erode slowly in the oral cavity over 7 – 13 minutes. Therefore, hard lozenges are usually made harder than regular tablets. The hardness of good lozenges ranges from 7 to 14 kg. The higher the proportion of sucrose, the more compact and harder the resulting tablet. This is because sucrose can form crystals (Banne *et al*., 2012). One-way ANOVA statistical analysis obtained a probability value of < 0.05, namely 0.00, which indicates a significant difference. So, the maltose-sucrose variation influences the hardness of Bajakah root ethanolic extract hard lozenges. The formula with variations in the sucrose-maltose 1:1 has a hardness value comparable to the brand product. The statistical analysis of the hardness test is provided in Table S4.

The results of the disintegration time test can be used to estimate the onset of a drug (Rusdiah *et al*., 2021). The disintegration time is usually proportional to the hardness of the tablet. The longer the time to disintegrate, the harder a table. The evaluation results of the average disintegration time of hard lozenges met the disintegration time requirements of between 7 and 13 minutes (Table 3). Then, a one-way ANOVA statistical analysis was carried out, and the probability value was < 0.05, namely 0.00; it could be concluded that variations in the addition of the sucrose-maltose base affected the disintegration time of Bajakah root ethanolic extract hard lozenges. The evaluation results of the disintegration time of formula 2 with variations in the Sucrose-Maltose 1:1 are closest to the disintegration time of hard lozenge brand products. The statistical analysis of the disintegration time is provided in Table S5.

Table 3. The physical properties of Bajakah root ethanolic extract hard lozenges.

Formula	Hardness (kg)	Weight (mg)	Disintegration time (minutes)
1	10.25 ± 0.031[a]	257 ± 1.00	14.37 ± 0.00[b]
2	9.43 ± 0.003	251 ± 2.08	10.48 ± 0.00
3	5.10 ± 0.012[a]	255 ± 4.93	3.08 ± 0.00[b]
Brand product	9.43 ± 0.008	-	10.35 ± 0.00

*a, b significant difference with the brand product

Stability Test

Drug stability is essential because it will have an impact on the effectiveness, safety, and quality of the drug. Several factors can influence the stability of a dosage form, such as oxygen, temperature, and pH (Zaini *et al*., 2016). A stable dosage form does not experience physical or chemical changes during storage. Based on the results of the hardness evaluation of the three formulas placed at room temperature (15 – 30 °C) compared to product brand hard lozenges, changes in hardness were experienced 24 hours before. Formulas 1 and 2 experienced a

physical change; that is, they became soft after 14 hours, while the third formula experienced a physical change to become soft within 2 hours, possibly due to the proportion of sucrose and maltose. The higher the proportion of sucrose used, the harder the prepared tablet will be, which will not soften quickly (Figure 1).

The hardness profiles of the three formulas at cool temperatures (8 – 15 °C) were compared with the brand product hard lozenges. It was found that the three formulas and the brand product formula were stable. Meanwhile, the aroma, color, and taste of the tablets, whether the preparation was placed at room temperature (15 – 30 °C) or cool temperature (8 – 15 °C), were considered unchanged.

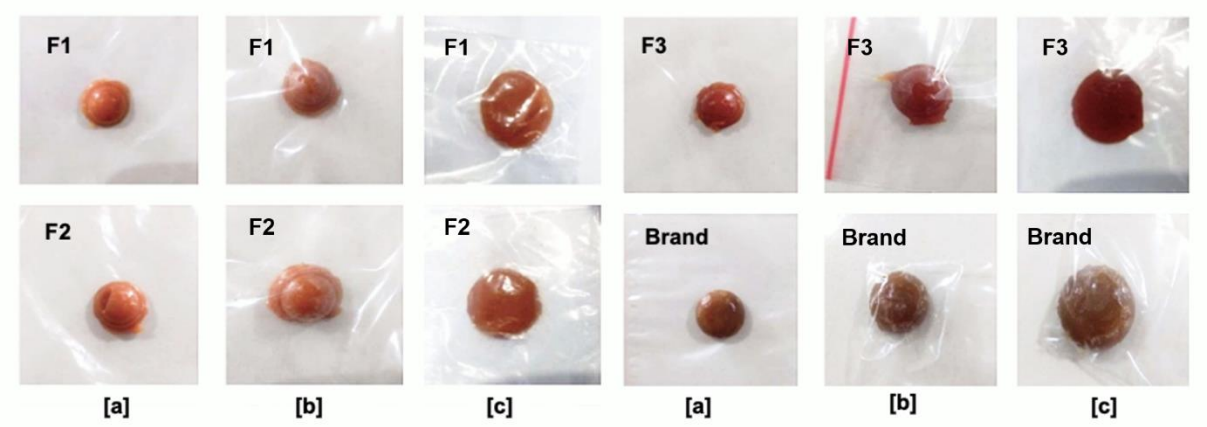

Figure 1. The results of the stability test of Bajakah root ethanolic extract hard lozenges: the hard lozenges condition after formulation process [a], storage at 8 – 15 ºC for 24 hours [b], and storage at 15 – 30 ºC for 24 hours [c]. F1, F2, and F3 represent Formula 1, Formula 2, and Formula 3, respectively.

Sensory Test

The sensory test was conducted on 20 untrained respondents aged 15 – 50 years old. The tests carried out include taste, aroma, color, and texture. The sensory test meets the requirements if 50% of respondents stated that they "very like" or "like" and can accept hard lozenges' taste, color, and texture. The taste of a product is influenced by several factors, including chemical compounds, concentration, temperature, and interactions between flavoring agents. The sensory test results on the respondents for Bajakah root ethanolic extract hard lozenges obtained the highest score for F2, with 65% expressing them as very like and 35% as like. The lowest score was obtained in F3, with 65% of the respondents expressing that they do not like it, and 30% dislike it. Based on the results, the respondents liked moderately sweet flavors. Adding the sucrose and maltose in the same concentration gave a moderately sweet taste. In contrast, F3 had a weak sweet taste compared to F1 and F2 because the amount of sucrose was lower than in the other formulas.

Texture refers to the sensory experience perceived through the mouth when biting, chewing, swallowing, or touching food with the fingers. It encompasses the physical attributes of food ingredients, such as size, amount, shape, and structural elements discernible by the senses of taste, touch, and sight. The tactile sensation arising from the physical stimulation in the oral cavity produces the overall texture, which can vary in consistency, thickness, or viscosity, depending on the solid, liquid, or semisolid form of the product (Milgaard *et al*., 1999). According to the texture preference test, the highest score was observed in F2, where 50% of respondents expressed a favorable liking. Meanwhile, the lowest was obtained in F1 and F3, where 50% of respondents expressed dislike.

The color of a product will influence consumers' assessment of the product. The more attractive the product's color, the more liked the product. The results of respondents' sensory test of the color in Bajakah root ethanolic extract hard lozenges showed that the highest score was in F3, with 45% saying they "very liked" it, while the lowest score was in F1, with 15% saying they "not like" it and 60% saying "dislike" it. In this study, the color of the hard lozenges produced from Bajakah root ethanolic extract was light brown to dark brown. This brown color is produced from the color of the 50% ethanol extract of Bajakah roots. The brown color also comes from sucrose, a non-reducing sugar with a caramelization process, resulting in a brown color (Ridhani and Aini, 2021). Because the brown color is produced from both extract and sucrose, the more sucrose is used, the darker the brown color will be. In F1, more sucrose was used to produce Bajakah root ethanolic extract in hard lozenges with a light brown color. Meanwhile, in F2, the same amount of sucrose as maltose was used, and the hard lozenges produced were

light brown. On the other hand, F3 uses a smaller amount of sucrose than maltose; thus, it produces hard lozenges with a dark brown color. Comprising the sensory test results, respondents like hard lozenges with a deep reddish-brown color (Figure 2).

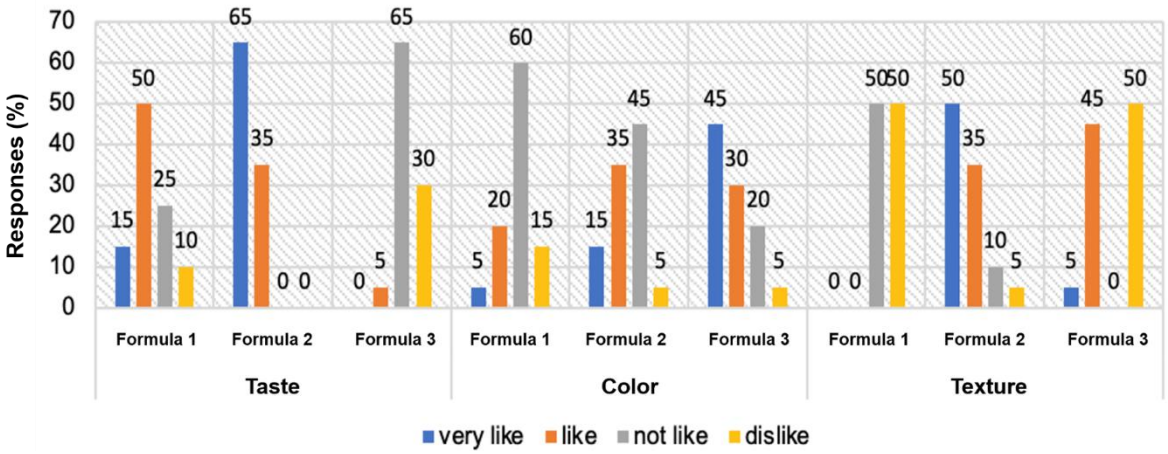

Figure 2. The graph of sensory test results on 20 respondents regarding the taste, color, and texture of Bajakah root ethanolic extract hard lozenges.

Release Test of Flavonoid

The results of the linear regression equation obtained are y = 0.0069x + 0.0021 with a correlation coefficient (r) of 0.9357, where the r value is close to 1, which indicates that the regression equation is linear. The dissolution test is one of the required test parameters. Pharmacopoeia guarantees the quality of solid dosage products, such as tablets and capsules (Salsabila *et al*., 2023). Dissolution testing is a method for developing new drug formulations, monitoring the quality of drug products, assessing the potential impact of post-approval changes on product performance, and predicting the in vivo performance of drug products. A dissolution test aims to determine the release profile of the active drug substance from the preparation in a solvent medium under predetermined conditions and ensure that product quality is continuously maintained.

Percentage Dissolution Efficiency (%DE) to determine the variations of sucrose-maltose based on the release of total flavonoids from Bajakah root ethanolic extract hard lozenge roots. The dissolution test results (Figure 3) show that the total flavonoid released for 60 minutes is more than 80%, so it meets the requirements of the Pharmacopoeia Edition VI (2021). Meanwhile, the %DE for Formula 3 still needs to meet this requirement due to several factors, namely formulation, tablet texture and density, dissolution media, and the environment of the experimental site. The %DE results show that the percentage of total flavonoid release in Formula 2 is optimal compared to the other formulas because it reaches 83.34%. The release test of flavonoids of Formulas 1, 2, and 3 is provided in Tables S6 – S8.

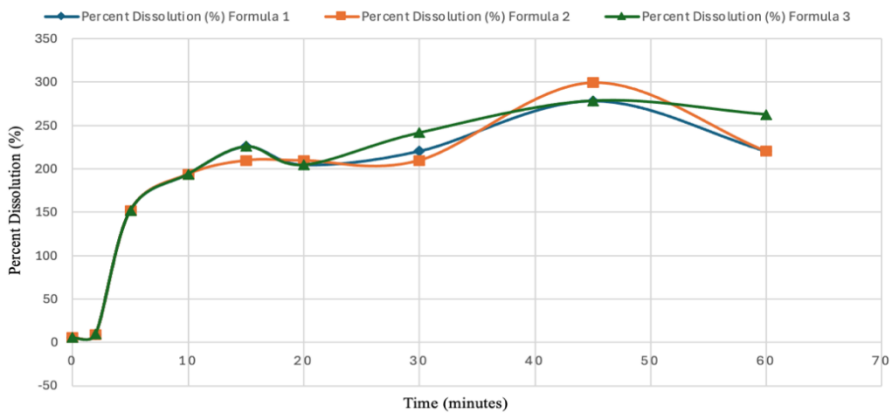

Figure 3. The profile release of active substance for 60 minutes Bajakah root ethanolic extract hard lozenges.

CONCLUSION

Variations in sucrose-maltose influence the physicochemical properties of Bajakah root (*Spatholobus littoralis* Hassk) ethanolic extract hard lozenges, such as hardness, disintegration time, stability, taste acceptability, and release of active substances. A more significant proportion of sucrose makes the preparation harder, has a longer dissolving time, has a sweet taste, can cover the aroma of the extract, and has a release rate that meets the requirements. Bajakah root ethanolic extract hard lozenge in Formula 2, with a sucrose-maltose weight ratio of 1:1, was the selected formula because it met the criteria for good hard lozenges according to the Pharmacopoeia edition VI and the Ministry of Health of the Republic of Indonesia. The average value of weight uniformity for Formula 2 is 250 mg; hardness 9.43 kg; disintegration time 10.48 minutes. The dissolution profile shows that the %DE at 60 minutes is 83.34%. Apart from that, Formula 2 is the formula most liked by respondents, with a percentage of 65% stating that they "very like" and 35% saying "like" based on taste, color, and texture.

SUPPLEMENTARY INFORMATION

Figures S1 – S2 and Tables S1 – S8 are available in Supplementary Information and accessible at https://jurnal.uns.ac.id/alchemy/article/view/95035/supp.info.

CONFLICT OF INTEREST

There is no conflict of interest in this article.

AUTHOR CONTRIBUTION

DEE, SR: Conceptualization; CTP, DEE: Data Analysis, Investigation, Manuscript Drafting, Editing; ANA, SR: Funding Acquisition; DEE, SR. ANA: Methodology, Manuscript Review; ANA: Project Administration; CTP: Tools Software.

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