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The Effect of Sucrose Concentration and Reaction Temperature on the Transparency and Physical Properties of Transparent Solid Soap Based on Virgin Coconut Oil and Secang Wood Extract (Caesalpinia Sappan L.)

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ABSTRACT: Soap is a product that plays a major role in the world of cosmetics in maintaining hygiene and preventing bacterial growth. One innovation in soap manufacturing is transparent soap. Transparent soap is soap with an attractive, classy, and luxurious appearance because it is clear and translucent, has moisturizing properties, effective cleaning power without leaving soap suds, and feels softer. To produce transparent soap, high-quality raw materials and optimal production conditions are required. The high-quality raw materials selected in this study were virgin coconut oil (VCO) and secang wood extract. VCO is pure coconut oil made from coconut meat, processed without heating so that the essential compounds needed by the body remain intact. Secang wood (Caesalpinia sappan L) has various biological benefits, such as anti-inflammatory, antibacterial, antioxidant, anti-allergic, analgesic, and so on.

This study was conducted to examine the effect of process temperature and sucrose concentration used in the manufacture of transparent soap. The raw materials used were VCO, sodium hydroxide (NaOH), stearic acid, citric acid, glycerol, ethanol, and secang wood extract as an additive. The results of the study indicate that the optimal conditions for obtaining relatively good transparent soap are a temperature of 70°C and a sucrose concentration of 70%. Under these conditions, the soap produced had good color and transparency, a moisture content of 15.2%, a pH of 10.33, and a foam stability of 89.41%.

KEYWORDS: secang, soap, transparent, VCO.

I. INTRODUCTION

Soap is a key product that plays a major role in the cosmetics industry for maintaining hygiene and preventing bacterial growth. Innovations in soap manufacturing include transparent soap. Soap is a compound produced from the reaction between fatty acids and alkali. High-quality ingredients that can be used include pure coconut oil, which has a high lauric acid content that serves to soften and moisturize the skin. An additional ingredient that can improve the quality of soap is secang wood (Caesalpinia sappan L.), which contains the main compound brazilin, a producer of red pigment and anti-inflammatory, antimicrobial, and antiviral agents. Other compounds found in secang wood are flavonoids, brazilin, alkaloids, saponins, tannins, phenyl propane, and terpenoids. The flavonoid content in secang wood is useful as an antioxidant that traps free radicals. One type of flavonoid in secang wood is anthocyanin. Anthocyanin is a compound that is good for health because it has antioxidant, antibacterial, and anti-inflammatory activities (Nomer et al., 2019). Soap can be made through a process called saponification. The saponification process is a reaction that breaks down triglyceride chains through a reaction with sodium hydroxide (NaOH) or potassium hydroxide (KOH), which produces soap as the main product and glycerol as a by-product (Hasibuan, 2019).

Solid soap can be in the form of regular solid soap that looks solid, opaque, and is called opaque soap or white soap, which is commonly found in the market. Meanwhile, transparent solid soap is a type of soap that is most easily penetrated by light when light is passed through the soap bar. It is used as a beauty soap for bathing that produces a soft lather on the skin. This transparent soap is a very attractive product for the public because of its attractive, classy, and luxurious appearance, so the price is relatively more expensive than solid soap in general. Another added value of transparent soap is that it can be used as a unique and exclusive souvenir ( ) (Tungadi et al., 2022). Transparent solid soap is a bar soap with the highest level of transparency and is more lustrous than other types of soap. This type of soap emits light that scatters in small particles, so that objects outside the soap are clearly visible or transparent (Anindita et al., 2023).

The added value of transparent soap is that, in addition to its attractive transparent appearance, it has moisturizing properties, effective cleaning power without leaving soap suds, and feels softer. In the manufacture of solid soap, NaOH alkali is used. NaOH causes crystals to form, which makes the soap opaque. To make soap transparent, a sufficient amount of solvent is added to make the crystals very small so that light can pass freely through the soap, making it appear transparent. Transparent soap is also often called glycerol soap because glycerol must be added to the soap to achieve its transparent properties (Kirana, 2017).

Transparent soap is made from a mixture of oil and NaOH solution called saponification reaction at a certain temperature. NaOH solution is an alkali source in the soap-making reaction. Other additives in the soap-making process are sugar solution, which functions to create transparency and texture in soap, as well as controlling moisture in soap. Next, ethanol is added to give the soap its transparency. Then, citric acid is added to remove heavy metals from hard water and bind divalent metals (Mg, Mn, and Fe). Glycerol is added to give the soap its transparency and moisture, as well as color and fragrance. Finally, the soap is poured into molds and left to harden.

Transparent soap has a finer lather than opaque soap. The quality and transparency of soap are influenced by the soap-making process and the alcohol, sugar, and glycerol content in the soap. Glycerol is good for the skin because it acts as a moisturizer and forms a gel phase in the soap. This study will examine the effect of temperature and sugar composition in soap on the transparency and physical properties of soap.

Table 1. Quality Standards for Solid Bath Soap based on SNI 3532:2021

No	Test Parameter	Quality Requirements
1	Moisture Content	Maximum 23%
2.	pH	6.00 – 11.00
3.	Foam stability	60% – 70%

(National Standardization Agency, 2021)

Virgin Coconut Oil (VCO) is pure coconut oil made from fresh coconut meat, processed without heating. Extracting coconut oil in this manner preserves the essential compounds needed by the body intact . Coconut oil contains saturated fatty acids that do not have double bonds or lose hydrogen atoms, making them less susceptible to oxidation and the formation of free radicals compared to unsaturated fats. Therefore, coconut oil with its saturated fatty acids is safer for human health (Loliger, 1991).

Figure 1. Coconut meat

Pure coconut oil with main ingredients of lauric acid and capric acid is very beneficial for the health of the body. Many researchers have proven that lauric acid in the human body will be converted into monolaurin which can combat various viral attacks such as *HIV*, herpes, influenza and various pathogenic bacteria. Lauric acid is a medium-chain saturated fat, often referred to as *Medium Chain Fatty Acid (MCFA). Lauric acid* functions to increase metabolism in the body, thereby boosting energy and stimulating effects and controlling body weight (Setiaji, 2005). There are many health benefits of *MCFA* in coconut oil. Each *MCFA* has its own important effect, but they complement each other and are all important overall. The percentage of *MCFA* in coconut oil is 48% lauric acid, 8% caprylic acid, 7% capric acid, and the rest are beneficial acids (Thampan, 1994).

Secang wood is part of the secang tree trunk. The secang tree is a small tree with a height of 4-10 m that has taproots and a trunk with protrusions that have many thorns, brown in color, and branches with thorns that curve downward. In addition, the secang tree has double pinnate compound leaves and yellow flowers. One of the uses of the secang tree is the inside of the trunk, which is usually called the pith. Secang wood has a brown trunk that can produce red pigments. Secang wood (*Caesalpinia sappan L*) has various biological benefits, such as anti-inflammatory, antibacterial, antioxidant, anti-allergic, analgesic, and others. (Sucita et al., 2019).

(a) (b)

Figure 2. Secang tree (a) and secang wood (b)

The taxonomic position of the secang plant is as follows (Alfonsius, 2015):

Division	: Spermatophyta
Subdivision	: Angiospermae
Class	: Dicotyledonae
Order	: Resales
Family	: Caesalpiniaceae
Genus	: Caesalpinia
Species	: Caesalpinia sappan L

Secang wood contains flavonoids, saponins, alkaloids, tannins, phenolics, and brazilin. The saponins, flavonoids, and alkaloids function as antioxidants, anti-inflammatories, and antifungals, while tannins can exhibit antiviral and antibacterial activity. A specific compound found in secang wood is brazilin, which has anti-inflammatory effects. These active compounds have the potential to be beneficial in the wound healing process. Secang wood is a plant that contains gallic acid, brazilin (sappan wood red), and tannic acid (Sucita et al., 2019). Several triterpenoids, flavonoids, and heterocyclic oxygen compounds were found in the isolation of compound components in secang wood, and brazilin was found to be the main component in secang wood, which is thought to play an important role in the pharmacological effects of secang wood. Brazilin has pharmacological activities such as anti-inflammatory, antimicrobial, antioxidant, and antiviral properties. This compound is the main component and characteristic compound of secang wood (Suraini and Enlita, 2015).

Sappanwood extract (Caesalpinia sappan L.) contains five active compounds related to flavonoids, both as primary and secondary antioxidants (Rusdi et al., 2005). It has been found that the flavonoids contained in secang wood extract have a number of abilities, namely to reduce or inhibit the formation of hydroxyl free radicals, superoxide anions, peroxyl radicals, alkoxyl radicals, and hydrogen peroxide (Rusdi et al., 2005).

II. RESEARCH METHOD

Ten grams of stearic acid were added to 70 grams of VCO, then heated using a water bath at varying temperatures. Thirty-five grams of 31% NaOH were then added and stirred for 5 minutes until a vaseline-like paste was formed. Next, 60 grams of sucrose solution with varying concentrations was added, along with 1 gram of citric acid ( ), 30 grams of glycerol, 30 grams of 96% ethanol ( ), and stirred until the soap melted and became transparent. After that, the soap was cooled to a temperature of 50 oC and 1 gram of secang wood extract was added.

The melted soap is poured into a silicone mold and left to set for 24 hours. The hardened soap is then removed from the silicone mold and transferred to a bamboo tray with holes for the curing process, which takes place over 3 weeks in a dry, open area.

The transparency of soap is tested using the organoleptic method. Hardened solid soap is placed on paper with Times New Roman font size 14, then observed from above to see how clear the writing under the soap is (Wati et al., 2025). If the writing is clear, the soap is transparent. If the text appears faint, the soap is semi-transparent. However, if the text is not visible at all, the soap is opaque.

III.RESULTS AND DISCUSSION

The effect of temperature and sucrose concentration in the manufacture of transparent soap was observed by examining the process and results obtained, with variations in process temperature and sugar concentration. Other process conditions and compositions were kept constant. The results of the observations are shown in Tables 1 to 5.

Table 1. Effect of sucrose concentration on color and transparency at a process temperature of 60°C

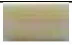
Temperature	Sucrose Concentration (% mass)	Color & transparency
60	50	
60	55	
60	60	
60	65	
60	70	

Table 2. Effect of sucrose concentration on color and transparency at a process temperature of 65°C

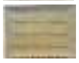
Temperature	Sucrose Concentration (% mass)	Color & transparency
65	50	
65	55	
65	60	
65	65	
65	70	

Table 3. Effect of sucrose concentration on color and transparency at a process temperature of 70°C

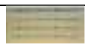
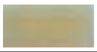
Temperature	Sucrose Concentration (% mass)	Color & transparency
70	50	
70	55	
70	60	
70	65	
70	70	

Table 4. Effect of sucrose concentration on color and transparency at a process temperature of 75°C

Temperature	Sucrose Concentration (% mass)	Color & transparency
75	50	
75	55	
75	60	
75	65	
75	70	

Table 5. Effect of sucrose concentration on color and transparency at a process temperature of 80°C

Temperature	Sucrose Concentration (% mass)	Color & transparency
80	50	
80	55	
80	60	
80	65	
80	70	

Tables 1 to 5 show that the optimal temperature for obtaining soap with good color and transparency is 70°C. Using a temperature of 70°C, good color and transparency are obtained at a sucrose concentration of 70% by mass. The color and transparency can be seen in Figure 3 below:

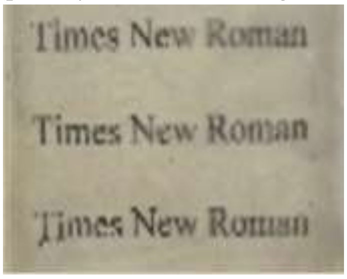


Figure 3, The best transparency of soap in this study

The results show that temperature and sucrose concentration greatly affect the physical properties of soap. If the temperature is lower than 70°C, the soap becomes less transparent and the color is uneven because the solubility of the ingredients decreases at lower temperatures. Conversely, if the temperature is higher than 70°C, the color of the soap becomes darker (brownish) and less transparent. At the optimal temperature, the higher the sucrose concentration, the clearer and more transparent the soap color will be.

Table 6. Properties of soap produced at various temperatures and sucrose concentrations

Temperature °C)	Sucrose (%)	Aater content (%)	pH	Foam Stability (%)
	50	16,4	10,58	92,94
	55	16,8	10,91	92,5
60	60	17,2	10,8	91,11
	65	17,8	10,87	88,31
	70	17,2	10,6	90,79
	50	14,4	10,49	93,75
	55	15,4	10,53	90
65	60	15,2	10,5	90,54
	65	15,4	10,42	90,77
	70	16,2	10,49	90,24
	50	13,2	10,34	94,12
	55	13,8	10,33	93,44
70	60	14,6	10,33	92,77
	65	14,8	10,34	92,63
	70	15,2	10,36	89,41
	50	11,6	10,28	92
	55	12,6	10,29	91,67
75	60	12,6	10,32	89,53
	65	13,8	10,24	91,95
	70	13,6	10,26	90,91
	50	6,6	10,15	85,71
	55	7,4	10,16	85,94
80	60	11	10,02	80,26
	65	11,4	10,14	79,31
	70	12	10,01	78,31

The water content in solid soap greatly affects its quality. Too much water makes the soap soft, prone to shrinkage, and quick to wear out, and can even cause it to smell musty. On the other hand, too little water makes it hard but difficult to dissolve and can damage the skin. Therefore, the ideal water content according to the Indonesian National Standard (SNI) for soap products is less than 23%.Table 6 shows that the higher the temperature, the lower the water content in soap, because the greater the heat absorbed by the ingredients, the greater the evaporation of water. The effect of concentration is not very significant on the water content in soap. The water content value under optimal conditions (temperature 70°C with a sucrose concentration of 70%) is 15.2%.

The effect of temperature and sucrose concentration on the pH of the soap is not very significant. The pH value under optimal conditions is 10.36, which is in accordance with the Indonesian National Standard (SNI) for soap products, which is 6 to 11. Meanwhile, the foam stability value under optimal conditions is 89.4. This value is too high for the SNI requirements for soap, which is a foam quality between 70 and 80. Further research can be conducted to reduce the foam stability percentage by increasing the oil content or adding additional softening oils such as olive oil.

Table 7. Quality Standards for Solid Bath Soap based on SNI 3532:2021

No	Test Parameter	Unit	Quality Requirements
1	Moisture content	%	Maximum 23
2.	pH	-	6.00 – 11.00
3.	Foam stability	%	60 – 70

(National Standardization Agency, 2021)

CONCLUSIONS

Based on the research conducted, it was found that temperature and sucrose concentration greatly affect the quality and physical properties of soap. If the temperature is lower than 70°C, the soap becomes less transparent and the color becomes uneven because the solubility of the ingredients decreases at low temperatures. Meanwhile, if the temperature is higher than 70°C, the color of the soap becomes darker (brownish) and less transparent. At the optimal temperature, the higher the sucrose concentration, the clearer and more transparent the soap color becomes. The water content is influenced by the reaction temperature. The higher the reaction temperature, the lower the water content. The pH and foam stability of the soap are not significantly affected by temperature or sucrose concentration. The optimal conditions for obtaining relatively good transparent soap are a temperature of 70°C and a sucrose concentration of 70%. Under these conditions, the soap produced has good transparency, a water content of 15.2%, a pH of 10.33, and foam stability of 89.41%.

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