Physicochemical Quality of Transparent Solid Soap with The Addition of Forest Honey (*Apis dorsata*) as An Environmentally Friendly Sanitizer

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Abstract. Soap is the result of a saponification reaction between fatty acids and bases, which produces soap and glycerol. Transparent solid soap has attracted public attention because it is more attractive and can be used as a body cleanser. Honey is known to contain secondary metabolites, namely alkaloids, flavonoids, tannins, and saponins, which have antibacterial and anti-free radical activity. So, honey has been developed as a business innovation in product diversification. This research aims to determine the physicochemical quality and antioxidant activity of transparent solid soap with the addition of forest honey. The research method used was laboratory experiments with the addition of honey concentration to transparent soap formulations with concentration values of 0%, 5%, 10%, 15%, and 20%. The results of the research show that transparent soap with the addition of honey has an average value for colors L*, a*, and b*, respectively, of 27.48–40.60, (-5.12)–(1.40), 3.06–10.93. The pH value and texture of soap have an average value of 9.48–10.17 and 8.47–13.27 N, respectively. The percentage of water content and foaming power has an average of 10.73–13.42% and 73.64–87.72%, respectively. The free fatty acid content and antioxidant activity of soap have average values of 0.24–0.64 and 1.48–1.86 μg/mL. These results indicate that transparent solid soap with the addition of forest honey produces a quality that conforms to SNI 06-3532-1994 and SNI 3532:2016 in terms of physicochemical properties and contains high antioxidant activity.

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1 Introduction

Honey is a natural product produced by honey bee colonies. Honey has a characteristically sweet and thick taste because most of it contains sugar [1]. Honey is known to contain secondary metabolites, namely alkaloids, flavonoids, tannins, and saponins [2]. This content has antibacterial activity [3]. Honey also contains carbohydrates, proteins, amino acids, organic acids, vitamins, minerals, and enzymes [4]. Flavonoid components such as luteolin, quercetin, apigenin, fisetin, kaemprefol, ishoramnetin, acacetin, tamarixetin, chrysin, and galangin in honey are known to act as antioxidants that can fight free radicals [5]. Forest honey is a type of honey that is often found in Indonesia. In Indonesia, one of the regions that produces forest honey products is Nusa Tenggara Timur (NTT), with production reaching 104 tons per year [6]. Forest honey is produced by dorsata bees. Many communities develop forest honey to develop business innovations [7]. The role of soap is not only to cleanse the skin of adhering dirt, but it must also contain ingredients that are beneficial for the skin and not damage the skin so that it can maintain healthy skin. Free radicals are very likely to be found in the skin, causing the skin to wrinkle quickly, causing premature aging, black spots, skin looking duller, and even skin cancer [1].

The current trend among consumers is to use skin care products that contain components made from natural ingredients. One type of skin care that is popular all over the world is solid soap because it does not cause dry skin. This is because solid soap is usually made from vegetable oils and other natural ingredients [8]. Soap is the result of a saponification reaction between fatty acids and bases, which produces soap and glycerol. Soap has hydrophobic properties [9]. People will always look for solid soap as a body cleanser. Transparent solid soap is currently gaining public attention because it is more attractive with its transparent character, produces softer foam, and looks shinier compared to other types of soap. The soft foam produced by transparent solid soap is caused by the addition of alcohol, sugar, and glycerine during its manufacture. Currently, the use of plant-based ingredients in making soap as a sanitizer is being developed, which is environmentally friendly and has good benefits for skin health. Virgin Coconut Oil (VCO) is used as vegetable oil and has a role in making the color of the soap transparent [10].

Honey is one of the natural ingredients that is usually added to skincare formulations, but the type of honey used in the formulation is never explained. The hope is that making transparent solid soap with the addition of honey can not only help provide benefits as an antibacterial and anti-free radical, but it can also add a soft, smooth, and moisturizing effect to the skin. The quality of making transparent honey solid soap was compared based on SNI 3532-2016 concerning bath soap. The aim of this research is to make a transparent solid soap formulation with the addition of various concentrations of forest honey and then observe its effect on the physicochemical quality.

2 Materials and Methods

2.1 Materials and Tools

The ingredients used in making transparent solid soap include virgin coconut oil (VCO), NaOH (crystals), propylene glycol, stearic acid, sorbitol, glycerin, distilled water, and forest honey (from PT. Kembang Joyo Sriwijaya). The materials used in parameter testing include NaOH, DPPH (2,2-diphenyl-1-picrylhydrazyl) solution, and methanol.

The tools used in this research include beakers, measuring cups, electric stoves, stirrers, hand mixers, analytical scales, digital scales, filter cloths, spatulas, silicone soap molds, test

tubes, pH meters, and Warner-Braztler Shear Force, burette, buffer, dropper pipette, micropipette, Erlenmeyer flask, UV-Vis spectrophotometry, and 3 mL cuvette.

2.2 Methods

The research was carried out using an experimental design at the Animal Products Technology Laboratory, Faculty of Animal Science, Universitas Brawijaya. The sample used was transparent solid soap with the addition of 0% (P0), 5% (P1), 10% (P2), 15% (P3), and 20% (P4) honey. Analysis parameters include L*a*b color, texture, foam power, pH, water content, free fatty acids, and DPPH antioxidant activity. Data were analyzed using a completely randomized design and continued using the Duncan multiple range test (DMRT) if there were significantly different results.

2.3 Making Transparent Solid Soap with Forest Honey

The transparent solid soap formulation was made according, which was modified in the use of ingredient measurements, sorbitol as a substitute for liquid sugar or sucrose, and the addition of honey [11, 12]. The formulation for adding forest honey with different concentrations (0%, 5%, 10%, 15%, and 20%) is presented in Table 1. The process of making transparent solid soap with honey includes: a) Dilute NaOH with distilled water and glycerin on a hotplate; b) Heat the VCO to a temperature of 90^{o}C, along with melting the stearic acid at a temperature of 70 ^{o}C; c) Add stearic acid to the VCO solution at a temperature of 90 ^{o}C and stir until homogeneous; d) Cooled to 40 ^{o}C (equivalent to the temperature of liquid NaOH), then added liquid NaOH until it forms a lump; e) Add liquid NaOH until it forms lumps; f) Add alcohol and blend in a blender/mixer until homogeneous (3-5 minutes). If foam appears, remove the foam; g) Add propylene glycol, then blend until homogeneous (1-2 minutes). Continue adding sorbitol, then blend until homogeneous (1-2 minutes); h) Heated on a hotplate to a temperature of 80^{o}C and while stirring until the color is transparent; i) Added honey and fragrance oil. Stir until homogeneous, then pour into the mold and let sit for up to 2 weeks.

Table 1. Formulation of ingredients for making transparent solid soap with forest honey

Ingredients	**Treatment**					**Function**
	P0 (g) 0%	**P1 (g) 5%**	**P2 (g) 10%**	**P3 (g) 15%**	**P4 (g) 20%**	
VCO	62,5	62,5	62,5	62,5	62,5	Foam producer
Propylene glycol	50	50	50	50	50	Solvent
Sorbitol	50	50	50	50	50	Transparent agent, humectant, foam former
Distilled water	47,5	47,5	47,5	47,5	47,5	Solvent
Alcohol 96%	42,5	42,5	42,5	42,5	42,5	Transparent agent
Stearic acid	25	25	25	25	25	Hardener and moisturaizer
NaOH	12,5	12,5	12,5	12,5	12,5	Soap hardener
Glycerin	6	6	6	6	6	Softener and moisturaizer
Oil fragrance	4	4	4	4	4	Soap fragrance

Forest Honey	0	15	30	45	60	Antioxidant
Total	300	315	330	345	360	

2.4 Physicochemical Analysis of Soap

The results of making transparent solid soap with various concentrations of forest honey are shown in Figure 1, followed by a physicochemical quality analysis. Physical analysis parameters for transparent solid soap include color L*a*b* using procedures from CIE Lab 2007, texture using the Warner-Bratzler Shear Force (WBS) tool [13], and foam power, referring to SNI 3532:2016 about solid bath soap [14]. Chemical analysis parameters for transparent solid soap include pH using a pH meter with a soap and distilled water ratio of $1:10^{12}$, water content and free fatty acids referring to SNI 3532:2016, and antioxidant activity using DPPH solution [15, 16].

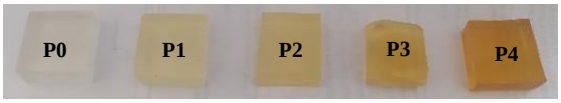

Figure 1. Transparent solid oap with various concentrations of forest honey.

3 Results and Discussion

3.1 Color L*a*b*

The color parameter L* has a value of 0 for black (dark) and a value of 100 for white (bright). The color parameter a* with a negative value indicates a greenish color, and a positive value indicates a red color. The b* color parameter with a negative value indicates blue, and a positive value indicates yellow. The color parameters a* and b* have a value range of -120 to +120 [17, 18]. The results of statistical analysis on transparent solid soap with the addition of different concentrations of honey showed very significant differences ($P<0.01$) in the color of L*a*b*. The results of statistical analysis of L*a*b* colors are shown in Table 2. The average color value L* of transparent solid soap with the addition of honey is 27.48–40.60. The honey soap that has the highest level of lightness is the P0 treatment, and the lowest is the P3 treatment. Soap without adding honey produces a transparent white color. Making soap using good VCO oil will produce clear (transparent) soap [10].

The greater the concentration of honey added to the soap, the darker the color, as evidenced by the L* color value obtained for each treatment, which decreases as the honey concentration increases. The darker the color of the soap, the more it affects the transparency of the soap. This shows that the addition of honey to soap making affects the level of brightness and transparency of the soap. The average color value a* of transparent solid soap with the addition of honey is (-5.12) – (1.40). The resulting a* color value shows a negative value, which means that this transparent solid soap has a greenish color. The increasing concentration of honey given shows a greater a* color value, which means that the addition of honey affects the color of the soap, which was initially greenish to slightly reddish. The average b* color value of transparent solid soap with the addition of honey is 3.06–10.93. The resulting b* color value shows a positive value, which means that this transparent solid soap has a yellowish color. The yellowish color of the soap is shown to be higher as the concentration of honey given increases, so it can be assumed that honey has an influence on the color of the soap becoming more yellowish.

Table 2. L*a*b* color analysis results.

Treatment	Color L*	Color a*	Color b*
P0	40.60 ± 0,26^{c}	-5.12 ± 0,19^{a}	3.06 ± 0,14^{a}
P1	35.98 ± 0,57^{b}	-4.04 ± 0,19^{b}	5.50 ± 0,20^{c}
P2	35.99 ± 0,28^{b}	-1.40 ± 0,07^{d}	10.93 ± 0,33^{d}
P3	27.48 ± 1,34^{a}	-3.03 ± 0,40^{c}	3.88 ± 0,14^{b}
P4	28.14 ± 0,77^{a}	-1.51 ± 0,20^{d}	4.91 ± 0,44^{c}

3.2 Texture

The texture analysis applied in this research is to determine the level of softness of the sample. Texture analysis uses the WBS tool, which is commonly used to estimate the level of tenderness in meat and can be used for other commercial products. Apart from detecting the level of tenderness, it also has a significant correlation with the level of chewiness and tenderness [13]. The results of statistical analysis on transparent solid soap with the addition of different concentrations of honey showed very significant differences ($P<0.01$) in the texture of the soap. The results of statistical analysis on texture are shown in Table 3. The average value of the softness level of transparent solid soap with the addition of honey is between 8.47 and 13.27 newtons. The addition of honey to transparent solid soap resulted in a harder soap texture, but the addition of 15% honey resulted in the lowest texture value, namely 8.47 newtons. The higher the texture value, the more it indicates that the texture is harder.

Based on the results of the Duncan test, it shows that treatment P0 is not significantly different from P3, but is significantly different from treatments P1, P2, and P4. The hardest texture was found in treatment P2, namely the addition of 10% honey. The addition of honey influences the texture of the soap to become harder. This is thought to be because honey still contains quite a high-water content. In this study, it was found that the forest honey used had a water content of 22%. Forest honey is known to have a water content range of 24–28%, which means that the water content in forest honey is quite high. Previous researchers stated that the level of softness in solid soap is influenced by the water content, which continues to decrease due to evaporation, causing the soap's texture to become harder [14]. It is proven by the positive correlation when looking at the results of the soap analysis in this study that the addition of honey can increase the water content and the level of tenderness (texture). On the other hand, solid soap must have a hard texture to maintain its shape [8]. In this research, the hardest transparent soap was P2 with the addition of 10% forest honey.

3.3 Foam Power

One of the important parameters in determining the quality of soap is foam. It is known that users prefer soap that has a lot of and stable foam to soap that has little and unstable foam [19]. The results of statistical analysis of transparent solid soap with the addition of different honey concentrations did not provide a significant difference ($P>0.05$) in foaming power. The results of statistical analysis on foam power are shown in Table 3. The average value of soap foam power in the study was between 73.64-87.72%. The highest foam power was produced from P2 treatment, while the lowest foam power was produced from P4. This shows that adding excess honey can reduce the foaming power of soap. The foaming power in this

study had a lower average compared to previous research, namely that soap with the addition of extracts produced a foaming power of 83.14–89.27% but still had almost the same range[1].

Standards for foaming power in soap have not been regulated in SNI, because the level of foam does not indicate its ability to clean. The addition of honey to transparent solid soap has no effect, so the addition of honey in various concentrations does not reduce the quality of the soap's foaming power. The higher the foam power produced, the lower the unsaponifiable fat value. Therefore, if the foam power is low, it can also reduce the ability of the soap during the cleaning process [3]. Foaming power is also influenced by the saturated fatty acid content of the oil used. VCO contains the highest saturated fatty acid, namely lauric acid. Saturated fatty acids can cause the foam produced to be more stable when used compared to unsaturated fatty acids [10]. This was proven in this research that the soap made had a stable foaming power of 73.64–87.72%, and adding 10% forest honey could produce the highest foaming power.

Table 3. Texture, foam power, and pH analysis results.

Treatment	Texture (N)	Foam Power (%)	pH
P0	$9.30 \pm 1{,}00^{a}$	$83.91 \pm 1{,}96$	$9.68 \pm 0{,}08^{x}$
P1	$12.57 \pm 1{,}21^{b}$	$73.64 \pm 10{,}31$	$9.48 \pm 0{,}02^{x}$
P2	$13.27 \pm 1{,}72^{b}$	$87.72 \pm 5{,}46$	$10.17 \pm 0{,}12^{y}$
P3	$8.47 \pm 0{,}76^{a}$	$81.74 \pm 8{,}38$	$9.63 \pm 0{,}01^{x}$
P4	$13.23 \pm 2{,}54^{b}$	$77.88 \pm 9{,}96$	$9.66 \pm 0{,}02^{x}$

Superscript : a,b different superscripts show that honey soap has a very significant effect ($P<0.01$) on the texture.
x,y different superscripts show that honey soap has a very significant effect ($P<0.01$) on the pH.

3.4 pH

The pH value of transparent soap plays an important role in knowing whether the pH of the soap is acidic or basic. The pH value of soap that is too low or high can cause irritation to the skin when used. The quality criteria for the pH value of transparent solid soap according to SNI 06-3532-1994 is between 9 and 11 [19]. Soap on the market has a pH of around 9.75-12.38[15]. The results of statistical analysis on transparent solid soap with the addition of different concentrations of honey showed very significant differences ($P<0.01$) in the pH value. The results of the pH statistical analysis are shown in Table 4. The average pH value of soap in the study was between 9.48 and 10.17. This shows that the soap in this study produces soap that is alkaline and meets the SNI 1994 criteria for bath soap. The addition of honey to treatment P2 (10%) produced the largest pH compared to treatments P0, P1, P3, and P4. Based on the results of the Duncan test, it shows that P0 has an insignificant difference compared to P1, P3, and P4, but the difference is very significant compared to P2.

Soap that has a pH value that is too high can increase the absorption capacity of the skin, so a soap pH that is too alkaline can cause the skin to itch or peel and cause the skin to become dry [16]. Based on the results of the average pH of soap in this study, it can be said to be safe to use because it has a low and medium alkaline pH. Previous research on making transparent solid soap with the addition of astaxanthin produced a pH value of 9.73; this shows that the pH value of the soap in this study still complies with existing quality criteria [19]. Honey

contains metabolite compounds, namely alkaloids, which are alkaline in nature, so they play a role in influencing the resulting acidity (pH) value [2, 9]. The pH of the soap in this study is in accordance with the provisions in SNI 1994. Apart from the soap raw materials, which influence the pH value, there are other factors, namely the stirring time. The stirring time when mixing the soap ingredients in this study was between 15 and 20 minutes. This is in accordance with previous research, which found that a stirring time that is too long (21–40 minutes) can reduce the pH of the soap because it can cause the interaction time between oil and alkali to be greater, so that the reaction will approach equilibrium and the alkali residue will be lower. causes the soap product to become less alkaline [9].

3.5 Water Content

You need to know the water content in soap because it can affect the solubility of the soap in water when used. The high levels of soap can make it easier for the soap to shrink when used. According to SNI 06-3532-1994, the maximum limit for solid soap water content is 15% [8]. The results of statistical analysis on transparent solid soap with the addition of different concentrations of honey gave very significant differences ($P<0.01$) in water content. The results of statistical analysis on water content are shown in Table 4. The average value of soap water content in the study was between 10.73-13.42%. This shows that the water content of honey transparent solid soap in this study still meets the criteria. Based on the results of the Duncan test, it shows that treatment P0 is not significantly different from P2, P3, and P4, but is significantly different from P1. The addition of 5% honey (P1) has the highest water content, while soap without the addition of honey has the lowest water content. The water content of soap has a close relationship with the quality of the texture because high water content will make it easier for the soap to shrink quickly and cause the texture of the soap to become harder. Previous research involved making transparent soap with the addition of astaxanthin to produce a water content of 12.35% [19]. The rubberonoid pigment in transparent solid soap is known to contain water, thus causing the water content of the soap to increase [13]. This confirms that the presence of chemical compounds, especially phytochemicals, causes an increase in water content. Transparent solid soap that uses VCO is known to have a lower water content compared to soap that uses palm oil. If the water content in soap is high, it will cause an increased risk of soap rancidity [10].

Table 4. Water content, free fatty acid, and antioxidant activity IC50.

Treatment	Water Content (%)	FFA (%)	Antioxidant Activity IC_{50} (µg/mL)
P0	$10.73 \pm 0{,}58^{a}$	$0.24 \pm 0{,}05^{p}$	1.48 ± 0.01^{x}
P1	$13.42 \pm 0{,}55^{b}$	$0.41 \pm 0{,}04^{q}$	1.47 ± 0.01^{x}
P2	$12.05 \pm 0{,}72^{a}$	$0.37 \pm 0{,}04^{q}$	1.55 ± 0.19^{x}
P3	$11.74 \pm 0{,}77^{a}$	$0.45 \pm 0{,}04^{q}$	1.86 ± 0.08^{y}
P4	$12.09 \pm 0{,}25^{a}$	$0.64 \pm 0{,}06^{r}$	1.45 ± 0.01^{x}

Superscript : a,b different superscripts show that honey soap has a very significant effect ($P<0.01$) on the water content.
p,q,r different superscripts show that honey soap has a very significant effect ($P<0.01$) on the free fatty acids.
x,y different superscripts show that honey soap has a very significant effect ($P<0.01$) on the antioxidant activity.

3.6 Free Fatty Acids

Free fatty acids are fatty acids that are present in soap but are not bound as triglyceride compounds (mineral fat) or sodium compounds. Based on SNI 3532:2016, the maximum free fatty acids in solid soap are 2.5%. The results of statistical analysis on transparent solid soap with the addition of different concentrations of honey showed very significant differences ($P<0.01$) in free fatty acid levels. The results of statistical analysis on free fatty acid are shown in Table 4. The average value of free fatty acids in transparent solid soap ranges from 0.24 to 0.64%. The higher the concentration of honey added, the higher the free fatty acid value. The transparent solid soap in the study had an average free fatty acid content below the maximum limit, which means that the free fatty acids in this soap met the standard. Free fatty acids that are too high can cause a decrease in the cleaning power of soap. This is because the free fatty acid component is not needed for the cleaning function. If the free fatty acids are high, the soap will attract the free fatty acids in the soap, thereby reducing the soap's ability to clean oil or oily objects [11]. The addition of honey resulted in an increase in free fatty acid levels in transparent solid soap. This makes it possible that honey can also be an ingredient that can contribute free fatty acids to soap. Transparent soap ingredients that allow the production of free fatty acids are vegetable oils, stearic acid, and glycerine. Glycerine is made from the by-product of oil or fat hydrolysis. The level of free fatty acids has a directly proportional relationship to the water content of the soap, so the higher the level of free fatty acids, the more likely it is to trigger rancidity and reduce the shelf life of the soap [20]. High levels of free fatty acids can also cause the skin to feel rough and have low cleaning power [21]. Based on this research, soap with the addition of 20% forest honey shows the highest levels of free fatty acids.

3.7 Antioxidant Activity (DPPH)

Skin needs substances that have antioxidant activity to neutralize free radicals and prevent skin damage caused by free radicals. Polyphenolic compounds are compounds that have antioxidant activity, which can damage free radicals, prevent the formation of free radicals through hydrogen bonds, and deactivate oxygen, which can react between free radicals and metal compounds in the body [22]. One of the natural ingredients that has antioxidant and antibacterial activity is honey. There are several groups of strength of antioxidant activity based on the IC_{50} value, namely IC_{50} value < 50 μg/mL including very strong, IC_{50} value 50-100 μg/mL including strong, IC_{50} value 100-150 μg/mL including moderate, IC_{50} value 150-200 μg/mL is considered weak, and the IC_{50} value of 200-1000 μg/mL is considered very weak [8].

The results of statistical analysis on transparent solid soap with the addition of different concentrations of honey showed very significant differences ($P<0.01$) in antioxidant activity. The results of statistical analysis on antioxidant activity are shown in Table 4. The average IC_{50} antioxidant activity value ranged from 1.45 to 1.86 μg/mL. The P4 treatment, namely soap with the addition of 20% honey, has a lower IC_{50} value compared to the others; this shows that P4 soap has the strongest antioxidant activity. Antioxidants at certain concentrations will reach a stable phase. The stability of this antioxidant activity is assumed to be due to the synergism between antioxidant compounds in the addition of the extract, so that the free radical scavenging activity remains stable or changes to prooxidants. The concentration of added antioxidants will affect the rate of oxidation. Apart from the concentration of antioxidant activity in the added ingredients, there are other factors, namely the condition that phenolic groups are often lost or antioxidants change to prooxidants [23]. Gallic acid is used as a comparison solution, which is an organic component of the phenolic

compound group [24]. Therefore, the antioxidant activity of soap with various concentrations of honey has different IC_{50} values due to the unstable phenolic compounds in the soap.

4 Conclusions

Transparent solid soap with the addition of forest honey is reviewed based on water content and free fatty acids and meets the requirements of SNI 06-3532-1994 and SNI 3532:2016. Based on the L*a*b color was observed to have a darker and yellowish color as the concentration of honey added increased. The pH value, foaming power, and antioxidant activity produced also meet the requirements for sanitizer soap because it has a pH that suits the skin, produces good foam, and has very strong antioxidant activity. The texture of the soap produced is also dense and hard, so it lasts longer when used. Of all the honey concentration treatments added, treatment P2 (10%) produced the most suitable soap product.

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