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Article

The Effect of Variations in the Concentration of Added Butyrum (milk fat) on the Making of Paper Soap and Organoleptic Properties: Sensory Tests and Product Stability

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ABSTRACT

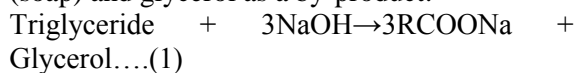
This study aims to determine the effect of variations in the concentration of butyrum (milk fat) addition on the quality of paper soap, including organoleptic properties, pH, free alkali, and solubility. Paper soap is made by the hot process method using the main ingredients of VCO, NaOH, distilled water, HPMC, camperlan, 96% ethanol, citric acid, and butyrum with 25 formulation variations. Organoleptic tests are carried out based on observations of color, aroma, texture, and foam volume. The pH test aims to ensure the acidity level of the soap is safe for the skin, the free alkali test is carried out by the titration method, and the solubility test measures the dissolving time of the soap in water. The results show that variations in butyrum concentration affect the physical properties of paper soap, especially the texture and foam produced. The pH value of the soap is in the range of 8–9 with an average of 8.5, thus meeting SNI standards. The free alkali test shows that all formulas are below the maximum limit of 0.1%, so it is safe to use. The dissolution time of the paper soap is in the range of 1–3 minutes, indicating good solubility. Overall, the addition of butyrum has a positive effect on the organoleptic quality and stability of paper soap.

1. Introduction

Soap is a cleaning product produced through a chemical reaction between a strong base (NaOH) and fatty acids from vegetable oils or animal fats through a saponification process (Rashati, 2022). The urgency of developing effective and practical soap products is increasing as public hygiene awareness increases. According to a World Health Organization report (2023), handwashing with soap can reduce the risk of infectious disease transmission by 30–50%. However, public compliance is still influenced by the availability and practicality of cleaning products. Good soap must have optimal cleaning power, be stable at various levels of water hardness, and be safe for the skin (pH according to SNI 8–11 standards). Innovations in soap forms have evolved from solids, liquids, to gels, including soap in thin sheets or paper soap. Paper soap is lightweight, hygienic (single-use), easy to carry, and minimizes cross-contamination (Pratita & Fathurohman, 2021).

One of the advantages of paper soap is its ability to reduce the use of harmful chemicals often found in conventional soaps. Paper soap can be formulated with natural ingredients, such as plant extracts or vegetable fats, which are not only effective in cleaning but also more environmentally friendly. For example, the use of butyrum (milk fat) in paper soap can enhance its emollient properties (the ability of a material to moisturize and soothe the skin), providing softness and a pleasant aroma (Fiskia and Mala, 2021).

Chemically, soap is formed through a saponification reaction between triglycerides ($C_3H_5(OOCR)_3$) and sodium hydroxide (NaOH), producing sodium salts of fatty acids (soap) and glycerol as a by-product:



This study used VCO, which is rich in lauric acid ($C_{12}H_{24}O_2$), to produce soap with good foaming ability. The addition of additives has a clear theoretical basis. Hydroxypropyl Methylcellulose (HPMC) functions as a film-forming agent through the formation of a hydrophilic polymer network that increases the flexibility and strength of the soap sheet. Ethanol acts as a polar solvent that increases system homogeneity, reduces viscosity, and accelerates evaporation during

drying (Putri et al., 2024). Meanwhile, butyrum (milk fat) contains saturated and unsaturated fatty acid fractions that are emollient, thereby increasing the softness and stability of the foam. A study by Sari & Wijayanti (2024) showed that the addition of milk fat in soap increases skin moisture and the sensory characteristics of the product. Thus, the formulation of VCO-based paper soap with the addition of HPMC, ethanol, and butyrum has a strong chemical and pharmaceutical basis.

Butyrum (milk fat) is a lipid fraction obtained from milk and is rich in short- and medium-chain saturated fatty acids such as butyric acid (C4:0), caproic acid (C6:0), caprylic acid (C8:0), and palmitic acid (C16:0). This composition provides natural emollient characteristics because it is able to form a thin occlusive layer on the skin surface that reduces transepidermal water loss. Furthermore, the triglyceride content and minor fractions such as vitamins A and E contribute to the moisturizing and skin-protecting effects. In paper soap systems, butyrum functions as a conditioning agent that increases sheet flexibility and reduces the potential for irritation from residual alkali. Its interaction with the HPMC polymer matrix and ethanol solvent produces a more elastic and less brittle film structure. Recent research has shown that the addition of milk fat to solid soap can significantly improve the softness of the texture, foam stability, and sensory quality of the product (Sari & Wijayanti, 2024).

Ethanol functions as a solvent while improving the structure, transparency, drying, texture, and stability of paper soap, thus determining its final quality. For optimal results, the addition of natural additives is required (Saputra, 2023). Based on this description, paper soap formulation requires optimization of the material composition, especially butyrum concentration, to obtain physicochemical characteristics and product quality that meet standards. This study aims to analyze the effect of variations in butyrum concentration on the quality of the resulting paper soap quantitatively and measurably. The independent variable in this study is the butyrum concentration, namely: in the paper soap formulation. The dependent variables include pH, free alkali content (%), organoleptic properties, and stability and dissolution time. With a quantitative

experimental approach, this study is expected to be able to determine the optimum formulation of VCO-based paper soap with sensory quality and safety that meet standards. $(\% \frac{b}{b'}) = \frac{\text{massa butyrum (g)}}{\text{massa total formulasi (g)}}$

2. Literature review

Soap is a product of the saponification reaction between fatty acids and a strong base such as sodium hydroxide (NaOH) or potassium hydroxide (KOH). This reaction produces fatty acid salts (soap) and glycerol as a byproduct. Soap works as a surfactant because it has hydrophilic and hydrophobic groups that can bind oily dirt and water together, making it easy to rinse. The quality of soap is influenced by the type and composition of its constituent fatty acids, which determine physical properties such as hardness, foaming power, softness, and product stability during storage (Wasitaatmadja, 2011).

Paper soap is an innovative solid soap product in the form of thin sheets that are practical, hygienic, and easy to carry. This soap is generally made by modifying solid or liquid soap and molding it into a thin film using a film-forming agent such as a water-soluble polymer. The advantages of paper soap lie in its ease of use and single-use dosage, making it more efficient and minimizing contamination. The stability of paper soap is influenced by its water content, fat composition, and the additives used in the formulation (Rowe et al., 2009).

Butyrum (milk fat) is an animal fat obtained from milk, especially butter, and is composed of triglycerides containing saturated and unsaturated fatty acids, such as butyric acid, palmitic acid, stearic acid, and oleic acid. A relatively high content of saturated fatty acids contributes to the hardness and stability of the soap structure, while short-chain fatty acids such as butyric acid can provide certain sensory characteristics (Gunstone, 2004). In soap making, variations in butyrum concentration have the potential to affect texture, hardness, solubility, and softness on the skin. The addition of milk fat is also known to increase the emollient effect so that the soap feels softer and is less drying to the skin.

Variations in the concentration of fat ingredients in soap formulations significantly affect the physical and chemical properties of

the final product. Higher fat concentrations can increase the superfat content, the unsaponified fat residue, which acts as a natural moisturizer. However, excessively high fat levels can reduce foam stability and accelerate rancidity due to fat oxidation (Ketaren, 2012). Therefore, optimizing butyrum concentration is a crucial factor in producing paper soap with balanced characteristics of softness, sheet strength, and storage stability.

The organoleptic properties of soap include color, aroma, texture, hardness, and comfort during use. Sensory testing involves panelists assessing these parameters using a hedonic scale or sensory quality scale. Organoleptic evaluation is important for determining consumer acceptance of a product. In paper soaps with added butyrum, changes in concentration can affect the distinctive aroma of milk fat, the color of the product, and the smooth sensation during use (Setyaningsih et al., 2010).

The stability of paper soap products includes physical stability (not easily brittle or soft), chemical stability (not experiencing rancidity), and organoleptic stability during storage. Factors that influence stability include water content, light exposure, temperature, and the content of unsaturated fatty acids that are susceptible to oxidation. Stability testing is usually conducted through storage at room temperature and accelerated temperature to observe changes in color, odor, texture, and pH of the product over a certain period (Rowe et al., 2009).

Thus, variations in the concentration of butyrum added in paper soap production have the potential to affect the saponification process, the physical characteristics of the soap sheets, the organoleptic properties, and the product's stability during storage. This literature review provides a scientific basis for examining the effect of variations in butyrum concentration on the quality and consumer acceptance of the resulting paper soap.

3. Research Methodology

This research was designed using a quantitative method. This research design will test the effect of variations in the concentration of added butyrum (milk fat) on the manufacture of paper soap and its organoleptic properties. This research will be divided into several stages, starting from the manufacture of paper

soap with different concentrations of butyrum (milk fat), to testing the organoleptic properties and product stability. The independent variables in this study are variations in the concentration of butyrum (milk fat), camperlane and ethanol. While the dependent variables include the quality of paper soap which includes hardness, solubility, cleaning power, aroma, and texture. The experimental design that will be used is a factorial experimental design with different concentrations of butyrum (milk fat) as the factors tested.

In the formulation process, the mole ratio of oil to sodium hydroxide (NaOH) is calculated based on the triglyceride saponification reaction. Stoichiometrically, one mole of triglyceride reacts with three moles of NaOH to produce three moles of fatty acid salt (soap) and one mole of glycerol. The NaOH requirement is calculated using the saponification value of butyrum, with the formula:

$$massa NaOH = \frac{SV \times massa minyak (g)}{1000}$$

Where SV is the saponification value (mg KOH/g oil) which is then converted to NaOH equivalents based on the ratio of the molecular weights of KOH (56.1 g/mol) and NaOH (40 g/mol). The mole ratio is calculated to ensure that the amount of NaOH used matches the stoichiometric requirements for a complete reaction.

The basis for determining the NaOH concentration in this study took into account the stoichiometric aspects of the reaction, the saponification value of butyrum, and the concept of superfatting, which is the addition of a small amount of excess oil (or a small reduction in NaOH) to produce a soap that is softer and does not cause skin irritation. The NaOH concentration was also adjusted so that it was not too high to prevent the soap from becoming too hard or excessively alkaline (too high a pH), while still maintaining the stability of the paper soap sheet structure. Thus, the optimization of the NaOH concentration was carried out to obtain a balance between the perfection of the saponification reaction, safety of use, and the physical characteristics of the resulting paper soap.

3.1 Tools and Materials

Table 1. Tools and materials used

Tool	Material
Beaker Glass	<i>Aquadest</i>
Thermometer	NaOH
Hotplate Magnetic Stirrer	VCO (Virgin Coconut Oil)
Scales	HPMC
Glass Stirrer	Camperlan
Watch glass	Ethanol 96%
Spoon	Citric Acid
Thin Print	<i>Butyrum</i> (Milk fat)
Oil Paper	
Scissors	
Packaging	
pH paper	

3.2 The course of the research

1) Preparation Stages

- a. Prepare all the tools and materials needed.
- b. Make a NaOH solution with the required concentration.
- c. Making butyrum (milk fat) solution with various concentrations.

2) Stages of Soap Making

- a. Put 50 grams of VCO into a beaker, heat on a hotplate magnetic stirrer to a temperature of 60-65°C (heating for 10 minutes with a stirring speed of 600 rpm).
- b. Weigh 6 grams of NaOH and dissolve it in distilled water, then stir until homogeneous.
- c. Mix VCO and NaOH at a temperature of 70°C until saponification occurs, stir until the mixture begins to thicken (heat for 20 minutes at a stirring speed of 600 rpm).
- d. Add 0.50 grams of citric acid.
- e. Add 0.50 grams of HPMC.
- f. Add camperlan (according to formula).
- g. Add 96% ethanol (according to formula).
- h. Add butyrum (according to formula)
- i. Stop heating and stirring after the soap is homogeneous (heating for 15 minutes with a stirring speed of 600 rpm).
- j. Pour the mixture into a thin mold,

thickness \pm 1 m.

3) Paper soap formulation

Table 2. Paper soap formulation

Formula	VCO (gram)	Aquadest (gram)	NaOH (gram)	HPMC (gram)	Camperlan (gram)	Asam Sitrat (gram)	Ethanol (gram)	Butyrum (gram)
1	50	21.00	6	0.50	2.0	0.50	19.80	0.20
2	50	20.95	6	0.50	2.0	0.50	19.75	0.22
3	50	20.90	6	0.50	2.0	0.50	19.70	0.24
4	50	20.85	6	0.50	2.10	0.50	19.65	0.26
5	50	20.80	6	0.50	2.10	0.50	19.60	0.28
6	50	20.75	6	0.50	2.10	0.50	19.55	0.30
7	50	20.70	6	0.50	2.20	0.50	19.50	0.32
8	50	20.65	6	0.50	2.20	0.50	19.45	0.34
9	50	20.60	6	0.50	2.20	0.50	19.40	0.36
10	50	20.55	6	0.50	2.30	0.50	19.35	0.38
11	50	20.50	6	0.50	2.30	0.50	19.30	0.40
12	50	20.45	6	0.50	2.30	0.50	19.25	0.42
13	50	20.40	6	0.50	2.40	0.50	19.20	0.44
14	50	20.35	6	0.50	2.40	0.50	19.15	0.46
15	50	20.30	6	0.50	2.40	0.50	19.10	0.48
16	50	20.25	6	0.50	2.50	0.50	19.05	0.50
17	50	20.20	6	0.50	2.50	0.50	19.00	0.52
18	50	20.15	6	0.50	2.50	0.50	18.95	0.54
19	50	20.10	6	0.50	2.60	0.50	18.90	0.56
20	50	20.05	6	0.50	2.60	0.50	18.85	0.58
21	50	20.00	6	0.50	2.60	0.50	18.80	0.60
22	50	19.95	6	0.50	2.70	0.50	18.75	0.62
23	50	19.90	6	0.50	2.70	0.50	18.70	0.64
24	50	19.85	6	0.50	2.80	0.50	18.65	0.66
25	50	19.80	6	0.50	2.80	0.50	18.60	0.68

4) Data analysis

a. Organoleptic Test

Organoleptic testing is the indirect assessment of product quality using the human senses (sight, smell, touch, and taste) during use. For paper soap, this test is used to assess user satisfaction and preference. The criteria assessed for paper soap are color, aroma, texture, and foaming rate.

b. pH test

A pH test measures the acidity or freedom of a product to ensure it's safe for use on the skin. The pH value indicates the concentration of hydrogen ions (H⁺) in the soap solution. A pH test can determine the soap's acidity level and ensure it's safe for skin.

c. Free Alkali Test

The free alkali in paper soap aims to measure the excess base (NaOH / KOH) that does not react, with a

maximum standard of 0.1% (SNI) to prevent irritation. The main method is acidimetric titration using 96% alcohol, phenolphthalein (PP) indicator, and 0.1 N HCl titrant, where the red/purple color that appears due to the base disappears during titration.

d. Solubility Test

The solubility test on soap paper aims to measure how quickly and accurately the soap paper dissolves in water (aquadest). Typically, a 2-gram sample of soap paper is dissolved in 50 mL of distilled water to observe the residue and dissolution rate. Good soap paper should dissolve completely or leave a small residue within a short time.

4. Results and Discussion

This study aims to determine the effect of variations in butyrum (milk fat) concentration on the quality of paper soap, including

organoleptic properties, pH, free alkali, and solubility. The paper soap manufacturing process in this study uses the hot process. The soap-making materials consist of VCO, Aquadest, NaOH, HPMC, Camperlan, 96% Ethanol, Citric Acid, and Butyrum. VCO functions as a basic ingredient for soap formation because it contains fatty acids that react with NaOH to produce good soap and foam. Aquadest is used as a solvent to dissolve NaOH and assist the reaction process. NaOH acts as a base that allows saponification to occur. HPMC functions as a film former so that the soap can be made into thin sheets and is not easily broken. Camperlan functions as a foam enhancer and stabilizer. 96% Ethanol helps dissolve ingredients, accelerates drying, and supports the formation of soap sheets. Citric acid plays a role in regulating pH and neutralizing residual base. Butyrum functions

as a natural softener that makes the soap more flexible, gentle on the skin, and helps reduce alkali free.

In this study, 25 paper soap formulas were created with different variations of 96% ethanol, camperlane, and butyrum. The paper soaps with added butyrum concentrations were tested for physical, chemical, and physical properties. Testing of the paper soaps included organoleptic, pH, free alkali, and solubility tests.

Based on the results of the Organoleptic Test of paper soap, the color, aroma, texture and amount of foam can be seen in the following table:

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Table 3. Organoleptic Test Observation Results

F	Color	Aroma	Texture	Lots of Foam
1	Transparent	Odorless	Fine	Currently
2	Transparent	Gentle	Fine	Currently
3	Transparent	Gentle	Fine	Currently
4	White	Gentle	Fine	Currently
5	White	Gentle	Fine	Lots
6	White	The distinctive smell of VCO	Fine	Lots
7	White	The distinctive smell of VCO	Fine	Lots
8	White	Gentle	Fine	Currently
9	White	Gentle	Fine	Currently
10	White	The distinctive smell of VCO	A bit stiff	Currently
11	Colored	Gentle	Fine	Lots
12	Colored	Gentle	Fine	Lots
13	White	The distinctive smell of VCO	Fine	Currently
14	White	The distinctive smell of VCO	Fine	Currently
15	White	The distinctive smell of VCO	Fine	Currently
16	Colored	Gentle	A bit stiff	Currently
17	White	Gentle	Fine	Lots
18	White	The distinctive smell of VCO	Rigid	Lots
19	White	The distinctive smell of VCO	Fine	Lots
20	Colored	Gentle	Fine	Currently
21	White	Gentle	Fine	Lots

22	White	Gentle	Fine	Lots
23	Colored	The distinctive smell of VCO	A bit stiff	Lots
24	Colored	The distinctive smell of VCO	A bit stiff	Lots
25	Colored	The distinctive smell of VCO	A bit stiff	Lots

Organoleptic testing aims to examine the physical appearance of paper soap, including shape, color, and odor. The 25 paper soap formulas obtained differed in color, aroma, texture, and foam volume due to varying concentrations.

Based on the results of the pH test of paper soap with the observed parameters, namely the level of acidity or alkalinity, can be seen in the following table:

Table 4. Results of pH Test Observations.

Formula	pH
1	8
2	8
3	8
4	8
5	8
6	8
7	8
8	9
9	9
10	8
11	8
12	9
13	8.5
14	8
15	8
16	8
17	8.5
18	8
19	8
20	8.5
21	8
22	8
23	8
24	9
25	9

The pH test is performed to ensuring the pH of the paper soap. Based on the observed parameters, the acidity or alkalinity of the soap solution is ensured to ensure it is still within a safe range for the skin.

According to SNI, the pH of paper soap is permitted between pH 8–11. Based on testing conducted with 25 paper soap formulas, the average pH was 8.5. The results showed that all paper soap formulas produced met the pH criteria for paper soap according to SNI.

Based on the results of the soap-free alkali test on paper with the observed parameters, namely the level of acidity or alkalinity, can be seen in the following table:

Table 5. Observation Results of Free Alkali Test

Formula	Volume of 0.01 N HCl (mL)
1	0.5
2	0.6
3	0.6
4	0.55
5	0.5
6	0.4
7	0.5
8	0.5
9	0.4
10	0.4
11	0.4
12	0.45
13	0.4
14	0.5
15	0.6
16	0.5
17	0.5
18	0.3
19	0.3
20	0.5
21	0.6
22	0.7
23	0.5
24	0.5
25	0.5

Based on the results of the free alkali test, the quality requirements for paper soap as specified by the Indonesian National Standard (SNI) in 2015 are soap that has a maximum

free alkali content of 0.1%. If using a 5 gram sample, then in order to meet the free alkali standard of $\leq 0.1\%$, the titration volume in the burette is ≤ 1.25 mL of 0.1 N HCl. The free alkali content should not be too high because it can cause irritation to the skin when used.

The solubility test on soap paper measures how quickly and easily soap paper dissolves in water (distilled water). The test results can be seen in the following table:

Table 6. Results of Solubility Test Observations

Formula	Solution Time (minutes)
1	02:17
2	02:12
3	02:12
4	02:25
5	03:00
6	01:47
7	02:21
8	02:22
9	02:35
10	02:39
11	02:04
12	02:22
13	02:32
14	02:21
15	02:33
16	02:11
17	02:27
18	01:55
19	02:23
20	03:32
21	02:04
22	02:10
23	02:06
24	02:10
25	02:20

Based on the results of the solubility test on paper soap, which ensures the soap dissolves quickly and completely in water, the effective time used to dissolve paper soap is 1-3 minutes, which is an indicator of practical solubility during use. The results showed that all paper soap formulas produced met the criteria.

5. Conclusion

Based on the results of research on the effect of variations in the concentration of added butyrum (milk fat) on the manufacture of paper soap, it can be concluded that butyrum has a real effect on the physical, chemical and organoleptic quality of the product.

Increasing the butyrum concentration tends to improve the characteristics of paper soap, particularly in terms of texture, softness, sheet flexibility, and lather stability. Soap with a higher butyrum content produces sheets that are less brittle, feel smoother when applied, and provide a soft sensation on the skin due to the emollient properties of milk fat.

Organoleptic test results showed differences in color, aroma, texture, and foaming intensity between the formulas. The formula with a balanced combination of butyrum and camperlan produced more abundant and stable foam, as well as a smoother soap texture. The distinctive aroma of VCO and butyrum also gives the product a natural character.

In the pH test, all formulas were within the pH range of 8–9, with an average of 8.5, which is still considered safe for skin and meets the quality requirements for paper soap. This indicates that the addition of butyrate and citric acid helps balance the pH of the saponified soap.

The free alkali test results showed that all formulas had free alkali levels below the maximum limit of 0.1%, indicating that the soap was not too alkaline and was safe to use without causing skin irritation. This indicates that the saponification process was successful and that butyrum helped reduce residual alkali.

In the solubility test, all paper soaps had a dissolving time of around 1–3 minutes, indicating good solubility and in accordance with the characteristics of paper soap which is practical and quick to use.

Overall, variations in butyrum concentration positively affected the sensory quality, stability, and safety of paper soap. Butyrum can be recommended as a natural additive that improves the quality of paper soap products, both in terms of user comfort and physical characteristics.

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