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Characteristics of Tallow-Based Soap by the Addition of Kefir Curd from Goat Milk

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ABSTRACT: Tallow is a less economical and underutilized animal's fat. In fact, tallow comprises triglycerides from several fatty acids which support skin protection by increasing moisture and preventing dryness. The use of tallow in soap manufacturing will gain its interest and enhance its value added. In this study, solid soaps are prepared using tallow as raw materials by adding kefir curd from goat milk. This study analyzed the physicochemical and organoleptic characteristics of the particular soaps by developing a completely randomized design (CRD) experiment. The kefir curd gradually increased its proportion in soap manufacturing and observed its effect on pH, moisture content, degree of foaming, and foam stability. Organoleptic tests for both hedonics and hedonic qualities were also performed and analyzed by Kruskal Wallis's nonparametric analysis. The statistical analysis reported a significant difference of 6% curd addition on pH ($p<0.05$) than fewer or without curd additions. The average moisture content of soap with a 6% curd addition did not differ significantly from the soap with a 4% curd addition. However, these moisture contents significantly differed from others by less or without curd addition. All soap formulations also showed no significant difference in foam height and stability. Meanwhile, the hedonic quality tests showed that the soaps has moderate foam forming degree and less fat aroma. In addition, the foam forming degree and fat aroma was not significant for all formula. The hedonic test showed that the panelists preferred tallow soap with a 6% curd addition, even though the analysis reported no significantly different ($p>0.05$).

Keywords*:* CRD; Kefir; Soap; Tallow; Triglycerides

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INTRODUCTION

Nowadays, soap is considered as a part of daily basic needs. Moreover, after the Covid-19 pandemic, public awareness of a clean lifestyle habits is increasing. Soap is a main product of a chemical reaction between triglycerides (oils or fats) and alkaline solutions through a process known as saponification (Hall, 2016). Soap can clarify skin surfaces by removing stains or grease. In general, soap is made by the addition of synthetic chemicals, triclosan, for example, that can trigger dermatitis for sensitive skin.

Tallow is a white fat that is usually found around internal organs, as well as under skin surface. Tallow is frequently avoided in food products due to its cholesterol content which is unsuitable for health. This unwanted chemical makes tallow to be less economical or even not worthwhile at all. Tallow is found as a solid phase at room temperature due to a significant amount of saturated fatty acid that can be melted by subjecting heat contents (Alm, 2021). Several essential fatty acids in tallow, such as palmitoleic, stearic, and oleic, can support skin protective function, increasing moisture and preventing dryness.

Kefir is a fermented milk product that will separate into two phases after settling down for a particular time. The liquid phase is known as whey, while the solid phase is called curd. Kefir contains several bioactive compounds, such as polysaccharides, peptides, and organic acids, which are known to be beneficial for skin health (Yilmaz-Ersan et al., 2016). A research study has shown that goat milk kefir has better antibacterial activity against *Bacillus cereus* than kefir from cow milk (Suhartanti & Septian, 2014).

Utilizing tallow as material feedstock for solid soap manufacturing is expected to enhance its economic and added value and provide an alternative source of raw materials with abundant availability. Adding kefir curd from goat milk as an additive is expected to improve the quality of soap products. In addition, experimental studies on soap preparation using these two ingredients have never been investigated and published.

Therefore, this research was conducted to manufacture solid soaps utilizing kefir curd and tallow as raw materials and characterize the physicochemical properties of soap products. In addition, organoleptic tests, including hedonic and hedonic quality tests, were carried out to determine the preference and acceptance of the soap products.

MATERIALS AND METHODS

Materials and instrument

Coconut oil (Barco), palm oil (Tropical), and soybean oil (Mazola) were purchased from supermarkets around Bandar Lampung. Beef fat was retrieved from Rajabasa traditional market, Bandar Lampung. The alkaline solution as another reactant was prepared by dissolving crystalline NaOH (pro analysis, Merck) into distilled water. Each ingredient was homogenized by using a hand mixer (Philips).

Raw materials preparation

Tallow beef was acquired by melting beef fat at 90ºC for 1 to 2 hours. The tallow purification was processed by separating fat and other impurities through filtration. The high purity of the treated tallow can be used directly or stored in a freezer for further use.

Kefir was produced by adding 10% (weight/volume) of kefir grains into goat milk which was previously pasteurized using the high-temperature short time (HTST) method. The mixture was fermented for 24 hours, and then the kefir grains were removed from the mixture by filtration. The kefir grains-free mixture was then incubated for 48 hours until a two-phase mixture was obtained. The kefir curd was then obtained as a solid phase and separated from the suspension through filtration by a clean gauze filter to be used as the soap ingredient.

Table 1. Tallow-based solid soap formulation and composition.

Ingredients	F0	F1	F2	F3
Beef tallow (%)	50	50	50	50
Coconut oil (%)	12	12	12	12
Palm oil (%)	6	6	6	6
Soybean oil (%)	32	32	32	32
Total (%)	100	100	100	100
NaOH concentration (%)	30	30	30	30
Oils/fat to NaOH solution ratio	2.33	2.33	2.33	2.33
Kefir curd addition (%)	0	2	4	6

Soap manufacturing

Solid soaps were manufactured through the cold processing technique with modifications (Marya et al., 2022). The formula and composition of the soap-making ingredients are shown in Table 1, which were made by differing in curd kefir addition. The soap formulations are symbolized as F0, F1, F2, and F3 to imply the formulation without curd kefir addition and by 2, 4, and 6% curd kefir addition, respectively.

The kefir curd was introduced after other ingredients were homogeneously mixed and had reached the trace. The mixture was then molded and allowed to be acclimatized for 24 hours until hardened. The solid product (soap) was then removed from the mold and stored on an open shelf at room temperature for 14 days for further analysis.

Characterizations and statistical analysis

The soap was characterized by its moisture content, pH, and foam stability. The moisture content was analyzed based on the National Standardization Agency of Indonesia (SNI 3532:2021) (BSN, 2021). Meanwhile, pH and foam stability were characterized by referring to previous work (Febriani et al., 2020). Moreover, organoleptic tests were also performed, including hedonic quality (aroma and foaming degree) and hedonic tests (level of preference involving 25 untrained panelists). The criteria for the hedonic quality test of aroma are strong fat aroma (1), moderate fat aroma (2), less fat aroma (3), and no fat aroma (4). The criteria for the hedonic quality test of foam forming degree are no foaming (1), less foaming (2), moderate foaming (3), and strong foaming (4). The criteria for the hedonic test are disliked (1), less liked (2), moderate liked (3), and strong liked (4).

The soap characterization data, including pH, moisture, and foam stability, were analyzed using ANOVA. The significantly different data were then continuously analyzed by Duncan's test. Meanwhile, the organoleptic test results were analyzed using a non-parametric Kruskal-Wallis.

RESULTS AND DISCUSSIONS

The characteristics of tallow-based soap made with a combination of kefir curd, vegetable oils, and beef tallow are presented in Table 2. As shown in Table 2, tallow-based solid soap characterization includes pH, water content, and foam stability.

The pH of tallow-based soaps

As shown in Table 2, the pH of solid soaps ranges between 9-10. The solid soap made by the addition of 6% kefir curd (F3) resulted in an average pH of approximately 9. It became the lowest pH value and significantly different ($p<0.05$) than other formulations. In addition, soap with the addition of 4% kefir curd (F2) resulted in an average pH of nearly 9.5 and was also significantly different ($p<0.05$) compared to other formulations. Meanwhile, soap prepared by the addition of 2% kefir curd (F2) and or without the addition of kefir curd

(F0) had the same average pH (around 10), which was also significantly different ($p<0.05$) with the soap formulation by the addition of 4% and 6% kefir curd.The addition of curd kefir (pH around 4.6) in the manufacture of solid soap decreased the pH of solid soap due to the presence of organic acids in curd kefir (Marya et al., 2022). Consequently, the higher the percentage of kefir curd in the soap formulation, the lower the pH value of the resulting solid soap.

Typically, soap is an alkaline salt with a pH value above 7 that might trigger skin irritation due to the high absorbance of the skin (Blaak & Staib, 2018). The previous study has reported that, generally, soap has a pH between 9 to 11 (Habib et al., 2016). The skin pH will increase immediately after exposure to soap and return to normal after 5 to 10 minutes of use. The increased pH value might open the skin pores, and then the soap foam will bind the excess soap and other stains that attach to the skin.

The pH value of soap resulting in this study, which was between 9 to 10, still meet the standard pH value of commercial soap, which ranges between 9 to 11, and also the National Standardization Agency of Indonesia (SNI 3532:2021), which range between 8 to 11 (BSN, 2021).

Moistures

The results of moisture content analysis of the tallow-based soaps, as shown in Table 2, revealed that tallow soaps had moisture between 12.01 to 14.37%. The moisture of the soap by 4% kefir cur additions did not differ significantly from that of 6% ($p>0.05$). Similarly, the moisture of the soap by 2% kefir curd addition did not differ significantly from that without kefir curd addition ($p>0.05$). However, both these two groups differed significantly ($p<0.05$).

Based on these tests, it can be indicated that the presence of kefir curd in soap formulation might affect the moisture of the soap. Adding kefir curd can affect the soap moisture due to fatty acids derived from kefir curd. Fatty acids (RCOOH) react with NaOH through saponification to produce soap (RCOONa) and water (H_2O). The presence of water as a side product might increase the soap moisture. However, overall, the soap moisture from all formulations still meet the National Standardization Agency of Indonesia, which has a 15% maximum moisture content (BSN, 2021).

The moisture content of the tallow-based soap correlates with the texture and durability of the soap. Soap with a high water content tends to have a soft texture, and vice versa, soap with a low water content will have a texture that tends to be harder (Setiawati & Ariani, 2021). Soap with a low moisture content will have a fairly good shelf life compared to soap with high moisture content. Soap with a moisture content exceeding the SNI standard will have a relatively shorter shelf life and will easily smell rancid.

Table 2. Characteristics of tallow-based soap by various formulations.

Formula	pH	Moisture (%)	Foam Stability (%)
F0	10.0 ± 0.09^c	12.01 ± 0.37^b	86.4±1.47
F1	10.0 ± 0.06^c	12.50 ± 0.29^b	89.5±1.46
F2	9.5 ± 0.05^b	13.90 ± 0.15^a	87.1±1.54
F3	9.0 ± 0.03^a	14.37 ± 0.23^a	89.0±1.20

Different superscripts in the same column showed a significant difference ($p<0.05$)

Table 3. The organoleptic test results from tallow-based soap from all formulations.

Parameter	0	2%	4%	6%	Value
Aroma	2.50	2.60	2.60	2.61	Less fat
Foam forming degree	2.61	2.66	2.85	3.09	Moderate foaming
Impression	2.61	2.85	2.90	2.95	Liked

Foam stability tests

The analysis of the soap foam stability is related to the foam height parameter, where the foam stability is calculated from the foam height in the zeroth minute divided by the foam height in the fifth minute and then multiplied by 100%. The results of the test on the height and stability of the foam in each treatment showed that the results were not significantly different ($p>0.05$). It can be seen that the difference in kefir curd addition did not affect the foam height and the stability of the tallow-based soap.

Soap foaming is affected by several factors, namely the presence of an active agent or surfactant (for example, sodium lauryl sulfate), foam stabilizer, and other constituents such as the type of oil used (Wibowo, 2015). In this experiment, no additives in the form of foam enhancers, such as sodium lauryl sulfate or foam stabilizers, were added. The foam formed might be derived from oil ingredients in the soap formula. The concentration of fatty acids or oils and alkaline solution can affect the foam formation rate and the amount of foam and stability, which was confirmed by literature (Yernisa et al., 2013).

The tallow-based soaps were produced with the same formulations, excluding the percentage of kefir curd additions. Palmitic and lauric acids are the two fatty acids in vegetable oils that play significant roles in soap production. Palmitic acid originates mainly from coconut oils, while lauric acid originates mainly from palm oils (Yernisa et al., 2013). Lauric acid significantly contributes to softening foam produced (Sulastri et al., 2016). On the other hand, palmitic acid plays a role as a soap hardener and foam stabilizer (Lestari et al., 2020). Manufacturing soap without coconut and palm oils might produce soft and less foamy soap. Soybean oil does not contain lauric acid, but linolenic acid composition in a significant portion can increase skin moisture. Foam is formed due to the decrease of water surface tension as soap concentration increase through the saponification reaction. The foam formation has little effect on the cleaning process. However, foam formation can increase consumer acceptance of the product. Consumers will prefer soap with much foam and stabile instead of soap with less foam and unstable (Febriyenti et al., 2014). The foam stability of the soap is not significantly different in all formulations, with values ranging between 86.40% to 89.50% owing to the use of similar amounts of oils and fats, and NaOH solutions.

Organoleptic tests

The organoleptic tests included the hedonic quality test, namely the soap aroma and the foam forming degree. Meanwhile, the hedonic test showed the overall impression of the panelists on the soap product. The analysis results are shown in Table 3. The assessment results showed that soaps produced from each formulation are less fat aroma and no significant difference ($p>0.05$). Therefore, it might be concluded that all the soaps produced still leave a slight smell of fat.

The results of the assessment also showed that there was no significant difference in aroma from all formulations ($p>0.05$). In addition, the results of other quality tests showed that the foaming degree (the ability to form foam) of soap made from all formulation variations was also not significantly different ($p>0.05$). The assessment concluded that the foam-forming ability score was between 2.61 and 3.09, with quality "moderate foaming." On the other hand, the hedonic test concluded that the preference for the soap produced was quite good, with scores in the range of 2.61-2.95, and there was no significant difference between all formulations ($p>0.05$). The results of the hedonic test indicated that the panelists tended to prefer soap with the addition of 6% kefir (F4), although overall, the differences obtained were not significant ($p>0.05$).

CONCLUSION

The addition of curd kefir in tallow-based soap formulations affected the pH and water content of the soap produced but did not affect the foam stability of the soap produced. The tallow-based soap with 6% curd kefir met the standard of pH and moisture and had good foam stability besides showing better consumer acceptance. Thus, tallow-based soap with this formulation has good prospects for further development.

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