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UTILIZATION OF FRUITS, LEAVES, AND PETIOLES EXTRACT OF BILIMBI (*AVERRRHOA BILIMBI LINN.*) IN DETERGENT SYNTHESIS

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Abstract

Bilimbi (*Averrhoa bilimbi Linn*.) contains saponins which are natural surfactants. Due to their cleaning properties, saponins can be developed as raw materials for detergent production. The synthesis of detergent with the addition of fruits, leaves, and petioles extract of the bilimbi has been successfully carried out. A series of tests, namely organoleptic, pH, foam stability and quantity, hedonic, and detergency tests, were performed to evaluate the quality of detergents. From the organoleptic test, it was found that the addition of the extract caused the detergent to change color to brownish, with a slight increase in density and a slight decrease in pH, and relatively did not change the phase and fragrance of the detergent. The addition of extract did not increase the quantity of foam produced but could increase the stability of the resulting foam. The hedonic test shows a relatively good level of panelist preference. The detergency from the stain removal test shows that the detergent has fairly good detergency.

Keywords: Bilimbi Extract, Liquid Detergent, Saponins

1. INTRODUCTION

Humans cannot be separated from three basic needs in daily life, namely clothing, food, and shelter. The importance of clothes in life causes humans to depend on cleaning products such as detergents. Routine use of detergents can cause environmental pollution because of their ingredients that poison aquatic biota. Phosphate-based compounds used in a detergent could probably cause eutrophication. The growth of the human population exacerbates this problem since more and more detergents are accumulated every year.

Detergents contain surfactants and additives to improve performance or change properties to compete with competing products and/or according to the properties expected by consumers. Commonly used surfactants for detergents are petroleum-based linear alkylbenzene sulphonates (LAS). LAS can be degraded by microbes both aerobically and anaerobically. The problem with anaerobic degradation is that the high LAS concentration in wastewater could hinder the degradation process (Braga et al., 2015; Faria et al., 2019).

In several studies, it was found that there was an accumulation of LAS in the waters of various countries in Asia, such as Indonesia, Philippines, Thailand, Japan, Cambodia, India, Turkey, Vietnam, Malaysia, and Vietnam (Akkan, 2017; Isobe et al., 2004). Even the results of research on waters in Turkey state that the LAS concentration has exceeded the specified threshold (Güven et al., 2010). This problem needs to be addressed, for starter, by looking for natural sources which are expected to be easier to degrade. Increased public awareness of the impact of using non-environmentally friendly detergents also contributes to the development of greener detergents (Adiwibowo et al., 2019).

Bilimbi (*Averrhoa bilimbi Linn*.) or known locally as *belimbing wuluh*, is a plant that grows a lot in tropical areas such as Indonesia. The fruit is widely used for consumption or as medicine because it is believed to cure various diseases. However, this utilization is still not optimal since bilimbi is not as famous as other fruits due to its bitter taste. On the other hand, the petioles and leaves are treated like garbage and only thrown

away or burned, which causes another problem to the environment.

Saponins are chemical compounds with polar and nonpolar groups thus can perform as a cleaning agent. The fruit, leaves, and petioles of bilimbi have this saponins content (Fahrunnida, 2015) so that when extracted, it has the potential to be used as raw material in detergent making. In addition, bilimbi has antibacterial properties (Aziz et al., 2014) so that it can provide added value for detergent application.

The use of saponins in the manufacture of environmentally friendly detergents has been carried out previously using hibiscus leaf and bullet wood flower saponins extracts (Rachmawati, 2018). The main objective of this study was to synthesize a liquid detergent with the addition of fruits, leaves, and petioles extracts of the bilimbi and to examine the effect of adding these extracts to the properties and performance of the detergent produced. The detergents were also tested to specific Indonesian National Standard criteria and another preliminary testing.

2. MATERIALS AND METHODS

2.1 Materials

The fruits, leaves, and petioles of bilimbi were obtained from Jombang Kali, Cilegon City, Banten province, Indonesia. CMC (carboxymethyl cellulose), dextrin, EDTA (ethylenediaminetetraacetic acid), MES (methyl ester sulfonate), and technical grade sodium sulfate, as well as aquadest and baby powder fragrance perfume, are obtained from local chemical stores.

2.2 Preparation and Preparation of Extract

The extraction procedure was similar to that carried out by Adiwibowo in 2020 using the study's optimum condition: ultrasound-assisted extraction with simplicia:solvent ratio 1:8 and 20 minutes extraction time. The leaves, petioles, and fruit ratio on the simplicia was 3:1:1.

2.3 Liquid Detergent Synthesis

Dextrin was dissolved in aquadest, then stirred while heated at a temperature of 50–70°C. MES was then added while stirring until a homogeneous phase was obtained. Next, the extract, EDTA, and CMC were poured and stirred until homogeneous. Sodium sulfates were then added, and the detergent was cooled to room temperature. After the temperature had dropped, baby powder fragrance perfume was added to give the detergent a pleasant fragrance. Subsequently, the liquid detergents were put into the sample bottles to test their characteristics and detergency further. The variation used in the detergents is the addition of extract 0, 1, and 2 g and marked as F1, F2, and F3, respectively.

2.4 Liquid Detergent Testing

2.4.1 Organoleptic testing

Organoleptic testing includes observation of color, shape, and odor of the liquid detergents formed. The detergents were expected to have a distinctive color and consistent shape and smell as in accordance with the Indonesian National Standard (National Standardization Agency of Indonesia, 1996). Although currently it is no longer required on the latest standard, this test can provide preliminary information regarding the stability of the detergents in a certain period. The observation of color was using the help of software to accurately estimating the color and removing a subjective result.

2.4.2 Foam quantity and stability testing

Measurement of the stability and quantity of foam was accomplished by dissolving 3 mL of the test formula into the water on a test tube. The test tube was then shaken until the foam was formed. The height of the foam formed was measured and recorded as foam quantity data. The foam height after 5 minutes was recorded and then compared to the initial foam height. This data was reported as foam stability data. The formula used is as follows:

$$\text{Foam stability a} = \frac{H}{H_0} \times 100\% \quad (1)$$

where, H = foam height after 5 minutes, cm

H_0 = initial foam height, cm

2.4.3 pH and density testing

pH testing was done by using a pH meter. The calibrated electrode was dipped into the liquid detergent sample, then wait until the pH reading was complete. The pH of liquid detergent that were still allowed was in the range of 5-10 by the Indonesian Nasional Standard (National Standardization Agency of Indonesia, 2017).

Detergent density was measured by filling the detergent into a pycnometer with a specific volume and then weighing the mass. The formula used for the calculation:

$$Density = \frac{m - m_0}{V} \quad (2)$$

where: m = mass of pycnometer filled with detergent, g

m_0 = mass of empty pycnometer, g

V = volume of the pycnometer, mL

According to the Indonesian National Standard, the specific gravity of the detergent that meets the standard is 1.0-1.5 at a temperature of 25°C (National Standardization Agency of Indonesia, 2017).

2.4.4 Detergency testing

The detergency test was carried out through a stain removal test. A clean white cloth was stained with animal fat, vegetable fat, and protein represented by milk, soy sauce, and curry sauce, respectively. The stained cloth was then left for a day so that the stain sticks to the cloth. The fabric was then washed using detergent, rinsed, and compared between before and after washing. The formula used to calculate detergency is as follows:

$$Detergency = \frac{C_0 - C_F}{C_0} \times 100\% \quad (3)$$

with: C_0 = initial impurity concentration, ppm

C_F = final impurity concentration, ppm

2.4.5 Preliminaries hedonic testing

The preliminary hedonic test was carried out by giving detergents to 10 participants, mostly college students who stay at a boarding house, and providing an assessment questionnaire for each detergent. The assessments include fragrance preference, homogeneity, level of irritation, and detergency. The level of irritation was assessed based on whether the detergent caused itching on the hands after use. The score uses in the range of 1-5, where 1 indicates bad perception and 5 as good perception from participants.

3. RESULTS AND DISCUSSION

3.1 Organoleptic Test

The data in Table 1 showed that the addition of the extract caused the detergent color to change. It was expected that the color change from white to brownish following the color of the extract. If dyes are used, specifically bright colors, to adjust the marketing concept and meet consumer expectations, it is necessary to decolorize the extract to not interfere with the coloring. During one month of observation, no change of color was observed.

Table 1. Organoleptic characteristic of detergents

Detergent	Colour	Form	Aroma
F1	Foggy White	Liquid	Baby powder
F2	Limed Oak	Liquid	Baby powder
F3	Raw Umber	Liquid	Baby powder

The form of the detergents produced was liquid without any phase separation. In general, it appeared that the three formulas have relatively good stability within a month. However, it is necessary to observe the long-term stability of the formulation if it is to be further developed on a larger scale.

The perfume added to liquid detergent gave its particular baby powder smells and was relatively stable within one month. Without the addition of perfume, liquid detergent with the addition of extracts has a smell like leaves, and without the addition of extracts has a smell like paraffin. The stability of the detergent odor in the longer term still needs to be tested.

3.2 Foam Quantity and Stability Testing

Based on the result of foam quantity and stability of liquid detergent as shown in Table 2, it was known that the addition of extract had no significant effect on the quantity of foam formed. This phenomenon is because the extract contains saponins included in the APG class surfactant (alkyl polyglucoside), a nonionicnonionic surfactant group. This group has the characteristics of low foaming ability (Butler, 2013; Showell, 2016). In addition, APG is known to have low foaming compared to LAS (Zoller, 2004), a surfactant commonly used in commercial detergents.

Table 2. Detergent foam quantity and stability

Detergent	H_0, cm	H, cm	Foam stability, %
F1	7,5	4	53,33
F2	7	5	71,43
F3	7	5	71,43
Commercial	8	6,25	78,13

In terms of foam stability, the addition of extract was better than liquid detergent without one. This phenomenon was because APG class surfactants had high stability (Zoller, 2008). According to research by Bera et al. in 2013, there was a synergistic effect of mixing ionic/nonionic surfactants, which causes more and more stable foam to be produced. Another study also obtained the same result where the addition of saponin extract made the foam more stable (Damayanti et al., 2017). However, when compared to commercial detergents, the foam stability is still inferior. This inferiority is because commercial detergents contain foam boosters and foam stabilizers, so they have better results. Even though foam does not affect detergency, it becomes consumer preferences and needs to be evaluated (Mainkar & Jolly, 2000). It is expected that the foam produced is stable enough until the washing process is complete and disappears after.

3.3 pH and Density Testing

Table 3 showed that all detergent formulas had a pH in the range of 6.5 to 6. The decrease in pH due to the addition of acidic extract (pH 4,5). The pH value of this detergent is in accordance with the Indonesian National Standard, which stated that liquid detergent pH must be at the range of 5-10 at a concentration of 1% (National Standardization Agency of Indonesia, 2017). Since the detergent's pH was close to the pH of human skin, 5-6, the detergents were expected to be safe and not irritating to the skin. However, an irritation test needs to be done to get more valid results.

Table 3. pH and density of detergents

Detergent	pH	Density
F1	6.5	0.98
F2	6.2	1.04
F3	6	1.02

Liquid detergents with the addition of extract had a specific gravity value in accordance with Indonesian National Standard where the permissible density range is 1.0-1.5 g/mL (National Standardization Agency of Indonesia, 2017), while liquid detergent without the addition of extract did not meet the requirements. The density of liquid detergents was influenced by the composition and concentration of the detergents.

3.4 Detergency Testing

According to the stain removal test in Figure 1, the addition of the extract provided better detergency. The extract, which contains saponins, a commonly known

natural surfactant, has nonpolar and polar groups. The nonpolar groups bonded to the stain on the clothes, and the water could carry away the polar groups to release the stain from the clothes.

When compared to commercial detergents, the performance of the formulated detergents was still inferior. This was probably because commercial detergents have many additives added to improve detergents' performance, such as enzymes and builders. Reformulation is needed to compete with the performance of commercial detergents, by means of adding performance-enhancing components or rebalancing the concentration of each component.

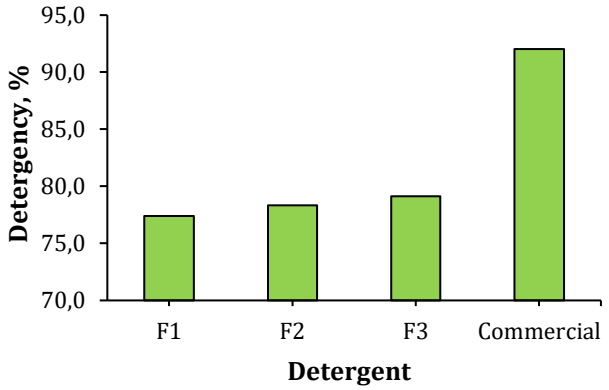

Figure 1. Detergency test

3.5 Preliminary Hedonic Testing

All detergents had distinctive fragrances, soft texture, and homogeneous liquid form. In terms of performance, the panellists felt that the detergent's performance was quite good in cleaning stains and deemed worthy of being circulated in the market because it has a good level of homogeneity and relatively does not cause an itchy effect on the hands during and after the washing process. Further study for sensitive and hypersensitive users should be assessed.

Table 4. Hedonic rating scale

Detergent	F1	F2	F3
Aroma, %	4,32	4,32	4,53
Homogeneity, %	3,82	4,27	4,38
Irritation level, %	4,10	4,40	4,50
Detergency, %	3,82	4,12	4,22

4. CONCLUSION

Detergents with the addition of fruits, leaves, and petioles extract of bilimbi have a reasonably good level of detergency and foam stability, with a consistent level of homogeneity and pH according to Indonesian National Standard, and does not cause itching effects on hands during and after the washing process.

5. ACKNOWLEDGMENT

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