Making of Effervecent Tablet Detergent from Hibiscus Leaf (*Hibiscus Rosa-Sinensis L.*) and Pineapple (*Anenas Comosus*) Peel Extract as Solutions to Domestic Waste Problems

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Abstract. Natural detergents can be an alternative to reduce the use of synthetic detergents that contain active ingredients that are difficult to decompose by the environment. Hibiscus leaf extract contains saponins which can produce foam and the enzyme bromelain from pineapple peel is able to lift protein stains on clothes. The purpose of this research is to utilize the use of the two extracts so that they can be used as a substitute for the active ingredients in synthetic detergents. The research method used is the experimental method, where the detergent will be made in the form of effervescent tablets with changing variables, namely the addition of hibiscus leaf extract (11%; 13%; 15%; 17%; 19%) and followed by a decrease in SLS (8%); 6%; 4%; 2%; 0%). The results of the analysis of the best effervescent detergent tablet products are shown in Formula 1 with the characteristics of using hibiscus leaf extract of 11% and SLS of 8% and pH test results of 7.5, foam stability of 79.2683%, detergent power by rinsing of 99.3824%, the detergent power without rinsing is 89.0876%, the insoluble material in water is 4.02%, and the soluble time test is 14.34 min. In the results of the toxicity test, it was analyzed that the greater the concentration of detergent given into the water, the greater the mortality rate of the existing fish. From these results, the effervescent detergent tablet product meets the quality requirements of the SNI 4594:2017 test and is an environmentally friendly detergent tablet.

Keywords: detergent · effervescent tablets · hibiscus leaves · pineapple peel

1 Introduction

As the population grows, so does the demand for basic goods, particularly clothing. Detergents are used to remove dirt attached to clothes, but the active ingredients in detergents can potentially cause pollution and be harmful to the environment. One of the active ingredients in detergents is Sodium Lauryl Sulfate (SLS) and Linear Alkyl Sulfonate (LAS), which function to increase cleaning power, form foam, and clean grease [1].

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SLS is a synthetic foaming agent that can contaminate water because it is difficult to decompose by microorganisms in water. The surfactant content has a negative impact on living things if its use is too high because the waste that comes out will be difficult to decompose properly by microorganisms and will become a problem for the environment [2]. It is necessary to have a material to replace or reduce the function of SLS in detergent with a natural ingredient (biodegradable). Therefore, we need a detergent that is more environmentally friendly by utilizing materials that are easily biodegradable in the environment with less use of SLS detergents in general.

Saponins are natural foam-producing compounds that can be used in the detergent, soap, and shampoo industries [3]. One of the plants that contain a lot of saponins is hibiscus (*Hibiscus rosa-sinensis L.*). The saponins found in hibiscus leaves can be used as natural ingredients to produce foam. Previous research on the manufacture of detergents from hibiscus extract materials has been widely carried out, including a study by Febriani et al. [4] who made a liquid detergent formulation of hibiscus leaf extract, which produces detergents with stable foaming power, as well as the content of saponins in hibiscus leaf extract, which can reduce surfactant use.

The protease enzyme found in pineapple peel is one of the enzymes that can help break down complex molecules in garment stains in addition to the saponins, which are utilized to form foam. Fajriyah et al. [5], who developed a detergent formulation from discarded pineapple peel with organoleptic features that meet the SNI criteria, including liquid, homogenous, color, and distinct pineapple fragrance, conducted earlier research on manufacturing detergent from pineapple peel extract.

In order to meet the testing procedures of the Indonesian National Standard (SNI 4594:2017), this study aims to determine the effects of each variation in the composition of the use of hibiscus leaf extract and SLS on the process of making effervescent detergent tablets. It also seeks to identify the composition of the best formula for the detergent effervescent tablet.

2 Experimental Procedure

2.1 Material

The raw material are hibiscus leaves, pineapple peel, PVP, lactose, sodium lauryl sulfate, magnesium stearate, $NaHCO_3$, citric acid, ethanol, aquadest.

2.2 Equipment

The equipments used in this research are rotary vacuum evaporator, a set of distillation, aeaker glass, erlenmeyer, pipette, porcelain cup, mortal, watch glass, glass filter, filter paper, sieve, thermometer, stirring rod, spatula, oven, ph paper, aluminum foil, hotplate, analytical balance.

2.3 Procedure

See Fig. 1.

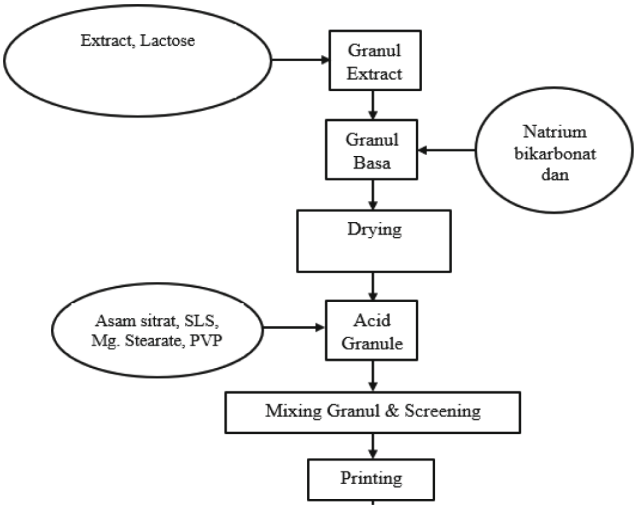

Fig. 1. Flow diagram making of detergent effervercent tablet

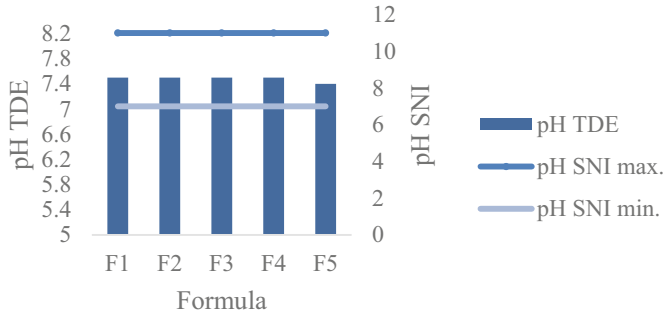

Fig. 2. Diagram of pH Measurement Results for Effervescent Detergent Tablets

3 Results and Discussion

3.1 pH

Effervescent detergent tablets will work effectively and well in alkaline conditions because they can neutralize dirt and help keep dirt suspended in solution [6]. According to the Indonesian National Standard (SNI 4594:2017) [7], the pH value of powdered detergent in water should range from 7 to 11.

The pH of the effervescent detergent tablets ranges from 7.4 to 7.5, with the resulting pH being neutral (see Fig. 2). This is due to the acidic pH value of hibiscus leaf extract, as well as the acidic properties of pineapple peel extract, which has a pH of 4.5. The acidic hibiscus leaf extract's pH affects the pH of the effervescent detergent tablet product. While there is no alkaline SLS in formula 5, it has a known SLS pH value of 8.5–10 (1% solution) [8]. Because of the acidic nature of the use of hibiscus leaf extract, the pH value in this formula did not increase due to the absence of SLS in formula 5.

3.2 Foam Stability

Foam stability is the ability of the foam to remain in the detergent solution. Foam is said to be stable if it has a stability value of around 60–80% after 5 min of foam being formed.

Figure 3 shows that the results of the foam stability test for effervescent detergent tablets obtained are not statistically significant. This is due to a decrease in the composition and use of SLS in each formula. Saponins in hibiscus extract can cause foam due to the combination of the structures of their constituent compounds, non-polar saponin chains and water-soluble polar side chains [9]. The presence of SLS and the addition of hibiscus leaf extract in the preparation were thought to contribute to the foam's stability in the first to fourth effervescent detergent tablets. SLS surfactants maintain foam stability by being adsorbed into the interphase region and binding to gas bubbles [10]. Meanwhile, hibiscus leaf extract adds to and supports the level of foaming, which results in the stability of the foam.

3.3 Detergency

Detergency testing was performed to determine the detergent's ability to clean dirt from the fabric. The detergent test was performed in two ways: with and without rinsing. The value is quite high when rinsing detergent; this can be attributed to the assistance of water in the washing process. The OH- group in water aids in the dissolution of any remaining stains in the fabric. The presence of OH-ions influences the detergency power

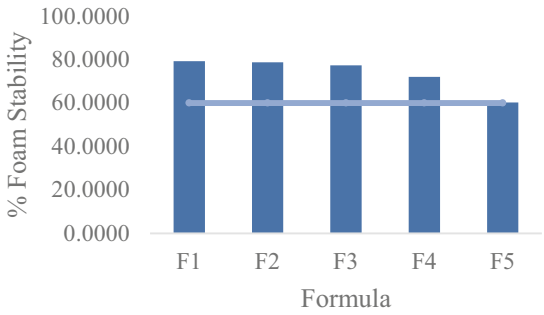

Fig. 3. Diagram of Effervescent Detergent Tablet Foam Stability Test

Fig. 4. Detergency Test Results

obtained. The OH-ion will bind to the nonpolar group (positively charged) in the fat or fatty acid. The more OH-ions produced, the more nonpolar groups will be bound by OH-ions, so that more fat will be released from the white cloth [11]. This can be proven by the difference in color between the fabric with and without rinsing (Fig. 4).

3.4 Insoluble in Water

Insoluble materials in water were carried out to determine the solubility of effervescent detergent tablets in water and the content of foreign objects or substances contained in the resulting effervescent detergent tablets. According to the Indonesian National Standard (SNI 4594:2017), the value of the water-insoluble material in powdered detergent is a maximum of 10.

From Fig. 5, it shows that insoluble materials in water intend to decrease. It can be caused by the use of variations in SLS in each composition. Although SLS is actually soluble in water, Amran [12] says that a number of concentrations of surfactants dissolved in water will form monomers that are concentrated in the water. Hydrophobic interactions will repel or distance the hydrocarbon tails of the surfactant from water and result in aggregation, while the hydrophilic head groups will remain in direct contact with water. This aggregation process will produce aggregates. The insoluble material is most probably the result of the surfactant aggregation process, which forms an aggregate that is insoluble in water and forms a group or agglomeration of these small particles. The supporting material in the effervescent detergent tablet, magnesium stearate, also influences the presence of insoluble materials in water. This compound is insoluble in water and ethanol, but is slightly soluble in hot benzene and 95% soluble in hot ethanol [13].

3.5 Dissolve Time

The solubility time test on effervescent detergent tablets was performed to determine how long it took for the tablet to dissolve in a certain amount of water.

Figure 6 depicts the longest dissolution time, 14.34 in formula 1, and the shortest dissolution time, 09.18 in formula 5. If the effervescent tablets contain a balanced source of acid and base, which react with water (H_2O) to produce carbon dioxide gas (CO_2)

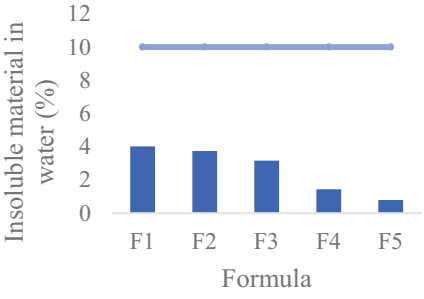

Fig. 5. Diagram of Water Insoluble Effervescent Detergent Tablets

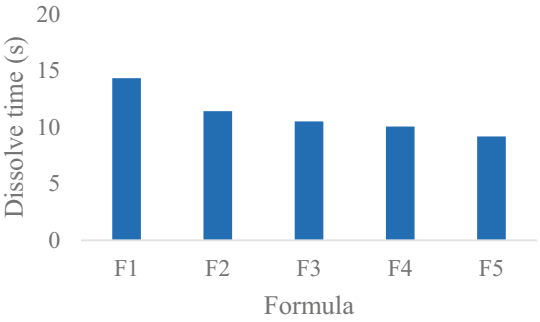

Fig. 6. Diagram of the Dissolution Time of Effervescent Detergent Tablets

Table 1. Data Analysis of Effervescent Detergent Tablet Toxicity Test.

Sample	Concentration(ppm)	% Mortalitas
F_0 (Kontrol)	0	0
F_1 (Terbaik)	5	14,2857
	10	28,5714
	15	42,8571
	20	71,429

[14], they will dissolve very quickly. It is well known that the use of sodium bicarbonate and citric acid in the composition is unbalanced because, in order to raise the pH of the effervescent detergent tablet to an alkaline level, in order to make a balance between acid and alkaline properties, initially the use of citric acid was smaller than the amount of sodium bicarbonate used. The greater the use of hibiscus leaf extract, the more it helps the citric acid to balance the reaction to form an effervescent reaction that produces carbon dioxide gas.

3.6 Toxicity Test

Toxicity test is a test to detect the toxic effect of a substance on organisms and to obtain response concentration data from the test material [15]. From the results of the 96-h observation test, the mortality of F0 (control) fish did not occur, this was because there was no addition of detergent tablet water concentration. The results of the detergent tablet toxicity analysis can be seen in Table 1.

Figure 7 yields a linear equation of $2.5157x + 2.0585$. This equation states that every 1 mg/L increase in detergent concentration results in a 2.51% increase in fish mortality. Figure 7 shows the correlation coefficient and the coefficient of determination between the concentration of effervescent detergent tablets and the mortality of sepat fish, with correlation ($r = 0.9591$) and determination ($R^2 = 91.99\%$) results. With a correlation coefficient that explains the magnitude of the relationship between the variables of

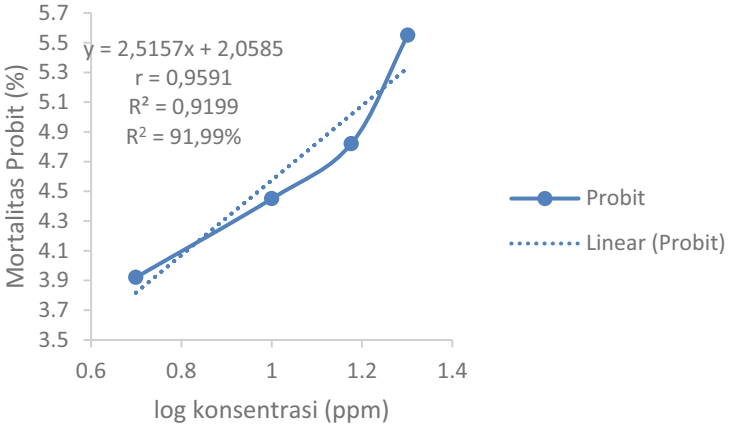

Fig. 7. Effervescent Detergent Tablet Toxicity Test Diagram

effervescent detergent tablet concentration (x) and sepat fish mortality (y) of nearly one, the relationship between effervescent detergent tablet concentration and sepat fish mortality shows a positive correlation.

According to the level of toxicity, the toxin level in the effervescent detergent tablets is in the classification of 10–100 mg/L or toxicity in water, indicating a moderate level of toxin. Based on the linear relationship between effervescent detergent tablet concentration and sepah mortality, it can be seen that the higher the concentration of effervescent detergent tablets given, the more samples will die. This can be attributed to the fish's decreasing resistance over time. At the time of observation, the swimming pattern of fish was still normal and quite active in moving in the water at concentrations ranging from 0 to 20 ppm. However, after entering a time range of 24 h to 96 h, one by one fish sample in each concentration variation showed a change in swimming pattern, with some fish swimming backwards, then sideways until they rose to the surface or were marked by floating (fish samples that died). Fish's reaction to changes in their swimming patterns is a form of survival or adaptation [16].

4 Conclusion

Optimization of the ingredient composition for making effervescent detergent tablets revealed that Formula 1 produced the best analysis results, with hibiscus leaf extract at 11% and SLS at 8% and pH test results of 7.5, foam stability of 79.2683%, detergent power with 99.384% rinsing, 89.0876% detergent without rinsing, 4.02% water-insoluble material, and a soluble time of 14.34 minutes. Based on this analysis, the composition of effervescent detergent tablets is optimized in accordance with SNI 4594:2017 as a reference for product test quality. The results of the test of the toxicity level of the effervescent detergent tablets showed that the level of toxicity of the tablets was in the moderate category with an LC50 value of 14.7650 mg/L.

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Authors' Contributions. All of the authors are involved in the process making of effervescent tablet detergent from Hibiscus Leaf and Pineapple Peel. The contributions of the authors are identifying problems, preparing all raw materials, observing the processes that occur, analyzing the resulting products, and collaborating in writing research papers.

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