

# Study of the process of Biodegradable dishwashing soap from the fruit of *Sapindus Saponaria*

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**Abstract** Our study present the production process for biodegradable liquid from the fruit of *Sapindus Saponaria* which have the standards of dishwashing soap. The three processes are carried out: traditional methods, surface active agent (SAA), fermented vinegar with the fruit of *Sapindus saponaria*. This study could give more options for producers. The traditional bio-dishwashing liquid from the fruit of *Sapindus saponaria* have a content of 10.10% surfactant with a ratio material: water 1: 4 (m/v, g/ml), and a shelf life of 8 days. From the traditional product, supplement the surfactant (vinegar) to increase the content of SAA, extend the shelf life (10 days). The method of fermentation of vinegar and *Sapindus* achieved high yield of 22.2% in fermentation at 32°C, 72h. Preservation time of this product at the time of research reached six months.

**Keywords:** bio-degradable dishwashing; ferment; vinegar; acetic bacteria.

## I. Introduction

Today, using natural products instead of synthetic one is a trend of environmental concerns [1]. Surfactants are known for increasing the cleansing power of water by reducing its surface tension, which makes them a common component of household detergents and cleaning products [2]. Surfactants are largely synthesized from raw petrochemicals which are mostly toxic and non-biodegradable, causing a great deal of environmental damage. Besides, natural surfactants are an eco-friendly. Natural surfactants produced (biosurfactants) by the plants and substances produced by fermentation of microbes. Plant saponins including *Sapindus Saponaria* have the most surfactant properties of all the bioactive chemical compounds. The name “saponins” is the name of a soapy lather when we agitated the fruit of *Sapindus Saponaria* with water. They are eco-friendly because of their natural origin, biodegradable and non-toxic which is of utmost importance from environmental and health perspectives [3][4].

Vinegar has the effect of cleaning stains, used to clean surfaces, whiten, kill mold or deodorize [5]. In order to prolong the shelf life of soapnut water, as well as increase the cleaning ability, combining vinegar fermentation and soapnut fruit can be a measure to produce a safe cleaning product for consumers, safe for the environment field and prolong the use time.

## II. Material and Methods

### 2.1 Material

The fruit of *Sapindus Saponaria* used in the process of experimenting from Bohon company, Ho Chi Minh city, Vietnam.

Acetic acid: isolated from cultured vinegar and cultured under suitable conditions.

### 2.2 Methods

#### 2.2.1. Determination of surfactants [6]

The content of ethanol-soluble surfactant (X1), expressed as a percentage by mass, is given by the following formula:

$$X1 = \frac{m1-m0}{m} \text{ (Equation 1)}$$

Including:

m0 - the mass of the cup, in grams;

m1 - mass of residue and cup, in grams;

m - mass of test piece, in grams.

#### 2.2.2. Determination of acetic acid content [6]

The content of acetic acid (X2) in % according to the formula:

$$X = \frac{V \cdot 0.006005 \cdot 100}{m} \quad (\text{Equation 2})$$

Including:

m - amount of sample, g;

V – volume of NaOH 0.1 N, ml;

0.006005 – amount of acetic acid, equivalent to 1 ml of exactly NaOH 0.1 N, g/ml.

### III. Results and Discussion

#### 3.1. The chemical composition of the fruit of *Sapindus Saponaria*

In our study, the chemical composition of the fruit of *Sapindus Saponaria* presented in Table 1:

Table 1. Chemical composition of the fruit of *Sapindus Saponaria*

Chemical composition	Humidity	Reducing sugar	Protein	Saponin
Content (%)	11.36 ± 0.03	0.48 ± 0.12	00.21 ± 0.04	26.21 ± 0.42

From the table of chemical composition of soapberry, it shows that the composition of soapberry is mainly saponin. Saponins have properties when dissolved in water have the effect of reducing the surface tension of solutions to create foam. Saponin accounts for the highest percentage of 26.21%, followed by reducing sugars 0.48% and the lowest is protein 0.21%.

This material contains mainly saponins, so the cleaning ability of this biological dishwashing liquid ensures the cleanliness of dirty items. The average content of saponins in soapnut fruit is 18% [3]. Therefore, the amount of saponins in soapnuts used in the study can meet the requirements for raw materials to be able to carry out studies on biological dishwashing liquid products from *Sapindus Saponaria*.

#### 3.2. Study on production of biological dishwashing liquid from the fruit of *Sapindus Saponaria* by traditional methods

##### 3.2.1. Determination of surfactants

In this study, we carried out to mix the fruit of *Sapindus Saponaria* and water, then we boiled them about 5 minutes. After that, we filtered and obtained the dishwashing liquid. The ratio of raw materials : water (g/ml) tested: 1:2; 1:3; 1:4 and 1:5 (g:ml) . The results shown in figure 1:

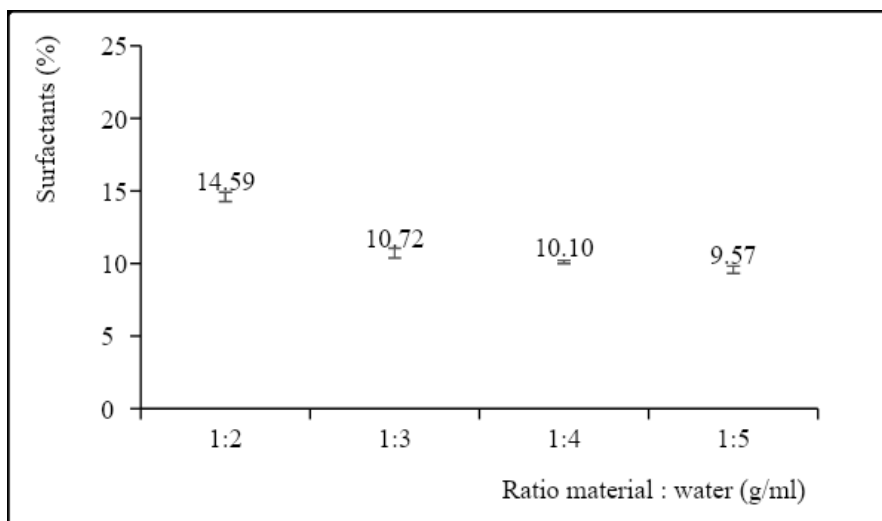


Fig 1. The content of surfactants of the sample after obtained the dishwashing liquid by traditional methods

According to the obtained results, the extracted surfactant have a value greater than 10 (Vietnamese standards for dishwashing liquid, surfactant should not be less than 10) at the ratio 1:2, 1:3, 1:4 (g/ml). The ratio material : water (1:2, g/ml) obtained the highest surfactant content. However, the soap solution obtained is so concentrated that it is difficult to filter. However, in terms of economic value, the study selected the ratio 1:4 to

achieve TCVN 6971-2001 and the soap solution obtained after filtering gave a high product volume). We have chosen the ratio of material: water as 1:4 (g/ml) to conduct the following experiments.

Dishwashing liquid is evaluated in addition to the quality criteria, also based on the sensory criteria. After surveying the surfactant content at different mixing ratios, the sample (the ratio material : water (1:4,g/ml) have met the set requirements on the value of the surfactant content of the product as well as the economic value. The results of sensory evaluation of biological dishwashing liquid from *Sapindus Saponaria* are shown in Table 2.

Table 2. Sensory evaluation results of the sample (the ratio material: water (1:4, g/ml))

Indicators Parameters	Description
Color	Dark Gold
Odor	Characteristic smell of Soapnuts
State	Liquid, homogeneous
pH index	$6.38 \pm 0.17$
Storage time	8 days

Based on the results in Table 2, the product has a dark gold and has been in liquid form, homogeneous. However, after 8 days, this product has been damaged. The fruit of have the effect of cleaning, washing and killing some microorganisms [7]. However, the storage time of the dishwashing water from *Sapindus Saponaria* according to the traditional method usually lasts from 3-14 days depending on the storage conditions. This can be explained, the product obtained after a period of time can be a nutrient medium for some spoilage microorganisms to grow and spoil the soapy water if preservatives are not used [8].

### 3.3. Study on the production process of biological dishwashing liquid from the traditional process with the addition of surfactants (vinegar).

Vinegar (acetic acid) has bleaching and antibacterial effects. When combining soap and vinegar, the content of surfactant will change and increase the storage time. In this study, we added vinegar to the traditional dishwashing process. The surfactant content of the product according to the ratio of vinegar: soapy water (ml/ml) is shown in figure 2.

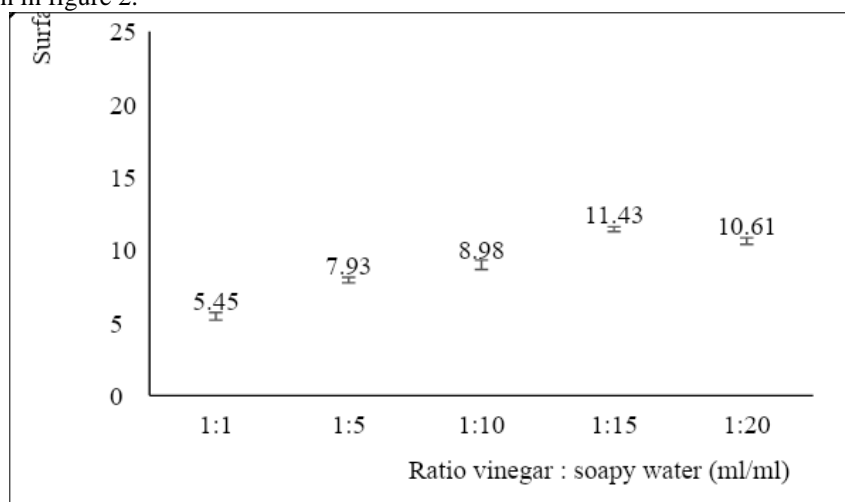


Fig 2. The content of surfactants of the sample after obtained the dishwashing liquid by traditional methods and vinegar

After adding vinegar directly, the results showed that: adding vinegar increased the content of surfactants for the product. Besides, the product preservation time in this study increased compared to the traditional method. The shelf life of the product is achieved 10 days.

#### 3.3.2. Evaluation results sensation of the sample

After determining the surfactant content of the above mixtures and comparing with the standards of detergents according to TCVN 6971-2001 [6], The test result (the ratio of vinegar: soap solution (1:15, g/ml)) was satisfactory.

The sensory results of the sample are shown in Table 3.

Table 3. Sensory evaluation results of the sample (the ratio of vinegar: soap solution (1:15, g/ml))

Indicators Parameters	Description
Color	Dark Gold
Odor	Mild vinegar smell
State	Liquid, homogeneous
pH index	6.12 ± 0.12
Storage time	10 days

### 3.4. Study on the production process of dishwashing liquid combining soapberry and vinegar fermentation

Acetic acid (vinegar) and soapberry both contain surfactants. The purpose of the study is to propose a process of acetic acid fermentation from molasses and a combination of soapy water to obtain a biological dishwashing liquid that can prolong the shelf life by killing mold and other microorganisms. Other microorganisms under the action of acetic acid produced during the fermentation of *Acetobacter* bacteria.

This study investigates the ratio of microorganisms: Soapberry juice, investigates the fermentation time to obtain a product with good surfactant content, increases the storage time and still ensures the organoleptic and pH standards.

#### 3.4.1. Determination of surfactant and acetic acid content after 3 days of fermentation

Survey the ratio of bacteria *Acetobacter*: Soap solution (v/v) as in the process of adding vinegar for easy comparison. After 3 days of fermentation, the surfactant content and acetic acid content in the fermentation solution are shown in Figure 3.

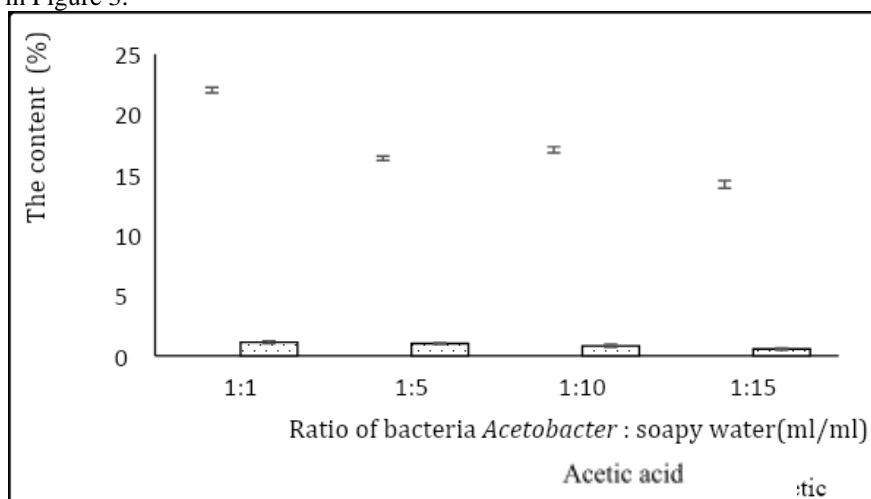


Fig 3. Content of surfactant and acetic acid after 3 days of fermentation

From the result of Fig 3, it can be shown that the content of surfactant obtained from 22.02% - 14.21%, the content of acetic acid from 1.12% to 0.57%, corresponding to the ratio of bacteria *Acetobacter* : soapy water from 1: 1 to 1:15 (v/v).

#### 3.4.2. Determination of surfactant and acetic acid content after 5 days of fermentation

The content of surfactant and acetic acid obtained after 5 days of fermentation is shown in Figure 4.

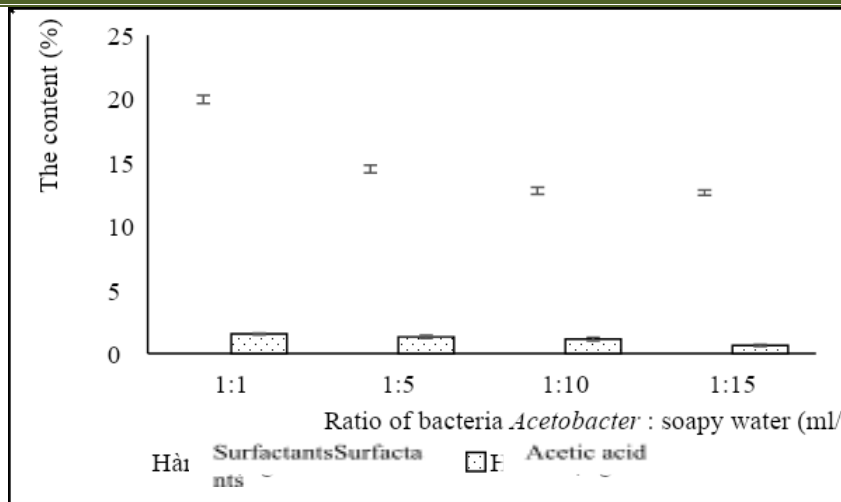


Fig 4. Content of surfactant and acetic acid after 5 days of fermentation

From the Fig 4, after 5 days of fermentation, the content of surfactants and acetic acid was obtained with the highest value corresponding to the ratio of bacteria *Acetobacter* : soapy water 1:1 (v/v).

### 3.4.3. Determination of surfactant and acetic acid content after 7 days of fermentation

The content of surfactant and acetic acid obtained after 7 days of fermentation is shown in Figure 5.

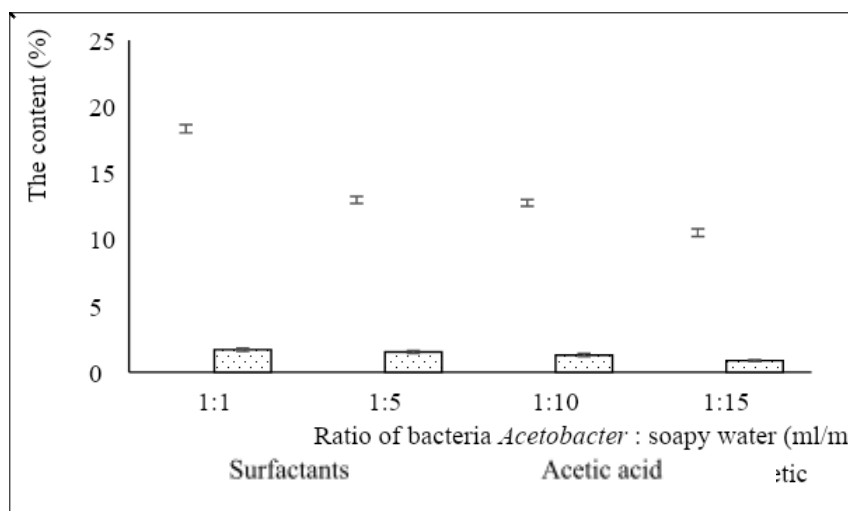


Fig 5. Content of surfactant and acetic acid after 7 days of fermentation

After 7 days of fermentation, the results are shown in Fig 5. In this study, the content of surfactants are lower than that of 3-5 days of fermentation. Meanwhile, the amount of acetic acid increased, reaching values from 1.69% to 0.87%.

### 3.4.4. Determination of pH value during fermentation

The pH index is one of the indicators of product quality. According to TCVN 6971-2001 on detergents, the required pH of the product is from pH 6-8. The pH value obtained during fermentation is shown in Fig 6.

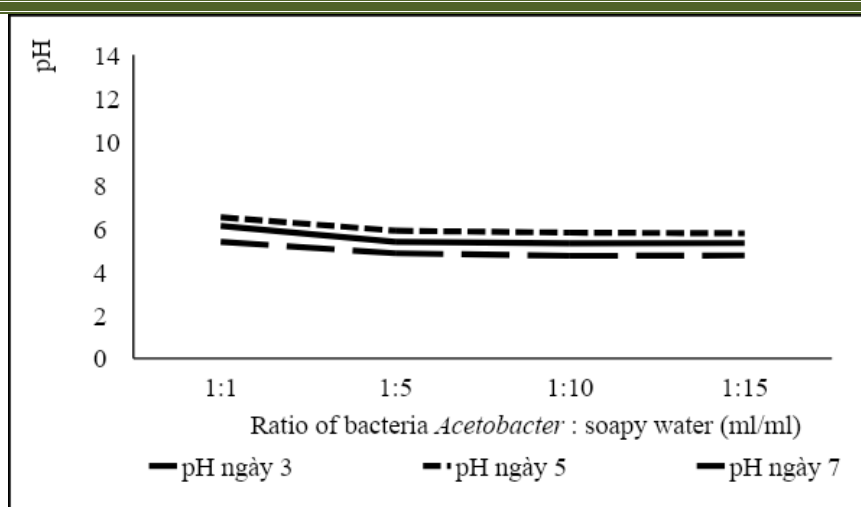


Fig 6. pH index of fermentation solution according to the rate and time of fermentation

After fermentation time from 3-7 days, the pH index are obtained as shown in Figure 5. The obtained biological dishwashing liquid has the values according to the standard 6971-2001; especially the sample obtained from ratio of bacteria *Acetobacter* : soapy water (1:1) after 3-5 days of fermentation.

Compared with the obtained surfactant value and the economic value of the product, we chose the ratio of acetic bacteria: soot solution 1:1 (g/ml) and fermented the product after 3 days.

### 3.4.5. Evaluation of sensory quality of products

From the results after 3 days fermentation, the sensations of the product are shown in Table 4:

Table 4. Sensory evaluation results of the product

Indicators Parameters	Description
Color	Dark Gold
Odor	Mild vinegar smell
State	Liquid, homogeneous
pH index	6.11 ± 0.2
Storage time (up to the time of study)	6 months

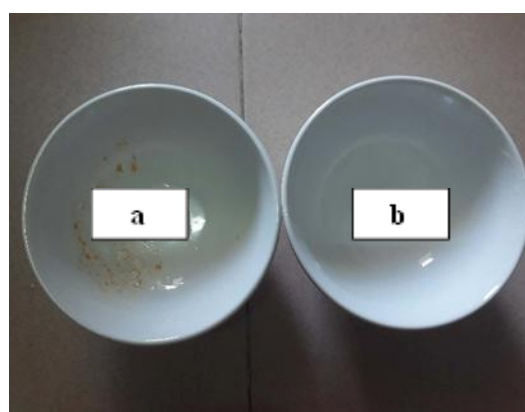


Fig 7 – Sample of water stain removal test sample (a) and biological dishwashing liquid from soap ferment (b)

## IV. Conclusion

The combination of soapberry and vinegar fermentation helps to increase the storage time, increase the cleaning ability of biological dishwashing products. The content of surfactant in the traditional process, respectively, reached 10.10%; the process of adding vinegar directly reached 11.43%. The combined process of vinegar-sodium glutamate fermentation after fermentation is 22.02%. The shelf life of the product increases in

proportion to the surfactant content obtained at each process.

Products of biological dishwashing liquid from soapberries obtained by the three processes mentioned above of the topic all met the criteria according to TCVN 6971:2001 on detergents in the kitchen. Provide quality biological dishwashing liquid products, safe for consumers and the environment.

### Acknowledgements

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### References

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A reference list **MUST** be included using the following information as a guide. Only *cited* text references are included. Each reference is referred to in the text by a number enclosed in a square bracket (i.e., [3]). References **must be numbered and ordered according to where they are first mentioned in the paper**, NOT alphabetically.

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