Characterization of liquid soap from castor oil (*Ricinus communis*) with the addition of white tea extracts

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**Abstract.** Soap is needed by all people to keep their bodies clean and healthy. Castor oil is one of the concerning plant oil that is produced from the kernel of castor plant that has the ingredients of ricinoleic acid and could make our skin become smooth. White tea contains polyphenol as the main ingredient. This research aimed to determine the quality of castor oil-based liquid soap based on SNI. The method used in this research was laboratory experimental using descriptive analysis and correlation-regression analysis. The treatments were the addition of white tea extract with 1% (v/v) concentration in amount of 0% (w/v), 0.5% (w/v), 1% (w/v), 1.5% (w/v), and 2% (w/v) out of 300 grams soap basis. The observation for liquid soaps included specific weight test, pH value test, total plate count test, organoleptic test, and antibacterial test. The analysis result showed that every formula complies with the requirement based on SNI 06-4085-1996 of liquid soap. The best soap product based on panelist preference from organoleptic test and the antibacterial test was liquid soap E with inhibition zone in the amount of 15.810 mm that is classified as a strong inhibition, specific weight of 1.0350 g/g, pH value of 9.653, and total plate count of 0.5 x 10^2 colonies/g.

**Keywords:** Liquid soap, castor oil, white tea extract

1. **Introduction**

Soap is a product that is already familiar in daily life. Soap has a fresh aroma and used by people to cleanse the body from impurities that are usually caused by bacteria and fungi in human activities. The type of bath soap that many used nowadays is liquid soap. The advantages possessed in liquid soap is practical packaging, hygienic, and easy to carry. The liquid soap offered today varies greatly with various types of fragrance and additional ingredients.

Liquid bath soap is used to clean the skin made from basic ingredients of soap or detergent by adding other ingredients that are permitted and used for bathing without causing any irritation to the skin [1]. Soap is a product made from the hydrolysis of fatty acids and alkaline which is often called saponification. Saponification process on soap involves the hydrolysis of triglyceride bonds that free fatty acids in the form of salt and glycerol and then free fatty acids will be separated from oil or fat by reacting free fatty acids with alkaline reactants to form soap. The main components in soap making are fatty acids and alkali. The fatty acids used will determine the characteristics of the soap produced.
Castor oil or what can be known as castor oil is vegetable oil produced from castor seeds. This jatropha plant has a large oil content, which is around 55% in the seed core or 33% of the total seed weight. The oil can be produced by extracting castor seeds with mechanical presses [2]. Castor oil can be used as a basic ingredient in making soap because it has high saturated fat content which is a major component in soap making. In addition, according to the later report from CNN Indonesia [3], castor oil can also be used to dilute scar keloids. This is due to the ability of castor oil to penetrate through several layers of skin.

The addition of active substances mixed into the soap preparation serves to increase the efficacy of the soap produced. Additional active ingredients mixed into liquid soap preparations in this study were white tea extract. White tea has many benefits, which include anticancer, antibacterial, anti-aging, and anti-obesity [4]. The main content found in white tea is polyphenols. Polyphenols are one of the antioxidants that can protect the skin from the harmful effects of free radicals. The preparations of white tea extract used in this study were 0.5% b/v, 1% b/v, 1.5% b/v and 2% b/v based on research on making transparent solid soap made from castor oil [5].

Research on the production of liquid bath soap made from castor oil with the addition of active ingredients of white tea extract is still not widely done, so information is needed on the proper process conditions to produce liquid bath soap using castor oil and the addition of white tea extract. The production of liquid soap needs to be tested for the quality of liquid bath soap produced based on the quality standard reference for SNI liquid bath soap 06–4085–1996. The purpose of this study was to determine the process of making liquid soap with castor oil, to decide the concentration of white tea extract that is suitable for the manufacture of castor oil liquid soap, and to define the quality of liquid soap produced against liquid soap quality standards SNI 06–4085–1996.

2. Material and methods
The materials used were castor oils from the Java Soap supplier and white tea are obtained from Tea and Quinine Research Center (PPTK), West Java. The chemicals used were kalium hydroxide (KOH) 30%, glycerin, aqua dest, coco-diethanolamine (Coco DEA), 96% ethanol, propylene glycol (PG), green tea fragrance oil, and supporting ingredients namely tissue, cotton, phenolphthalein (PP), acetone, diethyl ether, plate count agar (PCA), nutrient agar (NA), buffered peptone water (BPW) and 70% alcohol.

The tools used were analytical scales, beaker glass, measuring cup, stirring rod, pycnometer, pH meter, test tube, measuring pipette, volume pipette, knife, scissors, petri dish, water bath 45±1 °C, cupboard 36 ± 1 °C, colony counter, oven, cup, digital thermometer, mask and gloves.

The research method used was laboratory experimental using descriptive analysis and correlation-regression analysis. The treatment in this study was the difference in the addition of white tea extract concentration given to liquid soap. The concentrate white tea extract was diluted to 1% (v/v). The treatment was A (control), B (addition of extract 0.5% b/v), C (addition of extract 1% b/v), D (addition of extract 1.5% b/v), and E (addition of extract 2% b/v). The preparation of castor soap with various concentrations of white tea extract is presented in table 1.

| Materials                | Treatment | A (g) | B (g) | C (g) | D (g) | E (g) |
|--------------------------|-----------|-------|-------|-------|-------|-------|
| Castor oil               |           | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| Kalium hidroxyde (KOH) 30% |           | 52.50 | 52.50 | 52.50 | 52.50 | 52.50 |
| Glycerine                |           | 10.25 | 10.25 | 10.25 | 10.25 | 10.25 |
| Propylene glycol (PG)    |           | 22.50 | 22.50 | 22.50 | 22.50 | 22.50 |
| Aquadest                 |           | 134.29| 134.29| 134.29| 134.29| 134.29|
| Coco-DEA                 |           | 5.46  | 5.46  | 5.46  | 5.46  | 5.46  |
| White tea extract        |           | 0.1   | 0.1   | 0.1   | 0.1   | 0.1   |
| Green tea fragrance oil  |           | 0.1   | 0.1   | 0.1   | 0.1   | 0.1   |

2
This research consists of four stages, and the first stage was making white tea extract by Ultrasound Assisted-Extraction (UAE). The second stage was making a 30% KOH solution. The third stage was making liquid soap. The fourth stage was testing the quality of the liquid soap produced based on the Indonesian National Standard (SNI) 06-4085–1996.

2.1. White tea extraction

White tea extractions were performed by the UAE method. White tea powder 18 mesh was mixed with 96% ethanol solvent with a ratio of 1: 100 (b/v), which is 2 grams of white tea powder with 200 mL ethanol solvent. Then, the mixture was put in Ultrasonic Processor Q-Sonica Q500 (500 W, 20 kHz) with input amplitude at 100% for 30 minutes. After extraction, the white tea was separated from the liquid through filtration process using Whatman filter paper No.42. The filtrates were evaporated by rotary vacuum evaporator at 40 °C, and 55 rpm for 45 minutes until the white tea extract became concentrated and thick. For soap addition, the white tea concentrate needs to be diluted into 1% concentration by adding aqua dest and then proceed with stirring until the extract became homogeneous. The process diagram of white tea extraction can be seen in figure 1.

\[ \text{White Tea 18 Mesh} \]
\[ \text{18 mesh} \]
\[ \text{Extraction by Ultrasonic Processor (}(f= 20 \text{ kHz}, 500 \text{ W, Amplitudo 100%, for 30 min)} \]
\[ \text{Filtration using Whatman filter paper No. 42} \]
\[ \text{Evaporation using rotary vacuum evaporator} \]
\[ T = 40 \text{ °C, 55 rpm for 45 min} \]
\[ \text{White tea concentrate} \]
\[ \text{White tea extract 1% (v/v)} \]

**Figure 1.** Flow diagram of the UAE White tea extraction process

2.2. Making a KOH solution

A 30% KOH solution was the main material in making soap after castor oil. Making a 30% KOH solution was done by dissolving 30 grams of solid KOH in 100 mL of aqua dest.

2.3. Liquid soap making

Making liquid soap was done using the *hot-process-soap-making* method on a slow cooker. The raw materials for making liquid soap were castor oil that had been prepared previously. The process was started with the saponification process which was combining oil with 30% KOH solution until soap paste was formed, followed by a process of dilution or liquefaction by adding other materials such as
glycerine, propylene glycol, aqua dest, and coco-DEA to form liquid soap. The flow diagram of making liquid soap is presented in figure 2.

![Flow diagram of making liquid soap](image)

**Figure 2.** Flow diagram of the making paper soap process.

2.4. **Quality testing of liquid soap**
The quality testing of liquid soap involved specific gravity, pH value and total plate number based on SNI 06–4085–1996. Another test that was conducted was an organoleptic test that included color perception, scent, amount of foam, impression before and after using the liquid soap. An antibacterial activity test of the liquid soap was conducted by measuring the diameter of its inhibition zone. The result of liquid soap quality testing was then analyzed.

3. **Result and discussions**

3.1. **The yield of liquid soap**
Yield values resulted from liquid soap making are varied. One of the factors that affected the amount of a yield value was the oil layer found in the soap approximately after a week of being in the storage. It might be caused by the lack of KOH that was used for making the soap, hence the imperfect saponification. The percentage of the oil layer in the soap was around 17.05% of the total weight of the produced soap. Another factor that affected the yield values of making soap was the loss of mass during the process because making liquid soap required to heat that caused the added aqua dest to evaporate. On the other hand, there were scraps of the soap attached to the crockpot and they could not be moved to a bottle. The liquid soap being produced can be seen in figure 3 and the yield can be seen in table 2.
**Table 2.** The yield of liquid soap.

| Treatment | Average Yield (%) | Deviations (%) |
|-----------|-------------------|----------------|
| A         | 50.4626           | 0.0657         |
| B         | 44.8869           | 0.0071         |
| C         | 57.8626           | 0.0592         |
| D         | 49.1379           | 0.0552         |
| E         | 50.6763%          | 0.0884         |

**Figure 3.** Liquid soap being produced.

**3.2. Quality of Liquid Soap according to SNI 06–4085–1996**

**3.2.1. Specific gravity.** According to Voight research [6], specific gravity is the ratio of the weight of substances in the air at a temperature of 25°C to the weight of water with the same volume and temperature conditions. The method used was the pycnometer method. The results of the specific gravity measurement can be seen in figure 4.

![Figure 4. The relation between the white tea extract added to the specific gravity of liquid soap](image)

In general, the results of the specific gravity of liquid soap had increased because of the concentration of the addition of foreign material in the form of white tea extract added to liquid soap. Increasing specific gravity can be caused by additional material in liquid soap, because there were differences in the number of compounds from each ingredient added to liquid soap significantly affected the amount
of specific gravity in the liquid soap produced. According to figure 4, it revealed that the coefficient of determination \((R^2)\) obtained from the power equation was very influential on the specific gravity as much as 92.97%, while the remaining 7.03% was affected by other unknown factors. Based on the correlation coefficient that was the value of the root coefficient of determination \((\sqrt{R^2})\) the obtained value was 0.9642 and the value was the correlation index at a vulnerable 0.800–1.000 with a very strong closeness which stated by Sugiyono [7].

The castor oil which is the main ingredient in making liquid soap has a specific weight of 0.961–0.963 g/g. Meanwhile, the addition of white tea extract also causes an increase in the value of specific gravity liquid soap, which according to a study conducted by Widyasanti [8] the results of white tea extract UAE method with an amplitude of 100% has a specific weight of 1.0306 g/g. The specific gravity of all the treatments had fulfilled the quality standards of liquid soap in accordance with SNI 06–4085–1996, namely 1.01–1.10 g/g.

3.2.2. pH

pH value is the degree of acidity that shows the acidic or basic properties of liquid soap. The pH is one of the important parameters in the analysis of cosmetic products, this is caused by the pH of cosmetic products affecting the absorption of skin, so it can cause irritation to the skin. Soap that has a pH that is too high and contacts for a long time between soap and skin can cause irritated skin. Therefore, the pH of the soap should not be much different from the pH of the skin, where the pH of the surface of the skin mostly ranges from 5.0–7. To avoid irritation to the skin, humectants need to be added in liquid soap preparations that function as moisturizers and to maintain water content on the skin that is able to draw water from the air and hold water in order not to evaporate [9].

According to Wasitaatmadja research [10], the pH on the surface of the skin ranges from 5.5–6.0 as for the pH of the soap that is safe for human skin ranges from 8–11. If the pH value of liquid soap is too acid and too bases, it will cause irritation or accelerate the loss of fatty acid coat on human’s skin. Good liquid soap has a pH value in the range of 8–11 in accordance with SNI 06–4085–1996 concerning liquid soap. The results of pH value measurement can be seen in figure 5.

The tendency of the pH value of liquid soap to increase was presumably caused by different treatments during the liquid soap making which was the use of castor oil and white tea extract. One of active compounds that were contained in white tea was alkaloids. According to Lenny’s study [11], alkaloids are an organic compound that contains alkaline properties. More white tea extract is added, the pH of liquid soap slightly becomes higher.

From figure 5, it can be seen that the coefficient of determination \((R^2)\) obtained from the polynomial equation was 0.9366. The value showed that the treatment of various concentrations of white tea infused
oil on liquid soap was very influential on the pH value as much as 93.66%, while the remaining 6.34% was affected by other unknown factors. Moreover, correlation coefficient that was the value of the root coefficient of determination \(\sqrt{R^2}\) the obtained value was at 0.9893 and the value was the correlation index at 0.800 – 1.000 with a very strong closeness. The pH value that was obtained generally increased linear with the increase in white tea extract concentration and had fulfilled the quality standards of liquid soap in accordance with SNI 06–4085–1996 that was 8–11.

3.2.3. **Total plate number.** Total Plate Number (TPN) is one method in microbiological examination found in food or non-food products. A microbiological examination is carried out to determine the presence of microbial contamination found in food and non-food products [12]. According to SNI 7388: 2009 TPN is the number of mesophilic aerobic microbes found per gram or per milliliter of samples determined by the standard method. The principle of the total plate number is to calculate the growth of colonies of mesophyll aerobic bacteria after the sample is planted on the media plate according to the pouring method and then inserted into the incubator for 24–28 hours at a predetermined temperature [13].

The TPN test results showed that soap C has the highest amount of microbial contamination compared to other samples with an average value of 0.825 x 10^5 colonies/g, while soap B had the lowest amount of microbial contamination with an average value of 0.025 x 10^5 colonies/g. The results of the total plate count measurement on liquid soap can be seen in table 3.

| Treatment | Average total plate number (colonies/g) | Deviations |
|-----------|----------------------------------------|------------|
| A         | 0.800 x 10^5                           | 0.353      |
| B         | 0.050 x 10^5                           | 0.707      |
| C         | 0.825 x 10^5                           | 0.000      |
| D         | 0.025 x 10^5                           | 0.353      |
| E         | 0.500 x 10^5                           | 0.707      |

The measurement of the total plate number values on soap showed that the value had met the liquid soap quality standards in accordance with SNI 06–4085–1996 which was a maximum of 1 x 10^5 colonies/g. This was caused by the chemicals contained in liquid soap produced that had antibacterial and antimicrobial activities, one of which was derived from the raw material of castor oil itself and the addition of active ingredients of white tea in it.

Microbial growth in liquid soap can be influenced by two factors, namely intrinsic factors and extrinsic factors. Intrinsic factors include nutrient and antimicrobial compounds, while extrinsic factors include temperature and relative humidity. A low amount of colony in liquid soap produced can be caused by process temperature. All soap-making materials are heated during the manufacturing process, this can cause microbes, especially mold and yeast to die. Mold and yeast have an optimum temperature of 22–37 °C. In addition to these factors, the time and method of storage is thought to also affect the amount of microbial contamination in liquid soap. The more often soap is exposed to the outside environment, the greater the likelihood of soap being contaminated. While the addition of white tea extract did not significantly affect the amount of contamination found in liquid soap preparations.

3.2.4. **Overall physicochemical properties of liquid soap.** The results of the analysis of the quality of liquid soap in each treatment of various concentrations of white tea extract were recapitulated to measure the quality of produced liquid soap and compare it to the quality standards of liquid soap. The standard used as a reference for the analysis of liquid soap quality was SNI 06–4085–1996 made by the National
Standardization Agency (BSN). The results of the recapitulation of liquid soap quality analysis can be seen in table 4.

**Table 4. Physicochemical quality of liquid soap.**

| Parameters               | Treatment of white tea extract addition | Standard            |
|--------------------------|----------------------------------------|---------------------|
| Spesific gravity         | A: 1.0313, B: 1.0333, C: 1.0334, D: 1.0339, E: 1.0350 | 1.01–1.10 g/g (SNI Approved) 8–11 |
| pH                       | A: 9.505, B: 9.533, C: 9.562, D: 9.647, E: 9.653 | (SNI Approved) Max. 1 x 10^5 colonies/gram |
| Total Plate Number (colonies/g) | A: 0.8 x 10^5, B: 0.05 x 10^5, C: 0.825 x 10^5, D: 0.025 x 10^5, E: 0.5 x 10^5 | (SNI Approved) |

3.3. Organoleptic test

After getting the results of the liquid soap quality test, the organoleptic test was conducted. The organoleptic test carried out in this study was a favorite assessment where the panelists were asked for their responses about the level of contentment and discontentment towards the liquid soap produced. The parameters assessed by panelists included color, aroma, amount of foam, impression when using and after using the liquid soap that was tested. Panelists who were involved in this test were 30 untrained panelists with rating scales from 1 to 5, the greater the rating given implied how much the panelists liked the liquid soap. The results of the organoleptic test can be seen in table 5. Furthermore, table 6 showed that the liquid soap with the highest rank based on the percentage of the assessment, in general, was the liquid soap with treatment E with a percentage of 60%.

**Table 5. Overall results of organoleptic quality of liquid soap.**

| Parameters                  | Average Rating of the Panelists | Treatment |
|-----------------------------|---------------------------------|-----------|
| colour                      | A: 3, B: 4, C: 4, D: 4, E: 4    |           |
| Aroma                       | A: 4, B: 4, C: 4, D: 4, E: 4    |           |
| Amount of Foam              | A: 2, B: 3, C: 3, D: 3, E: 3    |           |
| Impression When Using       | A: 3, B: 3, C: 3, D: 3, E: 3    |           |
| Impression After Using      | A: 3, B: 4, C: 3, D: 3, E: 3    |           |

Notes: 1 = Very dislike; 2 = Dislike; 3 = Ordinary; 4 = Like; 5 = Very like

**Table 6. The Percentage of panelists rank of the liquid soap**

| Ranking | Treatment   |
|---------|-------------|
|         | A: 7%, B: 3%, C: 7%, D: 23%, E: 60% |
| Rank 2  | A: 13%, B: 23%, C: 33%, D: 13%, E: 17% |
| Rank 3  | A: 27%, B: 13%, C: 37%, D: 17%, E: 7% |
| Rank 4  | A: 30%, B: 20%, C: 17%, D: 23%, E: 10% |
| Rank 5  | A: 23%, B: 40%, C: 7%, D: 23%, E: 7% |

3.4. Antibacterial activity

The bacteria used for antibacterial tests on castor liquid soap with the addition of white tea extract are Gram-positive bacteria, namely Staphylococcus aureus which can attack the skin. It has been proven
that white tea extract has antibacterial activity against *Staphylococcus aureus* bacteria [14]. The complete antibacterial test results can be seen in figure 6. The value of $R^2$ from the antibacterial liquid soap test chart is 0.9606 or 96% changes in the inhibition zone value are influenced by the addition of white tea extract. The value of $r$ (correlation coefficient) between the inhibition zone and the addition of white tea extract is 0.980 which is included in the category of very strong correlation.

$$y = 0.2011x^2 - 0.4879x + 13.073$$

$R^2 = 0.9606$

![Figure 6. Bacterial inhibition zone diameter on liquid soap.](image)

Based on figure 6, it can be seen that all soap treatments have antibacterial activity against *Staphylococcus aureus* bacteria (>10 mm) and treatment soap E has the largest diameter inhibition zone of 15.81 mm. The area of bacterial resistance in the range of 10–20 mm has a relatively strong inhibitory power [15]. The more the addition of white tea extract, the larger the bacterial inhibition zone. This was caused by the content of polyphenols (catechins) from white tea in the soap that could inhibit the growth of *Staphylococcus aureus* bacteria. Moreover, white tea extract which has been added to transparent solid soap made from castor oil has an antibacterial activity to *Staphylococcus aureus* with a value of 6.9 mm to 18.5 mm along with the addition of white tea extract [5]. The flavonoid compounds contained in white tea have the ability to denature bacterial cells so that they can stop bacterial cell activity. This causes the permeability function of bacterial cells to be disrupted and bacterial cells will experience lysis which results in bacterial cell death [16].

### 4. Conclusions

The study concluded that:

1. The process of making white tea liquid soap was done by using hot-process soap-making. This method aimed to obtain a polyphenol compound in the white tea as an antibacterial.
2. Soap E (with 2% b/v white tea extract) was the best soap according to the general preference of organoleptic test and antibacterial activity test with an inhibitory zone diameter of 15.810 mm which was categorized as a strong antibacterial activity. The treatment soap E has a specific gravity value of 1.0350 g/g, a pH value of 9.653, and a total plate number of $0.55 \times 10^5$ colonies/gram.
3. The entire treatment of soap produced has complied with the Indonesian National Standards 06–4085–1996 with parameters of specific gravity, pH value, and total plate number, thus the liquid soap was safe to use.

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**Acknowledgment**

The author wishes to extend thankfulness to Padjadjaran University for providing financial support and opportunities to make this research possible.