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# Utilization of Waste Palm Shells to a Shampoo that Absorbs Dirt on Hair and Evaluated the Physical Properties of The Best Shampoo

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**Abstract.** Greasy hair becomes a major problem to the health of the hair, one of which is dandruff. This is because greasy hair can facilitate the adhesion of dirt. Active charcoal of palm oil shell is activated charcoal having a pore diameter in the range of 1.76 to 1.84 nm and it has been proven that it has absorption ability 2 times higher than commercial activated carbon to absorb the oil in hair. Based on this, active charcoal derived from palm oil shells is processed into cosmetic products. One of the cosmetic products that can be used to overcome hair health problems is shampoo. Shampoo formulations with a variety of concentrations of activated charcoal with palm shell with concentrations of 4% (FI), 8% (FII), 12% (FIII). Then the evaluation of shampoo's physical properties such as organoleptic, pH, homogeneity, viscosity, foam height, specific gravity, foam stability test and cycling test were carried out. In vitro test the effectiveness of the excess oil absorber by using a turbidimetric device. The comparison control used was Pantene shampoo as a positive control and the basis of the shampoo as a negative control. Showed that the higher the concentration of activated charcoal from the coconut shell, the better the ability to absorb excess oil with the largest NTU FIII value of 11,800. The formula that has good physical properties and is stable in storage and has good oil absorption ability is FIII.

**Keywords:** Active Charcoal, Palm Shell, Shampoo

## 1 Introduction

Greasy hair can make it easier for dirt to adhere to the hair, which can cause dandruff. This will be a problem for hair health. One of the cosmetic products that can be used to overcome this problem is shampoo. The shampoo is a cosmetic stock used to clean hair, so that hair and scalp become clean and as soft as possible, easily regulated and shiny [1,30].

Shampoo made with active palm oil shell (Elaeis guineensis Jacg) charcoal has the advantage over the shampoo that is widely available on the market made from coconut shell active charcoal [2]. The advantage of active palm oil shell charcoal compared to other activated charcoal is that it has diameter pores in the range of 1.76-1.84 nm and is proven to have 2 times higher absorption capacity than commercial active charcoal (coconut shell) [3]. Although the texture is quite old-fashioned, this shampoo has a dark or black color which is expected to be in great demand and can make hair healthy and discolor hair [4].

The advantages of shampoo stocks compared to other stocks such as hair tonic and conditioner are having a good clean power in a variety of water conditions, does not cause injury to the scalp and pain in the eyes when used, quite a lot of foam produced, easily rinsed and does not leave residue on the hair and scalp. The shampoo also contains surfactants that are useful for removing impurities such as dandruff and fat attached to the hair and scalp. In general, the price of shampoo is cheaper than hair tonic and conditioner [5].

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## 2 Method

The material used was palm oil shells obtained from PT Sumbertama Nusa Pertiwi which is processed into activated charcoal by physical activation. Sodium Lauryl Sulfate, Triethanolamine, NaCMC, Citric Acid, Methyl Paraben, Propyl Paraben, Oleum Menthae Pipiriae, Aquadest.

The tools that will be used in this research are Furnace, Ball Miling, sifter, digital scales, spatula, paper, porcelain cup, beaker glass, stirring rod, measuring cup, water bath, watch glass, and spatter, Tyler sleeves, oven, measuring cup, Erlenmeyer, thermometer, volume pipette, silicone soap molds, pH meter, burette.

**Table 1.** Formulas of palm oil shell charcoal shampoo

| No. | Shampoo | F1 (% W/w) | FII (% W/w) | FIII (% W/w) |
|---|---|---|---|---|
| 1 | Active palm oil shell charcoals | 4 | 8 | 12 |
| 2 | Sodium lauryl sulfate | 10 | 10 | 10 |
| 3 | triethanolamine | 4 | 4 | 4 |
| 4 | Na CMC | 3 | 3 | 3 |
| 5 | citric acid | 0.25 | 0.25 | 0.25 |
| 6 | methylparaben | 0.02 | 0.02 | 0.02 |
| 7 | propylparaben | 0.18 | 0.18 | 0.18 |
| 8 | Oleum menthae piperitae | 0.5 | 0.5 | 0.5 |
| 9 | distilled water | ad 100 | ad 100 | ad 100 |

Shampoo manufacturing was done by weighing all the ingredients that were used following the formulation. Na CMC developed with hot water in the mortar (M1). Methylparaben was dissolved in a few drops of ethanol to dissolve (M2). Most of the distilled water was heated on a hot plate at 60°C and included sodium lauryl sulfate, stirring until homogenous. TEA was added to it, stirring constantly until homogeneous. M1 and M2 were mixed into it and stirred until the liquid has thickened (M3). Active charcoal of palm oil shells mixed into the M3, stirring until homogenous. M3 shampoo solution was added citric acid which has been diluted with a few drops of ethanol and stirred. M3 shampoo solution was cooled and added menthol which has been diluted with a few drops of ethanol and stirred. Dicukupkan with up to 100 mL of distilled water and stirred until homogeneous.

Shampoos that have been made were tested as the shampoo evaluation of physical properties such as organoleptic, pH, homogeneity, high foam, specific gravity, the foam stability test, BJ, surface tension and stability, as well as the in-vitro test of the effectiveness of using the excess oil absorbent filter paper and turbidimetry instruments. The control comparator was used as a positive control was Pantene shampoo and shampoo base as a negative control.

The organoleptic inspection includes changes in color, smell, shape, consistency and the occurrence of phase separation visually. Specifications of shampoo that must be met were to have a homogeneous stock of color, fragrance, soft consistency and there was no phase separation [6]. Testing was done by reduplication of each formula for three times.

Homogeneity testing was done by applying the shampoo that has been created on the slide clean and dry to form a thin layer of glass then was covered by another object, and then observed under a microscope. The color uniform was observed. Shampoo otherwise homogeneous when observed using a microscope, the shampoo has a texture that looked flat and does not clot [6].Testing was done by replication in each formula three times.

The pH of shampoo measurement was done by putting it into a glass beaker, then the pH was measured by a pHmeter that previously calibrated with standard buffer (pH 4 and pH 7). Measurements were taken to new shampoos and those have been stored. The shampoo should have a pH of skin between 5.0 to 9.0 (SNI No. 06-2692-1992) [7]. Testing was done by reduplication of each formula for three times.

Foam height test aimed to demonstrate the ability of the surfactant to form foams. Foams from the shampoo were very important. This was because the foams keep the shampoo remain on the hair, making the hair easy to wash, as well as preventing hair to wrinkle [8]. Shampoo should meet the requirements of the foam height that is 1.3 to 22 cm [9].

Test capability and stability of the foam from the shampoo was conducted by Cylinder shake. The test was done by inserting 50 ml shampoo 1% into a 250 ml test tube then was shaken for 10 times stronger. The total volume of the foam content was measured as well as decline and foam stability was observed [6].

The determination of true specific gravity was done by using a pycnometer at room temperature (28-30°C). The true specific gravity of shampoo stock according to ISO (1992) was at least 1.0200 g / ml. True specific gravity was determined in a manner known as pycnometer weighed volume (a), namely (b), pycnometer filled

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with distilled water and weighed (c), weighed 2 grams of shampoo, put in the pycnometer and weighed (d), distilled water was added to the pycnometer until about half, closed and left for 5 minutes while shaken, the distilled water was added until the pycnometer was full and weighed (e), true specific gravity was calculated by the following equation:

$$BJ\ True = \frac{(d - b) \times \rho\ solvent\ g / ml}{(D - b) + (c - e)}$$

Surface tension test was carried out using all formulas made with a concentration of 1%, then put into a glass beaker attached to a millimeter block of paper. Capillary tubes are inserted and rising shampoo was measured in capillary tubes [10].

The viscosity measurements were performed using a Brookfield viscometer. anti-dandruff shampoo to be examined was put into a becker glass (± 200 mL), then it was placed under the Brookfield viscometer with an appropriate spindle. Spindles were put into the stock until submerged. Flow properties test can be obtained by making a curve between shear pressure vs shear velocity [11].

Qualitative test using filter paper. This method was done by dissolving 2 g sample in 100 ml of distilled water and put in a beaker. Then the filter papers were cut according to numbers of the formulas that will be tested. Oil was dripped onto filter paper and put into a soap solution to cover. It was shaken strongly for 1 minute, then the filter paper was removed and rinsed with distilled water [12]. The effectiveness of the cleaning power visually was assessed based on the oil that left on the filter paper.

Quantitative test using a turbidimeter. This method was done by dipping a cloth that has been smeared with margarine as oil-containing impurities in the soap, stirring and then removing the cloth. The turbidity level of water was assumed to be dirt that can be removed by transparent solid soap. Water turbidity was determined using a turbidimeter with a scale specified in the NTU (Nephelometric Turbidity Unit), which was selected based on the workings of SNI No. 06-6989.25-2005 [13]. The turbidimeter was calibrated first. The nephelometer tube was inserted with distilled water, the sample was shaken and inserted into the tube on the nephelometer (turbidimeter). The valve was blocked, the device that was left shows a stable reading value, and then updates are assessed. The turbidity was calculated by the formula:

$$Turbidity\ (NTU) = A \times fp$$

*Where:*
*A = turbidity in NTU diluted sample*
*Fp = dilution factor*

## 3 Results and Discussion

Palm oil shells were obtained from PT Sumbertama Nusa Pertiwi, with a yield of active palm oil shell charcoal obtained was 67.469% [2]. The recapitulation of the evaluation results of the physical properties of the shampoo such as organoleptic, pH, homogeneity, foam height, specific gravity, foam stability test, BJ, surface stress where replication is carried out 3 times in each formula can be seen in the table below:

**Table 2.** Summary of evaluation of physical properties

| No | Evaluation of physical properties | FI | FII | FIII | Parameter |
|---|---|---|---|---|---|
| 1 | organoleptic | | | | |
| | Color | Black* | Black* | Black* | [14] [15]. |
| | Smell | Typical aromatic mint * | Typical aromatic mint * | Typical aromatic mint * | [14] [15]. |
| | Shape | semisolid | semisolid | Semi-solid and liquid rather * | [14] [15]. |
| | Consistency | Soft* | Soft* | Soft* | [14] [15]. |
| 2 | homogeneity | Homogeneous* | Homogeneous* | Homogeneous* | Homogeneous[16] . |
| 3 | • high Foam<br>• foam stability | 7.10 *<br>Ups and down | 7 13 *<br>Ups and down | 7.23 *<br>Ups and down | 1.3 to 22 cm and there is no limit of stability [9] |
| 4 | pH | * 6,99 | * 7,11 | * 7.38 | 5-9 [16]. |

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| No | Evaluation of physical properties | FI | FII | FIII | Parameter |
|---|---|---|---|---|---|
| 5 | The degree of sedimentation | F = 1 * | F = 1 * | F = 1 * | F = 1 [17] |
| 6 | Specific gravity | 0.963 g / ml | 1.246 g / ml * | 1.398 g / ml * | at least 1.0200 g / ml [7]. |
| 7 | Surface tension | 1,5 cm | 1.7 cm | 1.9 cm | There is no limit [9] [26] |
| 8 | viscosity | 73.56333 Pa.s = 73563.33 cps | 96.98667 Pa.s = 96986.67 cps | 157.50333 Pa.s = 157,503.33 cps | viskosotas shampoo between 400-4000 cps [18]. |
| 9 | Personality Flow | plastically | plastically | plastically | Plastic flow [10]. |
| 10 | Stability test organoleptic<br>• Before<br>• After | Color Black Odor typical aromatic mint, semi-solid, soft<br>Color Black Odor typical aromatic mint, semi-solid, soft | Color Black, a distinctive smell aromatic roses, semi-solid, soft<br>Color Black, a distinctive smell aromatic roses, semi-solid, soft | Black color, the distinctive smell of aromatic mint and a little liquid and semi-solid, soft *<br>Black color, the distinctive smell of aromatic mint and a little liquid and semi-solid, soft * | [14], [15], [19] |
| | homogeneity<br>• Before<br>• After | Homogeneous*<br>homogeneous * | Homogeneous*<br>Homogeneous* | Homogeneous*<br>Homogeneous* | Homogeneous [20] |
| | Sedimentation degree<br>• Before<br>• After | F = 1 *<br>F = 1 * | F = 1 *<br>F = 1 * | F = 1 *<br>F = 1 * | F = 1 [17]. |
| | pH<br>• Before<br>• After | 6,99 *<br>8.00 * | 7,11 *<br>7,93 * | 7.38 *<br>7.90 * | 5-9 [20] |
| | high Foam<br>• Before<br>• After | 7.10 *<br>18.63 * | 7,13 *<br>17.00 * | 7.37 *<br>16.17 * | 1.3 to 22 cm [9] |
| 10 | Qualitative test the ability to absorb oil and dirt | Early: Late clear oil stains: oil stains fade / loss (Able to absorb oil) * | Early: Late clear oil stains: oil stains fade / loss (Able to absorb oil) * | Early: Late clear oil stains: oil stains fade / loss (Able to absorb oil) * | Faded / missing oil stains on paper filter then able to absorb oil [12]. |
| 11 | Quantitative test the ability to clean grease and dirt | Early (Shampoo) 314 NTU<br>End (shampoo + butter) NTU 444.33 | Early NTU 569<br>End NTU 786 | NTU initial 10,400 *<br>End NTU 11,400 * | The higher the NTU, the higher the turbidity level means that if the difference between NTU NTU shampoo with shampoo + butter bigger then activated charcoal present in the shampoo increasingly able to lift oil and dirt on the head [13] |

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Active palm oil shell charcoal shampoo is made in 3 formulas and replicated 3 times. The shampoo evaluation tests conducted were organoleptic, pH, homogeneity, viscosity, foam height, specific gravity, foam stability test, BJ, surface tension and cycling test. Invitro test of the effectiveness of the excess oil absorber is carried out using a turbidimetry device which is carried out from week 1 to week 4, because the shampoo is made using preservatives, namely nipagin and nipasol, which can inhibit bacterial and fungal growth so that shampoo is expected to remain stable during storage 4 weeks [9].

The observation of the physical stability for 4 weeks showed that the entire formula shampoo homogeneous and stable with black color and distinctive aromatic smell of mint and semi-solid form.

**Figure 1.** Palm oil shell charcoal shampoo stocks

Shampoos containing active palm oil shell charcoal has a pH value of 6.99 to 7.38, while the comparative shampoo had a pH of 7.0. The pH value is affected by the concentration of palm oil shell charcoal. This is because active palm oil shell charcoal has a neutral pH is pH 7[21]. All formulas were added with peppermint oil to provide a cooling effect because the peppermint oil directly interacting with the cold receptors in the body, and reduce the itching. At 4 weeks of storage after preparation, pH increased wherein the pH value in the range 7.93 to 8.00 but still met the test requirements of pH, 5.00 to 9.00 [22]. This was due to the influence of SLS has a base of alkaline pH [19, 27].

Shampoo's specific gravity increased with the increasing concentration of palm oil shell charcoal. The higher concentration of active charcoal was added, the less water in the shampoo, so that the specific gravity of the shampoo became higher [23]. Observations showed that the specific gravity of the entire shampoo is quite stable because of the changes were very small, so it did not affect the homogeneity and stability of shampoo for 4 weeks of storage. The specific gravity of palm oil shell charcoal shampoos those approaching specific gravity requirements set by ISO 1980 for the stock of shampoo were FI and FII, except shampoo with active palm oil shell charcoal concentration of 5%. This was because the concentration of palm oil shell charcoal was high so that the volume of water added was less and the specific gravity became larger.

Shampoo formulated with sodium lauryl sulfate as an anionic surfactant at a concentration of 10% -14% to form a shampoo that has a stable foam [19]. The resulting foam height shampoo after manufacture is still within the limits of the requirements, 1.3 to 22 cm, which after 4 weeks of storage increased foam height but still within the limits specified requirements [24]. Every week observation of stability and foam height had decreased and increased, but this was not an obstacle due the foam is usually associated with the aesthetic value of the consumer who prefers stocks of excess foam shampoo [25]. The cause of the decrease in foam stability is due to the thinning of the film and coalescent layers so that the foam becomes broken [24, 32]. Surface tension has a value related to the surfactant used in the shampoo, where the surfactant function is to reduce the surface tension of the shampoo so that the shampoo has good cleaning strength [10].

In this study, the shampoo stock viscosity increased with the concentration of active palm oil shell charcoals. The higher concentration of palm oil shell charcoal was added, the less water was added, so that the higher the viscosity of shampoo. Factors that may affect the viscosity was the temperature. At low temperatures, the viscosity will be higher, which meant the viscosity of shampoo stocks were likely to merge or close to each other to form a tighter bond structure so that the viscosity of palm oil shell charcoal shampoo will be increased (29).

According to Schimit and William, (2006) viscosity of shampoo stocks should be in the range of 400-4000 cps. If the viscosity of the shampoo stocks less than 400 cps then the shampoo will be too thin and if it exceeds 4000 cps then shampoo stocks will be too thick, so that when being used it is difficult to be poured. In this study, the viscosity of stocks produced ranged between 73563.33 cps - 157,503.33 cps. This meant that the viscosity of the shampoo stocks did not meet the desired viscosity, for the shampoo stocks they were too thick so that when being used it is difficult to be poured.

If non-Newton stocks are analyzed in a rotary viscometer and the results are plotted, various consistency curves are obtained which describe the three types of flow classes, namely: plastic, pseudoplastic and dilatant [10]. In this study, the flow properties of each stock illustrate the curve of plastic flow. Plastic flow does not

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pass through the point) but intersects the shearing stress axis (or will cut, if the straight part of the curve is extrapolated to the axis) at a certain point known as yield. Plastic fluids will not flow until shearing stress is achieved at the yield value.

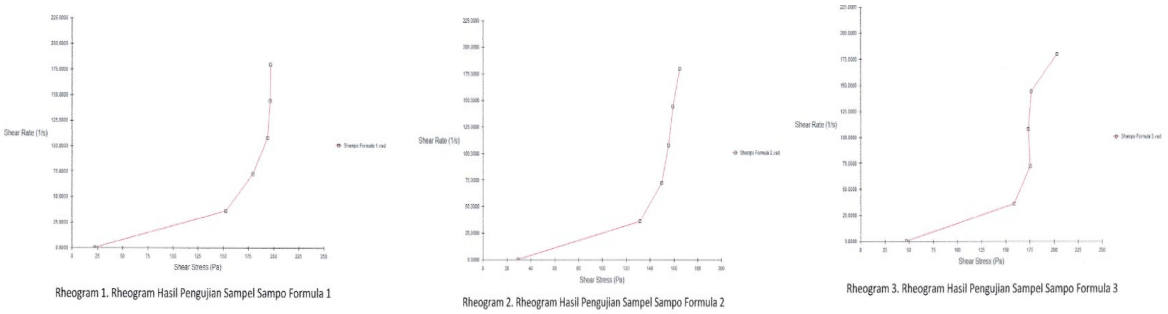


**Figure 2.** Plastic flow properties curve

The qualitative test using filter paper aimed to determine the effectiveness of the cleaning power of shampoo to oil absorption [12, 28]. Test on active palm oil shell charcoal shampoo showed that it could clean oil left on the filter paper, where it was seen visually that filter paper that has been dripped with oil and then washed or rinsed with shampoo caused oil stains to disappear or fade.

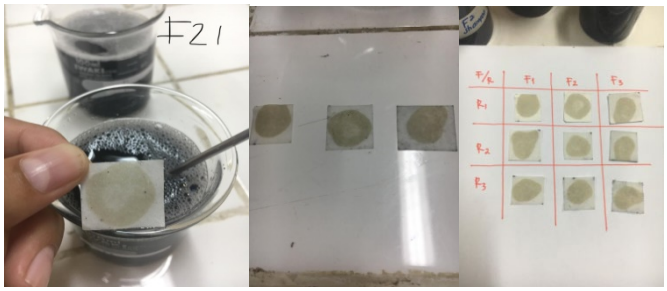


**Figure 3.** Oil stains before and after washing with shampoo

The quantitative test was done by using a turbidimeter or water turbidity measuring device with scales stated in NTU (Nephelometric Turbidity Units) (31). The results showed that the higher the concentration of activated charcoal from the palm oil shell, the better the ability to absorb excess oil with the largest NTU value was FIII of 11,800.

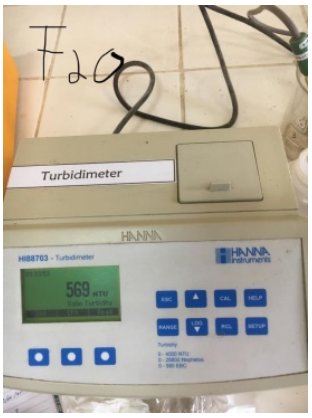


**Figure 4.** Turbidimetry Instrument

## 4 Conclusion

The formula that has good physical properties and is stable in storage and good ability to absorb excess oil is FIII.

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