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Development of An Eco-Shampoo Formulation Using Local Environmental Plant Extracts for Healthy Hair as an Effort to Increase the Potential of Environmental Resources

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Abstract

This research aims to develop an eco-friendly shampoo formulation (Eco-Shampoo) by adding local environmental plant extracts for hair health. This research method is a quasi-experimental development of existing shampoo formulations (base formulations) by adding local plant extracts such as aloe vera (Aloe vera L.) and lemongrass oil (Cymbopogon citratus) in three formulations. The resulting shampoo products were then carried out two evaluations, namely the stability test (organoleptic test), foam height observation, viscosity test, pH test, and preference test (hedonic test) by consumers to determine the feasibility and effectiveness of using shampoo. After a storage period of 2 days showed a Stability test, slightly changed color, constant odor, and texture did not change and the pH value was between 5.5 - 6.5. The smear test on the back of the hand and the skin behind the ear did not show skin irritation, whereas the hedonic test, 10 consumers stated that the color was like, the smell was stated like, and the texture was stated quietly. Aloe vera fraction and lemongrass oil can be formulated as a shampoo preparation to maintain hair fertility as well as an anti-dandruff shampoo.

Keywords: Eco-shampoo; Formulation development; Health hair; Local environment; Plant extracts.

INTRODUCTION

Indonesia is a fertile country and has various types of plants. The soil is fertile and the rainfall is sufficient for various types of plants to grow and develop (Arifin 2006). Plants are biological natural resources that can be managed to become a source for the establishment of industries such as the pharmaceutical industry, the food industry, the metal industry, the animal feed industry, the plastic industry, and the cosmetics industry. Several plants have been developed to treat hair problems, one of which is aloe vera and lemongrass leaves. Empirically, aloe vera leaves are used by the community to nourish their hair by using the inner gel of the leaf flesh (Ariyani *et al. 2*009). Likewise, lemongrass leaves are taken through extracts used by people for anti-dandruff hair treatment. Hair contains an important role for every human being. This is because hair can affect a person's appearance (Filbert 2014). The number of hairs on the human head is about 100,000 strands (Hotmauli 2010).

Even though hair has natural hair loss, for some people, hair loss is still a worrying thing. Hair loss can occur due to several factors such as age, hormonal disorders, pregnancy, drug use, continuous sun exposure, and lifestyle (Doughari 2006). To overcome hair problems, intensive care is needed, such as using shampoo, hair tonic, hair mask, hair oil, vitamins, and others.

Environmental factors that have been polluted in urban areas can disrupt hair health. Air or water impurities that hit the hair of the head will cause dandruff. Dandruff is a dry form of *seborrheic capitis* known as *seborea sika* (dry), which are dry, fragile, easily detached scales that stick to cover the epidermis of the scalp (Arifin 2006). One of the causes of dandruff is fungus on the scalp, which is dirty due to sweat, sebum (oil) glands, and dust. The fungus that develops on the scalp is called *Pityrosporum* ovale (Ariyani *et al. 2*009).

Symptoms of dandruff mainly include itching, flaking, and redness of the scalp. This fungus is naturally found on the scalp and can attack humans of all ages. Many anti-dandruff shampoos contain antifungal compounds such as sulfur, salicylic acid, selenium sulfide, and zinc pyrithione which have the effect of damaging the scalp and causing hair loss (Trueb 2007). Therefore, there need to be other alternatives, especially natural ingredients that can be used as anti-dandruff. Lemongrass (*Cymbopogon citratus*) is one of the essential oil-producing plants. In Indonesia, this species is usually used as a mixture of herbs and spices because it has a distinctive aroma like lemon (Boonme *et al. 2*011). Lemongrass oil is one of the most important types

of essential oil. This essential oil is used to produce *citral* which is the main constituent of lemongrass oil. Lemongrass oil is a pale yellow liquid that has a strong lemon smell due to its high levels of *citral* (65% to 85%) making it the most important ingredient in the pharmaceutical and cosmetic industries (Saputro 2009). The main constituents of lemongrass essential oil are *citral* (3,7-dimethyl- 2,6- octadienal), a mixture of geranial (*trans-citral* A), and neutral (*cis-citral* B) with small amounts of geranium, geranyl acetate, and monoterpene olefin ((Pooja *et al. 2*009).

Among the plants that can be used as hair, growers are aloe vera. Aloe vera is very effective for hair care because it has a composition similar to keratin, an important hair protein, and complex amino acids identical to hair follicles so that it can rejuvenate hair with the same nutrients, especially the content of the amino acid L-lysine which can help in growth hair (Limbani *et al. 2*009). According to Daisy (2011), the main elements of aloe vera liquid are aloin, emodin, resin, gum, and other elements such as essential oils. In terms of nutritional content, aloe vera leaf gel or mucus contains several minerals such as Zn, K, Fe and vitamins such as vitamins A, B1, B2, B12, C, E, inositol, folic acid, and choline (Potruli *et al. 2*011). Aloe vera is also a natural remedy that helps regulate the rich blood supply to the root hair follicles on the scalp, thereby helping to strengthen hair (Pooja *et al. 2*009). Treatment using traditional medicine today is very popular and is increasingly favored by the community. This is because affordable prices are easy to obtain and also have relatively few side effects (Naitullah *et al. 2*004; Pan *et al. 2*009). In addition, Indonesia is also the second mega biodiversity country after Brazil, where it is estimated that there are 30000 species of living plants in the Indonesian archipelago and at least 9600 species are known to have medicinal properties (Robinson 1995).

The cosmetic industry in Indonesia developed around the 1950s. Previously, traditional cosmetics had developed among kings in Java (Mahataranti *et al.* 2012). The Indonesian people at that time developed a complex of local plant ingredients that were used as powder, shampoo, and herbal medicine. The use of traditional cosmetics at that time was still limited among the royal family alone. Along with the development of chemistry, pharmaceutical science, and medical science, cosmetics and industrial sciences have also developed (Mitsui 1997).

Now the cosmetics industry is growing rapidly because of the demands of modern society. The cosmetic industry is more developed using chemicals such as paraffin, surfactants, dyes, and preservatives. As public awareness of environmental issues has increased, such as green products, environmentally friendly products, and herbal products, the cosmetics industry has begun to compete with industrial expansion related to environmentally friendly cosmetic preparations (Deeksha *et al.* 2014). However, not all the basic ingredients in the manufacture of the cosmetics industry have been replaced by natural ingredients, such as foam, thickeners, and preservatives. More active ingredients can be substituted by natural ingredients such as protein, dyes, and other nutrients (Aghel *et al. 2*007).

Many cosmetic companies in Indonesia produce shampoo, such as the Wahdah industry. Therefore, the formulation of the research problem arises: (1) Can the manufacture of shampoo be developed with local plant materials such as aloe vera and lemongrass oil? (2) How to evaluate shampoo preparations made from aloe vera and lemongrass oil? The objectives of this study were (1) to determine the formulation of shampoo that was given a mixture of aloe vera and lemongrass oil, and (2) to determine the evaluation results of shampoo preparations mixed with local plants such as aloe vera and lemongrass oil.

MATERIAL AND METHODS

The tools used in this research are measuring cup (Pyrex), beaker glass (Pyrex), Erlenmeyer (Pyrex), test tube (Pyrex), 65 mesh sieves, spatula, stirring rod, glass funnel (Pyrex), separating funnel (Pyrex). Petri dishes (Pyrex), analytical scales, blenders, hot plates, porcelain cups, shampoo containers, clamps and statives, pipettes, pH meters, filter paper, sterile gauze, and bunsen lamps.

The materials used in this research are aloe vera, lemongrass oil, sodium lauryl sulfate, cocamide diethanolamine (cocamide DEA), carboxymethyl cellulose (CMC), menthol, citric acid, methylparaben, aquadest, sodium chloride (NaCl). Aloe vera samples are purchased at supermarkets, as is slow mass oil. The initial stage is to collect fresh aloe vera leaves. Then the fresh aloe vera leaves are washed under running water to remove the dirt. The contents of the aloe vera gel are taken, then crushed then filtered with *apoach* to get a smooth and non-clumping gel.

This research method is an experiment, which is carried out in the chemistry laboratory of the Faculty of Engineering, State University of Jakarta. The ingredients used are sodium lauryl sulfate, aloe vera, lemongrass oil, and aquadest. This research method is an experimental design with a one-shot study. Where there is one group of independent variables is given treatment, then observations are made (Sugiyono 2008). The object research is existing shampoo formulations (base formulations) by adding local plant extracts such as aloe vera (*Aloe vera*) and lemongrass oil (*Cymbopogon citratus*) in three formulations (see Table 1) (Al-Badi and Khan 2014).

Table 1. Shampoo formulation for lemongrass and aloe vera oil fractions.

Ingredients	Shampoo Formulations with Various Fractions of Lemongrass and Aloe Vera Oil		
	F1	F2	F3
Lemongrass Oil	2%	7%	12%
Aloe vera	3%	3%	3%
Sodium Lauric Sulphate	10%	10%	10%
Cocamide DEA	4%	4%	4%
CMC	3%	3%	3%
Citric Acid	q.s.	q.s.	qs.
Menthol	0.5%	0.5%	0.5%
Methyl Paraben	0.15%	0.15%	0.15%
Aquadest	Ad.30 mL	Ad.30 mL	Ad.30 mL

The formulation results were tested for homogeneity, pH, viscosity, foam density and foam stability, wetting time, and cleaning power test. Homogeneity testing using a glass object. Anti-dandruff shampoo gel is made of a 10% solution and measured the pH using a pH meter. Viscosity check is done using a viscometer. The foam power test was carried out by making a 10% shampoo gel solution, shaken 10 times, and recorded the volume of foam formed (Munro 1954; Fazlolahzadeh & Masoudi 2015).

The foam stability test is done by recording the volume of foam reduction that occurs in the foam power test in 1–4 minutes intervals (Deeksha *et al. 2*014). The wetting time test was carried out by making a 1% shampoo gel solution then put it in a measuring cup and the canvas cloth was dropped into the solution. Measure the time it takes for the canvas to sink.

Weigh all the ingredients used according to the formulation. CMC is developed with hot water in a mortar. Diluted methylparaben with a few drops of ethanol until dissolved. Part of the aquadest is heated on a hot plate at 60°C and added with sodium lauryl sulfate, stirring until homogeneous. Cocamide DEA was added to the mixture while continuing to stir until it was homogeneous (Mitsui 1997). The general process of making shampoo with local plant mixtures is presented in Figure 1.

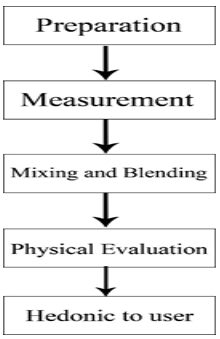

Figure 1. Diagram of the process of making shampoo with local plant mixtures.

RESULTS AND DISCUSSION

The results of organoleptic observations of the anti-dandruff shampoo for aloe vera leaf and lemongrass oil fraction with various concentrations showed that the higher the concentration of aloe vera leaf aquadest fraction contained in the anti-dandruff shampoo preparation, the stronger the distinctive odor of aloe vera leaves and lemongrass oil so that it covers the odor of the menthol fragrance used, and the darker brown in the shampoo preparation because of the red brick color of the citronella leaf aquadest fraction (see Table 2).

Table 2. Result of organoleptic observations for mixed aloe vera shampoo and lemongrass oil.

Shampoo Preparation Formulations	Observation Result		
	Shape	Colour	Smell
F1	liquid, nothing settles	Light Brown	Menthol, and lemongrass
F2	liquid, nothing settles	Brown	Menthol, and lemongrass
F3	liquid, nothing settles	Dark Brown	Menthol, and lemongrass

Table 3. pH scale measurement.

Shampoo Preparation Formulations	pH
F1	6
F2	5.5
F3	5.5

The pH test aims to determine the safety of the preparation at the time of use. Shampoo pH that is too acidic or too alkaline will irritate the scalp. The result of pH measurements is presented in Table 3. The result of the foam height test is presented in Table 4. The result of

the value of the water content test is presented in Table 5. The process of making shampoo from aloe vera and lemongrass oil and shampoo preparation is presented in Figure 2.

Table 4. Foaming hight measurement.

Shampoo Preparation Formulations	Foaming Hight
F1	6.2
F2	7.3
F3	8.1

Table 5. Results of measurement of water level content for shampoo preparations.

Shampoo preparation formulations	Water Level (%)
F1	89.83
F2	86.71
F3	82.36

Figure 2. The Process of Making Shampoo from Aloe Vera and Lemongrass Oil and Shampoo Preparation.

Based on the results obtained, the distilled water fraction has the greatest fungal inhibiting activity so that anti-dandruff shampoo preparations are made using active ingredients, namely the distilled water fraction of aloe vera leaves and lemongrass oil with a concentration of 5% 10%, and 15%, surfactants, and additives. The surfactants chosen in the manufacture of this shampoo are the surfactants that are widely used in shampoo preparations on the market, namely sodium lauryl sulfate as the primary surfactant and cocamide DEA as a secondary surfactant. By using primary and secondary surfactants, dandruff shampoo preparations can clean and form foam better. Additional ingredients used are CMC as a thickener, methylparaben as a preservative, citric acid as a buffer, and Menthol as a fragrance.

The anti-dandruff shampoo for the aloe vera leaf fraction was evaluated to determine its quality and safety. Then proceed with testing the antifungal activity of the anti-dandruff shampoo preparation.

The foam height test aims to show the surfactant's ability to form foam. The lather from the shampoo is very important. This is because the foam keeps the shampoo in the hair, makes hair easy to wash, and prevents the hair sticks from sticking together, causing tangles (Mitsui 1997). The foam height resulting from the three shampoo formulations has increased foam power. This increase was caused by an increase in the distilled water fraction in the shampoo preparation because the distilled water fraction of aloe vera leaves and lemongrass contained saponins. According to Harbone (1998), saponins are soap. The foam height test results of the three shampoo formulations met the foam height requirements according to Wilkinson and Moore (Wilkinson 1982), namely 1.3 - 22 cm.

Based on the results of pH measurements using universal pH indicator paper, the addition of aloe vera and lemongrass distilled fraction causes a decrease in pH due to the influence of active substances in aloe vera distilled water fraction which has an acidic pH. Although the pH of the shampoo decreased, the pH value of the three anti-dandruff shampoo formulations still met the requirements set forth in SNI No. 06-2692-1992 which is around 5.0 - 9.0.

Testing the value of water content is very important to do in a shampoo product because the moisture content is related to the physical shampoo and affects the shelf life of a shampoo product. From the measurement of water content, anti-dandruff shampoo with various concentrations of aloe vera and lemongrass distilled water still meet the requirements of SNI No. 06-2692-1992 which is a maximum of 95%. Based on the results obtained, the water content produced, the greater the concentration of the fraction added, the smaller the percentage of water content obtained. This higher water content comes from hygroscopic materials (the ability of a substance to attract water molecules from its environment), such as CMC.

The shampoo preparations made in this study used active ingredients which are obtained from the water *Pacar* leaves. Water *Pacar* leaves that are taken, cleaned and washed under running water to remove dirt. The leaves are already aerated and put in the oven to reduce moisture content in the leaves. The dried leaves of aloe vera are then blended until smooth and sieved to obtain a homogeneous powder with a surface area large so that it facilitates the release of active substances in the extraction process. The results of aloe vera leaf extract were obtained from the extraction process using the maceration method and 96% ethanol solvent. This maceration method also has the advantage of being able to maintain the compound content in the sample which is not heat resistant, undamaged and the sample can be

extracted directly in large numbers (Doughari 2006). This sample extraction using 96% ethanol solvent because ethanol solvent covers almost the entire content simplicia, both non-polar, semi-polar, and polar (Iswanti 2009).

The concentrated extract that has been obtained is then fractionated by the method partition using n-hexane, ethyl acetate, and distilled water. The use of solvents aims to attract compounds in the extract based on the level of polarity. Based on the yield of the extract fractionation, it can be seen that the distilled water solvent fraction had the highest yield. This shows that it is deep.

Based on the results obtained, the distilled water fraction has activity inhibits the most fungus so that anti-dandruff shampoo preparations are made with using the active ingredient, namely the water fraction of aloe vera leaves and lemongrass oil with concentration 5% 10%, and 15%, surfactants, and additives. Surfactants selected in this shampoo is a surfactant that is widely used in shampoo preparations on the market, namely sodium lauryl sulfate as primary surfactant and cocamide DEA as a secondary surfactant. By using primary surfactants and secondary, anti-dandruff shampoo preparations can clean and form more foam well (Deeksha *et al. 2*014).

Additional ingredients used are CMC as a thickener, methylparaben as a preservative, citric acid as a buffer and menthol as a fragrance. Shampoo anti-dandruff water fraction of aloe vera leaves that has been finished evaluated to know the quality and safety. Then proceed with testing the antifungal activity of the anti-dandruff shampoo preparation.

The results of organoleptic observations of anti-dandruff shampoo for water fraction *of Pacar* leaf with various concentrations show that the higher concentration of water fraction of *Pacar* leaf contained in the shampoo preparation anti-dandruff, the stronger the distinctive smell of aloe vera leaves so that it covers the smell of the menthol fragrance used, as well as the darker brown in the preparation shampoo because the color of the distilled water of aloe vera leaves is brick red. The pH test aims to determine the safety of the preparation at the time of use. Shampoo pH that is too acidic or too alkaline will irritate the scalp.

Based on the results of pH measurements using universal pH indicator paper, the addition of the distilled water fraction aloe vera causes a decrease in its pH due to the influence of the active substance in the water fraction of *Pacar* leaves which has an acidic pH. Although the pH of the shampoo has decreased, the pH value of the three shampoo formulations anti-dandruff still fulfills requirements stipulated in SNI No. 06-2692-1992 which is around 5.0 - 9.0. The foam height test aims to show the surfactant's ability to form foam. The lather from the shampoo is very important. This matters because the lather keeps the shampoo in the hair, making hair easily washed, and prevents the hair sticks from sticking together to cause tangled (Mitsui, 1997). High foam resulting from the three shampoo formulations experienced increased foaming. This increase was caused by the increase in the distilled water fraction in the shampoo preparation was due to the distilled water fraction of *Pacar* leaves containing saponins. According to Harbone, saponins are soap. The foam height test results of the three shampoo dosage formulations met the high requirements; foam according to Wilkinson and Moore (1982) is 1.3 - 22cm.

Test the value of water content is very important to do in a product shampoo because the water content is related to the physical shampoo and affects the shelf life of a shampoo product. From the measurement of water content, anti-dandruff shampoo with various concentrations of water fraction of *Pacar* leaf still meets the requirements of SNI No. 06-2692-1992 which is a maximum of 95%. Based on the results obtained from the resulting water content, the greater the concentration of the fraction added, the smaller the percentage of water content obtained. Water content higher comes from hygroscopic materials (the ability of a substance to attract water molecules from the environment) such as CMC. Anti-dandruff shampoo preparations with various concentrations tested its activity against the growth of the fungus *Candida albicans* by using media, method, fungus, and positive control were the same as those used on antifungal activity testing of the previous extracts and fractions. Negative control anti-dandruff shampoo formula is used without the water fraction of aloe vera leaves (base shampoo). The negative control is used to determine whether there is a basis effect shampoo against the growth of the test fungi, so it can be seen that the activity shown by the shampoo with various concentrations of leaf distilled water. Aloe vera is the substance contained in the distilled water fraction shampoo preparations and not derived from the shampoo base used (Putluri *et al. 2*011).

The results of testing the antifungal activity of anti-dandruff shampoo, distilled water fraction. Aloe vera and lemongrass oil with concentrations of F1 (5%), F2 (10%), F3 (15%), shampoo formula anti-dandruff without distilled water fraction of aloe vera leave as negative control and shampoo (June 2016).

Ketoconazole 2% as a positive control in each treatment indicates a zone of inhibition that has formed around the well. Obstacles zone the largest indicated by the anti-dandruff shampoo with a concentration of 5% distilled water, followed by anti-dandruff shampoo with the concentration of 10% distilled water and zone fraction. The smallest inhibition was shown by anti-dandruff shampoo with a fraction concentration of 15% distilled water with an average size of the inhibition zone in a row, namely 13.83 mm, 9 mm, and 7.83 mm. The difference in inhibition is influenced by the addition of distilled water fraction which affects the release of active substances for inhibited fungus (Aghel *et al. 2*007). The higher the concentration of distilled water, the thicker it is anti-dandruff shampoo preparation, the greater the

viscosity of the shampoo preparation. Viscosity is a statement about the resistance of a liquid to flow, the higher the viscosity, the greater the resistance (Al-Badi and Khan 2014). This is what makes it so that it blocks the release of the active substance which results in inhibition of the fungus *Candida albicans.*

Utilization of organic local environmental resources made from plants like Aloe vera, mangrove, and spice plants for a variety of products that help the economy and as natural treatments, particularly cosmetics (Daisy R. 2011). Phenolic compounds are found in the majority of Indonesian plants, including Aloe vera and mangrove leaves. Phenolic compounds are one of the dynamic mixtures found in aloe vera gel. Aloin, aloesin, aloemodin, and tannins are the primary components of these phenolic compounds (Iswanti DA. 2009).

In the past, the community did not know how to make cosmetics like organic shampoos and masks made from local environmental plants, which offered huge opportunities for business. Plants that contain nutrients and active substances that function as fundamental ingredients for skin and hair care are the strategy for utilizing the potential of local environmental resources in this instance (Deeksha D, Malviya R, Sharma PK. 2014). After getting to know one another and introducing the community to products that grow in the area, the community now knows how to make organic shampoos, soaps, and masks from local plants. These products are easy to make and can be used again and again, and the materials used are ones that can be found easily (Fazlolahzadeh O, Masoudi A. 2015). According to Pooja A, Arun N, and Maninder K. (2009), the production of organic shampoos and masks made from aloe vera and other plants could also be a solution to the issue of environmental pollution caused by chemical waste, which is difficult to convert into materials that are friendly to the environment.

Because there are so many "dysfunction" chemical-based cosmetics on the market, the usage of plants as cosmetic ingredients will continue to expand in the future. As a result, both the Central Government and the Regional Governments must continue to stimulate the exploration of the potential of local environmental resources, both types and benefits, through experiments and research. The cultivation of cosmetic ingredient plants can later become a source of revenue for the affected area (Naitullah N, Jamin F, Frengki, Dewi M. 2014). In this way it is important to go to preservation lengths for regions that have neighborhood natural assets through local guidelines so the stock of materials is ensured. On the off chance that the plant is unmistakable for its development climate, it is better assuming development is completed around there to increment plant material (Robinson T. 1995).

Involving the local community in the production process as well as in the cultivation of these plants is an equally crucial step. For instance, for each family, they are responsible for planting ten sticks or ten plants. We will eventually discover a "Cosmetic Village" (Saputro AD: 2006). In addition, it inspires researchers at universities, the private sector, and national research agencies like BRIN.

CONCLUSION

Based on the results of research on the physical stability test of mixed aloe vera and lemongrass oil shampoo with varying concentrations, namely 5%, 10%, and 15%, it can be concluded that aloe vera contains active compounds, fats, carbohydrates, and proteins. Aloe vera fraction and lemongrass oil can be formulated as a shampoo preparation to maintain hair fertility as well as an anti-dandruff shampoo that meets requirements such as organoleptic, pH, high foam, and moisture content. Evaluation of shampoos for quality assurance is a physical appearance test that is attractive, homogeneous, does not break, and can form foam. The pH value ranges from 5 - 6. The test for the ability and stability of the foam of the shampoo is carried out using the Cylinder Shake method at 6-8 cm, where the formulation of aloe vera is 3% and lemongrass oil is 12%.

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