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Formulation and Stability Tests of Hair Tonic from Oil Palm (*Elaeis guineensis* Jacq.) Leaves Extract and Effectiveness in Protecting Hair

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Abstract

Hair loss is a condition that unavoidable process, where the hair is detached more than 100 strands per day that occurs continuously. Oil palm leaf with their compounds can be used to treat hair loss and damage. The purpose of this study was to formulate oil palm leaf extract into hair tonic preparations and evaluate the effectiveness in preventing hair damage. Hair tonic formula from oil palm leaf extract contains 96% ethanol, menthol, propylene glycol, phenoxyethanol, and aquades. The evaluation of hair tonic preparations included organoleptic, homogeneity, pH, and viscosity tests, as well as tests of antioxidant activity and effectiveness of hair tonic preparations. The results of the antioxidant activity test of oil palm leaf extract hair tonic showed the IC_{50} value at room temperature (25°C) indicating an average value of 37.2519±8.535 ppm, warm temperature (50°C) 40.5459±9.086 ppm, and cold temperature (4°C) 36.8257±6.928 ppm, which belongs to the category of very strong antioxidant activity, with the results of the evaluation of the oil palm leaf hair tonic slightly colored. greenish to dark green, has a distinctive menthol aroma, has a pH and viscosity that meets the requirements of a good hair tonic preparation, with pH between 3-7 and viscosity less than 5 cPs. Hair tonic preparations of oil palm leaf extract can prevent hair decolorization due to sun exposure at concentrations of 25 ppm to 200 ppm.

Keywords: Oil Palm Leaf, Hair Tonic, Antioxidant, IC50, Effectiveness

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1 Introduction

Hair is often interpreted as a crown, especially for women, while for men, hair can affect self-confidence. Hair has an important role because hair can function in addition to providing warmth, protection, hair is also for beauty and supporting appearance. Healthy hair will tend to give a positive impression on someone, for example looking more beautiful, handsome, young, and confident. Healthy hair has characteristics that thick, black, shiny, and tangle-free. Therefore, many people do not hesitate to do hair care to maintain the health of their hair [1].

One of the hair problems that occurs in most people is hair that is damaged and brittle due to sunlight exposure. This causes strands of hair to become dry, fall out, brittle, become unruly, and even cause decolorization, and dehydration [2]. Factors that cause hair problems are divided into exogenous factors from stimuli of the environmental and usage of too much hair cosmetics; and endogenous due to genetic disorders, systemic disease, hormonal, nutritional status, and intoxication [3]. In Indonesia, which is country with a tropical climate, hair can be easily damaged due to various factors such as high humidity and very high intensity of sunlight. The scorching sun, dust, and pollution make hair limp and brittle more easily. So that people live in tropical areas really need hair care to overcome these problems[4].

The genus Elaeis belongs to the palm family (Arecaceae) which is one of the key members of an allogamous arborescent monocot group under the order Arecales [5]. In Indonesia, the palm oil industry is experiencing rapid development, especially its palm oil products. In the palm oil processing industry, only the fruit and peel are used, while other parts of the plant such as stems, midribs, and leaves are not used and will only become waste or be given to livestock, such as cattle. The part of the oil palm, especially the leaves, have benefits in wound healing, kidney disease, cancer, and cardiovascular, also several studies state that oil palm leaves have antioxidant activity [6] [7] [8].

Oil palm leaves (*Elaeis guineensis* Jacq.) is a plant that contains good antioxidants. Based on research conducted by [6], the IC_{50} value for mature oil palm leaf extract was 15.8767 µg/mL. Based on these data, it shows that the ability of mature oil palm leaves to capture free radicals is very strong. Based on research [7], palm oil leaf extract has a tyrosinase inhibitory activity of 254.88 µg/mL. Based on these data, palm leaf extract has tyrosinase inhibitory activity. Departing from these data, in this study palm leaf extract was used by looking at its antioxidant activity to be formulated into a hair tonic preparation that can protect hair from damage. Palm leaf extract has been reported to have no toxic effect for in vivo acute toxicity testing with an LD_{50} value >5000 mg/kg indicating that the oil palm leaf extract is in the low toxic category. In the in vitro toxicity test with BSLT oil palm leaf extract showed an LC_{50} value of 9,00 and 3,87 mg/mL at 6 and 24 hours of observation which showed that the oil palm leaf extract was not toxic [8]. In a study conducted by [9], it showed that palm leaf extract in vitro at concentrations of 1%, 5% and 10% did not cause irritation to the eyes and skin.

Hair care requires a variety of cosmetics such as hair conditioner, cream bath, to hair tonic. An easy way to treat dry, brittle, unruly and decolorized hair is to do a hair treatment using a hair tonic made from oil palm leaf extract (*Elaeis guineensis* Jacq.) as an antioxidant. Oil palm leaf extract was made in the form of hair tonic because in daily use, hair tonic are widely used to treat hair damage problems, with several advantages including easier application and less stickiness like semisolids form so it does not leave a thin film that can trigger hair loss, inflammation, and dandruff formation [3].

2 Materials and Methods

2.1 Preparation of Oil Palm leaves extract

Oil palm (*Elaeis guineensis* Jacq.) leaves were harvested in Sambera (Marangkayu, Kalimantan Timur) in September 2021. The plant was determined at the Dendrology and

Ecology Laboratory, Faculty of Forestry, Mulawarman University with number 41/UN17.4.08/LL/2021. Fresh oil palm leaves from mature palm were washed with running tap water and coarsely chopped and allowed to air dry without being exposed to sunlight. Those dry leaves ground into powder using a mechanical blender. The 750 grams powder of oil palm leaves was macerated with methanol (5×24 hours). Filtrate of maceration was filtered with flannel and filter paper. The macerate obtained and concentrated with a rotary evaporator at 50°C until produce a dark green waxy material or the solvent completely removed. The yield extraction was calculated as % (w/w) using the formula in equation 1.

$$\text{Yield} = \frac{\text{Mass of extract (g)}}{\text{Mass of oil palm leaves powder (g)}} \times 100\% \quad \text{(Equation 1)}$$

2.2 DPPH radical scavenging activity of oil palm leaves extract

The 4 mg of DPPH powder was dissolved in 100 mL of methanol (40 ppm). Then, the oil palm leaf extract stored at three different temperatures, at room temperatures (25°C), cold temperature (4°C), and hot temperature (50°C) was made in concentrations of 12,5 ppm, 25 ppm, 50 ppm, 100 ppm, and 200 ppm in methanolic solution; and reacted with 2 mL DPPH in vial. After 30 minutes incubation, the absorbance values of the samples were read at 516 nm using UV-Vis spectrophotometer. The absorbance of DPPH was used as a negative control. The analysis was carried out in triplicate to confirm the reproducibility of the data. That antioxidant activity, expressed as a percentage DPPH radical scavenging, calculated using equation 2. IC_{50} of the DPPH assay represents the concentration of the sample under test is required to reduce DPPH by 50% where the value is obtained linear regression graph.

$$\%\ \text{DPPH scavenging} = \frac{\text{Abs negative control} - \text{Abs sample}}{\text{Abs negative cotrol}} \times 100\% \quad \text{Equation 2}$$

2.3 Formulation of hair tonic oil palm leaves extract

In making hair tonic preparations, it is necessary to prepare the tools and materials that will be needed during the formulation process, all ingredients are weighed according to the calculation results, the hair tonic formula using [4] with slight modification can be seen in Table 1. Hair tonic preparation were made in concentration of 0 ppm, 12,5 ppm, 25 ppm, 50 ppm, 100 ppm, and 200 ppm in amount of 100 mL. The methanol extract of oil palm leaves was weighed according to the concentration of the hair tonic preparation to be made. The hair tonic was made by dissolving the extract with 10 grams of propylene glycol using sonicator until completely dissolved. Furthermore, 0,1 gram of menthol was dissolved in 15 mL of 96% ethanol. The two solutions were then mixed in a 100 mL beaker until homogenous, then added with 0,2 gram of phenoxyethanol and added distillated water until the volume of the preparation was 100 mL, strirring was carried out until the hair tonic was homogenous. After the preparation is homogenous, it can be stored in a spray bottle.

Table 1 Hair Tonic Preparation Formula

No.	Materials	Concentrations (%)					
		FHT1 (0 ppm)	FHT2 (12,5 ppm)	FHT3 (25 ppm)	FHT4 (50 ppm)	FHT5 (100 ppm)	FHT6 (200 ppm)
1.	Methanol extract of oil palm leaves	0%	0.00125%	0.0025%	0.005%	0.01%	0.02%
2.	96% of ethanol	15%	15%	15%	15%	15%	15%
3.	Menthol	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
4.	Propylene glycol	10%	10%	10%	10%	10%	10%
5.	Phenoxyethanol	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
6.	Aquadest	Ad 100 mL	Ad 100 mL	Ad 100 mL	Ad 100 mL	Ad 100 mL	Ad 100 mL

Description: ad = up to; FHT = Hair Tonic Formula; ppm = Part per million

2.4 Evaluation of hair tonic oil palm leaves extract

2.4.1 Organoleptic test

The color, odor, appearance, and homogeneity were being observed since preparations were made and during storage until 4 weeks in room temperature.

2.4.2 pH test

Measurement of the pH hair tonic using a digital pH meter. First, the pH meter was calibrated using a neutral pH and an acidic pH, then washed with distillated water and dried using tissue. The measurement of the pH value of the hair tonic is done by dipping the electrode in the hair tonic, then waiting for while until the pH meter shows a constant number. The test was triplicate, and the average pH was determined since the preparation were made until 4 weeks of storage.

2.4.3 Viscosity test

20 mL of hair tonic preparation were measured using a Rheosys viscometer with a spindle type 25 mm concentric cylinders. Used a shear rate of 12 rpm, a temperature of 25°C, and a time interval of 30 second. The test was triplicate, and the average viscosity was determined since the preparation were made until 4 weeks of storage.

2.5 DPPH radical scavenging activity of hair tonic

The 4 mg of DPPH powder was dissolved in 100 mL of methanol (40 ppm). Then, the hair tonic that contain oil palm leaf extract stored at three different temperatures, at room temperatures (25°C), cold temperature (4°C), and hot temperature (50°C) was made in concentrations of 12,5 ppm, 25 ppm, 50 ppm, 100 ppm, and 200 ppm; and reacted with 2 mL DPPH methanolic solution in vial. After 30 minutes incubation, the absorbance values of the samples were read at 516 nm using UV-Vis spectrophotometer. The absorbance of DPPH was used as a negative control. The analysis was carried out in triplicate to confirm the reproducibility of the data. That antioxidant activity, expressed as a percentage DPPH radical scavenging, calculated using equation 2. IC_{50} of the DPPH assay represents the concentration of the sample under test is required to reduce DPPH by 50% where the value is obtained linear regression graph.

2.6 Hair tonic effectiveness test

The data collection method for microscopic tests of hair tonic preparations of methanol extract of palm leaves (*Elaeis guineensis* Jacq.) is done by soaking the hair with the preparation for a certain time, then exposing it to a radiation source. In this test, the first step was to prepare several strands of hair that had been removed from the scalp and then cut 1 cm in length by 18 strands, which were divided into 6 groups. There were groups without hair tonic preparations, groups given hair tonic preparations without extracts, and groups given 25 ppm, 50 ppm, 100 ppm, 200 ppm hair tonic preparations. Next, the strands of hair were placed on an object glass and dripped with immersion oil and then observed under a microscope at 100× magnification, the results were documented in the form of an image. After all groups were observed, the hair strands were soaked in 5 mL of the preparation in a beaker for 30 minutes, then removed and placed on a flat mat marked, and exposed to sunlight for 3 hours. After 3 hours, the hair strands were again observed for their condition to see the changes that occurred using a microscope at a magnification of 100× and documented in the form of images.

2.7 Statictical analysis

All experiments were carried out in triplicate the results are given as mean and standard deviation.

3 Result and Discussion

3.1 Extraction of Oil Palm Leaves (Elaeis guineensis Jacq.)

The maceration method was chosen because it is effective for compound could degraded by heat, inexpensive, the equipment used is relatively simple, and easily available [10]. The principle of the maceration method is soaking, so that the liquid will penetrate the cell wall and enter the cell cavity containing the

active compound and the active compound will dissolve.

Methanol can damage the cell walls of the simplicia so that polar and non-polar compounds can be dissolved in methanol. Previous study reported that oil palm leaves extract contains phytochemical compounds such as flavonoid, phenolic, tannin which may contribute to its antioxidant activity. Methanol is the solvent with a high level of polarity, so that the polar compounds such a flavonoid will be extracted in methanol [11].

The organoleptic product of oil palm leaf extract is a thick, dark green waxy mass, with a distinctive odor of oil palm leaves. The yield of oil palm leaf methanol extract was 10.31%. In previous study yield of oil palm leaf methanol extract was 8.28% [11]. The yield obtained was higher than the previous research, this was due to the sampling with different geographical conditions, length of maceration time, and lack of stirring frequency during the extraction process.

3.2 DPPH Radical Scavenging Activity of Oil Palm Leaves Extract

DPPH radical scavenging activity of oil palm leaves extract is testing the antioxidant activity of the extract was carried out to determine the activity of the methanol extract in reducing free radicals. Preliminary tests were used to determine the antioxidant activity of the methanol extract of oil palm leaves. A compound is said to have very strong antioxidant activity when it has an IC_{50} value of less than 50 µg/mL, strong if the IC_{50} value is 50-100 µg/mL, moderate if the IC_{50} value is 100-250 µg/mL, weak if the IC50 value is 250-500 µg/mL mL and is inactive if the IC_{50} value is more than 500 µg/mL [12].

In this study the antioxidant test was carried out using the DDPH (2,2-diphenyl-1-pikrizylhidrazyl) radical scavenging method, because this method requires a relatively short analysis time, is inexpensive, and is easy to perform, so many are chosen to measure the ability of compounds to scavenge free radicals or donate hydrogen. The DPPH radical scavenging method enables reactions with almost all types of antioxidants due to the stability of the DPPH structure [13].

Based on the antioxidant activity test that was carried out on the methanol extract of oil palm leaves, the IC_{50} value of the extract stored at room temperature 25°C showed an average value of 28.98176 ± 8.118 ppm which was included in the very strong antioxidant group. Methanol extract of oil palm leaves at 50°C heat storage showed antioxidant activity with an average IC_{50} value of 34.42167 ± 9.267 ppm which can be categorized as very strong antioxidant activity. Methanol extract of oil palm leaves at 4°C cold storage showed antioxidant activity with an average IC_{50} value of 28.19002 ± 11.529 ppm which can be categorized as very strong antioxidant activity. The high antioxidant activity of palm leaf extract is influenced by the content of phenolic compounds which work to scavenge free radicals through the mechanism of transferring hydrogen atoms to the hydroxyl group on the phenol ring. In accordance with previous studies, the content of phenolic compounds in the methanol extract of coconut leaves has a value of 24.3 mg GAE/gram, which indicates a higher value than the total phenolic content of green tea of 22.5 mg GAE/gram [7] and based on research [14] showed total flavonoids of oil palm leaf extract of 136.6896 ± 0.3106 mg QCE/gram extract with an IC50 value of 15.8767± 2.8610 µg/mL.

The IC_{50} stability value of the extract can be seen in table 2, which shows that temperature and storage time have an effect on antioxidant activity. The instability of the antioxidant activity of the extract can also be affected by the activity of the compounds contained in the extract which can react optimally at different optimum temperatures. Although less stable, the antioxidant activity of the methanol extract of palm leaves is in the antioxidant group with very strong activity.

Table 2 Antioxidant Stability of Oil Palm Leaf Extract

Days to-	IC_{50} (ppm)			Category
	Room (25°C)	Heat (50°C)	Cold (4°C)	
0	38.35	38.35	38.35	Very strong activity [12]
3	18.61	28.16	36.22	
6	29.06	37.37	10.51	
9	35.27	45.94	32.98	
12	23.62	22.28	22.89	
Average	28.98176±8.118	34.42167±9.267	28.19002±11.529	

Description: IC_{50} = 50 % Inhibition concentration

3.3 Formulation of Hair Tonic Oil Palm Leaves Extract

The hair tonic formula used in the study refers to the research results of [15] with the evaluation results and physical stability of stable hair tonic preparations. The selected additional ingredients in the manufacture of hair tonic have a function, namely 96% ethanol as a solvent and penetration enhancer with a concentration of use in cosmetic preparations not more than 30%, propylene glycol is used to dissolve extracts, humectants and affect the viscosity of preparations with a concentration of 5-80 %, menthol as a penetration enhancer in the skin and a cooling sensation with a concentration of 0.05-10% for topical preparations, phenoxyethanol as a preservative with a concentration for use in cosmetic preparations of 0.5-1% and distilled water as a solvent [16].

3.4 Evaluation of Hair Tonic Oil Palm Leaves Extract

3.4.1 Organoleptic Test

Organoleptic test of hair tonic preparations of methanol extract of oil palm leaves includes color, scent, appearance, and homogeneity. The results of the organoleptic test observations can be seen in table 3. The results showed that hair tonic preparations from FHT1, FHT2, FHT3, FHT4, FHT5, and FHT6 did not change color, aroma, and appearance. It can be noted that as the concentration of palm oil leaf extract in the preparation increases, the color of the preparation becomes darker. Shows that the concentration of the extract can affect the appearance of hair tonic preparations. The scent of hair tonic preparations is affected by the addition of menthol, so that apart from giving a cold sensation, menthol can improve the scent of the preparation. The organoleptic test results of the hair tonic preparation showed that the preparation was very good, because during storage the preparation did not produce a rancid aroma, rough texture, and unattractive color of the preparation [17].

Homogeneity test of hair tonic preparations of methanol extract oil palm leaves was carried out by observing the particles that were not dissolved in the preparation. The results of the homogeneity test observations can be seen in table 3. The results showed that hair tonic preparations from FHT1, FHT2, FHT3, FHT4, FHT5, and FHT6 were homogeneous, characterized by the absence of coarse particles of the active substance or additives that were not dissolved in the preparation [17].

Table 3 Organoleptic Test of Hair Tonic Oil Palm Leaves Extract

Organoleptic	Formula					
	FHT1 (0 ppm)	FHT2 (12,5 ppm)	FHT3 (25 ppm)	FHT4 (50 ppm)	FHT5 (100 ppm)	FHT6 (200 ppm)
Color	Colorless	Slightly green	Light green	Yellowish green	Slightly dark green	Dark green
Scent	Menthol scent	Menthol scent	Menthol scent	Menthol scent	Menthol scent	Menthol scent
Appearance	Clear solution	Clear solution	Clear solution	Clear solution	Clear solution	Clear solution
Homogeneity	Homogenous	Homogenous	Homogenous	Homogenous	Homogenous	Homogenous

Description: FHT = Hair Tonic Formulation

3.4.2 pH Test

The pH test aims to determine which hair tonic preparations have been made safe and do not cause irritation when used. The surface of the scalp and hair has a pH that tends to be acidic, which is called an acid mantle. Acid mantle is the outermost layer of the skin which plays a role in providing protection [18]. When the pH is too alkaline, or too acidic, the skin's protective layer will be disrupted and cause certain skin conditions and trigger irritation [19]. The pH of hair tonic preparations test was carried out using a digital pH meter. The results of the preparation's pH test can be seen in table 6.5. The results showed that the pH values varied and experienced increases and decreases during storage. However, the results of the study showed that the pH of hair tonic preparations from FHT1, FHT2, FHT3, FHT4, FHT5, and FHT6 from day 0 of storage to week

4 met the good range of pH preparations based on SNI, namely 3.0-7.0 [20]. If the pH is too acidic it can cause skin irritation and if the pH is too alkaline it can cause dry scaly skin.

Good homogeneity of the preparation is indicated by the absence of coarse particles of the active substance or additives used. So that in the formulation of the pH of the preparation is very important to note. It can be seen based on the results of the study, that the pH of the preparation increased as the concentration of the extract in the preparation increased, this was influenced by the acidic nature of the extract. So that the higher the concentration of the extract in the formula, the more acidic the pH of the preparation.

Table 4 pH of Hair Tonic

Formula	pH Average (week)					Parameter
	Week 0	Week 1	Week 2	Week 3	Week 4	
FHT1	7±0	7±0	6.99±0.01	6.97±0.04	6.96±0.05	Based on SNI, the pH of hair tonic preparations ranges from 3.0 to 7.0 [20]
FHT2	6.89±0.02	6.7±0.04	6.76±0.03	6.85±0.02	6.72±0.005	
FHT3	6.7±0.03	6.45±0.09	6.61±0.04	6.7±0.03	6.77±0.03	
FHT4	6.65±0.03	6.51±0.02	6.55±0.05	6.65±0.01	6.65±0.03	
FHT5	6.62±0.005	6.43±0.03	6.43±0.03	6.62±0.01	6.53±0.04	
FHT6	6.56±0.01	6.42±0.03	6.41±0.02	6.57±0.02	6.41±0.01	

Description: FHT = Hair Tonic Formulation

Table 5 Viscosity of Hair Tonic

Formula	Viscosity (cPs) Average (week)					Parameter
	Week 0	Week 1	Week 2	Week 3	Week 4	
FHT1	4.08±0.01	3.97±0.08	3.91±0	4.01±0.2	4.01±0.2	Based on SNI, the viscosity of hair tonic is <5 cPs [20]
FHT2	3.97±0.03	4.01±0.02	4.14±0	3.84±0.1	3.84±0.1	
FHT3	3.77±0.09	4.01±0.04	3.79±0	3.86±0.1	3.77±0.08	
FHT4	3.94±0.05	4.07±0.04	3.77±0	3.97±0.02	3.97±0.02	
FHT5	3.8±0.03	4.07±0.01	3.94±0	4.08±0.05	4.08±0.05	
FHT6	3.67±0.03	4.03±0.005	3.79±0	4.01±0.05	4.01±0.05	

Description: FHT = Hair Tonic Formulation; cPs = Centipoise

3.4.3 Viscosity Test

Viscosity testing of hair tonic preparations was carried out using a rheosys viscometer. The results showed that the viscosity values varied and experienced increases and decreases with storage time. However, the results of the study showed that the viscosity of hair tonic preparations from FHT1, FHT2, FHT3, FHT4, FHT5, and FHT6 from day 0 of storage to week 4 met the good viscosity range based on SNI, namely <5cPs [20]. Viscosity changes that occur due to possible interactions between additives and active substances, as well as temperature instability during storage.

3.5 DPPH Radical Scavenging Activity of Hair Tonic Oil Palm Leaves Extract

Determination of the antioxidant activity of the hair tonic preparation of methanol extract of palm leaves obtained the IC_{50} value of the extract stored at room temperature 25°C showing an average value of 37.2519 ± 8.535 ppm which is included in the very strong antioxidant group. Methanol extract of palm leaves at 50°C heat storage showed antioxidant activity with an average IC_{50} value of 40.5459 ± 9.086 ppm which can be categorized in preparations with very strong antioxidant activity. Methanol extract of oil palm leaves at 4°C cold storage showed antioxidant activity with an average IC50 value of 36.8257 ± 6.928 ppm which can be categorized in preparations with very strong antioxidant activity. When compared with the antioxidant activity of the extract, the IC_{50} value of the hair tonic preparation has decreased. This decrease in activity can occur due to the effect or interaction of the extract with the carrier used in the formulation.

Hair tonic preparations also have antioxidant activity which is unstable affected by temperature and storage time. Stability data for hair tonic preparations of oil palm leaf extract can be seen in table 6. This can happen because the flavonoid compounds are unstable at certain temperature conditions, but the antioxidant activity of the hair tonic still shows activity that is included in the very strong category, which is less than 50 ppm [12]. Shows that the flavonoid compounds of methanol extract of oil palm leaves can be formulated in a hair tonic base.

Hair tonic preparations of oil palm leaf extract experienced an increase in IC_{50} value, when compared with the IC_{50} value of oil palm leaf extract, indicating that oil palm leaf extract in hair tonic preparations experienced a increase in DPPH inhibitory activity. This increasing shown that the antioxidant activity of hair tonic lower than the extract could be due to the fact that the hair tonic base was not given the addition of other antioxidants, so that the antioxidant compounds in the palm leaf extract

(*Elaeis guineensis* Jacq.) would be reduced to stabilize the free radicals present in the hair tonic base. The reason for not adding other antioxidant compounds to the hair tonic preparation was that there was no mistake in determining the antioxidant activity in the preparation.

Table 6 Antioxidant Stability of Hair Tonic Preparations

Days to-	IC50 (ppm)			Category
	Room (25°C)	Heat (50°C)	Cold (4°C)	
0	39.58	39.58	39.58	Very strong activity [12]
3	35.5	41.6	41.26	
6	45.85	44.74	32.61	
9	41.8	50.68	43.69	
12	23.53	26.13	26.88	
Average	37.2519±8.535	40.5459±9.086	36.8257±6.928	

Description: IC50 = 50 % Inhibition concentration

3.6 Hair Tonic of Oil Palm Leaves Extract Effectiveness Test

Research on the effectiveness of hair in preventing hair decolorization was carried out in vitro. Strands of hair given 25 ppm; 50 ppm; 100 ppm; and 200 ppm indicates dark pigment melanin. Meanwhile, strands of hair that were not given the preparation and strands that were given the preparation with a concentration of 0 ppm showed color pigments that looked bright or blonde. This could occur because the hair was decolorized due to the degraded melanin in the hair due to free radicals from exposure to sunlight. This shows that the antioxidants contained in the hair tonic preparation of methanol extract of oil palm leaves are effective in protecting hair by preventing damage to the melanin pigment due to exposure to sunlight which has an ultraviolet component [2]. Flavonoid compounds found in oil palm leaf extract act as antioxidants by reducing free radicals, so that free radicals do not attack the melanin pigment in hair [21].

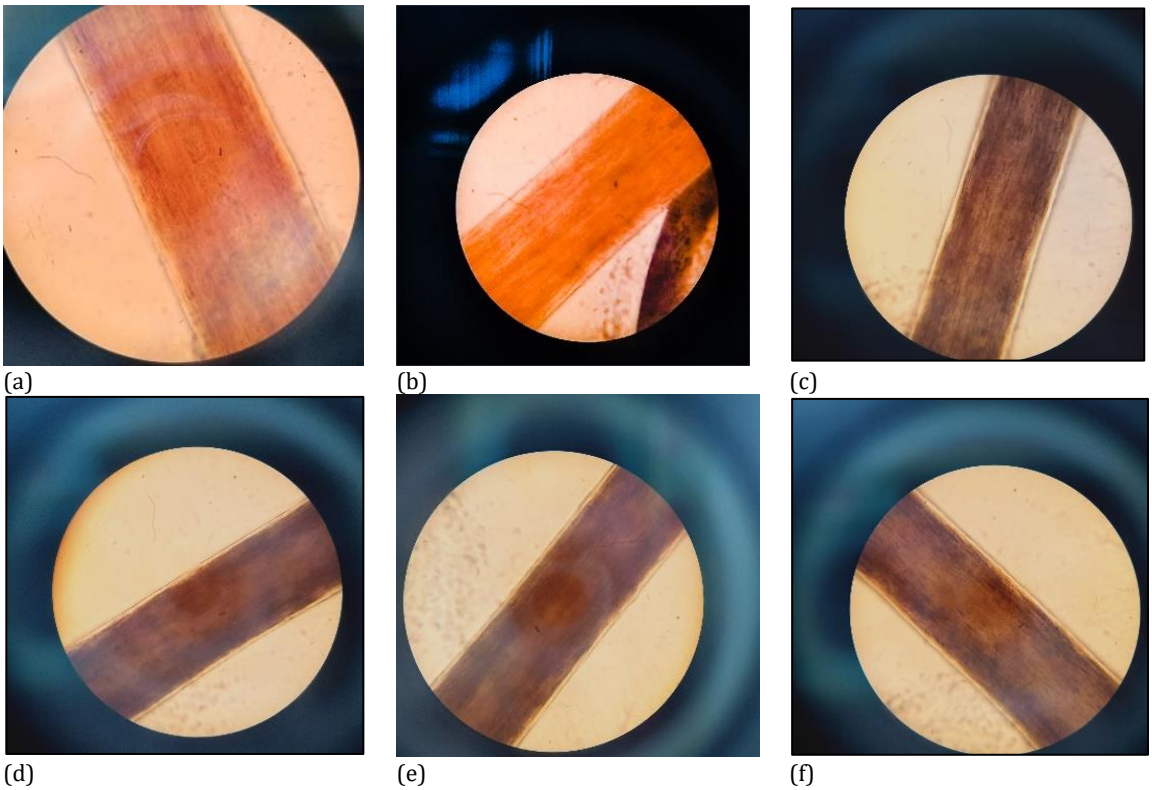

Figure 1 Microscopic observation of hair with a magnification of 100× (a) Without preparation; (b) 0 ppm; (c) 25 ppm; (d) 50 ppm; (e) 100 ppm; (f) 200 ppm

The mechanism of antioxidants in hair is to protect the hair keratin which causes the hair structure to be damaged, prevents the process of degradation of integral lipids in the hair fiber which causes weakening of the cell membranes in the hair so that the hair becomes brittle and causes hair loss, prevents oxidation of melanin which causes hair whitening, protects and repair damage by neutralizing free radicals and slowing lipid oxidation as a continuous diffusion pathway in the hair fiber, so that dehydration does not occur in the hair strands [2] [22].

4 Conclusions

Based on the research that has been done, oil palm leaf extract (*Elaeis guineensis* Jacq.) can be formulated in the form of hair tonic preparations that organoleptically stable. Oil palm leaf extract (*Elaeis guineensis* Jacq.) at concentrations 25 ppm, 50 ppm, 100 ppm, 200 ppm can prevent hair decolorization due to sun exposure, but the most effective concentration in prevent hair decolorization in 200 ppm.

5 Conflicts of Interest

The authors declare no conflict of interest.

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