Utilization of Nyamplung Oil as an Active Ingredient in an Antioxidant Facial Clay Mask

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Received: April-15-2025; Accepted: December-15-2025; Published: December-30-2025

Abstract

Nyamplung oil has active components that are beneficial to skin health due to its high antioxidant content. Nyamplung oil serves as an active element in clay masks. This study uses nyamplung oil, which is high in antioxidants, to harness the renewing and skin regenerating qualities of this natural component. The study involved creating a clay mask with various concentrations of nyamplung oil (4%, 6%, 8%) and xanthan gum (0.6% and 0.8%), and then analyzing its antioxidant activity. The clay mask formulated with 6% nyamplung oil and 0.8% xanthan gum demonstrated strong antioxidant activity (IC_{50} = 88.29), with a drying time of 5.6 minutes, a pH of 5.56, and a viscosity of 92.2 cP. Conclusion: The results demonstrate that nyamplung oil is a potent natural antioxidant suitable for cosmetic applications. The clay mask formulation with 6% nyamplung oil and 0.8% xanthan gum showed excellent physicochemical properties and very strong antioxidant activity, indicating its potential as an effective facial skin care product.

Keywords: *antioxidant; clay mask; nyamplung oil; skin; health*

1. INTRODUCTION

Nyamplung plant *(Calophyllum inophyllum)* is a plant that grows well in sandy or coastal areas with a pH of 4 - 7.4. The potential for nyamplung based on its standing area reaches 480.000 ha, with an area of 255.300 ha which is spread from Sumatra to Papua (Syakir and Karmawati, 2013). Nyamplung seed kernels contain 75% oil and 71% unsaturated fatty acids. Nyamplung oil can be obtained by mechanical extraction or chemical extraction (Heriyanto et al., 2011; Leksono et al., 2014). The oil from the nyamplung plant is thick, greenish brown in color, and has a strong scent akin to caramel (Leksono et al., 2014). Windyarini et al. (2018) reported that nyamplung oil contains 35.75% oleic acid, 29.05% linoleic acid, 17.95% stearic acid, and 15.17% palmitic acid. According to the test results for its phytochemical components, nyamplung oil contains steroid, flavonoid, saponin, and triterpenoid components. The liquid fraction comprises steroids, flavonoids, and saponins, but the solid fraction contains just flavonoids. Nyamplung oil inhibits *Staphylococcus aureus* with a diameter of 6.75 mm. Nyamplung oil or tamanu oil contains 41-52% saturated fatty acids, including 25-35% stearic acid, 16.5 ± 1.59% palmitic acid, and 18-22% unsaturated fatty acids (Liu et al., 2015). According to studies Amelia et al. (2024) nyamplung oil is very vulnerable to *Propionibacterium acnes* bacteria and contains terpenoids, quinones, flavonoids, phenols, and steroids. Nyamplung oil includes hymecromone, a derivative of coumarin. Nyamplung has an antioxidant type of fenol.

Although nyamplung oil contains active ingredients such as coumarin and hymecromone that are beneficial for skin health, their specific mechanisms have not been fully explained. These chemicals coumarin and hymecromone, have the potential to significantly boost the added value of nyamplung oil itself. Nyamplung oil has the potential to be a highly profitable cosmetic ingredient if used properly. One example is the presence of *Propionibacterium acnes*, which can be employed as the primary ingredient in clay mask products. With additional study and development, the potential of the active ingredients in nyamplung oil can be completely realized, resulting in more effective and high-quality skin care products. The presence of *Propionibacterium acnes* in nyamplung oil suggests that it could be employed as a clay mask product in the cosmetics business.

Clay masks are commonly formulated with ingredients such as bentonite and kaolin. These masks offer numerous benefits for the skin, including removing dirt and impurities, effectively cleansing the skin, and providing protection against the sun's rays (Fadhilah et al. 2022). Using facial masks can also help reduce the amount of UV light that reaches the skin. Premature aging is caused by frequent excessive activity under the sun, with UV rays causing the formation of free radicals. Nyamplung oil has a high antioxidant content, making it suitable for use as a cosmetic active ingredient, namely in clay masks.

Antioxidants are chemicals that can stabilize free radicals. Antioxidants compensate the deficiency of electrons caused by free radical exposure, avoiding chain reactions. As a result, skin care products, especially anti-aging solutions, rely heavily on antioxidants to protect the skin from free radical damage (Lushaini et al., 2015; Rumagit et al., 2015). Antioxidants can be obtained from nyamplung, which is known to have high antioxidant activity. Because of the high antioxidant content of the clay, it has the potential to be used as a clay mask product. According to Safrina et al. (2020) found that nyamplung oil had an IC_{50} of 1.28-24.18 µg/mL. High antioxidants will help facial skin care in rejuvenating the skin. Skin irritation will occur if the mask continues to produce a stinging effect after it has been removed. This sensation stimulates skin movement, with clay masks capable of reducing dirt and blackheads when removed from the face. The effect of using a mask is that the skin becomes smoother and more radiant.

The objective of this research is to develop a clay-based facial mask formulation containing nyamplung oil as a natural antioxidant active ingredient. Specifically, this study aims to assess the antioxidant activity of the formulation and its potential efficacy in protecting facial skin against oxidative damage. Nyamplung oil in clay mask formulations for skin treatment has various hurdles, but it also presents an appealing competitive niche in the skin care business. Key problems include stable product formulation, component compatibility, and the efficacy and safety of nyamplung oil for skin, all of which necessitate comprehensive clinical and allergy research. Furthermore, regulatory compliance and product certification are both time-consuming and expensive challenges. On the other side, the competitive landscape creates chances for distinctive product creation, particularly given the growing customer preference for natural and ecologically friendly components. Product differentiation through branding, as well as customer education on the specific benefits of nyamplung oil, are effective marketing methods. However, competing with established conventional items and maintaining competitive pricing present additional hurdles. Opportunities for additional research and development, as well as suitable market segmentation, present enormous growth opportunities. With the appropriate strategy, nyamplung oil can emerge as a standout innovation ingredient in the skin care business.

2. MATERIAL AND METHODS

2.1 Materials

The materials used in this study included nyamplung oil, cosmetic-grade bentonite clay, cosmetic-grade kaolin clay, food-grade xanthan gum (Fufeng), vegetable glycerin, food-grade titanium dioxide, sodium lauryl sulfate, distilled water, and fragrance.

2.2 Tools

The instruments used in this study included Pyrex glassware, a digital pH meter (TS), digital scales (DJ303A), a Brookfield viscometer, and an acid chamber

2.3 Method

The formulation of the clay mask in this study involved incorporating varying concentrations of nyamplung oil (4%, 6%, and 8%) and xanthan gum (0.6% and 0.8%), followed by an evaluation of the antioxidant activity of each formulation. The formulation clay mask is shown in Table 1.

Table 1. Formulation of clay mask

Material	(%)					
	A1	A2	A3	A4	A5	A6
Nyamplung oil	4	6	8	4	6	8
Bentonit	1	1	1	1	1	1
Xanthan gum	0.6	0.6	0.6	0.8	0.8	0.8
Kaolin	34	34	34	34	34	34
Gliserin	2	2	2	2	2	2
Sodium Lauryl Sulphate	1	1	1	1	1	1
TiO_2	0.5	0.5	0.5	0.5	0.5	0.5
Fragrance	10	10	10	10	10	10
Aquadest	100	100	100	100	100	100

Table 1 presents the ingredients used to formulate the clay mask. The important ingredients to made clay mask are bentonite, xanthan gum, glycerin, and active ingredients. Table 1 presents the six clay mask formulations developed in this study. Each formulation varied in the concentration of nyamplung oil (4%, 6%, and 8%) and xanthan gum (0.6% and 0.8%), while the other components such as bentonite, kaolin, glycerin, sodium lauryl sulfate, titanium dioxide, fragrance, and distilled water were kept constant. These variations were intended to determine the optimal composition for antioxidant activity and desirable physicochemical properties of the clay mask.

Bentonite is left wet, then xanthan gum is added and briskly mixed until completely dissolved. Kaolin is added gradually while stirring, followed by TiO_2 and glycerin, which are mixed until homogeneous (Solution A), then sodium lauryl sulfate is dissolved in distilled water (Solution B). Solutions A and B are slowly put into the mortar while stirring, followed by nyamplung oil. To evaluate the quality and performance of the clay mask formulations, several tests were conducted, including pH measurement, viscosity analysis, homogeneity assessment, spreadability test, drying time measurement, and antioxidant activity analysis using the DPPH method. These tests were used to determine the optimal formulation with desirable physicochemical characteristics and strong antioxidant potential. The analysis method for this research is:

a. pH

The pH test is used to determine whether the product has skin-acceptable properties. This needs to be considered because the skin is extremely sensitive to pH levels. The formulation's pH is determined by diluting a 0.5 gram Clay Mask sample in 50 mL of distilled water. The diluted sample is then measured with a pH meter.

b. Viscosity

A viscosity test is performed to determine whether the clay mask formulation produced can match the required specifications. The obtained viscosity value will influence the spreadability. The viscosity test is performed using a Brookfield viscometer with spindle number 4.

c. Homogeneity Test

The homogeneity test is performed by weighing 0.5 grams of formulation, placing it on a glass object, and covering it with a glass object cover. Homogeneity is observed by determining if the formulation is homogeneous or not. The formulation is considered homogenous if the particles are evenly dispersed, the color is consistent, and there are no lumps.

d. Spreadly Test

The spreadability test determines if the formulation can be applied equally to the face or not. This can be accomplished by weighing 1 gram of the formulation, depositing it on a glass plate, applying a load of 100 grams for 1 minute, and measuring the diameter of the mask that is distributed.

e. Drying Time Test

The drying time test involves applying 1 gram to the skin's surface and then calculating the rate at which the formulation is applied till it dries. The resulting time represents the rate at which the formulation dries. A good formulation drying time is between 15 and 30 minutes.

f. Antioxidant Test

Using the DPPH technique, an antioxidant activity test was performed. 5 mg of DPPH crystals were dissolved in 50 mL (1000 ppm) to perform the DPPH technique. After diluting the sample to achieve concentrations of 100, 80, 60, 40, and 20 ppm, 2 mL of DPPH solution was added, and the mixture was incubated for 30 minutes. The effectiveness of radical scavenging is shown by the degree of color reduction in the solution. After 30 minutes of incubation, absorbance was measured using a spectrophotometer set to 517 nm wavelength. The degree of color change in the solution shows how well the radicals were absorbed. Free radical scavenging activity was calculated as the percentage reduction in DPPH coloration using the following equation.

$$\% \text{ DPPH} = \frac{A - A_0}{A_0} \times 100\%$$

Description:
A_0 = absorbance of the negative control/absorbance of the DPPH solution without sample
A = absorbance of the sample.

The IC_{50} value was obtained using the linear regression equation, in which the y-value was set at 50, resulting in the following equation

$$X = \frac{50-b}{a}$$

3. RESULTS AND DISCUSSION

According to Amelia et al (2024) nyamplung oil has potential for ingredient cosmetics because effective as an antibacterial *Propionibacterium acnes* and has coumarin as an antioxidant (Amelia et al. 2024). The clay masks contain substances like bentonite and kaolin. Clay masks provide various skin benefits, including the ability to absorb oil, help with acne and blackheads, moisturize the skin nicely, and protect the skin from sun exposure. UV radiation can cause premature aging, thus using beauty masks can help prevent it. Premature aging is induced by excessive sun exposure, which produces free radicals. Nyamplung oil has highly strong antioxidants, thus it can be employed as an active cosmetic ingredient. The figure of the clay mask in this research is shown in Figure 1.

Figure 1. Clay mask with nyamplung oil

Clay mask characterisation was carried out to discover the material's basic components. In this study, pH, viscosity, homogeneity, spreadability, drying time, and antioxidant tests were performed to determine the optimal treatment. This characterisation is a critical foundation for developing an efficient product handling strategy that takes into consideration the chemical composition.

a. pH

According to study, the pH of a clay mask containing the active component nyamplung oil ranges between 5.5 and 5.8. The pH value obtained does not differ much between treatments. Figure 2 shows a graph of the test findings.

According to the study's findings, the pH value of the clay mask containing the active component nyamplung oil was consistent with the skin pH, which ranged between 5.5 and 5.8. The findings of this study are consistent with (Wananggari dan Oktavilantika 2024) research on clay masks with pandan leaf extract ranging from 4.5 to 6.5. This is consistent with the skin pH range of 4.5 to 7, implying that nyamplung oil preparations can be used in cosmetics (Liu et al. 2012). Normal human skin has a pH range of 4.5–6.5. An excessively high or low pH value can lead to skin dryness.

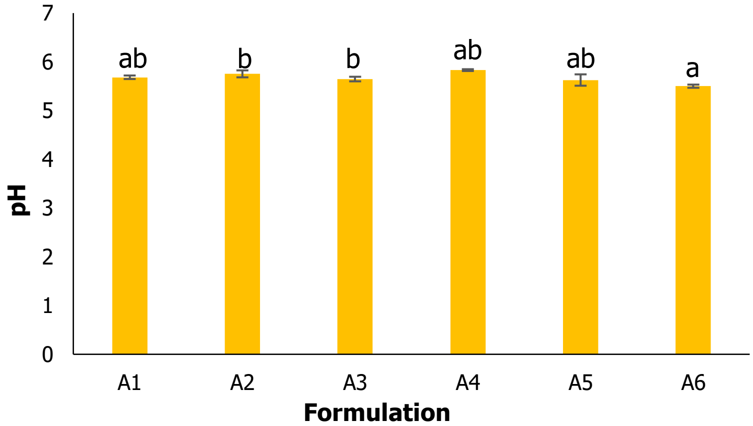

Figure 2. pH of clay mask with nyamplung oil

b. Spread

The study's findings indicated that the spreadability of clay masks based on nyamplung oil ranged from 3.63 to 3.76. Figure 3 displays the findings of the investigation. Good spreadability requires a distance of 2 to 5 cm (Santoso et al. 2018). Every formula satisfies the criteria for acceptable spreadability of clay mask preparations, according to the figure of the spreadability test results. The concentration in each formulation is the cause of the variations that arise. Each formulation's spreadability fluctuates while being different ingredients. This happens as different ingredients nyamplung oil. Because oil softens the texture of the mask by acting as an emollient. which impacts each formula's spreadability. The result is shown in Figure 3.

The results of this study are in line with (Fadhilah et al. 2022) the spreadability of clay masks produced from mangosteen peel extraction fluctuated, which is because the differences that occur in each formula occur due to the concentration of mangosteen peel extract in each formula. During storage, the spreadability of each formula increased and decreased. This occurs due to changes in temperature and humidity during storage which affect the spreadability of each formula.

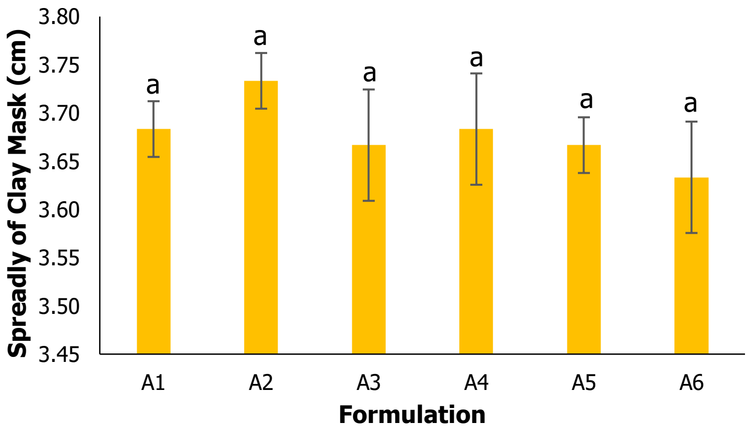

Figure 3. Spreadly clay mask with nyamplung oil

c. Viscosity

The viscosity value requirements for mask preparations are 4000 - 40000 cPs (Syamsidi et al. 2021). The result of viscosity in Figure 4.

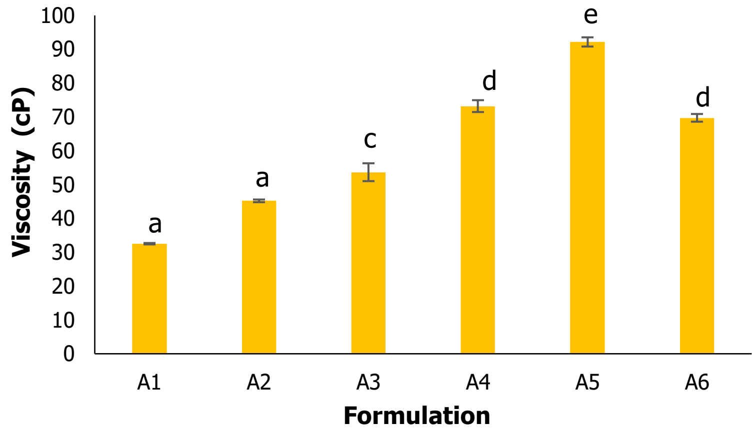

Figure 4. Viscosity clay mask nyamplung oil

The resulting mask's spreadability is also influenced by the viscosity value. An ideal clay mask should be easy to spread but should not readily disappear during use since mask preparations with high viscosity will be difficult to spread and mask preparations with low viscosity will be easily lost during use. The final product has a viscosity value between 32.53 to 92.17 cP. With the exception of treatments A4 and A6, where there was no discernible variation, the viscosity generated in this investigation varied greatly. The clay mask's spreadability may have an impact on this.

d. Adhesive

The overall adhesion at 30 minutes was determined by the adhesion test results. In contrast to the study conducted by (Zainal et al. 2023), which yielded an average adhesion of 0.77–4.81 seconds, this adhesion is quite high. The result of adding more kaolin basis is a clay mask that is tight and sticky; conversely, adding less kaolin base results in a clay mask that is less robust. The large weight pulling the glass plate has an impact on this as well. The adhesion strength increases with the applied load, as a heavier load makes it easier to separate the glass plates. According to (Dipahayu et al. 2021) he range of good adhesion is greater than one second. The results of the adhesion test are presented in Figure 5.

The adhesion test aims to determine how long it takes for the preparation to attach to the skin. According to (Pratimasari et al. 2015), topical treatments must adhere for at least four seconds. Accordingly, the clay mask used in this investigation satisfied the requirements for mask adhesion. The result adhesive clay mask nyamplung oil is shown in Figure 5.

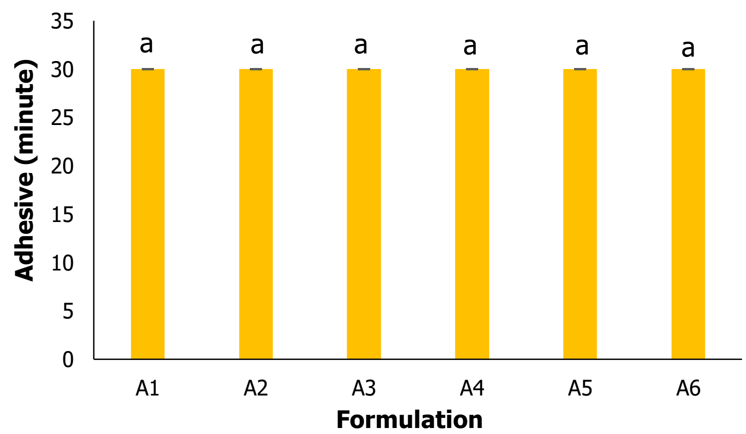

Figure 5. Adhesiveness Profile of Clay Mask Formulations

e. Drying Time

The drying time of the nyamplung oil-based clay mask ranged from 5.4 to 6.5 minutes. Based on the test results, sample A5 was significantly different from other samples; treatment A5 had a drying time of 5.4 minutes faster than the drying time of other treatments. The results of the drying time test can be seen in Figure 6.

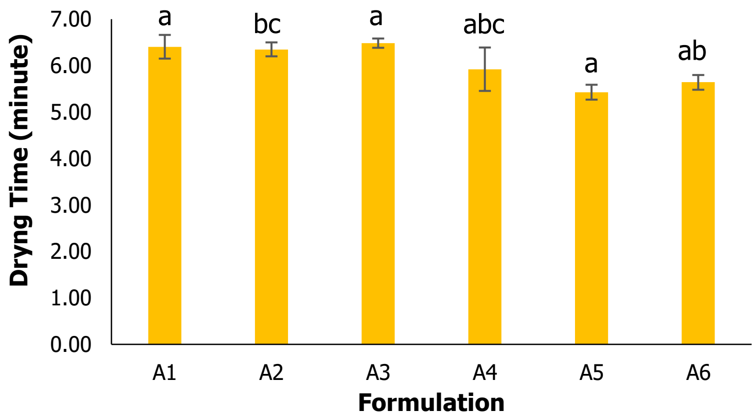

Figure 6. Drying Time Profile of Clay Mask Formulations

The drying time did not meet the standard range for clay masks. According to Sari et al. (2024) the good drying time for a clay mask is between 10-25 minutes. In this study, the drying time for the clay mask was faster than the specified standard, which was influenced by the viscosity of the clay mask produced. According to Indriastuti et al. (2022) thicker preparations can speed up the drying time of a mask, which dries quickly, can speed up the peeling time, and the active substances delivered are not optimal.

f. Antioxidant

Antioxidant testing was performed on the best sample based on viscosity and drying time on sample A5. This is because drying with a shorter time can maintain antioxidants better (Muñoz-López et al. 2018). Antioxidant activity was tested at concentrations of 20, 40, 60, and 80 ppm. The nyamplung oil antioxidant test was carried out using the DPPH method. The antioxidant absorbance of the nyamplung clay mask shows a strong concentration-dependent increase, indicating that higher sample concentrations produce higher antioxidant activity. As the concentration rises from approximately 20 to 80 (units not specified), the absorbance increases consistently from around 13 to 46. The IC_{50} value represents the concentration of the sample required to inhibit 50% of free radicals. To determine the IC_{50} from the linear regression equation obtained in the antioxidant assay, the equation $y = 0.551x + 1.35$ was used, where y represents absorbance and x represents sample concentration. The IC_{50} value is the concentration of the test compound that can reduce free radicals by 50 %. A compound is declared to have very strong antioxidant activity if the IC_{50} value is <10 μg/ mL, strong if the IC_{50} value is between 50 and 100 μg/mL, weak if the IC_{50} value is between 100 and 250 μg/mL, and inactive if the IC_{50} value is above 250 μg/mL (Phongpaichit et al. 2007). The IC_{50} value obtained in this investigation is in the high range of 88,29. Indicating that it is a strong antioxidant is a powerful antioxidant. Figure 7 shows the findings of the IC_{50} analysis.

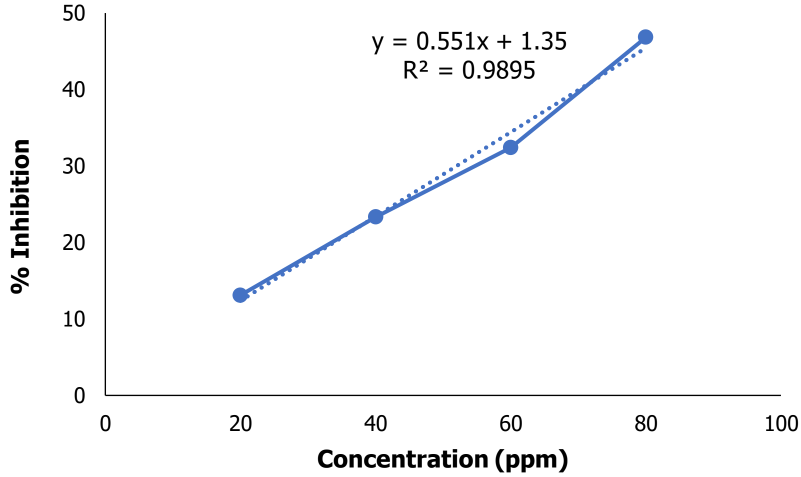

Figure 7. Antioxidant Activity of Clay Mask Formulations

4. CONCLUSIONS

The clay mask formulation containing 6% nyamplung oil and 0.8% xanthan gum (A5 treatment) demonstrated strong antioxidant activity with an IC_{50} value of 88,29. The product exhibited a relatively fast drying time of 5.6 minutes and had a skin-friendly pH of 5.56. In addition, its viscosity of 92.17 cP indicated a stable consistency and ease of application.

ACKNOWLEDGEMENT

Thank you to the Sumatra Institute of Technology for providing research grants. The authors also extend their appreciation to the supporting institution for granting access to laboratory facilities and other research infrastructure throughout the research.

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