Jurnal Pembelajaran Dan Biologi Nukleus p-ISSN: 2442-9481
Vol 10 (3): 809-819, November 2024 e-ISSN: 2685-7332

Clay Mask Formulation of Coconut Dregs and Virgin Coconut Oil as an Antibacterial Against *Propionibacterium acnes*

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Submitted July 21Th 2024 and Accepted October 11Th 2024

Abstract

Beauty and healthy skin as well as skin problems such as acne are challenges for the pharmaceutical sector in innovating to produce clay mask cosmetic products made from coconut dregs. Apart from maintaining healthy skin, coconut dregs clay mask products also maintain environmental health. Galactomannan contained in coconut dregs acts as a thickener, stabilizer, emulsifier and additive. The lauric acid contained in VCO acts as an antibacterial, antiviral and antiprotozoal. The combination of coconut dregs and VCO in a clay mask is more optimal as a cosmetic product. The aim of the research is to utilize coconut dregs waste into pharmaceutical products, produce a clay mask made from coconut dregs with a combination of VCO which has the potential to act as an antibacterial and produce a clay mask product that is effective as an anti-acne. The method was carried out by preparing coconut dregs flour, making various clay mask formulations: F0, F1, F2, F3 and F4, testing the stability of the clay mask product and testing the antibacterial properties of the clay mask against Propionibcaterium acnes using the well diffusion method. The results show that the organoleptic formulas are semi-solid, the colors are white, cream, brownish cream and light brown, while the odor ranges from odorless to vanilla, all formulas are homogeneous, pH 7, spreadability and dryness are stable and antibacterial is in the medium to strong category. The conclusion shows that F4 is more effective as an antibacterial against P. acnes with an inhibition zone of 16.21 ± 0.85 mm and the clay mask preparation has the potential as an anti-acne.

Keywords: *Antibacterial; Clay Mask; Formula; Propionibacterium acnes; VCO*

https://doi.org/10.36987/jpbn.v10i3.6041

INTRODUCTION

The 5.0 society era was a challenge for the pharmaceutical industry to always innovate, such as in the cosmetics sector. Innovation in the cosmetics sector was currently being echoed because it had an important role, especially in maintaining the beauty and

health of the skin, such as clay mask cosmetic products (Forestryana et al., 2021). Moreover, maintaining environmental health were everyone's responsibility, one of the efforts to overcome waste was to reuse it into valuable products, one of that was coconut waste (Purba et al., 2023; Sinaga et al., 2023).

Coconut dregs wasted from coconut oil processing, leftover coconut milk production, and grated coconut residue that was not used by the community (Azis & Akolo, 2018). Coconut dregs wasted was used to animal feed. However, based on the previous resulted research, The coconut dregs wasted contains 15.07% fiber, 5.78% protein, 38.24% fat and galactomannan (Lestari & Hanum, 2019). Galactomannan was a natural polymer that used in the pharmaceutical and cosmetic industries as a gel thickener (Prasetyo & Winarti, 2019), stabilizer, emulsion and additive (Annisa *et al.*, 2021), that caused coconut dregs wasted had a good potentialy to be used as an ingredient in making clay mask cosmetic. Clay mask was a facial mask that has the properties of tightening, cleansing, brightening the skin, and practically (Azizah *et al.*, 2024). Clay mask was a cosmetic preparation made from clay minerals such as bentonite and kaolin which can remove dirt and blackheads on the face (Ardhany *et al.*, 2022).

The advantages of coconut dregs wasted can be used as an additional active ingredient in making clay masks. To support the benefits of clay masks more optimally, a combination of VCO was needed. Virgin coconut oil acts as an antivirus, antibacterial, antiprotozoal and maintains skin health (Annisa *et al.*, 2021). The benefits of clay masks are not only to tighten and cleanse the skin, but can also be used as anti-acne cosmetics. Therefore, it was necessary to conduct research on the use of coconut pulp combined with VCO in clay mask preparations that have the potential as antibacterial *P. acnes* which causes acne.

Based on previous resulted research of Widiastuti *et al.*, (2015) the use of coconut dregs has been used as flour. However, the development of coconut dregs in the pharmaceutical field was only carried out in 2022 as a body scrub (Bunyanis *et al.*, 2022). Meanwhile, the development of coconut pulp as a clay mask had been growth rapidly. Therefore, research was needed that utilizes coconut dregs waste into a high-value material in the form of pharmaceutical preparations in the form of clay masks that have the potential as anti-acne.

The obejective of that research was to utilize coconut dregs waste into pharmaceutical preparation products, producing clay masks made from coconut dregs combined with VCO which have the potential as anti-acne and producing clay mask products that are effective as anti-acne. That research was useful for processing coconut dregs waste into alternative ingredients in cosmetic preparations of clay mask products. Clay mask products with a combination of VCO can be one solution in preventing acne or as an anti-acne medicine. The urgency of research was due to skin health problems such as acne which has a health problem that was a concern for every man/woman, because it has an impact on reducing self-confidence in appearance, so that the need for skin care becomes a important thing. Therefore, it was significat to innovate cosmetics in the form of clay masks that are useful in maintaining skin health and anti-acne made from coconut pulp combined with the benefits of VCO. The discovery of anti-acne clay mask products made from coconut pulp combined with VCO contributes to science in the fields of health, pharmacy and the environment.

METHODS

Coconut Pulp Preparation

The sample was collected 10 kg of coconut dregs, then dried in an oven at a temperature of 50°C. The dried coconut dregs are ground using a blender. Then filtered using mesh 60 (coconut dregs flour) (Hasan, 2018).

Clay Mask Dosage Formulation

Clay mask was made by, the mortar was heated by putting hot water with a temperature of 100°C into the mortar, closed and waited for a few minutes then the water was thrown away, then hot water was put into the hot mortar, kaolin was added little by little while being crushed, in another mortar bentonite was crushed, hot water was added, xanthan gum was dissolved with hot water and stirred, bentonite was put into the mortar containing kaolin, crushed until homogeneous and xanthan gum was added, crushed until homogeneous above the bunsen so that the mortar remains hot then TEA was added and VCO was added in F2, F3, F4, coconut pulp was added in F1, F2, F3. and F4 for this stage as mass 1.

Table 1. Formulation of Clay Mask dosage

Material	Formulation (%)						Function
	F0 control (-)	F1	F2	F3	F4	control (+)	
Coconut dregs	-	1	2	3	4		Active material
VCO	-	-	6	6	6		Active material
Bentonite	1	1	1	1	1		Adsorbent
Xanthan gume	0,8	0,8	0,8	0,8	0,8	Clay Mask Skintific Mugworth Acne	Stabilizing agent
Kaolin	30,5	30,5	30,5	30,5	30,5		Adsorbent
SLS	2	2	2	2	2		Wetting agent
Prophylen glikol	7	7	7	7	7		Emultion agent
TEA	2	2	2	2	2		Emultion agent
Methyl paraben	0,2	0,2	0,2	0,2	0,2		Preservative
Parfume	1	1	1	1	1		Fragrance
Aquadest	100	100	100	100	100		Solvent

Description,
F0 : clay mask without coconut dregs/control negative
F1 : clay mask adding 1 gr coconut dregs
F2 : clay mask adding 2 gr coconut dregs + VCO
F3 : clay mask adding 3 gr coconut dregs + VCO
F4 : clay mask adding 4 gr coconut dregs + VCO

Then SLS and propylene glycol are melted in this stage as mass 2. Then mass 1 is put into the mortar containing mass 2, distilled water was added and crushed until homogeneous, then methyl paraben and perfume are added, crushed until homogeneous over a hot flame and a cream clay mask mass was formed. According to Elfiyani et al., (2023) Clay mask each formula was tested for stability (organoleptic test, homogeneity test, pH test, spreading power test, drying speed test).

***Clay Mask* Stability Test**

Based on the reasearch procedure of Elfiyani *et al.,* (2023), the aims of stability test of *Clay mask* had to know the quality of cosmetic dosage with some variable as bellow:

a. Organoleptics test : includes shape, color, aroma visually in each clay mask formula.
b. Homogenicity test : As much as 1 gram of clay mask is applied evenly to the glass object and then observed under a microscope to see the level of homogeneity of the preparation.
c. Acidity (pH) : pH testing was carried out using a universal pH indicator which was inserted into the preparation, then the pH value is observed.
d. Distribution test : As much as 1 gram of clay mask was placed on a round watch glass, then covered with a second watch glass and given a load.
e. Drying speed test : As much as 1 gram of clay mask was applied to the surface of the skin of the hand, then the time needed to dry was calculated.
f. Viskosity test : The viscosity test of the preparation was carried out using a Brookfield viscometer at a speed of 10-20 rpm and spindle.

Bacterial rejuvenation

Nutrient Agar (NA) media was weighed as much as 1.4 grams then put into an Erlenmeyer flask, added with 50 ml of distilled water then stirred until dissolved and the NA media was heated over a fire, stirred continuously until the media boiled and looked transparent, then the media was covered with aluminum foil and waited until it reached 40°C. Then the NA media was put into a test tube and left to harden. *P. acnes* bacteria were taken and scratched into the media then covered with aluminum foil and wrapped in plastic wrap then put into an incubator at a temperature of 37°c for 2 hours.

Antibacteria Assay

Antibacterial testing method using the well diffusion method. Mueller Hinton Agar (MHA) media was weighed as much as 3.8 grams, put into an Erlenmeyer flask, dissolved in 300 ml of distilled water, then cooked until boiling and looks transparent, then waited until 40°C. Put into a petri dish, wait until it hardens. Heat the jung cork

borer and make holes in the media for each petri dish. After that, the rejuvenated bacteria were taken and then rubbed on the surface of the media. Each clay mask preparation formula was put into each hole in the media as well as the positive control. After that, wrapped in plastic wrap and put in an incubator at a temperature of 37°C for 24 hours.

Data Analysis

Data analysis using the ANOVA statistical test with SPSS Ver. 25 to determine the effect of coconut pulp variations in the clay mask which can affect the quality of the preparation through stability and organoleptic tests. In addition, to determine the effect of variations in clay mask formulation in inhibiting P. acnes bacteria so that it can produce an anti-acne clay mask by observing the diameter of the inhibition zone with the formula (Paliling *et al.*, 2016).

$$Inhibition\ Zone\ Diameter\ = \frac{(Dv - Ds) + (Dh - Ds)}{2}$$

Description of code,
Dv = Vertical diameter,
Ds = Well diameter,
Dh = Horizontal diameter

The results of measuring the diameter of the inhibition zone formed are classified into the inhibition zone diameter category by Davis & Stout (1971) which can be seen in the table 2.

Table 2. Inhibition Zone Diameter Categories

Inhibition Zone Diameter (mm)	Categories
< 5 mm	Weak
5 – 10 mm	Middle
10 – 20 mm	Strong
> 20 mm	Very strong

Table 3. The Results of Clay Mask Organoleptic Test

Organoleptic test	Formulation				
	F0	F1	F2	F3	F4
Shape	Semi solid	Semi solid	Semi solid	Semi solid	Semi solid
Colours	White	cream	Brownish cream	Brownish cream	Light brown
Smelling/Aroma	Odorless	Vanilla	Coconut Vanilla	Coconut Vanilla	Coconut Vanilla

RESULTS AND DISCUSSION

Stability Test Results of Clay Mask Dosage

Organoleptic test

Organoleptic test was a test of the preparation by observing the shape, taste, color, and smell which can be seen in table 3. Based on the results of the organoleptic test on each clay mask formulation, a consistent form was obtained in all formulas, namely a semi-solid form, different colors and aromas in formulations F1-F4, due to differences in the

composition of coconut pulp in each formula. The organoleptic test was an indicator that can be used as a reference in product marketing.

Homogeneity test, pH, distribution, driying time, Viskosity of Clay Mask

Based on table 4, it was found that each formula has a consistent level of homogeneity and pH. While the largest spreadability test was found in formula F3 and the fastest drying time was found in formula F2. pH 4.5-8.0 was a skin moisturizer quality requirement based on SNI 16-4399-1996. The requirements for the spreadability of the clay mask are 20-50 mm and the drying time for the mask was 10-20 minutes (Hasibuan *et al.*, 2023), while the viscosity of the clay mask obtained includes a good viscosity value because it was in accordance with the range of viscosity requirements for semi-solid preparations, namely 4,000 cPs-40,000 cPs (Syamsidin *et al.*, 2021).

Tabel 4. Homogenicity test, pH, Distribution, Drying time, Viskosity Clay Mask

Formulation	Homogeneity	pH	Daya Sebar (mm)	Drying time (second)	Viskosity (cPs)
F0	Homogen	7	41,23	53	10.000
F1	Homogen	7	43,26	54	9.400
F2	Homogen	7	44,10	35	10.000
F3	Homogen	7	44,46	54	10.000
F4	Homogen	7	43,50	48	9.400

Antibacterial Test Results of Clay Mask Dosage against Propionibacterium acnes

The results of the clay mask dosage as an anti-acne by testing the antibacterial activity against *P. acnes* bacteria using the well diffusion method by observing the diameter of the inhibition zone which can be seen in table 5 and figure 1. Based on table 5 and figure 1, it shows that the clay mask preparation formula that has the highest antibacterial activity was F4 with an inhibition zone diameter of 16.21 ± 0.85 mm compared to the positive control clay mask product. That was related to the composition of coconut dregs and VCO which have the potential to be antibacterial.

Coconut dregs contain galactomannan in the form of heteropolysaccharides and are applied as thickeners, stabilizers, emulsions and additives in the food and pharmaceutical industries (Nasution *et al.*, 2021). Galactomannan has the potential as an antioxidant, antimicrobial (Sarmi *et al.*, 2016) dan antidiabetic (Nursetiani & Herdiana, 2021). Galactomannan has antibacterial activity against *Staphylococcus aureus, Pseudomonas aureginosa, Salmonella enteridis, Listeria monocytogenes* (Almeida *et al.*, 2021). Galactomannan was included in polysaccharides. Polysaccharides can inhibit bacterial growth by inhibiting the permeability of cell walls and membranes, damaging cell membrane proteins which cause structural damage and release of cell components including electrolyte proteins (Zhang *et al.*, 2017).

Table 5. Results of the Inhibition Zone Diameter of Clay Mask Dosage against *Propionibacterium acnes*

Formulation	Inhibition Zone Diameter (mm)			Average (mm)	Categories
	U1	U2	U3		
F0	8,65	8,95	10,15	9,25±0,79	Middle
F1	14,40	12,50	14,30	13,73±1,07	strong
F2	9,90	10,70	12,25	10,95±1,19	strong
F3	13,95	13,65	14,20	13,93±0,28	strong
F4	15,85	15,60	17,18	16,21±0,85	strong
Control Positive	7,9	7,7	6,8	7,46±0,59	Middle

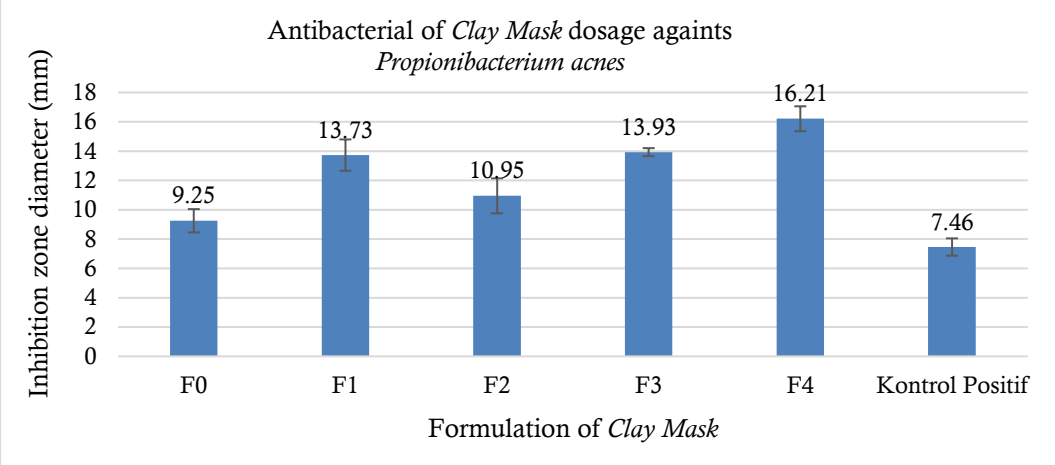

Figure 1. *Clay Mask* dosage againts *Propionibacterium acnes*

The lauric acid content in VCO is a supporting factor for the antibacterial activity found in clay mask preparations. Lauric acid which will be converted into monolaurin has antibacterial and antiviral properties (Sulastri *et al.*, 2016). Lauric acid has been reported as the main component in VCO. Lauric acid has hydrophilic properties contributed by the presence of the -OH group and the oxygen atom of the carbonyl group. Both functional groups allow the formation of hydrogen bonds with the polar parts of the cell wall of patogenic microorganism. Meanwhile, its lipophilic nature was contributed by the lauryl group, which has the potential to form Van der Waals interactions with non-polar parts of the cell wall of microorganisms. The surfactant nature of lauric acid potentiates interactions with the cell wall to inhibit and even kill pathogenic organisms. Furthermore, lauric acid has been reported to have a broad spectrum of antimicrobial activity against viruses, bacteria, and fungi (Nitbani *et al.*, 2022).

Based on table 6, the significance value <0.05, the variation of formulations with the diameter of the inhibition zone shows a strong correlation. This is related to the composition of each formulation that has the potential to be antibacterial. *P. acnes* bacteria are opportunistic microorganisms on the skin. *P. acnes* can be pathogenic which causes skin infections resulting in acne (Simanjuntak *et al.*, 2020). The mechanism of acne occurs because bacteria produce lipase enzymes to break down

fatty acids in the sebaceous glands, causing inflammation and accumulation of fat on the surface of the skin in the form of white pus (Afifi *et al.,* 2018).

Table 6. Correlation of Clay Mask Formula with Antibacterial Activity

	Correlations	Formulation	Inhibition zone
Formulation	Pearson Correlation	1	.784*
	Sig. (2-tailed)		<.001
	N	15	15
Inhibition zone	Pearson Correlation	.784*	1
	Sig. (2-tailed)	<.001	
	N	15	15

The combination of coconut dregs with VCO in clay mask preparations is a cosmetic product that is an alternative in treating acne. Clay mask preparations have many advantages such as high absorbency against dirt, absorbing oil on the skin, eliminating bacteria and tightening the skin layer (Wananggari & Oktavilantika, 2024) and easy to clean or rinse. In addition, the presence of coconut dregs and VCO provides an optimal effect on the function of the clay mask, because the compound content in coconut dregs makes the clay mask preparation more stable, the presence of lauric acid which is antibacterial and functions to moisturize the skin. So that the clay mask preparation is recommended as a cosmetic that has the potential to be anti-acne, tighten, cleanse and brighten the skin (Azizah *et al.*, 2024).

CONCLUSION

Based on the research that has been done, it can be concluded that coconut dregs can be used as a clay mask preparation, the combination of coconut dregs with VCO can inhibit activity of *P. acnes* bacteria with an inhibition zone diameter of 16.21 ± 0.85 mm. The effective formulation as an antibacterial and anti-acne found on F4 treatment.

ACKNOWLEDGMENT

The author would like to say thanks to STIKes Senior Medan for facilitating and accommodating the submission of proposals up to the research activity stage. Our deepest gratitude to the Directorate of Learning and Student Affairs, Directorate General of Higher Education and Technology-Ministry of Education, Culture, Research and Technology for the 2024 PKM-RE research grant.

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How To Cite This Article, with *APA style* :
Sitanggang, K.E.P., Zega, N.P., Br Manurung, W.A., Silaban, E.C.B., & Simanjuntak, H. A. (2024). Clay Mask Formulation of Coconut Dregs and Virgin Coconut Oil as an Antibacterial Against *Propionibacterium acnes*. *Jurnal Pembelajaran dan Biologi Nukleus*, *10*(3), 809-819. https://doi.org/10.36987/jpbn.v10i3.6041

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author contributions

All authors contributed to the study's conception and design. Material preparation, data collection and analysis were performed by all authors. The first draft of the manuscript was submited by [**Helen Anjelina Simanjuntak**]. All authors contributed on previous version and revisions process of the manuscript. All authors read and approved the final manuscript.