Formulation and Testing of Stick Deodorant Containing Bioactive Components from Molecularly Distilled Aceh Patchouli Oil

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ABSTRACT

The presence of harmful chemicals used as active components of deodorants that are widely circulated in the market allows for adverse risks in long-term use, ranging from skin irritation to potential cancer. Aceh Patchouli oil, which has been distilled with molecular distillation technology, has 3 types, namely light fraction, heavy fraction and purified crude fraction, all of which contain high patchouli alcohol which is very useful as a natural antibacterial. Therefore, Aceh patchouli oil is used as the main active ingredient which is an innovation in deodorant formulation because it can be a safe bioactive component. The method used in this study is based on deodorant formulation experiments with the 3 types of the main active ingredient, each in 3 formulations with the amount of 10%, 15% and 20%. Tests are also carried out for deodorant preparations such as anti-bacterial tests, bacterial isolate that was used in this study is *Staphylococcus aureus*, which is incubated on Mueller-Hitton Agar media for 24 hours at 35-37°C using the Kirby-Bauer method. The result of deodorant test showed inhibition of *Staphylococcus aureus bacteria* by 7.29 -14.12 mm, higher than other products tested, which did not use bioactive patchouli oil. Each sample also did not show any risk of irritation such as itching, redness to festering. Formulated as a convenient homogeneous with a smooth surface stick deodorant, this deodorant utilizes a natural patchouli oil extract as the antibacterial source, eliminating concerns about skin darkening associated with some commercially available stick deodorants. Based on the results of the study, this deodorant formulation is highly recommended to be developed towards product commercialization, because it has a bacterial inhibition that is classified as very strong and safe for long-term use.

Keywords: Aceh patchouli oil, Bioactive components, Molecular distillation, Stick deodorant

INTRODUCTION

Individuals experiencing excessive perspiration and prominent body odor often seek effective deodorants to mitigate social discomfort. However, deodorants with harmful components continue to be widely circulated in the market which can endanger the life of the wearer. Therefore, deodorants with natural active components from nature (bioactive) are present to overcome unpleasant body odor and avoid the risk of harmful ingredients [1].

When a person does a lot of activities, non-physical or physical, especially outdoors or indoors in hot weather, the body will sweat. Sweat is a habit of the body that is useful for stabilizing body temperature. The body that gets hot will receive the heat and will try to normalize it by sweating [2]. However, the sweat has a very large possibility to be mixed with bacteria that are on human skin. This bacterium is called *Staphylococcus aureus* [3].

Staphylococcus aureus bacteria are common flora on the surface of axillary skin and usually have a round or oval shape measuring about 0.8-0.9 µm [4]. *Staphylococcus aureus bacteria* mixed with sweat will cause unpleasant body odor and cause discomfort, especially for someone who is still doing activities and mingling with many people. Efforts that can be made to have a positive impact are by cleaning the body with water accompanied by soap, and other practical efforts are the use of deodorants or antiperspirant [5].

Deodorants and antiperspirants have a very close correlation in an effort to prevent and reduce odors caused by sweat mixed with bacteria [6]. For this reason, both require compounds with antibacterial properties [7]. Many deodorant products have been marketed in the world, but there are still many problems, starting with deodorants that are not and less effective in inhibiting bacteria, good quality deodorants but quite expensive prices, to deodorants that use harmful active ingredients to get deodorant effectiveness at low prices. Therefore, it is good to conduct research in this regard.

Anti-bacterial is a substance present in some essential oils that works as an inhibitor and even destroys bacteria by damaging the metabolism of bacteria that are bad for the body [8]. Anti-bacteria contained in deodorant preparations must be in accordance with the needs and not exceed the limit, so it needs to be formulated properly so that its benefits as an anti-bacterial can be maximized [1].

In Aceh, many plants have active compounds with useful content in them, one of which is Aceh patchouli (*Pogostemon cablin Benth*). Aceh Patchouli is a plant that produces essential oil. Essential oils are oils extracted from plants that make up a large group of vegetable oils, essential oils are known as flying oils because of their volatile nature [9]. Aceh patchouli leaves will be dried and then distilled to produce Aceh patchouli oil, patchouli oil distilled from farmers usually still contains impurity components such as iron, nickel and others. Therefore, it is necessary to refine with technology that can increase the quality of Aceh patchouli oil to be higher [10].

This technology is known as fractionated distillation or molecular distillation, this distillation is a process of separating liquids based on differences in boiling points. vacuum distillation (molecular distillation) which uses lower atmospheric pressure can reduce temperatures so that important substances in the liquid are not damaged [11].

Molecular distillation is the process of distilling one material that has many molecules, such as patchouli Aceh essential oil material (*Pogostemon cablin Benth*) which is an example of one material but has many molecules. Aceh patchouli oil distilled by molecular distillation with a non-vacuum distillation technique requires a temperature of 287 ℃ in order to separate the molecules in it but with this temperature, most of the important substances in Aceh patchouli oil have disappeared due to high temperatures. Therefore, the distillation is done with vacuum technique. This technique can produce 3 different weights of patchouli oil, namely, Light Fraction, Heavy Fraction, and Purified Crude Fraction [12].

Molecular distillation improves the quality of Aceh patchouli oil. Aceh patchouli oil is the best patchouli oil in the world because it contains the highest main compound patchouli alcohol (PA) compared to other patchouli oils [13]. With this process, the PA of patchouli oil can even be increased to 60% and even 99% (crystal). Various other compounds are also very useful as anti-oxidants, anti-fungal, anti-bacterial and others [13]. Therefore, it is very good if this compound is used as a bioactive component in various health and cosmetic products in the country. The use of Aceh patchouli oil as a bioactive component of deodorant will be a downstream product development based on regional superior commodities which will help drive the economy, in Aceh in particular and in Indonesia in general.

Deodorant with a solid form (stick) will make it easier to use because the preparation that is applied does have dry characteristics so it does not feel muddy when using the deodorant. Deodorants with bioactive ingredients also do not have a bad risk for prolonged use [14]. Based on research by [15], Aceh patchouli oil is proven to inhibit *Staphylococcus aureus bacteria* at concentrations of 1%, 3% and 5% [15]. The research conducted a deodorant lotion formulation using crude patchouli oil or patchouli oil without being processed by molecular distillation so that it included patchouli oil which was not clean from impurities, so it did not include hi-grade patchouli oil. Based on research by [16], liquid deodorant with a 30% inhibitory power against staphylococcal bacteria. $0.787\ cm^2 - 1.298\ cm^2$ has 30% inhibition against *Staphylococcus aureus bacteria* and 15% against Pseudomonas aeruginosa bacteria, the research conducted is patchouli oil from steam distillation.

In this study, the formulation and evaluation (testing) of deodorant preparations with the active component of hi-grade patchouli oil from the Light Fraction, Heavy Fraction, and Purified Crude Fraction, at several

concentration levels. In this study, the deodorant formulation will be made in the form of a stick preparation that makes it easy to apply and makes it easy to use, with stick deodorants absorption will occur faster because it has components that do not leave wet marks on the skin [16].

RESEARCH METHOD

Deodorant prototype formulation was carried out at the ARC PUI Laboratory of PT Nilam Aceh USK, anti-bacterial testing was carried out at the USK Microbiology Laboratory and physical testing was carried out at the Science Laboratory of Madrasah Tsanawiyah Negeri 1 Banda Aceh.

The tools used are a rotary vacuum evaporator, beaker glass, measuring cup, dropper pipette, digital scale and stick deodorant preparation container.

Table 1. Materials used

No	Materials	% Usage	Total Usage
1.	Light fraction, Heavy fraction, Purified Crude Fraction of Aceh Patchouli oil	10%; 15%; 20%	2 g, 3 g, 4 g
2.	Cera alba	Ad 100%	Ad 20 g
3.	Cethyl alcohol	15%	3 g
4.	Propilen glikol	15%	3 g
5.	VCO	10%	2 g
6.	Lily oil	5%	1 g
7.	Mentholum	0.4%	0.08 g
8.	Propil paraben	0.02%	0.004 g

This study uses experimental research methods to evaluate the effect of treatment on subjects to achieve the desired results in a laboratory. It uses quantitative data processing techniques to study phenomena using numbers, statistics, and controlled experiments [17].

Aceh patchouli oil can be distilled by molecular distillation technology in 2 ways. In the double-step molecular distillation, the process is carried out in two distinct stages: the temperature is first raised to 105℃ to isolate the light fraction, and only after this fraction has been completely collected, the system is reheated to 125℃ to obtain the heavy fraction. This method allows for more selective separation of different molecular weight components. In contrast, the single-step molecular distillation involves gradually increasing the temperature from 105℃ to 125℃ in a single continuous run, resulting in a purified crude fraction without separating it into distinct light and heavy components.

The data that will come out is in the form of data on the results of deodorant tests in this study, namely:

Antibacterial Test

The antibacterial assay was performed by the disc diffusion method. The test was conducted using the Kirby-Bauer method. Bacterial isolates used in this study are normal flora on the skin, namely *Staphylococcus aureus*, incubated on Mueller-Hitton Agar (MHA) media for 24 hours at 35-37°C [18]. Three representative samples each from Light Fraction (LF), Heavy Fraction (HF) to Purified Crude Fraction (PCF) with

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concentrations of 10% (F1), 15% (F2), 20% (F3) % plus a comparison variable which is formulation without active substance (F0) and amoxicillin antibiotic as positive control (K+).

Irritation Test

The irritation test was conducted on the skin of panelists for 24-48 hours on each sample from Light Fraction, Heavy Fraction to Purified Crude Fraction with a concentration of 10% (F1), 15% (F2), 20% (F3)% with indicators:

0= no irritation

1= irritation

Homogeneity Test

The homogeneity test is measured by looking at the texture and surface of the deodorant [19] and tested on panelists with the same sample as the irritation test with indicators:

1= homogeneous

2= less homogeneous

3= not homogeneous

Organoleptic Test

Organoleptic test. The organoleptic test is a physical test that describes the color, aroma and shape characteristics of a preparation with the same sample as the homogeneity test and irritation test [20].

RESULT AND DISCUSSION

Antibacterial Test

The antibacterial test was conducted to see the potential inhibition of Hi-grade Aceh patchouli oil against *Staphylococcus aureus bacteria*, which causes bad-smelling sweat. The following are the results of testing bacteria inhibition on preparation samples (formulations) using Light Fraction, Heavy Fraction, Purified Crude Fraction, and without patchouli active ingredients.

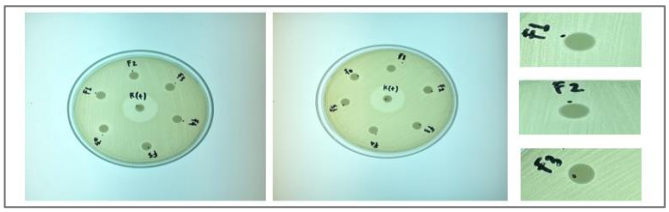

Fig. 1 Patchouli oil deodorant testing plate

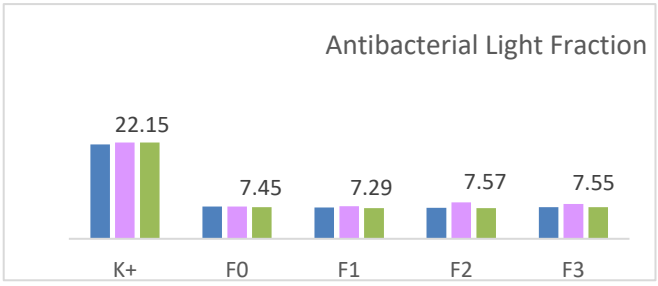

Fig. 2 Bacterial inhibition testing using Light Fraction

Based on Figure 2, it can be seen that the antibacterial inhibition of Light Fraction deodorant is in the range of 7.29-7.57 mm. Formulation 1, using a Light Fraction of 10%, showed inhibition in P1 of 7.23 mm, P2 of 7.52 mm, and P3 of 7.13 mm and obtained an average of 7.29 mm. Formulation 2, using a Light Fraction of 15%, showed inhibition in P1 of 7.17 mm, P2 of 8.42 mm, and P3 of 7.12 mm and obtained an average of 7.57 mm. Formulation 3 using Light Fraction 20% showed inhibition in P1 of 7.30 mm, P2 of 8.03 mm, and P3 of 7.22 mm and obtained an average of 7.55 mm.

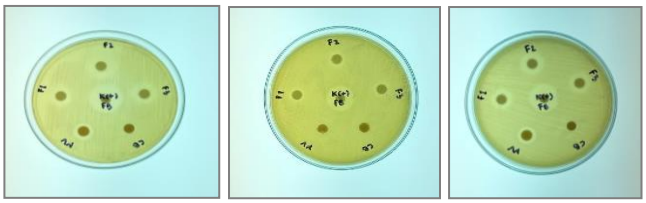

Fig. 3 Patchouli oil deodorant testing plate

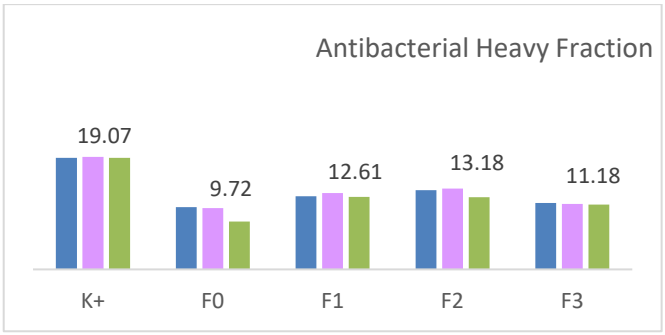

Fig. 4 Bacterial inhibition test using Heavy Fraction

Based on Figure 4, the antibacterial inhibition of heavy-fraction deodorant ranges from 11.18 to 13.18 mm. Formulation 1 using a 10% Heavy Fraction, showed inhibition in P1 of 12.48 mm, P2 of 13.01 mm, and P3 of 12.34 mm and obtained an average of 12.61 mm. Formulation 2, using a Heavy Fraction of 15%, showed inhibition in P1 of 13.51 mm, P2 of 13.78 mm, and P3 of 12.27 mm and obtained an average of 13.18 mm. Formulation 3, using a Heavy Fraction of 20%, showed inhibition in P1 of 11.33 mm, P2 of 11.15 mm, and P3 of 11.06 mm and obtained an average of 11.18 mm.

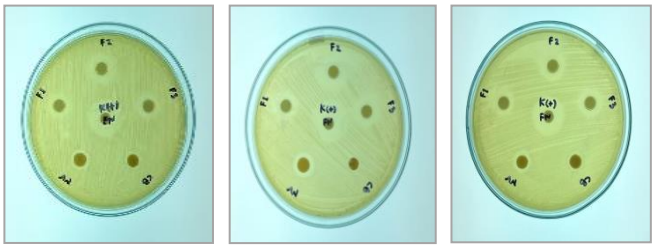

Fig. 5 Bacterial inhibition test using Purified Crude Fraction

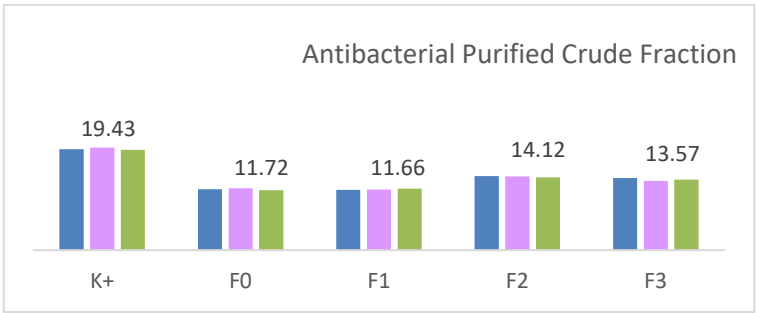

Fig. 6 Bacterial inhibition test using Purified Crude Fraction

Based on Figure 6, the antibacterial inhibition of Purified Crude Fraction deodorant ranges from 11.66-14.12 mm. Formulation 1, using a purified crude fraction of 10%, showed inhibition in P1 of 11.55 mm, P2 of 11.62 mm, and P3 of 11.83 mm and obtained an average of 11.66 mm. Formulation 2 using a purified c rude fraction of 15% showed inhibition in P1 of 14.24 mm, P2 of 14.14 mm, and P3 of 14.00 mm and obtained an average of 14.12 mm. Formulation 3 using purified crude fraction 20% showed inhibition in P1 of 13.86 mm, P2 of 13.29 mm, and P3 of 13.56 mm and obtained an average of 13.57 mm.

The inhibitory power antibacterial in the Light Fraction formulation is included in the size of the solid inhibitory power then, for the inhibitory power in the formulation of Heavy Fraction and Purified Crude Fraction, the inhibitory power is very strong. According to Adibi et al., inhibition <5 mm including weak 5<x<10 strong and >10 mm very strong [21].

Irritation Test

Irritation tests are conducted to see if there are symptoms of irritation, such as itching, redness, and festering, caused by using stick deodorants.

Table 2. Deodorant irritation testing using Light Fraction

Hives score ($\bar{x}$)			
F0	F1	F2	F3
0	0	0	0
Redness score ($\bar{x}$)			
F0	F1	F2	F3
0	0	0	0
Festering score ($\bar{x}$)			
F0	F1	F2	F3
0	0	0	0

0= No Irritation

Table 3. Deodorant irritation testing using Heavy Fraction

Hives score ($\bar{x}$)			
F0	F1	F2	F3
0	0	0	0
Redness score ($\bar{x}$)			
F0	F1	F2	F3
0	0	0	0
Festering score ($\bar{x}$)			

F0	F1	F2	F3
0	0	0	0

0= No Irritation

Table 4. Deodorant irritation testing using Purified Crude Fraction

Hives score ($\bar{x}$)			
F0	F1	F2	F3
0	0	0	0
Redness score ($\bar{x}$)			
F0	F1	F2	F3
0	0	0	0
Festering score ($\bar{x}$)			
F0	F1	F2	F3
0	0	0	0

0= No Irritation

Based on the table, it can be seen that deodorant with patchouli oil does not irritate the skin, marked by a score of 0 in each normal panelist who is the test subject. This proves that deodorant with Light Fraction is safe for the skin and can be used continuously. This proves the absence of irritant chemicals used in the formulation of this stick deodorant. According to Rachmasari, skin irritation occurs due to chemicals that irritate the skin reddish and cause skin diseases [22].

Homogeneity Test

In the homogeneity test, the panelists are needed to test the homogeneity of the stick deodorant preparation. The homogeneity of a preparation is measured by looking at the surface of the preparation and observing the level of good mixing between the ingredients that have been formed into a preparation.

Table 5. Deodorant homogeneity testing

Active Component	F0	F1	F2	F3
Light fraction	1	1	1	1
Heavy fraction	1	1	1	1
Purified crude fraction	1	1	1	1

1= Homogeneous

Based on the table, the deodorant that the five panelists tested got a score of 1 or homogeneous. This data shows that the solvent of all ingredients works well and makes the preparation smooth and not grainy.

According to this, the homogeneity test needs to be done to make one of the indicators match the preferences of each individual [23].

Organoleptic Test

Organoleptic tests were conducted on panelists with physical testing of the stick deodorant preparation's color, scent, and shape. In organoleptic deodorant testing using light fraction, it can be seen that all preparations are white. However, the most preferred white color is formulation 1. Meanwhile, the fragrance level of the lily is dominated by formulation 1, which uses 10% patchouli oil alone, followed by formulation 2 with 15% patchouli oil and formulation 3, which has the most potent fragrance of patchouli oil with a percentage of patchouli oil of 20%. According to Timur & Latifah, stick deodorant has a solid form because it contains Cera alba, which functions as a hardener that makes a preparation solid so that it is easier to apply [24].

Organoleptic testing of deodorant using Heavy Fraction, the deodorant preparation remains white. While the aroma of each sample is different, it can be seen that formulation 2 has a soft texture, and the lily aroma released is greater than formulations 1 and 3; this occurs due to the presence of patchouli oil with a specific concentration that can optimally bind a perfume of essential oils such as lily oil. This shows that a 15% percentage of Heavy Fraction can bind optimally compared to a 10% and 20% percentage of Heavy Fraction. According to Sitanggang et al., patchouli oil is used as a fixative substance (binder) of aroma in the world's perfume industry to make its aroma last up to 48 hours [25]. The deodorant form remains solid.

Organoleptic testing of Purified Crude Fraction deodorant described the white color becoming the overall color in the formulation of patchouli oil stick deodorant, including light, heavy, and purified crude fractions. The aroma obtained by formulation 1 tends to have a more robust lily oil aroma than other formulations. This can occur because the percentage of patchouli in this formulation is the lowest compared to other formulations. In this stage, formulation 2 has a preferred texture and is easily absorbed into the skin due to the content of virgin coconut oil as a moisturizer that correlates with cethyl alcohol as a stabilizer that manages to work optimally with other ingredients [26]. This proves that virgin coconut oil and cethyl alcohol can work optimally at 15% of the Purified Crude Fraction compared to 10% and 20%.

CONCLUSIONS

Based on the results of this study, it can be proven that the use of Aceh patchouli oil from molecular distillation is excellent as a bioactive component of stick deodorant because it can inhibit bacteria (antibacterial). All stick deodorant formulations using Light, Heavy, and Purified Crude Fractions have potent bacterial inhibition. Even after comparing bacterial inhibition with several other deodorants on the market, the bacterial inhibition of deodorants with Heavy Fractions and Purified Crude Fractions is higher. Then, based on physical tests on stick deodorants, the results of this formulation have also met the requirements of a good deodorant because they do not contain irritants that cause irritation, redness, itching, or festering to skin diseases so that they can be used continuously in the long term. Furthermore, the deodorant has a long-lasting fragrance with a soft texture and quickly absorbs into the skin. Based on the results of this study, the formulation of stick deodorant with bioactive components of Aceh patchouli oil from molecular distillation is highly recommended for use.

Further research can be carried out, such as stability testing, pH testing, clinical testing, antibacterial tests in Vivo, and other dosage variations. It is also essential to calculate the economic added value of this innovative product to encourage downstream product development.

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