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Formulation, Evaluation, Antibacterial Activity Of Roll-On Deodorant With Butterfly Pea Flower Extract Against Staphylococcus Aureus

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Abstract

Body odor is a common physiological problem caused by the metabolic activity of *Staphylococcus aureus*, which converts odorless sweat compounds into malodorous substances. Conventional deodorants often rely on synthetic agents that may cause skin irritation and long-term health risks. Therefore, herbal-based deodorants have gained growing attention. Butterfly pea (*Clitoria ternatea*) contains flavonoids, tannins, and alkaloids with known antibacterial activity. This study aimed to formulate a roll-on deodorant containing butterfly pea extract, evaluate its physical characteristics, and determine its antibacterial activity against S. aureus. The extract was obtained by maceration in 70% ethanol and incorporated into three concentrations: 5% (F1), 10% (F2), and 15% (F3). Physical evaluation included organoleptic properties, homogeneity, pH, viscosity, spreadability, and adhesion. Antibacterial activity was tested using the disc diffusion method. Results showed that all formulas met physical requirements, with increasing extract concentration leading to higher viscosity and adhesion but reduced spreadability. Antibacterial activity increased significantly with concentration, with F3 showing the highest inhibition zone (19.89 mm), classified as strong activity. One-way ANOVA confirmed significant differences among formulas ($p<0.05$). These findings suggest that butterfly pea extract is a promising candidate for developing safe, effective, and eco-friendly herbal *roll-on* deodorants.

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Introduction

Body odor is a natural human condition, but it often causes discomfort and lowers self-confidence. Although sweat is essentially odorless, an unpleasant odor arises when sweat reacts with microorganisms living on the skin's surface. These microorganisms break down sweat components into volatile compounds that have a distinctive and often undesirable odor. This process often occurs in warm, humid environments, where increased sweat production and moisture favor bacterial growth (Schäfer et al., 2021).

The armpits are one of the areas of the body most susceptible to body odor. This is due to the high concentration of sweat glands, warm temperatures, and minimal air circulation. These conditions are ideal for bacterial growth, so their metabolic activity quickly produces a pungent odor. Maintaining cleanliness in this area is important not only for personal comfort, but also to prevent skin health problems (Callewaert et al., 2017).

Roll-on deodorant has long been one of the most widely used solutions for controlling body odor. These products generally work by masking odor, reducing sweat production, or inhibiting the growth of odor-causing bacteria. However, many conventional deodorants contain synthetic ingredients, which, while effective, can cause skin irritation, allergic reactions, and risks from long-term chemical exposure. This has also driven interest in safer, more natural, and environmentally friendly products (Teerasumran et al., 2023).

Herbal-based deodorants offer an alternative, utilizing natural compounds with antibacterial properties. These products not only effectively control odor but also reduce the risk of side effects and minimize their negative impact on the environment. Roll-on dosage forms are a popular choice because they are easy to use, have an easy application system, are easy to spread on the underarms, and are comfortable for everyday use. (Bhatt & Patel, 2021).

This research focuses on the development of a roll-on deodorant with natural active ingredients designed to inhibit bacterial growth. This study not only assesses its antibacterial performance but also its physical properties and skin compatibility. By exploring the use of butterfly pea flower extract in a practical roll-on deodorant preparation, this study seeks to combine traditional medicinal plants with modern cosmetic science (Oluwole & Johnson, 2024).

Methods

Collection and Drying of Plant Parts: Butterfly pea flowers are picked and collected, washed, then dried by airing them and in an oven at no more than 60oC, then blended until smooth and sieved using a 40 mesh.

Preparation of Plant Extract: The butterfly pea flowers were blended into powder and sieved using a 40 mesh sieve. The powder was macerated with 70% ethanol for 3x24 hours with daily stirring. The filtrate obtained was filtered using filter paper, then evaporated with a rotary evaporator at 50°C until a thick extract was obtained. The extract was stored in a closed container and protected from light.

FIG. 1B: EXTRACT BUTTERFLY PEA FLOWER (Clitoria ternatea)

Phytochemical Screening of Extract: Ethanol extract of butterfly pea flowers has undergone initial phytochemical tests to detect main compounds such as tannins, flavonoids, and alkaloids (Table 1).

Procedure: Carbopol was developed with sufficient distilled water and added triethanolamine and BHT, while sodium metabisulfite was dissolved in sufficient distilled water, then added tween 80. Dissolved the butterfly pea flower extract and propylene glycol, stirred until dissolved. The mixture was added to the developed carbopol and then homogenized, added the remaining distilled water and dripped enough essence, stirred until homogeneous, then put into the packaging for further testing (Table 2).

Evaluation Of Physical Characteristics:

Organoleptic: Visual observation of color, odor, and physical form of the preparation.

pH: Measured using a digital pH meter.

Homogeneity: Performed using a glass object.

Spreadability: Tested by dropping 0.5 grams of the preparation onto a glass, then applying a load of 100 grams, then measuring the diameter of the spread.

Viscosity: Measured using a Brookfield type RV viscometer with spindle number 2 at a speed of 60 rpm.

Antibacterial Activity Test: The test method used was the disc diffusion method. Staphylococcus aureus cultures were suspended in 0.9% NaCl solution equivalent to the 0.5 McFarland standard. Nutrient Agar media was poured into petri dishes, then inoculated with bacteria using the zigzag streak method. Sterile paper discs were soaked in each deodorant formula for 15 minutes, then placed on the surface of the inoculated media. The plates were incubated at 37°C for 24 hours. The inhibition zone was measured in millimeters using a digital caliper (Hombach et al., 2015).

Results

Table 1: Phytochemical Screening Extract

No.	Compounds	Results
1	Tannins	+
2	Flavonoids	+
3	Alkaloids	+

The results of the secondary metabolite compound group of Clitoria ternatea flower extract showed that in testing with 3% $FeCl_3$ reagent, a color change to blackish green, indicating the presence of tannin compounds. The flavonoid test using a combination of 70% ethanol, concentrated HCl, and magnesium produced an orange-yellow color, indicating the presence of flavonoid compounds. Meanwhile, for testing alkaloid compounds, three types of reagents were carried out, namely dragendroff, Wagner, and Mayer.

All three tests showed positive results with the formation of orange deposits (dragendroff), brown deposits (Wagner), and yellowish-white deposits (Mayer). This indicates that Clitoria ternatea flower extract also contains alkaloid compounds. Thus, Clitoria ternatea flower extract contains active compounds in the form of tannins, flavonoids, and alkaloids which have the potential to provide pharmacological effects as antibacterials.

TABLE 2: FORMULATION DEODORANT ROLL-ON

No.	Component	F0 (%)	F1 (%)	F2 (%)	F3 (%)
1	Ekstrak Bunga Telang	-	5	10	15
2	Karbopol	0,75	0,75	0,75	0,75
3	TEA	1	1	1	1
4	BHT	0,1	0,1	0,1	0,1
5	Natrium	0,1	0,1	0,1	0,1
6	Metabisulfit	1,5	1,5	1,5	1,5
7	Tween 80	15	15	15	15
8	Propilen Glikol	qs	qs	qs	qs
9	Essense Aquadest	ad 100	ad 100	ad 100	ad 100

TABLE 3: ORGANOLEPTIC

No.	Formulas	Texture	Smell	Color
1	F0	Not thick	Odorless	Bone white
2	F1	Little thick	Smells a bit	Fawn
3	F2	Thick	Quite smelly	Reddish brown
4	F3	Very thick	Very smelly	Dark chocolate

The formulation without extract (F0) showed a non-thick texture, was odorless, and had an off-white color. The formulation with 5% extract (F1) showed a slightly thick texture, had a slight odor, and was yellowish-brown in color. The formulation with 10% extract (F2) showed a thick texture, had a moderate odor, and was reddish-brown in color. Meanwhile, the formulation with 15% extract (F3) showed a thick texture, had a strong odor, and was reddish-brown in color.

TABLE 4: PHYSICAL CHARACTERISTICS

No.	Formulas	pH	Homogeneity	Spreadability	Viscosity	Inhibition Zone
1	F0	4,7	homogeneous	6,3	684	0,00
2	F1	5,3	homogeneous	5,8	755	12,87
3	F2	5,7	homogeneous	5,4	843	16,04
4	F3	6,2	homogeneous	5,1	964	19,89
5	K-	-	-	-	-	0,00
6	K+	-	-	-	-	17,73

All formulations are still within the appropriate range for roll-on deodorant preparations, namely between pH 4.5 and 6.8, which is generally safe and does not irritate the skin. The results showed homogeneity. This means that no coarse grains were found in any of the preparations, thus concluding that all formulations had a good level of mixing and were physically stable. The formulation without extract (F0) showed the highest spreadability. Furthermore, spreadability decreased with increasing extract concentration. This decrease in spreadability indicates that the addition of butterfly pea flower extract can increase the viscosity of the preparation, thereby reducing its ability to spread. Formulation F0 (without extract) had the lowest viscosity value. With the addition of butterfly pea flower extract, viscosity increased. This indicates that the addition of butterfly pea flower extract increased the viscosity of the preparation. The results showed that the higher the concentration of the extract, the larger the inhibition zone obtained and the higher the inhibition of staphylococcus aureus bacteria.

Discussion

This study produced four formulas of *roll-on* deodorant preparations containing butterfly pea flower extract with varying extract concentrations (no extract, 5%, 10%, and 15%). Evaluations were conducted on physical parameters (organoleptic, pH, homogeneity, spreadability, and viscosity) and antibacterial activity against *Staphylococcus aureus*.

Evaluation Of Physical Characteristics

Organoleptic

All three formulas have the distinctive reddish-brown color of butterfly pea flower extract, with a mild herbal odor that is quite acceptable sensorially. The gel texture of the preparations appears homogeneous, free of small particles, and is easy to apply **(Table 3)**.

pH

The pH values of the preparations are within the safe range for skin use, namely 4.5–6.8. A digital pH meter was used for the pH test. The decrease in pH with increasing extract concentration is due to the acidic flavonoid and phenolic compounds. Nevertheless, all formulas remain compatible with the skin's natural pH and do not cause irritation (Ayu *et al*., 2024) **(Table 4)**.

Homogeneity

All formulations showed homogeneous results. Homogeneity was determined using a glass slide. No coarse grains were found in any of the formulations, thus concluding that all formulations had a good level of mixing and were physically stable **(Table 5)**.

Spreadability

The tool used to measure spreadability is a spreader. A 0.5-gram sample is loaded with a 100-gram load and left for 1 minute. Results show that spreadability decreases with increasing viscosity and thickness of the preparation, thus reducing its ability to spread. The required spreadability is 5-7 cm. (Jufri *et al*., 2018) **(Table 6)**.

Viscosity

The instrument used was a Brookfield RV viscometer with spindle number 2 at a speed of 60 rpm. Viscosity increased with increasing extract concentration. This indicates that the active compounds in butterfly pea flower extract can affect the viscosity of the preparation. The viscosity requirement is 255-3.194 m.Pas. A preparation viscosity that is too high can reduce spreadability, while too low can reduce comfort when used. (Estanqueiro *et al*., 2016) **(Table 7)**.

Therefore, the evaluation results of all formulas meet the requirements for a good *roll-on* deodorant preparation.

Antibacterial Activity Test

The results of antibacterial tests using the disc diffusion method against Staphylococcus aureus showed that the higher the extract concentration, the larger the inhibition zone formed. Formula F3 showed the highest antibacterial activity, meaning it was most effective in inhibiting the growth of Staphylococcus aureus. The effectiveness of butterfly pea flower extract in inhibiting Staphylococcus aureus is due to its secondary metabolite content. Flavonoids work by damaging bacterial cell membranes, inhibiting nucleic acid formation, and disrupting metabolic processes. Tannins act by precipitating bacterial cell wall proteins, causing cell lysis. Alkaloids also act as inhibitors of microbial DNA and RNA synthesis. Comparisons between formulas showed that extract concentration significantly affected antibacterial activity. (Bindhu & Umadevi, 2015; Górniak *et al*., 2019). This is consistent with research showing an increase in the inhibition zone proportional to the concentration of flavonoids in herbal plant extracts. An inhibition zone of ≥10 mm is considered strong, so formula F3 can be categorized as having strong antibacterial activity against *Staphylococcus aureus* **(Fig. 2B; Table 8)**.

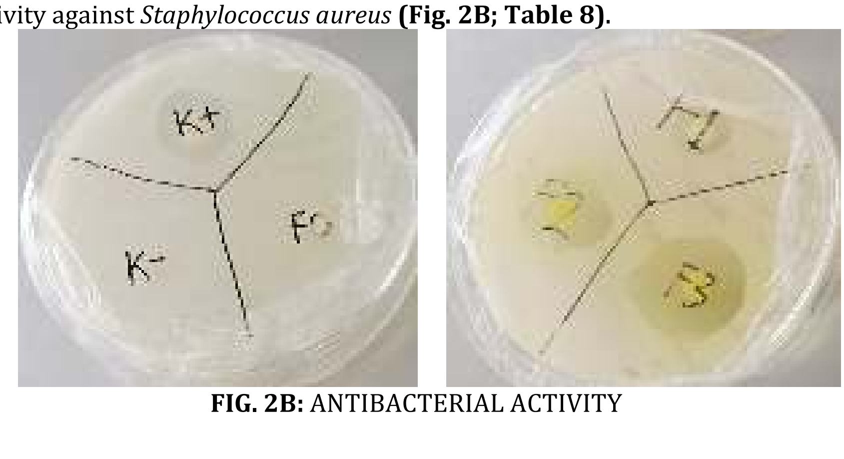

FIG. 2B: ANTIBACTERIAL ACTIVITY

Conclussion

This study shows that butterfly pea flower extract (*Clitoria ternatea*) can be formulated into a *roll-on* deodorant with good and stable physical characteristics. All formulas have a pH suitable for the skin, balanced and homogeneous viscosity and spreadability. Antibacterial activity tests against *Staphylococcus aureus* showed that the extract concentration affected the effectiveness of bacterial growth inhibition. Formula F3 (15% extract) provided the largest inhibition zone diameter, which was 19.89 mm, indicating strong antibacterial activity. This activity is caused by the content of tannins, flavonoids, and alkaloids that work to damage bacterial cell membranes and inhibit DNA synthesis. Thus, *roll-on* deodorant with butterfly pea flower extract (*Clitoria ternatea*) has the potential to be a safe, effective, and environmentally friendly natural deodorant alternative.

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