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Formulation and Evaluation of Transdermal Gel From Bajakah Extract (Spatholobus Littoralis) as an Anti-Inflammatory Agent

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KEYWORDS
Bajakah Tampala; Tampala Bajakah Extract; Transdermal gel; inflammatory response; Anti-inflammatory.

ABSTRACT
The objectives of this study were threefold: (1) to formulate Bajakah Tampala extract (Spatholobus littoralis) into a stable transdermal gel with variations in gelling agent and penetration enhancer concentrations; (2) to evaluate the physical characteristics of the resulting transdermal gel; and (3) to determine the anti-inflammatory efficacy of the gel in a white mouse model. The study hypothesizes that there is no significant difference in anti-inflammatory activity between the transdermal gel and the negative control, and that the gel formulation does not fully meet all standard evaluation parameters, such as thickness. A laboratory experimental design with pre-test and post-test approaches was employed using twenty-two male white rats (Rattus norvegicus), aged 2–3 months and weighing 200–250 grams. Data were analyzed using the paired t-test. Results indicated that the transdermal gel exhibited good and stable physical characteristics, with a homogeneous texture, skin-compatible pH (5.2–6.2), and the ability to withstand over 400 folds without damage. Formulas containing penetration enhancers (F2 and F3) demonstrated superior pH stability and weight uniformity compared to F1. In vivo testing revealed that F2 and F3 reduced edema to 0.30–0.31 mL, nearly matching the positive control (diclofenac sodium, 0.45 mL). These findings suggest that the incorporation of penetration enhancers significantly improves the gel's ability to deliver Bajakah extract and suppress inflammatory responses.

INTRODUCTION

Inflammation is the body's physiological response to injury, infection, or irritation, characterized by symptoms such as redness, swelling, pain, and heat. While inflammation serves as a natural defense mechanism, chronic or prolonged inflammation can contribute to various diseases, including arthritis, dermatitis, and autoimmune disorders (Vera Yulandari, 2016; Yeuyana, 2025; Yunus, 2016). Conventional anti-inflammatory treatments typically involve nonsteroidal anti-inflammatory drugs (NSAIDs), which, despite their efficacy, can lead to adverse effects such as gastrointestinal disturbances, renal impairment, and cardiovascular risks with long-term use.

Given the side effects of using NSAIDs, research on natural ingredients as alternatives for anti-inflammatory treatment continues to grow. Indonesia, a country with high biodiversity, possesses various traditional medicinal plants with anti-inflammatory potential, one of which

is the bajakah plant. Bajakah is a liana plant that grows in the tropical forests of Borneo and has been used for generations by local communities to treat various diseases, including wounds and inflammation (Gibran, 2022).

In recent years, research based on natural ingredients has become a focus in the search for safe treatment alternatives. Tampala bajakah (Spatholobus littoralis), a typical Indonesian plant, has great potential in the treatment of inflammation due to its content of bioactive compounds such as flavonoids, tannins, and saponins (Nugraha & Yuliani, 2024). These compounds are known to have antioxidant and anti-inflammatory activities by inhibiting the release of inflammatory mediators such as prostaglandins and cytokines (Nuroini et al., 2024). Previous research has shown that bajakah extract possesses comparable effectiveness to standard anti-inflammatory drugs (Amalia & Dalimunthe, 2022; Scott, 2021). However, the use of bajakah extract in modern pharmaceutical preparations remains very limited, necessitating further research to explore its potential.

Transdermal gel preparations offer innovations in the use of natural materials such as Tampala bajakah (Oktaviani & Sukmawati, 2024). As a semi-solid preparation, transdermal gel possesses several advantages, including ease of application, good penetration of active ingredients, and rapid local effects (Novia & Noval, 2021). In addition, these preparations can deliver active ingredients in a controlled manner, thereby reducing the risk of systemic side effects. The transdermal gel formulation based on Tampala bajakah extract is expected to provide a safer and more effective anti-inflammatory therapy (Ayuchecaria et al., 2023).

Despite the promising pharmacological profile of bajakah tampala, a significant research gap persists. Most existing studies focus on crude extracts or simple preparations, leaving a critical lacuna in the development of stable, standardized, and patient-friendly dosage forms that can reliably deliver its bioactive compounds. This gap underscores the urgent need to bridge traditional knowledge with modern pharmaceutical technology. The potential of bajakah extract (Spatholobus littoralis) as an anti-inflammatory agent presents a great opportunity for the development of modern pharmaceutical products (Prayoga, 2013). The bioactive compounds contained in bajakah, such as flavonoids, tannins, and saponins, have been scientifically proven to inhibit inflammatory mediators. This makes bajakah a promising candidate for inflammation treatment, especially in the form of innovative pharmaceutical preparations. Unfortunately, despite numerous studies demonstrating its pharmacological potential, the application of bajakah extract in advanced delivery systems such as transdermal gels is still very limited (Nuroini et al., 2024). Therefore, this research is urgently needed to translate the proven bioactivity of bajakah extract into a clinically viable, stable, and effective topical formulation.

In the development of transdermal gels, their technical and pharmacological advantages offer significant added value. Transdermal gels not only provide ease of use but also exhibit high skin penetration ability, allowing the active ingredients to reach target tissues more effectively. This ability is especially important in the treatment of local inflammation, where rapid therapeutic effects and minimal systemic side effects are prioritized (Novia & Noval, 2021). By using Tampala bajakah extract as the main active ingredient, this gel formulation is expected to provide a safer solution than conventional anti-inflammatory drugs such as NSAIDs.

Physical and chemical evaluation is an essential step in the development of transdermal gels based on natural ingredients. Determining parameters such as viscosity, homogeneity, pH, and stability is necessary to ensure product quality and safety. Pharmaceutical products that do not meet physical and chemical standards risk reducing therapeutic effectiveness and user comfort (Jannah et al., 2024). In addition, this evaluation ensures that the active ingredients remain stable during storage and use so that the product can deliver maximum benefits to consumers.

Biological activity testing completes the development process of this transdermal gel. An in vivo test model using white mice (Rattus norvegicus) provides a relevant approach to assess the effectiveness of active ingredients in reducing inflammation (Banjarnahor, 2024). Inflammatory induction with a carrageenan solution is a method often used to observe the reduction of edema, which serves as a key indicator of anti-inflammatory activity (Nastiti & Nugraha, 2022). The results of this test will not only confirm the effectiveness of Tampala bajakah extract but also provide scientific validation for the use of gel preparations as innovative natural ingredient-based pharmaceutical solutions

By combining innovative formulations, rigorous quality evaluation, and comprehensive biological testing, this research is expected to make a tangible contribution to the development of pharmaceuticals based on natural ingredients. It aims not only to meet the need for safe and effective anti-inflammatory treatments but also to support the sustainable use of Indonesia's local resources. Tampala bajakah, as a typical Indonesian plant, has great potential to be developed into high-value pharmaceutical products that can compete in the global market while supporting the conservation of local biological resources (Ayuchecaria et al., 2023; Nuroini et al., 2024).

Considering the great potential of Tampala bajakah as a pharmaceutical active ingredient, the advantages of transdermal gel preparations, and the need for safe and effective alternative anti-inflammatory treatments, I chose the title “Formulation and Evaluation of Tampala Bajakah Extract Transdermal Gel as Anti-Inflammatory.” This research is expected to provide innovative solutions in the treatment of local inflammation while contributing to the development of pharmaceuticals based on natural ingredients that promote the sustainable and value-added use of local resources.

Some of the research questions that will be answered in this study include whether Tampala bajakah extract can be formulated as a transdermal gel, how the physical evaluation of the transdermal gel based on Tampala bajakah extract is conducted, and whether the transdermal gel exhibits in vivo anti-inflammatory activity.

This study aims to determine whether Tampala bajakah extract (Spatholobus littoralis) can be formulated into a stable transdermal gel with variations in gelling agent or enhancer concentrations. In addition, this study aims to evaluate the physical characteristics of transdermal gels based on Tampala bajakah extract and to determine the effectiveness of their anti-inflammatory activity in a white mouse model.

METHOD

Research Design

This study uses laboratory experimental methods with pre-test and post-test approaches on white rats (Rattus norvegicus). The study will include formulation of preparations, evaluation of physical characteristics, and testing of anti-inflammatory activity.

Subjects and Objects of Research

a) Study Subjects: 22 male white rats (Rattus norvegicus), weighing 200–250 grams, healthy 2–3 months of age.
b) Research Object: Transdermal gel based on Tampala bajakah extract.

Research Time and Place

a) Research Time: December 2024 to April 2025 (5 months).
b) Place of Study: Laboratory of Formulation and Pharmacology, Faculty of Pharmacy.

Data Analysis Methods and Techniques

1. Plant Determination

   The samples of Tampala bajakah plants used in this study were obtained from the Kalimantan region. The determination of species is carried out in the Biology Laboratory of the Faculty of Pharmacy to ensure the authenticity of the species used. Determination was made based on morphological characters such as trunk shape, leaves, and tissue structure using relevant taxonomic literature. This process aims to ensure that the samples used are suitable for the Tampala bajakah species which has anti-inflammatory potential.

2. Simplicia Setup

   Samples of Tampala bajakah stems were washed using running water three times to remove dirt and surface contaminants. After washing, the rod is cut into small sizes (± 2 cm) to expand the contact surface during the drying process. Drying is carried out using an oven at 50°C for 48 hours or until the sample is completely dry and does not contain excess moisture content. The dried simplicia are then sorted to make sure there are no damaged or moldy parts. Simplicia that meet the criteria is stored in a tightly closed container to prevent contamination until it is used in the extraction process.

Ethanol Extraction Bajakah Tampala

The extraction process is carried out by the maceration method using a 96% ethanol solvent, which is known to be effective in attracting bioactive compounds such as flavonoids, tannins, and saponins from simplicia (Amalia & Dalimunthe, 2022; Hutahean, 2018; ; Sinaga, 2023; Tarigan et al., 2019). The extraction stages are as follows:

1. Dried simplisia of 500 grams is soaked in 4 liters of 96% ethanol in a closed glass container.
2. Soaking is carried out for 72 hours with stirring every 12 hours to ensure the homogeneity of the solution.
3. The soaking filtrate is filtered using a filter cloth and Whatman paper to separate the solution from the dreg.
4. The maceration process is repeated until the resulting filtrate is clear.
5. The collected filtrate is evaporated using a rotary evaporator at a temperature of 40°C until a thick extract is obtained.
6. The thick extract is dried using a water bath until a stable concentrated extract is formed.

7. The extract yield is calculated using the following formula:

$$\text{Rendemen } (\%) = \frac{\text{Berat ekstrak kering}}{\text{Berat simplisia awal}} \times 100\%$$

8. The concentrated extract is stored in a tightly closed container at room temperature until used in the formulation.

Manufacture of Extracted Trandermal Patches of Bajakah Trunk (Spatholobus littoralis)

Bajakah root extract patches are made with the formula composition listed in Table 3.6.1 using the solvent evaporation technique in a petri dish. HPMC is developed by adding WFI (Water For Injection) to form a thick colloids. Bajakah root extract, propylene glycol and Tween 60 enhancer are mixed together, then put into the developed HPMC, the mixture is stirred until homogeneous. The homogeneous mixture is poured into a petri dish with a diameter of 9 cm slowly so as not to create bubbles, then let it sit for 24 hours at room temperature. The petri dish that has been filled with the mixture is placed in the oven at a temperature between 40°C for 24 hours until a patch sheet is formed that has dried. The patch was given to animals trying to be cut to a size of about 2 cm x 2 cm containing bajakah root extract, adjusted to the weight of the rat.

Physical and Chemical Evaluation of Gels

Here are some of the tests carried out, namely:

1) Thickness Test

   The resulting patch thickness testing was carried out by measuring the thickness of the matrix at three points measured using a caliper.

2) Resistance test to creases

   Folding endurance testing is done by folding the matrix multiple times in the same place until it breaks or up to 300 folds manually to produce a good patch.

3) pH Test

   The pH in this test was done by adding 2mL of free aquadest 〖CO〗_2 and allowed to expand at room temperature and pH determined by placing pH paper on the surface layer of the patch.

4) Uji Organoleptis

   Organoleptic examination is carried out visually including observation of smell, shape, color and surface conditions.

5) Weight Uniformity Test

   Weight testing was carried out by weighing each patch with a diameter one by one using an analytical balance.

Data Analysis

Data obtained from physical, chemical, and biological evaluations were analyzed using SPSS software. The analysis procedure includes:

1. Normality test: To ensure data is distributed normally.
2. One-way ANOVA test: To find out the significant differences between treatment groups.
3. Paired t-test: To compare the results before and after treatment in the same group.

4. The results of the analysis are presented in the form of graphs or tables to make interpretation easier.

RESULTS AND DISCUSSIONS

In supporting the formulation of transdermal gel preparations based on Tampala bajakah extract, the initial stage carried out is the process of extracting the active ingredients from simplisia. This extraction aims to obtain key bioactive compounds that act as anti-inflammatory agents (Ayuchecaria et al., 2023). This process uses a specific method that is able to produce a thick extract with optimal concentration. The yield of the extracts produced is one of the important indicators to assess the efficiency of the extraction process and the potential of the active ingredients contained in simplicia. The higher the yield obtained, the greater the likelihood of the content of active compounds that will play a role in the pharmacological mechanism of the preparation (Dienilah, 2022).

Determination on plants was carried out at the Mulawarman Herbarium, Laboratory of Ecology and Conservation of Tropical Forest Biodivertas, Faculty of Forestry, Mulawarman University. The determination results stated that the plant was a Bajakah Tampala plant with the species Spatholobus littoralis Hassk. of the family Fabaceae.

The extraction process is carried out using the maceration method using 96% ethanol solvent. Of the weight of the simplicia used is 500 grams. Simplicia powder was then extracted and obtained a thick extract of 97.042 grams with a yield percentage of 19.4%.

Patch Thickness Test Results

Testing of the thickness of the transdermal patch preparation was measured using a coupler micrometer with an accuracy of 0.01 mm from 3 different sides. The results of the thickness test on the transdermal patch can be seen in the following table.

Table 1. Patch Thickness Test Results

Number	Patch Thickness (mm)			
	F0 (-)	F1	F2	F3
1	0.13	0.12	0.14	0.13
2	0.13	0.13	0.15	0.16
3	0.13	0.14	0.13	0.11
Average ± elementary school	0,12 ± 0,01	0.13 ± 0,01	0,14 ± 0,01	0,143 ± 0,015

Patch Fold Resistance Evaluation Results

The folding resistance test of transdermal patch preparations is measured manually, which *patch* folded 300 times or more to determine the folding resistance of the patch. The results of the folding resistance test can be seen in the following table.

Table 2. Folding Resistance Test Results

	Patch Fold Thickness (Fold)			
	F0 (-)	F1	F2	F3
1	>400	>400	>400	>400
2	>400	>400	>400	>400

	Patch Fold Thickness (Fold)			
	F0 (-)	F1	F2	F3
3	>400	>400	>400	>400

pH Evaluation Results

pH testing on transdermal patch preparations is performed using a pH meter. The results of pH testing of the fertilizer extract patch preparation can be seen in the following table

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Table 3. pH Test

Number	PH Measurement			
	F0 (-)	F1	F2	F3
1	5,5	5,2	5,9	4,9
2	5,4	5,1	5,5	5,1
3	5,5	5,2	5,0	5,1
Average ± elementary school	5,46 ± 0,057	5,16 ± 0,057	5,46 ± 0,45	5,06 ± 0,152

Organoleptic Test Results

The organoleptic test was carried out with several parameters, including the shape, texture and surface conditions of the negative control (F0), F1, F2 and F3. The results of the observations can be seen in the following table.

Table 4. Organoleptic Results

Formula	Shape	Texture and Conditions Permukaan
K (-)	Film	Dry does not crack
I	Film	Dry does not crack
II	Film	Dry does not crack
III	Film	Dry does not crack

Uniformity of Patch *Weights*

Weight uniformity testing was measured using an analytical balance using 3 patches that were randomly taken. The results of the weight uniformity test on the transdermal patch can be seen in the following table.

Table 5. Uniformity of Patch Weights

Number	Uniformity of patch weights			
	F0	F1	F2	F3
1	0,37	0,36	0,37	0,36
2	0,34	0,32	0,36	0,37
3	0,29	0,28	0,34	0,38
Average ± elementary school	0.33 ± 0.04	0.32 ± 0.04	0.35 ± 0.01	0.37 ± 0.01

Plant Determination

Determination on plants was carried out at the Mulawarman Herbarium, Laboratory of Ecology and Conservation of Tropical Forest Biodivertas, Faculty of Forestry, Mulawarman University. The determination results stated that the plant was a Bajakah Tampala plant with the species Spatholobus littoralis Hassk. of the family Fabaceae.

Extraction

The process of making simplicia begins by cleaning the roots of the bajakah to remove dust and soil (Intan, 2018). The next step is wet sorting, in which the bajakah roots are washed thoroughly to eliminate any remaining impurities. Then, the bajakah roots are sun-dried for three days. After drying, dry sorting is carried out to remove any remaining foreign particles still attached to the roots of the plant. Next, the roots are cut using a knife or other sharp cutting tool. These pieces are then weighed using an analytical balance, resulting in 500 grams of powder. The next process is immersion, which aims to extract secondary metabolites from the simplicia material.

Ethanol extract from bajakah roots is produced through the soaking method. A total of 500 grams of simplicia powder are placed in a closed container, and then 5 liters of 96% ethanol are added as the solvent. The selection of 96% ethanol is based on research by Amini et al. (2019), which showed that this solvent can yield extracts with high concentrations and purity, making it easier to identify active compounds. Additionally, ethanol is volatile, inexpensive, easily obtainable, and relatively safe to use. The choice of solvent for the extraction process significantly affects the quantity and type of compounds extracted, following the principle of "like dissolves like," where polar compounds dissolve in polar solvents, while nonpolar compounds dissolve in nonpolar solvents.

Transdermal Gel Formulation Based on Bajakah Extract as Anti-Inflammatory

The formulation of transdermal patches based on bajakah extract is made in three concentration variations, namely F1 containing 0.5 grams of bajakah extract, F2 with 1 gram, and F3 with 1.5 grams. The objective is to evaluate how variations in extract concentration influence the product's characteristics and effectiveness. Each formula contains 0.8 grams of HPMC as a film-forming agent, 0.4 grams of Tween 60 as a surfactant to enhance solubility and formulation stability, and 4 mL of propylene glycol, which serves as both a humectant and a penetration enhancer to facilitate the absorption of active substances through the skin.

HPMC is prepared by adding aquadest to form a thick colloid. Bajakah root extract, propylene glycol, and Tween 60 are mixed together and then blended with the prepared HPMC, stirring until homogeneous. The homogeneous mixture is carefully poured into a Petri dish to avoid bubble formation. The Petri dish containing the mixture is then placed in an oven at about 40°C for 4–6 hours until a dry patch sheet is formed. The patch is subsequently cut to a size of approximately 1 cm × 1 cm, corresponding to the content of the bajakah root extract and adjusted to the rat's weight.

The manufacture of transdermal patches involves several main components, such as matrix polymers that form the physical structure of the patch, moisturizing agents that maintain its flexibility and moisture, and permeation enhancers that increase drug penetration through skin layers—especially the stratum corneum(Maulira, 2025). One commonly used polymer is Hydroxypropyl Methylcellulose (HPMC). HPMC serves as a flexible and strong film matrix capable of holding the drug and other additives within the patch formulation. The

manufacturing process begins by dispersing HPMC into heated aquadest, forming a homogeneous gel that serves as the base of the patch matrix. The correct HPMC concentration influences the thickness, weight, moisture absorption, and folding endurance of the patch, thereby supporting both physical stability and user comfort (Wardani, 2021).

To enhance drug absorption through the skin, patches are usually formulated with surfactants as permeation enhancers and emulsion stabilizers. Tween 60, a nonionic surfactant, is often chosen because it increases drug solubility and stabilizes the patch matrix. With its high HLB value (approximately 14.9) and hydrophilic characteristics, Tween 60 helps retain moisture in the patch and improves physical attributes such as thickness and adhesion to the skin. The combination of Tween 60 and HPMC produces a patch matrix with good mechanical properties and controlled drug release.

The drying process of the developed transdermal patch is a crucial step to achieve optimal physical properties, such as appropriate thickness, flexibility, and adhesion. Drying is generally performed in an oven at a relatively low temperature—around 40°C—for 4–6 hours. A temperature of 40°C is selected so that solvents like water and ethanol can evaporate gradually without damaging the matrix-forming polymers or active substances in the patch. Drying at this temperature maintains the product's physical and chemical stability, preventing material degradation or structural changes that could reduce its therapeutic effectiveness.

This drying method also serves to reduce excess moisture, resulting in a patch that is dry, non-sticky, and flexible enough to adhere well to the skin without breaking easily. A drying time of 4–6 hours at 40°C is sufficient to ensure complete solvent evaporation while maintaining optimal mechanical properties. Furthermore, drying at a low temperature minimizes the risk of skin irritation or side effects that could result from overheating during patch application. After drying, the patches are generally stored in airtight containers to maintain product stability and prevent moisture absorption from the environment (Wandari et al., 2020).

Physical Trait Test

1. Thickness Test

   The thickness test was carried out with the aim of illustrating that the active substances in the preparation of the patch extract of the patch have been well distributed and appropriate in each patch. Patch thickness evaluation was performed using a coupler micrometer with an accuracy of 0.01 mm on three different sides of a randomly taken patch. Based on the evaluation of patch thickness, the results were obtained that patch F0 was used as a negative control because it did not have an extract with an average value of 0.12 and a standard deviation of 0.01. Formula I or F1 obtained an average score of 0.13 and a standard deviation of 0.01. Formula II or F2 obtained an average score of 0.14 and a standard deviation of 0.01. Formula III or F3 obtained an average score of 0.143 and a standard deviation of 0.015. Based on the results of the evaluation carried out for the patch thickness of the patchy bajakah extract, it meets the requirements of a good patch. The transdermal patch thickness requirement is no more than 1 mm (Andriani et al., 2024).

2. Fold Resistance Test

   The crease resistance test aims to see the ability of all concentrations of transdermal patches of patchwork extract to hold up to folds. This test is done manually

by folding the patch on two sides repeatedly until the patch is damaged or more than 300 times. In the folding resistance test, 3 replications were carried out, then the average value was calculated. The number of folds performed and the absence of damage shows the value of the resistance of the transdermal patch preparation. Patches are said to meet the criteria if they are resistant to folding more than 300 times (Andriani et al., 2024). Based on the fold resistance test conducted on each formula, the patch was able to withstand folds more than 300 times, both F0 patches were used as negative controls because they did not have extracts, FI, FII, and FIII showed that the patchwork extract transdermal patches were eligible for resistance to folds. Patches are considered to have good folding resistance if they are able to withstand folding more than 200 times without damage. High folding resistance indicates good film consistency and durable patches during storage and use. In some studies, transdermal patches have shown resistance to folding up to above 300 folds, and the use of plasticizer materials such as propylene glycol can increase flexibility and prevent patches from becoming brittle and tearing easily (Rahmi et al., 2025).

3. pH Test

   The pH evaluation test aims to determine the suitability of the patch preparation formulated with the pH. of the skin. The pH test in this study was carried out by adding 10 mL of C02-free aquadest to the transdermal patch and letting it sit for 1 hour. pH is determined by using a pH meter on the surface of the patch.

   The measurement results showed that the pH value of each formulation varied but remained within the safe range (around 4.9 to 5.9), which generally corresponds to the pH of the skin so that the patch does not have the potential to irritate the skin during use. The average pH value for F0, F1, F2, and F3 is 5.46; 5,16; 5,46; and 5.06 respectively, showing pH stability in a fairly good range. This explanation is in accordance with the pH test procedures on transdermal patches in various pharmaceutical journals, which emphasize the importance of stable pH values to be comfortable for the skin and safe as a topical preparation (Rahmi et al., 2025).

4. Uji Organoleptik

   Organoleptic evaluation testing was performed visually by observing the physical characteristics of the patchwork extract transdermal patch which included evaluation of the shape, texture, and surface condition and color of the patch of the patch of patch of patch patch of patch patch extract patch. Based on the results obtained in table 4.3, it can be seen that the patch preparations of each formula do not have a significant difference in appearance but there is a slight difference in the color of each patch. The results of the evaluation for the F0 patch were used as a negative control because it did not have an extract obtained an unusual aroma, thin and flexible texture and surface conditions, clear white in color. For FI, FII, and, FIII have similarities that are extract-scented, texture and surface conditions that are smooth, even and crack-free. And each of these formulas has a difference in terms of brown, slightly dark brown, and dark brown. Based on the results of observations of transdermal patch preparations, patchy bajakah extract can be said to meet the criteria of good organoleptic testing in accordance with previous research, where organoleptic evaluation of transdermal patch

preparations with conditions considered good when the surface looks dry and there are no cracks (Andriani et al., 2024).

5. Weight Uniformity Test

The weight uniformity test on the patch of patchy bajakah extract transdermal patch was carried out by weighing the patches of each formula that had been made. Patches were taken randomly as many as three patches and then weighed using an analytical balance. Based on the results of the evaluation carried out, the results for the F0 patch were used as a negative control because it did not have an extract with an average value of 0.33 and a standard deviation of 0.04. Formula I or F1 obtained an average score of 0.32 and a standard deviation of 0.04. Formula II or F2 obtained an average score of 0.35 and a standard deviation of 0.01. Formula III or F3 obtained an average value of 0.37 and a standard deviation of 0.01. This test is based on the results obtained, the evaluation of the uniformity of the weight of the patch extract is eligible for the appropriate uniformity of weight. The patch is said to be uniform if the standard deviation value is ≤ 5% or ≤ 0.05.

Anti-Inflammatory Activity of Transdermal Gel Based on Bajakah Patchy Extract

1. General Analysis of In Vivo Test Results

The anti-inflammatory activity test was performed using male white rats (Rattus norvegicus) with acute inflammatory induction using a 1% carrageenan solution on the soles of the hind legs. This model is a reliable standard method for assessing anti-inflammatory potential because the resulting inflammation resembles an inflammatory process in humans, characterized by an increased volume of edema. The bajakah extract transdermal gel is then applied topically to the inflamed area and edema volume measurements are carried out periodically for up to 6 hours after induction .

The results showed that the negative control (gel base without extract) did not decrease the volume of edema, in fact there was an average increase of -0.21 ml, indicating further inflammatory development. In contrast, a positive control (diclofenac sodium) showed an average reduction in edema of 0.45 ml (± 22–35% of post-induction conditions), proving the validity of the method and becoming a benchmark.

2. Anti-Inflammatory Activity Test Formula

The three formulas tested showed different results in anti-inflammatory effectiveness:

a. Formula 1 (F1) showed an average reduction in edema of 0.13 ml, with a percentage reduction of about 2.6–12%. This activity was lower than that of the positive control, but still indicated the anti-inflammatory effect produced by the bajakah extract. This weak effect can be attributed to the limitations of the extraxe used.
b. Formula 2 (F2) showed an average reduction in edema of 0.30 ml, with a percentage of 6–11%. This value is much higher than F1 and is close to positive control. The success of F2 can be seen from the use of quite a lot of extracts, so that flavonoids and tannins from bajakah extract can diffuse more effectively to the target tissue.
c. Formula 3 (F3) showed an average reduction in edema of 0.31 ml, with a percentage of 4–18%, which is the closest result to a positive control. The consistency of decreased edema across multiple replications suggests that F3 has stable effectiveness.

3. Pharmacological Mechanism of Bajakah Extract

   The anti-inflammatory effectiveness seen from F2 and F3 is closely related to the bioactive content of Tampala bajakah extract. Flavonoid compounds act as antioxidants and inhibitors of the enzyme cyclooxygenase (COX), thereby suppressing the synthesis of prostaglandins, the main mediators of inflammation (Hadanu & Wahyuningrum, 2023). Tannins are astringent, able to reduce capillary permeability and fluid infiltration, thereby reducing edema. Saponins, on the other hand, contribute to increasing the adaptive immune response, accelerating inflammatory resolution. Thus, the anti-inflammatory effect in this study does not come from just one single mechanism, but rather a combination of the activity of various compounds in the extract.

4. Comparison with Standard Drugs

   Although the edema-reducing values of F2 (0.30 ml) and F3 (0.31 ml) were not yet equivalent to diclofenac sodium (0.45 ml), these results were very promising. Given that the prepared tested is based on natural ingredients, the effects that are close to standard drugs already show significant potential for further development. In addition, the gastrointestinal and cardiovascular side effects that often appear with long-term use of NSAIDs can be minimized with the use of natural extract-based gels.

5. Implications and Significance of Research

   The results of this study confirm that the transdermal gel based on Tampala bajakah extract has effective anti-inflammatory activity, especially in formulas with penetration enhancers. The effectiveness of F2 and F3 shows that the transdermal formulation technology is able to optimize the potential of herbal extracts. These findings support the use of bajakah as an alternative to inflammatory therapy based on natural ingredients, as well as open up opportunities for commercialization of local Indonesian pharmaceutical products.

   In addition, the success of this in vivo test reinforces the empirical validity that the preparation meets three main aspects: (1) physical-chemical stability (proven in previous tests), (2) real biological activity, and (3) safety of topical use with physiologically appropriate pH.

CONCLUSION

Based on the formulation and evaluation of transdermal gel containing Bajakah Tampala extract (Spatholobus littoralis Hassk.), it can be concluded that the gel exhibits stable physical characteristics, including appropriate thickness, folding endurance, skin-compatible pH, and uniform weight. The extract yield of 19.4% indicates efficient extraction of bioactive compounds. Formulations containing penetration enhancers (F2 and F3) demonstrated superior physical stability and in vivo anti-inflammatory efficacy, reducing edema by 0.30–0.31 mL, which approached the effect of diclofenac sodium (0.45 mL). Therefore, the transdermal gel of Bajakah Tampala extract is effective as an anti-inflammatory agent, meets pharmaceutical quality standards, and holds promise as a safer, natural alternative to synthetic anti-inflammatory drugs.

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