

The Effectiveness of Providing Pineapple Core Gel (*Ananas Comosus* (L.) Merr) on Burns Healing Degree II in White Rats (*Rattus Novergicus*)

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ABSTRACT

Pineapple core can be an alternative in accelerating wound healing. Pineapple contains a proteolytic enzyme of bromelain, predominantly located in the pineapple core (*Ananas comosus* (L.) Merr). It has anti-inflammatory properties needed in the wound healing process, accelerates the inflammatory phase of the wound, and hopefully will accelerate it during the proliferative phase. The study aimed to analyze the effectiveness of pineapple core gel in recovering second-degree burns. This research formulated pineapple core as a moisturizer in gel preparations. The research methods employed an experimental study of pre-posttest with a control group design. They utilized 25 laboratory white mice (*Rattus Novergicus*) divided into five groups (each group 5 mice). The sample consisted of 5 treatment groups, namely group I (10% concentration), group II (20% concentration), group III (30% concentration), group IV (bioplacenton/positive control) and group V (negative control). The research obtained gel stability test of group I (viscosity 2.55 poise, pH 5.25, spreadability 5, comogen and gel dosage form), group II (viscosity 2.75 poise, pH 5.4, spreadability 5, comogen and shape gel preparation), group III (viscosity 2.8 poise, pH 5.2, spreadability 5, comogen and gel dosage form). In conclusion, group III (30% concentration) had more significant burn healing and a more stable stability test against storage than other groups.

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1. INTRODUCTION

Indonesia, as a tropical country, possesses a wealth of natural resources, encompassing both terrestrial and marine ecosystems. Among its abundant natural assets is the pineapple (*Ananas comosus*). The pineapple (*Ananas comosus* (L.) Merr) usually grows in the highlands up to 1-3000 meters above sea level and is a widely cultivated food crop commodity distributed across several areas. In Indonesia, people consume pineapples only on the flesh fruit, while the core and skin are discarded as waste or used as animal feed. Pineapple skin and core include organic waste that contains numerous nutrients and could be utilized. If left untreated as waste, it will contribute to environmental pollution. Currently, research for burns treatment has begun to be conducted by

many researchers. One of the herbal ingredients that have the potential to be developed for wound healing is pineapple core, pineapple hump waste (Pineapple comosusL. Merr.) It has not been utilized optimally even though it is known that pineapple humps contain bromelain enzymes and it is known that pineapple humps contain bromelain enzymes which have protease activity. (Mulyani et al., 2024) (Rusmini et al., 2019). Burn wounds are a major global health issue, often requiring extended treatment and associated with a high risk of infection and delayed healing. The search for effective, natural, and affordable remedies for burn treatment has led researchers to explore the therapeutic potential of plant-derived enzymes. One such enzyme is bromelain, a proteolytic enzyme complex predominantly found in pineapple (*Ananas comosus*), particularly in its stem or core. The pineapple core (also referred to as the stem or central axis) contains the highest concentration of the enzyme bromelain compared to other parts of the fruit, such as the pulp and peel. Activity of bromelain extracted from the pineapple core reached 0.33 U/mg after dialysis, which is significantly higher than the 0.21 U/mg measured in the pulp. Furthermore, the purification fold for bromelain.

Extracted from the core was recorded at 141 times that of the crude extract, compared to only 108 times for bromelain from the pulp. This suggests that the core is a more potent and enzymatically active source of bromelain. (Ilyas, 2020). Similarly, (Mossfika et al., 2024) found that bromelain extracted from the pineapple core exhibited notable antimicrobial activity against *Staphylococcus aureus*, further supporting the notion that the enzyme concentration in this part of the fruit is particularly high. Additionally, bromelain isolated from the pineapple core possesses dominant proteolytic activity. Although the total protein content in the pulp was higher, the core's protein profile was more heavily enriched in bromelain, indicating a higher proportion of functional enzyme. These findings highlight the core's superiority as a source of bromelain, particularly for biotechnological and pharmaceutical applications. In conclusion, based on converging empirical evidence from multiple recent studies, the pineapple core is recognized as the richest and most active source of bromelain in terms of both enzymatic activity and purity. (Fissore et al., 2023)

Bromelain, a proteolytic enzyme extracted from the stem and fruit of *Ananas comosus*, has been shown to be clinically effective in accelerating wound healing, specifically burns and ulcers through the mechanism of selective debridement of necrotic tissue. A recent meta-analysis of ten studies with a total of 596 patients showed that topical use of bromelain significantly accelerated eschar removal (mean acceleration = 3.9 days), as well as lowering the need for surgical excision and skin transplantation (low odds ratio) compared to standard care without increasing the risk of long-term complications. (Sudarman et al., 2025) This proves that bromelain from pineapple is able to clinically improve wound healing efficiency. Other clinical studies have shown that in burns treated with bromelain enzyme debridement, post-procedure pain management is better than other methods, with minimal use of anesthesia, small blood loss, and satisfactory long-term aesthetic results (Laurens Acevedo et al., 2025). Every human being in the world has felt wounds, including second-degree burns. Second-degree burns are the most common type of burn in the world, requiring attention and care so that infection does not occur. (Ji et al., 2023). It is stated that women are the highest victims of burns. Globally, the mortality rate due to burns reaches 27% and almost 70% of them are women. (Thedjakusuma et al., 2022)

Given these properties, researchers have been motivated to investigate the effectiveness of topical formulations, such as gels made from pineapple core extract, in accelerating burn wound healing. Such studies aim to provide a natural, cost-effective alternative to synthetic burn treatments, while also promoting the sustainable use of agricultural byproducts. This line of research aligns with global trends toward the development of bioactive, plant-based therapeutic agents and has significant implications for both clinical practice and local resource utilization

2. RESEARCH METHOD

The research employed a laboratory experimental study with a post-test design with a control group. It was conducted at the Kusuma Husada University Laboratory, Surakarta. The sample utilized a white rat (*Rattus Novergicus*) which was provided a wound. The research materials were; pineapple core that has been peeled and separated from the ripe fruit flesh, and the thorns removed; white mouse (*Rattus Novergicus*); and Bioplacenton. The research procedure commenced with the preparation of tools and materials, followed by the manufacture of pineapple core gel through the maceration method. The maceration method is an extraction technique that is commonly used in obtaining bioactive compounds from plants, including pineapple cores (*Ananas comosus*). This process involves soaking simplicia powder in a solvent such as 70% ethanol or water for several days at room temperature without heating, making it ideal for extracting thermolabile compounds such as bromelin. Bromelin is the main proteolytic enzyme in pineapple cores that is known to have anti-inflammatory, antimicrobial, and antioxidant activity. Maceration is carried out in a duration of 72 to 120 hours with a solvent-to-ingredient ratio generally 1:10, and produces extracts with good yield and enzymatic activity (Fissore et al., 2023) Extraction was performed at the Kusuma Husada University Surakarta Laboratory using the maceration method with 70% ethanol diluent. Subsequently, the gel base was prepared. The tools operated heat induction, thermometer, stopwatch, caliper, glassware (Pyrex), Viscoster RION (VT-04E RION), rotary evaporator

(Reidolph), and caliper. The materials used in this study were pineapple cob, HPMC SH 60 (Bratachem), methylparaben (Bate Chemical Co. Ltd.), propylparaben (Bate Chemical Co. Ltd.), propylene glycol (Bratachem), bioplacenton, test animals namely male rats, aquadest and 70% ethanol. The procedures were as follows:

1. Making Pineapple Core Extract

Pineapple cobs are thinly chopped and dried in an oven at 70°C. A 500 g sample is subjected to extraction using the Maceration method, with a solvent ratio of 70% ethanol at 1:3 for four days. The resulting extract is dried using a water bath to produce a dry extract.

2. Making Pineapple Core Extract Gel

The gel was formulated according to the composition in Table 1, with each ingredient weighed. HPMC was dispersed into 30 ml of water at a temperature (80-90°C) until it swelled and stirred until it formed a clay (gel). The stirring process should be performed under cold conditions, specifically in a basin containing ice cubes. Methylparaben and propylparaben were mixed in 15 ml of propylene glycol, after which the extract was added until mixed. The mixture was combined with the HPMC clay mixture and stirred until homogeneous. Cold water was added to achieve 100.0 grams of gel, which was packed in a tightly sealed tube.

3. Stability Test of Pineapple Core Gel

Stability tests of pineapple core gel include tests of viscosity, pH, dispersion, homogeneity, and organoleptic.

Data analysis was performed in two stages: univariate analysis and bivariate analysis. The calculated data underwent the Shapiro-Wilk normality test to assess whether the data in each group was normally distributed ($p > 0.05$). The bivariate analysis in this study utilized One Way ANOVA with a significance level ($p < 0.05$) to see the effect of pineapple weevil concentration in all treatment groups. Ethical clearance from health research ethics committee Dr. Moewardi Hospital, Central Java, Indonesia with the number of ethical clearances 709/VI/HREC/2021.

3. RESULT AND DISCUSSION

3.1 The distribution of mean pre- and post-intervention group I (10% concentration), group II (20% concentration), group III (30% concentration), group IV (bioplacenton/positive control) and group V (negative control).

Table 1. The distribution of mean pre- and post-intervention

Group	Average (Pre)	Average (Post)
Extract 10%	67	9,4
Extract 20%	68	5,2
Extract 30%	69,2	0,2
Positive control	68,2	1,4
Negative control	68	3,8

Results of the univariate analysis presented that the 10% extract group had an average wound area of pre-67 and post-9.4. The 20% extract group had a pre-68 and post-wound area of 5.2 while the 30% extract group had a pre-69.2 and 0.2 post-wound area.

Table 2. The results of the data normality test

Variable	df	p value
Wound area	25	0,724

The results of the data normality test using Shapiro Wilk obtained a value of 0.724. Therefore, $p\text{-value} > 0.05$ then the data was normally distributed.

Table 3. The effect of pineapple core gel in each treatment group was compared with the positive and negative groups

Group	Comparison	p value
Extract 10%	positive	0,046
	negative	0,154
Extract 20%	positive	0,373
	negative	0,005
Extract 30%	positive	0,080
	negative	0,000

The results of bivariate analysis using independent t-test by comparing the intervention group with the positive and negative control groups. Based on the results above, it demonstrated that the group that had a comparison of 10% extract is compared to the positive control with a p-value of 0.046. There was a difference between the 20% extract and the negative control with a p-value of 0.005. There was a difference between the 30% extract and the negative control p-value of 0.000.

Table 4. The difference between pineapple core gel is the most effective in healing burns degree II

Group	Pre	Post	LSD	p value
Extract 10%	67	9,4	5.20200	
Extract 20%	68	5,2	11.13400	0,000
Extract 30%	69,2	0,2	21.73400	

Based on the one-way ANOVA analysis, a p-value of 0.000 was obtained. There was a significant difference between the 10%, 20%, and 30% groups based on a comparison with the negative control group. The most efficient group in healing wounds was the 30% extract group with the highest LSD value of 21.73400

Table 5. Viscosity test data results

Formula	Viscosity Test (week)		
	1	2	3
I	2.5	2.55	2.55
II	2.7	2.75	2.75
III	2.8	2.8	2.8

As shown by these results, the stable viscosity test on storage was Formulation III. If the viscosity changes, it will affect the quality of the gel preparation

Table 6. pH test data results

Formula	pH Test (Week)		
	1	2	3
I	4,9	5	5,25
II	4,9	5,05	5,4
III	5	5,1	5,2

Based on the pH test data for Formulas I, II, and III over a 3-week observation period, they were within the standard range. The pH value of the preparation that meets the skin pH criteria and is not irritating is pH 4.5-6.5. (Wiyono et al., 2021)

Table 7. Spread Power Test Data Result

Formula	Spread power test (week)		
	1	2	3
I	4	4,5	5
II	5	5	5
III	5	5	5

The results of the Spreadability Test data for the gel preparations in formulations I, II, and III fulfilled the standards in the test. The dispersion range was 5-7 cm. Gel dispersion to determine the gel's ability to spread when applied to the skin, so that it is easy to find out whether the gel's dispersion ability is easy or not to be applied to the skin.

Table 8. Organoleptic Data Results

Formula	Organoleptic test (week)		
	Smell	Color	Consistency
	1	2	3
I	Aromatic	Light brown	gel

Formula	Organoleptic test (week)		
	Smell	Color	Consistency
	1	2	3
II	Aromatic	Dark brown	gel
III	Aromatic	Dark brown	gel

In view of the Organoleptic Test Research data revealed Formulation I (Aromatis, Light Brown, and Gel), Formulation II (Aromatis, Dark Chocolate, and Gel), and Formulation II (Aromatis, Dark Chocolate and Gel).

3.2 The Effectiveness of Providing Pineapple Core Gel (*Ananas comosus (L.) Merr*) on Burns Healing Degree II in White Rats (*Rattus Novergicus*)

Every human being's skin has a function as the main protector from the impacts of the outside environment. Therefore, it is very important to do skin care to prevent potential skin problems. Some of the problems that can arise on human skin include signs of aging, bothersome acne conditions, skin that loses moisture, the appearance of freckles, and wounds. Injuries can be caused by several things such as injuries due to physical, chemical, and burn injuries. To overcome skin problems, there are many products that rely on natural ingredients, are useful, easy to obtain, and can be felt by the community. Plant products have minimal side effects and have economic advantages due to their easy availability. (Fitri et al., 2023) Wounds have a variety of causes that can be grouped according to their type, including traumatic, pressure, vascular, metabolic, infection, and burns. Burns occur due to exposure to heat, chemicals, electricity, or radiation that cause damage to the dermis to the hypodermis depending on the severity. Understanding the types and mechanisms of these injuries is essential so that prevention and treatment strategies can be tailored to the right target. (Wojciech, 2023) Traumatic wounds caused by direct mechanical injuries such as punctures or strong friction Wound healing involves four steps: hemostasis, inflammation, proliferation, and remodeling. The goal of burn wound care is to fully restore the barrier function of the tissue as quickly as possible while minimizing infection, scarring, and contracture (Tatarusanu et al., 2023)

Pineapple (*Ananas comosus (L.) Merr*) is one example of a plant that has potential in the skincare industry. Pineapple fruit is a type of horticultural plant that is popular in Indonesia The results show that pineapple core extract contains several secondary metabolite compounds, kaloids, flavonoids, tannins, saponins, steroids, glycosides. Organoleptic assay all formulas have clear and transparent colors. (Fitri et al., 2023)

The results of another study stated that the inside of the pineapple stem or core contains various active compounds that are beneficial for skin health, especially in the wound healing process. Among its main ingredients, bromelain is known as a proteolytic enzyme that helps speed up the exfoliation of dead tissue and relieve inflammation. In addition, compounds such as vitamin C, flavonoids, and phenolics in pineapple core support skin cell regeneration as well as lower oxidative stress which generally slows down wound healing, including burns. The topical use of pineapple core extract has been studied in several studies and has been shown to stimulate collagen production as well as accelerate reepithelialization in mild to moderate burns. With this content, pineapple core has great potential as a natural active ingredient for wound skin care products. Pineapple cores are known to contain high levels of bromelain enzymes, especially the bromelain stem type, which has proteolytic, anti-inflammatory, and debridement effects capable of destroying dead tissue and reducing edema that supports burn recovery. (Fissore et al., 2023). Pineapple plants (*Ananas Comosus (L.) Merr*) belong to the Bromeliaceae family and contain a protein known as bromelain or sulfhydryl proteolytic enzymes. (Yulastri et al., 2024) In addition, other opinions say that pineapple core is also rich in phenolic compounds, flavonoids, and vitamin C which function as powerful antioxidants, help reduce oxidative stress and stimulate collagen synthesis and skin reepithelialization (Ng et al., 2023) The combination of these compounds makes pineapple core extract potentially a natural ingredient to accelerate skin regeneration and improve post-burn conditions.

Pineapple contains nitrogen, bromelain enzymes, and high amino acids to reduce the growth of bacteria in the mouth and plaque formation. In addition, pineapple also contains chlorine, iodine, and phenol as an antiseptic. Chlorine reacts with water to produce hypochlorite, which exhibits bactericidal properties. Iodine is the most potent bactericidal agent, capable of killing almost all pathogenic bacteria by causing protein agglomeration. Phenol denatures bacterial cell proteins, leading to bacterial cell death. The chemical content of pineapples includes water, crude fiber, carbohydrates, protein, bromelain enzymes, reducing sugars, flavonoids, and tannins. Tannins have antibacterial activity related to their ability to inactivate microbial cell adhesion. The content of the bromelain enzyme is more abundantly in the pineapple core. (Mosayan et al., 2022)

The analysis results demonstrated significant differences between the 10%, 20%, and 30% groups based on the comparison with the negative control group. The most efficient group in healing wounds was the 30% extract group, with the highest LSD value of 21.73400. Based on the average decrease in the second-degree burns area in each preparation, it indicated a reduction of 10% extract preparation from 67 to 9.4 after 15 days. The 20% extract presented a decrease in burn area reduction from 68 to 5.2 after 15 days. The 30% extract exhibited a decrease in burn area from 69.2 to 0.2 after 15 days. Considering these outcomes, it explained that the higher the dose or provided preparation, the more effective healing burns. Prominent from 3 different preparations, 10%, 20%, and 30% extract preparations, demonstrated that 30% preparations were faster than 20% and 10% preparations and 20% preparations healed second-degree burns faster than 10% preparations. The PH results of the 10%, 20% and 30% groups obtained PH values of 4.9-5.4. This indicates that the gel is safe for the skin. (Thomas et al., 2024)

Pineapple core gel with a concentration of 30% has been proven to be effective in accelerating the healing of burns because of the main content of bromelain which is proteolytic, anti-inflammatory, and able to selectively encourage the debridement process without damaging healthy tissues. In moderate to deep degree burns, bromelain functions to break down necrotic tissues, reduce edema, and accelerate skin reepithelialization, thereby accelerating the proliferation phase in the wound healing process. (Shah & Srivastava, 2024) A concentration of 30% is considered optimal because it provides enough active enzymes for the penetration of wound tissue affected by high temperatures and denatured collagen, while remaining safe for healthy tissue (Honardar et al., 2022). In addition, other antioxidant compounds in pineapple cores such as flavonoids and vitamin C support skin regeneration and prevent secondary infections. (Ng et al., 2023) The combination of enzymatic and antioxidant activity makes 30% pineapple core gel a promising natural topical therapy in burn management

In clinical studies, the application of bromelain to dermal burns in accelerating eschar removal, lowering the need for surgical excision and autograft, and supporting faster reepithelialization (Shah & Srivastava, 2024)(Sudarman et al., 2026). On a practical level, national animal studies have also shown that Carbopol-based bromelain gel preparations (albeit at lower concentrations) accelerate the healing of burns in rabbits without irritating effects. (Thomas et al., 2024) Bromelain demonstrated various fibrinolytic, antiedematous, antithrombotic, and anti-inflammatory activities both in vitro and in vivo.(Agrawal et al., 2022). The results of the study (Thomas et al., 2024) show that bromelain with Formula 1C (1%) as an efficient debridement agent as it is beneficial in burn treatment and tissue regeneration. This can be seen from the decrease in the diameter of the wound and visual observation where the wound has begun to be completely closed on the observation of the 15th day. This is in line with the results of peeling from (Mosayan et al., 2022) which shows that pineapple hump extract made in the form of wound plaster to heal wounds with a concentration of 15% has been proven to be effective in healing cut wounds within 3 days. The combination of bromelain's proteolytic, antiedema, and anti-inflammatory activity and gel packaging allows for effective therapeutic benefits in burn management. Pineapple also contains flavonoids, flavonoid compounds were found in all parts of plants in leaves, roots, wood, juice, flowers, fruits, and seeds, and create complexes with extracellular proteins through hydrogen bonds. Hydrogen bonding with extracellular proteins causes the bacterial cell membrane structure that contains proteins to become unstable. As a result, the permeability of the bacterial cell wall will be disturbed, resulting in bacterial cell death. Saponins could suppress bacterial growth because they reduce the surface tension of the cell wall that generates lysis (Minarni, 2019).

Various in vivo and in vitro studies have shown that bromelain anti-edematous, anti-inflammatory, anti-cancerous, anti-thrombotic, fibrinolytic, and facilitate the death of apoptotic cells (Varilla et al., 2021) Other research results also point to the skin of pineapple fruit to inhibit the growth of *Staphylococcus aureus* bacteria. (Waznah et al., 2021)

4. CONCLUSION

The most effective wound decrease was group III (30% concentration) because it had lower from pre result test 69.2 to 0.2 after 15 days in the post-results compared to other groups. The results of the bivariate test revealed a difference between group III (30% concentration) and the negative control with a p-value of 0.000. The multivariate test obtained a p-value of 0.000 with the group of the most efficient in healing wounds was group III with 30% concentration. Preparations that have good stability were groups I, II, and III because all groups have stability in storage conditions, namely viscosity, pH, dispersion, homogeneity, and gel.

The limitations of the research include that it is difficult for researchers to get pineapple hump waste, because it is rare for fruit traders to sell pineapples in a peeled condition. And the implication of this study is that this research can be advanced by combining other ingredients that can have a moist impact on the wound and accelerate cell proliferation, so that the wound will heal faster.

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