

The Study Utilization of Mangosteen (*Garcinia mangostana L.*) Peel Extract as a Gel-Based Burn Wound Plaster

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ABSTRACT. The industry in Indonesia is currently experiencing significant development dominated by workers in the informal sector. During the business/production processes, problems are often encountered, leading to injuries or wounds. Burn wounds are caused by heat sources such as fire, electricity, hazardous chemicals, and radiation. One natural substance with the potential to be used as an alternative treatment for burn wounds is mangosteen peel. Mangosteen peel contains active biochemical compounds, including flavonoids, tannins, xanthonenes, and alkaloid derivatives, which have anti-inflammatory effects that can aid in the wound-healing process by promoting collagen formation. Additionally, the presence of saponins in mangosteen peel makes it antibacterial. This research aims to explore the potential of mangosteen peel patches in the healing of burn injuries often experienced by informal industrial workers. The research method used secondary data through a literature review study. Article searches were conducted using keywords such as 'wound' and 'mangosteen peel.' Through the analysis of 10 articles, it was found that mangosteen peel has great potential to be utilized as a mangosteen peel patch, with a wound healing percentage of up to 83% over 21 days at an optimum concentration of 15%. The availability of patches made from mangosteen peel extract (*Garcinia mangostana L.*) is expected to assist informal workers or UMKM in addressing burn wounds they may encounter during work while also helping to utilize waste that would otherwise go unused.

1. INTRODUCTION

Industrialization in Indonesia is currently experiencing rapid development due to the influence of globalization and increased human needs [1]. In the process, goods or services are transformed into economically valuable and useful products [2]. The industry is divided into the formal and informal sectors, but the distribution of workers in the informal sector is more significant than in the formal sector [3]. According to data from BPS in 2019, the number of informal workers reached 74,093,224.00, while formal sector workers reached 55,272,968.00. As a small-scale economic industry, the informal sector has characteristics including 1) irregular activities, 2) lack of binding regulations or laws, 3) nomadic production places, and 4) not requiring specialized skills.

In the execution of business or production processes, the role of workers is essential to provide the best quality of service, increase business profitability, and respond to company needs. Therefore, worker productivity is one of the efforts to survive in the fierce competition in today's industries [4]. Considering the dominance of the informal sector in the industry, it is also a factor in the implementation of Occupational Health and Safety. However, the reality is that many work accidents still occur, including burn injuries experienced by workers. Research by Asilah and Yuantri, showed that 95.5% of workers in the tofu industry experienced work accidents, while 4.5% did not, from a total of 66 respondents surveyed [5]. One of the most common work accidents, especially among informal workers or small and medium-sized enterprises (UMKM), is burn injuries. According to data from RISKESDAS in 2018, women experienced more burn injuries than men, with the highest potential for burn injuries occurring in the self-employed sector. Prompt treatment of burn injuries is necessary to avoid infection in the affected area [6]. Infection is a disruptive factor in the healing process, with aerobic bacteria being the main contaminants in burn wounds. Improper treatment of burn injuries, such as using toothpaste, butter, oil, soy sauce, cold water, and similar substances, can exacerbate the severity of the burns [7]

Flavonoids are a chemical compound that has the potential to heal burn wounds. Flavonoids are known to have

anti-inflammatory potential through various mechanisms such as inhibiting the regulation of enzymes and transcription factors related to inflammatory mediators in inflammation. Flavonoid compounds can be found in various fruits, one of which is the skin of the mangosteen fruit. Mangosteen peel contains xanthone which is part of the flavonoid polyphenol group. This compound is greatest in the skin, namely 70-75%, while the flesh is only 10-15% and the seeds are 15-20%. The highest xanthone content is found in mangosteen peel, namely 107.76 mg per 100 g of fruit peel [8]. Xanthone also plays an important role in accelerating the formation of collagen which helps in the maintenance and healing of burn wounds [9].

The use of mangosteen peel for healing burns can be made easier by using mangosteen peel extract as a hydrogel in plaster. The gel concept was chosen because it has a high water content, so it can hydrate the stratum corneum and reduce the risk of further inflammation due to oil accumulating in the pores. Through literature studies and literature reviews, we will discuss the potential of bioactive compounds in mangosteen peel in treating burns. It is hoped that through the literature review that has been carried out, researchers can use it to further develop burn plasters made from mangosteen peel.

2. MATERIALS AND METHODS

2.1 Data Collection Technique

The data collection technique used in this paper is through a literature review by gathering various sources obtained from several research journals available on the internet. This literature review was conducted online, which includes journals and articles that have been published and are relevant to the topic of this paper. Specifically related to the pharmacology of mangosteen peel patches for wound healing. Subsequently, the data obtained from journals, books, or other literature sources were analyzed to develop a suitable product concept for addressing the issue.

2.2 Data Processing

The collected data was processed using qualitative descriptive techniques to draw conclusions. In this study, the gathered data will be presented in the form of reports and descriptions. Through a qualitative descriptive approach, the data analysis will be presented in narrative form, aligning with the situation or condition being studied. Data processing was conducted objectively to avoid the writer's subjectivity in interpretation.

2.3 Data Analysis

Data processing in qualitative research was carried out during and after the data collection within a specific period. In this scientific paper, the author employed an interactive analysis model, which comprises four components: data collection, data reduction, data display, and conclusion drawing or data verification.

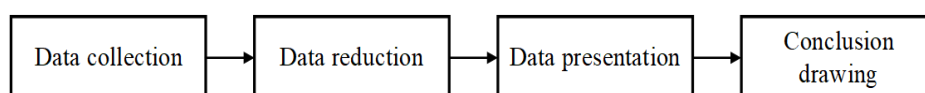


Figure 1. Data Analysis Model

In this research paper, a data reduction process was carried out through the selection and focus on the utilization of mangosteen peel in treating burn injuries. Based on the search, 10 articles published from 2017 to 2022 were obtained, which had relevant topics to the subject being discussed. Subsequently, data analysis was conducted on the data collected during the data collection process, resulting in a conclusion regarding the healing properties of mangosteen peel.

3. RESULTS AND DISCUSSION

3.1 The Concept of Burn Wound Plaster

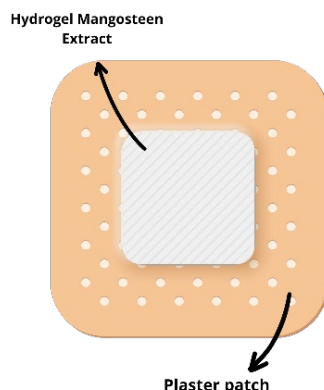


Figure 2. Design of Burn Wound Plaster Patch Product Based on Gel From Mangosteen Peel Extract

The plaster patch is a burn wound plaster designed in the form of a hydrogel with a waterproof adhesive. The hydrogel itself is a non-adhesive sheet containing cross-linked hydrophilic polymers. This component can absorb a significant amount of water without compromising the density or material structure [10]. Its gel-like form provides a cool and refreshing sensation on the wound, enhancing patient comfort. The functions of the hydrogel include maintaining a moist and soft wound environment, softening and debriding necrotic tissue without damaging healthy tissue, and reducing pain due to its cooling effect.

This plaster is made from mangosteen peel extract, pectin, gelatin, 70% ethanol, 98% glycerol, water, and citric acid. The extraction process is carried out by macerating the peel with an ethanol solution in a mass ratio of 1:10. The maceration process takes place for 5 days. The obtained raffinate is then evaporated in a rotary vacuum evaporator at 60°C for 6 hours to obtain a thick mangosteen peel extract [11]. Next, in the hydrogel synthesis, a pectin, gelatin, and citric acid solution is prepared. The pectin solution is made by dissolving 10%w/v pectin in water and stirring until fully dissolved. Then, gelatin is dissolved in 4%w/v concentration in 50 ml of water, and heated at 65°C until fully dissolved. The citric acid solution is prepared by dissolving citric acid in water and slowly mixed into the pectin solution. The cross-linking process begins by heating the solution at 100°C for 30 minutes. Subsequently, 1 mL of glycerol and 2 grams of the thick mangosteen peel extract are added and stirred until homogenous. The solution is then placed in a petri dish and dried at 55°C until completely dry, followed by the final molding process [12].

This dressing indication can be used for survivors of burn injuries categorized as type I and II. The use of the plaster from mangosteen peel extract helps absorb exudate fluid and prevents bacterial contamination on the burn wound, keeping it sterile. Before applying this plaster, make sure the skin has been rinsed with clean water. Then, the plaster can be directly applied to the surface of the burn-affected skin. The frequency of changing the plaster depends on the amount of exudate on the wound. If there is a significant amount of exudate, the product should be replaced regularly. If the exudate level is normal, the product can be changed every 2-3 days. The wound area does not need to be cleaned with each product change unless there are foreign objects or necrotic tissues in the wound. The substances visible, such as milk or pinkish areas on the wound surface, are epithelial cells and should not be cleaned. To remove contamination, use gloves and tweezers carefully to lift the edges of the plaster from the wound, and if necessary, rinse the wound with running water or a saline solution.

3.2 The Level of Effectiveness of Mangosteen Peel in Wound Healing

Table 1. Study the Level of Effectiveness of Mangosteen Peel on Healing Burns

Type of Plant	Result of Research
Mangosteen peel	This study used 3 rabbits with burns on their backs. The rabbit's back was burned with an area of 2 cm ² . The research results showed that a 20% Mangosteen Peel Extract exhibited a 22.16% wound-healing effect on burns in rabbits. The effect was not significantly different from Bioplasenton as the positive control. Based on the normality test, the results were significantly distributed normally with P>0.05, and the homogeneity test with P>0.05 indicated that the statistical data using analysis of variance showed significant differences in the effects among treatment groups (P>0.05). The One-way ANOVA statistical test indicated significant results,

	indicating a difference in the topical treatment effects on burn wound healing in rabbits. [13]
Mangosteen peel and watermelon peel	Mangosteen peel contains flavonoid compounds, such as xanthenes, which have anti-inflammatory effects. Each rabbit was burned using a hot metal plate with a diameter of 2 cm. Wound diameter measurements were taken for 14 days. The research results showed that the combination gel of watermelon peel and mangosteen peel extracts could reduce burn wound diameter. The effective formula was the Watermelon Peel Mangosteen Peel 75:25 formula with an average diameter of 1.29 cm.[14]
Mangosteen peel	The research results showed that the ethanol extract of mangosteen leaves contains triterpenoid, flavonoid, tannin, and saponin compounds that can provide pharmacological effects. Mangosteen leaves have high toxicity, with a Lethality Concentration 50 (LC50) value of 30,327 µg/mL. [15]
Mangosteen peel	All treatment groups showed more new blood vessel formation compared to the control group. The group with a dose of 200 mg mangosteen peel extract showed significant differences in new blood vessel formation compared to the control group and the groups with 100 mg and 150 mg mangosteen peel extract treatment ($p < 0.05$). Mangosteen peel extract was effective in enhancing angiogenesis in wound healing. [16]
Mangosteen peel	The research results indicate that mangosteen peel extract with concentrations of 5%, 10%, and 15% achieved healing percentages of 55%, 67%, and 83% respectively. This suggests that mangosteen peel extract at a concentration of 15% demonstrates optimum healing within 21 days. [17]
Mangosteen peel	The phytochemical content found in mangosteen peel extract includes flavonoids as antibacterial agents, tannins that accelerate the proliferation process, and saponins that stimulate collagen formation. The results of physical property testing indicate that mangosteen peel extract with ethanol concentrations of 2.5%, 5%, and 10%, respectively, is capable of increasing viscosity, pH, adhesive strength, and accelerating the healing of burn wounds. [18]
Mangosteen peel and 2-hydroxypropyl-β-cyclodextrin	This research indicates that the combination of alpha-mangostin in mangosteen peel with 2-hydroxypropyl-beta-cyclodextrin (α -mangostin/HP-β-CD) shows that this compound combination stimulates wound healing activity in mice. The wound area was measured after 7 and 14 days of treatment. Based on their observations, α -mangostin/HP-β-CD CX exhibited a faster wound closure rate compared to the control group. [19]
Mangosteen peel	This research used 32 female Swiss albino mice were divided into 4 groups and treated with creams containing mangosteen peel extract at concentrations of 5%, 10%, 15%, and a control group. The results showed that mangosteen peel extract improved wound healing and significantly reduced the number of inflammatory cells. Especially in the samples treated with concentrations of 5% and 10%. [20]
Mangosteen peel	The purified mangosteen pericarp extract (containing > 90% alpha-mangostin) in the healing of incision wounds in male white mice at a concentration of 1%, as assessed using the General Linear Model Repeated Measures test, demonstrated a significant difference ($p < 0.05$) in wound healing percentage. Furthermore, based on the T-test for epithelialization time, a significant difference ($p < 0.05$) was observed. [21]

Based on Table 1 of the reviewed article with publication years 2017-2022, shows the same research objective, which is to determine the effectiveness of using mangosteen peel extract in burn wound healing. Based on the results of the One-way ANOVA statistical test, indicates significant differences in the topical treatment effects for burn wound healing in rabbits. The wound healing activity with Mangosteen Peel Extract is related to the presence of active compounds in the extract that assist in burn wound healing, starting with the inflammation phase, where cell membrane permeability occurs, leading to inflammation, redness, and bleeding [13]. The effects demonstrated by watermelon peel and mangosteen peel are due to the presence of secondary metabolite compounds. The

compound gamma-mangostin in mangosteen peel extract has anti-inflammatory properties through COX-2 inhibition, thus accelerating the wound healing process during the inflammation phase [14].

According to the research by Pangow, mangosteen peel extract has an LC₅₀ value of 30.327 µg/mL. The extract can be considered toxic if it has an LC₅₀ value with a concentration of less than 1000 µg/mL [15]. The smaller the LC₅₀ value, the stronger the dependence on secondary metabolite compounds. The main compound found in mangosteen peel is xanthone, and within xanthone, there is an important component for wound healing called gamma-mangosteen. The presence of gamma-mangostin in mangosteen peel plays a crucial role in stimulating collagen formation, which is essential for maintaining the structure and wound healing action. Additionally, other compounds in mangosteen peel, such as flavonoids, vitamins B1, B2, C, saponins, and tannins, also contribute to accelerating wound healing.

Different concentrations of mangosteen peel extract showed significant differences in comparison. This means that variations in extract concentration affect the percentage of burn wound healing in Wistar rats. Increasing the concentration also increased the percentage of wound healing area. These concentrations have provided wound healing ability equivalent to the positive control or products already available in the market [22]. According to Khairani and Noverita, the extract of mangosteen peel cream has activity in accelerating wound healing. The optimal concentration of mangosteen peel extract for burn wound healing is 15%. [17]

3.3 The Potential Use of Mangosteen Peel as Burn Wound Plaster.

The treatment of wounds has traditionally relied on synthetic drugs such as red medicine, borax water, and sulfate powder. However, these wound medications have dangerous side effects, including toxicity to the brain and nerves, as well as hypersensitivity reactions on the skin. Therefore, there is a need for wound healing medications that are skin-friendly, one of which is the patch plaster. Patches are crucial for wound healing, especially for burn wounds. Leaving wounds open causes the new cells on the surface to dry out, which can worsen pain. Wounds also require moisture to accelerate healing, and covering them with a patch will expedite the healing process. Additionally, wound patches are useful for protecting wounds from dirt, bacteria, and further infection. These plaster patches were designed to have low oxygen permeability, leading to higher oxygen pressure on the wound surface, resulting in faster collagen formation in the surrounding tissue naturally.

The choice of using mangosteen peel as the material is due to the significant amount of waste generated. Generally, only the fruit flesh is used when consuming mangosteen, while about three-quarters of the fruit peel is discarded. Furthermore, Mangosteen Peel Extract contains Flavonoid compounds that have antibacterial, anti-inflammatory, and antioxidant properties. The compounds saponin and tannin stimulate angiogenesis and function as antiseptics, promoting the formation of new cells.

In the long term, the plaster has the potential to reduce the amount of fruit peel waste in Indonesia, creating a more comfortable and cleaner environment. Moreover, from a functional perspective, utilizing mangosteen peel waste can help accelerate burn wound healing while increasing the value of mangosteen peel itself. The use of this plaster also aligns with the SDG's (Sustainable Development Goals) objectives, specifically Good Health and Well-Being and Responsible Consumption and Production. Therefore, plaster from extracted mangosteen peel is hoped to be widely produced and marketed, even internationally.

4. CONCLUSION

The phytochemical compound flavonoids found in mangosteen peel has promising potential for use as burn wound patches. Flavonoids have specific biological effects related to anti-inflammation through various pathways, such as inhibiting prostaglandin biosynthesis, inhibiting phosphodiesterase, and various other important mechanisms. In the future, further research is needed regarding the utilization of mangosteen peel extract as burn wound patches. This includes the addition of new materials that can enhance the functionality of mangosteen peel-based burn wound patches.

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