

Contents of Banana Peel Extract as Hemostasis in Wound Healing

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ABSTRACT

Background:Wound healing is a response to tissue damage that includes both molecular and cellular processes for tissue repair. In several studies, it is often found substances in plants that help in the process of stopping bleeding such as flavonoids, saponins, and tannins. These three ingredients are owned by Kepok banana peels(*Musa paradisiaca L.*).Flavonoids have an effect on capillary blood vessels, saponins have a hemostatic effect by reducing blood clotting, and tannins can have a vasoconstrictive effect on capillary blood vessels. In Kepok banana peel waste, it is found that the content of saponins, alkaloids, tannins, and flavonoids.**Objective:**To make systematic review the banana peel extract's content as a hemostasis in wound healing.**Methods:**The data was collected by searching the literature on article search sites, namely Google, Pubmed and Science Direct which were published from 2011 to 2021, the search was carried out in January 2021. The data search was carried out systematically using keywords *wound healing, banana peel extract*.**Result:**After eliminating duplicate articles, the titles and abstracts of each article were analyzed across 122 articles excluding 94 articles. The full-text articles in the remaining 10 articles were analyzed again and 28 articles were excluded.**Conclusion:**Recent literature shows that the extract content of banana peels has been described as having bioactive compounds which can be an alternative in wound healing.

Keywords:*Banana Peel Extract, Hemostasis, Wound Healing*

INTRODUCTION

Wounds are a condition that arises from damage to body tissues. In healing wounds, the body has a physiological reaction to restore the condition and shape of the injured part, back to its normal and ideal shape. Wound healing is a response to tissue damage that includes both molecular and cellular processes for tissue repair.^{1,2}

When a wound occurs, a bleeding process will occur. Under normal conditions the bleeding will stop within 2-7 minutes and will heal after going through several phases of wound healing.³The wound healing phase that plays the most role is the inflammatory process and the body's ability to return to a hemostatic state to facilitate the regeneration process of the wound and also the cleanliness of the wound from microorganisms.³The duration of wound healing can be influenced by several factors, including infection, age, drug consumption and the condition of the wound that was not cleaned.⁴

Hemostasis is a normal mechanism by which the body stops bleeding at the site of damage or injury. There are three main steps in hemostasis, namely: (1) vascular spasm, (2) platelet plug formation, and (3) blood coagulation (formation of blood clots). Platelets have a key role in hemostasis which plays a major role in forming platelet plugs.⁵

The first aid measure for bleeding is applying external pressure to the wound to temporarily stop the bleeding so that the torn vessel can be surgically closed.⁵ In addition, it can also provide blood clotting drugs to accelerate the occurrence of blood clots, such as administration of epinephrine as a vasoconstrictor or tranexamic acid as an antifibrinolytic. However, the use of these drugs has side effects that can affect the systemic circulation whereas tranexamic acid can cause vascular events (myocardial infarction, stroke, pulmonary embolism, deep vein thrombosis).

In Indonesia, consumption of bananas is in great demand by various groups. Banana is one type of fruit that contains antioxidants, vitamins and minerals that are important for the body. One part of the banana that can become waste is banana peel. Traditional ingredients have the advantages of being more effective, non-toxic and cost-effective, becoming increasingly popular. Ideally an agent would promote healing without causing adverse side effects.⁶ So that encourages scientists to conduct research related to traditional ingredients such as banana peel waste as an alternative to wound healing.⁷

In several studies, it is often found substances in plants that help in the process of stopping bleeding such as flavonoids, saponins, and tannins. These three ingredients are owned by Kepok banana peels (*Musa paradisiaca L.*).^{2,8,9} Flavonoids have an effect on capillary blood vessels, saponins have a hemostatis effect by reducing blood clotting, and tannins can have a vasoconstrictive effect on capillary blood vessels. In Kepok banana peel waste, it is found that the content of saponins, alkaloids, tannins, and flavonoids.⁸ Therefore, this systematic study aims to examine the content of Kepok banana peel extract as a hemostatis for wound healing.

MATERIALS AND METHODS

Data Source

The data was collected by searching the literature on article search sites, namely Google, Pubmed and Science Direct which were published from 2011 to 2021, the search was carried out in January 2021. The data search was carried out systematically using keywords *wound healing*, *banana peel extract*.

Research Criteria

A. Inclusion criteria

1. Articles published from 2011-2021
2. Articles in English
3. Scientific articles that have been published and are available online
4. An article that examines the content of banana peel extract as a hemostatis in wound healing

B. Exclusion criteria

1. Articles included in systematic reviews, literature reviews, case reports, interviews, and editorials

2. Articles that cannot be accessed for online free

Data Collection

The data that will be used in this research are secondary data. The data is obtained from articles that are searched for in the article database which will then be reviewed according to the research criteria set by the researcher.

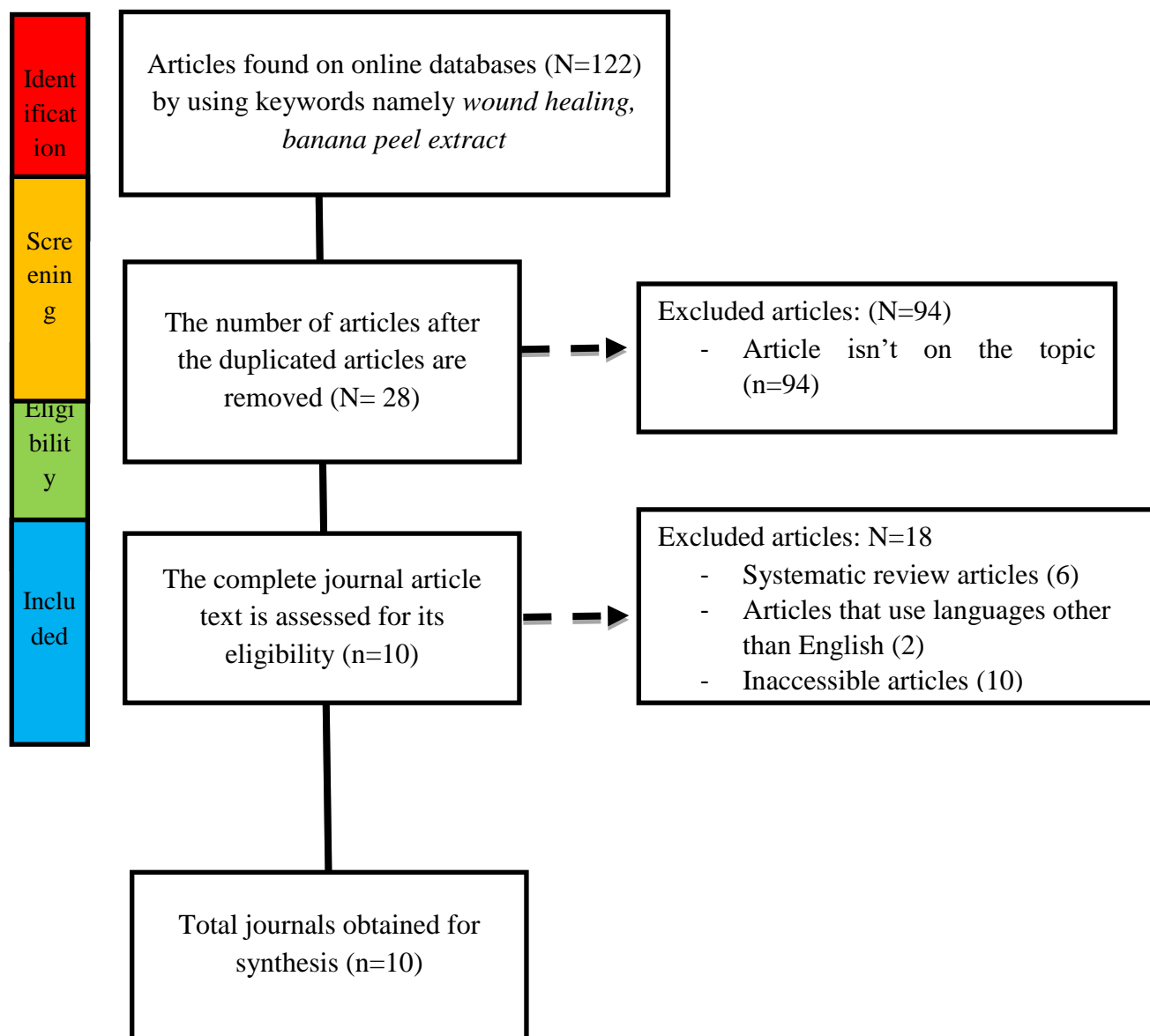


Figure 1. A diagram showing the selection of articles for review

Literature searches were conducted on online databases, namely Google, Pubmed, and Science Direct using keywords namely wound healing, banana peel extract, there are 122 articles found. After eliminating duplicated articles, the titles and abstracts of each article were analyzed across 122 articles excluding 94 articles. The full-text articles in the remaining 10 articles were analyzed again and 28 articles were excluded.

Table 1. Research of banana peel extract's content as a hemostatis in wound healing

No.	Author	Year	Title	Conclusion
1.	Tamri, et al ⁷	2016	Evaluation of the wound healing activity of the hydroalkolic extract of banana peels in rabbits	Research shows that the hydroalcohols in banana peel extracts improve wound healing in experimental animals. Wound healing is assessed by wound contraction and epithelialization rate and tensile strength in the wound tissue which is measured or observed through histopathological and clinical examinations.
2	Rao, et al ¹⁰	2016	The activity of antiulcer extract from heart and banana peel extracts against ulcers in albino rats	The healing properties of banana peel extract are due to its flavonoids, glycosides and phenols which have an antibacterial effect, stimulate the immune system and regulate physiological processes, especially the healing process.
3	Camberos et al ³	2016	Wound healing and antioxidant bark extracts of <i>Musa paradisiaca</i> linn	The wound healing ability of banana peel extract is due to the presence of alkaloids, tannin saponins and phenols which are owned as antioxidants, thus affecting the effectiveness of tissue recovery which has a major role in the wound healing process as antioxidants.
4	Atzingen et al ¹¹	2015	Surgical wound repair in mice using raw banana peel gel (<i>Musa sapientum</i>) 10%	The 10% banana peel gel shows anti-inflammatory activity and stimulates wound healing with the presence of flavonoids such as leucocyianidin which have inflammatory and anticancer effects.
5	Bunga, Sufriadi ¹²	2020	Test the effectiveness of ethanol extract from kepok banana peel for healing cuts in rats	The ethanol extract of kepok banana kulis at a dose of 750 mg/kg body weight can improve wound healing in white rats effectively.

6	Enemchukwu et al ¹³	2014	Antiulser effect of water extract of raw banana peel on male albino wistar rats	The water extract from the raw banana peel has an antiulser effect which can be attributed to the phytochemical content of flavonoids, tannins and saponins.
7	Rita W et al ¹⁴	2020	The antibacterial activity and antioxidant capacity were selected in the methanol extract of local banana peels (<i>Musa sp</i>) cultivation in Bali	The content of flavonoid and phenolic active compounds in banana peels has the ability to inhibit bacterial growth (antibacterial) and accelerate wound healing (antioxidants).
8	Cheng YZ et al ¹⁵	2019	Wound healing was promoted in <i>Musa paradisiaca</i> extract in diabetic rats	Topical application of banana peel extract can improve wound repair in diabetic rats due to its antioxidant and antibacterial effects resulting in anti-inflammatory effects on wound healing.
9	Akpanyung et al ¹⁶	2019	The effect of methanolic fruit peel extract <i>Musa paradisiaca</i> through several hematological and biochemical indices in male Wistar rats	Banana peel extract contains bioactive compounds such as tannins, flavonoids and glycosides which are shown to provide positive results for modulation of hematopoietic activity on the ability to increase hemoglobin, PCV, RBC.
10	Rosida et al ¹⁷	2014	Increased expression of VEGF and re-epitheliasis of dermal wounds in the wound healing process after administration of banana peel extract	Topical application of banana peel extract has increased in various phases of healing through VEGF expression, collagen synthesis and re-epithelialization. The deposition of new collagen that is synthesized in the wound area increases the collagen concentration. Collagen fibers are found in flavonoids and catechins.

DISCUSSION

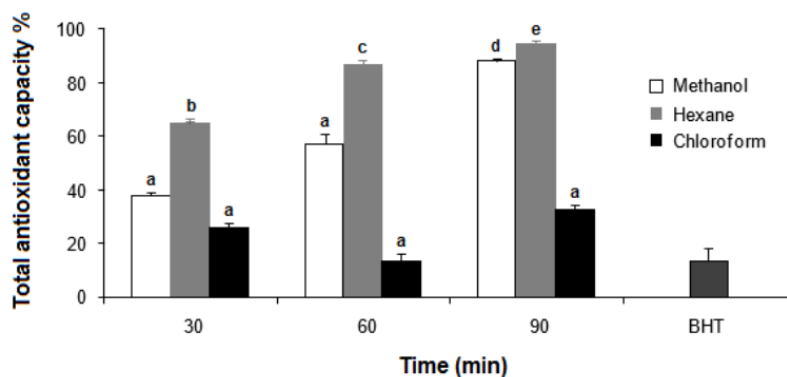


Figure 1. Total antioxidant capacity at different times of *Musa paradisiaca* peel extracts at a concentration of 100 mg/mL.

Source: (Camberos CD, et al. Wound healing and antioxidant capacity of musapradisiaca Linn. peel extract. Jpurnal of Pharmacy and Parmacognosy Research, 2016; 4(5): 165-173).²

Wound healing is the body's natural reaction to tissue injury that involves a series of cellular events that result in restructuring, reconstitution, and improvement in the tensile strength of the injured skin. In the wound healing process, collagen is the main extracellular protein in tissue granulation. After injury there is increased collagen synthesis to provide the integrity and strength of the matrix to the tissue. Wound healing involves 4 stages, namely, hemostasis, inflammation, proliferation, and tissue remodeling. Wound care continues to evolve with advances in treatment, but wounds are still a significant health problem worldwide, and can have severe complications.⁷

Table 1. Phytochemicals form the various solvent extracts of *Musa paradisiaca*

Extract	Glycosides	Phenols	Flavonoids	Saponins
Skin/peel	+	+	++	-
Flesh	+	+	+	-
Tepal methanol	++	++	+	+
Tepal Ethanol	++	++	+	+
Tepal Aqueous	+	+	+	-

Source: (Rao, USM, et al. Antiulcer activity of musapradisiaca (banana) tepal and skin extract in ulcer induced albino mice. Malaysian Journal of analytical science. 2016;20(5):1203-16).¹⁰

Peel waste as a natural source of antioxidants which is rich in essential minerals, especially high calcium content such as banana peels. Banana peels have antioxidant, anti-inflammatory and several biological activities such as wound healing, hypoglycemic, hepatoprotective, antimicrobial, antifungal and others.^{2,6,18,19,20,21,22,23} Raw navel skin also contains leucocyanidin which is a flavonoid that plays a role in inducing cell proliferation, accelerating the healing of wounds on the skin.^{11,24,25,26,27,28} Banana peel extract is considered to be a good antibacterial agent against gram-positive and negative bacteria.^{23,29,30} Banana peels are a source of potential bioactive compounds such as flavonoids and polyphenols that can eliminate free radicals.³¹ The therapeutic agent chosen for wound healing should enhance the healing process with minimal side effects.^{7,32,33}

The content of banana peels such as glycosides, anthocyanins, tannins, and flavonoids, phenols, saponins.^{16,20,24} Agents such as alkaloids can affect the phase of the

wound healing process.²The initial phase of wound healing inflammation occurs with increased vascular permeability, extravasation of plasma, erythrocytes, platelets, and leukocytes, especially neutrophils, monocytes and macrophages. The inflammatory response is an important step in wound healing in the preparation of the wound area for the repair process.¹¹

Flavonoids are a common bioactive group found in foods of plant origin. Besides having the ability to help the wound healing process, flavonoids also have a positive impact on general health, these impacts include the ability to prevent cardiovascular disorders. The antioxidant ability of flavonoids also helps in preventing atherosclerosis, due to the ability of antioxidants to form ROS or reactive oxygen species that reduce the level of inflammation in the endothelium of blood vessels. flavonoids may provide better protection by preventing progressive deterioration of pancreatic beta cell function due to oxidative stress and thereby reducing the incidence of type 2 diabetes. The results also indicated that banana peels were protective against ROS.^{25,34,35}

Flavonoids also have an impact on the nervous system and also have potential as anti-cancer, anti-tumor.^{26,36,37}On the nervous system, flavonoids have the ability to modulate neuronal function and slow down the degeneration of the nervous system that causes conditions such as Alzheimer's, Dementia and Parkinson's, while the anti-cancer potential possessed by flavonoids is able to inhibit the proliferation and activation of cancer cells.^{27,28}

Research conducted by Ambiga S et al, showed that the application of materials containing flavonoids had an impact on the final outcome of the wound, namely providing a more compact and similar tissue regeneration result to normal tissue.²⁹The tannin content in Kepok banana peel extract has bactericidal and bacteriostatic abilities, so that the presence of Tannin in the wound healing process can minimize wound healing obstacles that arise due to the presence of bacteria.^{38,39,40}

Tannin has antioxidant abilities that have an impact other than on wound healing abilities. It should be noted that Tannin is a polyphenol compound, just like flavonoids, so tannins also have the same systemic capabilities and effects as flavonoids, in this case tannins have the ability to inhibit the development of cancer cells. Another thing that tannins have and differ from flavonoids, in the context of their systemic impact, is based on research conducted by Ghosh D et al and Mitra E in 2013 and 2014 with quoted in further research from Ghosh D in 2015, showing that tannins have the ability to detoxify the body for heavy metal content such as cadmium and lead.^{30,31} Tannins, saponins, alkaloids are reported to play a role in improving wound healing due to their antioxidant activity.²

The content and impact both locally on wound healing as well as on systemic properties of flavonoids and tannins, indicate the potential for the utilization of these 2 polyphenol compounds in the medical world. It should be noted that neither in animal experiments nor in humans have shown a negative impact from the consumption of foods containing flavonoids and tannins.^{31,32,41}

The healing properties of banana peel extract are due to its ingredients such as antibacterial, stimulating the immune system and regulating physiological processes, especially the healing process.^{10,33}The use of banana peels is a good alternative for the treatment of wounds on the skin.^{42,43}

According to research conducted by Vipa and Chidchom, cited in research by Espinosa et al, found that the Tannin content in the Kepok banana peel extract (*Musa*

paradaisica) is 1130mg TAE (Tannic Acid Equivalents)/100g of banana peel, this amount is higher than the results of Espinosa et al's research on 3 other banana variants, namely *Musa cavendish*(209mg/100g) *Musa cavandanaishandMusa acuminata* (154,5mg/100g).³⁴Tannin works by inhibiting the process of forming substrates and enzymes from certain microorganisms so that these microorganisms experience inhibited development, tannin toxicity can damage the membranes of these microorganisms.^{35,36}Besides containing flavonoids, Kepok banana peels also contain high Tannin content so that the extract from the Kepok banana peel also has anti-microbial properties.³⁷

With the discovery of the content of these two phenolic compounds in the peel of Kepok banana, there is a potential for the banana peel to affect wound healing time due to the anti-inflammatory ability of flavonoids and the anti-microbial content of Tannin. Apart from that, Kepok banana peels as a medium to help heal wounds, can reduce the build-up of waste production from commercial use of Kepok bananas.³⁸

In Camberos et al's study carried out by administering methanol and hexanoic extract of banana peels, it was observed that the wound healing process occurred, there was thickening with the addition of collagen fibers and the presence of cellular infiltration of fibroblasts. The methanol and hexane extracts from banana peels can accelerate wound healing.²

In Atzingen et al's study, the use of 10% banana peel gel extract significantly increased the inflammatory response on postoperative day 14. This increase in inflammation includes a response that contributes to a reduction in healing time. Lack of neutrophils in the blood does not appear to affect tissue repair in the absence of infection. Re-epithelialization occurs several hours after injury by migration of epithelial cells from the margins. Fibroplasia and vascular proliferation play an important role in wound healing because they are involved in the formation of granulation tissue.¹¹

Additional factors that can affect wound healing time are poor nutrition, age and protein, deficiencies of vitamins and minerals. Several drugs have also been found to have the effect of slowing wound healing such as glucocortoids, NSAIDs and chemotherapy agents.^{39,48}Flavonoids work by inhibiting cyclooxygenation or lipooksigenase and inhibiting the accumulation of leukocytes in the area so that they can be anti-inflammatory.^{40,49,50,51,52,53,54,55}

Conclusion

Recent literature shows that the extract content of banana peels has been described as having bioactive compounds that can be an alternative in wound healing. Banana peels contain ingredients such as flavonoids, saponins, tannins and others that function as antioxidants, anti-inflammatory, antibacterial that help improve wound healing, so this systematic review can be used as a reference in developing alternative wound healing agents in the future, especially in the field of dentistry.

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