Journal of Midwifery and Nursing, 6 (3) (2024) pp. 646-658

Published by: IOCSCIENCE

Journal of Midwifery and Nursing

Journal homepage: www.iocscience.org/ejournal/index.php/JMN

Effectiveness of Honey in Healing Diabetic Foots in Indonesia: Systematic Review

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ARTICLE INFO

Article history:

Received Jun 15, 2024
Revised Jul 03, 2024
Accepted Jal 22, 2024

Keywords:

Diabetic foot;
Honey.

ABSTRACT

Diabetes Mellitus (DM) is a heterogeneous group of disorders characterized by increased blood glucose levels or hyperglycemia. People with DM are prone to developing sores on their feet. Such incidents have been attributed to three factors, namely the presence of sensory neuropathy, ischemia, and high plantar pressure. Therefore, it is critical to treat local wound infections early and aggressively. Wound treatment in Diabetes Mellitus patients can be done with non-pharmacological therapy, one of which is using honey. Honey has antimicrobial, anti-inflammatory effects and increases fibroblastic, angioblastic and has a small water content to speed up the wound healing process. Objective: This research is to determine the effectiveness of honey in diabetic foot therapy. Method: This research uses a Systematic Review based on Preferred Reporting Items for Systematic Reviews & Meta-Analyses (PRISMA) to identify all published articles using relevant databases and keywords. Results: Based on 25 journals reviewed, the results showed that honey is effective for use as diabetic foot therapy. Conclusion: honey is a good alternative choice in treating diabetic foot wounds. Honey contains antibiotics which function as an antiseptic and antibacterial to protect wounds and can help treat infections that occur in wounds.

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1. Introduction

Diabetes Mellitus (DM) is a disease characterized by an increase in blood sugar levels (hyperglycemia) due to both absolute and relative deficiency of the hormone insulin. According to the International Diabetic Federation (IDF), in 2021, it is stated that 537 million of the total world population or around 9.3% of adults aged 20-79 years. Basic Health Research (Riskesdas) shows a significant increase in the prevalence rate of Diabetes, namely from 6.9% in 2013 to 8.5% in 2018, bringing the estimated number of sufferers in Indonesia to more than 19 million. (1)

Complications in DM are divided into 2, namely macrovascular and microvascular complications. One of the microvascular complications that often occurs is peripheral neuropathy. Peripheral neuropathy is a cause of diabetic ulcers that is difficult to control. A decrease in pain sensation can

increase the risk of skin damage due to trauma or excessive pressure on the feet which then develops into lesions and infections. (2)

Diabetic foot wounds are always associated with infections which cause the wounds to become wider, resulting in ulcers and gangrene, and even amputation if the treatment given is not good. Diabetic wounds also have a wide impact, because they can result in death, morbidity, increased treatment costs, and decreased quality of life. (3)

Wound management in DM patients can be done with conventional and modern wound care. The use of modern dressings can be said to be more effective in reducing wound grade scores compared to conventional dressings. One alternative that can be used in wound care is using honey. (4)

Honey has ingredients that can cure diabetic foot infections (IKD), for example the catalase enzyme which functions as an antibacterial and because the water content in honey is less than 18%, it allows honey to attract pus around the wound area. The anti-bacterial properties of honey help treat infections in wounds and its anti-inflammatory action can reduce pain and increase circulation which influences the healing process. Honey also stimulates the growth of new tissue, so that apart from speeding up healing it also reduces the appearance of scars or scars in diabetes (5)

Honey has been used as an orthodox alternative medicine to treat wounds for thousands of years. Records from ancient Greece, Egypt, Indian Ayurveda, Hippocrates, Aristotle, and the Koran all refer to the healing effects of honey, and have now been rediscovered through rational clinical evidence that shows the most recent (10 years) successful treatment of honey on diabetic wounds. from various parts of the world. In Greece, a dressing infused with Manuka honey significantly reduced healing time and provided rapid disinfection of neuropathic diabetic foot ulcers in type 2 diabetes patients when compared with conventional dressings. (6)

Therefore, we carried out this systematic review to draw conclusions about whether honey is more effective in healing diabetic feet..

2. Methods

We searched the literature using PubMed, Science Direct, Google and Scholar databases. Medical Subject Headings (MeSH) terms include "Diabetic foot", "Foot ulcer", "Diabetic ulcer", "Diabetic foot", "Honey". The inclusion criteria used were all studies that evaluated the relationship between honey and healing of diabetic foot wounds, studies on humans or animals, using honey originating from Indonesia, research locations in Indonesia. The search was limited to publications and studies in the 2015-2024 time period and in Indonesian or English. Exclusion criteria included unavailability of full text and irrelevant articles. We screened and identified study titles and abstracts to determine articles that met inclusion and exclusion criteria. The Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) flow diagram depicting the study selection process is presented in Diagram 1. Information obtained from journals is then summarized and compiled using a narrative synthesis approach.

The risk of bias (ROB) was assessed by all authors using a standard approach and in accordance with guidance criteria for evaluating in-vitro studies with some adjustment. Fourteen parameters were identified as guidance criteria for quality assessment of final list of records for focussed evaluation. Broadly, these quality assessments include the standard criteria of the definition of the issue, the identification of purpose and hypothesis, the study design, the quality of the methodology for data collection, data analysis and manuscript drafting. If the report described the quality assessment criteria, the article received a "Y" (yes) on that specific parameter, if it was missing information, the article received an "N" (no). The scoring from all three reviewers were collated, averaged and the ROB calculated. Records that reported 0–5 items were considered as having high ROB (score +++), those reporting 6 to 7 items as having medium ROB (score ++), and those reporting 8–10 items as having low ROB (score +).

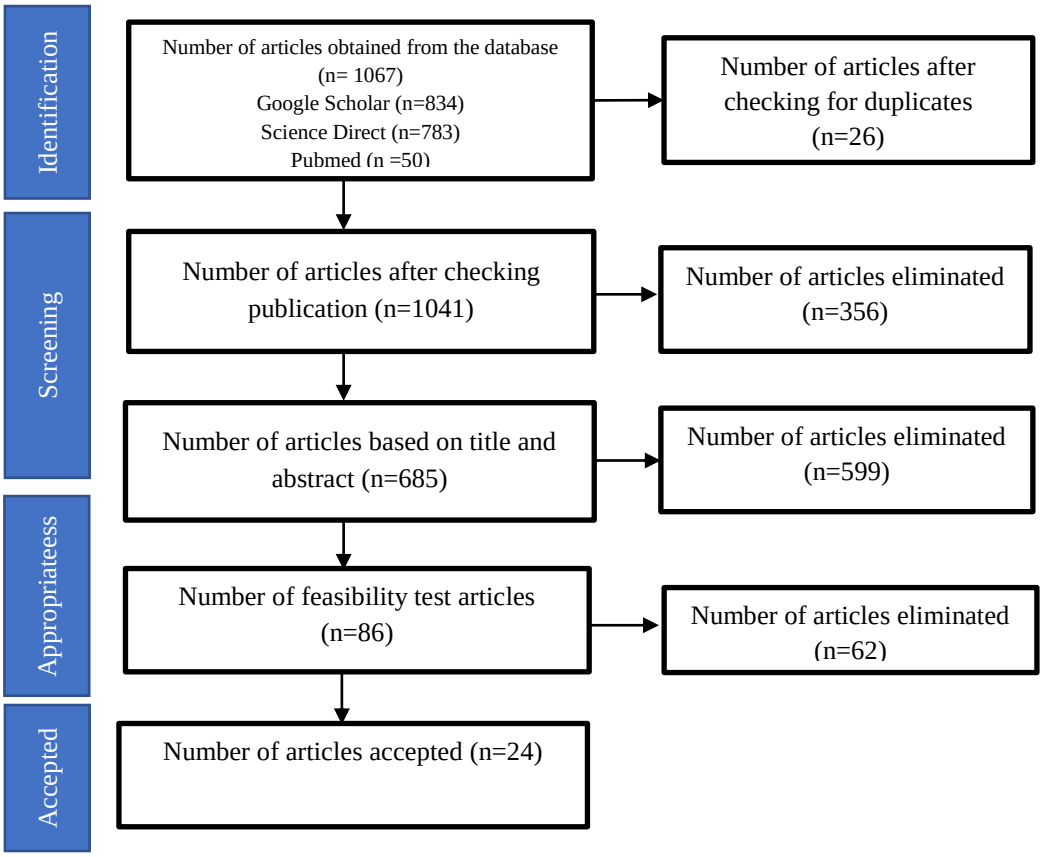

Diagram 1: Article Selection Flow

3. Results and Discussion

Based on Figure 1, the results of searching for articles from the selected database by entering keywords resulted in 1067 articles with details: 834 articles from Google Scholar, 783 articles from Science Direct and 50 articles from PubMed. Furthermore, the data obtained is entered into the next stage, namely the identification, screening, feasibility and acceptance stages, which are the methods used to analyze the search results that have been obtained. The search results were then checked for duplicate articles and 26 articles were found that were the same, leaving 1041 articles to be screened. From the screening results, the author excluded 356 articles because the articles were published before 2015, so the remaining 685 articles. Next, the articles were screened again based on the title and abstract, 599 articles were excluded because there were discrepancies in the article titles and abstract discrepancies, leaving 86 articles that would be tested for eligibility. At the feasibility test stage, there were 62 that had to be excluded because they did not match the inclusion criteria, so there were 24 articles that would be accepted and an article review would be carried out.

Table 1: Results of literature search regarding the effectiveness of honey in healing diabetic wounds

No	Author Name, Year	Study design	Participant	Intervention	Outcome
1	Purba, 2020	Quasi Eksperimental	Respondents were 20 patients with infected diabetic foot wounds.	The wound is cleaned with 0.9% NaCl then given pure honey and bandaged for a certain period of time.	The wound healing process given 0.9% NaCl and honey showed a fairly fast granulation process. The results of the Willcoxon p-value statistical test are 0.001 < α 0.05, so Ho is rejected and Ha is accepted, meaning there is a significant effect between giving

No	Author Name, Year	Study design	Participant	Intervention	Outcome
					real honey on diabetic foot injuries.
2	Kefani, 2018	Case study	The research sample was 2 patients with chronic diabetes mellitus wounds	Case 1, a diabetic foot ulcer that was unresponsive to surgical debridement and conventional wound care for three months. Case 2, gangrene in the left antebrachii (post necrotomy + exploration of multiple abscesses). The honey used is pure honey taken from the nectar of kapok flowers. The wound is then bandaged with sterile gauze smeared with honey.	Clinically visible tissue granulation and epithelization at the wound edges was observed and the size of the wound was reduced significantly with no reported side effects. Honey clinically stimulates epithelialization and granulation in the treatment of chronic wounds.
3	Lasito, 2021	Pre-Experimental with pre and post tests	The population in this study were 20 diabetes mellitus patients who were undergoing treatment for diabetic wounds	Diabetic ulcer wound treatment using honey and NaCl, 10 respondents were treated with honey and 10 respondents were treated with NaCl. The instrument used in this research was Bates Jansen	From the research results, before the honey therapy was carried out, the wounds were still undergoing regeneration and after the honey therapy was carried out, there was no wound regeneration. And the research results show that some of the wounds before being given NaCl therapy were still regenerating, whereas after being given NaCl therapy, the wound regeneration was no longer there. So it can be concluded that honey therapy and NaCl therapy can reduce the wound healing process in diabetes mellitus patients.
4	Sukarno, 2019	Case study	The population in this study was 10 patients with diabetic ulcers	Wound treatment was carried out on 10 respondents, 5 respondents were treated routinely with pure kapok flower nectar honey and 5 respondents were treated with modern primary dressings (dressings containing silver, cadexomer, and antimicrobial dressings) for 2 weeks.	Respondents who were given honey produced better wound healing and could improve wound size, type of necrotic tissue, reduce the amount of necrotic tissue, increase granulation, and increase epithelialization.
5	Awaluddin, 2019	Pre-Experimental and pre dan post test	The research sample was 20 respondents who suffered from diabetic ulcers	Respondents were divided into 2 groups, 10 respondents as a group wound care experiment with honey and 10 respondents as a group Wound care experiments with sofratulle.	Statistically there is a difference in the effectiveness of wound care using honey and sofratulle on the healing process of diabetic wounds. Based on the independent parametric t-test, it can be concluded that honey has higher effectiveness than sofratulle in healing diabetic wounds.
6	Suriadi, 2017	Case report	A total of 4 patients suffered	Case 1 was a patient with a diabetic ulcer due	This case report clearly shows that the use of honey dressing on

No	Author Name, Year	Study design	Participant	Intervention	Outcome
			from diabetic ulcers with different causes	to a pricked fish bone, Case 2 had a diabetic ulcer due to an insect bite, case 3 had a diabetic ulcer due to trauma and case 4 had a diabetic ulcer due to a furuncle. These 4 cases were treated with honey dressings which were treated with daily wound care.	wounds in four patients showed no allergic reactions, no significant side effects and no maceration; there is rapid elimination of wound odor, increased granulation and epithelialization, and reduced exudate. Meanwhile, the wound healing phase in four patients who used honey dressings showed variations in healing time depending on the size of the wound, condition of infection, and age.
7	Ritonga, 2016	Quasi Eksperimental	There were 31 people suffering from diabetic foot wounds, diabetic foot wounds with degrees 4 and 5 based on The Wagner Wound Classification System	Wound treatment is carried out with honey as topical therapy. 10 cm x 10 cm gauze smeared with 20 ml of honey. The gauze that has been smeared with honey is attached directly to the wound surface until the entire wound is covered. Fixomul stretch is used as a secondary dressing. This activity is carried out every 2 days for a maximum of 7 meetings (13th day).	The most common wound stage before intervention was grade 5 (necrotic gangrene), namely 16 research subjects (51.6%) and the remaining 15 research subjects (48.4%) were grade 4 (partial gangrene). Meanwhile, after the intervention, the majority of research subjects were grade 1, namely 17 research subjects (54.8%) but there were still research subjects, namely 8 (25.8%) who were still at grade 5.
8	Rahman, 2016	Quasi Eksperimental	Respondents were 15 people who suffered from grade II and III diabetic foot ulcers	The samples were given mixed honey which has a higher water content than real honey	The use of mixed honey for the healing process of foot ulcers at the Diabetic Foot Clinic, Ulin Hospital, Banjarmasin, showed effective results. On average, granulation grew on days 14 to 21 days of treatment.
9	Sundari, 2016	Pre-Experimental and pre dan post test	The total sample in this study was 10 people suffering from diabetic ulcers	The respondent had the wound cleaned with 0.9% NaCl liquid, dried with dry gauze, then 2-3 drops of honey are applied over the wound, leveled and covered with dry gauze then observed for changes in the wound.	The distribution of the degree of injury of respondents after honey therapy showed that of the 10 respondents, 4 people (40%) experienced moderate degrees, 3 people (30%) experienced mild and severe degrees. From these results it can be said that the majority of respondents in RW 011, Pegirian Village, Surabaya experienced changes in the degree of injury after honey therapy.
10	Sari, 2020	Quasi Eksperimental	The number of samples required in this study was 10 diabetic ulcer patients with grades II to IV.	This study consisted of 10 diabetic ulcer patients with details of 10 people as the control group and 10 people as the experimental group who were given calliandra honey therapy for 30 days.	The research results showed that there was a significant difference between the amount and color of tissue before and after calliandra honey therapy. Calliandra honey therapy is effective in the growth of granulation tissue in diabetes mellitus wounds.
11	Nuridayanti, 2022	Pre-Experimental	There are 20 diabetic ulcer	This research used aloe vera gel and pure honey	The research found that 2 respondents (10%) had

No	Author Name, Year	Study design	Participant	Intervention	Outcome
		and pre dan post test	patients at the Griya Husada Clinic, Kediri City	from the forest, then both ingredients were applied as topicals in wound care.	degenerated wounds that eventually regenerated, 5 respondents (25%) regenerated wounds that had healed tissue. Data analysis using Wilcoxon showed differences before and after wound treatment (p=0.008<0.05), so Ho was rejected and Ha was accepted. Conclusion: there is an effect of wound care using aloe vera and honey on healing diabetic wounds in diabetes mellitus patients at the Griya Husada Clinic, Kediri City.
12	Husaini, 2023	Quasi Experimental	The sample consisted of 60 people suffering from diabetic ulcers	The sample of 60 people was divided into 2 groups, namely 30 respondents using topical honey and 30 respondents using zinc cream.	The process of epithelizing diabetic foot wounds with topical honey treatment is faster than using zinc cream.
13	Fuadi, 2022	Case study	The case study subjects were 2 people suffering from diabetic ulcers obtained from purposive sampling	This study applies the use of honey in the treatment of chronic wounds. Wound treatment was carried out for 2 weeks with a frequency of 1 day, 1 treatment, then the wound was assessed using the Bates-Jensen Wound Assessment Tools.	The results of the case study of wound care with honey for 14 days and daily wound care using honey from both study cases showed that there was a decrease in the Bates-Jensen Wound Assessment Tools value at the wound edge point, type of exudate, granulation tissue and epithelialization.
14	Nabhani, 2017	Quasi Experimental	The sample in this study consisted of 4 diabetic ulcer patients who met the criteria	Subjects were compared before administering honey to the wound and after administering honey for 2 weeks.	From the results of the pairet t test data, the t count result is 5,000 and the p value is 0.015 because the t count result is 5,000 above the price or > t table: 2.35 and p < 0.05, it is concluded that there are benefits of honey to speed up the healing process of gangrene wounds so that the hypothesis that states exists The benefits of honey in healing gangrene wounds are accepted.
15	Riani, 2017	Quasi Eksperimental	The samples in this study were all 20 Type II DM patients with grade II gangrene who were hospitalized at Bangkinang District Hospital.	This study was divided into 2 groups, namely, a group of diabetic wound patients with 0.9% NaCl + pure honey treatment of 10 people and a group of diabetic wound patients with Moist Wound Healing treatment in the surgical treatment room of 10 people.	Based on the research results, it was found that there was a fairly large reduction in wound grade scores in the group using the Moist Wound Healing method compared to using 0.9% NaCl + Honey, which means that wound treatment using MWH was more effective than NaCl 0.9% + original honey.
16	Dwi, 2023	Quasi Eksperimental	one case of a patient who experienced	Wound care management with a TIME approach	Increased skin/tissue integrity with the color of the base of the wound being necrotic or

No	Author Name, Year	Study design	Participant	Intervention	Outcome
			diabetic ulcers for 5 months		sloughed has disappeared and turned red which is a granulation process and the edges of the wound are pink which indicates an epithelialization process.
17	Yanuar, 2023	Case study	Two people suffer from diabetes wounds in Wuryantoro Village	Treating Diabetic Ulcer Wounds using a honey compress and re-bandaging the wound. The instrument used in this research was Bates Jansen	There are changes in Mrs. S and Mrs. W before and after treating the wound with a honey compress. Development of Mrs. S, namely on the 6th day, experienced a change in the type of exudate which was initially purulent (thick yellow) to serosanguineous and for Mrs. W on the 5th day, the exudate type was initially serosanguineous and became bloody.
18	Yuslianti, 2021	Laboratory experiments	The research sample used 36 male Wistar rats. Samples were divided into positive control group (P1), negative control (P2), rambutan honey group (P3)	All mice were given palate injuries. Group (P1) was given alloxan induction and given wounds then given topical povidine iodine, group (P2) were rats without alloxan induction then given wounds then given topical povidine iodine, and group (P3) were diabetic rats and given wounds and topical rambutan honey.	The results of the study showed that rambutan honey could reduce the area of wounds on the 7th and 14th days and reduce levels of MDA free radicals in diabetes mellitus wounds.
19	Nengke, 2020	Quasi Eksperimental	This study used a sample of 20 people and divided them into 2 groups, namely the first group (A) was the group that was not given treatment and the second group (B) was given honey therapy.	Both groups underwent wound irrigation, wound debridement, then group (B) gave topical calliandra honey according to the condition of the wound, while group (A) did not give it, then bandaged the wound.	Treatment was carried out for 14 days, it was found that 4 people (40%) had dry wounds, 4 people (40%) had wounds that looked moist but no exudate was visible, 2 people (20%) had a small amount of exudate.
20	Nurman, 2015	Quasi Eksperimental	The sample for this study used 20 type II diabetes mellitus patients with gangrenous wounds in the work area of the Bangkinang City Community Health Center.	In the honey + 0.9% NaCl and 0.9% NaCl only groups, the intervention was carried out by dividing the respondents into 2 parts at different times, wound care was carried out every other day, on the 15th day the wound was healed again.	The results of the dependent T test show that there is a significant difference in wound care using honey + 0.9% NaCl, namely p value = 0.001 < α, and wound care using 0.9% NaCl, namely p value = 0.003 < α. The results of the independent T were that there was a comparison between wound treatment using honey + 0.9% NaCl and 0.9% NaCl alone.
21	Izzah, 2019	Case study	The case study subjects were patients with diabetes mellitus accompanied by diabetic foot	Subjects received 1 intervention in the form of treating diabetic wounds with modern dressings and honey.	There were significant changes in wound development starting from the first, third and fifth days of treatment. The results of the examination on day 1 showed that the Ankle Brachial Index

No	Author Name, Year	Study design	Participant	Intervention	Outcome
			wounds		(ABI) = 0.8, Woud bed slough 100%, there were signs of inflammation and edema. The results of the examination on the 5th day showed an ABI value of 0.6, the condition of the wound was identified as woud bed: slough 65, biofilm, granulation 35.
22	Ariansyah, 2023	Case study	The population in this study was 1 patient with diabetes mellitus.	Application of honey as a wound care medium	After the honey therapy intervention was carried out on the patient for 3 days. The results showed that: the wound improved, the wound area was 2 cm, the length of the wound was 5 cm, there was no necrosis, there was no push, the granulation around the wound improved, the hematoma was reduced.
23	Suarni L, Fitarina. 2019	Quasi Eksperimental	The sample consisted of 31 people suffering from diabetic ulcers with intervention using VCO: 11 people, Honey: 10 people and branded medicine: 10 people.	Wound care interventions are carried out according to the SOP, namely: the ulcer is opened and cleaned with Na.Cl + Gentamicin injection in a ratio of 1 tablet: 1 ampoule, and debridement is carried out for wounds with necrosis for dead tissue, the ulcer is smeared/given: VCO/Honey/branded medicine, The ulcer is wrapped with a sterile bandage.	There was a significant difference in the scores of diabetic ulcers before and after treatment using VCO, honey and branded drugs, while for the comparison of wound healing in the three preparations, the results showed that there was no difference in the scores of ulcers treated using VCO, honey and branded drugs.
24	Septiananda, 2023	Pre-Experimental and pre dan post test	The sample in this study consisted of 2 respondents who had diabetic ulcers	In this study, the degree of injury was measured on respondents who had diabetes wounds before and after honey therapy. Before implementation, wounds will be measured first using a pretest, then after implementation they will be measured again using a posttest	There was a decrease in the scores of both respondents on the wound scale after wound treatment was carried out for both respondents who obtained the results, The first respondent, Mr. S, experienced a decrease in the scale from 27 (regeneration) to 12 (tissue healed) and in the second respondent there was a decrease in the injury scale from 25 (regeneration) to 16 (regeneration).

3.1 General description

Based on the 25 journals reviewed, all journals found that honey was effective for use as diabetic foot therapy because it had a positive effect on healing diabetic foot wounds. An overview of the research design used in the research consisted of quasi-experimental (n=11), pre-experimental (n=6), case study (n=7), and Case Report (n=1). Most studies use quasi-experimental methods.

In several studies, honey was not only used for wound care, but several studies used a combination of honey with NaCl, Virgin Coconut Oil, aloe vera and zinc cream. Several studies have also compared wound dressings with honey and other ingredients.

3.2 Types of honey used in diabetic foot therapy

Based on 24 journals reviewed, there are several types of honey used for therapy for diabetic foot. 2 studies used calliandra honey, 1 study used rambutan honey, 2 studies used kapok flower nectar honey, 3 studies used pure honey and 16 studies did not mention what type of honey was used.

Honey is a thick, sweet liquid produced by bees, this material has long been used as medicine and research conducted in the last decade has shown the great benefits of honey. Apart from having an antimicrobial effect, honey also has anti-inflammatory properties and increases fibroblastic and angioblastic activity. (7) Honey is a thick liquid containing saturated sugar derived from flower nectar which is collected and modified by the Apis mellifera honey bee. Honey has the main content of approximately 30% glucose, 40% fructose, 5% sucrose, and 20% water as well as a number of amino acid compounds, vitamins, minerals, and enzymes. (8)

Honey contains antibiotics which function as an antiseptic and antibacterial to protect wounds and can help treat infections that occur in wounds. Honey also functions as an anti-inflammatory which functions to relieve pain, can maintain circulation which can help the wound healing process, accelerates the growth of new tissue so that it can fade scar tissue or scars on the skin. (9)

The wound healing process consists of an inflammatory phase, a proliferation phase, and a remodeling phase. In the inflammatory phase, honey can suppress this phase by activating neutrophils and macrophages. In addition, the antibacterial content in honey such as acidity and non-peroxide activity is useful for reducing microorganisms on the wound surface. Therefore, honey can prevent unnecessary delays in the wound healing process due to infection. In the proliferation phase, honey has the effect of stimulating blood vessel growth and accelerating angiogenesis, thereby increasing granulation. Honey increases myofibroblast activity in granulation tissue. Stimulation of fibroblasts can release connective tissue elements such as collagen which play a role in wound edge restoration and cause reduction in wound size. Furthermore, in the remodeling phase, honey is reported to increase epithelialization.(10)

Topical application of honey has an effect on wound granulation tissue in diabetes mellitus wounds. Granulation tissue is the growth of small blood vessels and connective tissue to fill deep wounds. Granulation tissue will be healthy if the color is bright, red like flesh. (11)

Honey has a water content of 18.25%: moisture/water activity (AW) of 0.58%: Hydrogen peroxide of 0.038 mmol/L: Acidity (pH) of 3.95: protein content of 0.29%: Fructose of 38 .87%: glucose by 29.98% and minerals by 0.20%. The average water content in honey is around 17% with an AW of 0.56-0.62. This does not support the growth of most bacteria which require an AW of 0.94-0.99. Bacterial growth is inhibited by hydrogen peroxide, apart from that only pathogenic bacteria can live at a pH between 4.0-4.5. (12)

The use of mixed honey in this case is a honey product that has been mixed with a water composition of approximately 20% which is made close to the water composition of real honey and research has been carried out and shows improvement in burns within a period of 21 days. (7)

In the wound healing process, calliandra honey has high antibacterial properties compared to other honey, the vitamin C content and the performance of peroxidase enzymes act as antioxidants and can protect cells. This peroxidase enzyme catalyzes/breaks down H_2O_2 into H_2O and O_2. Various studies say that for wound healing, a moist environment and good O_2 circulation are needed. Honey contains three times higher vitamin C than vitamin serum which is good for collagen synthesis. (13)

Research conducted by Hayati (2019) in assessing the sensitivity of kapok honey as an anti-bacterial showed that the concentration of kapok cattle honey effectively inhibited the growth of Staphylococcus aureus bacteria with a concentration of 80% with an inhibitory zone diameter of 20.5 mm and Pseudomonas aeroginosa bacteria with an inhibitory zone diameter of 10 .5mm. Honey's antibacterial ability is due to the presence of Reactive Oxygen and Nitrogen Species (RONS) from cold plasma with honey osmolarity, acidity (gluconic acid), and compounds (hydrogen peroxide). (14)

Natural honey contains ingredients that can heal diabetic foot wounds. For example, the catalase enzyme functions as an antibacterial and the water content which is less than 18% allows honey to attract pus (pus) around the wound area that is smeared with natural honey. (3)

By using real honey the wound healing process occurs more quickly, it has been proven that within 2 weeks there is a gradation of tissue in diabetes wounds which gets bigger and bigger. Honey contains lots of vitamins, acids, minerals and enzymes which are very beneficial for the body as traditional medicine, antibodies and anti-inflammatory drugs. growth of cancer cells or tumors. Apart from organic acids, honey also contains amino acids which play a role in making body protein (non-essential amino acids). Apart from non-essential amino acids, there are also essential amino acids, including lysine, histadine, tryptophan, etc. The properties of honey itself can foster good tissue granulation and create a moist effect (the wound will heal if the conditions around the wound are moist). (15)

3.3 The effectiveness of honey in healing diabetic wounds

Purba (2020) in his research on the use of honey on diabetic wounds used a wound dressing by first cleaning the wound with 0.9% NaCl then applying 3-5 cc of natural honey to the wound and bandaging it. Wound treatment was carried out for 50 days then observed and compared before giving honey and after giving honey, the results of the research showed that honey + 0.9% NaCl accelerated the granulation process of the wound, provided moisture to the wound, and the pus dried quickly. (15)

According to research, patients who treated DM wounds using 0.9% NaCl had better healing rates than patients who used other fluids. This is due to the nature of the 0.9% NaCl liquid which is a physiological fluid that is safer to use. 0.9% NaCl is an isotonic solution that is safe for the body, non-irritant, protects tissue granulation from dry conditions, maintains moisture around the wound and helps the wound undergo the process. healing and easy to obtain and the price is relatively cheaper. (16)

Research conducted by Lasito (2021) compared the use of honey for treating diabetic wounds with the use of 0.9% NaCl. Lasito used the Bates-Jensen Wound Assessment Tool (BJWAT) to meni

other changes in the wound. The results of this study prove that using 0.9% NaCl or honey gives good results, namely that wound regeneration stops after giving therapy. (17)

Sukano (2019) compared wound healing between those given pure nectar honey and those given a modern primer containing silver, cadexomer and antimicrobials for 2 weeks. Wound size assessment also uses the Bates-Jensen Wound Assessment Tool (BJWAT). Using the Wilcoxon test, the results showed that honey dressing was significantly associated with a decrease in wound size ($p = 0.043$), improvement in necrotic tissue ($p = 0.041$), a decrease in the amount of necrotic tissue ($p = 0.042$), an increase in granulation tissue ($p = 0.038$) and increased epithelialization ($p = 0.042$). In contrast, modern primary dressings were significantly associated with improvement in necrotic tissue type ($p = 0.046$) and increase in granulation tissue ($p = 0.042$).(10)

Awaluddin (2019) in his research entitled the difference in the effectiveness of honey and sofratulle in healing diabetic wounds, obtained statistical results, namely that honey had higher effectiveness than sofratulle in healing diabetic wounds. (18)

Research by Nuridayanti (2022), used a combination of honey and aloe vera to heal diabetic wounds. The results of the Wilcoxon statistical test obtained a p value <0.05, so Ho was rejected and Ha was accepted. So it can be concluded from the results of this study that there is an effect of wound care using aloe vera and honey on healing diabetic wounds in diabetes mellitus patients at the Griya Husada Clinic, Kediri City with a p-value of $0.008 < 0.05$. (19)

Husaini (2023) in his journal comparing wound care with honey and zinc cream, the results of the study showed that there was no significant difference in the epithelialization of wound tissue between the wound care groups with zinc topical cream and honey topical cream (p-value> 0.05), however Clinically, the process of epithelialization of diabetic foot wounds with topical honey treatment is faster than using zinc cream. The advantage of this journal is that it uses a comparison of therapies other than honey which can be used to treat diabetic wounds. (20)

Research by Dwi (2023) which provides wound care using the TIME approach (T: Autolytic debridement, I: wound washing with chlorhexidine, M: primary dressing using honey, secondary foam dressing and tertiary elastic bandage, E: consuming high protein). Wound care is carried out 3 times a week. After carrying out intensive wound care 3 times a week for a period of 1 month, it showed that

there was significant wound development in the client's wounds. In the first wound treatment after being evaluated for 3 days, it showed that there was a significant change, namely 80 percent of the wound base showed a red color, 20 percent of the wound color was yellow/slough. (11)

In contrast to other studies, Yuslianti (2021) conducted laboratory experimental tests on 36 mice which were divided into 3 treatment groups, group 1 of mice were induced by alloxan and given wounds then applied with povidone iodine, group 2 of mice without alloxan induction were given wounds and applied with povidone. iodine, group 3 was given wounds and smeared with honey. The results of this study prove that administration of rambutan honey can accelerate wound healing by reducing levels of MDA free radicals in the oral mucosal wounds of rats with diabetes mellitus. (21)

Suarni 2019 used a quasi experimental method to compare the effectiveness of using Virgin Coconut Oil, Honey and branded drugs. The results obtained were no significant differences between the three drugs. (22)

Research by Nangke 2020 and Sari 2020 which examined the effectiveness of using calliandra honey in healing diabetic wounds by testing pre and post administration of honey, both of these studies obtained results that therapy with calliandra honey was effective in the growth of granulation tissue in diabetes mellitus wounds. (13,23)

In the wound healing process, calliandra honey has high antibacterial properties compared to other honey, the vitamin C content and the performance of peroxidase enzymes act as antioxidants and can protect cells. This peroxidase enzyme catalyzes/breaks down H_2O_2 into H_2O and O_2. Various studies say that for wound healing a moist environment and good O_2 circulation are needed. Honey contains three times higher vitamin C than vitamin serum which is good for collagen synthesis. (13)

Honey is osmotic because it contains almost 20% water. This property of honey can improve the moisture balance in the wound and can ultimately trigger autolytic debridement. (24) Studies of the wound healing process show that a moist environment is more necessary for wound healing compared to a dry environment. A moist environment is the most important thing for wound healing because a moist environment affects the speed of epithelialization. The faster the growth of granulation tissue and epithelial tissue, the faster the wound will heal. (18)

Apart from an environment with balanced humidity, honey can also trigger autolytic debridement with the mechanism that honey stimulates the activity of protease enzymes in wounds. Activation of this enzyme in the wound will stimulate plasmin, where plasmin will break down blood clots in the necrotic tissue at the base of the wound. (24)

The wound healing process occurs more quickly using honey when compared with pharmacological therapy, it is proven that within two weeks the granulation tissue in diabetic wounds grows. Honey contains many vitamins, acids, minerals and enzymes, which are very useful for the body as traditional medicine, antibodies and inhibitors of the growth of cancer cells or tumors. (4)

Honey is one of the oldest medicines for the wound healing process that has ever existed, which focuses on treating or speeding up wound healing. The category of wounds in respondents can change from severe to moderate or light categories. This is also inseparable from the willingness and compliance of respondents to heal the diabetic wounds they experience, where they are always diligent in applying honey to the wound area every day and don't forget to balance it with setting the pattern. eat well and maintain cleanliness of the wound area. (12)

4. Conclusion

Several articles have been reviewed and it is known that honey is a good alternative choice in treating diabetic foot wounds. Honey contains antibiotics which function as an antiseptic and antibacterial to protect wounds and can help treat infections that occur in wounds. Meanwhile, to conclude that honey is one of the best alternatives in wound care, many randomized clinical studies are still needed that compare honey with various existing topical agents. A limitation in this research is that scientific journals discussing honey in wound care are still rare and some of the information needed was not found, such as detailed information about how much honey based on the type of tissue that can be used.

Suggestions for further research could be to further examine the amount of honey that is effective for healing diabetic wounds.

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