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Enhancing Wound Healing and Reducing Staphylococcus Bacteria in Diabetic Patients: The Impact of VCO

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KEYWORDS

Wound healing,
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ABSTRACT:

The delayed healing of wounds is a significant concern frequently encountered by individuals suffering from diabetes mellitus (DM). Virgin Coconut Oil (VCO) has garnered considerable attention as a promising treatment for promoting wound healing, supported by both laboratory (in vitro) and real-world (in vivo) studies. However, the use of VCO in treating wounds in DM patients is notably lacking in the current medical literature. This study's main objective was to investigate the potential effectiveness of VCO in enhancing wound healing in DM patients. The research involved 16 patients, who were divided into two groups: the control group and the intervention group, with each group comprising 8 participants. Over a 4-day period, wound care protocols were implemented, and subsequently, an evaluation of wound size, wound characteristics, and the quantity of Staphylococcus bacterial colonies within the wounds was conducted. Data analysis was carried out using an independent t-test with the support of SPSS version 20. The study's results revealed that the mean wound size in the intervention group was 0.8 cm, in contrast to the control group where it averaged 3.4 cm. This significant difference in mean wound size between the two groups was observed, with a p-value of 0.033, signifying statistical significance. Furthermore, a notable discrepancy in the average count of Staphylococcus aureus bacterial colonies was detected, substantiated by a p-value of 0.000. Consequently, this investigation indicates that the utilization of VCO may have the potential to expedite the wound healing process in patients with diabetes mellitus. However, it is crucial to emphasize the need for further research efforts to elucidate the mechanisms by which VCO enhances wound healing and to validate these findings on a larger scale.

A. Introduction

Diabetes mellitus (DM) is an escalating global health issue that continues to grow (Maruhashi, T., & Higashi, 2021). This upward trend not only affects the increasing number of individuals grappling with the condition but also contributes to the emergence of serious complications, such as non-healing diabetic ulcers (Monteiro-Soares, M., Boyko, E. J., Jeffcoate, W., Mills, J. L., Russell, D., Morbach, S., & Game, 2020). Diabetic ulcers,commonly found on the feet of diabetic patients, pose a significant health concern. These wounds are challenging to heal due to various factors, including

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prolonged inflammation, bacterial infection, inhibited angiogenesis, and the adverse effects of hyperglycemia (Chang, M., & Nguyen, 2021).

Hyperglycemia, characterized by consistently elevated blood sugar levels in individuals with diabetes, Plays a pivotal role in worsening the wound healing progression (Amin & Doupis, 2016). High blood sugar levels can damage blood vessels, impeding the flow of oxygen and nutrients necessary for wound healing. Additionally, hyperglycemia increases oxidative stress and worsens inflammation within the wound, all of which hinder the healing process and may lead to serious complications, including amputation (Eleftheriadou, I., Samakidou, G., Tentolouris, A., Papanas, N., and Tentolouris, 2021)

At present, clinicians have implemented a range of wound care approaches, yet the results remain far from desirable. Conventional therapies often focus on reducing inflammation and controlling bacterial infections, while enhancing epithelialization remains a challenge (Nur et al., 2020). Antibiotics, for example, primarily target bacterial colonization, with limited positive effects on the wound healing process. Therefore, there is a need to explore alternative wound care materials derived from natural sources that are accessible to the wider population, safe, and devoid of adverse side effects (Bakal et al., 2017).

Virgin coconut oil (VCO) stands out as a promising natural material for wound care (Soliman et al., 2018). VCO contains various compounds with anti-inflammatory, antiviral, antibacterial properties, and the ability to enhance angiogenesis in wounds (Ibrahim et al., 2017). Many studies have examined the benefits of VCO in wound healing, both in vitro and in vivo laboratory settings (Dafriani et al., 2020). Nevertheless, research regarding the effect of VCO on wound healing in diabetic patients remains limited.

Hence, the purpose of this study is to investigate the potential of VCO in wound care for diabetic patients. By comprehending the impact of VCO on wound healing, it is hoped that valuable insights will be gained to improve the management of diabetic ulcers and reduce the risk of serious complications in individuals with diabetes.

B. Materials and methods

1. Study Participants:

The respondents in this research are diabetic patients with wounds receiving treatment at the hospital. All patients have provided informed consent by signing an informed consent form. This research has received ethical clearance from the ethics committee of the Faculty of Medicine at Andalas University under the reference number 141/KEP/FK/2020.

2. Wound Treatment

Wound care is administered daily for a duration of 4 days, following the hospital's standard protocols. The wound is cleaned using 0.9% NaCl (normal saline) and sterile gauze to remove surface debris. In the intervention group, treatment includes applying Virgin Coconut Oil (VCO) to the wound surface, followed by dressing it with gauze. The VCO used is sourced locally from Sumatra Barat, Indonesia.

3. Data Collection

a. **Assessment of Wound Dimensions**: Wound size is determined by employing a ruler to compute the product of its length and width. Furthermore, daily photographs of the wounds are captured to observe any alterations resulting from the administered treatments.

b. **Collection of Wound Fluid Data:** Information is gathered through the swabbing of wound fluid.Colony counts are performed.

c. **Equipment for Obtaining Wound Swabs:** The tools used for collecting wound swabs include sterile cotton swabs, physiological saline solution (NaCl), sterilized gauze, sterile test tubes, labels, and markers.

d. **Swab Collection Procedure**: The procedure involves careful wound cleaning with sterile gauze and physiological saline. Sterile cotton swabs are then gently swabbed over the diabetic ulcer without touching the wound's edges. The swabs are placed into test tubes, labeled, and transported to the laboratory.

4. Bacterial Analysis

a. **Bacterial Culture**: Each test bacterium is inoculated onto Muller-Hinton Agar (MHA) plates using a zigzag streaking pattern and incubated for 24 hours at 37°C.

b. **Bacterial Staining**: Gram staining is performed to confirm the presence of Staphylococcus bacteria.

c. **Dilution Process**: The bacterial suspensions are diluted through a manual dilution method. The test bacteria suspension underwent dilution according to a manual dilution formula, which corresponds to

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0.5 McFarland (0.1µL of the ulcer sample + 100 µL of NaCl). After the absorbance fell within this designated range, the bacterial suspension was then further diluted to achieve the desired bacterial concentration for each well.

d. **Colony Enumeration**: The colony numbers are ascertained through the pour plate method. The basic principle behind the pour plate technique is that when viable microbial cells are cultured on agar medium, they will multiply and generate visible colonies that can be seen without the requirement of a microscope. The pour plate method is a microbiological counting method in which dilutions and culture media are prepared in advance. The dilution is dispensed in either 1 ml or 0.1 ml increments. In this procedure, the sample is initially placed into a Petri dish, and then agar medium is added to it.

5. Data Analysis Using Statistical Methods

The analysis of the data is performed with the utilization of SPSS version 20. An independent t-test is used to investigate the variances in means between the VCO and 0.9% NaCl groups. A significance threshold of $p < 0.05$ is applied to determine statistical significance among the groups.

C. Result

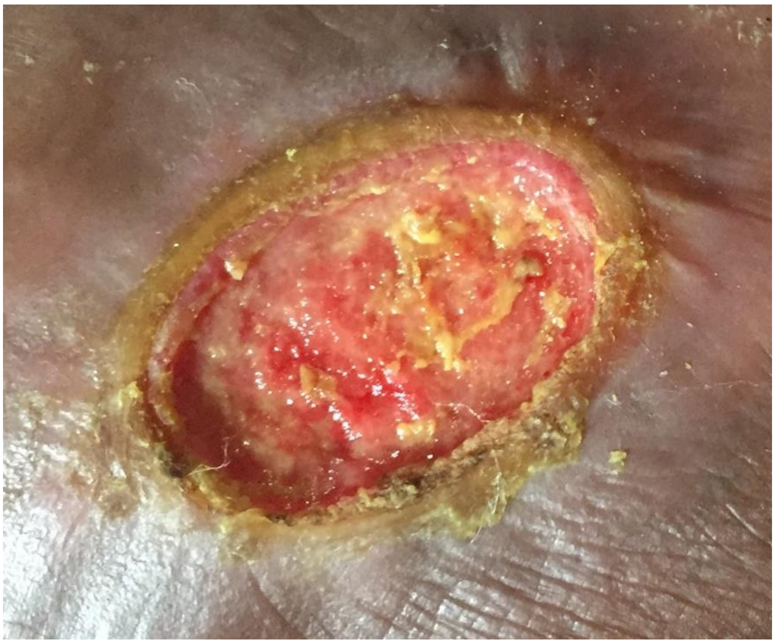

FIGURE 1. The visible characteristics of wounds in the therapeutic process group with VCO day 1

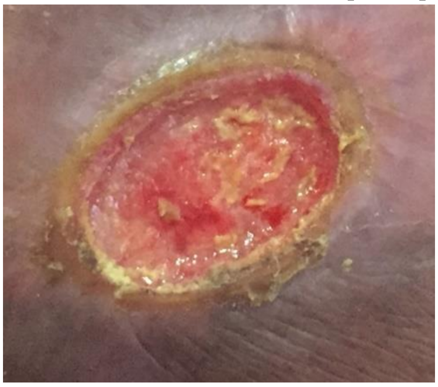

FIGURE 2. The visible characteristics of wounds in the therapeutic process group with VCO day 2

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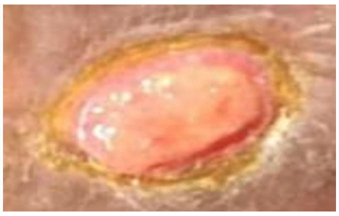

FIGURE 3. The visible characteristics of wounds in the therapeutic process group with VCO day 3

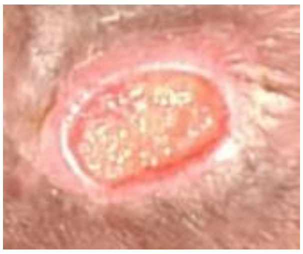

FIGURE 4. The visible characteristics of wounds in the therapeutic process group with VCO day 4

FIGURE 5. The macroscopic appearance of wounds in the treatment group with NaCl 0,9% day 1

FIGURE 6. The macroscopic appearance of wounds in the treatment group with NaCl 0,9% day 2

FIGURE 7. The macroscopic appearance of wounds in the treatment group with NaCl 0,9% day 3

FIGURE 8. The macroscopic appearance of wounds in the treatment group with NaCl 0,9% day 4

TABLE I. The Effect of Applying Virgin Coconut Oil (VCO) on Wound Size in Diabetes Mellitus Patients Following VCO Treatment in the Intervention and Control Groups

Wound Region	Category	Average	Standard Deviation (SD)	95% CI		P-Value
				Lower	Upper	
Post Test	Intervention	0,83	0,53388	-4,9235	-0,2365	0,033
Post Test	Control	3,41	3,04396	-5,1336	-0,0264	0,048

TABLE II. The Mean Count of Staphylococcus aureus Colonies in the Control and Intervention Groups for Diabetic Ulcers

Variable	Mean	N
Number of Staphylococcus colonies after administration VCO	38,88	8
Number of Staphylococcus colonies after administration NaCl	72,75	8

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TABLE III. The Effect of VCO on Staphylococcus aureus Colonies in Diabetic Ulcers

Variable	Mean	SD	P-Value	N
The Impact of Administering VCO for Wound Treatment on Staphylococcus Aureus Bacterial Colonization in Diabetic Ulcers within the Control and Intervention Groups	33.375	5.020	0.000	8

D. Dialogue

The findings of the study demonstrate that the utilization of VCO within the intervention group had a notable impact on the wound healing process in comparison to the control group. VCO contains a diverse array of nutrients and bioactive compounds that have the potential to stimulate the proliferation of skin cells, boost collagen synthesis, and facilitate tissue regeneration procedures, as evidenced in previous research (Narayanankutty et al., 2016). This could elucidate why patients within the intervention group witnessed a substantial reduction in wound size (Rajagukguk, H., Syukur, S., Ibrahim, S., & Syafrizayanti, 2017). There was a marked decrease in wound area within the intervention group, This suggests that VCO could potentially accelerate the process of wound healing in individuals with diabetes, as indicated by previous research (Nurul Aqilah A. Ghani, Amy-Arniza Channip, Phoebe Chok Hwee Hwa, Fairuzeta Ja'afar, Hartini M. Yasin,2018) (Refer to Figure 1 and 2).

The utilization of Virgin Coconut Oil (VCO) for wound healing has attracted interest in the field of medical investigation because of its potential antioxidant properties. VCO contains various antioxidant compounds that may aid in enhancing the process of wound healing (Nurul Aqilah A. Ghani, Amy-Arniza Channip, Phoebe Chok Hwee Hwa, Fairuzeta Ja'afar, Hartini M. Yasin, 2018). Here are some of the key antioxidant contents in VCO and how they can influence wound healing: **Lauric Acid**: Lauric acid is a major component of VCO. It possesses antimicrobial and anti-inflammatory properties that can help combat bacterial infections in wounds and reduce inflammation around the wound (Kuhlmann et al., 2019). **Vitamin E:** Virgin Coconut Oil (VCO) also contains vitamin E, a potent antioxidant that aids in shielding skin cells from oxidative harm triggered by free radicals, which can decelerate the wound healing process (Nagase, S., Matsue, M., Mori, Y., Honda-Ogawa, M., Sugitani, K., Sumitomo, N., …& Okamoto, 2017). Phenols: VCO comprises various types of phenolic compounds, which possess anti-inflammatory properties capable of reducing inflammation around the wound, thus potentially expediting the healing process (Kardinasari, E., & Devriany, 2020). Sterols: VCO includes sterols, such as beta-sitosterol, which can enhance skin moisture, a critical factor for optimal wound healing. Well-moisturized skin tends to heal more rapidly. Healthy Fatty Acids: Alongside lauric acid, VCO contains other beneficial fatty acids like caprylic acid and capric acid. These healthy fatty acids have the potential to support the normal inflammatory processes involved in wound healing. The application of VCO to wounds may assist in maintaining skin moisture, defending against infections, reducing inflammation, and promoting tissue regeneration (Wong, S. K., Rangiah, T., Bakri, N. S. A., Ismail, W. N. A., Bojeng, E. E. F., Abd Rahiman, M. A., ... & Teoh, 2019). Additionally, bacterial analysis revealed a significant reduction in the number of Staphylococcus aureus colonies in the intervention group's wounds. This suggests that VCO may possess antimicrobial properties that potentially inhibit the growth of pathogenic bacteria in diabetic wounds (Table 2,3). The reduction in the number of bacterial colonies may be attributed to the natural antimicrobial properties found in VCO (Widianingrum et al., 2019). Several components in VCO, such as lauric acid, are known to possess potent antibacterial properties and can influence the bacterial population on the wound (Febri Odel Nitbani, Jumina, Dwi Siswanta, 2016).

VCO may influence various molecular and cellular pathways involved in wound healing. This includes the regulation of gene expression that controls inflammation, cell proliferation, and collagen synthesis. These findings support the idea that VCO has the potential to be a beneficial adjunct therapy in the management of diabetic wounds. The anti-inflammatory and antimicrobial properties of VCO may play a role in expediting the healing process and reducing the risk of infection in diabetic patients (Suryani, S., Dharma, A., & Nasir, 2018).

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The clinical implications of this research are that the use of VCO may be considered as part of wound care in diabetic patients. Physicians and nurses may consider administering VCO as one of the components of wound care to expedite healing and reduce the risk of complications.

There are several limitations to be noted in this study. One of them is the relatively small sample size. Additionally, the study was conducted for only 4 days, and the long-term effects of VCO usage have not been explored. Further research with a larger sample size and a longer duration could provide deeper insights into the benefits of VCO in diabetic wounds.

E. Conclusions

VCO can enhance wound healing by reducing wound size and the number of staphylococcus aureus bacterial colonies. Future research could involve more control groups and incorporate additional measurements, such as patients' blood glucose levels. Furthermore, further investigation into the mechanisms of VCO in expediting wound healing could be a focus to better understand its impact on diabetic wounds.

Potential Conflicts of Interest

The authors state that they have no potential conflicts of interest.

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