Journal of
Food and Pharmaceutical Sciences

Original Article

Effect of Avocado Leaf Ethanol Extract Gel (*Persea americana* Mill) on Healing Diabetic Wounds

Wahyu Widyaningsih[1], Sapto Yuliani[1], Fairuz Khairunnisa Anasyua[2], Tasya Bahagia[1], and Risma Yuliawanti[1]

[1]Faculty of Pharmacy, Universitas Ahmad Dahlan, Yogyakarta, Indonesia.
[2]Nutrition Science Department, Faculty of Public Health, Universitas Ahmad Dahlan, Yogyakarta, Indonesia
*Corresponding author: Wahyu Widyaningsih | Email: wahyu.widyaningsih@pharm.uad.ac.id

Received: 21 October 2025; Revised: 10 January 2026; Accepted: 12 January 2026; Published: 25 April 2026

Abstract: Diabetic wounds are a major clinical challenge due to delayed healing and increased complication risks. Ethanol extract of avocado leaves (*Persea americana* Mill.) has previously shown promise in enhancing tissue regeneration in diabetic wounds, but its potential in gel form remains untested. This study aimed to develop an avocado leaf ethanol extract-based gel and evaluate its wound-healing potential in diabetic mice. Avocado leaves were extracted using 70% ethanol and formulated into a gel, which was evaluated for physical properties and topical suitability. Diabetic mice were divided into five groups: normal control, negative control (gel base), positive control (bioplacenton), and two treatment groups (5% and 10% gel). Diabetes was induced using alloxan (150 mg/kg BW), followed by wound induction and treatment. Wound healing was assessed through visual assessment, wound diameter reduction, and healing duration. Statistical analysis was performed using one-way ANOVA with a 95% confidence level. Results showed the gel meets physical properties (pH test, organoleptic test, homogeneity test, spreadability test) and significantly improved wound healing in diabetic mice. The 5% gel demonstrated wound-healing activity due to bioactive compounds such as saponins, tannins, alkaloids, and flavonoids. Further analysis is needed to identify the specific components responsible for the healing effects, highlighting the gel's potential for diabetic wound treatment.

Keywords: alloxan, diabetic wounds, gel, *Persea americana* Mill

1. INTRODUCTION

Diabetes remains a major health problem both in Indonesia [1] and globally. In 2021, the global prevalence of diabetes among individuals aged 20–79 years was 10.5% (536.6 million people), and it is projected to rise to 12.2% (783.2 million people) by 2045 [2]. One of the significant complications of diabetes is chronic wounds, which can develop into diabetic ulcers. Diabetic wounds are characterized by prolonged healing times and, if left untreated, can lead to serious infections and even amputation [3]. These wounds are typically associated with chronic hyperglycemia, which damages various organs and impairs the natural healing process. Wound healing involves a complex interplay between cellular, humoral, and connective tissue components, progressing through interconnected inflammatory, proliferation, and maturation phases. Fibroblasts, as the main cellular components of connective tissue, serve as the principal source of protein matrix synthesis essential for tissue repair [4].

Effective management of diabetic wounds is crucial, highlighting the need for the development of suitable wound healing preparations. Gels are among the most commonly used formulations due to their ease of application and patient comfort. Natural medicines have gained increasing attention as effective therapeutic sources, with avocado leaves (*Persea americana* Mill.) emerging as a promising candidate. Ethanol extracts of avocado leaves, particularly when fractionated with ethyl acetate and n-hexane solvents (2:1), have been shown to accelerate diabetic wound tissue

regeneration [5]. Avocado leaves are rich in active compounds, including saponins, tannins, alkaloids, and flavonoids [6]. Moreover, the secondary metabolites present in avocado leaf extracts exhibit antibacterial activity against *Staphylococcus, Pseudomonas, Proteus, Escherichia,* and *Bacillus* species [7].

The antioxidant properties of flavonoids protect wound tissues from oxidative damage, thereby promoting healing. Saponins stimulate collagen production, facilitating faster wound closure, while tannins act as astringents, shrinking pores and promoting new skin formation [8]. Alkaloids further support wound healing by strengthening collagen fibers, enhancing cell protection, and increasing DNA synthesis for new tissue growth [9]. Additionally, the antimicrobial activity of these metabolites contributes to faster wound regeneration [10]. Previous studies have demonstrated the potential of avocado leaf extracts in wound healing, with a 5% concentration of avocado leaf extract gel proving most effective in treating burns [11],[12].

This study aimed to formulate an avocado leaf ethanol extract gel that meets the required physical properties and to evaluate its activity as a diabetic wound healing. This research is significant as it provides a scientific foundation for the use of avocado leaf ethanol extract gel as an alternative treatment for diabetic wounds and supports the development of Indonesia's natural resources to enhance national pharmaceutical independence.

2. MATERIALS AND METHODS

2.1. Tools and Materials

The tools used in this study included a vernier caliper (Vernier Caliper®), a set of surgical instruments (Arugamed®), a glucometer (Accu-Chek®), a pH meter (Lutron Digital®), a magnetic stirrer (Thermo Scientific®), a biopsy punch (Ribbel®), a rotary evaporator (IKA®), an analytical balance (Kern-Germany®), and glassware (Iwaki®).

The materials used were avocado leaf extract from PT Rachma Sari Group, Sukoharjo, Central Java, with the following specifications: dry powder form, distinctive aromatic smell, brown in color, bland taste, and 1.70% moisture content, 0.9% NaCl solution (Otsu-NS®), alloxan monohydrate (Sigma-Aldrich®), ketamine (Pfizer®), Bioplacenton® (Kalbe®), 70% ethanol (Onemed®), Carbopol (Sigma-Aldrich®), triethanolamine (Sigma-Aldrich®), methyl paraben (Sigma-Aldrich®), and distilled water (Onemed®).

2.2. Extract Preparation and Phytochemical Screening

A total of 600 g of avocado leaf powder was extracted by maceration using 70% ethanol for three days. The maceration extract was concentrated using a rotary evaporator to obtain a thick extract and calculate the yield [13]. Phytochemical screening was performed by dissolving 0.5 g of the extract in 10 mL of ethanol [14].

2.2.1. Flavonoid Test

Extract 0.5 mL was mixed with 1 mL of ethanol, 0.5 g of magnesium, and 1 mL of concentrated HCl. A positive result is indicated by the appearance of yellow, red, or orange coloration.

2.2.2. Alkaloid Test

Extract 1 mL was mixed with 1 mL of ethanol and 0.5 mL of 2 M HCl. Then, 0.5 mL of the solution was transferred into a test tube, and 4–5 drops of Mayer's and Dragendorff's reagents were added. A white precipitate (Mayer's reagent) or an orange-red precipitate (Dragendorff's reagent) indicated a positive result.

2.2.3. Saponin Test

Extract 1 mL was mixed with 1 mL of ethanol and 1 mL of distilled water, then shaken vigorously. A stable foam formation indicated a positive result.

2.2.4. Tannin Test

Extract 0.5 mL was mixed with 1 mL of ethanol and 5 drops of 1% $FeCl_3$. The formation of a greenish-brown or blackish-blue color indicated a positive result.

2.3. Avocado Leaf Extract Gel Formulation

Methyl paraben was dissolved in a mortar until clear, followed by the addition of triethanolamine (TEA) and Carbopol, mixed continuously until a gel mass formed (Table 1). After the gel base was prepared, the avocado leaf ethanol extract was added and mixed until homogeneous.

Table 1. Avocado Leaf Extract Gel Formulation

Formulation	F1 (Base Gel)	F2 (5% Extract)	F3 (10% Extract)
Avocado leaf extract	0	5 g	10 g
Carbopol	1.5 g	1.5 g	1.5 g
Triethanolamine	1.76 mL	1.76 mL	1.76 mL
Methyl paraben	0.2 g	0.2 g	0.2 g
Aquadest	100 mL	100 mL	100 mL

The variation in extract concentrations in the gel formulation was intentionally designed to explicitly identify the optimal extract dose for promoting wound healing under diabetic conditions and to clearly evaluate the dose–response relationship between extract concentrations and wound healing efficacy.

2.4. Gel Physical Property Test

In addition, gel physical property tests were also conducted to evaluate the quality of the formulation, including organoleptic test, homogeneity, pH, and spreadability tests:

Organoleptic Test: Organoleptic testing is conducted by observing changes in the shape, color, and smell of the gel preparation during storage at room temperature [15].

2.4.1. pH Test

The pH of the gel is measured using a pH meter. The pH of each formula that shows stability is within the pH range of 4.0-7.0, so it can be concluded that the gel produced will not irritate the skin and meets the requirements for good physical properties and gel stability [15].

2.4.2. Homogeneity Test

Application of gel onto a clean, transparent glass plate; a homogeneous gel shows no insoluble particles [16].

2.4.3. Spreadability Test

To test the spreadability, 0.5 grams of gel was placed on a glass and then stuck onto another glass. After that, the diameter of each side of the gel was measured. To test additional loads of 50, 100, 150, 200, and 300 grams, the load was left for one minute. After that, the diameter of the gel was measured as before. The spreadability of a good gel preparation is 5-7 cm [16].

2.5. Animal Test

Healthy male Balb/C mice, aged 2–3 months and weigh 20–30 g, were obtained from UD. Abadi Jaya. Mice were housed under controlled conditions: temperature 23–25°C, humidity 60–70%, and a 12 h light/12 h dark cycle. All mice were acclimatized for 7 days under standard laboratory conditions and were provided with standard BR2 feed and drinking water *ad libitum*.

2.6. Treatment of Test Animals

This study was approved by the Research Ethics Committee (KEP) of Ahmad Dahlan University (No. REC-UAD/02/01/01-2025/016). A total of 15 mice were acclimatized for 7 days and then randomly divided into five groups (Table 2).

Table 2. Treatment Groups

Group	Description
Normal	Non-diabetic mice, wounded, without gel treatment
Bioplacenton	Diabetic mice, wounded, treated with Bioplacenton®
Base Gel	Diabetic mice, wounded, treated with base gel
5% Gel	Diabetic mice, wounded, treated with 5% extract gel
10% Gel	Diabetic mice, wounded, treated with 10% extract gel

All mice were fasted (water only) for 16 hours before baseline blood glucose measurements. Diabetes was induced by intraperitoneal injection of alloxan at a dose of 150 mg/kg BW dissolved in NaCl [17]. After three days, blood glucose levels were measured via tail vein sampling using a glucometer. Mice were considered diabetic when fasting blood glucose levels reached ≥200 mg/dL after alloxan induction. Under normal conditions, fasting blood glucose levels in mice typically range from 72 to 105 mg/dL, which serves as a physiological reference for mice and not as a basis for conversion from human diabetes criteria [18]. Mice with blood glucose levels >200 mg/dL [19], were subsequently selected for wound induction using a 5-mm biopsy punch on the dorsal surface under ketamine HCl anesthesia (80 mg/kg BW) [20]. Each group of test animals was given a predetermined treatment, except for the normal group of mice, which was treated with 50 mg of gel. Treatments were applied once daily between 09:00 and 10:00 WIB for 21 days. The wounds were then covered with sterile gauze and plaster to reduce contamination [19]. Observations were conducted on days 0, 4, 7, 14, and 21 to measure blood glucose levels, wound appearance, wound diameter, and healing time. Wound appearance was evaluated using an ordinal semi-quantitative scoring system by two independent observers at days 0, 4, 7, 14, and 21. As the scores represent ordinal levels, the data were expressed as median (interquartile range). Statistical analysis was performed using non-parametric tests, including the Kruskal–Wallis test followed by the Mann–Whitney U test for comparisons among groups.

The percentage reduction in blood glucose and wound healing was calculated using the following formulas:

$$Reduction\ in\ Blood\ Glucose\ (BG)\ (\%) = \frac{(BG\ on\ Day-1)-(BG\ on\ Day-21)}{(BG\ on\ Day-1)} \times 100 \qquad (1)$$

$$Reduction\ in\ Wound\ Diameter\ (WD)\ (\%) = \frac{(Initial\ WD)-(WD\ on\ Day-X)}{(Initial\ WD)} \times 100 \qquad (2)$$

Wound healing assessment was conducted to determine the percentage of tissue regeneration over time.

2.7. Data Analysis

Data including blood glucose levels, wound healing percentage, and healing time were analyzed statistically using SPSS. The data were tested for normality and homogeneity, followed by ANOVA testing. The results showed that the data had a normal distribution ($p>0.05$), were homogeneous ($p>0.05$), and were significant ($p<0.05$). If the results show a non-normal distribution, use a non-parametric test such as the Kruskal-Wallis test followed by the Mann-Whitney test. If the significance is less than the α value ($p < 0.05$), it means there is a meaningful difference.

3. RESULTS AND DISCUSSION

3.1. Avocado Leaf Extract and Phytochemical Screening

Based on the Certificate of Analysis (COA), the organoleptic test results showed that the extract was a dry powder with a brown color, a distinctive avocado leaf aroma, and a bland taste, with a moisture content of 1.7%. Based on the organoleptic and moisture content tests, the product was confirmed as avocado leaf extract, and the moisture content met the Indonesian Herbal Pharmacopoeia (FHI) requirements, which stipulate a maximum of 14.0%.

Phytochemical screening results showed that the avocado leaf extract was positive for flavonoids, saponins, alkaloids, and tannins (Table 3). These findings are consistent with research by Putri et al. [14], who also reported the presence of these compounds in avocado leaves.

Table 3. Phytochemical Screening Results

Phytochemical Test	Reagent	Color Change	Result
Flavonoid	$AlCl_3$	Yellow	Positive
Alkaloid	Mayer, Dragendorff	Sediment	Positive
Saponin	HCl	Bubbly	Positive
Tannin	$FeCl_3$	Brownish green	Positive

3.2. Avocado Leaf Extract Gel Formulation

The organoleptic evaluation of the gel formulations showed differences in consistency among the formulations (Figure 1). Higher extract concentrations resulted in gels with greater thickness and a more intense green color.

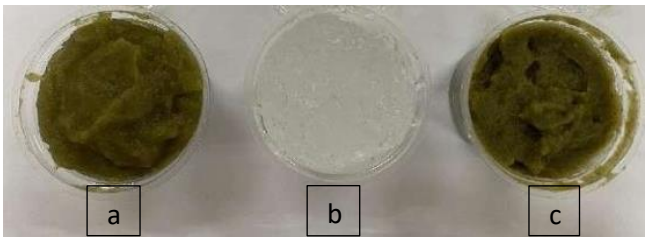

Figure 1. Visual appearance of gel formulations. a) 5% avocado leaf extract gel, b) base gel, c) 10% avocado leaf extract gel

Table 4. Results of Evaluation of Gel Formulations

Formulation	Organoleptic Properties	pH Test	Spreadabillity (cm)
Base Gel	Thick, clear white, odorless	6.104±0.112	3.67±0.197
5% Gel	Thick, green, distinctive avocado leaves smell	6.345±0.041	3.50±0.523
10% Gel	Thick, dark green, distinctive avocado leaves smell	6.416±0.038	3.13±0.862

Result of evaluation of gel formulation (Table 4). The pH value of the entire formulation is within the acceptable pH range for topical application (4.0–7.0), so it does not have the potential to cause skin irritation [21]. Spreadability tests indicated that although all formulations showed good spreadability, none reached the ideal range of 5–7 cm recommended for optimal topical application [22]. This is influenced by the use of the extract in dry powder form, which increases the viscosity and stiffness of the gel matrix, thereby inhibiting the ability of the preparation to spread [23].

3.3. Avocado Leaf Extract Gel Activity Test on Diabetic Wound Mice

In this study, diabetes was induced in mice using alloxan (150 mg/kg BW), which damages pancreatic beta cells, leading to increased blood sugar levels [24]. Figure 2 shows a significant rise in blood sugar levels. Blood sugar levels were monitored on days 0, 4, 7, 14, and 21 (Figure 3). Bioplacenton was used as a positive control because it has been proven effective in wound healing models, and was administered at the same dosage and frequency as the test gel. Among all groups, the 5% avocado leaf extract gel group exhibited the greatest reduction in blood glucose, with a decrease of 51.82% (Figure 4).

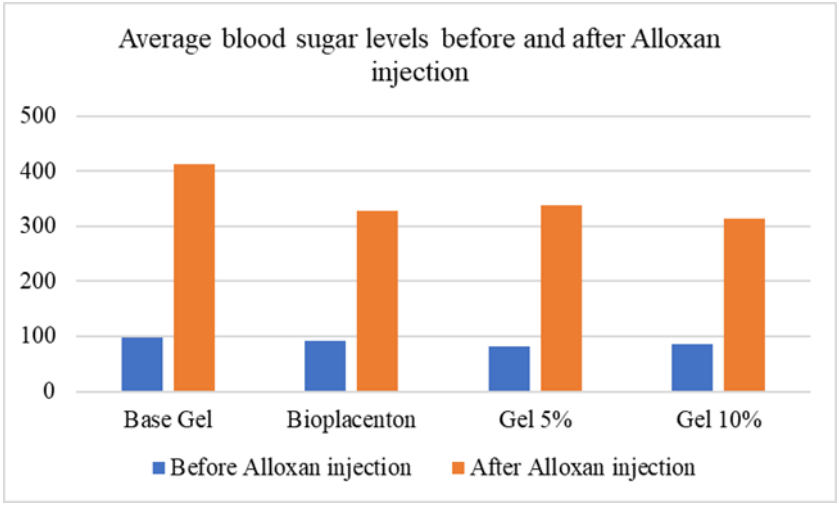

Figure 2. Comparison of average blood sugar levels (mg/dL) in mice before and after alloxan injection

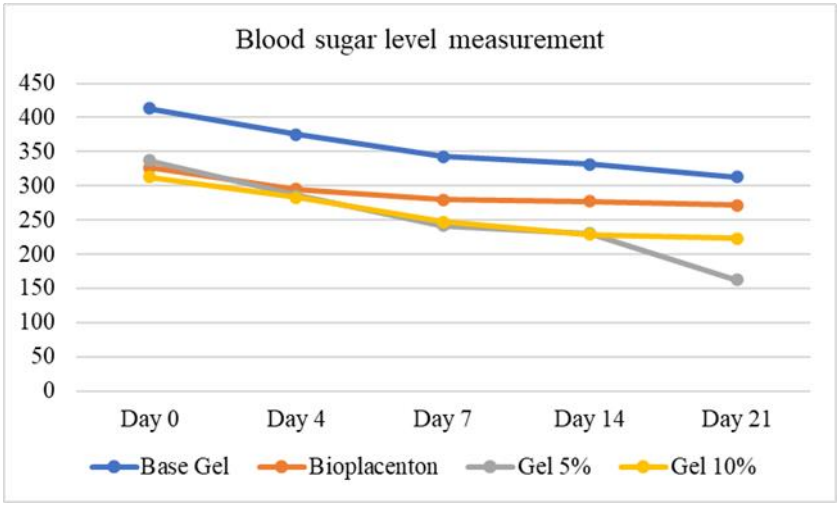

Figure 3. Blood sugar measurements (mg/dL) at different time points

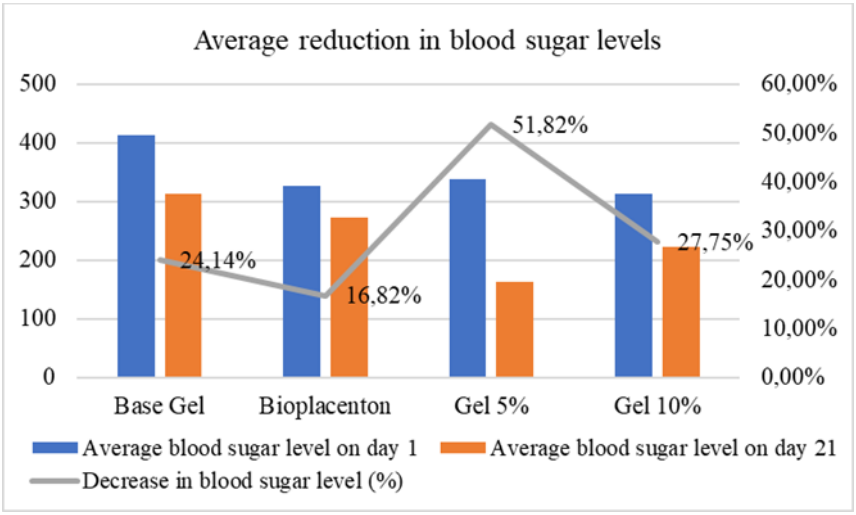

Figure 4. Percentage decrease in blood sugar levels from day 1 to day 21

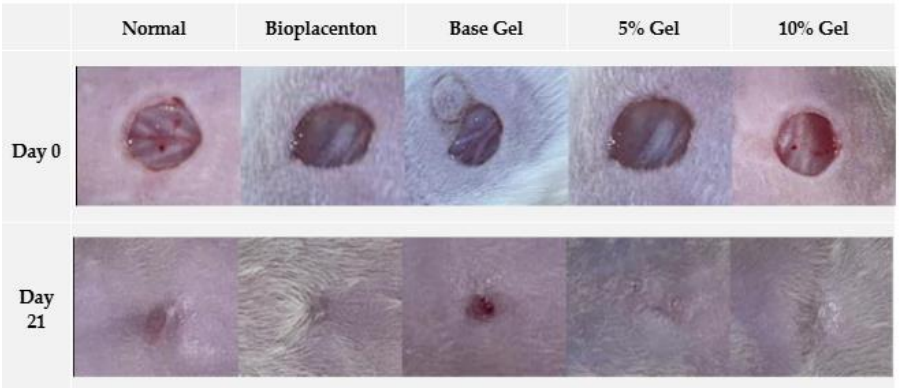

Figure 5. Macroscopic description of the wound healing process on day 0 and day 21

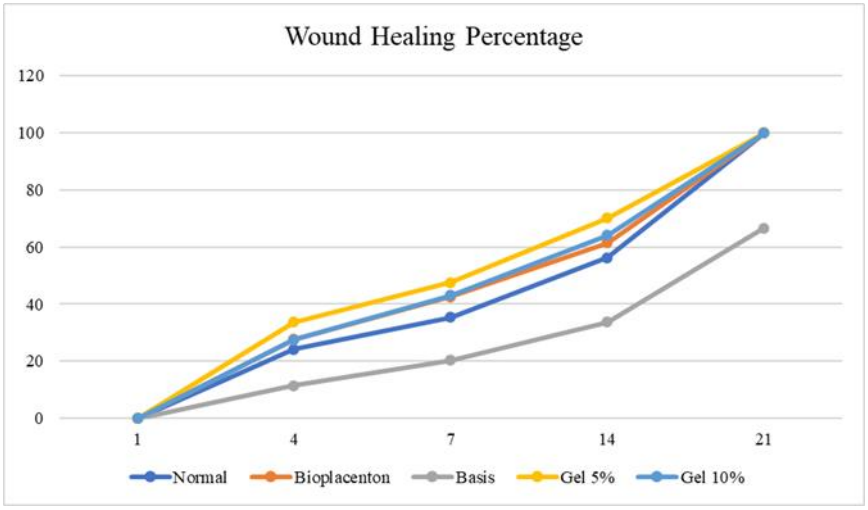

Figure 6. Graph showing wound healing percentage on days 1, 4, 7, 14, and 21

Table 5. Results of Evaluation of Gel Formulations

Group	Wound Healing Time (Days)
Normal	18±0.00 *
Bioplacenton	16±0.00 *
Base Gel	21+ (Not yet recovered)
5% Gel	16.6±0.89*
10% Gel	19.4±0.55*

Note: *There is a significant difference with base control ($p<0.05$).

Interestingly, the normal (non-diabetic) group also showed complete wound closure by day 21, which aligns with the fact that normal blood glucose levels support better oxygen and nutrient delivery needed for tissue repair [25]. Controlled blood sugar levels play an important role in supporting the wound healing process because hyperglycemia (high blood sugar) can damage blood vessels and interfere with blood circulation, thereby reducing the flow of oxygen and nutrients to the wound area [26]. Adequate oxygen and nutrient supply through good blood flow is essential for the proliferation and regeneration phases of tissue during wound healing [27].

Macroscopic observations of wound healing from day 1 and day 21 are shown in Figure 5. Wounds healing percentage (%) treated with 5% and 10% from avocado leaf extract gels showed complete closure by day 21 (Figure 6). These results suggest that the 5% extract gel group not only had the greatest reduction in blood sugar levels but also showed faster wound healing compared to other groups. The results showed that the application of 5% and 10% extract gels accelerated wound healing time. On day 14, the 5% ethanol extract of avocado leaf gel group showed the highest wound healing percentage of 71.59% compared to other groups. On day 21, complete wound closure (100%) was observed in the healthy positive control group (Bioplacenton), 5%, and 10% gel groups. In contrast, the negative control group (gel base) showed a wound healing rate of only 63.11%, indicating slower recovery due to the absence of active ingredients.

The wound healing time data are presented in Table 5. From this data, it can be seen that the 5% and 10% avocado leaf extract gels were significantly different from the negative control group (gel base). The 5% avocado leaf extract gel showed a significance of 0.136 compared to the positive control (Bioplacenton), which means that the 5% avocado leaf extract gel has the same healing time as the positive control (Bioplacenton) with an average wound healing time of 16.6 days. Wound healing percentages were calculated to evaluate recovery.

Wound healing is a complex process involving interactions between cells and the extracellular matrix (ECM), mediated by cytokines and growth factors [28]. Diabetic conditions significantly

interfere with the wound healing process because diabetes causes physiological and metabolic changes that affect almost all phases of wound healing, including inflammation, proliferation, and remodeling. In diabetes, chronic hyperglycemia slows blood perfusion, reduces tissue oxygenation, and inhibits leukocyte migration and immune cell activity, which then causes a prolonged inflammatory response and a higher risk of infection compared to non-diabetic conditions [29].

The healthy group achieved 100% healing faster because non-diabetic conditions ensured proper delivery of nutrients and oxygen to the wound site [30]. Active phytochemical compounds in avocado leaves, including flavonoids, alkaloids, tannins, and steroids, play a critical role in accelerating wound healing in diabetic patients [31].

Avocado leaf extract is rich in flavonoids, which possess antioxidant and anti-inflammatory properties aiding in wound healing [32]. Flavonoids also help lower blood sugar levels by enhancing pancreatic function [33]. Additionally, alkaloids, saponins, and tannins in the extract contribute antibacterial, anti-inflammatory, and wound-sealing effects [34]. Alkaloids lower blood sugar levels by increasing glucose transport, inhibiting glucose absorption in the intestines, and stimulating glucose storage as glycogen [35]. Saponins and tannins act as antidiabetics by inhibiting the enzymes α-glucosidase and α-amylase, thereby slowing the breakdown and absorption of carbohydrates into glucose and helping to control hyperglycemia [36]. Additionally, carbopol-based gels are widely used in wound formulations due to their biocompatibility, ability to maintain a moist wound environment, and ability to facilitate the transport of active compounds to wound tissue, thereby creating favorable conditions for tissue repair even though they do not have biological activity themselves [37].

4. CONCLUSION

Avocado leaf ethanol extract gels with concentrations of 5% and 10% meet the physical properties requirements for gels and contain saponins, alkaloids, tannins, and flavonoids. Both formulations show wound healing activity as measured by wound healing percentage and significantly accelerate the healing process ($p < 0.05$). However, the gel with a concentration of 5% showed a faster wound healing time compared to the gel with a concentration of 10%.

Funding: The reseach was funded by LPPM UAD with reseach contrack number : PD-072/SP3/LPPM-UAD/XI/2024

Acknowledgement: We would like to thank the Lembaga Penelitian dan Pengabdian Masyarakat (LPPM) UAD numbers: PD-072/SP3/LPPM-UAD/XI/2024

Conflicts of interest: The authors declare no conflict of interest.

References

1. Kementerian Kesehatan. Suvei Kesehatan Indonesia (SKI). Lap Temat Ski 2023 [Internet]. 2023;965. Available from: https://www.badankebijakan.kemkes.go.id/laporan-tematik-ski/
2. H. Sun, P. Saeedi, S. Karuranga, M. Pinkepank, K. Ogurtsova, B.B. Duncan DJM. IDF Diabetes Atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. Elsevier. 2022;183.
3. Idramsyah I, Novira D. Studi Fenomenologi Persepsi Pasien dan Keluarga tentang Luka Kaki Diabetes Phenomenological Study of Patient and Family Perceptions of Diabetic Foot Wounds. Heal Inf J Penelit. 2023;15(3):e970.
4. Abidin Z, Meuraxa R, Aceh B, Fitria E, Nur A, Marissa N, et al. Karakteristik Ulkus Diabetikum pada Penderita Diabetes Mellitus di RSUD dr . Zainal Abidin dan RSUD Meuraxa Banda Aceh. Bul Penelit Kesehat. 2017;45(3):153–60.
5. Yulisma N. Uji aktivitas ekstrak etanol daun alpukat (Persea americana Mill.) dalam proses mempercepat regenerasi jaringan luka pada mencit diabetes melitus. Skripsi thesis, Univ Muhammadiyah Sukabumi. 2021;
6. Fajarizki G.R, Tandi J., Tuldjanah M. MM. Penetapan kadar metabolit sekunder ekstrak etanol daun alpukat (Persea americana Mill.) secara spektrofotometri UV-Vis. Farmakol J Farm. 2022;19(1):31–42.
7. D. Anggorowati, G. Priandini T. Potensi daun alpukat (persea americana miller) sebagai minuman teh herbal yang kaya antioksidan 1) 1,2,3). Ind Inov. 2016;6(1):1–7.
8. Nurwahita, Masriadi, N.U. Mahmud RA. The Effect of Ginger, Lemongrass, Clove Extract Ointmenton

Diabetes Mellitus Wound Healing. J Pharm Sci Technol. 2024;11(1):62–71.
9. Y.D. Cahyani SRM. Aktivitas Biologis Tanaman Bandotan (Ageratum conyzoides Linn.) Sebagai Terapi Luka Terbuka. J Farmaka. 2018;16(2):125–33.
10. Wijaya I. Potensi Daun Alpukat (Persea Americana Mill) Sebagai Antibakteri. J Ilm Kesehat Sandi Husada. 2020;12(2):695–701.
11. A.R. Alvita, T.S. Wardani, T.A.Listyani. Formulasi Sediaan Gel Ekstrak Daun Alpukat (Persea americana Mill.) Sebagai Terapi Pengobatan Luka Bakar Terhadap Kelinci New Zeland White. J Med Nusant. 2023;1(4):272–95.
12. Suparman A, Nurpatmawati, Wahyuni. Uji Efektivitas Gel Ekstrak Daun Alpukat (Persea americana Mill) Terhadap Luka Bakar pada Tikus Putih Jantan (Rattusnorvegicus). PRAEPARANDI J Farm dan Sains. 2020;3(2):167–75.
13. Rohenti IR. Uji Aktivitas Ekstrak Etanol 70% Daun Alpukat (Persea americana Mill.) terhadap Penurunan Kadar Glukosa Darah pada Mencit Jantan (Mus musculus L.). J Sabdariffarma. 2023;10(2):21–33.
14. Putri NPDP, Sari NKY, Permatasari AAAPP. Skrining Fitokimia Ekstrak Etanol Daun Alpukat (Persea americana Mill.) dan Rimpang Jahe Merah (Zingiber officinale Rosc var. rubrum). J Kesehatan, Sains, Dan Teknol. 2023;2(3):35–48.
15. Rusli D, Amelia K, Gading S. Formulasi dan Evaluasi Sediaan Gel Ekstrak Daun Kelor (Moringa Oleifera Lam .) Dengan Variasi NaCMC Sebagai Basis. J Ilm Bakti Farm. 2021;VI(1):7–12.
16. Hastuti R, Endah SRN, Nofriyaldi A. Formulasi Dan Uji Stabilitas Fisik Sediaan Gel Ekstrak Daun Alpukat (Persea americana. Mill). Pharmacoscript. 2020;3(2):150–61.
17. Mansur AP, Septiman AP, Rahman NF, Feni A, Aulia M, Nirma I, et al. Krim Rajabetrin: Uji Efektivitas Sediaan Krim Limbah Rambut Jagung (Zea Mays L.) Terhadap Penyembuhan Luka Mencit Diabetes Mellitus. Hasanuddin Student J. 2017;1(2):144–50.
18. Mbaya JK, Mbanzulu D, Nsonizau P, Nsolani NM. Blood Glucose Reference Interval in Mus musculus Mice. Open Access Libr J. 2023;10.
19. Chandra PPB, Laksmitawati DR, Rahmat D. Pengaruh Gel Ekstrak Buah Okra (Abelmoschus esculentus L.) pada Luka Mencit Hiperglikemik. J Ilmu Kefarmasian [Internet]. 2022;3(2):268–76. Available from: https://journal.ummat.ac.id/index.php/farmasi/article/view/9252
20. Nurani LH, Sikumbang IM, Yuliani S, Edityaningrum CA. the Effect of Betel Leaf Extract Spray on Histopathology of Wound Healing. J Farm Sains dan Prakt. 2022;8(2):185–93.
21. AnnaL Yusuf, Davit Nugraha, Panji Wahlanto, Marlina Indriastuti, Rian Ismail FAH. ormulasi dan Evaluasi Sediaan Gel Ekstrak Buah Pare (Momordica charantia L.) dengan Variasi Konsentrasi Carbopol 940. Pharm Genius. 2022;01(01):50–61.
22. Alma Dita Rizkia, Fauzia Ningrum Syaputri TDAT. Pengaruh Variasi Konsentrasi Na-CMC sebagai Gelling Agent Terhadap Stabilitas Fisik dan Kimia Sediaan Gel Ekstrak Daun Sereh Wangi (Cymbopogon nardus (L.) Rendle). Farm J Sains Farm. 2022;3(1):1–11.
23. Honary S, Chaigani M, Majidian A. The Effect of Particle Properties on the Semisolid Spreadability of Pharmaceutical Pastes. Indian J Pharm Sci. 2007;423–6.
24. Anita Wulandari, Sudiastuti S. Efek hipoglikemik ekstrak etanol batang karamunting (Melastoma malabathricum) terhadap kadar gula darah dan perubahan struktur mikroanatomi pankreas mencit (Mus musculus L.) diabetesi. Bioprospek. 2016;11(2):48–51.
25. Arifah Rakhmawati, Dewi Purnamawati WJ. Efektivitas Penggunaan Antimicrobial Dressing Terhadap Lama Proses Penyembuhan Luka pada Pasien Ulkus Kaki Dabetik di Pelayanan Kesehatan Wilayah Kabupaten Bekasi. J Penelit Kesehat Suara Forikes. 2021;12(2):80–6.
26. Xiaona Lang, Lu Li, Yuntao Li XF. Effect of Diabetes on Wound Healing : A Bibliometrics and Visual Analysis. J Multidiscip Healthc. 2024;17:1275–89.
27. Castilla DM, Liu Z jun, Velazquez OC. Oxygen : Implications for Wound Healing. 2012;1(6):225–30.
28. Park, S. A.Teixeira, L. B.Covert, J.Dubielzig, R. R.Isseroff, R.Schurr, M.Abbott, N. L.McAnulty, J.Murphy CJ. Full-thickness splinted skin wound healing models in db/db and heterozygous mice: implications for wound healing impairment. Wound Repair Regen. 2014;22(3):368–380.
29. Nina Dasari, Austin Jiang, Anna Skochdopole, Jayer Chung, Edward M Reece, Joshua Vorstenbosch SW. Updates in Diabetic Wound Healing , In fl ammation , and Scarring. Semin Plast Surg. 2021;35(3):153–158.
30. Raharjo SB, Suratmin R, Maulidia D, Pratiwi O, Keperawatan J, Aceh PK. Perawatan luka ulkus diabetikum: tinjauan literatur. J Keperawatan. 2022;1(2):98–104.
31. Rahmadhita E, Iqbal M, Oktoba Z, Triyandi R, Kedokteran F, Lampung U. Aktivitas Farmakologi Daun Alpukat (Persea americana Mill .) Pharmacological Activity of Avocado Leaf (Persea

americana Mill .). Med Prof J Lampung. 2024;14(7):1249–52.
32. Kastika SM, Rahayu R. Pengaruh Formula Obat Herbal Untuk Penyembuhan Luka Bakar. Bioprospek [Internet]. 2018;13(1):26–32. Available from: http://jurnal.fmipa.unmul.ac.id/index.php/bioprospek/article/view/203
33. Rahayuningsih N, Pratama A, Suhendy H. Aktivitas Antidiabetika Beberapa Fraksi Ekstrak Daun Alpukat (Persea Americanna Mill) Pada Tikus Putih Jantan Dengan Induksi Aloksan. J Kesehat Bakti Tunas Husada J Ilmu Ilmu Keperawatan, Anal Kesehat dan Farm. 2020;20(1):43–51.
34. Priamsari MR, Yuniawati NA. Skrining Fitokimia dan Aktivitas Penyembuhan Luka Bakar Ekstrak Etanolik Morinda Citrifolia L. pada Kulit Kelinci (Oryctolagus Cuniculus) Phytochemical Screening and Activity of Ethanolic Leaves Extract Morinda Citrifolia L. Against Healing Burn in Rabbit. J Pharm. 2019;8(1):22–8.
35. Hamsidar Hasan1, A.Mu'thi Andy Suryadi2 ZD. Uji Aktivitas Antidiabetes Ekstrak Etil Asetat Daun Lamun (Enhalus acoroides) Pada Mencit (Mus musculus). J Syifa Sci Clin Res. 2022;4(1):293–305.
36. Muwaffaq NF, Handayani MN. Potensi saponin pada kacang-kacangan sebagai pangan fungsional pencegah penyakit diabetes melitus tipe-2. ARGIPA (Arsip Gizi dan Pangan). 2022;7(1):40–7.
37. Wu X, Chen H wei, Zhao Z yu, Li L, Song C, Xiong J, et al. Medicinal Chemistry combination of quercetin and luteolin from the Staphylococcus aureus infected wound healing. RSC Med Chem [Internet]. 2024;15(2):553–60. Available from: http://dx.doi.org/10.1039/D3MD00611E