# Effectiveness of *Moringa oleifera* Leaves for Wound Healing: Systematic Review

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## ABSTRACT

Moringa oleifera leaves are a rich source of protein, minerals, and fiber. This extract can be an antioxidant, anticancer, anti-inflammatory, antidiabetic, and antimicrobial. This systematic review was designed to determine the effectiveness of Moringa oleifera leaves for wound healing. Databases were searched for relevant studies: ProQuest, ScienceDirect, Pubmed, Springer Link, and EBSCO to study screening tools used to identify the effectiveness of Moringa oleifera leaves for wound healing that was published within 2018-2023, information about study objectives, method, population characteristics, statistical techniques, primary findings, and region. Research data analysis was assessed using the ANOVA statistical test. Data from identified studies were analyzed based on objectives, study design, and outcomes. Records identified from databases (n = 1,375), screened records (n = 1,344), reports searched for retrieval (n = 25), reports assessed for eligibility (n = 17), studies included in the review (n = 9) full-text articles in the systematic review. Eligibility of the nine articles was based on critical findings that had been carefully selected to meet the study inclusion criteria. Research with a systematic review of the effectiveness of Moringa oleifera leaves for wound healing is very important to provide additional information for patients with acute and chronic wounds who are treated at home or in the hospital.

**Keywords: *Moringa oleifera*, leaves, wound healing**

## INTRODUCTION

Moringa leaves are a rich source of protein, minerals, and fiber (Riaz & Wahab, 2021). The Moringa oleifera leaf extract (MOL) is a potent herbal remedy rich in beneficial compounds (Ningrum et al., 2023). This extract can be an antioxidant, anticancer, anti-inflammatory, antidiabetic, and antimicrobial (Gopalakrishnan et al., 2016). Methanolic leaf extract of M. oliefera can be among the guideline extracts for the antioxidant movement of M. oliefera, which might be utilized to treat a few sicknesses (Sayyed et al., 2019).

Moringa oleifera leaf (MOL) extract was cold macerated in different solvents to maximize the surrender and percentage of bioactive compounds that help in wound recuperating rate. After cold maceration extraction, the cruel surrender rate was calculated based on the dry weight of each dissolvable extract (Chin et al., 2018). Moringa oleifera plant can be an important source within the human diet and can overcome a few well-being issues because of its high phenolic

(Dasat et al., 2020). Purified Moringa leaf extract is more active as a tyrosinase inhibitor than the crude extract but less active than hydroquinone (Abidin et al., 2019).

The leaf is the most commonly utilized plant part for restorative purposes. The most phytochemical compounds extracted from the leaves of Moringa oliefera include glucosinolates, flavonoids, and phenolic acids that have a protective against persistent illnesses (blood vessel hypertension, diabetes mellitus, cancer metabolic disorder, and generally inflammation) (Vergara-Jimenez et al., 2017). The study by Muzammil et al. (2023) will assess the diabetic wound-healing properties of Moringa oleifera leaf extracts and explore its potential to improve wound healing in diabetic conditions.

This study was designed using a systematic review to evaluate the effectiveness of Moringa oliefera leaves on wound healing. These findings will be used to propose the use of Moringa leaves in the wound healing process, which can be used in the health industry.

## METHODS

This systematic review is organized around selected components for a Systematic Review.

### Search Strategy

Databases were searched for relevant studies, ProQuest, ScienceDirect, Pubmed, Springer Link, and EBSCO, to study screening tools used to identify the effectiveness of Moringa oleifera leaves for wound healing, published between 2018 and 2023.

### Population

The research was carried out with a diabetic mouse model for wound healing studies. The study by Chin et al. (2018) stated healthy rats for acute dermal toxicity testing, STZ/HFD-induced diabetic rat model for wound healing studies, Two groups of dietary regimens: regular pellet diet (non-diabetic control group) and high-fat diet (diabetic group). Islam et al. (2018) study included female Wistar rats weighing between 180 and 400 g. The study by Al-Ghanayem et al. (2022) stated that Wistar rats at the age of 3-4 months of either sex, with weights ranging from 200 to 250 g.

The study's population demographics are essential to individuals who have diabetes and non-healing skin ulcers, particularly those in economically developing countries and those who use traditional medicines and herbal remedies (Muzammil et al., 2023). The study discusses how acute and chronic wounds are a global burden, showing that the study is essential to a large population affected by different kinds of wounds (Pagano et al., 2020).

**Interventions**

We considered for inclusion studies that reported interventions aimed at the effectiveness of Moringa oleifera leaves for wound healing. We define this activity as improving health services by using Moringa leaves.

When searching for an article, the first step is to use keywords to identify the title and determine its compatibility with the search context. The screening instruments identified in this systematic review had to meet the following three inclusion criteria: (a) Moringa oleifera leaves and wound healing, (b) the primary objective of evaluating the benefits of Moringa oleifera leaves. Furthermore, the articles reviewed had to have been published. Articles were excluded if (1) they were systematic reviews or meta-analyses, (2) only program analyses were discussed, (3) only abstracts, (4) they were not full text, and (6) the year of the articles ≤ 2018.

**Comparison**

We considered studies that used Moringa Olivera leaves.

**Outcome**

We included studies that reported at least one result of using Moringa oleifera leaves in wound healing conducted with animals and individuals. We considered studies that reported subjective and objective outcomes of performed clinical practice.

The leaves of the MO plant contain high bioactive compounds such as minerals, vitamins, and phytochemicals, making it a valuable source of active ingredients for health products. MOE displays potent antioxidant and antimicrobial properties, qualifying it as a viable option for healing wounds (Pagano et al., 2020).

**Selection Process**

The selection process takes place in three stages. In the identification stage, the authors collected records identified from the database (n = 1,375). In the next stage of screening, authors independently classified articles for approval and exclusion after purging duplicate articles and screening records (n = 1,344). Next, related articles were filtered based on relevant research titles in English, not reviews, and not textbooks. The reports obtained were searched for retrieval (n = 25). At the inclusion stage, reports were assessed for eligibility (n = 17) based on the complete text, and 9 articles were found that could be reviewed (Figure 1).

**PRISMA 2020 flow diagram for new systematic reviews, which included searches of databases**

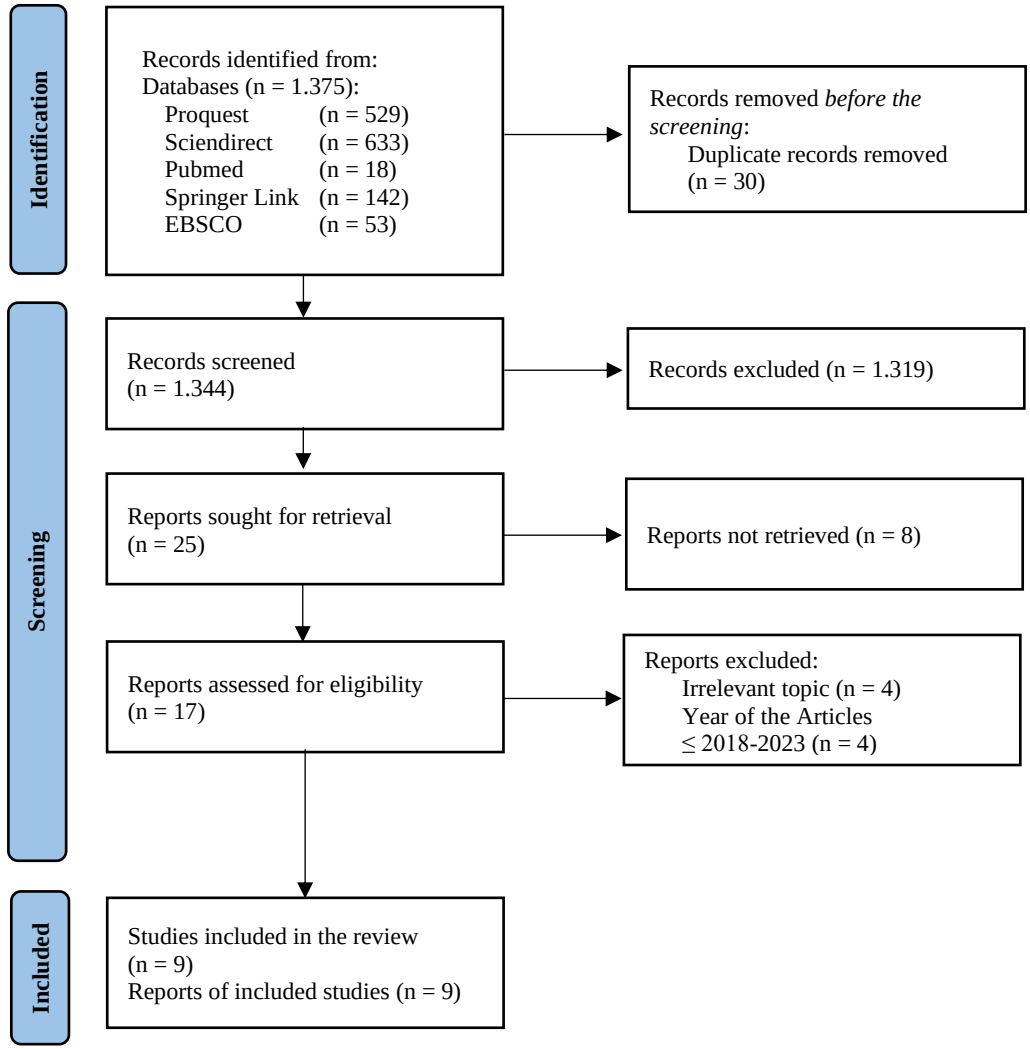


Figure 1: Searching strategy using Preferred Reporting Items for Systematic Reviews (Page et al., 2021)

## Data Extraction

The author extracted data and obtained nine studies in a systematic and standardized manner. He summarized research features and general findings about Moringa oleifera leaves and wound healing. This is a relevant quantitative and qualitative design article-based experimental study.

The study design of Chin et al. (2018) is a laboratory-based experimental study focusing on the formulation and characterization of a wound dressing containing M. oleifera leaf aqueous extract. The study design by Chin et al. (2018) uses a controlled, non-randomized, non-blinded, non-placebo-controlled, parallel design.

Islam et al. (2018). used experimental techniques in the study, which included the preparation of amniotic membrane and Moringa oleifera, gel formulation, and viscosity determination. An

experimental study by Muzammil et al. (2023) involving in vitro assessments includes creating wound dressings using a freeze-thaw process. The study by Chin and Ng (2020) involves analyzing and improving MOL nanofibers impregnated hydrocolloid films, modifying nanofiber production through electrospinning, examining rheology, studying swelling ratio using a simulated wound fluid model, and conducting Moisture Vapor Transmission Rate research.

**Intervention**

In the study of Chin et al. (2018), the intervention is applying alginate SA-PC film dressing containing Moringa oleifera leaf standardized aqueous extract in various strengths from 0.1% to 1% w/v. The study by Al-Ghanayem et al. (2022). involves applying two different concentrations (10% w/w and 20% w/w) of Moringa oleifera extract as an ointment directly onto the wounds of diabetic rats infected with MRSA or P. aeruginosa. The study's Chin et al. (2018), standard hydrocolloid dressings containing aqueous extract of Moringa oleifera leaves (MOL) at different concentrations (0.1%, 0.5%, and 1%) on full-thickness excision and abrasion wounds partial thickness with high-fat diet and streptozotocin (HFD/STZ) diabetic rat model.

The study's Islam et al. (2018) participants were given a combination of amniotic membrane (AM) and Moringa oleifera (MO) formulated into a gel with sodium carboxymethylcellulose (CMC-Na), propylparaben, glycerin, distilled water, and triethanolamine on the burned skin of Wistar rats, as well as receiving AM gel, MO gel, and a combination of AM+MO gel twice a day. The study by Ningrum et al. (2023) consists of wound dressings based on hydrogel containing PVA, MOL extract, and GO.

The study's Chin and Ng (2020) intervention involves applying Moringa oleifera (MOL) leaf extract nanofibers onto an alginate-pectin hydrocolloid film for chronic wound healing, with application times of 15, 30, and 60 minutes, respectively. The study by Kamel et al. (2023) includes the arrangement of SA/PVA platforms with diverse concentrations (0.0-2.5%) of Moringa oleifera extract immobilized in them, utilizing sodium alginate and poly(vinyl) liquor.

The study's Pagano et al. (2020) used Moringa oleifera leaf extract (MOE) to make bioadhesive microparticles that can swell to treat wounds. The study intervention by Muzammil et al. (2023) will investigate how drying temperature and solvents affect the polyphenolic composition and diabetic wound healing activity of Moringa oleifera leaves.

**Quality appraisal**

All articles selected for inclusion in the systematic review (9 articles) provided information about study objectives, method, population characteristics, statistical techniques, main findings, and region. The articles that met the inclusion criteria outlined in the procedure were assessed. The results can then be used to inform the synthesis and interpretation of research results. Research data analysis was assessed using the ANOVA statistical test.

## RESULTS

Moringa oleifera leaves contain antioxidant compounds (Kamel et al., 2023). The extract of the leaves reveals potent antioxidant and antimicrobial qualities, as well as the capacity to inhibit the growth of keratinocytes (Pagano et al., 2020). Muzammil et al. (2023) found that the leaves have antioxidant, antidiabetic, and cell migration properties.

The main findings of Chin et al. (2018) were that M. oleifera leaf extract was standardized against seven bioactive compounds, and the standardized M. oleifera leaf aqueous extract was successfully loaded into Sodium alginate (SA) and pectin (PC) film dressing and showed satisfactory mechanical properties and wound dressing physicochemical characteristics. In the study by Chin et al. (2018), histological results and hydroxyproline testing showed that high collagen deposition and complete re-epithelialization were observed for wounds treated with 0.5 and 1% MOL films. All MOL film dressings have been tested for non-toxicity through in vivo skin safety. Chin and Ng (2020) describe a hybrid MOL nanofibers-impregnated hydrocolloid film dressing that could treat chronic wounds.

The study by Al-Ghanayem et al. (2022), the formulation of Moringa oleifera extract demonstrated enhanced wound healing effects in Methicillin-resistant Staphylococcus aureus (MRSA) infected diabetic rats, resulting in improved wound contraction and shortened epithelization period. The study by Islam et al. (2018) shows that when Amniotic membrane (AM) and Moringa oleifera (MO) gel are combined, they exhibit better healing properties such as higher healing rate, quicker epithelialization, and positive effects on the rats' overall health. The study's Ningrum et al. (2023) stated the polyvinyl alcohol (PVA)/ Moringa oleifera leaves (MOL)/graphene oxide (GO) hydrogel, specifically, has displayed strong antibacterial properties against both Gram-positive S. aureus and Gram-negative E. coli, making it an effective wound dressing.

**Table 1. Effectiveness of Moringa Oleifera Leaves on Wound Healing: Systematic Review**

| Author/Year/Topic/ Publisher/Doi | Study Objectives | Methods | Statistical Techniques | Main Findings | Region |
|---|---|---|---|---|---|
| Chin et al. (2018)<br><br>Development and formulation of Moringa oleifera standardized leaf extract film dressing for wound healing application.<br><br>Journal of Ethnopharmacology 212 (2018) 188–199<br><br>http://dx.doi.org/10.1016/j.jep.2017.10.016 | The study objectives are to develop standardized M. oleifera leaf extracts, identify bioactive compounds, formulate M. oleifera leaf extracts into alginate-pectin hydrocolloid film dressing, characterize the physicochemical properties of the film dressings, and investigate the release of bioactive from the M. oleifera leaf film dressing. | An experimental study in vitro.<br><br>M. Oleifera leaf was extracted in different solvents and standardized using the UHPLC technique. It was added to SA-PC film dressing in various concentrations from 0.1% to 1% w/v for characterization of properties and bioactive release. Loaded film dressing in Franz diffusion cells was also studied. | t-tests and a one-way ANOVA | The extracts contained vicenin-2, chlorogenic acid, gallic acid, quercetin, kaempferol, rosmarinic, and rutin. Oleifera extracts significantly affected human dermal fibroblast and keratinocyte cells, promoting their proliferation and migration. The SA-PC composite film dressing with 3% w/v M. oleifera extracts showed the highest efficacy, making it ideal for wound dressing. | Malaysia |
| Chin et al. (2018)<br><br>Moringa oleifera standardized aqueous leaf extract-loaded hydrocolloid film dressing: in vivo dermal safety and wound healing evaluation in STZ/HFD diabetic rat model.<br><br>Drug Delivery and Translational Research<br><br>https://doi.org/10.1007/s13346-018-0510-z | The study objectives are to assess the potential of MOL film dressings containing different concentrations of MOL (0.1, 0.5, and 1%) to accelerate the diabetic wound healing process. | Experimental study in vivo.<br><br>The methodology involved in vivo dermal toxicity assessment, wound healing studies on diabetic rat models, and evaluation of wound healing-related factors using histology staining, hydroxyproline assay, and ELISA assays.<br><br>Healthy rats for acute dermal toxicity testing, STZ/HFD-induced diabetic rat model, two groups of dietary regimens: regular pellet diet (non-diabetic control group) and high-fat diet (diabetic group) | ANOVA and Dunnett's post hoc test. | The 0.5% MOL extract-loaded film significantly improved wound closure in diabetic rats, and all MOL film dressings are non-toxic in vivo safety dermal toxicity testing. This film was identified as the most promising approach for accelerating diabetic wound healing in full-thickness excision and partial-thickness abrasion wounds on the HFD/STZ-induced diabetic type II model. | Malaysia |

| Author/Year/Topic/ Publisher/Doi | Study Objectives | Methods | Statistical Techniques | Main Findings | Region |
|---|---|---|---|---|---|
| Islam et al. (2018)<br><br>The Combined Effect of Amniotic Membrane and Moringa Oleifera Leaves Derived Gel for Wound and Burn Healing in Rat Model.<br><br>Regenerative Engineering and Translational Medicine<br><br>https://doi.org/10.1007/s40883-018-0060-4 | The study objectives are to find an alternative treatment for burned patients and to evaluate the use of a gel mixed with AM and MO for treating burn and wound healing in a rat model. | Experimental study in both in vivo and in vitro models.<br><br>The methodology involved preparing three types of burn healing gels: creation of second-degree burns on the rats' skin, application of gels twice a day, testing the physical appearance and pH of the gels, and observation of wound contraction rate.<br><br>The study involved female Wistar rats with a body weight ranging from 180 to 400 g. The amniotic sacs used were collected from seronegative donors of cesarean deliveries aged 25 to 35. | One-way ANOVA | The combination of AM and MO gel demonstrated superior healing properties, including a maximum healing rate, faster epithelialization, and positive effects on the rats' overall health. The gel was also found to be safe for use. | Banglades h |
| Chin and Ng (2020)<br><br>Development of Moringa oleifera Standardized Leaf Extract Nanofibers Impregnated onto Hydrocolloid Film as A Potential Chronic Wound Dressing.<br><br>Fibers and Polymers 2020, Vol.21, No.11, 2462-2472<br><br>https://doi.org/10.1007/s12221-020-1356-9 | This study focuses on developing a hybrid dressing. Specifically, Moringa oleifera (MOL) leaf extract and nanofibers impregnated on an alginate-pectin hydrocolloid membrane for chronic wound healing. | An experimental study in vitro.<br><br>The methodology includes characterization and optimization of MOL nanofiber-impregnated hydrocolloid films, adaptation of nanofiber fabrication via electrospinning method, rheology study, swelling ratio study using a wound simulating fluid model, and MVTR study. | One-way ANOVA | The main findings are the successful formulation of hybrid MOL nanofibers-impregnated hydrocolloid films dressing for the potential treatment of chronic wounds, the implication that MOL nanofibers-film could be an alternative treatment option for treating chronic wounds, and the potential of nanofibers to provide excellent support for the growth of specialized cells and delivery of therapeutic agents for wound healing. | Malaysia |

| Author/Year/Topic/ Publisher/Doi | Study Objectives | Methods | Statistical Techniques | Main Findings | Region |
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| Pagano et al. (2020)<br><br>Preparation and characterization of polymeric microparticles loaded with Moringa oleifera leaf extract for exuding wound treatment.<br><br>International Journal of Pharmaceutics 587 (2020) 119700<br><br>https://doi.org/10.1016/j.ijpharm.2020.119700 | The study objectives are to develop an innovative formulation for treating exuding wounds using an extract from Moringa oleifera leaves (MOE) and to prepare microparticles with good swelling ability, providing an exciting tool for treating exuding wounds. | An experimental study in vitro.<br><br>The methodology involved using an eco-friendly extract from Moringa oleifera leaves (MOE) as the active ingredient, chitosan as the polymer for microparticles obtained by spray drying, and an in vitro release study to assess the sustained release of MOE. | One-way ANOVA | The extract from Moringa oleifera leaves (MOE) showed high antioxidant and antimicrobial activity and the ability to stimulate keratinocyte keratinocyte growth. Moringa oleifera leaves are rich in bioactive compounds such as minerals, vitamins, and phytochemicals, making them an interesting source of active ingredients for health products. The developed microparticles loaded with MOE represent an interesting tool for treating exuding wounds. | Italy |
| Al-Ghanayem et al. (2022)<br><br>Moringa oleifera Leaf Extract Promotes the Healing of Infected Wounds in Diabetic Rats: Evidence of Antimicrobial, Antioxidant, and Proliferative Properties.<br><br>Pharmaceuticals 2022, 15, 528.<br><br>https://doi.org/10.3390/ph15050528 | The study objectives are to evaluate the healing properties of M. oleifera extract in infected wounds, determine gene expression of VEGF and TGF-β1, conduct phytochemical and GC-MS analyses, and assess its effectiveness in promoting wound healing in diabetic rats (MRSA vs. P. aeruginosa) | An experimental study in vitro.<br><br>The methodology includes evaluating the healing properties of M. oleifera extract in excision wounds infected with MRSA or P. aeruginosa in diabetic rats, conducting in vitro studies to determine gene expression, performing preliminary phytochemical and GC-MS analyses, and assessing wound contraction, period of epithelization, antioxidant enzyme activities, and histological changes.<br><br>Adult Wistar rats, aged 3-4 months, either sex, weighing between 200 and 250 g, Diabetic rats were induced | One-way ANOVA with Tukey's post-test | The study found that M. oleifera extract improved wound contraction and reduced epithelization in diabetic rats infected with MRSA. It also increased antioxidant enzyme activities, epithelization, capillary density, and collagen formation. The extract also exhibited antimicrobial and antioxidant properties, induced VEGF and TGF-β1 gene expression, and increased wound proliferative activity. However, its effectiveness was less pronounced in wounds infected with P. aeruginosa. | Saudi Arabia |

| Author/Year/Topic/ Publisher/Doi | Study Objectives | Methods | Statistical Techniques | Main Findings | Region |
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| | | using streptozocin, a drug that selectively damages the pancreas. | | | |
| Ningrum et al. (2023)<br><br>In Vitro Biocompatibility of Hydrogel Polyvinyl Alcohol/Moringa oleifera Leaf Extract/Graphene Oxide for Wound Dressing.<br><br>Polymers 2023, 15, 468.<br><br>https://doi.org/10.3390/polym15020468 | The study objectives are to develop wound dressings based on PVA, MOL extract, and GO for healing DFU and to evaluate the potency of the combined materials as a biocompatible DFU wound dressing. | An experimental study in vitro.<br><br>The methodology involves developing wound dressings based on PVA, MOL extract, and GO using a freeze-thaw process. The physical crosslink method was employed to avoid using chemical crosslinkers that may result in toxicity. The evaluation of the hydrogel included its morphology, functional group, mechanical properties, degradation rate, antibacterial properties, cell viability, and scratch assay. | One-way ANOVA with Tukey's post-test | Hydrogel-based wound dressings, like PVA/MOL/GO hydrogel, have potent antibacterial properties against Gram-positive S. aureus and Gram-negative E. coli. This combination is biocompatible for diabetic foot ulcers. Moringa oleifera leaves (MOL) is a potent herbal extract with medicinal properties for treating diseases like cancer, cardiovascular issues, atherosclerosis, and diabetes. | Indonesia |
| Muzammil et al. (2023)<br><br>Effects of Drying Temperature and Solvents on In Vitro Diabetic Wound Healing Potential of Moringa oleifera Leaf Extracts.<br><br>Molecules 2023, 28, 710.<br><br>https://doi.org/10.3390/molecules28020710 | The study objectives are to investigate the effects of drying temperature and extraction solvents on the polyphenolic composition of Moringa oleifera leaves, evaluate the diabetic wound healing activity of Moringa oleifera leaves extracts, and determine the potential of Moringa oleifera leaves extracts to enhance wound healing in diabetic conditions. | An experimental study in vitro.<br><br>The study utilized drying Moringa oleifera leaves, extracting them in different solvents, and assessing their antioxidant, antihyperglycemic, and cell migration properties. It also evaluated cytotoxicity on various cell lines and identified phenolic compounds using high-performance liquid chromatography.<br><br>The study focuses on individuals with diabetes and non-healing skin ulcers, | Two-way ANOVA and Tukey's post hoc test | Antioxidant, antidiabetic, and cell migration properties of Moringa oleifera leaf extracts were observed, with the best results obtained from leaves dried at $10^0$C and $30^0$C and extracted in ethanol. The choice of solvent and drying temperature significantly affected the biological activities of the extracts. The study suggests the potential of M. oleifera leaf extracts to enhance wound healing in diabetic conditions. | Pakistan |

| Author/Year/Topic/ Publisher/Doi | Study Objectives | Methods | Statistical Techniques | Main Findings | Region |
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| | | especially those in economically developing countries who utilize traditional medicines and herbal remedies. | | | |
| Kamel et al. (2023)<br><br>Wound dressings are based on sodium alginate, which is polyvinyl.<br>Alcohol–Moringa oleifera Extracts.<br><br>Pharmaceutics 2023, 15, 1270.<br><br>https://doi.org/10.3390/ pharmaceutics15041270 | The study objectives are to prepare a new hydrogel by immobilizing polyphenol extracted from Moringa oleifera leaves onto a scaffold based on SA and PVA, evaluate its antioxidant biocompatibility and wound healing potential, characterize the scaffolds, assess their cytotoxicity and wound healing abilities, and investigate their in vivo wound healing capacity using zebrafish embryos. | Experimental study in vivo and in vitro.<br><br>FT-IR, XRD, TGA, SEM, cell culture and viability assays, zebrafish embryo experiments<br><br>The intervention involves preparing SA/PVA scaffolds with different concentrations (0.0-2.5%) of Moringa oleifera extract immobilized in them using sodium alginate and poly(vinyl) alcohol. | One-way ANOVA | Moringa oleifera leaves contain antioxidant compounds. Successful preparation and characterization of scaffolds for potential wound healing applications. High biocompatibility of the pure extract and MOE/SA/PVA with human fibroblasts. Effectiveness of the S5 scaffold in regenerating zebrafish tails. | Egypt |

## DISCUSSION

The leaves of Moringa oleifera contain a wealth of bioactive substances such as minerals, vitamins, and phytochemicals, making them a valuable source of active ingredients for health products. The microparticles that have been developed and are filled with MOE are a critical instrument for healing exuding wounds (Pagano et al., 2020). Al-Ghanayem et al. (2022) found that the formulation of M. oleifera extract has both antimicrobial and antioxidant properties. It also showed that the extract formulation induces the expression of VEGF and TGF-β1 genes and promotes increased tissue proliferation in wounded areas. However, the efficacy of M. oleifera extract was observed to be less pronounced in treating wounds contaminated with P. aeruginosa in diabetic rats, suggesting a varying impact depending on the infecting pathogen.

This was substantiated by heightened antioxidant enzyme activities, increased epithelization, greater capillary density, and increased collagen formation (Al-Ghanayem et al., 2022). The most effective results were seen in leaves that were dried at $10^0$C and $30^0$C and then extracted using ethanol. The biological activities of the extracts were significantly affected by the choice of solvent and drying temperature Muzammil et al. (2023). Effective planning and characterization of scaffolds for potential wound healing applications (Kamel et al., 2023).

Moringa oleifera leaves (MOL) are known for their potent herbal extract and have various medicinal properties that effectively treat diseases such as cancer, cardiovascular issues, atherosclerosis, and diabetes (Ningrum et al., 2023). The study by Muzammil et al. (2023) indicates that M. oleifera leaf extracts can potentially improve wound healing in diabetic conditions.

They also found that MOL nanofibers-film may offer an alternative treatment for chronic wounds. Insight into developing nanofiber-based wound dressing for chronic wound treatment and delivering therapeutic agents for wound healing (Chin & Ng, 2020). It was concluded that film containing 0.5% MOL extract was found to be the most promising method to accelerate diabetic wound healing in full-thickness excision and partial abrasion wound thickness in the HFD/STZ-induced type II diabetes model (Chin et al., 2018). It has been shown that the combination of PVA, MOL, and GO is a biocompatible wound dressing for diabetic foot ulcers (DFU) Ningrum et al. (2023). The gel was suitable for use (Pagano et al., 2020).

## CONCLUSION

Moringa leaves are valuable because their herbal extracts are potent and have several health benefits that make them useful for treating diseases. Moringa leaves contain protein, minerals, and fiber, which have been proven to have potential uses as antioxidants, antibacterials, anticancer, and anti-inflammatory agents.

## LIMITATION

This research can determine the effectiveness of Moringa oliefera leaves in healing wounds. It can also provide additional information to improve health about the benefits of antioxidants and antibacterials in Moringa leaves. However, this research is limited in that it only discusses Moringa leaves for wound healing; it needs to discuss the type of wound and the time it takes to heal. It is hoped that future researchers will discuss external factors in the wound healing process so that Moringa leaves can be put to good use.

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