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Formulation and Evaluation of a *Moringa oleifera*-Based Herbal Cream for Accelerated Wound Repair.

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Abstract

This study evaluated the wound-healing potential of creams formulated with *Moringa oleifera* aqueous leaf extract. Fresh leaves of *Moringa oleifera* were air-dried, powdered, and extracted using Soxhlet extraction. The resulting extract was screened for phytochemical constituents and incorporated into cream formulations at concentrations of 0.2, 0.4, and 0.6%. The wound healing efficacy of the creams was evaluated using an excision wound model in rats over a 12-day period. Wound contraction was monitored and recorded at intervals of 2 days. Phytochemical screening revealed the presence of alkaloids, saponins, flavonoids, tannins, carbohydrates, and reducing sugars. The formulated creams showed desirable physical characteristics, including smooth texture, pleasant smell, and good washability. In vivo wound-healing evaluation revealed that the 0.6% *Moringa* cream consistently produced the highest percentage of wound contraction across all time points, reaching a peak of 97.06% by Day 12. The 0.2 and 0.4% formulations also produced positive healing trends but at a slower rate. This study therefore shows that *Moringa oleifera* aqueous leaves extract have wound-healing potentials and can serve as a natural, safe, and cost-effective ingredient for topical formulations.

Keywords: *Moringa oleifera*, wound healing, phytochemical screening, herbal cream formulation.

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Introduction

Wound healing is a fundamental biological process that plays a crucial role in restoring skin integrity and function after injury. Topical wounds, such as cuts, abrasions, burns, and surgical incisions, are among the most common types of injuries encountered in both clinical and everyday settings. While minor wounds typically heal without complications, improper wound care can lead to delayed healing, infections, and scarring, highlighting the importance of effective treatment strategies (Ventura *et al*., 2021). Factors such as wound contamination, moisture imbalance, age, and inadequate skin regeneration can significantly influence healing outcomes, validating the need for proper wound care and management (Susanto *et al*., 2019).
Appropriate topical wound care, with the right medicines is necessary for promoting complete healing, preventing infection, and potential complication that might occur. Various treatment approaches, including the use of antiseptics, antibiotics, and advanced dressings, are commonly employed to accelerate tissue repair. Among these, topical formulations such as ointments, creams, and hydrogels are widely used due to their ease of application, ability to maintain a moist wound environment, and potential to deliver active healing agents directly to the affected area (Ventura *et al*., 2001). Alongside conventional pharmaceutical products, herbal-based formulations such as those containing aloe vera, calendula, and turmeric have gained increasing attention for their various therapeutic benefits. These natural remedies have been shown to possess anti-inflammatory, antimicrobial, and tissue-regenerative properties, making them valuable alternatives or complementary options in wound management (Susanto *et al.*, 2019).

Given the growing interest in natural therapies, medicinal plants such as *Moringa oleifera* Authority, have emerged as promising candidates for wound healing applications. *Moringa oleifera* (*Moringaceae)* is a highly significant medicinal plant extensively utilized across both rural and urban communities in developing countries, particularly in Africa and Asia (Susanto *et al*., 2019). It is widely recognized for its antioxidant, anti-inflammatory, and antimicrobial properties, which can enhance tissue repair and reduce the risk of infection (Azevedo *et al*., 2018; Mohammed *et al*., 2022). Herbal formulations incorporating Moringa offer several advantages, including lower costs, widespread availability, and minimal side effects compared to some synthetic drugs (Chin *et al*., 2018; Ventura *et al*., 2021). Integrating plant-based therapies into topical wound care could provide a safe, effective, and accessible alternative, particularly in settings where advanced medical treatments are limited (Shuaibu *et al*., 2014)

This study investigated the wound-healing potential of *Moringa oleifera* through the formulation of a topical cream. Findings from this research will contribute to the growing body of evidence supporting herbal medicine in modern wound care, offering a cost-effective alternative to conventional treatments and expanding the range of accessible wound management solutions.

Materials and Methods

Materials

Ethanol, Stearic Acid, Cetostearyl Alcohol, Liquid Paraffin, White Soft Paraffin, Glycerol, Sodium Propyl Paraben, Methyl Paraben, Triethanolamine, Lemon Oil, Distilled water. The equipment used include, Soxhlet apparatus (Sigma-Aldrich, India), Electronic weighing balance (Ohaus, United States of America), Water bath (Jiangsu Jinyi Instrument Technology Company Limited, China).

Methods

Collection of Moringa oleifera

The leaves of *Moringa oleifera* were collected from Ibagwa-aka, Nsukka, Enugu State, Nigeria in December 2023. The leaves were identified and authenticated by Mr. Felix Nwafor, of the Department of Pharmacognosy and Environmental Medicine, University of Nigeria, Nsukka. The collected materials were shade-dried, ground using a mortar and pestle, and stored in a cool, dry place until extraction.

Extraction procedures

The thimble with 200 g of powdered *Moringa oleifera* was inserted inside the soxhlet chamber. The distillation procedure started after 500 ml of distilled water as the solvents were added to the soxhlet extractor and put in a round-bottom flask. The soxhlet extractor was assemble, and heated using a heating mantle, allowing the solvent to reflux continuously. The extraction was carried out for several hours until the solvent in the siphon tube appeared very clear, indicating complete extraction. Thereafter the aqueous extract was collected and concentrated on a water bath at 50 °C. The concentrated extract was transferred into a Petri dish and allowed to dry by evaporation. The resulting dried extract was stored in an airtight container for subsequent analysis.

Phytochemical Screening of Moringa Extract

The extract was screened for the presence of secondary metabolites following methods outlined by Evans, 2009, Shuaibu *et al*., 2014 and Sucharitha *et al*., 2025.

Cream Formulation

A total of 50 grams of oil-in-water (O/W) cream was formulated in three separate batches, each containing different concentrations of the Moringa extract. The purpose of formulating in three batches was to evaluate the effect of increasing concentrations of the extract on the physical

properties and wound healing activity of the cream. Batch A was formulated with 0.2% w/w of Moringa extract, Batch B with 0.4% w/w, and Batch C with 0.6% w/w, all in 50 grams of the final product. The formulation process was carried out by first separating the excipients into two main components based on their solubility profiles: the aqueous phase and the lipid (oil) phase. The aqueous phase included all ingredients soluble in water, such as emulsifiers, humectants, preservatives, and the Moringa extract itself. The lipid phase included oil-soluble excipients such as stearic acid, ethyl alcohol, and any lipid-based emulsifiers. Each phase was weighed separately and heated in a water bath to a temperature of approximately 80 °C. This heating step was essential to ensure complete melting and dissolution of the ingredients in their respective phases, which is necessary to facilitate proper emulsification during the mixing process. Once both phases were fully dissolved and reached the same temperature, the aqueous phase was slowly added to the lipid phase with continuous stirring. The mixing was carried out manually using a ceramic mortar and pestle to ensure gradual and even incorporation of the two phases. Continuous stirring during this step was critical to promote the formation of a stable emulsion and to avoid phase separation. After complete mixing, the cream was allowed to cool gradually at room temperature while stirring was continued intermittently to maintain uniform consistency. As the cream cooled, it began to thicken and set into a smooth, semi-solid formulation. The final product was observed for homogeneity, color, odor, and consistency. Each batch was transferred into sterile, labeled containers and stored at room temperature for further evaluation.

Table 1. Cream Formulation composition

Ingredient	Batch A	Batch B	Batch C
Moringa Extract (Conc. %)	0.2	0.4	0.6
Stearic Acid (g)	6	6	6
Ceto stearyl Alcohol (g)	4	4	4
Liquid Paraffin (ml)	6	6	6
White soft Paraffin (g)	2	2	2
Glycerol (ml)	8	8	8
Sodium propyl Paraben (g)	0.2	0.2	0.2
Methyl Paraben (g)	0.6	0.6	0.6
Triethanolamine (ml)	2	2	2
Lemon Oil (ml)	0.5	0.5	0.5
Distilled Water	q.s	q.s	q.s

Physical Characterization of the Cream Formulation

The prepared cream formulations were inspected visually for color, odor, consistency, state and texture. Test for washability was carried out by washing applied cream on the skin surface with water.

Wound healing experimental protocol

Albino male Wistar rats weighing between 175-200 g were obtained from Department of Pharmacology Animal House, University of Nigeria and housed in standard cages as groups. Animals were housed in polypropylene cages maintained at 22±2°C temperature with 12 h light and 12 h dark cycle. The animals were fed on a standard pelleted diet and had free access to water throughout the experiment. Animals were housed individually in separate cages at animal care center of Department of Pharmacology Animal House, University of Nigeria, Nsukka.

Experimental design

The wound healing potential of the formulated cream was assessed using an excisional wound model. Thirty albino rats were randomly divided into five groups, each containing six animals. The first group served as the negative control and

received only the blank cream formulation. The second group acted as the positive control, where wounds were treated with a gentamycin cream. The remaining three groups received test treatments with varying formulations: 0.2%, 0.4% and 0.6% moringa cream, respectively. All prepared herbal creams were tropically applied to the excision wound area.

Wound induction

Excision wound was made on the depilated region of the back skin. A circular wound of approximately 2.0 cm in diameter was marked on the dorsal surface of the anaesthetized rats and skin in full thickness was excised to obtain a wound area of about 8 mm^2 using forceps and iris scissors, following the earlier method (Shrivastav *et al*., 2018; Sucharitha *et al*, 2025). Homeostasis was attained by blotting the ulcerated area with cotton swab dipped in normal saline. The wound diameter was measured using calipers on alternate days and recorded throughout the period under investigation. The wound area was measured with a translucent paper and traced on every alternate day (Shravan and Sajal, 2020). The contraction or healing of wound was expressed as percentage of the reduction in wound size. Percentage of wound contraction was measured using the formula given below.

Percentage wound contraction =

$$\frac{Initial\ wound\ area - treatment\ day\ wound\ area}{initial\ wound\ area} \times 100$$

Statistical analysis

One-way analysis of variance (ANOVA) was used in data analysis. The Tukey's HSD *post hoc* analysis was applied for between group comparisons. The *p* value less than 0.05 were considered as significant.

Results

Phytochemical composition of Moringa oleifera Aqueous Leaf Extract

The phytochemical analysis of *Moringa oleifera* aqueous leaf extract revealed that alkaloids and saponins were strongly present, flavonoids, tannins, carbohydrates, and reducing sugars were moderately present, while oils and fats were slightly present (Table 2).

Physical Characterization of the Cream Formulation

The formulations (Batches A, B, and C) exhibited a light-shaded green color with a citrus, slightly sweet aroma (Table 3). The creams were consistent, semi-solid in state, smooth in texture, and easily washable.

Table 2: Phytochemical composition Moringa *oleifera* aqueous leaf extract

Phytochemical	Result	Inference
Alkaloids	+++	Strongly present
Saponins	+++	Strongly present
Flavonoids	++	Moderately present
Tannins	++	Moderately present
Carbohydrates	++	Moderately present
Reducing Sugars	++	Moderately present
Oils and Fats	+	Slightly present

Table 3: Physical Properties of Moringa Cream Formulation

Batches	Colour	Odour	Consistency	State	Texture	Washability
		Characterizations				
A (0.2%)	Light green	slight citrus	consistent	Semi solid	Smooth	Washable
B (0.4%)	Light green	slight citrus	consistent	Semi solid	Smooth	Washable
C (0.6%)	Light green	slight citrus	consistent	Semi solid	Smooth	Washable

Percentage Wound Contraction

To investigate the wound healing effect of the various formulation of the extracts, animals were treated with three different concentrations and compared to positive and negative control. Application of *Moringa oleifera based* ointment on marked area showed significant wound healing activity when compared to control group. All the animals

treated with the formulation showed normal healing process with signs of improvement at every alternate day's intervals and this was determined by their contraction rate as per the morphology of the area are shown in Figs 2A-2C, and the values/data as per the percentage healing level are shown in Fig.1. Interestingly, a concentration dependent effect was observed in rats treated with the topical formulation. All the groups showed faster wound contraction when compared to negative control group. On day 12, 0.2 and 0.4% ointment treated groups showed 76.0 and 79.3% respectively, wound contraction while 97% wound healing activity was observed at 0.6% ointment, which was higher than standard drug gentamicin cream (84%) as shown Figure 1. The mean time taken for near complete closure of the wound area in 0.6% ointment treated group was less in comparison to positive control group (Figure 1). However, untreated control group animals showed some level of improvement in the contraction rate with 60% as the wound was visible on day 12. It was observed if the study was evaluated for average wound healing time of three weeks, there is every tendency to have full recovery in batch C as shown in Fig. 1.

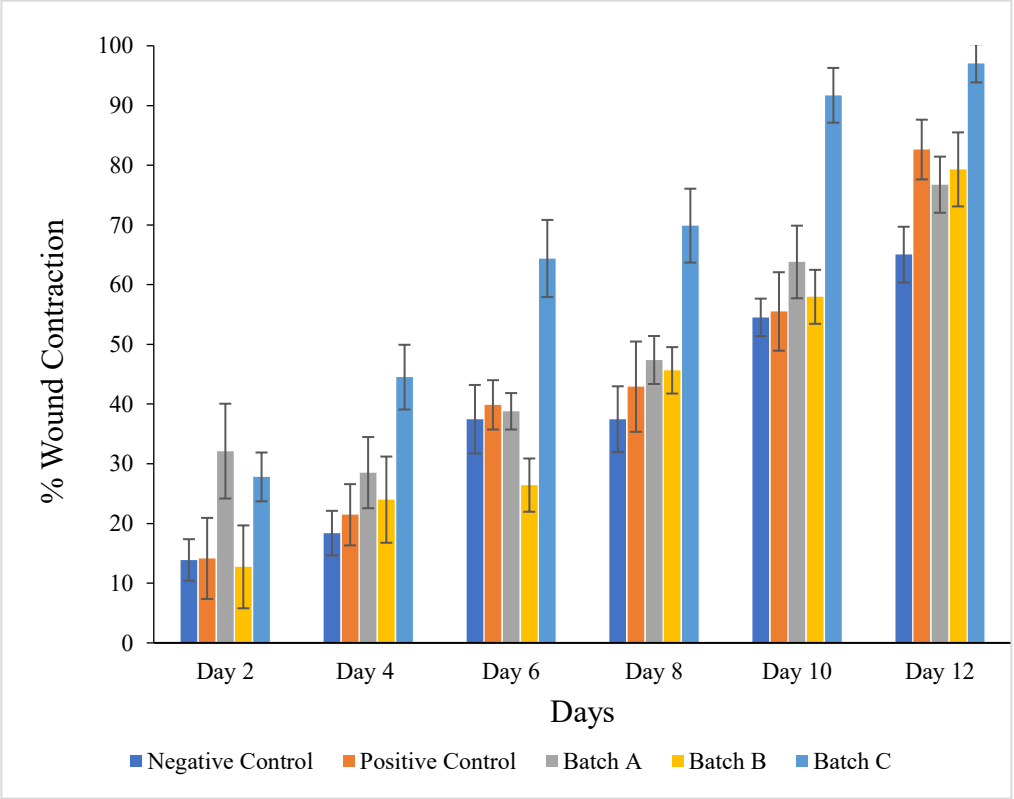

Figure 1: Percentage wound contraction in rats treated with different concentrations of *Moringa oleifera* aqueous leaf extract

Figure 2A: Rats treated with 0.2 % of *Moringa oleifera* based cream

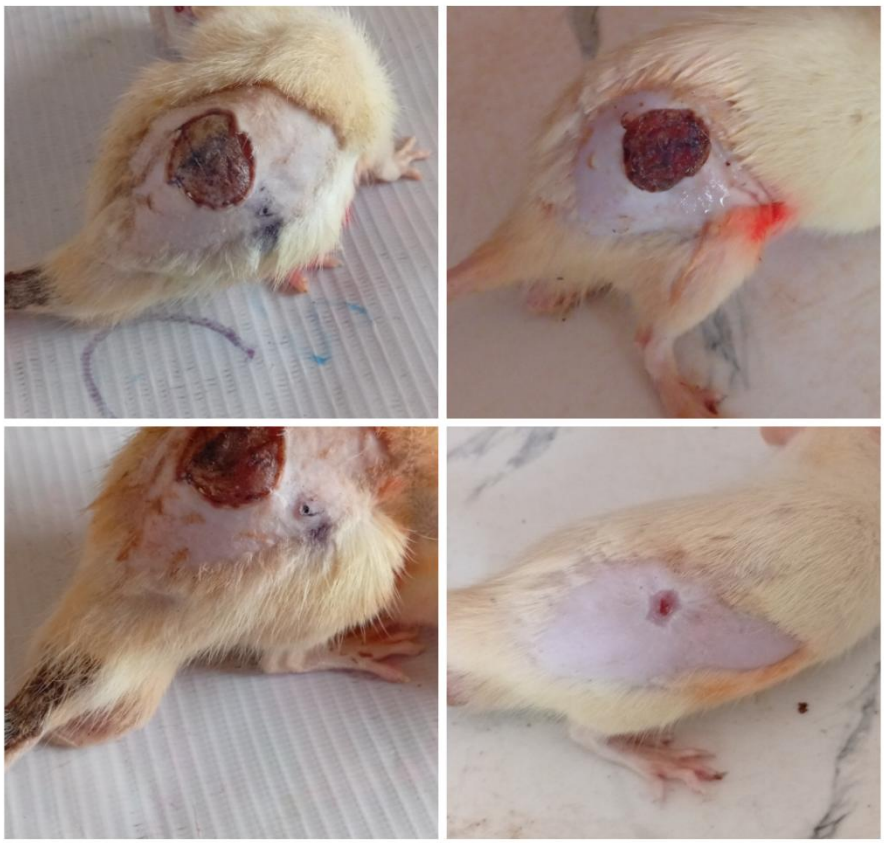

Figure 2B: Rats treated with 0.4 % of *Moringa oleifera* based cream

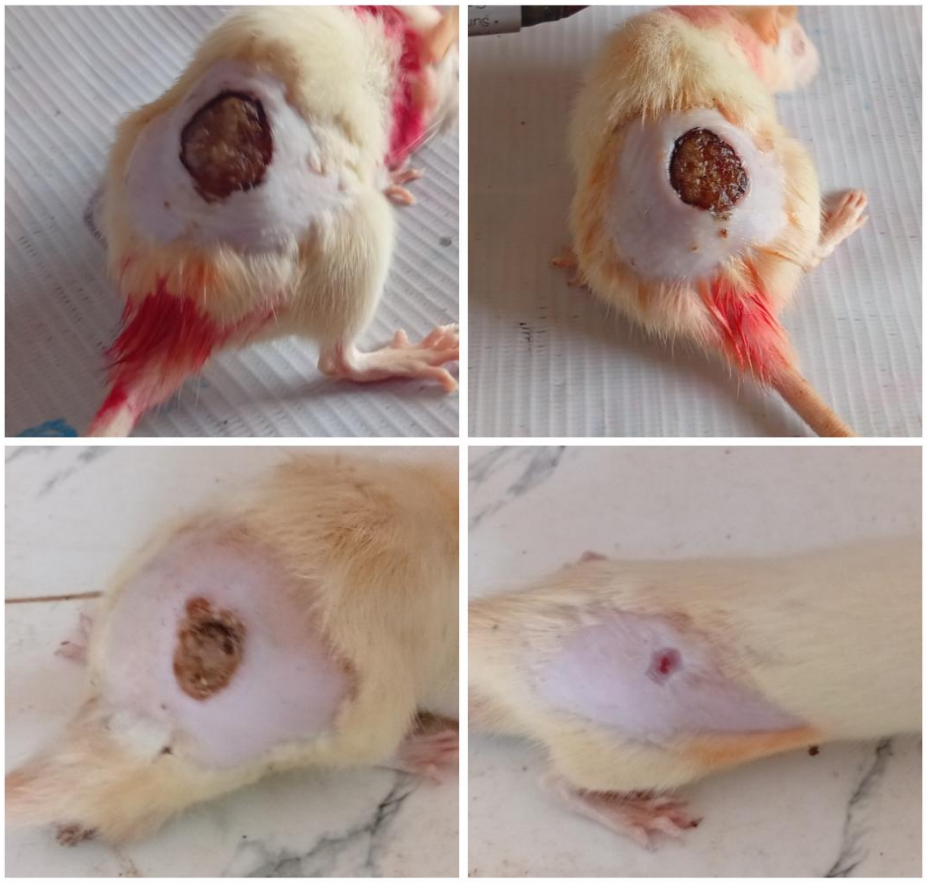

Figure 2C: Rats treated with 0.6 % of *Moringa oleifera* based cream

Discussion

This study investigated the wound healing properties of cream formations containing *Moringa oleifera* aqueous leaf extract. The phytochemical screening of the aqueous leaf extract of *Moringa oleifera* revealed the presence of several bioactive constituents, known for antimicrobial, anti-inflammatory, antioxidant activities and wound healing properties. These findings are consistent with earlier reports (Premarathna *et al.,* 2019; Tatiya *et al*., 2024).

The physical evaluation of the formulated *Moringa oleifera* creams showed desirable characteristics in terms of color, odor, consistency, texture, and washability. All formulations (Batches A, B, and C) exhibited a uniform light-shaded green color, which may be attributed to the natural chlorophyll pigments present in the *Moringa oleifera* leaves. The citrus, slightly sweet aroma suggests that the extract and incorporated excipients imparted a pleasant scent suitable for topical application. The formulations were semi-solid and consistent in nature, indicating good homogeneity and stability of the emulsion system. The smooth texture of the creams implies even dispersion of ingredients and ease of application on the skin surface. Additionally, the washability of all formulations suggests that the cream base was properly balanced between the oil and aqueous phases, allowing for easy removal after application. As shown in Figure 1, the wound healing effect is directly proportional to the concentration of the extract in the formulation. For instance, batch C, with highest moringa extract 0.6% show faster effect of wound closure (97.06%) within the treatment period (Fig. 2C), followed by batch B and A with corresponding Fig. 2B and 2A, respectively. The positive control with standard cream has similar effect, though lower than that of batch C, while the negative show list in the wound healing progression (figures not shown). The observable effect of the negative control is expected as the natural body mechanism has a way of helping in wound healing.

Scientifically, the wound healing properties of the moringa cream could be attributed to the presence of bioactive compounds such as flavonoids, tannins, alkaloids, and saponins, which are known to possess wound healing activity through multiple mechanisms. Previous evaluation has shown that flavonoids and tannins possess strong antioxidant and

astringent properties that help reduce oxidative stress, promote collagen synthesis, and facilitate tissue remodeling at the wound site (Cedillo-Cortezano *et al*., 2024; *Samavati et al.,* 2025). Similarly, saponins enhance epithelialization and angiogenesis, thereby accelerating granulation tissue formation, while alkaloids exhibit antimicrobial effects that minimize infection and inflammation which are critical for effective wound closure (University Research Centre Kampala International, 2025). Wound contraction was minimal during the first six days, likely because the natural healing process was progressing without any supportive agents. However, from Day 8 onwards, there was a gradual improvement in wound contraction, possibly as the body's natural immune and repair systems began to catch up.

Conclusion

This study showed that creams formulated with *Moringa oleifera* aqueous leaf extract possess good physical properties and strong wound-healing potential. The extract contained bioactive compounds such as flavonoids, tannins, saponins, and alkaloids, which likely contributed to its healing effects. Overall, *Moringa oleifera* extract proved effective for wound healing and can serve as a natural, affordable ingredient for herbal cream formulations. Further studies focusing on histological evaluation and the molecular mechanisms of healing are recommended to support and expand these findings.

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