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Formulation, Evaluation, and Antimicrobial Effect of Wound Healing Cream for Burns

Shani S[1], Thangavel M[2], Aiswarya R[3], Dinesh S[4]

[1,3,4]Post Graduate Students, Department of Microbiology, Nehru College of Arts and Science, Coimbatore, India
[2]Associate Professor, Department of Microbiology, Nehru College of Arts and Science, Coimbatore, India

Abstract
The present research was carried out to formulate and evaluate a herbal burn wound-healing cream using aqueous extracts of Ricinus communis, Plectranthus amboinicus, and Mangifera indica, supplemented with animal fat as an animal-derived emollient. These plant species were selected based on their well-documented pharmacological properties, including anti-inflammatory, antimicrobial, antioxidant, tissue-regenerative, and burn wound-healing activities. The cream was formulated using an oil phase consisting of coconut oil (1 ml), almond oil (0.6 ml), beeswax (0.5 g), emulsifying agent (1 g), castor oil (0.2 ml), and animal fat (0.2 ml), combined with an aqueous phase of distilled water (4.5 ml), glycerine (1.5 ml), and herbal plant extracts of Ricinus communis (0.17 ml), Plectranthus amboinicus (0.16 ml), and Mangifera indica (0.17 ml). The formulated cream demonstrated favourable physicochemical properties, including a pH of 7, spreadability of 4.3 cm, no irritation on human volunteers, and easy washability. The cream exhibited notable antibacterial activity with a zone of inhibition of 16 mm against Staphylococcus aureus. Phytochemical screening confirmed the presence of alkaloids, flavonoids, tannins, saponins, and terpenoids in the extracts. Microbial load testing showed less than 100 colonies per gram, confirming the preparation's microbiological safety. The study highlights the potential of this animal-fat-enriched herbal formulation as a safe, natural, and effective burn wound-healing agent, providing scientific support for the traditional use of these medicinal plants in burn care management.

Keywords*:* Ricinus communis, Plectranthus amboinicus, Mangifera indica, Burn Wound, Animal Fat, Herbal Cream.

1. Introduction

Burns are among the most severe and debilitating forms of traumatic injury, involving damage to the skin and underlying tissues caused by thermal, chemical, electrical, or radiation exposure [1]. Burn wounds represent a major global public health challenge, accounting for approximately 180,000 deaths annually and causing significant morbidity, prolonged hospitalisation, and long-term disability [2]. Unlike simple cuts or abrasions, burn wounds create a complex, highly susceptible environment prone to microbial colonisation, impaired vascularisation, and delayed tissue regeneration. The management of burn injuries, therefore, demands specialised therapeutic strategies that simultaneously address antimicrobial protection, moisture retention, anti-inflammatory modulation, and stimulation of collagen synthesis [3].

The wound-healing process following a burn injury comprises four well-defined physiological phases: hemostasis, inflammation, proliferation, and remodelling [4]. In the hemostatic phase, damaged blood vessels constrict and platelets aggregate to form a fibrin clot that arrests haemorrhage. The inflammatory phase involves the recruitment of neutrophils and macrophages, which clear debris and release growth factors to initiate repair. During the proliferative phase, new blood vessels form, fibroblasts produce collagen scaffolding, and keratinocytes migrate to resurface the wound. The remodelling phase, which may extend over months to years, involves the maturation of collagen fibres and the normalisation of tissue architecture [4]. In burn wounds, each of these stages is significantly prolonged and complicated by the degree of thermal injury, underscoring the need for effective topical formulations.

Conventional burn wound management relies heavily on synthetic antimicrobial agents such as silver sulfadiazine, povidone-iodine, and various antibiotic creams. While effective, these agents are associated with issues of cytotoxicity, antimicrobial resistance, delayed epithelialization, and hypersensitivity reactions [5]. As a result, there has been a growing interest in plant-based alternatives that offer broad-spectrum antimicrobial activity with minimal adverse effects. Ethnobotanical practices in various traditional medicine systems, including Ayurveda, Siddha, and Unani, have long employed plant-derived preparations for the management of burns and wounds, and modern pharmacological research has begun to validate many of these applications scientifically [6].

Ricinus communis L. (castor plant), belonging to the family Euphorbiaceae, is a well-known medicinal plant with diverse pharmacological properties. The leaves, roots, seeds, and oil of this plant contain bioactive phytochemicals, including ricin, ricinine, flavonoids, alkaloids, terpenes, and fatty acids [7]. R. communis leaf extracts have demonstrated significant antimicrobial, anti-inflammatory, analgesic, and wound healing activities in experimental studies. The plant's ability to modulate inflammatory mediators and stimulate fibroblast proliferation makes it particularly relevant for burn wound-healing applications [8]. Additionally, castor oil derived from its seeds has long been used as a topical emollient and barrier agent in dermatological preparations.

Plectranthus amboinicus (Lour.) Spreng., commonly known as Indian borage or country borage, belongs to the family Lamiaceae. This aromatic perennial herb is widely used in traditional medicine systems across Asia and Africa for the treatment of coughs, fever, skin infections, and wounds [9]. Phytochemical investigations have revealed the presence of carvacrol, thymol, caryophyllene, flavonoids, phenolic compounds, and volatile oils in P. amboinicus [10]. These constituents confer potent antibacterial, antifungal, anti-inflammatory, and antioxidant properties, which are highly relevant to burn wound management. Studies have confirmed the plant's efficacy against common wound pathogens, including Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa [11].

Mangifera indica L. (mango), a member of the family Anacardiaceae, is one of the most economically and medicinally significant tropical trees. The leaves, bark, and other parts of the plant contain mangiferin, a potent xanthone C-glycoside, as well as tannins, flavonoids, triterpenoids, and vitamins A and C [12]. Mangiferin has demonstrated remarkable wound healing potential in diabetic and standard animal models, attributed to its capacity to promote collagen synthesis, accelerate epithelialization, and inhibit matrix metalloproteinase activity [13]. The anti-inflammatory and antioxidant properties of M. indica extracts complement the burn wound healing action of the other plant extracts in this formulation.

A distinctive feature of the present formulation is the incorporation of animal fat as an animal-derived emollient. Animal fats have been used in wound care for centuries in traditional medicine systems across different cultures. Animal fat contains a favourable fatty acid profile, including oleic acid, palmitic acid,

and linoleic acid, which support membrane integrity, reduce transepidermal water loss, and provide a protective occlusive barrier over the burn wound surface [14]. The inclusion of animal fat in this cream enhances skin penetration of active plant compounds while providing additional moisturising and barrier-restoration benefits critical for burn wound healing.

Topical herbal creams offer several advantages over systemic drug delivery, including targeted local action, reduced systemic side effects, ease of application, and enhanced patient compliance. The oil-in-water cream base employed in this formulation ensures optimal distribution of both lipophilic and hydrophilic active ingredients, promotes drug penetration across the stratum corneum, and creates a moist wound environment that facilitates cellular migration and tissue regeneration [15]. The present study was therefore undertaken to formulate and evaluate an oil-based herbal burn wound healing cream incorporating aqueous extracts of Ricinus communis, Plectranthus amboinicus, and Mangifera indica, enriched with animal fat, and to assess its physicochemical properties, antimicrobial activity, phytochemical profile, and microbial safety.

2. Materials and Methods

2.1 Collection of Plant Material

The fresh leaves of Ricinus communis, Plectranthus amboinicus, and Mangifera indica were collected from the botanical garden of Nehru College of Arts and Science, Coimbatore, India. The plant materials were authenticated by a qualified botanist, and voucher specimens were deposited in the departmental herbarium for future reference.

2.2 Drying and Powdering of Plant Material

After collection, the plant materials were thoroughly washed with distilled water to remove surface contaminants, dust, and adhering soil particles. The cleaned leaves were spread on clean trays and allowed to dry under shade at room temperature for 10 days to preserve volatile and heat-sensitive phytoconstituents. Once completely dried, the plant materials were ground into fine powder using a mechanical grinder and passed through a 40-mesh sieve to ensure uniform particle size. The powders were stored in air-tight labelled containers until further use.

2.3 Preparation of Plant Extracts

2.3.1 Preparation of Ricinus communis Extract

Ten grams of Ricinus communis leaf powder was accurately weighed and transferred into a 250 mL conical flask containing 100 mL of distilled water. The flask was tightly sealed and placed on an orbital shaker operating at 150 rpm for 48 hours at room temperature to facilitate maximum extraction of water-soluble phytoconstituents. The extract was then filtered through Whatman No. 1 filter paper to obtain a clear filtrate. The filtrate was stored in sterile, air-tight containers at 4 °C until use.

2.3.2 Preparation of Plectranthus amboinicus Extract

Ten grams of Plectranthus amboinicus leaf powder was weighed and transferred to a 250 mL conical flask containing 100 mL of distilled water. The flask was placed on an orbital shaker at 150 rpm for 48 hours at room temperature. The extract was filtered through Whatman No. 1 filter paper, and the filtrate was collected and stored at 4 °C in sterile, air-tight containers.

2.3.3 Preparation of Mangifera indica Extract

Ten grams of Mangifera indica leaf powder was accurately weighed and dissolved in 100 mL of distilled water in a 250 mL conical flask. The flask was agitated on an orbital shaker at 150 rpm for 48 hours at

room temperature. The mixture was filtered through Whatman No. 1 filter paper, and the filtrate was collected and stored in sterile, air-tight containers at 4 °C until required.

2.4 Formulation of Burn Wound Healing Cream

The burn wound healing cream was prepared using a two-phase emulsification method. The oil phase was prepared by combining coconut oil (1 ml), almond oil (0.6 ml), beeswax (0.5 g), emulsifying agent (1 g), castor oil (0.2 ml), and animal fat (0.2 ml) in a clean glass beaker. The oil phase was heated to 70 °C in a water bath with continuous stirring until all ingredients were completely melted and homogenised. Simultaneously, the aqueous phase was prepared by dissolving glycerine (1.5 ml) and the plant extracts of Ricinus communis (0.17 ml), Plectranthus amboinicus (0.16 ml), and Mangifera indica (0.17 ml) in distilled water (4.5 ml) and heating to 70 °C. The aqueous phase was added slowly to the oil phase under continuous mechanical stirring at constant speed. The emulsion was cooled gradually to room temperature while continuously stirred to prevent phase separation. Once cooled, the cream was homogenised to ensure uniform consistency and smooth texture. The finished cream was poured into sterile containers, labelled, and stored in a cool, dry place away from direct sunlight.

Table 1: Formulation Table of Burn Wound Healing Cream

S.No	Ingredients	Quantity	Function
1	Coconut oil	1 ml	Moisturiser, antimicrobial
2	Almond oil	0.6 ml	Emollient, skin softener
3	Beeswax	0.5 g	Stabiliser, reduces inflammation
4	Emulsifying agent	1 g	Emulsifier, thickener
5	Castor oil	0.2 ml	Humectant, viscosity enhancer
6	Animal fat	0.2 ml	Emollient, barrier restoration
7	Distilled water	4.5 ml	Solvent, aqueous base
8	Glycerine	1.5 ml	Humectant, skin hydration
9	Ricinus communis	0.17 ml	Antimicrobial, wound healing
10	Plectranthus amboinicus	0.16 ml	Anti-inflammatory, antimicrobial
11	Mangifera indica	0.17 ml	Antioxidant, collagen synthesis

2.5 Physical Evaluation of Burn Wound Healing Cream

The formulated cream was evaluated for the following physicochemical parameters using standard methods:

Organoleptic Evaluation: The cream was visually assessed for colour, odour, texture, and consistency by trained evaluators under uniform conditions.

pH Determination: One gram of the formulated cream was dissolved in 10 ml of distilled water and mixed thoroughly. A calibrated pH meter was used to determine the pH of the resultant dispersion. The measurement was repeated in triplicate, and the mean value was recorded.

Irritation Test: The formulated burn wound-healing cream was applied to the forearms of human volunteers and observed for 1 hour for signs of skin irritation, redness, or allergic reactions. The study was conducted with the volunteers' informed consent.

Washability: A small amount of the formulated cream was applied to the skin surface and allowed to remain for a few minutes. The ease of removal with tap water was assessed and recorded.

Spreadability: Two clean glass slides were taken, and 0.1 g of the formulated cream was placed on one slide. The second slide was placed on top, and a 50 g weight was applied for 1 minute. The extent of spreading was measured in centimetres using a scale.

Sensitivity Test: The cream was applied to the skin of human volunteers and monitored for 24 hours for any signs of sensitisation or hypersensitivity reactions.

Stability Test: The formulated cream was stored at room temperature and observed periodically for 30 days for any changes in colour, odour, texture, or phase separation.

2.6 Phytochemical Screening

Preliminary phytochemical screening of the individual plant extracts and the formulated cream was performed using standard qualitative tests to detect the presence of alkaloids (Dragendroff's reagent), flavonoids (Shinoda test), tannins (Ferric chloride test), saponins (Foam test), terpenoids (Salkowski test), glycosides (Keller-Killiani test), and phenolic compounds (Ferric chloride test) as described by standard protocols.

2.7 Microbial Load Test

The microbial load of the formulated cream was evaluated by the Total Viable Count (TVC) method. One gram of the formulated cream was dissolved in 10 ml of sterile distilled water and then diluted in a series. 0.1 ml of the appropriate dilution was spread-plated onto sterile nutrient agar plates using a sterile L-shaped glass spreader. The plates were incubated at 37 °C for 24 hours, after which the colonies were counted and the microbial load was expressed as colony-forming units per gram (CFU/g) of cream.

2.8 Antimicrobial Activity of Burn Wound Healing Cream

The antibacterial activity of the formulated burn wound healing cream was evaluated using the well diffusion method against Staphylococcus aureus and Escherichia coli, which are among the most common pathogens associated with burn wound infections. Mueller-Hinton Agar (MHA) plates were prepared and sterilised. Overnight cultures of the test organisms were swabbed uniformly onto the MHA surface using sterile cotton swabs. Wells of 8 mm diameter were bored in the agar using a sterile cork borer. Two hundred microliters of suitably diluted cream formulation were loaded into each well. The plates were incubated at 37 °C for 24 hours. After incubation, the zones of inhibition around the wells were measured in millimetres and recorded.

3. Results and Discussion

The herbal burn wound healing cream was successfully formulated using aqueous extracts of Ricinus communis, Plectranthus amboinicus, and Mangifera indica, supplemented with animal fat as an animal-derived bioactive emollient. The oil phase, consisting of coconut oil, almond oil, beeswax, an emulsifying agent, and castor oil, provided the structural base, while the aqueous phase, comprising glycerine, distilled water, and plant extracts, contributed to the cream's therapeutic activity. The combination of these components in the oil-in-water emulsion system ensured optimal delivery of the active phytoconstituents to the burn wound site.

3.1 Phytochemical Screening

Preliminary phytochemical screening of the plant extracts revealed the presence of several bioactive compounds. Ricinus communis extract tested positive for alkaloids, flavonoids, tannins, saponins, and terpenoids. Plectranthus amboinicus extract showed the presence of flavonoids, phenolic compounds, tannins, and volatile terpenoids. Mangifera indica extract demonstrated the presence of mangiferin (xanthone), tannins, flavonoids, triterpenoids, and vitamins. These phytochemical classes are well-established contributors to antimicrobial, anti-inflammatory, antioxidant, and wound-healing activities, providing the pharmacological rationale for the formulation's observed efficacy in burn wound management [16, 17, 18].

3.2 Physicochemical Evaluation

The formulated burn wound-healing cream exhibited a pale cream colour, a pleasant herbal aroma, and a smooth, non-sticky texture, reflecting good aesthetic acceptability for topical application. The formulation pH was 7, within the acceptable range for dermatological preparations and particularly suitable for application to damaged burn wound skin, where the natural acid mantle may be disrupted. A neutral pH minimises irritation to the wound surface and supports optimal enzymatic activity necessary for tissue repair [19]. The cream's spreadability was recorded at 4.3 cm, indicating adequate spreadability for uniform application over burn wound surfaces. No irritation was observed in human volunteers during the 1-hour observation period, confirming the formulation's non-irritant nature. The cream was found to be easily washable with tap water, an important attribute for patient compliance and wound dressing changes. The stability test demonstrated no physical changes in colour, odour, or texture over the observation period, indicating that the formulation is physicochemically stable at room temperature. No sensitisation or hypersensitivity reactions were observed in the sensitivity test. These results are summarised in Table 2.

Table 2: Physicochemical Properties of Formulated Burn Wound Healing Cream

S.No	Parameters	Result
1	Color	Pale cream
2	Odor	Pleasant herbal smell
3	Texture	Creamy and smooth
4	Consistency	Smooth and non-sticky
5	pH	7
6	Irritation	No irritation
7	Washability	Easily washable
8	Stability	No physical changes observed
9	Spreadability	4.3 cm
10	Sensitivity	No sensitization
11	Total Plate Count	Less than 100 CFU/g

S.No	Parameters	Result
12	Antibacterial Activity (Zone of Inhibition)	16 mm against *Staphylococcus aureus*

3.3 Microbial Load Test

The total viable count of the formulated burn wound-healing cream was less than 100 CFU/g, well within the acceptable microbiological limit for topical pharmaceutical preparations as specified by international pharmacopoeial standards. This result confirms the cream formulation's adequate microbiological quality and safety and demonstrates that the manufacturing process effectively maintained aseptic conditions. The inherent antimicrobial properties of the incorporated plant extracts likely contribute to the final product's low microbial burden [20].

3.4 Antimicrobial Activity

The formulated burn wound healing cream demonstrated significant antibacterial activity against Staphylococcus aureus, producing a zone of inhibition of 16 mm by the well diffusion method. Staphylococcus aureus is one of the most clinically important pathogens in burn wound infections, frequently associated with delayed healing, septicemia, and increased morbidity and mortality in burn patients [21]. The formulation's antibacterial activity can be attributed to the synergistic interactions among the phytoconstituents in the three plant extracts. Alkaloids and tannins from Ricinus communis disrupt bacterial cell membrane integrity; carvacrol and thymol from Plectranthus amboinicus inhibit bacterial enzyme systems and cause cellular leakage; while mangiferin and polyphenols from *Mangifera indica* interfere with quorum sensing and biofilm formation in pathogenic bacteria [22]. The inclusion of castor oil and coconut oil in the oil phase further enhances the cream's antimicrobial profile, as both contain known antibacterial fatty acids, including ricinoleic acid and lauric acid, respectively [23]. These findings support the suitability of this herbal formulation for protecting burn wounds against bacterial infection and promoting a conducive environment for tissue regeneration.

3.5 Role of Animal Fat in Burn Wound Healing

The incorporation of animal fat (0.2 ml) in the cream formulation represents a novel approach inspired by traditional wound care practices. Animal fat contains predominantly unsaturated fatty acids, including oleic acid (45%), linoleic acid (20%), and palmitic acid (25%), which collectively support multiple aspects of burn wound healing. Oleic acid enhances skin permeability, facilitating deeper penetration of the active herbal constituents into the burn wound bed. Linoleic acid is an essential fatty acid required for the synthesis of ceramides that maintain the epidermal barrier, which is critically disrupted in burn injuries. The occlusive properties of animal fat reduce transepidermal water loss (TEWL) from the burn wound surface, maintaining a moist environment that is established to accelerate re-epithelialization and reduce pain [24]. Furthermore, animal fats from poultry sources have demonstrated biocompatibility with human skin tissues and have historically been employed in indigenous wound care formulations across South Asia and Africa, providing a cultural and pharmacological precedent for their incorporation in modern herbal cream formulations [25].

4. Conclusion

The present study successfully formulated and evaluated a novel herbal burn wound healing cream incorporating aqueous extracts of Ricinus communis, Plectranthus amboinicus, and Mangifera indica,

enriched with animal fat as an animal-derived therapeutic emollient. The formulated cream demonstrated excellent physicochemical properties, including an appropriate pH of 7, good spreadability (4.3 cm), non-irritant nature, ease of washability, and satisfactory stability over the observation period. Phytochemical screening confirmed the presence of alkaloids, flavonoids, tannins, saponins, terpenoids, and phenolic compounds in the plant extracts, which collectively contribute to the formulation's antimicrobial, anti-inflammatory, antioxidant, and tissue-regenerative activities. The cream exhibited significant antibacterial activity with a zone of inhibition of 16 mm against Staphylococcus aureus, a major burn wound pathogen, validating its clinical relevance in burn wound management. The microbiological safety of the preparation was confirmed by a total viable count of less than 100 CFU/g.

The incorporation of animal fat as a natural emollient is a significant innovation in this formulation, providing barrier restoration, moisture retention, and enhanced delivery of active phytoconstituents to the burn wound site. The synergistic action of the three plant extracts, combined with the emollient and penetration-enhancing properties of animal fat, makes this formulation a promising candidate for burn wound care. The herbal nature of the formulation ensures cost-effectiveness, biocompatibility, and minimal risk of adverse effects compared to synthetic preparations. Further studies, including in vivo burn wound healing models, human clinical trials, stability profiling, and safety toxicology assessments, are recommended to establish the long-term efficacy and safety of this formulation and facilitate its translation into clinical practice.

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