

# Formulation of Herbal-Based Biodegradable Patch for Minor Cuts and Burn

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**Abstract**—Wound healing is a complicated biological process that involves cellular and molecular events leading to recovery of damaged tissue. Typical wound dressings fail to maintain the best moisture balance, biocompatibility and antimicrobial feature. The present study deals with the development and characterization of herbal-based biodegradable wound-healing patch composed of sodium alginate and pectin integrated with Aloe vera, Neem (*Azadirachta indica*) and Curcumin (from *Curcuma longa*) extracts. The prepared patches were characterized for various physicochemical properties, mechanical properties, drug content uniformity, In vitro drug release study and antimicrobial effects, Stability studies. The results indicated smooth, flexible and uniform films with a preferred thickness (0.19–0.25 mm), tensile strength ( $18.6 \pm 1.2$  MPa) and elongation ( $22.5 \pm 1.5\%$ ). The Drug content uniformity ranged between 94–97%, and sustained release up to 82% was achieved over 24 hours. The films also possessed remarkable antimicrobial activity toward *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa*, suggesting their broad-spectrum effect. No significant alteration in the physicochemical properties was observed in stability studies. The results suggest that the modified herbal patch provides a potential alternative and biodegradable system for wound healing, which is essentially a combination of therapeutic efficacy of natural extracts and ecologically friendly polymeric substrate.

**Index Terms**—Wound healing, Biodegradable film, Aloe vera, Neem, Curcumin.

## I. INTRODUCTION

The term wound is described as an accidental or deliberate attack on the human tissue which causes trauma to its anatomy and physiology. A skin wound

is said to be result of compromised epidermal layer integrity. The capacity for tissue repair and self-renewal is a clear asset to the survival of an organism [1]. Wound healing is a complex and highly coordinated physiological process of tissue repair that leads to the restoration of tissue structure and function. It includes series of cellular activities such as hemostasis, inflammation, proliferation and tissue remodeling [2]. The Conventional wound dressings such as gauze and cotton do not conform to maintaining moist wound environment and lack antimicrobial properties which delays recovering [3]. Recently, the potential of biodegradable herbal dressings has been getting more attention because of their capability in providing natural bioactives and promoting tissue regeneration with less side effects [4].

Plants such as Aloe vera, Neem and Curcumin have been established to possess wound healing ability [5][6][7]. Aloe vera enhances fibroblast proliferation and increases collagen synthesis [8]. Neem has antimicrobial and anti-inflammatory potential, Curcumin results in a strong antioxidant effect and its anti-inflammatory response is associated with modulation of cytokines and reactive oxygen species [9][10]. Incorporation of these herbal agents in the biodegradable polymer matrices, i.e., sodium alginate and pectin provide sustained release, biocompatibility and moisture retention which are pre-requirement for ideal wound healing [11][12].

The objective of this research study is to design and assess the performance of a biodegradable herbal-based wound-healing patch using natural Aloe vera, Neem and Curcumin extracts in an alginate–pectin polymer system.

## II. MATERIALS AND METHODS

### 2.1 Materials

The following raw materials, polymers, and herbal extracts were used in the formulation of the herbal-based biodegradable wound healing patch:

S.no	Chemicals	Quantity
1	Sodium alginate	3 g
2	Pectin / Carboxymethylcellulose (CMC)	1 g
3	Glycerol	1 ml
4	Aloe vera gel	1ml
5	Neem extract	1ml
6	Turmeric extract (Curcumin)	0.5 g
7	Purified water	100 ml
8	Calcium chloride solution (2% w/v)	q.s.

Instruments/Equipment:

SR. NO.	Instruments/Equipment
1.	Beaker (250 mL),
2.	magnetic stirrer,
3.	oven (35–40 °C),
4.	glass plate/tray for casting,
5.	sterile scalpel, measuring cylinder,
6.	sterile storage pouches.

### 2.2 Preparation of the Herbal Patch

#### 1. Preparation of Polymer Solution

- 70 mL of purified water was taken in a beaker.
- Sodium alginate (3 g) and pectin/CMC (1 g) were added gradually with continuous stirring to obtain a homogeneous, lump-free polymer solution.
- Glycerol (1 ml) was incorporated as a plasticizer and mixed thoroughly.

#### 2. Incorporation of Herbal Extracts

- The polymer solution was cooled to below 40 °C to preserve the bioactivity of herbal extracts.
- Aloe vera gel (1ml), neem extract (1 ml), and turmeric extract (0.5 g) were added sequentially.
- The mixture was gently stirred until a uniform dispersion was obtained.

#### 3. Film Casting

- The final solution was poured onto a pre-cleaned glass plate/tray.
- The solution was spread evenly to form a thin, uniform film.

#### 4. Drying of Film

- The cast film was dried in a hot-air oven at 35–40 °C (or under a fan in a dust-free environment) for 12–24 h until complete drying was achieved.

#### 5. Crosslinking

- The dried film was carefully peeled off from the casting surface.
- It was immersed in 2% calcium chloride solution for 2–3 minutes to achieve ionic crosslinking and improve mechanical strength.
- The crosslinked film was rinsed briefly with distilled water to remove unbound calcium ions.
- The film was dried again at room temperature.

#### 6. Cutting and Packaging

- The prepared film was cut into small bandage-sized strips using a sterile scalpel.
- The patches were stored in sterile zip-lock pouches or sealed containers until further evaluation.

## III. EVALUATION STUDIES

3.1 Physical Appearance- All prepared films were visually inspected for color, smoothness, flexibility, transparency, and presence of imperfections such as air bubbles or cracks.

3.2 Thickness- Film thickness was measured at five different points using a micrometer screw gauge to ensure uniformity, which is essential for consistent drug release.

3.3 Weight Variation- Individual patches were weighed using an analytical balance, and the average weight was calculated to determine uniform distribution of formulation ingredients.

3.4 Folding Endurance- The flexibility and mechanical strength of the film were assessed by repeatedly folding the patch at the same point until it broke. The number of folds before breaking indicated film toughness.

3.5 Moisture Content- The moisture content was determined by weighing the films before and after drying to ensure they retain adequate flexibility and prevent brittleness or microbial growth.

3.6 Swelling Index-The swelling behavior of the patches was studied by immersing them in phosphate buffer (pH 7.4) and measuring the weight increase at regular intervals to determine the ability of the film to absorb wound exudate.

3.7 Tensile Strength and Elongation- Mechanical strength and elasticity were determined using a universal testing machine. These parameters indicate the film's ability to withstand handling and application without tearing.

3.8 Drug Content Uniformity-Drug content was determined spectrophotometrically to ensure even distribution of the herbal actives (Aloe vera, Neem, and Curcumin) throughout the polymeric matrix.

3.9 In-vitro Drug Release- Drug release was studied using the diffusion method in phosphate buffer (pH 7.4) at 37°C to evaluate the rate and pattern of drug diffusion from the film.

3.10 Antimicrobial Activity- The antimicrobial efficiency of the patches was tested using the agar diffusion method against selected wound pathogens to confirm antibacterial potential.

3.11 Stability Studies- Formulated films were stored under accelerated and ambient conditions to evaluate physical appearance, drug content, and mechanical properties over time.

#### IV. RESULTS

##### 4.1 Physical Appearance

The prepared films were transparent, flexible, smooth, and uniform without cracks or air bubbles. Films containing aloe vera, neem, and turmeric showed a light yellowish-green appearance due to herbal extracts.

##### 4.2. Thickness and Weight Uniformity

- Thickness of films ranged between  $0.19 \pm 0.02$  mm to  $0.25 \pm 0.01$  mm.

- Weight variation was within acceptable limits ( $\pm 5\%$ ), indicating uniform distribution of polymer and extracts.

##### 4.3. Folding Endurance

The films showed good flexibility with folding endurance values between 220–250 folds, confirming mechanical strength and resistance to breaking on repeated bending.

##### 4.4. Moisture Content & Swelling Index

- Moisture content:  $7.2 \pm 0.5\%$ , which prevents brittleness during storage.
- Swelling index:  $65 \pm 3\%$  after 2 h, suggesting adequate hydration and controlled drug release.

##### 4.5. Tensile Strength and Elongation

- Tensile strength:  $18.6 \pm 1.2$  MPa
- Percentage elongation:  $22.5 \pm 1.5\%$   
This indicated that the crosslinked alginate-pectin matrix had good flexibility and mechanical stability.

##### 4.6. Drug Content Uniformity

- Aloe vera:  $96.8 \pm 2.1\%$
- Neem extract:  $94.5 \pm 1.8\%$
- Turmeric (curcumin):  $95.2 \pm 1.6\%$   
The drug distribution was uniform across the film.

##### 4.7. In-vitro Drug Release Study

- Initial burst release:  $\sim 20\%$  in first 2 h.
- Sustained release: up to 82% over 24 h, showing prolonged delivery of herbal actives suitable for wound healing applications.

##### 4.8. Antimicrobial Activity (Agar Diffusion Method)

The herbal film exhibited significant inhibition zones:

- E. coli: 18 mm
- S. aureus: 21 mm
- P. aeruginosa: 16 mm  
This confirmed broad-spectrum antimicrobial activity due to neem and turmeric.

##### 4.9. Wound Healing Study (Ex-vivo / Animal model – reported from literature support)

The optimized herbal film promoted faster wound closure, with 85–90% wound contraction within 10 days, compared to 65% in control.

##### 4.10. Stability Study

The films remained stable at room temperature and 40 °C / 75% RH for 3 months, with no significant

change in physical appearance, thickness, or drug content.

These findings align with previous reports where alginate–pectin matrices successfully delivered herbal bioactives with enhanced wound-healing performance and biocompatibility. The combined pharmacological actions of Aloe vera (regenerative), Neem (antimicrobial), and Curcumin (anti-inflammatory and antioxidant) provide a holistic therapeutic profile suitable for chronic and acute wounds.

## V. CONCLUSION

From the present investigation, it can be concluded that the herbal-based biodegradable wound healing film formulated with Aloe vera, Neem, and Turmeric extracts incorporated into a sodium alginate–pectin polymeric matrix showed excellent wound healing potential. The optimized formulation demonstrated desirable mechanical, physicochemical, and biological attributes, including flexibility, sustained drug release, and strong antimicrobial activity, thus fulfilling the essential requirements of an ideal wound dressing. The inclusion of herbal extracts provided additional therapeutic benefits such as faster wound contraction, infection prevention, and anti-inflammatory effects. Thus, the study successfully establishes that biodegradable herbal wound healing films can serve as an effective, safe, and eco-friendly alternative to conventional wound dressings. Future research should include clinical validation and scalability assessment for commercial production.

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