INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: https://www.ijpsjournal.com

OPEN ACCESS

Review Article

Film Dressings: An Innovative Approach in Wound Management

Janhavi Narkhede*, Trunali Ghude, Manasi Navle, Tanshri Nifade, Pratap Nimbalkar, Pallavi Nichite

Konkan Gyanpeeth Rahul Dharkar College of Pharmacy and Research Institute, Karjat, Maharashtra

ARTICLE INFO

Published: 30 Apr 2026
Keywords:
Wound Management, Moist Wound Healing, Polymeric Films, Advanced Wound Care, Bioactive Dressings, Controlled Drug Release, Hot-Melt Extrusion
DOI:
10.5281/zenodo.19918772

ABSTRACT

Dressing systems that actively promote the natural healing cascade must go beyond simple coverage in order to provide effective wound care. In the context of modern wound care, this paper objectively assesses polymer-based film dressings and compares their functional performance to that of traditional materials like gauze and bandages. To determine the fundamental characteristics needed for the perfect dressing system, the physiological stages of wound healing are taken into account. According to published research, traditional dressings primarily serve as absorbent layers and passive barriers, frequently failing to maintain proper moisture levels and sometimes upsetting delicate regenerating tissue during removal. Film dressings, on the other hand, offer a thin, semi-permeable, and conformable matrix that can prevent external microbial contamination, enable oxygen to pass through, and maintain a balanced wet environment. Their structural flexibility also makes it possible to add therapeutic ingredients, such as bioactive substances and antimicrobials, which improves their clinical use. When taken as a whole, these features present film dressings as cutting-edge, patient-focused platforms with substantial potential to enhance healing effectiveness, reduce the risk of infection, and enable cutting-edge wound care techniques.

INTRODUCTION

Wound management is a crucial aspect of healthcare, as proper healing prevents infection, reduces complications, and improves patient comfort.[1] A wound is defined as a disruption of the integrity of skin ,mucous membranes, or tissue often resulting from trauma, surgery .Clinically, wounds are categorized as acute (e.g., surgical, traumatic) or chronic (e.g., diabetic foot ulcers, venous leg ulcers, pressure ulcers), with chronic wounds posing a substantial burden on healthcare systems due to delayed healing, susceptibility to infection, and high morbidity rates. [2] In earlier practices, wounds were commonly covered using cotton, gauze, or bandages.[3] Although these materials provide basic protection, they often fail to maintain the ideal wound environment, may

***Corresponding Author:** Janhavi Narkhede
Address: *Konkan Gyanpeeth Rahul Dharkar College of Pharmacy and Research Institute, Karjat, Maharashtra.*
Email : janunarkhede@gmail.com

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

adhere to the wound surface, and require frequent replacement, which can slow the healing process.

In complex or chronic wounds when tissue regeneration is impeded and inflammation persist conventional bandages have a limited functional contribution to healing while acting as barriers to external contamination. Because untreated wounds can result in infection, systemic sepsis, extended hospital stays, and higher medical expenses, advanced wound care management is essential. These difficulties demonstrate the inadequacy of conventional wound dressings for more complicated wound types, especially chronic ulcers linked to diabetes or vascular insufficiency, where management is further complicated by prolonged healing times and susceptibility to infection.[4]

Film dressings have become increasingly important among contemporary dressings. These are thin, flexible, transparent polymeric membranes that stick to the skin and let moisture vapour and oxygen through while keeping water and microbes out. Film dressings allow for visual monitoring of the healing process without the need for frequent dressing changes, maintain a moist wound environment, and lower the risk of infection. Additionally, some cutting-edge films are made to transport medicinal substances like growth factors, antimicrobials, or anti-inflammatory medications straight to the wound site.

WOUND MANAGEMENT

The primary goal of wound management is to restore the normal structure and function of the damaged tissue. The wound healing process is a natural physiological reaction to tissue injury that consists of four highly integrated phases: hemostasis, inflammation, proliferation, and remodeling. These phases must occur in a specific sequence, at a specific time, and for a particular duration.

1. Hemostasis: -

The hemostasis phase begins minutes to hours after an injury through a cascade of serine protease activation, resulting in platelet activation. This activation also facilitates the release of growth factors, such as PDGF (platelet-derived growth factor), VEGF (vascular endothelial growth factor), and TGF-α (transforming growth factorα), as well as immune mediators.

PDGF and TGF-β recruit neutrophils and monocytes Furthermore, this leads to the formation of a fibrin clot, which acts as a plug for the wound, preventing blood loss, providing a scaffold for incoming immune cells, and offering protection against bacterial invasion. Releasing molecules such as serotonin that induce localized vasoconstriction Subsequently, platelets aggregate and forming a hemostatic plug.

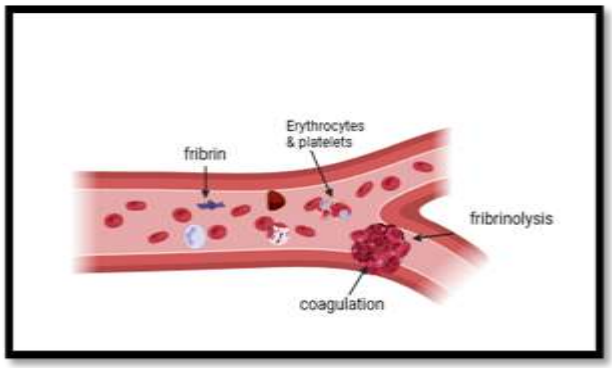

Fig. No.1 Hemostasis

2. Inflammation: -

The inflammatory phase, which overlaps with hemostasis, occurs within the first 72 hours after injury. During this phase, humoral and cellular immune responses are activated to protect the wound from infection. Neutrophils and monocytes infiltrate the wound bed to remove debris and microorganisms. The inflammatory phase is

divided into early and late stages. 4 In the early phase, neutrophils dominate, performing phagocytosis of bacteria and damaged tissue.

They also release enzymes, reactive oxygen species, and inflammatory mediators such as TNF-α and interleukins. After completing their function, neutrophils undergo apoptosis within 2–3 days. In the late phase, monocytes migrate to the wound site and differentiate into macrophages. These macrophages clear dead cells and secrete enzymes like matrix metalloproteinases and elastase. They also release growth factors such as PDGF, TGF-α, TGF-β, IGF-1, FGF, IL-1, and IL-6, which promote fibroblast activation and transition to the proliferative phase. A decline in macrophage activity signals the end of the inflammatory phase.

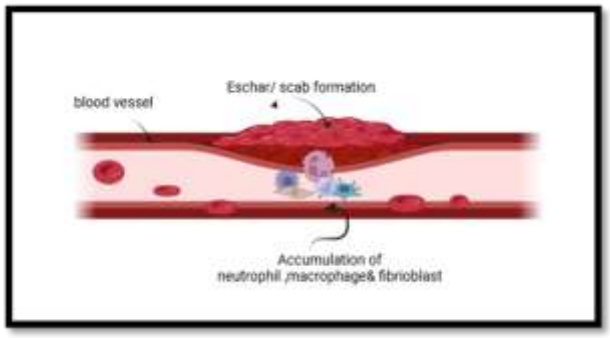

Fig. No.2 Inflammation

3. Proliferation: -

The proliferative phase of wound healing involves several interconnected processes that restore tissue structure and function. It begins on the third day after the injury and lasts approximately two weeks. During this phase, angiogenesis, the generation of granulation tissue, collagen deposition, re-epithelialization, and wound contraction occur. It involves the migration and proliferation of endothelial cells to form new blood vessels.

Granulation tissue formation occurs concurrently with angiogenesis and primarily comprises type III collagen, fibroblasts, and new vessels. proliferation, and synthesis of extracellular matrix components, contributes to tissue restoration.

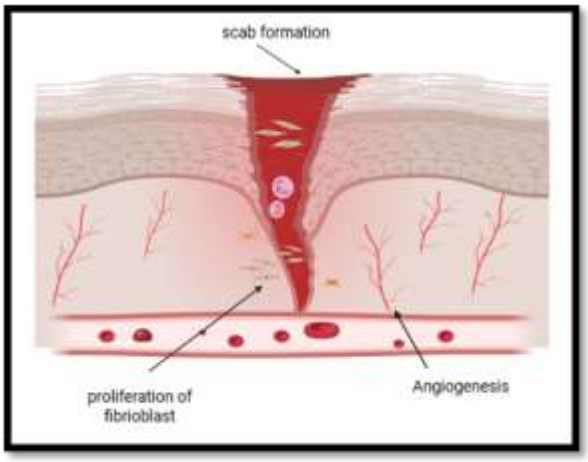

Fig. No.3 Proliferation

4. Remodeling: -

His final phase begins several weeks after injury and can last up to 1–2 years. Granulation tissue gradually transforms into a mature scar. Type III collagen is replaced by stronger type I collagen, increasing tissue strength. Myofibroblasts, derived from fibroblasts under TGF-β influence, promote wound contraction through smooth muscle actin (SMA) activity and undergo apoptosis after healing. Capillaries decrease, vessels enlarge, and collagen fibers reorganize and cross-link via lysis oxidase, enhancing tensile strength. However, the healed tissue regains only about 80% of its original strength.

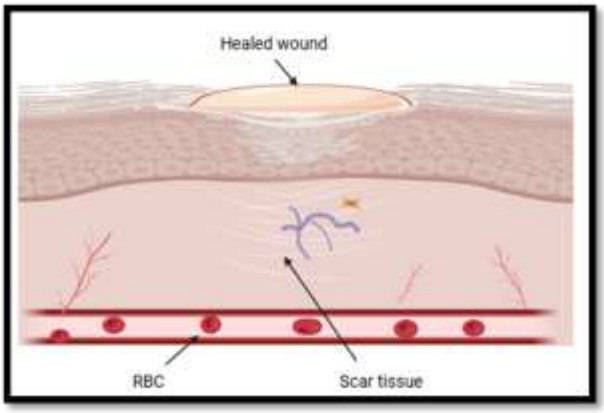

Fig. No.4 Remodeling

A SMART AND ADVANCED STRATEGY FOR WOUND CARE FILMS

The limitations of conventional dressings have driven the development of advanced wound dressing systems designed to actively support the healing environment. Recent years Advancements in wound care technology have led to the development of modern dressing materials that actively support the healing process. Among these, film dressing has emerged as an innovative solution. These transparent, flexible, and adhesive films, which are usually made of polyurethane and related polymers, offer a number of practical benefits, including the ability to facilitate gaseous exchange (the transfer of oxygen and water vapour), form a barrier that protects against contaminants and bacteria, and allow for clinical monitoring of the wound without the need for frequent removal. [5]

In contrast to traditional dressings, film dressings offer a conformable covering appropriate for superficial and low-exudate wounds, as well as low adherence to wound tissue, which reduces damage during dressing changes. They act as secondary coverings for wounds treated by absorbent or bioactive primary dressings as well as primary dressings for mild wounds. These dressings reinforce the idea of moist wound healing, which was first proven by studies showing faster epithelialisation in hydrated environments. It has been demonstrated that keeping the wound surface moist hasten healing in contrast to the development of dry scabs.[6] This regulated setting lowers the possibility of microbial contamination and encourages quicker tissue regeneration. They are especially well suited for superficial and low-exudate wounds because they allow water vapour transport while preventing bacterial invasion. [7] During dressing changes, their flexible and non-adherent qualities reduce pain and shield freshly produced tissue. Modern film dressings are a useful and cutting-edge choice in modern wound care because of their ability to include therapeutic ingredients, which further improves localised treatment and healing efficiency. Localised therapeutic agents are a useful and cutting-edge choice in modern wound management since they further improve localised treatment and healing efficiency. Clinical data indicates that sophisticated dressings may enhance the rate at which chronic wounds heal when compared to traditional dressings. Meta-analyses indicate superiority of advanced dressings in achieving complete wound closure, although evidence varies by wound type and study quality. Thus, film dressing. represent a significant advancement in wound care technology combining protection comfort and healing efficacy in a single easy -to-use system. [8]

Fig. No.5 Ideal properties of Film

MATERIAL UESD IN FILM DRESSING

The selection of materials plays a critical role in determining the physicochemical, mechanical, and biological performance of film dressings. Materials used for film dressings must exhibit biocompatibility, non-toxicity, flexibility, appropriate permeability, and the ability to support wound healing. Based on origin, these materials are broadly classified into natural polymers and synthetic polymers.

Table No.- 01 Polymers used in film dressings

POLYMERS	TYPES	KEY PROPERTIES	LIMITATIONS
1) Chitosan	Natural Polymer	Chitosan is a cationic polysaccharide, Excellent biocompatibility and biodegradability, Intrinsic antimicrobial activity	brittleness and limited mechanical strength often necessitate blending with synthetic polymers.
2) Alginate	Natural Polymer	Alginate is an anionic polysaccharide that has haemostatic qualities because of calcium ion exchange, a highwater absorption capacity, and the ability to create hydrogels when it comes into touch with wound exudate.	low mechanical strength and poor elasticity limit their standalone use.
3) Gelatin	Natural Polymer	Gelatin is a protein-based polymer, Excellent cell adhesion and proliferation, High biocompatibility and biodegradability.	Gelatin films are water-soluble and mechanically weak, requiring crosslinking or blending with polymers such as PVA or chitosan for improved stability.
4) cellulose Derivative	Natural Polymer	High film-forming ability, Good moisture retention, Non-toxicity and biocompatibility, Controlled permeability to oxygen and water vapor.	Cellulose-based films are commonly used as secondary dressings and drug carriers in wound care systems.
5) Aloe vera, Curcumin, Honey	Natural Polymer	Aloe vera promotes fibroblast proliferation, collagen synthesis, and epithelialization, Honey provides broad-spectrum antimicrobial action and supports autolytic debridement, Curcumin exhibits potent antioxidant, anti-inflammatory, and antimicrobial activity.	
6) Polyvinyl Alcohol	Synthetic Polymer	High flexibility and tensile strength, Biocompatibility and transparency, Suitable for drug incorporation and controlled release.	
7) polyvinyl Pyrrolidone	Synthetic Polymer	Excellent drug solubilization capacity, Non-irritant and biocompatible, Enhances moisture retention.	PVP films are mechanically weak and typically combined with PVA or PU.
8) polyurethane	Synthetic Polymer	Excellent elasticity and durability, Optimal oxygen and moisture vapor permeability, Strong bacterial barrier properties	
9) polylactic Acid	Synthetic Polymer	Good mechanical strength Controlled biodegradation, Suitability for drug- loaded and nanocomposite films.	

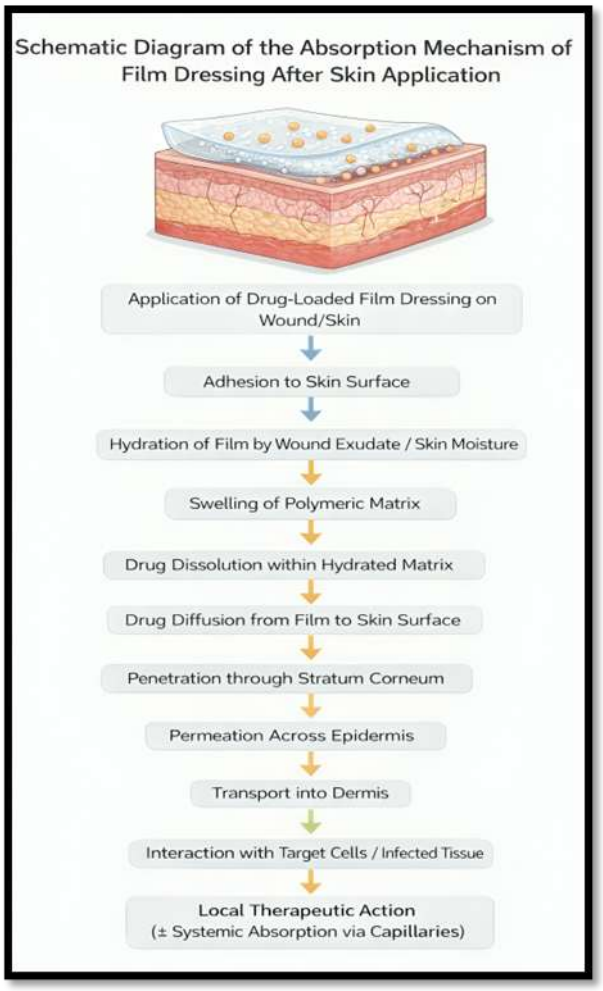

Fig. No.6 Absorption Mechanism of Film

5. TYPES OF FILMS

1. Transparent Film: -

Transparent films are usually made from polyurethane, polyethylene, or polyvinyl chloride (PVC). These materials form a thin, elastic, and clear membrane that adheres to the skin using a hypoallergenic adhesive. Transparent Allows visualization of the wound without removal. Semi-permeable Permits oxygen and water vapor exchange but prevents bacterial invasion. Elastic and conformable: Fits easily over joints and contoured surfaces. Forms a thin protective layer preventing bacteria and dirt entry. Allows oxygen and CO_2 exchange but blocks water and microbes. Retains wound moisture, promotes epithelial growth and autolytic debridement. It acts as a barrier to contaminants and supports autolytic debridement by retaining endogenous enzymes within the wound bed. Allows wound observation without removing dressing. Promotes moist wound healing & Prevents contamination by bacteria and water. Thin, flexible, and comfortable. can stay in place for up to 7 days. Not suitable for heavily exuding wounds. Difficult to use on irregular wounds.

Examples are: Tegaderm ®, Bioclusive ®, Polyskin ®.

2. Hydrogel: -

Hydrogel films are water-based polymer networks that can hold large amounts of water while maintaining a soft, elastic structure. They are used as moist wound dressings that cool, soothe, and promote healing. Hydrogel films are made from hydrophilic polymers such as polyvinyl alcohol (PVA), polyethylene glycol (PEG), carboxymethylcellulose (CMC), or polyacrylamide, containing 70–90% water. Soft, elastic, and transparent. Capable of absorbing wound exudate while maintaining moisture. Cooling effect due to high water content.

Maintains hydration at the wound surface, promoting epithelialization. Provides soothing and pain-relieving effect due to high water content. Absorbs exudates moderately and keeps the wound clean. Allow oxygen to pass but prevents bacterial contamination. Maintain a moist and cool, soothing effect for burns. Non-adherent and easy to remove. Poor mechanical strength. Require secondary dressing for fixation.

Burns and scalds. Pressure ulcers and necrotic wounds.

Radiation-damaged skin. Examples are: AquaClear ®, Intrasite ® Gel Sheet, Derma-Gel®, Nu-Gel®.

3. Hydrocolloid Film: -

Hydrocolloid films are modern occlusive or semi-occlusive wound dressings that promote healing by maintaining a moist environment, protecting the wound, and facilitating autolytic debridement (natural removal of dead tissue)

Hydrocolloid films contain gel-forming agents like gelatin, pectin, and carboxymethylcellulose (CMC) combined with an adhesive layer and a polyurethane backing film. Occlusive and adhesive to the skin. Swells and forms a gel when in contact with wound exudate. Self-healing and conformable. When exudate interacts with the hydrocolloid layer, a moist gel forms, protecting granulating tissue and stimulating autolytic debridement. Maintains optimal moisture. Waterproof and bacterial barrier. Encourages granulation tissue formation. Not suitable for infected wounds (occlusive nature). Can leave residue upon removal. Pressure ulcers, burns, and donor sites.

Light to moderately exuding wounds. Venous leg ulcers.

Examples are: DuoDERM®, Comfeel®, Hydrocoll®, Tegasorb®.

4. Bioactive films: -

Bioactive films are an advanced form of wound dressing designed not only to protect the wound but also to actively promote the healing process. Natural Polymers: - Chitosan, Alginate, Gelatin. Synthetic Polymers: - Polyvinyl alcohol (PVA), Polycaprolactone (PCL)Polyethylene glycol (PEG), Polylactic acid (PLA). Composite Blends: - Chitosan–PVA, Alginate–PCL, Collagen–PCL (used to balance biological and mechanical properties). Plasticizers: - Used to improve flexibility and film-forming properties. Examples: Glycerol, Propylene glycol, Sorbitol. Bioactive Agents: - The key component responsible for therapeutic action Antimicrobial Agent, Antioxidants & Anti-inflammatory Compounds, Growth Factors. Crosslinking Agents: - Enhance film strength and regulate degradation. Examples: Glutaraldehyde, Calcium chloride. maintains a moist environment at the wound site, essential for epithelialization. The bioactive agents are gradually released from the film matrix to the wound bed. Growth factors stimulate fibroblast migration, collagen synthesis, and angiogenesis. Provides active healing through drug or bioactive release. Maintains optimal moisture balance for cell growth. Can be biodegradable, avoiding painful removal. Suitable for chronic, diabetic, and infected wounds. Complex preparation process. Stability issues with sensitive bioactive agents. Limited shelf life due to degradation of natural ingredients. Chronic non healing wounds, Burn wound, Infected wounds.

FORMULATION AND MANUFACTURING METHOD OF FILM DRESSINGS

Film dressings' mechanical strength, thickness, permeability, drug release behaviour, and biological efficacy are all greatly influenced by the formulation and manufacturing process used. The kind of polymer, the intended wound application, and the addition of active agents all influence the choice of a suitable technique. Solvent casting, hot-melt extrusion, electrospinning, and cross-linking processes are the most frequently reported methods.

1. Solvent Casting Method: -

The most popular and straightforward approach for creating polymeric film dressings, especially in

a lab setting, is solvent casting. [9] This technique involves dissolving or dispersing polymers in an appropriate solvent system (organic or aqueous), then adding plasticisers and active agents. [10,11] Solvent evaporation and film formation result from pouring the homogenous solution into a mould or Petri dish and letting it dry at a regulated temperature. [12] This method works well with hydrophilic synthetic polymers like PVA and PVP as well as natural polymers such chitosan, alginate, gelatin, and cellulose derivatives.[13] Solvent casting is frequently used to create drug-loaded film dressings because it allows for easy formulation optimisation and uniform drug distribution inside the polymer matrix. [14]

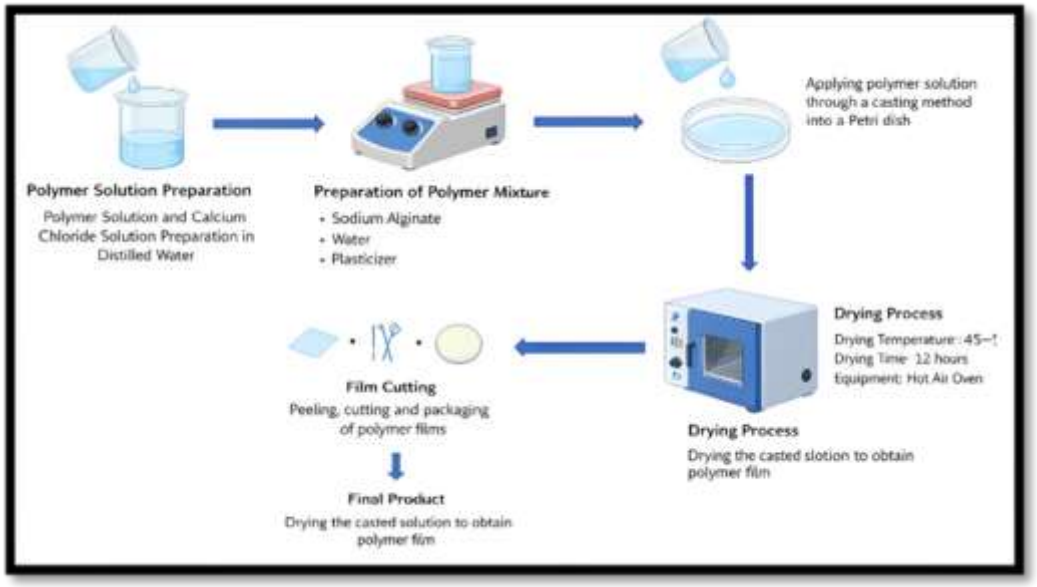

Fig. No.7 Solvent Casting Method

2. Hot-Melt Extrusion (HME): -

Hot melt extrusion (HME) is a continuous, solvent-free manufacturing process that is frequently used in pharmaceutical formulation to improve solubility, bioavailability, and controlled drug delivery in wound treatment systems such bioactive scaffolds and antimicrobial films. To create a homogenous physical mixture, the active pharmaceutical ingredient (API) is first precisely weighed and combined with appropriate thermoplastic polymers (such as polyvinylpyrrolidone, polyethylene oxide, ethyl cellulose, or polycaprolactone) and functional excipients. The selection of polymers is based on glass transition temperature (Tg), melting point, and drug–polymer miscibility to guarantee molecular dispersion. [15,16]

A single-screw or twin-screw extruder's hopper receives the prepared blend, which is then passed via a heated barrel divided into numerous zones with varying temperatures. [17,18] Under regulated shear stress and heat energy, the material melts, mixes, kneads, and homogenises as it moves along the revolving screws, promoting the production of amorphous solid dispersion or drug solubilisation. [19,20]

Depending on the intended wound dressing application, the molten mass is then driven through a die with a predetermined shape to produce extrudates in the form of films, rods, filaments, or implants. [21,22] To stabilise the drug-polymer matrix and harden the structure, the extrudate is cooled using conveyor systems or air cooling after leaving the die.

The solidified extrudates are then gathered and put through downstream processing, such as cutting, milling, or shaping into transdermal films, implanted devices, or wound dressings. Mechanical strength, drug content homogeneity, and in vitro release behaviour are next characterised. [23] Solvent-free processing, enhanced content consistency, scalability, and the capacity to create controlled or sustained medication release systems appropriate for advanced wound care are some benefits of the HME process. [24]

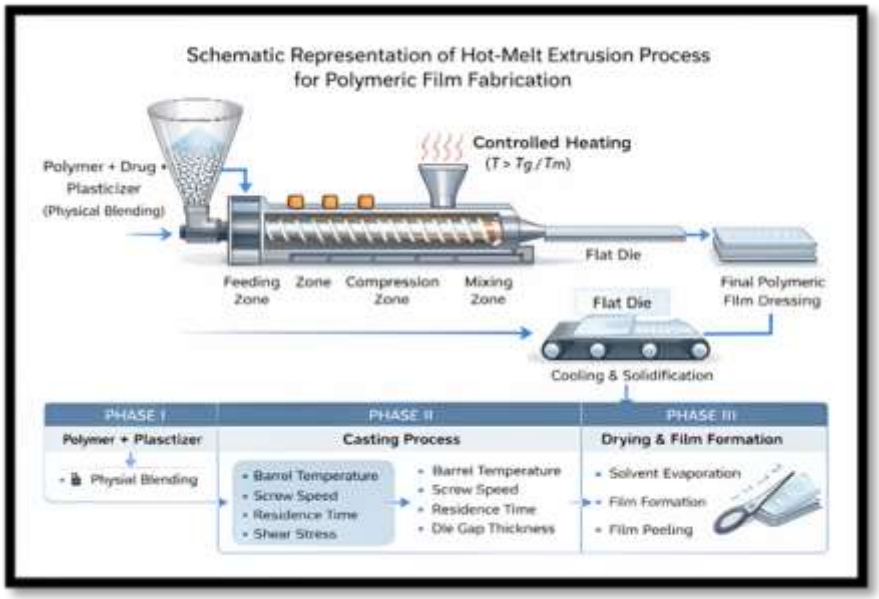

Fig. No.8 Hot Melt Extrusion Method

3. Electrospinning Method: -

In order to create bioactive nanofibrous dressings that resemble the extracellular matrix (ECM), electrospinning is a flexible nanofabrication process that is frequently used in wound care. To create a homogenous spinning solution, a suitable biocompatible polymer, such as polyvinyl alcohol (PVA), polycaprolactone (PCL), chitosan, or Gelatin is first dissolved in a suitable solvent. Therapeutic agents, such as antibiotics, growth factors, or anti-inflammatory compounds, are then added. Viscosity, conductivity, surface tension, and polymer concentration are important factors that affect fibre morphology and spinnability. [25,26] After that, the prepared solution is put into a syringe with a metallic needle and placed on a syringe pump. During processing, a regulated flow rate guarantees steady and continuous jet formation. [27,28] Subsequently, a high-voltage power supply (typically 5–30 kV) is applied between the needle and a grounded collector, generating electrostatic forces that overcome surface tension and produce a Taylor cone followed by the ejection of a charged polymer jet. [29,30] As the jet travels toward the collector, it undergoes rapid elongation and whipping instability, accompanied by solvent evaporation, resulting in the formation of ultrafine nanofibers with high surface area. [31,32] These nanofibers are deposited onto a stationary or rotating grounded collector to form a nonwoven nanofibrous mat, with fiber diameter and morphology influenced by process parameters such as applied voltage, flow rate, needle-to-collector distance, temperature, and humidity.

The resulting nanofibrous scaffold exhibits high porosity, excellent oxygen permeability, moisture retention capacity, and the ability to provide

sustained drug release, thereby making electro spun membranes highly suitable for advanced wound dressing applications. [33,34]

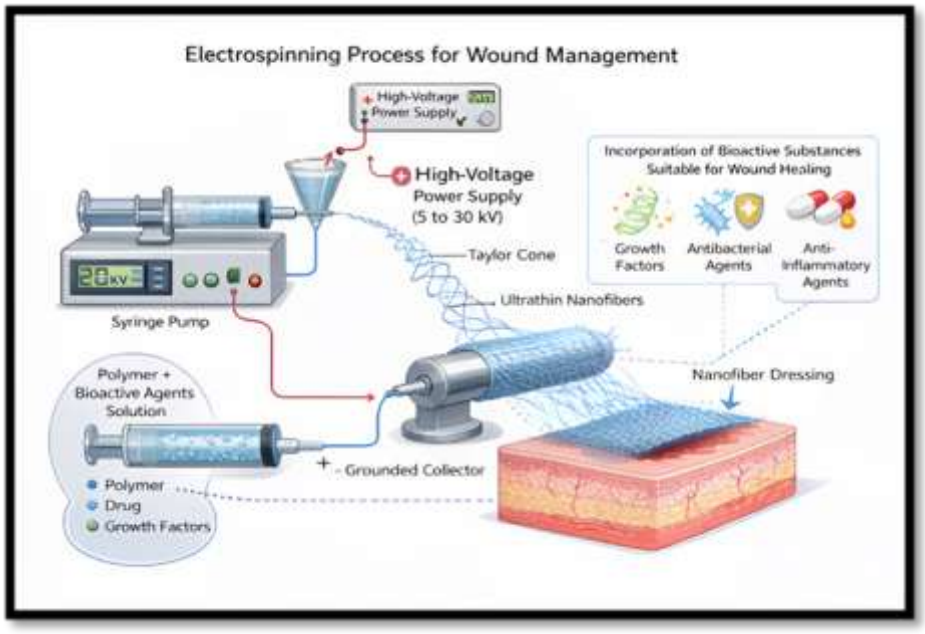

Fig. No.9 Electrospinning Method

EVALUATION TEST

Evaluation of film formulations is essential to ensure uniformity, mechanical integrity, flexibility, and moisture permeability. These factors have a direct impact on topical and transdermal film systems' stability, performance, and patient acceptability.

1. Thickness Test: -

Fig. No.10 Thickness Test

- **Principle: -**

Diffusion properties, mechanical strength, and drug content homogeneity are all impacted by film thickness, which is an important quality attribute. Consistent medication is ensured by uniform thickness. release and consistent therapeutic outcomes. [4]

- **Method:**

A calibrated vernier calliper or digital micrometre screw gauge is used to measure the thickness of the film. To prevent deformation, the film is carefully positioned between the measuring surfaces without using too much pressure. Three to five separate locations—usually the center and the periphery—are used for measurements. Every measurement is noted, and the average thickness is computed.

- **Calculation: -**

Average Thickness (T)= {T-1 + T-2 + T-3 + … + Tn}/n

Where:

t= is the thickness at every measurement point.

n =is the quantity of readings.

- **Significance: -**

Uniform thickness guarantees predictable mechanical and diffusion properties and verifies homogenous casting

2. **Folding endurances: -**

Fig. No.11 Folding Endurance

- **Principle: -**

The folding endurance test establishes how many times a film can be folded at the same spot before experiencing mechanical failure. A film's tensile strength, elasticity, and general mechanical stability are all reflected in its capacity to tolerate repeated folding. Higher folding endurance values are typically shown by films with the proper polymer–plasticizer balance.[2]

- **Materials and Apparatus: -**

Prepared film samples

Manual folding technique or folding endurance tester, if available

Cutting template (for consistent film strips)

- **Method: -**

To prevent edge flaws, uniformly sized film specimens—typically 2 × 2 cm or 4 × 4 cm—are properly cut. Each strip is manually folded in the same spot between the fingers, or it can be placed on a folding endurance tester, which allows for controlled mechanical folding. The folding operation is carried out continuously until the film exhibits obvious fissures or breaks entirely at the folded website. The folding endurance value is the number of folds needed to break. The average value is reported after the test is typically run in triplicate.

- **Expression of Results: -**

The number of times a film can be folded in the same spot without breaking is known as its folding-endurance.

The mean ± standard deviation is used to express the results.

- **Significance: -**

A high folding endurance number suggests that the film has good mechanical strength, elasticity, and flexibility. These films have a lower chance of failing when being stored, transported, or used by patients. Low folding endurance ratings, on the other hand, indicate brittleness and inadequate plasticization, which could impair product performance.

3. **Water Absorption and Swelling Study: -**

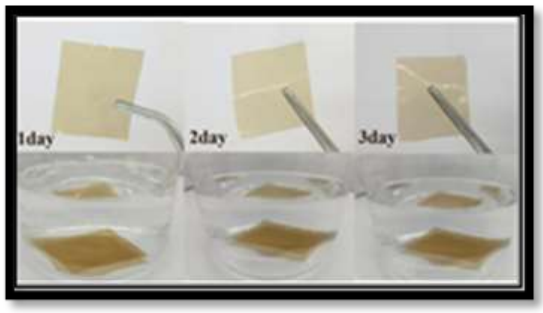

Fig. No.12 Water Absorption and Swelling Study

- **Principle: -**

A polymeric sheet stretches and absorbs fluid when submerged in an aqueous environment. Cross-linking and polymer composition determine how much swelling occurs. density as well as the surrounding circumstances. The percentage swelling is computed using the weight increase following immersion.[33]

- **Materials: -**

Pre-weighed film samples

Phosphate buffer solution (pH 7.4)

Analytical balance

Filter paper

- **Method: -**

On the other hand, inadequate swelling might restrict medication diffusion.

Uniformly sized film discs were precisely weighted (W_1) and submerged in a phosphate buffer solution (pH 7.4) for a predefined amount of time. Following immersion, the films were carefully removed, and surplus liquid was gently wiped off the surface using filter paper without applying pressure.

The proportion of swelling was determined by reweighing the swollen films (W_2).

- **Calculation: -**

% Swelling= f {(W2 - W1)} / {W1} x times 100

Where:

W_1 = Initial weight of film

W_2 = Weight after swelling

- **Interpretation: -**

In order to preserve film integrity and guarantee prolonged medication release, controlled swelling is preferred. The polymer matrix may become weaker and less mechanically stable due to excessive swelling.

4. In Vitro Drug Release Studies: -

Fig. No.13 In Vitro Drug Release Studies

- **Principle: -**

Diffusion of the drug from the polymeric film into an appropriate dissolving solvent under carefully regulated experimental circumstances is the foundation of the in vitro drug release investigation. The A Franz diffusion cell or USP dissolution device is used to assess the release pattern. Drug diffusion may adhere to kinetic models like zero-order, first-order, Higuchi, or Korsmeyer-Peppas models and is based on concentration gradient principles.

- **Method: -**

The film is put in the donor compartment of a Franz diffusion cell, and the receptor compartment's phosphate buffer (pH 6.8) is kept at 37 ± 0.5°C to mimic physiological circumstances. Sink conditions are maintained by constantly stirring the liquid. To maintain a consistent

volume, aliquots of the receptor media are removed and replaced with new buffer at predefined intervals. Spectrophotometric analysis is performed on the samples at the chosen wavelength.

Plotting the cumulative proportion of medication release against time is done. [35]

- **Interpretation: -**

The process and rate of drug diffusion from the film matrix are shown by the release profile. Sustained medication delivery is suggested by a consistent and extended release pattern, however Rapid release means that the medication is available right away. The release mechanism can be ascertained by fitting the data to kinetic models.

5. Antimicrobial Studies: -

Fig. No.14 Antimicrobial Studies

- **Principle: -**

The agar diffusion principle was used to assess the generated wound healing films' antibacterial effectiveness. The active ingredients in an antimicrobial film permeate into the surrounding medium when it is applied to an agar surface that has been infected with microorganisms. If the formulation has antibacterial qualities, it prevents the test organism from growing in the vicinity of the film, creating a transparent area called the zone of inhibition.

- **Method: -**

The agar diffusion (zone of inhibition) method was used to measure the antibacterial activity. After making sterile nutritional agar, it was transferred into Petri dishes and left to solidify. To guarantee even dispersion of germs, a sterile cotton swab was used to inoculate the solidified agar's surface with standardised bacterial solutions.

Under aseptic conditions, uniformly sized film samples were carefully positioned on the inoculated agar surface. After that, the plates were incubated for a full day at 37°C. The presence of clear zones surrounding the film samples was checked on the plates following incubation. A calibrated measuring scale was used to determine the zone of inhibition's diameter in millimetres.[36]

- **Interpretation: -**

Antimicrobial action is confirmed when a clear zone appears around the film, indicating inhibition of microbiological growth. The efficiency of the formulation is reflected in the size of the zone of inhibition. Stronger antimicrobial qualities are indicated by larger zones, whereas less or no antibacterial activity is suggested by smaller or non-existent zones. Information on the range of activity of the created wound healing film can be obtained through comparative evaluation against various pathogens.

6. Stability Study: -

- **Principle: -**

The foundation of stability studies is assessing how environmental elements like light, humidity, and temperature affect the effectiveness, safety,

and quality of wound-healing films over time. The International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use (ICH) requirements are adhered to in this investigation. The drug's rate of deterioration and changes in its mechanical and physical characteristics can be predicted by storing the formulation under predetermined long-term and accelerated settings. This allows for the estimation of shelf life and storage needs.[6]

- **Method: -**

Films are stored under the following conditions after being put in appropriate containers:

Long-term conditions: 30°C ± 2°C / 75% ± 5% RH

Accelerated conditions: 40°C ± 2°C / 75% ± 5% RH

Samples are withdrawn at predetermined intervals (e.g., 0, 1,2, 3, and 6 months).

- **Interpretation: -**

A formulation is deemed stable if: The outward appearance does not significantly change. The drug content stays within permissible bounds, usually between 90 and 110%.

Mechanical characteristics Tensile strength and folding endurance, for example, stay within specifications. There is little heterogeneity in the drug release profile. There is no evidence of microbial growth or deterioration.

CONCLUSION

By actively promoting the physiological healing process rather than only offering passive protection, film dressings mark a substantial leap in contemporary wound care. Their semi-permeable construction avoids microbial contamination, improves oxygen exchange, and preserves an ideal wet environment. Film dressings are more comfortable for patients and cause less tissue damage during removal than traditional bandages. Better mechanical strength, flexibility, and biocompatibility are made possible by the use of both synthetic and natural polymers. Through regulated medication release, advanced bioactive films further improve therapeutic efficacy. Film characteristics can be customised using a variety of manufacturing processes, including solvent casting, hot-melt extrusion, and electrospinning. All things considered, film dressings provide an inventive, patient-centred and clinically successful method for treating both acute and chronic wounds.

ACKNOWLEDGMENT

The management and staff of Konkan Gyanpeth Rahul Dharkar College of Pharmacy and Research Institute are greatly appreciated by the writers for their unwavering support and direction. We are appreciative of the facilities and technical support provided by our Department of Pharmaceutics. We also thank our mentors and colleagues for their support during the development of this review. We would especially want to thank all of the researchers whose important studies helped with this work. Lastly, we would like to thank all of the authors for their cooperative efforts in successfully finishing this work.

REFERENCES

1. Winter GD. Formation of the scab and the rate of epithelialization of superficial wounds in the skin of the young domestic pig. Nature. 1962;193:293–294. DOI: 10.1038/193293a0
2. Bhageerathy A, Sandhya M, Teny Sara T, Sigi Vasanth K, Prasanth VV. Formulation and evaluation of fast dissolving film of losartan potassium. Int J Pharm Sci Rev Res.

2021;68(1):238–239. doi:10.47583/ijpsrr.2021.v68i01.036
3. Thomas S. Wound management and dressings. 2nd ed. London: Pharmaceutical Press; 2015.
4. Uttam B, Shishir S, Namrata D, Ruby S. Formulation and in vitro evaluation of fast dissolving oral film of furosemide using a combination of natural and synthetic disintegrant. Int J Pharma O2. 2020;2(5):330–336.
5. Jones V, Grey JE, Harding KG. Wound dressings. BMJ. 2006;332(7544):777–780. doi:10.1136/bmj.332.7544.777
6. Hitesh C, Shabana B, Sandeep K, Pradeep K, Inderbir S. Preparation and evaluation of chitosan/PVA based hydrogel films loaded with honey for wound healing application. Gels. 2022;8(2):2–13. doi:10.3390/gels8020111
7. Dash M, Chiellini F, Ottenbrite RM, Chiellini E. Chitosan—a versatile semi-synthetic polymer in biomedical applications. Prog Polym Sci. 2011;36:981–1014. doi:10.1016/j.progpolymsci.2011.02.001
8. Ruben P, Anabela C, Ausenda M, Paulo B. Development of novel alginate-based hydrogel films for wound healing application. Int J Biol Macromol. 2013;52:221–230. doi:10.1016/j.ijbiomac.2012.09.031
9. Rowe RC, Sheskey PJ, Quinn ME. Handbook of pharmaceutical excipients. 6th ed. London: Pharmaceutical Press; 2009.
10. Dash S, Murthy PN, Nath L, Chowdhury P. Kinetic modelling on drug release from controlled drug delivery systems. Acta Pol Pharm. 2010;67:217–223.
11. Aulton ME, Taylor KMG. Aulton's pharmaceutics: the design and manufacture of medicines. 5th ed. Elsevier; 2018.
12. Cilurzo F, Minghetti P, Selmin F, Montanari L. Design and characterization of fast-dissolving films. Eur J Pharm Biopharm. 2008;70:895–900.
13. Sultana N, Wang M. Fabrication of HA/PHBV composite scaffolds via solvent casting. Biomaterials. 2008;29:3612–3620.
14. Perumal VA, Lutchman D, Mackraj I, Govender T. Formulation of monolayered films for drug delivery. Drug Dev Ind Pharm. 2008;34:437–446.
15. Repka MA, Bandari S, Kallakunta VR, Vo AQ, McFall H, Pimparade M, et al. Melt extrusion with poorly soluble drugs—an integrated review. Int J Pharm. 2018;535:68–85.
16. Crowley MM, Zhang F, Koleng JJ, McGinity JW. Stability of amorphous pharmaceuticals and hot-melt extrusion. J Pharm Sci. 2007;96:259–272.
17. Maniruzzaman M, Boateng JS, Snowden MJ, Douroumis D. A review of hot-melt extrusion: process technology to pharmaceutical products. ISRN Pharm. 2012;2012:436763.
18. Repka MA, Shah S, Lu J, Maddineni S, Morott J, Patwardhan K, et al. Melt extrusion: process to product. Expert Opin Drug Deliv. 2012;9:105–125.
19. Breitenbach J. Melt extrusion: from process to drug delivery technology. Eur J Pharm Biopharm. 2002;54:107–117.
20. Patil H, Tiwari RV, Repka MA. Hot-melt extrusion: from theory to application in pharmaceutical formulation. AAPS PharmSciTech. 2016;17:20–42.
21. Grymonpré W. Development of antimicrobial polymer films via hot-melt extrusion. Int J Pharm. 2017;529:427–438.
22. Thakkar R, Pillai AR, Zhang J. Application of hot-melt extrusion in wound healing drug delivery systems. Drug Dev Ind Pharm. 2015;41:1922–1933.
23. Zhang F, McGinity JW. Properties of sustained-release tablets prepared by hot-melt

extrusion. Pharm Dev Technol. 1999;4:241–250.
24. Vasoya JM, Desai HH, Gumaste SG, Tillotson J, Kelemen D, Dalrymple D, et al. Development of solid dispersion by hot melt extrusion. J Pharm Sci. 2019;108:26–38.
25. Greiner A, Wendorff JH. Electrospinning: a fascinating method for the preparation of ultrathin fibers. Angew Chem Int Ed. 2007;46:5670–5703.
26. Bhardwaj N, Kundu SC. Electrospinning: a fascinating fiber fabrication technique. Biotechnol Adv. 2010;28:325–347.
27. Li D, Xia Y. Electrospinning of nanofibers: reinventing the wheel? J Control Release. 2004;100:165–180.
28. Ramakrishna S, Fujihara K, Teo WE, Lim TC, Ma Z. Electrospinning and nanofibers: an introduction. Mater Today. 2006;9:40–50.
29. Taylor G. Disintegration of water drops in an electric field. Proc R Soc A. 1964;280:383–397.
30. Reneker DH, Yarin AL. Electrospinning jets and polymer nanofibers. Polymer. 2008;49:2387–2425.
31. Huang ZM, Zhang YZ, Kotaki M, Ramakrishna S. A review on polymer nanofibers by electrospinning. Compos Sci Technol. 2003;63:2223–2253.
32. Yarin AL, Koombhongse S, Reneker DH. Bending instability in electrospinning of nanofibers. J Appl Phys. 2001;89:3018–3026.
33. Boateng JS, Matthews KH, Stevens HNE, Eccleston GM. Wound healing dressings and drug delivery systems. J Pharm Sci. 2008;97(8):2892–2923.
34. Zhang YZ, Venugopal J, Huang ZM, Lim CT, Ramakrishna S. Crosslinking of the electrospun gelatin nanofibers. Biomaterials. 2005;26:3356–3364.
35. Gerardo LG, Sonia JF, Jonathan JM, Emiliano PP. Films for wound healing fabricated using a solvent casting technique. Polymers. 2023;15(7):1914.
36. Cornelia W, Martin A, Peter R, Peter E. In vitro assessment of antimicrobial activity of wound dressing: influence of test method and pH. J Mater Sci Mater Med. 2015;26(1):18.
37. Van den Bulcke AI, Bogdanov B, de Rooze N, Schacht EH, Cornelissen M, Berghmans H. Structural and rheological properties of methacrylamide modified gelatin hydrogels. Biomaterials. 2000;21:2155–2163.
38. Czaja W, Krystynowicz A, Bielecki S, Brown RM. Microbial cellulose—the natural power to heal wounds. Biomacromolecules. 2006;7:1–10.
39. Atiyeh BS, Costagliola M, Hayek SN, Dibo SA. Effect of silver on burn wound infection control and healing. Burns. 2007;33:139–148.
40. Hassan CM, Peppas NA. Structure and applications of poly(vinyl alcohol) hydrogels. Adv Polym Sci. 2000;153:37–65.
41. Buhus G, Popa M, Desbrieres J. Controlled release of antibiotics from chitosan-based systems. Eur J Pharm Biopharm. 2009;72:427–432.
42. Middleton JC, Tipton AJ. Synthetic biodegradable polymers as orthopedic devices. Biomaterials. 2000;21:2335–2346.
43. Zhang W, et al. Hydrogel-based dressings designed to facilitate wound healing. Mater Adv. 2024;5(4):1364–1394.
44. Haque ST, Saha SK, Haque ME, Biswas N. Advanced biomaterials for wound healing applications. Biomater Sci. 2021;9:1234–1256.
45. Rezvani Ghomi E, Khalili S, Nouri Khorasani S, Esmaeely Neisiany R, Ramakrishna S. Wound dressings: current advances and future directions. J Appl Polym Sci. 2019;136:47738.

46. Andrei S, Simona MT, Iulian C, Lorena H, Lenuta P. Modern approaches in wound management. Polymers. 2023;15(17):3648.

HOW TO CITE: Janhavi Narkhede, Trunali Ghude, Manasi Navle, Tanshri Nifade, Pratap Nimbalkar, Pallavi Nichite, Film Dressings: An Innovative Approach in Wound Management, Int. J. of Pharm. Sci., 2026, Vol 4, Issue 4, 4960-4976. https://doi.org/10.5281/zenodo.19918772