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Synthetic Spray Bandages

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ABSTRACT:

By applying aseptic medication precisely and effectively, pharmaceutical spraying technology provides a cutting-edge approach to improving wound care. The most recent advancements in spray bandages use either liquid or solid particles in a pressurized container, allowing for a controlled release through a fine spray nozzle when activated. To guarantee efficient adhesion and wound protection, these formulations use hydrophilic polymers, low-volatile plasticizers, and solvent systems to create an in situ protective coating on the skin.

Spray bandages, mostly used to prevent minor wounds and abrasions from becoming infected, can be utilized as transdermal drug delivery systems since they can adjust the concentration of drugs for systemic absorption. This paper examines the composition, manufacture, and assessment of spray-on bandages. It also addresses important issues and suggests fixes for increased effectiveness.

It also identifies new research and commercial trends, establishing spray bandages as a promising advancement in medication delivery and wound treatment.

Keywords: hydrogel, fibrin, tissue engineering, skin, and spray.

Graphical Diagram=

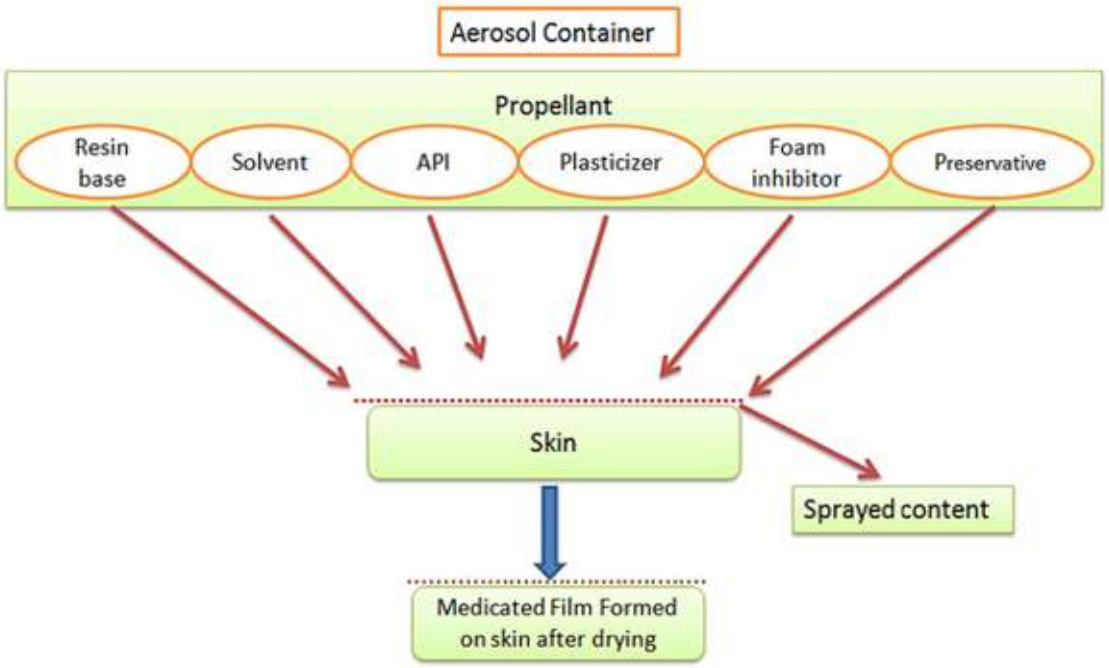

Fig. 1

1. Introduction

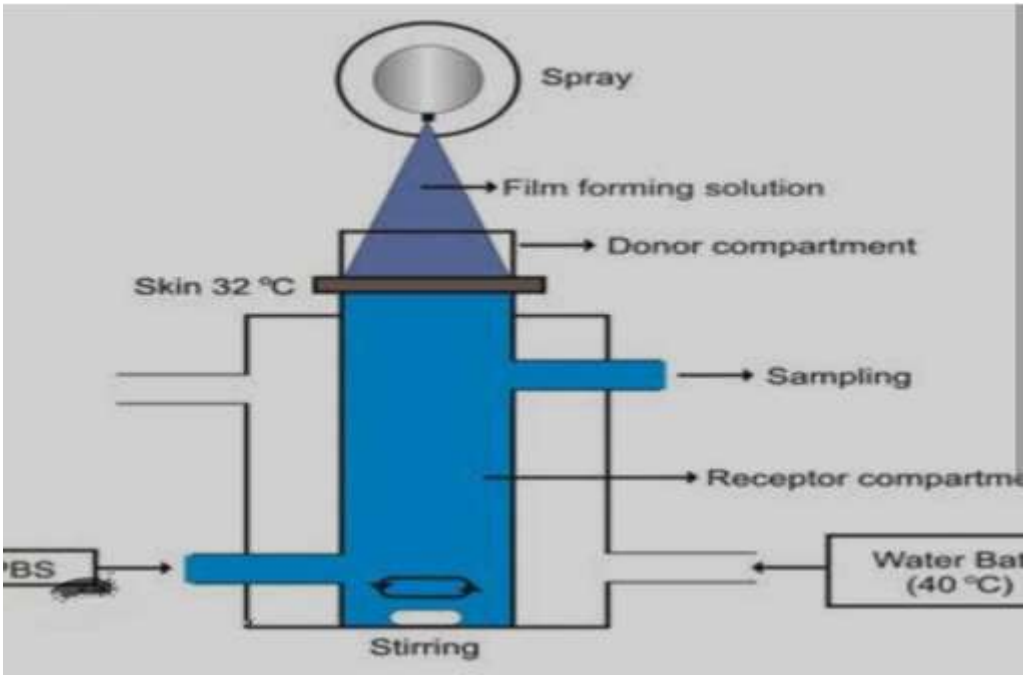

Fig. 2

Because they instantly create a protective layer over the skin, spray-on bandages are a cutting-edge method of wound care. To provide a flexible and permeable barrier, these formulations make use of solvent systems, hydrophilic polymers, and low-volatile plasticizers. Although their main purpose is to keep small wounds from becoming infected, they may also be used as transdermal drug delivery devices.

2. Wound Healing and Skin Structure

Three main layers comprise the skin:

• **Epidermis:** The outermost layer of defense, primarily made up of keratinocytes.

• **Dermis**: Supports healing by having blood vessels and structural proteins like collagen and elastin.

• **Hypodermis**: Offers insulation and support.

Classifying wounds is essential for treatment plans:

• The skin's capacity for regeneration causes superficial wounds to heal on their own.

• External intervention is necessary for deep wounds (both partial and complete thickness) to avoid problems such as fluid loss, scarring, and infections.

3. The Development of Spray Bandages

• 1966: The first study on spray bandages was released.

• 1969 saw the filing of the first American patent for spray-on bandage technology.

• the 1990s saw new patents for spray-on wound dressings as a result of developments in polymeric film production.

4. Spray Bandages Using Biomaterials

Fig. 3

Biomaterials, both natural and synthetic, have been investigated:

• **Natural Polymers**: Alginate, collagen, fibrin, gelatine, chitosan, and silk fibroin improve wound healing and biocompatibility.

• **Synthetic polymers**: polycaprolactone, polyurethane (PU), and polylactic acid provide increased mechanical strength but lack biological cues that promote cell regeneration.

5. Spray Bandage Evaluation Standards

Important parameters consist of:

• **pH and viscosity:** guaranteeing skin compatibility and application simplicity.

• **Fluid affinity and bio adhesion:** maximizing wound protection while avoiding excessive moisture buildup.

• **Water Wash Capability:** Guarantee that the film stays in place but may be taken off as needed.

• **Rheological Properties:** Evaluating homogeneity of film and spray capabilities.

6. Advantages & Disadvantages

✅ **Advantages**

• Lowers the risk of infection by offering a sterile, protective coating.

• Long-lasting (5–10 days) and waterproof.

• The ability to reduce scarring.

❌ **Disadvantages**

• May result in a slight burning feeling.

• In damp environments, it might encourage the growth of microorganisms.

• Overuse may affect the deeper layers of the skin.

7. Applications

• **Medical Uses:** Handling minor cuts, diabetic ulcers, burns, and surgical wounds.

• **Military & Emergency Medicine:** Provides soldiers and trauma patients with prompt wound care.

• **Veterinary Uses:** Closing wounds after surgery.

8. Clinical Research & Future Outlook

Commercial spray-on treatments (such as ReCell, SkinGun, and HP802-247) have been evaluated for wound healing applications in recent clinical trials. Spray bandages' future depends on combining bioactive formulations, intelligent medication delivery methods, and antimicrobial agents to promote wound healing and reduce adverse effects.

Conclusion

Since the 1960s, spray-on bandages have undergone substantial change, with improvements in formulation and biomaterials increasing their effectiveness. Their broad use in contemporary wound care will depend on further optimization for increased antibacterial qualities, better adherence, and quicker drying.

Evaluation Parameters of Spray Film

1. pH

To ensure stability and compatibility with the application site, the spray film's pH should be adjusted:

• Skin pH ranges from 4 to 6.

• Wounds from diabetes: 6.5–8

• Burns heal best when the pH is less than 7.

2. Viscosity

The film-forming solution's playability is influenced by its viscosity. It is a critical metric for metered-dose sprays (MDS) and changes according to the king and concentration of the polymer.

3. Tonicity

Films used on sensitive areas (such as wounds or the mucosa of the eyes) require tonicity modification. Irritation or pain may result from non-isotonic compositions. It is calculated and adjusted for tonicity using the Kahar method.

4. Bioadhesive Strength

The way the film interacts with skin determines its bioadhesive strength:

1. Wet mouse skin (2 × 5 cm) is covered with a test film.

2. A measurement is made of the force (Fb per unit area (A)) needed to separate the film.

3. Better wound coverage and longer-lasting effectiveness are guaranteed by higher adhesion.

5. Water Wash ability

The dried film's washability is evaluated using a three-point rating system:

- **Easily washed**
- **Moderately washed**
- **Poorly washed**

For films placed on delicate regions (such as the lips or eyes), this value is crucial.

6. Fluid Affinity

Fluid affinity dictates how the film:

• Prevents excessive moisture, which can lead to tissue degradation;

• Absorbs wound moisture, speeding healing.

7. Rheological Properties

A thixotropic solution guarantees that the film is easily sprayed but maintains its viscosity after application. These characteristics enable the film to pass through the nozzle effectively without clogging. Flow attributes also affect the uniformity and application of the film.

Fig. 4

Benefits and Drawbacks

Benefits

✔ Infection Prevention: The risk of contamination is decreased by the sealed wound barrier.

✔ Waterproof: Enables washing and showering without compromising the dressing.

✔ Extended Protection: Naturally peels off after 5–10 days.

✔ Scar Reduction: This could lessen the amount of scarring from wounds.

Drawbacks

Risk of Bacterial Growth: Retention of moisture may encourage the colonization of bacteria. ✖ Initial Burning Sensation: Certain formulations may cause moderate irritation.

✖ Over-Spraying Issues: Excessive use might irritate skin by penetrating dermal layers.

Uses for Spray Bandages

✔ **Tough to Bandage**: Joints, knuckles, and places where conventional bandages don't work.

✔ **Medical & Veterinary Use**: Used on internal organ cuts or surgical incisions.

✔ **Military and Emergency Use**: In dire circumstances, soldiers use it to treat temporary wounds.

✔ **General Wound Care**: Handles minor abrasions, diabetic wounds, burns, and surgical incisions.

✔ **Skin Protection**: Guards against environmental irritation (e.g., chemical exposure).

Film-Forming Spray Technology

Fig. 5

• Applied with an applicator or spray, creating a non-irritating, quickly drying layer.

• A precise dosage of medication is administered for each application thanks to the Metered Dose Pump (MDP).

• The film releases active chemicals gradually, acting as a transdermal drug delivery method.

• When therapy needs to end, or the wound heals, it can be peeled off.

Need for Spray Bandages

Innovative wound care treatments must:

✔ Be small and portable for convenience;

✔ Allow for painless application, particularly for burns.

✔ Prevent microbiological diseases by preventing cross-contamination.

✔ Give musculoskeletal applications a sense of grip.

From an industrial standpoint, research is concentrated on intelligent delivery technologies that provide longer-lasting protection, non-sticky formulations, and quicker drying times.

History of Spray Bandages

✔ **1966**: The first study on spray bandages was released.

✔ **1969** saw the filing of a U.S. patent for "Preparation of Spray-On Bandage."

✔ **1990s**: More patents were granted as a result of improvements in spray technology.

• **1990**: "Spray-on Wound Dressing Composition"

• **1993**: "Aerosol Composition with Film-Forming Polymer"

Sprayers and Filling Techniques

Spray containers need to be chemically inert and able to tolerate high pressure (140–180 psig at 130°F). Tin-plated steel, aluminum, stainless steel, and glass (coated or uncoated) are examples of common materials.

Methods of Filling

1. Cold Filling

2. Filling under pressure

Film Strength Testing

A texture analyzer is used to determine the strength of the film:

1. Upon contact, the probe measures displacement and force.

2. A variety of sample holders guarantee the stability of the film.

3. Until the film separates, the probe applies pressure and speed continuously.

Clinical Trials for Skin Sprays

In May 2021, a search for skin spray therapies was conducted on www.clinicaltrials.gov to analyze clinical development.

✔ "Skin AND Spray"

✔ "Skin Aerosol"

✔ "Skin Airbrush" are search phrase.

ReCell, KeraHeal, TISSEEL, SkinGun, and HP802-247 are commercial products.

✘ Studies with "Unknown Status," "Terminated," or "Withdrawn" (unless follow-up studies were available) were excluded from the analysis.

✘ Experiments in which the product was not directly sprayed.

Conclusion

One significant development in pharmaceutical medicine delivery is spray-on bandages. This technology has developed since 1966 to incorporate:

- ✔ NSAIDs (for pain management)
- ✔ Antibacterial & Antiseptic Agents
- ✔ Steroids (to reduce inflammation)

Future studies seek to improve formulations for better adherence and faster drying.

- ✔ Durable, non-stick protective coatings
- ✔ Intelligent medication delivery methods for regulated release

These developments have the potential to transform wound treatment and increase the market for spray bandages in the future.

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