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# FORMULATION AND EVALUATION OF SPRAY BANDAGE FOR WOUND HEALING

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## ABSTRACT

To formulate a spray bandage that provides good protective and therapeutic activities for an extended duration, and forms a film that acts as a protective barrier for open wounds or other topical diseases, it is easy to use and apply by spraying directly on the affected area. Thes pray forms a film within a few seconds and has good patient compliance. Curcumin is useful in various activities such as anti-tumor, antioxidant, anti-arthritic, anti-amyloid, anti-inflammatory, bacterial infections, wound healing, and tissue repair. Curcumin has low gastrointestinal (GI) stability; hence, it is administered through a topical drug delivery system for sustained release of the drug. Film forming sprays offer many advantages compared to conventional topical preparations because they provide uniform drug distribution and dosage, increased bioavailability, lower incidence of irritation, continuous drug release, and accelerated wound healing through moisture control. Conventional formulations for topical and dermatological administration of drugs have certain limitations, such as poor adherence to the skin, poor permeability, and compromised patient compliance. For the treatment of diseases of body tissues and wounds, the drug must be maintained at the site of treatment for an effective period. Topical film-forming systems are emerging drug delivery systems designed for topical application to the skin. These systems adhere to the body, forming a thin transparent film, and provide delivery of the active ingredients to the tissue. They are intended for skin application as emollients or protectives and for local action or transdermal penetration of medicaments for systemic action. Further, various types of film forming systems (sprays/solutions, gels, and emulsions), along with their evaluation parameters, have also been reviewed.

**KEYWORDS:** Spray bandage, Anti-inflammatory, Topical film, Transdermal, Film forming.

## 1. INTRODUCTION

### CURCUMIN

Synonyms: Indian saffron, turmeric, haldi, haridra.

Biological Source: Curcumin is a diaryl heptanoid compound obtained from the dried rhizomes of turmeric.

Family: Zingiberaceae.

Chemical Constituents: Curcumin, demethoxycurcumin, and bisde methoxy curcumin, collectively known as curcuminoids (3-6%), are the major polyphenolic compounds in turmeric rhizomes.

USES: Anti-inflammatory Properties, Antioxidant Effects, Digestive Health,Heart Health: Brain Health, Cancer Prevention, Skin Health, antimicrobial properties.

### EUCALYPYUS OIL

Synonyms: Eucalyptus, Stringy Bark Tree, Blue Gum, Blue Gum Tree

Biological Source: Eucalyptus oil is the essential oil obtained by the distillation of freshleaves from Eucalyptus globulus and other species such as E. polybractea, E. viminalis, and E. smithii.

Family: Myrtaceae

Chemical Constituents: The main chemical constituents of eucalyptus oil include p-cymene (42.1%), eucalyptol (1,8-cineole) (14.1%), α-pinene (12.7%), and α-terpinol (10.7%). Theprimaryconstituents of fruit oil are eucalyptol (1,8-cineole) (34.5%), p-cymene (30.0%), α-terpinol (15.1%),and α-pinene (9.0%).

Uses: Antimicrobial (disinfecting surfaces), Pain relief (muscle, joint, headaches), Insect repellent, Skincare (acne, minor irritations), Oral health (antibacterial, fresh breath), Hair care (scalp health, reduces dandruff), Respiratory relief (colds, coughs, sinus congestion)

**SPRAY BANDAGE**

Spray bandage is a novel approach that serves as an alternative to conventional topical and transdermal formulations. It is a non-solid dosage form that produces a film in situ after application on the skin or other body surfaces. This system contains the drug and film-forming excipients in a vehicle that, upon contact with the skin, leaves behind a film of excipients along with the drug after solvent evaporation. The formed film can be either a solid polymeric material acting as a matrix for sustained drug release or a residual liquid film rapidly absorbed into the stratum corneum.Various drug delivery systems are available for topical applications, including creams, lotions, gels, transdermal patches, and sprays. Their use depends on the drug's pharmacokinetic profile, specifically the degree of immediate versus prolonged release. Some formulations on the market have drawbacks, such as discomfort during application, skin irritation, or cross-contamination. The spray bandage formulation was developed to address these issues. It reduces skin irritation, prevents cross-contamination by direct spraying on affected areas, and minimizes application pain.

Types of Film-Forming Sprayer

- Ordinal Spray
- Metered Dose Spray
- Electrostatic Spray
- Ultrasonic Spray

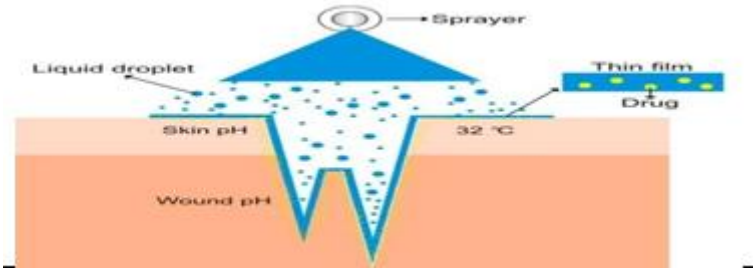



**Fig. No-1.**

Transdermal spray-on systems (TSS) deliver drugs through the skin using a solution containing the drug, volatile solvent, and penetration enhancers.

The process involves

- Solvent evaporation
- Drug-solvent drag into the skin
- Increased thermodynamic activity, enhancing drug loading in the skin.

This facilitates effective transdermal drug delivery.[3] The skin is the largest organ, covering the entire body surface. It consists of three main layers: 1. Epidermis (outermost layer), 2. Dermis (middle layer), 3. Subcutaneous tissue (innermost layer)

These layers work together to protect the body from external factors.[6] The epidermis is the outermost skin layer, composed of keratinocytes and dendritic cells. It's divided into four layers:1. Stratum germinativum (basal cell layer) 2. Stratum spinosum (squamous cell layer) 3. Stratum granulosum (granular cell layer) 4. Stratum corneum (horny cell layer). These layers work together to provide a barrier function.[7] the dermis is connected to the epidermis by the basement membrane and consists of two layers: 1. Papillary layer (thinner, loose connective tissue) 2. Reticular layer (thicker, dense connective tissue with collagen fibers) The dermis contains: Sweat glands**,** Hair and hair follicles**,** Muscles**,** Sensory neurons**,** Blood vessels.[8] The hypodermis (subcutaneous tissue) is a fat layer that:Stores fat**,** Insulates heat**,** Acts as a shock absorbed It lies below the vascular system, having minimal impact on percutaneous drug absorption.[9]

**WOUNDS[10]**

A wound is defined as damage or disruption to the normal anatomical structure and function of the skin. This can range from a simple break in the epithelial integrity of the skin to deeper damage extending into subcutaneous tissue, affecting other structures such as tendons, muscles, vessels, nerves, parenchymal organs, and even bones. Wound healing begins immediately after injury and involves resident and migratory cell populations, the extracellular matrix, and soluble mediators.

**Types of Wounds**

1. Acute Wounds: Heal normally within 5-30 days.
2. Chronic Wounds: Fail to heal in a timely manner.

Stages of Wound Healing

1. Homeostasis: Vasoconstriction, coagulation, platelet aggregation.
2. Inflammation: Vasodilation, cellular infiltration.

3. Proliferation: Fibroplasia, angiogenesis, epithelialization.

4. Remodeling: Wound contraction, collagen remodeling.

Transdermal drug administration aims for either topical skin treatment or systemic absorption. Benefits include a large surface area, ease of application, and an alternative to oral or injectable routes. However, current dosage forms (patches, ointments, creams) have limitations

- Patches: skin irritation, difficulty applying to curved surfaces, pain upon removal.
- Creams/ointments: short contact time, easily wiped off, sticky/greasy texture.

A new dosage form is needed to ensure prolonged skin contact, reduce application frequency, and improve patient compliance.[12]

Curcumin's anti-inflammatory mechanism

- Decreases production of TNF-α and IL-1 cytokines
- Blocks NF-KB transcription factor, reducing inflammatory reactions.This results in reduced inflammation

**Inhibition of Bacterial Quorum Sensing System and BiofilmFormation**

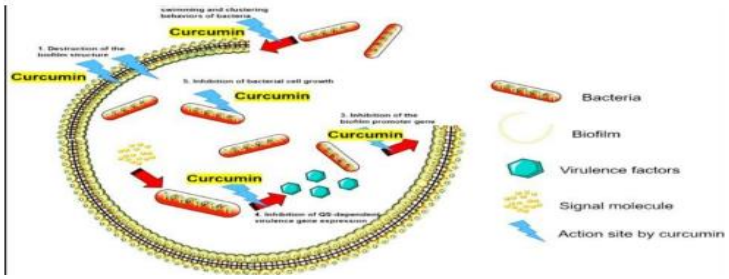



**Fig no -2.**

The main mechanisms of curcumin in QS inhibition involve (1), destruction of the biofilmstructure; (2) inhibition of bacterial swimming and clustering behavior; (3) inhibitionof theexpression of biofilm promotor genes; (4) inhibition of the gene expression of QS- dependent virulence; (5) inhibition of bacterial cell growth.

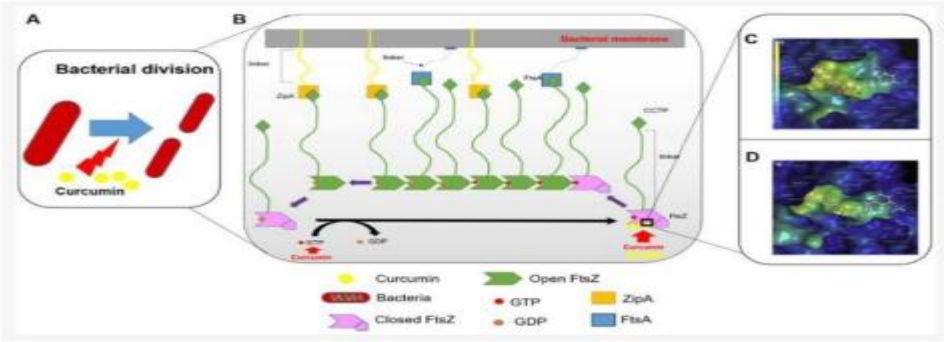



**Fig no – 3.**

**Induction of Oxidative Stress and Programmed Cell Death[14]**

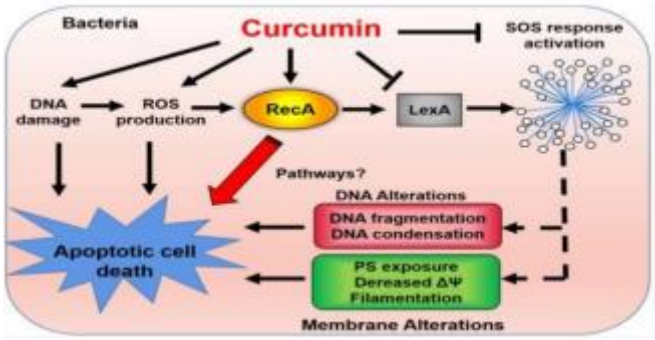



**Fig no – 4.**

**MECHANISM OF ACTION OF EUCALYPTUS OIL**

Eucalyptus oil has the ability to disrupt cell wall and membranes, leading to ATP and metabolite leakage. Additionally, the hydrophobic nature of the oil enables increased cell permeability, leading to bacterial cell leakage.[15]

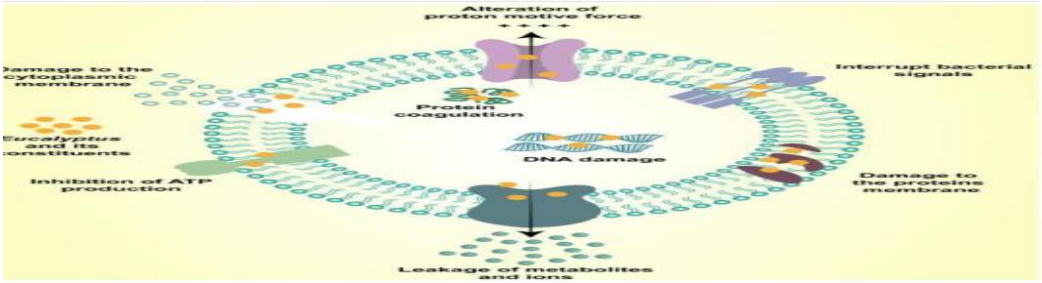



**Fig no -5.**

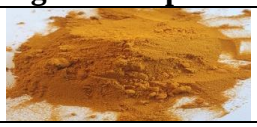
## 2. MATERIALS AND METHODS

### METHOD OF PREPARATION

- ✓ Preparation of Polymer Solution: In a suitable container, combine 0.75 g (2%) of hydroxyl methyl cellulose with 22.75 mL of ethanol. Heat gently while stirring until the polymer is fully dissolved.

- ✓ Incorporation of Curcumin: Dissolve Curcumin In a small container, mix 0.5 g (5%) of curcumin with a few drops of ethanol to dissolve it.
- ✓ Mix with Polymer Solution: Add the dissolved curcumin to the polymer solution and stir thoroughly to ensure uniform distribution.
- ✓ Incorporation of Eucalyptus Oil: Add Eucalyptus Oil Measure and add 0.125 ml (0.5%) of eucalyptus oil to the polymer-curcumin mixture. Stir well to ensure it is evenly distributed.
- ✓ Plasticizer: Add 0.375 mL (0.5%) of diethyl phthalate and 0.5 mL (1%) of propylene glycol to enhance the flexibility of the bandage and mix thoroughly.

**FORMULATION TABLE-1**

| Ingredients | Ingredients photos | F1 | F2 | F3 | F4 | F5 | F6 |
|---|---|---|---|---|---|---|---|
| 1.Curcumin |  | 0.5g | 0.5g | 0.5g | 0.5g | 0.5g | 0.5g |
| 2.Euclaytpus oil |   | 0.125ml | 0.125ml | 0.125ml | 0.125ml | 0.125ml | 0.125ml |
| 3.Hydroxypropyl methylcellulose |  | 0.5g | 0.625g | 0. 75g | 0.875g | 1g | 1.125g |
| 4.Diethyl phthalate |   | 0.125g | 0.25g | 0.375g | 0.50g | 0.625g | 0.75g |
| 5.propylene glycol |   | 0.25ml | 0.375ml | 0.5ml | 0.625ml | 0.75ml | 0.875ml |
| 6.Alcohol |  | 22.75ml | 22.75ml | 22.75ml | 22.75ml | 22.75ml | 22.75ml |


**EVALUATION TEST**

1. ph meter Place the pH meter probe into the sample, ensuring it is fully submerged in the liquid. Wait for the pH meter to stabilize and display a reading. Once the pH reading has stabilized, record the value.

2. Viscosity Viscosity is measured using a Brookfield viscometer (DV III+). Pour a sufficient amount of liquid into the container to ensure there is enough fluid for the viscometer's measurements. Select an appropriate spindle and speed based on the expected viscosity range of the spray bandage. Immerse the spindle into the sample and start the viscometer. Allow the reading to stabilize, then record the viscosity value.

3. Microbial test Take a representative sample of the spray bandage liquid solution. Use a sterile swab to collect a sample from the spray bandage or from the inside of its container. Streak the swabon to the surface of a sterile nutrient agar plate using a zig-zag pattern for even distribution. Dilute the spray bandage in sterile saline or broth. Pipette a specific volume onto a nutrient agar plate and spread it evenly with a sterile spreader.Incubate the inoculated agar plates at 30-37°C for 24-48hours. If specific pathogens are targeted, consider using selective media and adjusting the incubation time accordingly. After incubation, examine the plates for microbial growth.[29]

4. Film formation The spray bandage solution is sprayed onto the surface of a Petri plate and allowed todryat room temperature. After 2-3 minutes, the film is dry, and a glass plate is placed gentlyagainst the film without applying pressure. If no water adhesion is observed on the glassplate, the film is considered dry.[30]

5. Film flexibility Film flexibility is evaluated based on cracking and skin fixation, determined by stretchingthe skin in 2–3 directions. The film is considered flexible if there is no cracking or skinfixation, and non-flexible if cracking or skin fixation is observed.[12]

6. Drying time For the evaluation of drying time, the formulation is applied to the inner side of the forearm. After a fixed time period, a glass slide is placed on the film without applying pressure. If noliquid is visible on the glass slide after removal, the film is considered to be dried. If anyliquid remains on the glass slide, the experiment is repeated with an increased dryingtime.[12]

7. Stickiness The stickiness of the film formed is determined by pressing cotton wool on the dry filmwithlow pressure.[12]

8. Water washability The film is washed with water, and then evaluated using a scale: easily erased, moderatelyerased and poorly erased.[20]

9. Spray pattern A pH-sensitive paper was prepared by dipping the Whatman filter paper in a methyl redsolution. The formulation (one actuation) was then sprayed onto this paper. The spray patternwas assessed by spraying the concentrate both vertically and horizontally.[31]

10. Leak test The leakage of the container was verified by placing it at 37°C and at roomtemperature, andby monitoring weight variability in a water bath. Testing was conducted on selected samples, and the examination passed successfully.[31]

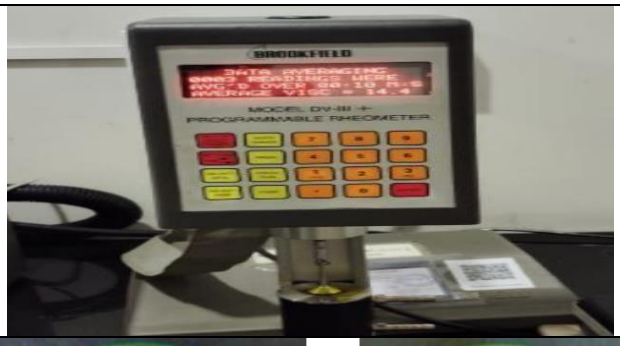
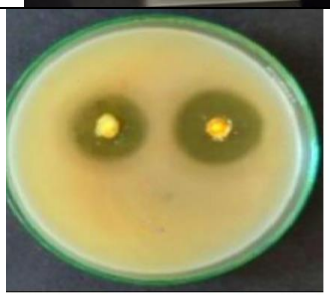
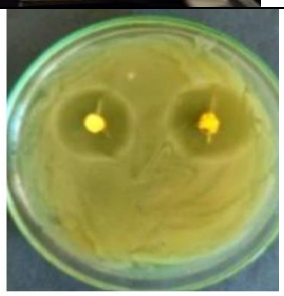
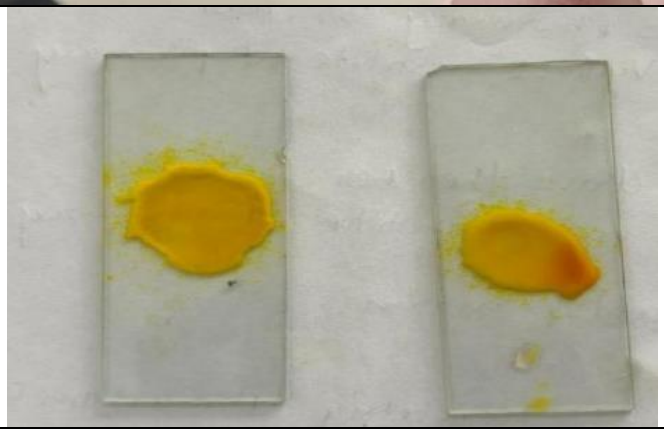
## 3. RESULTS AND DISCUSSION

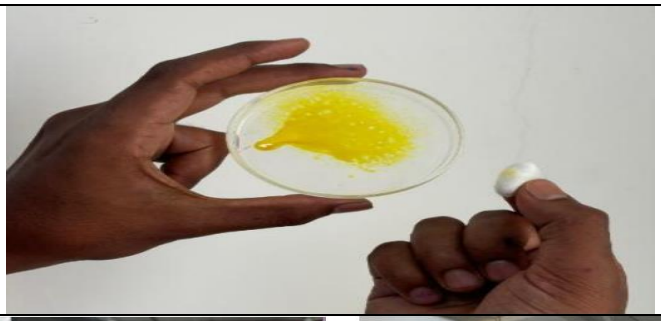
***RESULTS table -2***

| Formulation | F1 | F2 | F3 | F4 | F5 | F6 |
|---|---|---|---|---|---|---|
| Ph | 6.7 | 6.2 | 6.22 | 6.7 | 6.8 | 6.6 |
| Viscosity | 13.8pa.s | 14.1pa.s | 14.4pa.s | 14.9pa.s | 15.2pa.s | 15.6pa.s |
| Microbial test Gram +ve (straphyllus coocus aureus) | 8.5mm | 9.2mm | 11.1mm | 10.7mm | 9.4mm | 8.9mm |
| Microbial test Gram –ve (E.coli) | 7mm | 8.2mm | 10.2mm | 8.7mm | 8.3mm | 7.5mm |
| Film formation | poor | good | Excellent | Very good | good | poor |
| Film flexibility | low | low | High | Moderant | low | Very low |
| Drying time | 2min/03sec | 2min/17sec | 2min/38sec | 3min/12sec | 4min/04sec | 4min/34sec |
| Stickiness | Low | low | none | Moderant | High | High |
| Water washability | Excellent | Excellent | Excellent | Moderant | Moderant | Good |
| Spray pattern | 2.25cm | 2cm | 2.65cm | 2.35cm | 1.8cm | 1.75cm |

**TABALE -3**

| Si. No | Name | Instruments |
|---|---|---|
| 1 | PH meter |  |

| | | |
|---|---|---|
| 2. | Viscosity |  |
| 3 | Microbial test |   Staphylococcus aureus E.coli |
| 4 | Film formation |  |
| 5 | Film flexibility |  |
| 6 | Drying time |  |

| | | |
|---|---|---|
| 7 | Stickiness |  |
| 8 | Water Washability |   |
| 9 | Spary pattern |  |
| 10 | Leak test |  |

## 4. DISCUSSION

Our project focuses on the development of a spray bandage for wound healing by incorporatin gcurcumin and eucalyptus oil. Curcumin has been shown to possess anti-inflammatory, antioxidant, antibacterial, and wound-healing properties, making it a promising candidate for wound care application. Eucalyptus oil act as antimicrobial and provides soothing effect.

The goal of our project is to formulate a spray bandage that can be easily applied to wounds, provide a protective barrier, promote healing, and reduce the risk of infection. The spray bandageis designed to be a liquid solution that can be sprayed onto a wound to forma thin protective layer. The formulation must ensure that the active ingredients curcumin is

delivered effectively to the wound while maintaining stability and promoting healing. Curcumin is the key active component in the spray bandage formulation. However, due to its poor solubility in water, curcumin needs to be formulated in a way that enhances its bioavailability and stability. Ethanol is used as a solvent and may also assist with the drying and film-forming process. Hydroxypropyl Methylcellulose (HPMC) forms a film over the wound and enhances the adhesion of the spray to the skin, ensuring that the active ingredients remain in contact with the wound. Diethyl phthalate is used as a plasticizer, while propylene glycol serves as a penetration enhancer and plasticizer.

Based on the evaluation results, Formulation F3 has shown good film formation, film flexibility, drying time, stickiness, water washability, viscosity, pH, and spray pattern.

## 5. SUMMARY

The main aim of our project is to develop a spray bandage that utilizes curcumin, the active compound found in turmeric, to enhance wound healing. Curcumin is known for its antiinflammatory, antioxidant, and antimicrobial properties, making it an ideal candidate for promoting faster and more effective healing by delivering curcumin directly to wound sites in a convenient and non-invasive form. The spray forms a protective layer over the wound, helping to prevent infection and supporting the body’s natural healing process. Curcumin's ability to reduce inflammation, combat bacterial infections, and promote tissue regeneration further enhances its therapeutic potential. By incorporating curcumin into the spray, the bandage can accelerate the wound healing process, reduce complications, provide consistent coverage, reduce the frequency of dressing changes, and minimize discomfort for patients. Additionally, the natural properties of curcumin help reduce the risk of side effect s often associated with other wound healing agents. The project aims to develop a natural, effective, and user-friendly wound care product that can improve healing outcomes and reduce health care costs. This curcumin-based spray bandage could be particularly beneficial in treating chronic wounds, minor injuries, and burns.

## 6. CONCLUSION

Our project on the development of a spray bandage utilizing curcumin highlights the significant potential of this natural compound in wound healing applications. The incorporation of curcumin provides not only antimicrobial and anti-inflammatory benefits but also promotes tissue regeneration and reduces pain, making it an effective alternative to

traditional wound caremethods. The ease of application and the spray format enhance user convenience, encouraging better adherence to treatment.

As we continue to refine this product through further research and testing, we believe that thi curcumin-infused spray bandage could represent a valuable advancement in woundcare, ultimately contributing to faster healing and improved patient compliance. Additionally, it demonstrates a combination of actions, including anti-inflammatory, antiseptic, antimicrobial, and analgesic properties.

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