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A Comprehensive Review of Antiseptic Formulations: Principles, Applications, and Future Directions

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Abstract

Antiseptic Ointments are a semi-solid dosage form that can be a great option for nearly every type of wound. Ointments can either be by itself or in a clinical dressing for acute and chronic wound care. The ointments are topically applied over a cut

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wound may prevent microbial contamination and assist with wound healing by the dressing. It contains synthetic medicinal ingredients like chlorhexidine and benzialkonium chlorideare used for the therapeutically effect. And the suitable ointment bases like absorption base, oleaginous base, water soluble base, emulsify base are used for better consistency. The varies formulation of the ointment is done by preparing the ointment bases and include the active ingredient within the accurate relationship into the based on the fusion method, emulsion method and trituration method. The efficacy of the formulation as a viscosity spreadability, stability and physical characteristics are can be evaluated.

Keywords: Antiseptic Formulations, Fusion Method, Oleaginous Base, Water Soluble Base, Wound Healing.

1. INTRODUCTION

Pharmacists often utilize skin as a target for the transdermal drug route of administration to achieve topical therapeutic effect largely because skin is the largest and most superficial organ in the body (Ghule et al., 2025). The layers of skin are defined by 'cut or surgical planes' from hypodermal fat and facial internal skeletons, allowing for the skin to flow over contraction of muscle given the loose connective tissue compartment between layers Ubbink et al., 2008). It is the largest organ in the body, accounting for approximately 16% of total adult body weight (Ubbink et al., 2008). The skin provides many important functions, such as protection against external physical, chemical, and biological agents, helping to retain excessive fluid loss through the body's surface, and regulate body temperature (Mishra et al., 2014). The skin is comprised of 3 main layers (epidermis, dermis, and hypodermis, or subcutaneous fat); however, as is evident by their names, each layer serves varying degrees of special functions (Ubbink et al., 2008), (Mikesha et al., 2013).

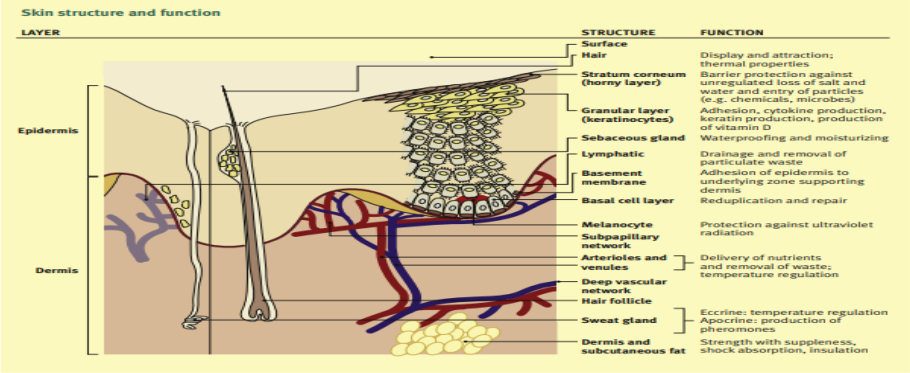

Fig. 1. Skin Structure and Function.

1.1. *Epidermis*

The epidermis denotes the outermost layer of the skin (Mishra et al., 2014.). This epidermis is a mortally differentiated stratified squamous epithelium and keratinocyte. Keratinocytes are the primary and essential cells of the epidermis

(Cañedo-Dorantes & Cañedo Ayala, 2019). There are five horizontal layers that classify according to thickness (Mishra et al., 2014).

1. Stratum basal (basal cell layer).
2. Stratum lucidium.
3. Stratum spinosum (spinous layer/ prickle cell layer).
4. Stratum granulosum (Granular layer).
5. Stratum corneum (horny layer).

1.2. *Dermis*

According to MacLeod and Mansbridge (2014), the dermis is the layer of skin located directly beneath the outer covering layer of skin which is called the epidermis. The dermis, which is attached externally at its junction with epidermis, is attached on the deep side to the subcutaneous fat (Cañedo-Dorantes & Cañedo Ayala, 2019). The thickness of the dermis goes from 2000-3000 μm (Mishra et al., 2014), and contains a matrix of loose connective tissue that is made of fibrous protein within a non-structured ground substance. The dermis has two layers (Ubbink et al., 2008), with in the dermis being the papillary dermis which is the most superficial layer, and beneath or deeper, being the reticular dermis. The fibrous reticulum of tissue gives the skin its structure and plasticity (Mishra et al., 2014.).

1.2.1. *Hyposermis*

The hypodermis, the most inferior layer of skin located beneath the dermis and above the backbone, contains cells capable of energy storage, fat, connective tissue, blood vessels and nerves (MacLeod & Mansbridge, 2014). The hypodermis adds to the thickness of fat located beneath the dermis which insulates the body from the snow and absorbs impact (Mishra et al., 2014). The hypodermis also serves to soothe and protect the body (MacLeod & Mansbridge, 2014).

Factors affecting skin absorption

1. Physical condition of the skin.
2. Solubility of substance.
3. Duration of contact.
4. Molecular mass of the atoms.
5. Concentration.
6. Fat soluble (Ghule et al., 2025).

1.2.1.1 Skin Infection

Viruses, bacteria, fungi, and parasites can all affect skin bugs. Group A β hemolytic streptococci and Staphylococcus aurous are the most prevalent bacterial skin pathogens (Mishra et al., n.d.).

The skins infections are classified into 2 types are as follows:

- Primary Infections.
- Secondary Infections.

The motivations that reason for lesions can be exterior or interior, as well as physical, chemical, electric, or thermal ("Exploring Skin Anatomy," n.d.). They are two types of sores: 1) Acute wound. 2) Chronic wounds. In 2011, Dissemond et al discriminate the wound into the four different groups based on their bed clinical and microbial state.1) Contamination or else colonized soresshort ofhazard of infection. 2) colonised sores at the hazard or censoriously colonized sores. 3) Sores with local infection. 4) Systemic infection also infected wounds (Venus et al., 2011).

2. WOUNDS

Chronic wounds are undoubtedly among the more challenging wounds faced by medical staff. Wound care always includes a prominent aspect of local cares (Babalska et al., 2023). There has been much effort into any intervention to enhance the chronic wound healing trajectory. The most significant shared barrier to wound healing is possible infection risk, and topical antimicrobials have been used for a considerable amount of time based on an empirical basis to address wound infections (Jadhav et al., 2023).

Moreover, antiseptic agent and clinical dressing are also key components of chronic wound management. The word antiseptic comes from the Greek word anti: against and sepsis: decay (Kosanam & Pasupula, 2025). Chronic wounds are those wounds that get 'stuck' in the healing process – they have not healed in the timeframe we would typically expect.

A reduction in the pathogen burden in an environmental disease is necessary for the healing of an implied wound (Mishra et al., 2014.). In the context of this study, these agents are referred to as antimicrobial agents, which, by definition, can help to reduce the proliferation of pathogens in living tissue (Venus et al., 2011). The most common disinfectants employed on chronic wounds are halogen gauze, alcohol-based compounds, biguanides, and quaternary ammoniums (Venus et al., 2011.). Phytochemical drugs developed from plants use seeds, roots, leaves, bark, or flowers for different types of therapies (Jadhav et al., 2023).

Some herbal antiseptic medicines are also used as a main compound to treating the wound healing Are neem oil, honey, curcuma, turmeric, Gilroy stem, and leaves (Madake & Pawar, n2024), (Kolhe et al., 2018). International guidelines command opposes the regular use of the topical disinfectants to control the pathogenic chronic wounds (Venus et al., 2011).

2.1. *Chronic Wounds*

In chronic wound the environmental contamination are common issue in healing process (Venus et al., 2011.). As the microbial load proliferations to serious colonization, woundscuring becomes diminished (local wound infection) (Kaushal & Upadhyaya, 2022). They are three types of chronic wounds which are defined by wound healing society: a) Diabetic foot ulcer b) Vascular ulcer c) pressure ulcer. The vascular ulcer having a venous ulcer and arterial ulcer.

Fig. 2. Chronic Wound.

2.2. *Acute Wounds*

Acute wounds are sustained by simple wound healing processes in a time frame appropriate to the severity of the wound ("Antibiotics," 2022). Damaged skin or tissue will saturate and organize the restoration and stochastic wound tissue. This means that functional barriers begin to restore arbitrarily after injury to the Tissue (Kosanam & Pasupula, 2025). In this process of healing, adjacent blood cells that migrate to the site of the injury, resident skin cells, and various other participants (i.e., extracellular matrix, resident skin cells, cytokines and chemokines, growth factors, and signaling molecules) play an important biological part in the wound healing process (Cañedo-Dorantes & Cañedo Ayala, 2019). Upon injury, the pathway for oxidative stress and inflammation unfolds (Kosanam & Pasupula, 2025).

Fig. 3. Acute Wound.

3. OINTMENT

Antiseptic formulations can be dispensed in various topical dosage forms such as cream, lotions, ointment, aerosol, transdermal patches, liniments, gels and solutions (Ghule et al., 2025). A formulation for a topical antiseptic consists of one or more active ingredients which may be solved or uniformly dispersed in the appropriate base as well as excipients such as but not limited to, an emulsifier, viscosity

manipulators, antimicrobial, and antifunguals, antioxidants, stabilizers, and so forth. (Toppo, & Pawar 2015.). Ointments are greasy, semi-solid medicated topical applications. Ointments are applied to the skin for the healing of damaged skin such as wounds, cuts, abrasions, rashes and other skin conditions, Ointments are composed of oils but will have a vehicle for topical application.

Two types of ointments.

1. Medicated ointment
2. Undedicated ointment. (Ghule et al., 2025)

Fig. 4. Ointment.

3.1.1. *Advantages*

- It is used on the surface.
- Chance of complication is reduced.

3.1.2. *Disadvantages*

- Unit dose is not possible.
- Appling with fingers may lead to contamination. (Tasleem et al., 2013)

4. MATERIALS

4.1. *Chlorhexidine*

The pursuit of an antiviral agent resulted in the discovery of chlorhexidine in the late 1940s (Fardal et al., 2006.). Chlorhexidine is well regarded for its antiseptic properties and its ability to inhibit matrix metalloproteinase (MMPs) while maintaining protective bond strength, and is therefore one of the most commonly used and effective broad-spectrum sterile agents in bonding agent dentistry (Toppo & Pawar, 2015). Chlorhexidine is used to manage burns and disinfect skin, as well as gynecologic, urologic, and ophthalmologic purposes (cet al., 2019.).

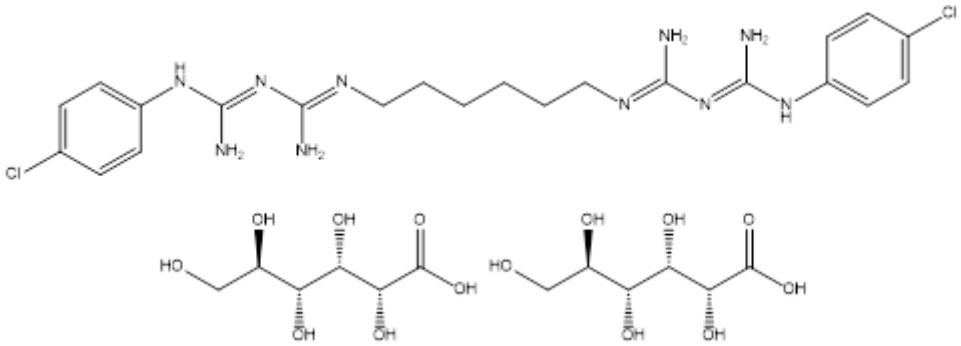

Fig. 5. Structure of Chlorhexidine.

Fig. 6. Chlorhexidine.

4.2. *Benzalkonium Chloride*

In addition to its broad-spectrum action against bacterial endospores, benzoalkonium chloride is a cationic antimicrobial (Maillard, 2018.). According to Hoekstra et al. (2017), it is harmless to use on all washable surfaces, impartial to basic, and non-corrosive on metallic surfaces. Thus, it might be beneficial to incorporate an antiseptic pre-treatment prior to IDS. BAC is another well-known MMP inhibitor with established antiseptic qualities (Toppo & Pawar, 2015.).

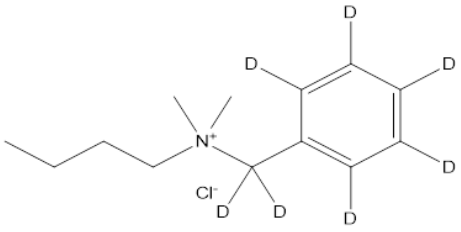

Fig. 7. Structure of the Benzoalkonium Chloride.

Fig. 8. Benzoalkonium Chloride.

5. OINTMENT BASES

Ointment base is mixture of oils a Semisolid, viscous, Fats and hydrocarbons that used in the preparation of ointments. Ointment bases used are as follows

5.1. *Absorption Base*

It is used as emollients. Examples are White soft paraffins and liquid paraffins.

5.2. *Water Soluble Base*

These are work as drug carrier. Example is Propylene glycol. (Ghule et al., 2025)

5.3. *Emulsifying Base*

It works as emulsifier. Example is Cetostearyl alcohol.

5.4. *Preservatives*

It reduces the development of microbes in ointment. Example is Benzyl alcohol. (Kolhe et al., 2018.)

Table 1. Ingredients for preparation of antiseptic ointment and their role.

Sl. No	Ingredients	Role
1	Chlorhexidine gluconate	Antiseptic.
2	Benzalkonium chloride	Antiseptic.
3	White soft paraffin	Base, emollient.

4	Liquid paraffin	Base, emollient.
5	Cetostearyl alcohol	Emulsifier, stabilizer.
6	Propylene glycol	Humectant, solvent.
7	Benzyl alcohol	Preservative.

5.5. METHODOLOGLY

The ointments are formulated by the various techniques.

1. Fusion method.
2. Emulsion method.
3. Trituration method.

5.5.1. *Fusion Method*

This is the most common method for preparing ointment, especially when the base containing a waxes or solid ingredients.

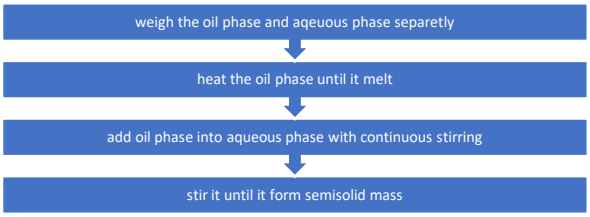

Fig. 9. Steps involved in the fusion method of Ointment Preparation.

The superior melting point, or decreasing order of their warmth, is what keeps the fundamentals fair gauge from dissolving. The first step should be to liquefy the constituent, followed by the subsequent temperature, and so forth. Additionally, the drug is gradually contained by the dissolving components and stimulated completely until the frame cools down and the same invention is ready. (Kolhe and others, undated).

5.5.2. *Emulsion Method*

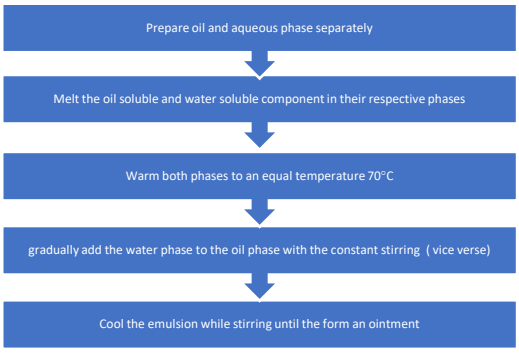

Fig. 10. Steps involved in the Emulsion Method of Ointment Preparation.

This technique is implemented when the ointment is a type of emulsion such as w/o or o/w emulsion. To only investigate the emulsions effects, w/o/w multi and o/w simple emulsions were prepared according to the same formulation. (Shireesha et al., 2024)

5.5.3. *Triturating Method*

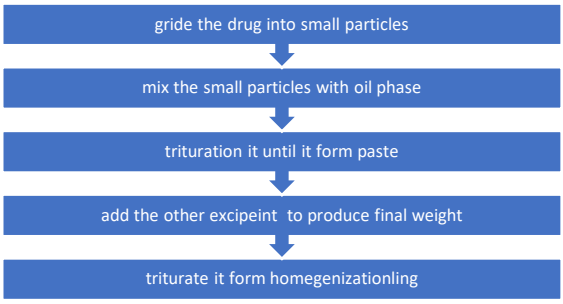

Fig. 11. Steps involved in the Triturating Method of Ointment Preparation.

6. EVALUATION

A number of criteria, including color, odor, pH, uniformity, solubility, washability, non-irritancy test, spreadability, and diffusion study, are used to evaluate the finished ointment. (Jadhav et al., 2023)

6.1. *Colour*

The colour estimate has been tested using clear testing through a black and white background and any addition to a colour will now see a change in colour. (Jadhav et al., 2023), (Ahn et al., 2017) They are to be testing for the appearance and presence of any combinations. ("Pharmaceutics," 2021)

6.2. *Odour*

The three volunteers have examined the ointment's odor for more in-depth reflection. (Jadhav et al., 2023)

6.3. *pH*

The ointments were weigh approximately 2 g of ointment was placed in the beaker and followed by a total of 100 ml of distilled water. They were then heated to a temperature of approximately 70 °C. [(Jadhav et al., 2023)] The pH of the ointments was then measured using a valid, calibrated pH meter with the calibration occurring before use via standard buffer solutions of pH 4.0, 7.0 & 9.0. ("Pharmaceutics", 2021) The pH was measured in the ointment solution using the calibrated pH meter. Each ointment solution had its pH measured in triplicate and averaged for each ointment solution pH. (Ahn et al., 2017)

6.4. *Washability*

The topical formulation is administered onto the skin of two subjects. The ease of water removal is then assessed. (Jadhav et al., 2023) The washability test involves the application of a small amount of topical formulation to the skin and washing with tap water. Good washability is demonstrated for all four formulations. (Jadhav et al., 2023)

6.5. *Non-irritancy Test*

Ointment formulate is spread over to the skin of human being and notice for the outcome (Ahn et al., 2017). Spot the zone (1cm) on the left-hand dorsal exterior region. Then the ointments are spread over the spot and note the time. Then it is crisscross for irritancy if any for an intermission up to 24 h and concludes it. According to the domino effect all the four preparations that are A1, A2, A3 and A4 showed no sign of irritancy. (Jadhav et al., 2023)

6.6. *Spread Ability*

To quantify the spread ability, an emulsion was placed in excess between two glass slides which were then squeezed into a uniform thickness, by placing a specified weight it for a specified time. The time required to pull apart the glass pieces was recorded as the emulsion spread ability. (Jadhav et al., 2023)
Spread ability was calculated using the following equation

$$S = (MXL)/T \quad (1)$$

Where, S= Spread ability; M= Weight tide to the upper slide; L= Length of glass slide; T= Time taken to discrete the slides (Jadhav et al., 2023; Shireesha et al., 2024; Pharmaceutics, 2021; Ghule et al., 2025)

7. FUTURE DIRECTION

The chlorhexidine gluconate and benzalkonium chloride are given better compatible with all the experiments are used in the antiseptic ointment's formulation. The benzalkonium chloride is gives synergic effect to the chlorhexidine gluconate. It gives the better therapeutic effect on the chronic wounds and has the minimum side effect while applying on cut wounds and reduce the spread of infections during the surgeries by clinical dressing.

8. CONCLUSION

According to survey of the literature, the review of antiseptic formulation is concluded as they are the vital in reducing and treatment infections, particularly in healthcare settings and wound treatment. The skins are the primary barriers they contain various layers like epidermis, hypodermis, and dermis. The skin infection is caused by when cut wounds are exposed to external environment it infected by various microorganisms like bacteria and viruses. To avoid the infections on wounds

the surgical or medical dressing play important role in reduce the microbial infection and enhance the wound healing. The chlorhexdine gluconate and benzalkonium chloride they play important role in preventing infection in a surgical site and controlling the spread of microorganisms and treating a skin and soft tissue infections. This antiseptic ointment is formulated by various methods like fusion method, emulsion method and trituration method. The fusion method and emulsion method are most used in ointment formulation. After formulating the ointment, it can be evaluated by various parameter like organoleptic properties, pH, spredability, solubility, washability, non-irritancy test and diffusion test.

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