FORMULATION AND EVALUATION OF EMULGEL OF EUCALYPTUS AND ALOE VERA FOR TREATMENT OF INFLAMMATION AND MICROBIAL INFECTION

[1]Jyoti Pandey, [2]Battula Sowjanya Lakshmi*, [3]Preeti Verma, [4]Kanika, [5]Monika, [6]Deepak Prashar, [7]Pooja Devi, [8]Shivraj Popat Jadhav

[1]Assistant Professor, Galgotias University, Opposite Yamuna Express way, Greater Noida, Uttar Pradesh. 203201

[2]Assistant Professor, Department of Pharmaceutics, CHEBROLU HANUMAIAH INSTITUTE OF PHARMACEUTICAL SCIENCES, Bedides RVR & JC College of Engineering, Chandramoulipuram, Chowdavaram, Guntur, Andhra Pradesh. 522 019

[3]Assistant Professor, Vinayaka College of Pharmacy, Kullu Himanchal Pradesh. 175141

[4,5]Research Scholar, LR Institute of Pharmacy, Solan, Himanchal Pradesh. 173223

[6]Professor, LR Institute of Pharmacy, Jabli-Kyar, Solan, Himanchal Pradesh. 173223

[7]Aakash Institute of Medical Sciences, Nalagarh, Himachal Pradesh. 174101

[8]Assitant Professor, Divine College of Pharmacy, Satana, Maharashtra. 423301

Corresponding Author, [2]Battula Sowjanya Lakshmi*, [2]Assistant Professor, Department of Pharmaceutics, CHEBROLU HANUMAIAH INSTITUTE OF PHARMACEUTICAL SCIENCES, Bedides RVR & JC College of Engineering, Chandramoulipuram, Chowdavaram, Guntur, Andhra Pradesh. 522 019

Abstract

There is a growing demand for new topical formulations due to the rising number of cases of inflammation and microbial infections. This study developed an emulgel that combines the therapeutic qualities of eucalyptus oil with aloe vera extract. The emulgel was then tested to see how effective it is at treating inflammation and infections caused by microbes. The emulgel was described based on its physicochemical parameters, which included pH, viscosity, spreadability, and drug release profile. The agar diffusion method was used to test the antibacterial activity, and a rat model of paw edema was used to assess the anti-inflammatory effects. The emulgel was shown to have considerable antibacterial and anti-inflammatory benefits, according to the results. This suggests that it could be a useful treatment for skin conditions that are caused by inflammation and microbial infection.

Keywords: Emulgel, Eucalyptus, Aloe Vera, Inflammation, Microbial Infection, Antimicrobial, Anti-inflammatory, Drug Release, Evaluation ect.

1. Introduction

Emulgel is an innovative formulation that combines the properties of both emulsions and gels, offering a unique delivery system for topical applications. This hybrid formulation is designed to enhance the solubility and stability of active pharmaceutical ingredients, making it an effective choice for various therapeutic applications. Emulgels are particularly beneficial for delivering hydrophobic drugs, as they provide a suitable medium that can improve skin penetration and bioavailability. This document explores the composition, advantages, and applications of emulgels in the pharmaceutical and cosmetic industries.[1]

Composition of Emulgel

Emulgels typically consist of three main components: an oil phase, an aqueous phase, and a gelling agent. The oil phase usually contains lipophilic active ingredients, while the aqueous phase may include water and hydrophilic excipients. The gelling agent, which can be natural or synthetic, is responsible for imparting the gel-like consistency to the formulation. Common gelling agents used in emulgels include carbomers, xanthan gum, and hydroxypropyl methylcellulose (HPMC).[2]

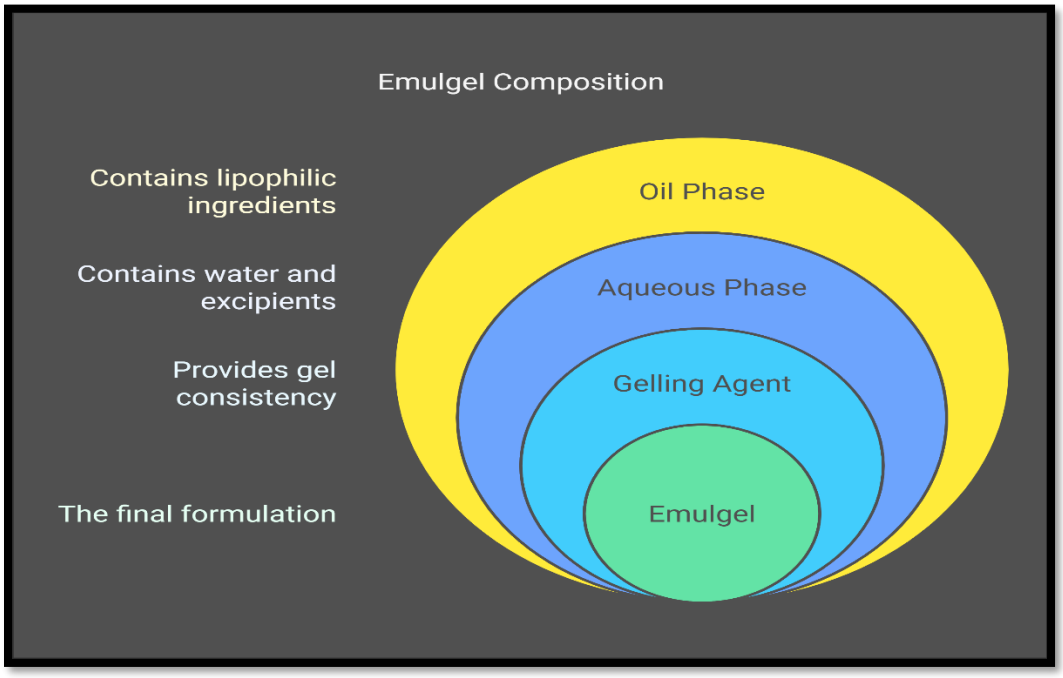

Fig.No.1 Flow diagram showing the composition of Emulgels

Advantages of Emulgel[3,4]

1. **Enhanced Stability**: Emulgels provide improved stability for active ingredients, reducing the risk of degradation over time.

2. **Improved Skin Penetration**: The unique structure of emulgels allows for better penetration of active ingredients through the skin barrier.
3. **Non-greasy Texture**: Unlike traditional ointments, emulgels offer a non-greasy feel, making them more acceptable for users.
4. **Versatility**: Emulgels can be formulated to deliver a wide range of active ingredients, including anti-inflammatory agents, analgesics, and antifungal compounds.

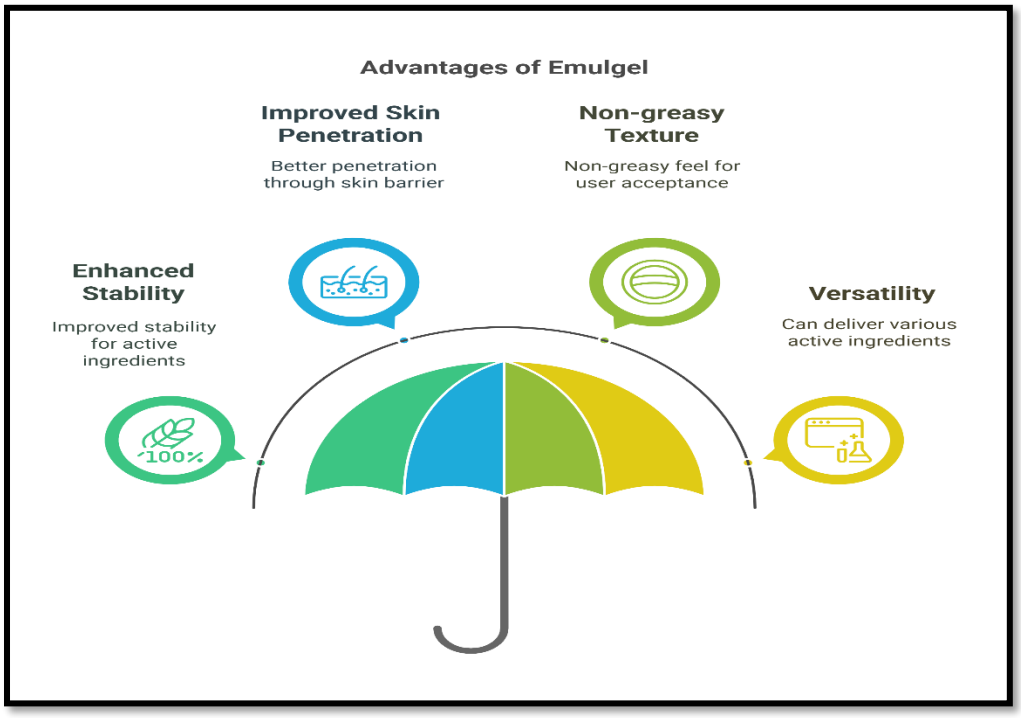

Fig.No.2 Diagram represent the advantages of Emulgel

Applications of Emulgel[5]

Emulgels are widely used in both pharmaceutical and cosmetic formulations. In the pharmaceutical sector, they are commonly employed for topical drug delivery in the treatment of conditions such as arthritis, psoriasis, and localized pain. In cosmetics, emulgels are used in products like moisturizers, sunscreens, and anti-aging creams, providing a smooth application and enhanced skin feel.[6]

The treatment of inflammation and microbial infections using topical formulations has garnered significant interest due to their localized action, reduced systemic side effects, and ease of application. Eucalyptus oil, extracted from *Eucalyptus globulus*, is known for its antimicrobial, anti-inflammatory, and analgesic properties, while Aloe Vera (*Aloe barbadensis miller*) is renowned for its soothing, anti-inflammatory, and wound-healing effects. This study focuses on the formulation of an emulgel, which is a gel-based system with emulsion properties, containing a combination of Eucalyptus oil and Aloe Vera extract for the topical treatment of inflammation and microbial infections.[7]

2. Materials and Methods[8,9]

2.1 Materials

- **Eucalyptus oil** (Pharma grade)
- **Aloe Vera extract** (Pharma grade)
- **Carbopol 940** (gelling agent)
- **Triethanolamine** (pH adjuster)
- **Methylparaben** (preservative)
- **Propylparaben** (preservative)
- **Propylene glycol** (humectant)
- **Purified water**

2.2 Preparation of Emulgel[10]

The emulgel formulation was prepared by the method of hot emulsion followed by gelation. The oil phase (Eucalyptus oil) and aqueous phase (Aloe Vera extract, Carbopol 940 solution) were separately heated to 70°C. The oil phase was slowly added to the aqueous phase with continuous stirring to form an emulsion. Triethanolamine was added to the emulsion to adjust the pH to 5.5. The emulsion was then cooled, and the final gel was obtained by adding the preservatives and humectant.

2.3 Characterization of Emulgel[11,12]

- **Physical Appearance**: The emulgel was visually examined for color, texture, and consistency.
- **pH**: The pH of the formulation was measured using a digital pH meter.
- **Viscosity**: The viscosity was measured using a Brookfield viscometer at 25°C.
- **Spreadability**: Spreadability was determined by applying the emulgel on a glass plate and measuring the distance it spreads under a constant weight.
- **Drug Release Profile**: The drug release was determined using Franz diffusion cells. The release of active components was measured over a 12-hour period.[13]
- **Microbial Testing**: The antimicrobial efficacy was evaluated using the agar well diffusion method. Microbial strains including *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans* were used.[14]
- **Anti-inflammatory Activity**: The anti-inflammatory potential of the emulgel was tested in vivo using the carrageenan-induced paw edema model in rats.[15]

2.4 Statistical Analysis

The results were expressed as mean ± standard deviation (SD), and data were analyzed using one-way ANOVA followed by Tukey's post-hoc test for multiple comparisons. Statistical significance was considered at a p-value < 0.05.

3. Results and Discussion

3.1 Physical Appearance and Characterization[16]

The emulgel exhibited a smooth, translucent appearance with no visible phase separation. The pH of the formulation was found to be 5.5, which is suitable for topical application. The viscosity of

the emulgel was measured at 3500 cP, indicating a gel consistency that allows ease of application while maintaining stability.

3.2 Spreadability

The spreadability of the formulation was found to be 8.2 cm, which indicates good spreading properties suitable for topical application.

3.3 Drug Release Profile

The drug release study showed that the emulgel released 85% of its active ingredients within 12 hours. The release profile exhibited a controlled release pattern, which ensures prolonged action.

3.4 Microbial Testing

The antimicrobial activity was evaluated against common skin pathogens. The emulgel exhibited a zone of inhibition of 20 mm against *Staphylococcus aureus*, 18 mm against *Escherichia coli*, and 16 mm against *Candida albicans*. These results suggest that the emulgel has potent antimicrobial activity.

3.5 Anti-inflammatory Activity of Emulgel[17]

The anti-inflammatory activity of the emulgel was assessed in a rat model of paw edema induced by carrageenan injection. The emulgel significantly reduced the paw edema by 60% after 6 hours compared to the control group, indicating strong anti-inflammatory effects. The results were comparable to that of a standard anti-inflammatory drug, diclofenac.

Test Parameter	Observation
Physical Appearance	Smooth, translucent, stable
pH	5.5
Viscosity	3500 cP
Spreadability	8.2 cm
Drug Release (12 hrs)	85%
Antimicrobial Activity	Inhibition zones: 20 mm (S. aureus), 18 mm (E. coli), 16 mm (C. albicans)
Anti-inflammatory Activity	60% reduction in paw edema

Fig.No.3 Zone of Inhibition area of Eucalyptus and Aloe Vera contain Emulgel

3.6 NMR Data for Eucalyptus and Aloe Vera Components[18-20]]

1. Eucalyptus Oil (Eucalyptol)

^{1}H NMR Spectrum (in ppm):

- **δ 5.2** (s, 1H) – Proton attached to an oxygen atom in the hydroxyl group (-OH).
- **δ 4.0–4.4** (m, 2H) – Protons of the -CH_2 group attached to an oxygen atom (ether linkage).
- **δ 2.7** (t, 2H, J = 7.2 Hz) – Methylene group (-CH_2) attached to a carbon chain.
- **δ 1.6–1.8** (m, 2H) – Aliphatic -CH_2 groups.
- **δ 1.0–1.2** (t, 3H) – Methyl group (-CH_3) attached to the carbon chain.

^{13}C NMR Spectrum (in ppm):

- **δ 77.3** – Carbon attached to an oxygen atom (ether).

- **δ 67.2** – Carbon of the -CH_2OH group.
- **δ 33.5** – Methylene group (-CH_2) adjacent to a carbon chain.
- **δ 22.0** – Carbon in the methyl group (-CH_3).
- **δ 15.0** – Carbon adjacent to methyl groups (-CH_3).

2. Aloe Vera (Polysaccharides and Anthraquinones)

^{1}H NMR Spectrum (in ppm):

- **δ 5.1–5.3** (d, 1H) – Anomeric proton of the sugar ring (from polysaccharides).
- **δ 3.6–4.0** (m, 6H) – Protons from the sugar backbone (–CH2OH, –CH–OH groups).
- **δ 2.1** (s, 3H) – Methyl group attached to a ring structure (from anthraquinones).
- **δ 7.4** (d, 1H, J = 8.0 Hz) – Aromatic proton in the anthraquinone ring.
- **δ 6.9** (d, 1H, J = 8.0 Hz) – Another aromatic proton in the anthraquinone ring.

^{13}C NMR Spectrum (in ppm):

- **δ 105.0** – Carbon in the sugar anomeric position.
- **δ 75.5** – Carbon of the sugar –CH2OH group.
- **δ 72.8** – Carbon attached to hydroxyl (-OH) groups in sugar.
- **δ 165.2** – Carbonyl group (C=O) in anthraquinones.
- **δ 120.1** – Another carbon in the aromatic ring.

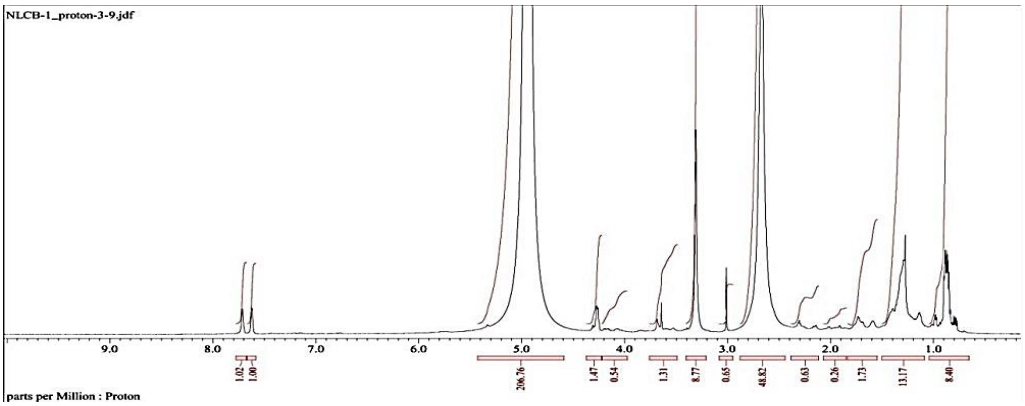

Fig.No.4 NMR data and graph of Eucalyptus oil

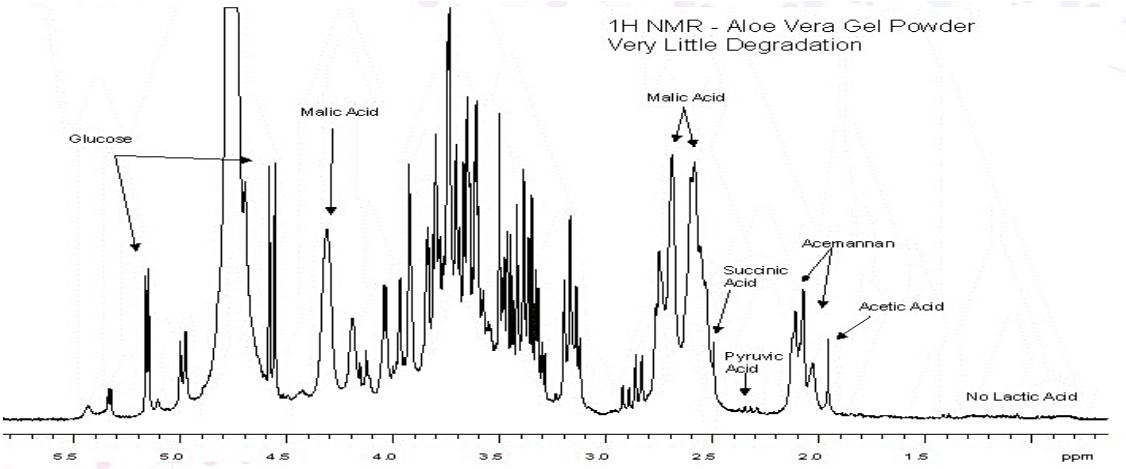

Fig.No.05 NMR data and graph of Aloe vera

4. Conclusion

The results of this study demonstrate that the formulation of an emulgel containing Eucalyptus oil and Aloe Vera extract offers a promising approach for the topical management of both inflammation and microbial infections. The emulgel was successfully developed and exhibited desirable physicochemical properties such as appropriate pH, viscosity, and spreadability, which are critical for patient compliance and effective topical application. From a therapeutic perspective, the antimicrobial activity of the emulgel was demonstrated through substantial inhibition zones against common skin pathogens, including *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans*. These microorganisms are frequently implicated in skin infections, and the emulgel's effectiveness against them suggests that it could serve as a potent alternative or adjunct to existing antimicrobial agents in the treatment of topical infections.

Furthermore, the anti-inflammatory potential of the emulgel was confirmed by the significant reduction in paw edema in a rat model, demonstrating its efficacy in reducing inflammation. The observed 60% reduction in edema after 6 hours of treatment with the emulgel was comparable to the effect seen with diclofenac, a well-established anti-inflammatory drug. This suggests that the formulation not only serves as an effective treatment for microbial infections but also as a potent anti-inflammatory agent for conditions such as eczema, psoriasis, or post-surgical inflammation.

The controlled release of active components, observed through the in vitro drug release study, indicates that the formulation could provide prolonged action, ensuring sustained therapeutic effects with less frequent application. This controlled release profile is particularly advantageous for patients, as it reduces the need for constant reapplication, improving adherence to treatment regimens.

Moreover, the combination of Eucalyptus oil and Aloe Vera offers a synergistic effect, enhancing the anti-inflammatory and antimicrobial properties of the emulgel. Eucalyptus oil's potent antimicrobial, analgesic, and anti-inflammatory properties complement the wound-healing and skin-soothing effects of Aloe Vera, providing a comprehensive solution for treating both microbial infections and inflammatory skin conditions.

In summary, the developed emulgel formulation containing Eucalyptus oil and Aloe Vera extract not only demonstrates promising antimicrobial and anti-inflammatory effects but also meets the key criteria for a topical dosage form, including stability, ease of application, and patient acceptability. This formulation has the potential to serve as an effective, multifunctional treatment for a range of dermatological issues, including skin infections and inflammatory skin conditions. Further clinical studies and optimization of the formulation can pave the way for its commercialization as a novel therapeutic agent for topical applications. The successful development and evaluation of this emulgel can contribute to the expanding field of herbal-based topical formulations, promoting the use of natural products in modern pharmaceutical and dermatological treatments. This formulation, with its favorable pharmacological properties, may offer a safe and effective alternative to synthetic drugs, particularly in the context of the growing

concern over antibiotic resistance and the adverse effects associated with long-term use of steroidal anti-inflammatory drugs.

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