Formulation And Evaluation of Emulgel Containing Neem and Aloe Vera Extract for Antimicrobial Activity

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***Abstract*—The goal of the current study was to create and assess a topical emulgel with neem and aloe vera herbal extracts for antimicrobial use. Because of their availability, safety, and therapeutic effectiveness against microbial infections, herbal medicines have attracted a lot of attention. However, the topical efficacy of many plant constituents is limited by their poor permeability and solubility. By combining the characteristics of gels and emulsions, the emulgel system improves patient acceptability, stability, and drug delivery. The extracts were made with the right solvents, added to an oil-in-water emulsion, and then gelled using Carbopol polymer. Physicochemical properties of the prepared emulgel, such as pH, viscosity, spreadability, drug content, and stability, were assessed. Using the agar diffusion method, antimicrobial activity was evaluated against specific bacterial strains. The developed herbal emulgel may be a viable option for topical treatment of microbial infections, according to the results, which showed acceptable physicochemical characteristics and strong antimicrobial activity.**

***Index Terms*—Emulgel, Neem, Aloe vera, Antimicrobial activity, Herbal formulation, Topical delivery.**

I. INTRODUCTION

Because topical drug delivery systems minimize systemic exposure while delivering therapeutic effects directly at the site of application, they are frequently used to treat localized skin disorders. Creams, ointments, and lotions are examples of conventional semisolid preparations that frequently have drawbacks like poor drug penetration, greasiness, and decreased stability. Emulgel, a sophisticated topical dosage form that combines the benefits of gels and emulsions, has emerged as a solution to these problems. Patient compliance and therapeutic efficacy are increased when an emulsion is added to a gel base because it increases drug solubility, spreadability, and controlled drug release.(1)

Because of their safety profile, affordability, and lower incidence of side effects when compared to synthetic drugs, herbal medicines have attracted a lot of attention in recent years. Because it contains bioactive substances like flavonoids, tannins, and limonoids, Azadirachta indica (neem) is well known for its antimicrobial, anti-inflammatory, and wound-healing qualities. Similar to this, aloe vera's abundance of polysaccharides, vitamins, enzymes, and phenolic components gives it moisturizing, calming, antimicrobial, and skin-regenerating qualities. These two herbal remedies are good candidates for topical antimicrobial formulations because their combination may have a synergistic therapeutic effect.(2)

In order to create an efficient and patient-friendly topical preparation for the treatment of microbial skin infections, the current study focuses on the formulation and assessment of a herbal emulgel containing extracts from Azadirachta indica and Aloe vera.(3)

Emulgel is one of the topical drug delivery systems that has gained a lot of importance in pharmaceutical research. Emulgel is a combination of emulsion and gel drug delivery systems that offers the advantages of both drug delivery systems. The emulsion drug delivery system is a two-phase system that has both oil and water phases that are stabilized by an emulsifying agent. The gel drug delivery system is a semisolid system that is formed by a gelling agent. The drug delivery system that is formed by incorporating an emulsion into a gel is called an emulgel drug delivery system. The drug delivery system is found to be promising for hydrophobic drug delivery and plant extracts through the skin. The stability of the drug is enhanced along with easy drug release.(4)

Emulgel is one of the topical drug delivery systems that has acquired significant importance in the field of pharmaceutical research. Emulgel is the combination of the emulsion drug delivery system and the gel drug delivery system. The combination of the two drug delivery systems provides the benefits of the emulsion drug delivery system and the gel drug delivery system. The emulsion drug delivery system is the combination of two liquids. One of the liquids is the oil phase, and the second liquid is the water phase. The two liquids are stabilized by an emulsifying agent.(5) The gel drug delivery system is the combination of the solid and the liquid phases. The gel drug delivery system is formed by the gelling agent. The drug delivery system that is formed by the combination of the gel drug delivery system and the emulsion drug delivery system is called the emulgel drug delivery system. The drug delivery system is effective for the delivery of hydrophobic drugs and the extracts of plants through the skin. The drug stability is enhanced along with the drug release.(6)

Neem, also known as “village pharmacy” and belonging to the family Meliaceae, is considered to be one of the most important and medicinally significant plants used in traditional medicine. Various parts of the neem plant, such as its leaves, barks, seeds, and oil, have been traditionally used for their therapeutic properties. Neem leaves are reported to contain several biologically active compounds, such as nimbidin, nimbin, azadirachtin, flavonoids, and tannins. These compounds exhibit significant antibacterial, antifungal, antiviral, and anti-inflammatory properties.(7) Neem extracts have been reported to show significant activity against the growth of several pathogenic microorganisms, including Staphylococcus aureus, Escherichia coli, and Candida albicans. Neem is widely used in dermatological formulations for the treatment of various skin infections, acne, and wounds owing to its significant antimicrobial properties.(8)

Another significant medicinal plant that has applications in dermatology is Aloe vera, also referred to as Aloe barbadensis Miller. Aloe vera is well known and recognized for its soothing, moisturizing, and healing properties on the skin. The gel from the leaves of Aloe vera contains active biological compounds like vitamins, enzymes, amino acids, and phenolic compounds. Aloe vera has shown significant pharmacological activities like antimicrobial, anti-inflammatory, and antioxidant, and it promotes wound healing, skin hydration, and regeneration of damaged tissues. It is therefore widely applied in dermatology in formulations like cosmetics and pharmaceuticals.(9)

The use of neem and Aloe vera extracts may result in a synergistic effect, considering the variety of compounds in both plants. Neem may offer antimicrobial and antifungal properties, while Aloe vera may help in soothing, hydrating, and healing the skin. The use of these plant extracts in the form of an emulgel may improve the stability, penetration, and release of these compounds. In recent years, the development of herbal emulgel formulations has gained significant importance in pharmaceutical research.(10)

Herbal emulgel formulations have incorporated the advantage of medicinal plants with the advantage of modern drug delivery systems. The use of herbal extracts in emulgel formulations may offer a promising alternative to antimicrobial agents in the treatment of minor infections and inflammatory conditions.(11)

Thus, in the current study, an attempt has been made to formulate and evaluate an emulgel formulation containing neem (Azadirachta indica) and Aloe vera (Aloe barbadensis) extracts and evaluate its efficacy against microbial growth. For this, the formulated emulgel will be evaluated on the basis of various physicochemical parameters, and in addition, the efficacy of the formulated emulgel will be checked against microbial growth.(12)

The preparation of a herbal emulgel with neem and Aloe vera extracts may provide a potential solution for the management of microbial infections in a safer, effective, and natural way. This study is intended to advance the progress in the formulation of herbal topical products and encourage the use of medicinal plants in modern medicine.(13)

II. MATERIALS AND METHODS

- Carbopol 934 – used as a gelling agent
- Neem extract – used for antimicrobial activity
- Aloe vera extract – used for soothing and antimicrobial effect
- Liquid paraffin – used as oil phase component
- Glyceryl monostearate – used as emulsifying agent

- Sodium lauryl sulfate – used as surfactant
- Propylene glycol – used as humectant and penetration enhancer
- Methyl paraben – used as preservative
- Propyl paraben – used as preservative
- Triethanolamine – used for pH adjustment
- Distilled water – used as vehicle

Method of Preparation

The emulgel was prepared by combining an emulsion with a gel base. The work was carried out carefully using clean apparatus to ensure a uniform and stable formulation.

Neem Extraction

Preparation of Plant Material

- Collect neem leaves or seeds.
- Wash and dry them in shade.
- Grind into coarse powder**.**

Soaking (Maceration)

- Place the powdered neem in a container.
- Add solvent in a ratio (commonly 1:5 or 1:10 w/v).
- Seal the container.

Extraction Period

- Leave the mixture for 24–72 hours.
- Shake occasionally to improve extraction**.**

Filtration

- Filter the mixture using filter paper or cloth.
- Collect the liquid extract (filtrate).(14)

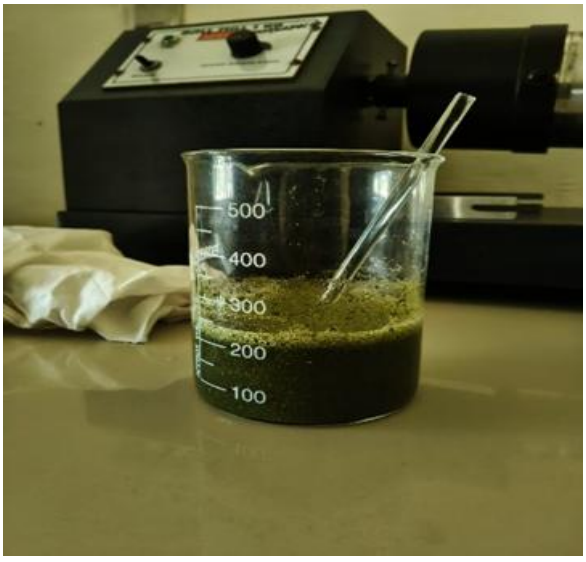

Figure no 1: Neem extract

Aloe Vera Gel Extraction

Collection

- Cut mature, thick leaves from the plant base.

Washing

- Wash thoroughly to remove dirt.

Removal of Latex

- Keep the leaf upright for 10–15 minutes to drain yellow latex (contains aloin, can be irritating).

Peeling

- Remove the outer green skin using a knife.

Gel Extraction

- Scoop out the transparent gel with a spoon.

Storage

- Store in a clean container (preferably refrigerated).(15)

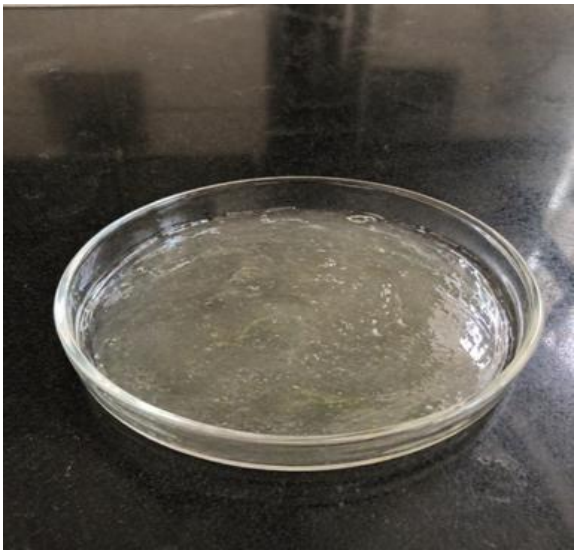

Figure no 2: Aloe Vera Extract

Preparation of Gel Base

- First, the gel base was prepared using Carbopol 934. About 1 g of Carbopol 934 was taken and slowly added to 40–50 ml of distilled water with continuous stirring. Care was taken to add it gradually to avoid lump formation. The mixture was then kept aside for about 30–60 minutes so that the polymer could swell properly. After complete swelling, the dispersion was stirred to obtain a smooth mixtureThen, Sodium hydroxide was added dropwise while stirring. The pH was adjusted to around 6 to 6.5. As the neutralization occurred, the mixture became thicker and formed a clear gel.(16)

Figure no 3: Gel Base

Preparation of Oil Phase

- In a separate beaker, 7.5 g of liquid paraffin and 3 g of glyceryl monostearate were taken. The mixture was heated on a water bath at about 70–75°C until the solid component melted completely.
- The contents were stirred continuously to obtain a uniform oil phase.(17)

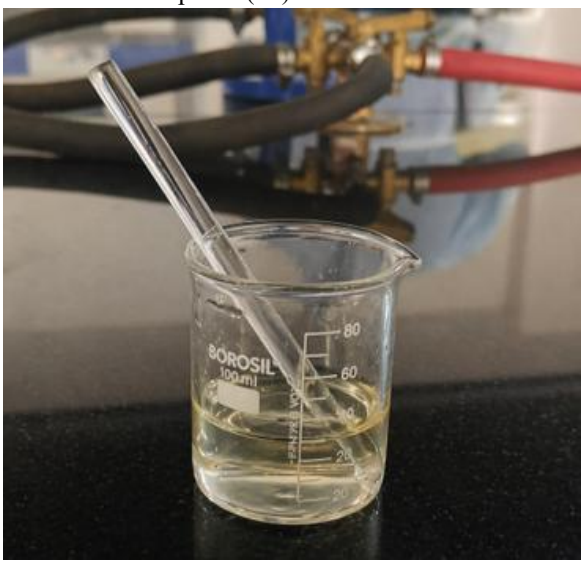

Figure no 4: Oil Phase

Preparation of Aqueous Phase

- In another beaker, 0.5 g of sodium lauryl sulfate, 0.1 g of methyl paraben, and 0.05 g of propyl paraben were dissolved in about 30 ml of distilled water.
- After that, 5 g of propylene glycol was added and mixed properly. The solution was then heated to 70–75°C, maintaining the same temperature as the oil phase.(18)

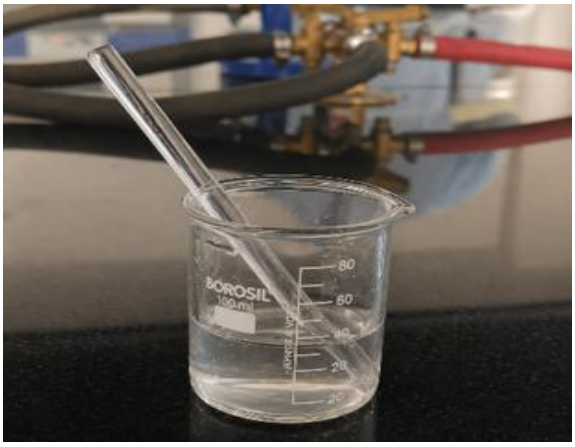

Figure no 5: Aqueous Phase

Preparation of Emulsion

- The hot oil phase was slowly added to the aqueous phase with continuous stirring. The addition was done carefully to ensure proper mixing.
- Stirring was continued until a uniform oil-in-water emulsion was formed. The mixture was allowed to cool gradually while stirring to maintain stability.(19)

Figure no 6: Prepration of Emulsion

Addition of Herbal Extracts

- When the emulsion cooled to a lower temperature (below 40°C), 2 g of Neem extract and 2 g of Aloe vera extract were added.
- The mixture was stirred well so that the extracts were evenly distributed throughout the formulation.(20)

Formation of Emulgel

- The prepared gel base was then added slowly to the emulsion with continuous stirring. The

addition was done in small portions to ensure proper mixing and to avoid formation of air bubbles.

- Stirring was continued until a smooth and uniform emulgel was obtained.
- The final wight was adjusted to 100 g using distilled water, if required.(21)

Figure no 7: Emulgel Prepared

Evaluation of Emulgel

The prepared emulgel was tested to check its quality, stability, and suitability for application on skin. Different tests were performed as described below:

1. Physical Appearance

The formulation was checked visually for its color, smoothness, and uniformity.

Procedure:

A small amount of emulgel was taken on a glass slide and observed under normal light.

Observation:

The prepared emulgel was smooth in texture, uniform in appearance, and did not show any lumps or separation.(22)

2. pH Measurement

The pH of the formulation was determined to ensure that it is safe for skin use.

Procedure:

About 1 g of emulgel was mixed with 10 ml of distilled water. The pH was then measured using a pH meter.

Observation:

The pH of the formulation was found within the range suitable for skin application.(23)

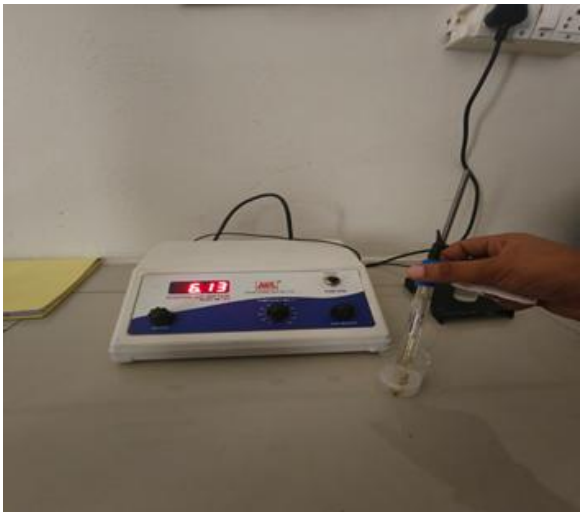

Figure no 8: pH

3. Spreadability

This test was carried out to see how easily the emulgel spreads on the skin.

Procedure:

A small quantity of emulgel was placed between two glass slides. A weight was placed on the upper slide, and the time required for the slides to move was noted.

Observation:

The formulation spread easily without much effort, indicating good spreadability.(24)

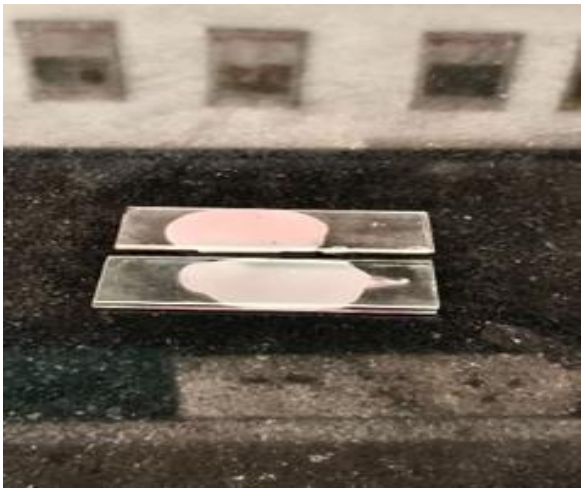

Figure no 9: Spreadibility

4. Drug content

Procedure

- Prepare sample solution of emulgel using methanol/buffer.
- Scan in UV spectrophotometer from 200–400 nm.
- From the graph, note λmax ≈ 295–300 nm (peak point).

- Measure absorbance of your sample at this λmax.

Observation: The UV spectrum showed a maximum absorbance (λmax) at around 298 nm with an absorbance of 0.109, indicating the presence of active constituents.(25)

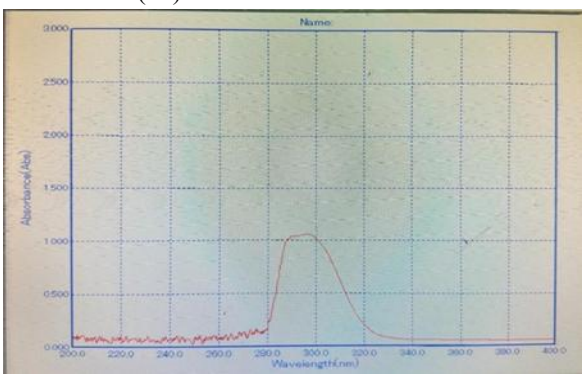

Figure no 10: Drug content

III. CONCLUSION

The present study successfully developed and evaluated a herbal emulgel formulation containing neem and aloe vera extracts for antimicrobial activity. The formulation showed good physical characteristics, including smooth texture, homogeneity, appropriate pH, and satisfactory spreadability, making it suitable for topical application. Stability studies indicated that the emulgel remained stable under different storage conditions without significant changes in its properties.

The antimicrobial study confirmed that the combination of neem and aloe vera extracts exhibited effective activity against selected microorganisms. This may be attributed to the presence of bioactive constituents such as flavonoids, tannins, and alkaloids, which are known for their antimicrobial potential. The emulgel base also enhanced the penetration and uniform distribution of the active compounds.

Overall, the developed herbal emulgel can be considered a promising and safe alternative to conventional topical antimicrobial formulations. Further studies, including clinical evaluation, can be carried out to confirm its efficacy and potential for large-scale use.

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