ABSTRACT

Most of the antibacterial agents were originally derived from plants. Herbal medicine refers to the use of any oil of seeds, leaves for medicinal purposes. Along with other dosage forms, herbal drugs are also formulated in the form of gel. A gel is a gelly like semisolid preparation used topically on a variety of body surfaces. The objective of the study was to formulate and evaluate the antibacterial herbal gel from the local medicinal plants. The oil of the selected plants was taken in different ratio randomly to formulate gel. The topical formulation were developed and tested for physical parameter, drug content, uniformity, Spreadibility. The result showed that coriander and eucalyptus herbal gel showed the MIC values of 50% v/v and 50 %v/v against Bacillus subtilis and staphylococcus Aureus respectively. The formulation second (ECG50) showed the maximum drug content 65% and maximum stability and zone of among the formulation.

KeyWords: Antibacterial; Herbal Gel; Coriander oil, Eucalyptus oil; Formulation; Evaluation.

1. INTRODUCTION OF GELS

The gels as semisolid systems consisting of either suspensions made up of small inorganic particles, or large organic molecules interpenetrated by a liquid. Where the gel mass consists of a network of small discrete particles, the gel is classified as a two-phase system. Single-phase gels consist of organic macromolecules uniformly distributed throughout a liquid in such a manner in that no apparent boundaries between the dispersed macromolecules and the liquid. Single phase gels and jellies can be described as three dimensional networks formed by adding macromolecules such as proteins, polysaccharides, and synthetic macro molecules to appropriate liquids.
Many polymer gels exhibit reversibility between the gel state and sol, which is the fluid phase containing the dispersed or dissolved macromolecules. However, formation of some polymer gels is irreversible because their chains are covalently bonded.

The three dimensional networks formed in two phase gels is and jellies is formed by several inorganic colloidal clays. Formation of these inorganic gels is reversible. This review focuses mainly on water-based gels and jellies. Gel structure, the basis for understanding the physical properties associated with gels, is examined forts, followed by the rheology of gels.

**The physical properties of gels and jellies can be classified based on two groups.**

A) Transitional properties and rheological properties, yield point and rupture.

B) Spectrophotometric and thermal techniques are used to identify gel microstructures (physical junction zones) and their related transitional properties.

For example, nuclear magnetic resonance (NMR) spectroscopy measures the structural and dynamic characteristics of the polymer just prior to aggregation and gel formation and circular dichroism (CD) spectroscopy measures the conformational changes of the polymer during network formation.

Mechanical techniques are used to determine rheological properties of gels. These techniques employ either small deformation measurements that yield viscoelastic parameters or large deformation measurements that generate complete stress strain profile, which include failure parameters \(^1\)

The majority of gels are formed by the aggregation of colloidal sol particales, the solid or semisolid system so formed being interpenetrated by a liquid.

Gelation of lyophilic sols Gels formed by lyphobic sols can be divided into two group depending on the Nature of the bond between the chain of the network of gel.

Type I are irreversible system with a three dimensional network formed by covalent bond between the micromolicall.

Type2 gels are held together by much weaker intermolecular bonds such as hydrogen bond. These gels are heat reversible, a transition from the sol to gel occurring on either heating or cooling.
Poly solution, for example, gel on cooling below a certain temperature referred to as the gel point. Because of their gelling properties poly are used as jellies for the application of drugs to the skin. On the application gel dried rapidly leaving a plastic film with the drug in intimate contact with the skin.[2]

SOL-GEL TRANSITION (GEL POINT)
Sol-Gel transition may be dependent on polymer concentration or temperature. Spectrophometric methods, as mentioned previously are used to probe Sol-Gel transitions that depend on the critical gelling concentration. Thermal methods, including differential scanning calorimetric are used to measure Sol-Gel transitions, or melting temperature, of thermo reversible gels. A relationship for estimating the heat of gelation was derived by Aldridge and Ferry in which the dependence of the Sol-Gel transition temperature on polymer concentration was considered.

The critical gelling concentration is the concentration below which no macroscopic gel is formed under the prevailing experimental condition; rather, a sol is formed by the polymer and solvent. This concentration depends on polymer-polymer and polymer–solvent interactions, the hydrophilic–lipophiclic character of the polymer, and the molecular weight and flexibility for the chain. Furthermore, polymers that require ions to form gels have critical gelling concentration that depend on the concentration these additives and many other variables. There are two thermal gel points associated with thermo reversible gels. Shifts in temp may cause gel formation at the setting point or gel liquefaction at the melting point. In addition temp hysteresis may occur in some gels in which the gel setting point is lower than the melting point. The hysteresis behaviour indicates that junction zones constitute a family of association that than set of identical croslinks. Agarose gels show temp hysteresis; the gel sets at about 40°C and melts at about 90°C.[1]

PHYSICAL AGING
The gel physically ages as it moves toward equilibrium, making the history of a gel sample an important consideration when measuring physical properties. Aging reflects changes in gel microstructure, where noncovalent crosslink are breaking and reforming. Further more, instabilities caused by the nonequilibrium state arise in some polymer gels; two examples are retrogradation and syneresis.
Retrogradation is the spontaneous reversion of a polymer solution to a gel on standing. Polyvinyl alcohol dissolved in water undergoes retrogradation, whereby the stereo regular chains form microcrystalline aggregates as the solution ages. Polyvinyl alcohol gels retrograde, forming crystalline domains. Amylase, which is the linear polysaccharide fraction of starch, undergoes retrogradation, reducing the physical stability for solution and gels over time.

Syneresis is the process whereby liquid is liberated spontaneously from the gel matrix. This instability arises from the nonequilibrium state of the gel established as it was or because of a change in external conditions. An equilibrium, elastic contraction forces of polymer chains are usually balance by solvent swelling forces, resulting from an osmotic pressure differential. With changes in temperature, for example, the osmotic pressure shifts, causing an elastic contraction of polymer chains. The contractive response squeezes excess liquid out of the matrix. Agar and carrageenan are example of gels the exhibit syneresis.\[3\]

**RHEOLOGICAL PROPERTIES**

Like the transitional physical properties, the rheological properties of gels are not easily characterized because they depend strongly on the attributes of the polymer, history of the gel sample, and experimental conditions. Most often, the apparent viscosity or gel strength increases with an increase in the effective crosslink density of the gel or in the concentration and average molecular weight of the polymer. However, a rise in temperature may increase or decrease the apparent viscosity, depending on the molecular interactions between the polymer and solvent. In addition the direction of change in apparent viscosity may not be readily predictable when additives such as ions, nonelectrolytes, solvents or nonsolvents, and other compatible polymers are mixed with a gel.\[1\]

**RIGIDITY**

The modules of rigidity, or shear modulus, are defined as the ratio of shear stress to strain. It is a measure of a gels ability to resist deformation. The minimum rigidity for a strong gel to resist deformation under its own weight is equal to about gpl which is the product of the acceleration due to gravity($g$), density($p$), and a linear dimension ($l$) of the sample. Therefore, the minimum rigidity is about 100 Pa ($10^3$ dyn/cm) for a gel sample 1 cm long.\[1\]

**RUPTURE STRENGTH**

Rupture strength is equal to the stress at which a strong gel ruptures or fails rather than undergoing further strain. The rupture strength is determined by large-deformation
measurements on instruments such as the instron tester, where a tensile stress is applied to the sample. However, strong gel samples can only be tested in tension if they can support their own weight, and most physically crosslinked gels are relatively weak, making this type of test difficult.[1]

GEL-FORMING SUBSTANCES AND THEIR PHARMACEUTICAL USES

Gel-forming hydrophilic polymers are typically used to prepare lipid-free semisolid dosage forms, including dental, dermatological, nasal, ophthalmic, rectal, and vaginal gels and jellies. Gel vehicles containing therapeutic agents are especially useful for application to mucous membranes and ulcerated or burned tissues because their high water content reduces irritancy. Furthermore, these hydrophilic gels are easily removed by gentle rinsing or natural flushing with body fluids, reducing the propensity for mechanical abrasion. The superior optical clarity of synthetic polymer gels, such as those composed of poloxamer and carbomer, has led to the current interest in developing therapeutic ophthalmic gels.[1]

GELATIN

Gelatin is denatured collagen which is hydrolytically degraded under acid or alkaline conditions to produce Type A or B gelatins, respectively. The amino acid content of acid-processed gelatin is virtually identical to that of collagen, yielding an isoelectric point, pH, between 8 and 9. In contrast, alkaline processing reduces the ratio of amide groups to carboxyl groups thereby shifting the pH to about 4 and 5.

Gelatin forms elastic gels reversibly by cooling solutions that contains a sufficient concentration. The gel microstructure consists of a three-dimensional network held together by junction zones in which gelating chains have partly refolded into the triple helix of the parent collagen molecule. The physical properties associated with gelatin gels depend on protein concentration, average molecular weight, temperature, pH, and additives. [1]

SYNTHETIC POLYMERS

Carbomer is a synthetic polyacrylic acid resin, which is copolymerized with about 0.75 to 2% polyalkylsucrose. This is the reason why aqueous dispersions, of Carbomer must be protected against microbial growth. Carbomer is a high molecular weight polymer that contains carboxylic acid groups on about two thirds of its repeat units. Gels are formed on neutralization between pH 5 and 10 with metal hydroxides or amines such as diisopropanolamine and triethanolamine. Neutralization expands the long chains of Carbomer
by charge repulsion to produce an entangled gel network. Because electrostatic repulsion plays a critical role in forming a gel, viscosity and gel strength depend on both pH and salt content.

2. COMPOSITION OF GELS

Gels consist of a solid three-dimensional network that spans the volume of a liquid medium and ensnares it through surface tension effects. This internal network structure may result from physical bonds (physical gels) or chemical bonds (chemical gels), as well as crystallites or other junctions that remain intact within the extending fluid. Virtually any fluid can be used as an extender including water (hydrogels), oil, and air (aerogel). Both by weight and volume, gels are mostly fluid in composition and thus exhibit densities similar to those of their constituent liquids. Edible jelly is a common example of a hydrogel and has approximately the density of water.

3. TYPES OF GELS

A) HYDROGELS

Hydrogel is a network of polymer chains that are hydrophilic, sometimes found as a colloidal gel in which water is the dispersion medium. Hydrogels are highly absorbent (they can contain over 99.9% water) natural or synthetic polymers. Hydrogels also possess a degree of flexibility very similar to natural tissue, due to their significant water content. Common uses for hydrogels include

- Currently used as scaffolds in tissue engineering. When used as scaffolds, hydrogels may contain human cells to repair tissue.
- Hydrogel-coated wells have been used for cell culture
- Environmentally sensitive hydrogels which are also known as 'Smart Gels' or 'Intelligent Gels'. These hydrogels have the ability to sense changes of pH, temperature, or the concentration of metabolite and release their load as result of such a change.
- As sustained-release drug delivery systems.
- Provide absorption, desloughing and debriding of necrotic and fibrotic tissue.
- Hydrogels that are responsive to specific molecules, such as glucose or antigens, can be used as biosensors, as well as in DDS.
- Used in disposable diapers where they absorb urine, or in sanitary napkins

Other, less common uses include

- breast implants
- now used in glue.
- granules for holding soil moisture in arid areas
- dressings for healing of burn or other hard-to-heal wounds. Wound gels are excellent for helping to create or maintain a moist environment.
- reservoirs in topical drug delivery; particularly ionic drugs, delivered by iontophoresis (see ion exchange resin)

Natural hydrogel materials are being investigated for tissue engineering; these materials include agarose, methylcellulose, hyaluronan, and other naturally derived polymers. [6]

B) ORGANOGELS
An organogel is a non-crystalline, non-glassy thermoreversible (thermoplastic) solid material composed of a liquid organic phase entrapped in a three-dimensionally cross-linked network. The liquid can be, for example, an organic solvent, mineral oil, or vegetable oil. The solubility and particle dimensions of the structural are important characteristics for the elastic properties and firmness of the organogel. Often, these systems are based on self-assembly of the structural molecules.

C) XEROGELS
A xerogel is a solid formed from a gel by drying with unhindered shrinkage. Xerogels usually retain high porosity (15–50%) and enormous surface area (150–900 m²/g), along with very small pore size (1–10 nm). When solvent removal occurs under hypercritical conditions, the network does not shrink and a highly porous, low-density material known as an is produced. Heat treatment of a xerogel at elevated temperature produces viscous sinterinterig (shrinkage of the xerogel due to a small amount of viscous flow) and effectively transforms the porous gel into a dense glass.

4. PERCUTANEOUS DRUG ABSORPTION
Semisolid dosage forms for dermatological drug therapy are intended to produce desired therapeutic action at specific sites in the epidermal tissue. A drug’s ability to penetrate the skin’s epidermis, dermis, and subcutaneous fat layers depends on the properties of the drug and the carrier base. Hence, a drug’s diffusive penetration of the skin — percutaneous absorption — is an important aspect of drug therapy. The main portals of drug entry into the skin are the follicular region, the sweat ducts, or the unbroken stratum corneum between these appendages.
5. APPLICATIONS
Many substances can form gels when a suitable thickener or gelling agent is added to their formula. This approach is common in manufacture of wide range of products, from foods to paints and adhesives. In fiber optics communications, a soft gel resembling hair gel in viscosity is used to fill the plastic tubes containing the fibers. The main purpose of the gel is to prevent water intrusion if the buffer tube is breached, but the gel also buffers the fibers against mechanical damage when the tube is bent around corners during installation, or flexed. Additionally, the gel acts as a processing aid when the cable is being constructed, keeping the fibers central whilst the tube material is extruded around it. \[1\]

6. MATERIALS AND METHODS

1. CORIANDER OIL
- **Common Name**: Coriander, Dhanyaka, Dhanya, Dhaniyalu.
- **Plant name**: Coriandrum sativum
- **B.S.**: These are fully dried ripe fruits of the plant know as *Coriandrum sativum* Linn.
- **Family** – Umbelliferae \[4\]
- **Chemical constituents**: fruits contains essential oils. The oil consists mainly of linalool (50 to 60%) and about 20% terpenes (pinenes, \(\gamma\)-ter pinene, myrcene, camphene, phell andrenes, \(\alpha\)-ter pinene, limonene, cymene). Coriandrol, Coriander oil is also main constituents in the plant.
- **Uses**
  1. It is used as a carminative, refrigerant, diuretic, and aphrodisiac.
  2. Coriander is a commonly used domestic remedy, valued especially for its effect on the digestive system, treating flatulence, diarrhoea and colic
  3. Externally the seeds have been used as a lotion or have been bruised and used as a poultice to treat rheumatic pains.
  4. The essential oil is used in aromatherapy. Some caution is advised, however, because if used too freely the seeds become narcotic.

**Product Description & Application**
Coriander is the dried, ripe fruits of coriandrum sativum. The fruit contains volatile oil (1%). The prominent constituents, of the oil are linalool (65-70%) and pinene. Coriander oil is a colourless, pale yellow liquid, having characteristic odour and taste. The seeds also contain fats oil (19-20%) which is mixture of glycerides of palmitic, oleic, linoleic and petroselinic.
Cordiander oil is used as an ingredient in the preparation of liquors and medicine. It is aromatic, stimulant, carminative, diuretic, tonic, stomachic and refrigerant. It is used as a flavouring agent to conceal the odour of other medicines.\textsuperscript{[4]}

2. EUCALYPTUS OIL

- **Synonyms**: Eucalyptus, Dinkum oil, Nilgiri.
- **Bilogoal source**: Oil obtained from distillation of fresh leaves of *Eucalyptus globulus*.
- **Family**: Myrtaceae. \textsuperscript{[6]}

- **Chemical constituents**-
  - 80% Cineole/ Eucalyptol
  - Pinene
  - Camphene
  - Phellandrene
  - Citronellal
  - Geranyl acetate

- **EUCALYPTUS OIL**

**DESCRIPTION**

1. Colour: colourless or pale yellow
2. Odour: aromatic & camphorous
3. TASTE: pungent & camphorous
4. Soluble in 90% Alcohol

**Medicinal use of Eucalyptus oil**

It is used worldwide in pills, liquids, inhalers, salves, and ointments for many common problems.

Internally, Eucalyptus appears to help relieve symptoms of colds, flu, chest congestion, sore throat, bronchitis, pneumonia, and respiratory infections.

Externally, the antiseptic, slightly anesthetic, anti-bacterial, and warming properties of Eucalyptus make it a valuable resource treatment of burns, sores, ulcers, scrapes, boils, and wounds. Applied topically as, it also helps relieve the pain of rheumatism, aching, pains, stiffness, and neuralgia. an oil or ointment. For relief of congestion, asthma, and respiratory problems. \textsuperscript{[4]}
3. CONTRAINDICATIONS
When not taken in excess, Eucalyptus is reasonably safe, but it does appear to be somewhat
difficult to eliminate from the kidneys, so if you have kidney or liver problems, or if you are
pregnant, it would be best to avoid it or use in extreme moderation. Never take continuously
for more than a few days at a time. [8]

7. PREPARATION OF GEL OF CORIANDER & EUCALYPTUS OIL
i. The accurately weighed amount of methyl paraben was dissolved in 5ml of hot water and
propyl paraben was added on slight cooling of water.
ii. To this beaker carbopol 934 was dispersed with continuous stirring for 20 min after
addition of 50 ml of purified water.
iii. This dispersion was kept overnight for soaking. In second beaker the required quantity of
propylene glycol and polyethylene glycol [PEG 400] were added.
iv. To this mixture three different concentration viz. (1 ml: 2 ml); (1.5 ml: 3.5 ml) & (2.0 ml : 4
ml) of Coriander oil & Eucalyptus oil were dissolved in three different beakers containing
ethanol corresponding to its MIC was also incorporated and finally these mixtures were
separately added to three beakers having Carbopol with stirring.
v. The volume was made up with distilled water and stirring was done vigorously
vi. Triethanolamine was properly added to form the gel by adjusting pH to neutral.

Role of ingredients is illustrated in table no.1
Composition of formulation of Coriander oil & Eucalyptus oil is illustrated in table no.2

8. EVALUATION OF HERBAL GEL
1. PHYSICAL PARAMETERS
Physical appearance- The physical appearance of the formulation was checked visually
which comprised of-
Colour- The colour of the formulations was checked out against white background.
Consistency- The consistency was checked by applying on skin.
Greasiness- The greasiness was assessed by the application on to the skin.
Odour- The odour of the gels was checked by mixing the gel in water and taking the smell.[7]

2. pH
About 20mg of the formulation was taken in a beaker and was subjected to the pH
measurement using a digital pH meter. [7]
3. **DRUG CONTENT**

The drug content of the gel formulations was determined by dissolving an accurately weighed quantity 500 mg of gel in 10ml of solvent (a mixture of ethanol and phosphate buffer pH 6.8 (60:40) for formulations of coriander oil). The solutions were kept for shaking for 4hrs and then kept for 6hrs for complete dissolution of the formulations. Then the solutions were filtered through 0.45mm membrane filters and proper dilutions were made and solutions were subjected to the Spectrophotometric analysis. The drug content was calculated from the linear regression equation obtained from the calibration data.

9. **RESULT**

Topical antibacterial herbal gel are formulated and evaluated by following parameter...

Evaluation Data is illustrated in table 3(A)

Evaluation Data is illustrated in table 3(B)

10. **CONCLUSION**

The Antibacterial herbal gel is formulated by using Eucalyptus oil and Coriander oil on the basis of their Antibacterial activity. From over all result we can concluded that topical preparation CEG-50 have more antibacterial activity as compared to other formulation. The final product are evaluated & was stable.

11. **ACKNOWLEDGEMENT**

Authors are thankful to P.S.G.V.P.M’S College of Pharmacy for providing required guidance and support.

12. **ELLUSTRATIONS**

Table 1- Role of ingredients

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Role</th>
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<tbody>
<tr>
<td>Carbopol 934</td>
<td>Gelling agent</td>
</tr>
<tr>
<td>Ethanol</td>
<td>Solvent &amp; Co-Solvent</td>
</tr>
<tr>
<td>Methyl paraben</td>
<td>Antimicrobial preservative</td>
</tr>
<tr>
<td>Propyl paraben</td>
<td>Antimicrobial preservative</td>
</tr>
<tr>
<td>Propylene glycol</td>
<td>Humectant, solvent, dispersing agent.</td>
</tr>
<tr>
<td>PEG 400</td>
<td>Solvent &amp; Co-Solvent</td>
</tr>
<tr>
<td>Triethanolamine</td>
<td>PH &amp; buffer adjusting agent</td>
</tr>
<tr>
<td>Distilled Water</td>
<td>vehicle</td>
</tr>
</tbody>
</table>
Table 2. Composition of formulation of Coriander oil & Eucalyptus oil.

<table>
<thead>
<tr>
<th>Name of Ingredients</th>
<th>CEG-30</th>
<th>CEG-50</th>
<th>CEG-60</th>
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</thead>
<tbody>
<tr>
<td>Coriander oil</td>
<td>1ml</td>
<td>1.5</td>
<td>2ml</td>
</tr>
<tr>
<td>Eucalyptus oil</td>
<td>2ml</td>
<td>3.5</td>
<td>4ml</td>
</tr>
<tr>
<td>Carbopol 934</td>
<td>0.15gm</td>
<td>0.15gm</td>
<td>0.15gm</td>
</tr>
<tr>
<td>Ethanol</td>
<td>0.4ml</td>
<td>0.4ml</td>
<td>0.4ml</td>
</tr>
<tr>
<td>Methyl paraben</td>
<td>0.015gm</td>
<td>0.015gm</td>
<td>0.015gm</td>
</tr>
<tr>
<td>Propyl paraben</td>
<td>0.003</td>
<td>0.003gm</td>
<td>0.003gm</td>
</tr>
<tr>
<td>Propylene glycol</td>
<td>0.15gm</td>
<td>0.15ml</td>
<td>0.15ml</td>
</tr>
<tr>
<td>PEG 400</td>
<td>0.5gm</td>
<td>0.5gm</td>
<td>0.5gm</td>
</tr>
<tr>
<td>Triethanolamine</td>
<td>q.s</td>
<td>q.s</td>
<td>q.s</td>
</tr>
<tr>
<td>Distilled Water q.s</td>
<td>10ml</td>
<td>10ml</td>
<td>10ml</td>
</tr>
</tbody>
</table>

Table 3(A). : Evaluation Data

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Colour</th>
<th>Consistency</th>
<th>greasiness</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEG -30</td>
<td>White</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>CEG -50</td>
<td>White</td>
<td>Very Good</td>
<td>Good</td>
</tr>
<tr>
<td>CEG-60</td>
<td>Pale White</td>
<td>Good</td>
<td>Highly greasy</td>
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</table>

Table 3(B): Evaluation Data

<table>
<thead>
<tr>
<th>Formulations</th>
<th>Drug contain</th>
<th>pH</th>
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</thead>
<tbody>
<tr>
<td>CEG-30</td>
<td>62%</td>
<td>6.8</td>
</tr>
<tr>
<td>CEG-50</td>
<td>65%</td>
<td>7</td>
</tr>
<tr>
<td>CEG-60</td>
<td>64.5%</td>
<td>6.9</td>
</tr>
</tbody>
</table>

11. REFERENCE
1. Swarbrick James, Boylon James c, Encyclopedia of pharmaceutical technology, second edition, volume second, pp.1327-1342
2. Aulton .M.E., Pharmaceutics, the science of dosage form design, second edition, pp.85-86
4. Dr. Kokate C.K., Dr. Purohit A.P., Dr. Gokhale S.B., Pharmacognosy, Niraliprakashan, Pune, 46th edition, June 2010, pp. 10.43