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Formulation and evaluation of curcumin gel

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ABSTRACT :

The present investigation aimed to develop and study topical gel delivery of curcumin for its anti-inflammatory effects.

Carbopol 934P (CRB) and hydroxypropylcellulose (HPC) were used for the preparation of gels. The penetration-enhancing effect of menthol (0–12.5% w/w) on the percutaneous flux of curcumin through the excised rat epidermis from 2% w/w CRB and HPC gel system was investigated.

All the prepared gel Formulations were evaluated for various properties such as compatibility, drug content, viscosity, in vitro skin permeation, and anti-inflammatory effect. The drug and polymers compatibility was confirmed by Differential scanning calorimetry and infrared spectroscopy.

The percutaneous flux and enhancement ratio of curcumin across rat epidermis was markedly enhanced by the addition of menthol to both types of gel formulations. Both types of developed topical gel formulations were free of skin irritation.

In anti-inflammatory studies done by carrageenan induced rat paw oedema method in Wistar albino rats, anti-inflammatory effect of CRB, HPC and standard gel formulations

Introduction :

What is a Gel

A pharmaceutical gel is a semi-solid dosage form that consists of either small inorganic particles or large organic molecules dispersed in a liquid vehicle, usually water. The mixture forms a three-dimensional matrix, giving the gel its structure and consistency.

Types of Gels

Hydrogels

Water-based gels (most common in pharmaceuticals).
Example: Carbomer gel, cellulose-based gels.

Organogels

Non-aqueous gels using organic solvents like alcohol or oils.
Example: Lecithin-isopropyl palmitate gel.

Emulgels

Combination of emulsion and gel systems.
Enhances drug penetration and stability

Characteristics of Pharmaceutical Gels

- Semi-solid and smooth in texture.
- High water content, providing a cooling effect.
- Non-greasy and easily washable.
- Provide localized or systemic drug delivery.
- Often clear or translucent in appearance.
- Can have controlled or sustained release properties.

Common Ingredients in Gels

- Gelling agents: Carbomer, xanthan gum, HPMC (hydroxypropyl methylcellulose).
- Solvents: Water, ethanol, glycerin, propylene glycol.
- Preservatives: Methylparaben, benzalkonium chloride.
- pH adjusters: Triethanolamine (TEA), sodium hydroxide
- Penetration enhancers: Alcohols, dimethyl sulfoxide (DMSO).

Advantages of Gels :

- Easy to apply and spread.
- Quick absorption through the skin
- Enhanced patient compliance.
- Suitable for oily or acne-prone skin.
- Less sticky than creams or ointments.
- Good for mucosal and ophthalmic use.

Turmeric :

Common name :-Haldi
Botanicalname:-Curcuma longa
Family:-Zingiberaceae
Biologicalsource:-Rhizomeofthe plant
Geographical source: India, Sri Lanka, Indonesia, Myanmar, Thailand
Chemical constituents:- Curcumin, Demethoxycurcumin, Bidemethoxycurcumin, Turmerone
Uses:- Antimicrobial, antioxidant, anti-inflammatory, anticancer

Turmeric contains yellow colouring matter called as curcuminoids (5%) and essential oil (6%). The chief constituent of the colouring matter is curcumin I (60%) in addition with small quantities of curcumin III, curcumin II and dihydrocurcumin. The volatile oil contains mono- and sesquiterpenes like zingiberene (25%), α-phellandrene, sabinene, turmerone, arturmerone, borneol, and cineole. Choleretic action of the essential oil is attributed to β-tolylmethyl carbinol.

Process of curcumin extraction :

- Mix turmeric powder with ethanol in a ratio of 1:10 (w/v) (e.g., 100 g turmeric powder + 1 liter ethanol).
- Stir or shake for 3–6 hours at room temperature (or heat mildly to ~40–50°C to improve yield).

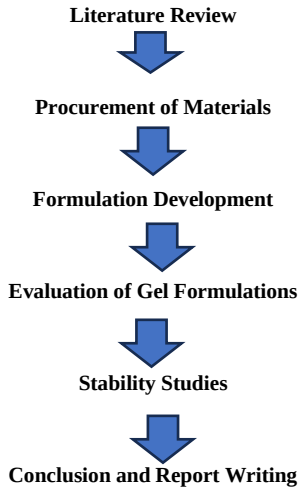
- Filter the mixture using filter paper or centrifugation to separate the solid residue.
- Collect the curcumin-rich ethanol extract
- Use rotary evaporation or gentle heating under reduced pressure to evaporate ethanol and concentrate the extract.
- You are left with a thick, viscous curcumin extract.

AIM : To formulate and evaluate a topical gel containing curcumin for enhanced skin delivery, improved therapeutic efficacy, and patient compliance.

Objectives :

- To extract and/or source pure curcumin from natural or commercial sources with verified purity and quality.
- To formulate different gel batches containing curcumin using varying concentrations of gelling agents and penetration enhancers
- To perform antimicrobial or anti-inflammatory activity tests of the gel
- To conduct stability studies under different storage conditions as per ICH guidelines
- To compare the optimized formulation with a standard or marketed formulation.

Plan of work:



Literature survey :

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2. Baskaran K., Sagar S., Rethinam S., Jeyaraj R.et.al(2023) :Formulated a curcumin-based gel aimed at enhancing topical delivery for skin ailments. The study emphasized improved bioavailability and stability
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4. Vandana D., Shweta Pawar et.al (2021):Formulated a gel incorporating a curcumin-β-cyclodextrin inclusion complex to improve aqueous solubility. Evaluations demonstrated enhanced antimicrobial and anti-inflammatory activities.
5. Chandra, S., et al.(2020):Prepared transdermal gels using Carbopol 934 with various absorption enhancers like mannitol and sodium lauryl sulfate. The study highlighted improved drug release profiles and stability
6. Nawaz A, Farid A, Safdar M, et al.(2022)Formulated hydrogels containing 2% curcumin and natural enhancers like aloe vera oil. The presence of these enhancers significantly increased skin permeation rates

Material required :

Active Ingredient:
Curcumin (pure) – 1 g (1% w/v concentration for anti-inflammatory or cosmetic use; can be adjusted based on intended use)

Gelling Agent:
Carbopol 940 – 0.5 to 1 g (used for forming a smooth, stable gel base)

Neutralizer:
Triethanolamine (TEA) – q.s. (quantity sufficient) (to adjust pH and form the gel)

Solvent :
Ethanol or Propylene Glycol – 10–15 ml (curcumin is poorly soluble in water, so a co-solvent is used)

Preservative (optional, for shelf life):
Methylparaben – 0.2 g
Propylparaben – 0.05 g

Distilled Water – q.s. to 100 ml

Equipment Needed:

- Beakers

- Stirring rod or magnetic stirrer
- pH meter or pH strips
- Weighing balance
- Measuring cylinder

Procedure :

Preparation of Aqueous Phase:

Disperse Carbopol 934 in a small amount of distilled water (about 1% w/v)Allow it to swell for 2–3 hours or overnight for complete hydration

Solubilization of Curcumin:

Dissolve the required amount of curcumin in propylene glycol or a mixture of ethanol and propylene glycol (to enhance solubility). Stir continuously until a clear solution is obtained.
Add the curcumin solution to the hydrated Carbopol gel base slowly under continuous stirring.Stir gently to avoid air entrapment and ensure uniform mixing.

Neutralization:

Slowly add triethanolamine dropwise to adjust the pH to around 6.5–7.0. This step causes the Carbopol to thicken and form a transparent gel.

Final Adjustments:

Add any required preservatives and mix uniformly. Make up the volume with distilled water if needed

Storage:

Transfer the prepared gel into suitable airtight containers. Store in a cool and dry place, away from light

Evolution test:

1. **Physical Appearance**
   Check: Color, odor, texture, homogeneity
   Expected: Smooth, uniform yellow/orange gel, no lumps or grittiness

2. **pH Determination**
   Procedure:
   Take 1 g of gel and dilute in 10 ml of distilled water.
   Measure pH using a calibrated digital pH meter.
   Acceptable Range: 5.5–6.5 (ideal for topical use without skin irritation)

3. **Viscosity**
   Instrument: Brookfield viscometer (Spindle No. 64, speed 10–20 rpm).
   Procedure:
   Fill a 100 ml beaker with the gel.
   Measure viscosity at room temperature (~25°C).
   Typical Value: 20,000 to 80,000 cP (varies with gelling agent).

4. **Drug Content (Assay)**
   Method: UV-Visible spectrophotometry at ~420–430 nm (wavelength for curcumin)
   Purpose: Ensure correct curcumin concentration in the final gel

5. **Stability Studies**
   Conditions: Room temp, refrigerated, and accelerated (40°C ± 2°C, 75% RH ± 5%)
   Duration: 1–3 months
   Observation: Check for phase separation, color change, pH variation

Conclusion :

The formulated curcumin gel was successfully prepared using Carbopol 940 as the gelling agent and evaluated for various physicochemical parameters. The gel exhibited desirable characteristics such as a smooth texture, homogeneity, and a pH compatible with skin (5.5–6.5). The viscosity and spreadability were found to be optimal for topical application, ensuring easy application and retention on the skin surface

Drug content analysis confirmed the uniform distribution of curcumin throughout the formulation, meeting the acceptable pharmacopeial standards. The extrudability and stability tests further supported the formulation's physical integrity and shelf-life under different storage conditions. No microbial contamination was observed, indicating good preservative efficacy and hygienic formulation practices.

Overall, the curcumin gel demonstrated promising attributes suitable for topical delivery, and it can be considered a stable, effective, and safe formulation for anti-inflammatory or cosmetic use

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