INTERNATIONAL JOURNAL OF
Clinical and Pharmaceutical Innovations
An International Peer Reviewed Open Access Journal

Review Article

ISSN (Online): 3142-8665
CODEN (USA): IJCPSM

2026, Volume 1, Issue 4, Page No: 87-90.

A REVIEW ON FORMULATION AND EVALUATION OF DICLOFENAC OINTMENT

***K. V. M. Krishna, B. Jayaroop Prasad, V. Jwayal Kumar, I. Surendra, M. Rohith**

Department of Pharmaceutics, Browns College of Pharmacy, Telangana, India.

Article Info: **Received:** 20 May 2026, **Revised:** 10 June 2026, **Accepted:** 30 June 2026

***Corresponding Author: K.V.M. Krishna**

Department of Pharmaceutics, Browns College of Pharmacy, Telangana, India.

Citation:
*K. V. M. Krishna, B. Jayaroop Prasad, V. Jwayal Kumar, I. Surendra, M. Rohith. (2026). A Review On Formulation And Evaluation Of Diclofenac Ointment. International Journal of Clinical and Pharmaceutical Innovations, 1(4), 87-90.
DOI: https://doi.org/10.5281/zenodo.21207215

ABSTRACT
Diclofenac sodium is a widely used non-steroidal anti-inflammatory drug (NSAID) employed for the treatment of pain, inflammation, and musculoskeletal disorders. The present project focuses on the formulation and evaluation of a topical diclofenac ointment intended to provide localized therapeutic action while minimizing systemic side effects associated with oral administration. Topical delivery offers advantages such as improved patient compliance, reduced gastrointestinal irritation, and targeted drug delivery. Diclofenac acts by inhibiting cyclooxygenase (COX) enzymes, thereby reducing prostaglandin synthesis. This study aimed to formulate and evaluate diclofenac sodium ointment using different concentrations of ointment bases. Diclofenac sodium was incorporated into a hydrophobic base by the fusion method. The prepared formulations were evaluated for appearance, pH, spread ability, viscosity, drug content, and in-vitro drug release. Results indicated that the formulation containing an optimized concentration of emulsifying agents exhibited satisfactory physical characteristics and enhanced drug release.

KEYWORDS: COX: Cyclooxygenase, NSAID: Non-steroidal anti-inflammatory drug.

INTRODUCTION

Pharmaceutical dosage forms are designed to deliver therapeutic agents effectively to the site of action and achieve the desired pharmacological response. Semisolid topical preparations like ointments have gained considerable importance due to their ability to provide localized treatment with minimal systemic side effects, bypassing first-pass metabolism and reducing gastrointestinal irritation. Ointments are homogeneous semisolid preparations intended for external application to the skin or mucous membranes, providing prolonged contact and facilitating sustained drug absorption. The skin is the largest organ of the human body, covering approximately 1.8 square meters in adults, and acts as a protective barrier. Topical drug delivery involves applying formulations onto the skin to achieve therapeutic action at the site of application. It consists of three primary layers: Epidermis (outermost protective layer where the stratum corneum acts as the main barrier), Dermis (contains blood vessels, nerves, and connective tissue supporting absorption), and Hypodermis (subcutaneous tissue providing insulation).

Diclofenac is a widely used non-steroidal anti-inflammatory drug (NSAID) that possesses analgesic, anti-inflammatory, and antipyretic properties. It is commonly prescribed for the treatment of musculoskeletal disorders, arthritis, sprains, strains, and other painful inflammatory conditions. Diclofenac exerts its pharmacological action by inhibiting the cyclooxygenase (COX) enzymes, thereby reducing the synthesis of prostaglandins, which are responsible for

pain and inflammation. Due to its effectiveness and relatively favourable safety profile, diclofenac has become one of the most frequently used NSAIDs worldwide.

Topical drug delivery systems such as ointments have gained significant attention in pharmaceutical research and clinical practice. Diclofenac ointment is a semisolid dosage form designed for external application to the skin, providing localized therapeutic effects while minimizing systemic side effects associated with oral administration. The ointment base serves as a vehicle that facilitates the release of the drug from the formulation and its penetration through the skin. Topical diclofenac preparations are particularly useful in the management of localized pain and inflammation because they deliver the drug directly to the affected site, thereby reducing gastrointestinal irritation and other adverse effects commonly observed with oral NSAIDs.[1]

Advantages

- Avoidance of hepatic first-pass metabolism.
- Reduced gastrointestinal irritation and systemic toxicity.
- Localized targeted drug action with improved patient compliance.
- Easy application, non-invasive route, and lower dosing frequency.

Disadvantages

- Limited drug penetration due to the skin barrier (stratum corneum).
- Possibility of local skin irritation, rash, or allergic reactions.
- Variable absorption depending on skin condition, thickness, and age.

DRUG & EXCIPIENT PROFILE

Active Pharmaceutical Ingredient: Diclofenac Sodium

Diclofenac sodium is a phenylacetic acid derivative with potent anti-inflammatory, analgesic, and antipyretic properties. It is one of the most widely prescribed NSAIDs globally for conditions such as rheumatoid arthritis, osteoarthritis, ankylosing spondylitis, sports injuries, and postoperative pain.

Mechanism of Action

Diclofenac acts primarily by inhibiting cyclooxygenase enzymes (both COX-1 and COX-2). These enzymes catalyze the conversion of arachidonic acid to prostaglandins, which are key mediators of pain, inflammation, swelling, and fever. By blocking the COX pathway and stopping prostaglandin formation at inflammatory sites, diclofenac significantly reduces local pain sensation, redness and tissue inflammation.

Excipients and Ointment Bases

Classification of Ointment Bases Used

- Hydrocarbon Bases: Examples include White Petrolatum, Yellow Petrolatum, and Hard Paraffin. They provide excellent occlusive and emollient effects with high structural stability.
- Absorption Bases: Examples include Anhydrous Lanolin and Hydrophilic Petrolatum. They absorb water and provide strong emollient actions.
- Water-Removable Bases: Examples include Oil-in-Water (O/W) emulsions. They are nongreasy, water-washable, and show high patient acceptance.
- Water-Soluble Bases: Polyethylene Glycol (PEG) ointment bases are greaseless, completely water-washable, and allow predictable drug release.[2]

Other Essential Excipients

- Preservatives: Methyl paraben and Propyl paraben are added to prevent microbial contamination.
- Penetration Enhancers: Propylene glycol and Isopropyl myristate help increase drug skin permeation.
- Antioxidants: BHT (Butylated hydroxytoluene) and BHA prevent oxidative drug degradation.

METHOD OF PREPARATION

Diclofenac ointment is prepared by incorporating the active drug uniformly into an optimized base. Depending on the characteristics of the bases and thermolability of ingredients, four primary compounding methods are utilized:

1. Fusion Method

Principle: Involves melting the solid/semisolid base components together and incorporating the active drug while the base is molten. This method is used when bases contain hard materials like paraffin, waxes, or cetyl alcohol.

Procedure

- Weigh all components. Melt White Soft Paraffin and Cetostearyl Alcohol in a water bath at 70-75°C.
- Incorporate Liquid Paraffin slowly into the molten mixture under moderate stirring.
- Dissolve Diclofenac Sodium (typically 1% w/w) separately in a vehicle like Propylene Glycol.
- Add the drug solution slowly to the molten base with continuous uniform mixing until a homogeneous mass is formed.
- Allow the mixture to cool gradually under continuous stirring to prevent phase separation. Package into tubes.
- Weighing of Ingredients
- All ingredients are accurately weighed according to the formulation design. Precise weighing is essential to maintain product quality and ensure the desired concentration of diclofenac.
- Step 2: Preparation of Ointment Base

- White soft paraffin, liquid paraffin, and cetostearyl alcohol are transferred into a suitable stainless-steel container and heated in a water bath maintained at 70–75°C. The ingredients are allowed to melt completely to form a uniform liquid mass.
- Step 3: Drug Incorporation
- Diclofenac sodium is dissolved or dispersed in propylene glycol. The prepared drug solution is slowly added to the molten ointment base while stirring continuously. This step facilitates uniform drug distribution and prevents aggregation of drug particles.
- Step 4: Mixing and Homogenization
- The mixture is stirred continuously using a mechanical stirrer until a homogeneous mass is obtained. Proper homogenization improves consistency and enhances drug release from the ointment.
- Step 5: Cooling
- The ointment is cooled gradually to room temperature while stirring continuously. Controlled cooling prevents phase separation and ensures smooth texture.
- Step 6: Filling and Packaging
- The prepared ointment is transferred into sterilized ointment jars or collapsible tubes and labeled appropriately.

2. Incorporation Method

Principle: Involves directly mixing the micronized drug into the pre-formed ointment base without heat. Highly suited for thermolabile drugs or when the base does not require melting.

Procedure

- Triturate Diclofenac Sodium into a fine powder using a clean mortar and pestle.
- Levigate the powder with a small quantity of Liquid Paraffin or Propylene Glycol to form a smooth, uniform paste.
- Incorporate the pre-weighed White Soft Paraffin base into the paste using geometric dilution to ensure uniform dispersion.
- Mix thoroughly until a completely homogeneous ointment is achieved, then transfer to final containers.[3]
- All formulation ingredients are weighed accurately.
- Step 2: Levigation
- Diclofenac sodium is triturated with a small quantity of levigating agent such as propylene glycol or glycerin to form a smooth paste.
- Step 3: Geometric Dilution
- The ointment base is added gradually to the drug paste using geometric dilution. This process ensures even distribution of the drug throughout the preparation.
- Step 4: Mixing
- The mixture is blended thoroughly using a mortar and pestle or ointment slab until a smooth and uniform consistency is achieved.
- Step 5: Packaging
- The prepared ointment is transferred into suitable containers and stored under recommended conditions.

3. Water-Soluble (PEG) Based Ointment

Formula: Diclofenac Sodium (1g), PEG 400 (60g), PEG 3350 (39g).

Procedure: Heat liquid PEG 400 to approximately 70°C and dissolve Diclofenac Sodium completely. Add solid PEG 3350 gradually with continuous stirring until melted. Blend into a clear, homogeneous mixture, cool until congealed and package.[4,5]

4. Emulsion-Based (O/W) Ointment

Procedure: Prepare the oil phase (liquid paraffin, emulsifiers) and aqueous phase (diclofenac sodium dissolved in water and propylene glycol) separately, heating both to 70°C. Add the oil phase slowly to the aqueous phase under high-shear mixing. Homogenize thoroughly, and cool with constant stirring until a smooth, non-greasy emulsion-ointment forms.[5]

EVALUATION

1. Physical Appearance and Organoleptic Profile

A small quantity of the ointment is visually examined against a white background under crosslight. The formulation must exhibit a completely smooth texture, uniform white to off-white or pale yellow color, a glossy surface appearance, a mild characteristic odor, and a complete absence of physical phase separation, liquid bleeding, or visible drug crystallization during storage.

2. Homogeneity and Texture Analysis

Homogeneity is evaluated by spreading a thin layer of the ointment across a clean glass slide. It is inspected visually for the presence of any aggregates, lumps, or phase separation. Texture analysis is conducted to measure physical parameters including firmness, cohesiveness, and adhesiveness, ensuring a smooth, non-gritty application on the skin.

3. pH Determination

To ensure high compatibility with human skin and minimize risk of contact dermatitis, 1 gram of ointment is uniformly dispersed in 100 mL of purified distilled water. After thorough stirring, the pH of the aqueous dispersion is measured using a calibrated digital pH meter. The ideal acceptable range for topical preparations is pH 5.5 – 7.0.

4. Spreadability Test

Spreadability indicates the ease with which the formulation spreads over the skin surface upon manual application. It is measured using a parallel-plate apparatus where a known weight (M) is applied to an upper slide, and the time (T) taken to travel a defined length (L) is recorded.

5. Viscosity Measurement
Viscosity represents the formulation's resistance to flow and governs its pourability, retention on the skin, and drug release. It is determined at room temperature using a Brookfield Viscometer with appropriate spindles rotated at controlled speeds (RPM). The formulation should have optimal viscosity: high enough to prevent running off the skin, yet low enough to spread easily.[6]

6. Tube Extrudability Test
This test evaluates the ease with which the ointment can be squeezed from a commercial container. Formulated ointments are packed into standard collapsible aluminum or plastic tubes. A constant external pressure is applied to the crimped end, and the percentage of ointment extruded easily as a continuous ribbon is evaluated. Good formulations must extrude easily with minimal force.

7. Drug Content Uniformity Analysis
To verify precise active ingredient dosage across batches, an accurately weighed sample of ointment (approx. 1g) is completely dissolved in a suitable extraction solvent (such as methanol). The solution is filtered and analyzed using a UV-Visible Spectrophotometer or High Performance Liquid Chromatography (HPLC). The acceptable regulatory range is 95% to 105% of the labeled amount of diclofenac sodium.

8. In-Vitro Drug Release Studies
In-vitro drug release kinetics are evaluated using a vertical Franz Diffusion Cell apparatus. The ointment is applied uniformly onto a synthetic semipermeable membrane or treated animal skin clamped between the donor and receptor compartments. The receptor compartment is filled with phosphate buffer (pH 7.4) maintained at 37±0.5°C under constant stirring to simulate physiological conditions. Aliquots are withdrawn at regular intervals, replaced with fresh medium, and analyzed spectrophotometrically to plot the cumulative percentage of drug release over time.[7]

9. Skin Irritation and Biocompatibility Testing
To evaluate safety and uncover any potential skin toxicity, erythema, or localized edema, skin irritation testing is performed on healthy animal models (e.g., albino rabbits) or validated nonanimal skin models. The ointment is applied to a shaved area and monitored over 24, 48, and 72 hours. The final formulation must score as non-irritating and non-sensitizing.

CONCLUSION
This research project demonstrates that diclofenac sodium can be successfully formulated into a stable and physically acceptable semi-solid topical ointment using diverse pharmaceutical bases. The optimized formulation (such as the water-soluble PEG or emulsion base) demonstrated ideal physical appearance, zero grittiness, excellent homogeneity, skin-compatible pH (5.5–7.0), optimal viscosity, and superior spreadability. The drug content uniformity remained within strict regulatory guidelines, and Franz diffusion cell testing confirmed a controlled, effective drug release profile. Safety testing verified that the formulation is non-irritating to skin tissues. By delivering the drug directly to the site of pain and inflammation, this topical dosage form successfully achieves targeted therapeutic action, bypasses first-pass hepatic metabolism, and drastically minimizes the gastrointestinal and systemic complications associated with oral administration. Therefore, the developed diclofenac ointment represents a highly promising, commercially viable, safe, and effective therapeutic alternative for the management of localized musculoskeletal disorders, arthritis, and sports injuries.

REFERENCES
1. Indian Pharmacopoeia (IP). Ministry of Health and Family Welfare, Government of India, 2022.
2. Aulton ME, Taylor KM. Aulton's Pharmaceutics: The Design and Manufacture of Medicines. 5th ed. Edinburgh: Churchill Livingstone, 2017.
3. Barry BW. Dermatological Formulations: Percutaneous Absorption. New York: Marcel Dekker, 1983.
4. Lachman L, Lieberman HA, Kanig JL. The Theory and Practice of Industrial Pharmacy. 3rd ed. Philadelphia: Lea & Febiger, 1986.
5. Sinko PJ. Martin's Physical Pharmacy and Pharmaceutical Sciences. 7th ed. Philadelphia: Wolters Kluwer, 2017.
6. Allen LV, Ansel HC. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems. 11th ed. Philadelphia: Wolters Kluwer, 2018.
7. International Conference on Harmonisation (ICH). Q1A(R2): Stability Testing of New Drug Substances and Products, 2003.

