International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Formulation & Evaluation Combination of Anti-Inflammatory & Skeletal Muscle Relaxant Gel

Ms. Shraddha Haridas Mahabole[1], Dr. Balakrishna Tiwari[2], Ms. Mahevish Samir Ahmad Hudewale[3], Ms. Neha Bhimrao Harihar[4], Ms.Vaishnavi Ramchandra Hatture[5]

[1]Assistant Professor, Department of Pharmaceutical Quality Assurance, Amepurva Forum Nirant Instiute of pharmacy Boramani Solapur, Maharashtra, India
[2]Principal, Department of Pharmaceutical Chemistry, Amepurva Forums Nirant Institute of Pharmacy, Solapur, Maharashtra, India
[3, 4, 5]B Pharmacy, Amepurva Forum NirantInstiute of pharmacy BoramaniSolapur, Maharashtra, India

Abstract

This study focuses on developing a topical gel formulation that combines a nonsteroidal anti-inflammatory drug (NSAID) and a muscle relaxant to manage musculoskeletal pain and inflammation. The gel's physicochemical properties, including spreadability, pH, and viscosity, were evaluated to ensure optimal performance. The solution showed good spreadability, an ideal viscosity for user-friendliness, and a pH appropriate for skin application. In investigations on skin irritation, there were few negative reactions, suggesting acceptable tolerance. A topical gel containing NSAID and muscle relaxant offers a promising treatment option for musculoskeletal disorders by reducing systemic adverse effects and reducing localised pain. There may be clinical uses for this formulation in the treatment of ailments like sports injuries, muscle spasms, and lower back discomfort. The created gel composition offers patients with musculoskeletal pain and inflammation a practical and efficient therapeutic choice. Systemic exposure and any adverse effects are reduced by the gel's direct delivery of the active components to the site of action. The clinical efficacy and safety of this formulation need to be investigated further.

Keywords: Anti-inflammatory, Muscle relaxant properties, Topical gel formulation, Evaluation parameters

INTRODUCTION

Topical drug administration methods are becoming more and more common, and a number of medications have been effectively administered by this route for both systemic and local activity. For a long time, the idea of delivering drugs through the skin has shown promise because to its accessibility, broad surface area, extensive exposure to the lymphatic and circulatory networks, and non-invasive nature. Topical formulation reduces gastrointestinal irritation, stops the liver from metabolising the medicine, and increases the drug's bioavailability. Because of the first pass effect, only 25–45% of the oral dose enters the bloodstream, meaning that topical treatments work directly at the site of action.

These issues have been avoided by designing the gel composition for topical use[1]. A gel structure network is made up of both organic macromolecules and inorganic particles. Permanent covalent bonds hold chemical gels together. Conversely, weaker and reversible secondary intermolecular forces such hydrogen bonding, electrostatic interactions, hydrophobic interactions, and Vander Waals forces hold physical topical gels together[2, 3,]. Increased viscosity brought on by interlacing and the ensuing internal friction are the causes of the semisolid state. To create crystalline and amorphous regions throughout the system, a gel can also be made up of twisted, matted strands that are usually held together by stronger Vander Waals forces[4]

Ideal Properties of Topical Gels:

I. The gel should be clear and homogenous.
II.The gel should split easily if you shear it or apply force while the container is shaking..
III. The gel should be inert.
IV. The gel should not be sticky.
V. The gel should never interact with other formulation components.
VI. The gel should be stable.
VII. The gel shouldn't irritate the skin or any area where it is applied..
VIII. The viscosity is optimum.
IX. It should have antimicrobial activity[5]

Gel

A gel is a two-component, cross-linked, three-dimensional network made up of structural components separated by a sufficient but proportionately huge volume of liquid to create an endlessly rigid network structure that holds the liquid continuous phase inside immobilised.

MATERIALS AND METHODS

MATERIALS

Diclofenac sodium, Eperisone hydrochloride, Carbopol 934 , Menthol, Propylene glycol, Polyethylene glycol, Triethanolamine, Methyl paraben (Amepurva Forums Nirant Institute of Pharmacy).

METHOD FOR FORMULATION OF TRANSDERMAL GEL

Each of the four batches that were made used carbopol. Before adding penetration enhancers such propylene glycol to the gel base, a precisely weighed amount of carbopol 934P was stirred in water for roughly 20 minutes to ensure even mixing. Diclofenac sodium and Eperisone hydrochloride dosages were precisely measured. With caution to prevent air entrapment, the medication was introduced to the polymer at a speed of 500 rpm. Once the gel was created, tiny quantities of triethanolamine were added to modify its pH. The final volume was then adjusted by adding methyl paraben, menthol, and PEG (polyethylene glycol). Different formulations were made according to the information listed in Table 1[6].

Table 1: Formulation of preparation of Diclofinac sodium and Epiriosone Hydrochloride Transdermal gel.

Ingredients	F1	F2	F3	F4
Diclofenac Sodium (gm)	1.0	1.0	1.0	1.0
Eperisone hydrochloride (gm)	1.0	1.0	1.0	1.0
Carbopol 934P (gm)	1.0	1.5	2.0	1.5
Menthol (gm)	0.5	0.5	0.5	0.5
Propylene glycol (ml)	10.0	10.0	10.0	10.0
Polyethylene glycol (ml)	7.00	7.00	7.00	7.00
Methyl paraben (gm)	0.15	0.15	0.15	0.15
Triethanolamine (ml)	0.5	0.8	1.0	0.6
Distilled water (ml)	QS	QS	QS	QS

EVALUATION OF GEL

1. Appearance:

Color is important when it comes to patient acceptability. The generated gels were visually inspected for clarity, color, and particle presence.

2. PH

Since the pH of gel causes skin discomfort, a digital pH meter was used to measure the gel's pH precisely. Avoid using items with an alkaline pH if you have sensitive skin. Additionally, skin permeability depends on pH [7].

3. Homogeneity:

The homogeneity of each created gel was confirmed by visual inspection after the gels were placed in the container. They were inspected to see how they appeared and whether any aggregates were present.

4. Consistency

In order to estimate the consistency of the prepared gels, a cone that was linked to a holding rod was dropped from a predetermined distance of 10 cm so that it would land in the middle of the glass cup that contained the gel. From the gel's surface to the cone's tip inside the gel, the penetration of the cone was precisely measured. Afterten seconds, the cone's total distance travelled during that time was recorded [8].

5. Spreadability:

The spreadability of the formulation was determined using a glass slide apparatus, where the time taken for the upper slide to slide over the lower one under a specified load (50g) was measured, and the spreadability was calculated using a formula.

$S = M . L / T$

Where M = wt. tied to upper slide

L = length of glass slides

T = time taken to separate the slides[9]

6. Skin irritation test:

The test for irritation was conducted on human participants. Each gel was applied to five individuals, and 1.0g of the prepared gel was placed in a 2-square-inch area on the back of the hand. We looked for sores or irritation on the participants.

7. Grittiness

Under a light microscope, all of the prepared gels were examined for the existence of any pieces; however, no discernible particle debris was observed. Therefore, it is clear that the gel formulation satisfies the requirements for gritiness and particle matter freedom that are needed for any topical medication.

8. Stability

The optimized formulation F4 underwent stability testing over a period of one month in compliance with ICH guidelines. The evaluation was carried out under two storage conditions 25 ± 2°C with 60 ± 5% relative humidity and 40 ± 2°C with 75 ± 5% relative humidity. Following one month of storage, the formulation was assessed for any alterations in physical appearance, pH, drug content, and in-vitro diffusion characteristics, as per the previously described methods.[8]

9. Washability

To assess the washability of the gel, approximately 1 gram of the formulation was evenly applied on a marked area (around 4 cm^2) of the skin, usually the forearm. After allowing the gel to remain undisturbed for 15 minutes to simulate actual application conditions, the area was rinsed under running tap water for 1 minute without using any soap or scrubbing.

RESULT

PRE FORMULATION STUDY

1. Solubility profil.

Diclofenac sodium is freely soluble methanol , soluble in ethanol, sparingly soluble in water.
EperisoneHCl is freely soluble in methanol, ethanol, water.

2. Melting pointdetermination .

The melting point of Diclofenac sodium is 285°C.
The melting point of Eperisonehydrochloride is 170°C

3. FTIR

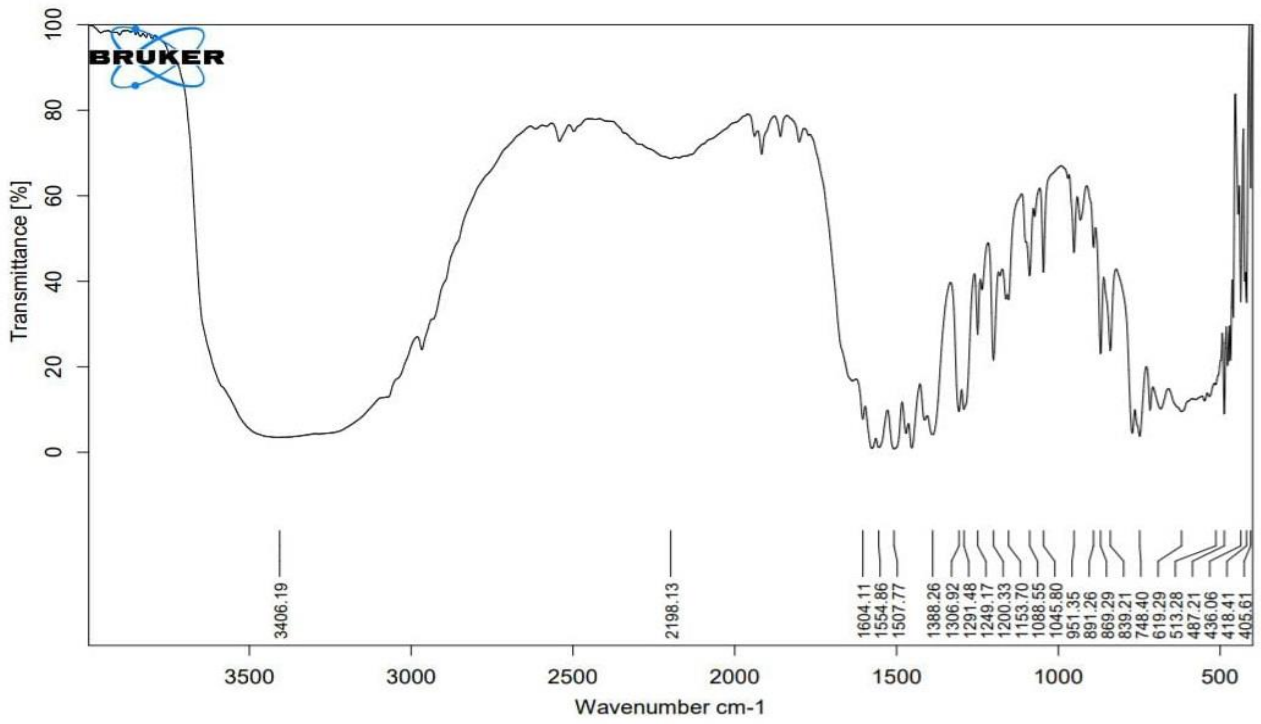

Fig1: IR Spectroscopy of Diclofenac Sodium

Wavenumber (cm^{-1})	**Assignment**	**Functional Group**
~3406 (not labeled clearly)	O–H stretching (broad)	Phenolic O–H or possibly H-bonded N–H
~2920–2850	C–H stretching (aliphatic or aromatic)	Alkyl or aryl C–H groups
2198	Possible triple bond stretch (C≡C or C≡N), or artifact	Not typically present in Diclofenac
~1604, 1570	C=O asymmetric stretching and aromatic C=C stretching	Carboxylate ion & aromatic ring
~1500–1450	C=C stretching	Aromatic rings
~1300–1200	C–N stretching and/or C–O stretching	Aromatic amines or esters
~1150–1000	C–Cl stretching	Aryl chloride (Diclofenac contains Cl)
~850–600	Aromatic C–H out-of-plane bending	Mono-substituted or disubstituted benzene
~500–400	Fingerprint region	Skeletal vibrations

Table 2: Characteristics IR spectroscopy of Diclofenac Sodium

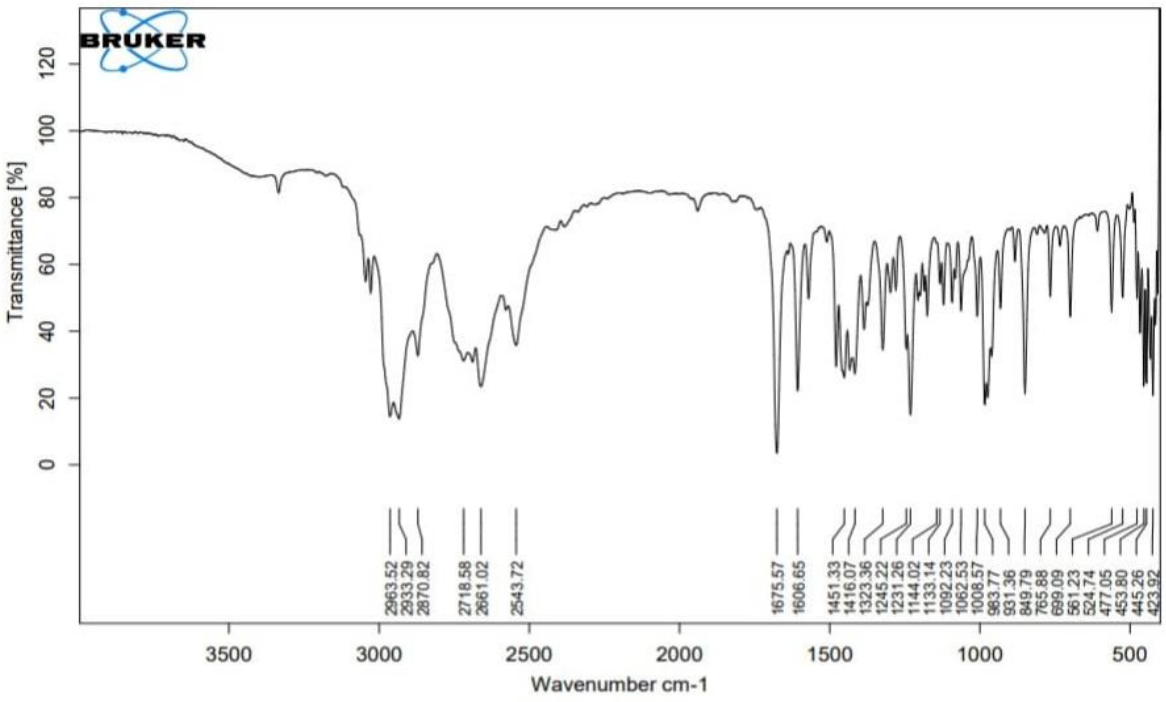

Fig 2: IR spectroscopy of Eperisone Hydrochloride

Wavenumber (cm^{-1})	Assignment	Functional Group
~2933, 2870, 2852	C–H stretching (alkyl groups)	Aliphatic C–H
~2718	Possibly N–H stretching or aldehydic C–H	Secondary/Tertiary amine or aldehyde
~2543	Possibly weak overtone or impurity	—
1675, 1606	C=C or C=O stretching, possibly aromatic ring	Aromatic or carbonyl (C=O) group
1450–1350	C–H bending (methyl/methylene)	Aliphatic groups
1235–1000	C–N and C–O stretching	Amine or ether functional groups
900–600	Aromatic C–H bending	Aromatic ring
500–400	Fingerprint region	Skeletal vibrations

Table 3: Characteristics IR spectroscopy of Eperisone Hydrochloride

Evaluation of Transdermal gels:

Formulation	F1	F2	F3	F4
Color	White	White	White	White
Homogeneity	Homogeneous	Homogenous	Homogenous	Homogenous

Texture	Smooth	Smooth	Smooth	Smooth
Washability	Washable	Washable	Washable	Washable

Table 4 : Colour, Homogeneity, Texture, Wshability

Sr. No.	**1**	**2**	**3**	**4**
Batch No.	F1	F2	F3	F4
Observation pH	6.7	6.8	7.2	7

Table 5: pH for Formulation

Formulation	**F1**	**F2**	**F3**	**F4**
Spreadability(gm.cm/sec)	1.21	1.31	1.25	1.23
Grittiness	No	No	No	No

Table 6: Spreadability (gm.cm/sec),Grittiness

Skin irritation test:

The optimized gel formulation (selected from F4 based on in-vitro diffusion studies) showed no irritation or erythema in human volunteers during skin irritation testing, indicating good skin tolerability.

Stability:

The optimized formulation stability after one month under storage condition was observed. The formulation's stability and performance were assessed by monitoring changes in its physical characteristics, acidity, active ingredient concentration, and release profile. The stability of formulated gel was stable.

CONCLUSIONS:

The CarbopoL 934P-based gel formulation (F4) containing Diclofenac sodium and Eperisone hydrochloride demonstrated optimal physicochemical properties, including good spreadability, consistency, homogeneity, and stability. With no skin irritation observed, this formulation shows promise as a topical drug delivery system for effective management of musculoskeletal pain and inflammation. The water-soluble nature of Carbopol 934Pmakes it an ideal candidate for developing topical gels with wider clinical applications.

REFERENCES:

[1] PoonamKamate, GhanshyamPotadar, VinayakGhunake,,Dr.PranjalChougule, Dr. NileshChougule . Formulation And Evaluation Of Skeletal Muscle Relaxant Topical Gel, 2024 IJCRT | Volume 12, Issue 8 August 2024 | ISSN: 2320-2882.

[2] Cevc G, Gebauer D, Stiber J, Schatzlein A, Blume G.: Ultra flexible vesicles, transfersomes, have a meagre pore penetration resistance and transport therapeutic amounts of insulin across the intact mammalian skin, Biochemical et Biophysical Acta, 1998, 1368; 201-215.

[3]Trommer H, Neubert RH: Overcoming the stratum corneum: the modulation skin penetration, skin pharmacology and physiology,2006,19:106-121.
[4]Quinones, D., et al., Formulation and characterization of Nystatin gel, PRHSJ Vol. 27 No. 1, March 2008.
[5] Karande P, Mitragotri S: Enhancement of transdermal drug delivery via synergistic action of chemicals, Biochimica et Biophysica Actas,2009, 1788:2362-237.
[6]AshutoshTiwari , Puja Bag , MrinmoySarkar , VineyChawla , and Pooja A. Chawla ,Formulation, validation and evaluation studies on metaxalone and diclofenac potassium topical gel.Environmental Analysis Health and Toxicology 2021, 36(1):e2021001.
[7]Michaels AS, Chandrasekaran SK, Shaw JE. Drug permeation through human skin: theory and in vitro experimental measurement. AIChE J 1975;21(5):985-996.
[8] SatyabrataBhanja, P.KishoreKumar ,Muvvala Sudhakar1, Arunkumar Das. Formulation and evaluation of Transdermal gels.Journal of Advanced Pharmacy Education & Research Jul-Sept 2013 Vol 3 Issue 3.
[9]Garg A, Aggarwal D, Garg S, Singla AK. Spreading of semisolid formulations: an update. Pharm Tech 2002;26(9):84-105.