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Research Article

Formulation And Evaluation of Quetiapine Fumarate Transdermal Patch

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ABSTRACT

The present study was aimed at the formulation and evaluation of transdermal patches of Quetiapine fumarate to enhance its bioavailability and provide sustained drug release for improved therapeutic efficacy. Quetiapine fumarate, an antipsychotic agent with extensive first-pass metabolism and limited oral bioavailability, was selected as a suitable candidate for transdermal drug delivery. Patches were prepared by the solvent casting technique using polymers such as HPMC 15 cps, ethyl cellulose, and sodium carboxymethyl cellulose, with PEG 400 and glycerine as plasticizers, DMSO as a permeation enhancer and methanol: water (1:2). The formulated patches were evaluated for physicochemical parameters including thickness, weight uniformity, folding endurance, moisture content, and drug content uniformity. FTIR analysis confirmed the absence of drug–excipient interactions, indicating compatibility of the formulation components. In vitro drug release studies were carried out using phosphate buffer solution (pH 7.4) to assess drug release behaviour. Among all the prepared formulations, F4 was optimized, showing uniform thickness, adequate flexibility, good stability, and 90% drug content. In vitro diffusion studies revealed a sustained release profile with 82% cumulative drug release at 12 hours. Release kinetics indicated that the formulation followed the Higuchi model and the Hixson–Crowell model suggesting diffusion-controlled release with surface area–dependent dissolution. The findings confirm that Quetiapine fumarate can be effectively delivered through a transdermal patch system, offering advantages such as bypassing first-pass metabolism, reducing dosing frequency, and improving patient compliance. Thus, the developed formulation holds promise as a potential alternative to conventional oral therapy in the management of psychotic disorders.

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INTRODUCTION

The term "Transdermal" originates from the root "trans" meaning through, across, or beyond, and "derma" meaning skin. The concept of transdermal drug delivery was developed to address the limitations associated with oral drug administration. Transdermal systems have emerged as a preferred dosage form due to their multiple advantages over conventional delivery routes. They allow patients to administer medications conveniently and painlessly without the need for professional assistance.[1] A transdermal drug delivery system is a self-contained and discrete dosage form that, when applied to intact skin, ensures the controlled release of a drug into systemic circulation.[1] Commonly referred to as transdermal patches, these systems are specifically designed to deliver therapeutically effective amounts of drugs across the skin barrier. By bypassing the gastrointestinal tract, they not only avoid first-pass metabolism but also improve patient compliance, providing a significant advantage over oral and injectable routes. [1] A transdermal patch is a medicated adhesive system designed to deliver a precise amount of drug across the skin and into systemic circulation. One of its key advantages is that therapy can be terminated immediately by removing the patch whenever drug input is no longer required. It also enables reduced dosing frequency, which is particularly beneficial for drugs with a short biological half-life, thereby improving patient compliance. Despite these advantages, the effectiveness of transdermal systems is limited by the barrier function of the skin, which restricts the range of drugs that can be administered. Nevertheless, several therapeutic agents have been successfully delivered through this route, making transdermal systems a significant advancement in controlled drug delivery technology. [1] The first adhesive transdermal patch, Transderm Scop® developed for motion sickness using scopolamine, received FDA approval in 1979. This was followed by the approval of nitro-glycerine patches in 1981 and the introduction of nicotine patches in 1991. Since then, transdermal drug delivery systems have gained significant attention in pharmaceutical research due to their therapeutic benefits over oral administration, including enhanced patient compliance and improved pharmacokinetic profiles.[2] Transdermal patches provide several advantages: enhanced patient compliance, ease of application and removal, reduced systemic side effects, and stable plasma drug concentrations. Over the years, advances in polymer science, skin penetration technology, and drug-carrier systems have led to the development of transdermal patches for a wide range of therapeutic agents, including hormones, analgesics, cardiovascular drugs, and central nervous system (CNS) acting drugs.

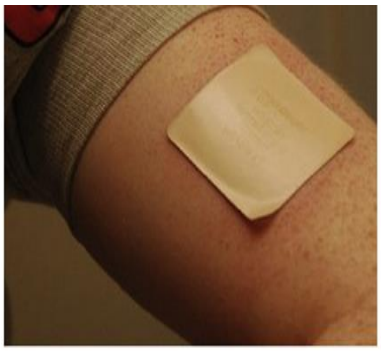

Fig.1: Transdermal Patch [3]

ADVANTAGES:[4]

- Bypasses first-pass metabolism and degradation by gastrointestinal enzymes, thereby improving the bioavailability of certain drugs.
- Enables self-administration without the need for medical supervision, enhancing patient convenience.

- Provides a sustained and controlled release of the drug into systemic circulation, maintaining steady plasma drug concentrations.
- Offers a non-invasive and painless alternative to parenteral routes of drug delivery.
- Minimizes systemic side effects and adverse reactions compared to conventional oral administration.
- Prevents issues of gastrointestinal incompatibility such as irritation, degradation, or poor absorption of drugs.
- Ensures precise dosing and promotes enhanced therapeutic efficacy by maintaining steady plasma drug concentrations.
- Provides a durable and reliable mode of treatment suitable for chronic therapy.
- Enhances patient compliance due to convenience and comfort.
- Reduces the need for frequent dosing, which is particularly beneficial for drugs with short half-lives.

DISADVANTAGES:[4]

- Some patients may experience contact dermatitis or skin irritation at the site of application due to one or more patch components, which can lead to discontinuation of therapy.
- TDDS is generally unsuitable for ionic drugs, as their permeability through the skin barrier is very limited.
- There is a risk of allergic reactions to adhesives, excipients, or enhancers present in the patch formulation.
- Transdermal systems are limited to drugs with appropriate molecular size and physicochemical characteristics that enable passage through the skin barrier.
- Transdermal delivery is applicable only to potent drugs that require small doses, as the skin cannot accommodate high drug flux.
- They are unsuitable for medications that require high doses or very high blood levels to be effective.

Types of Transdermal Drug Delivery Systems [5]

Transdermal drug delivery systems can be categorized based on the mechanism of drug incorporation and release. The major types include:

a) Single-Layer Drug-in-Adhesive System

b) Multi-Layer Drug-in-Adhesive System

c) Vapour Patch

d) Reservoir System

e) Matrix System

Drug-in-Adhesive Matrix System

Matrix-Dispersion System

f) Micro-Reservoir System

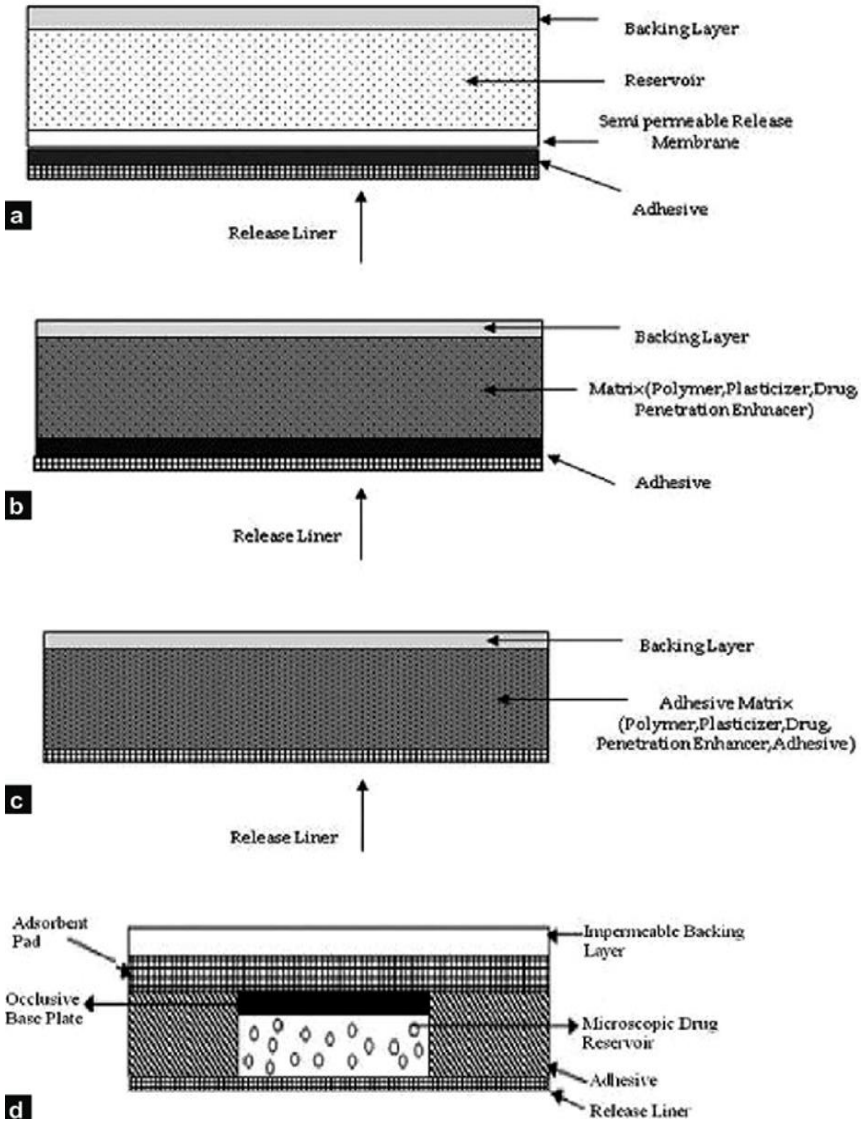

Fig.2. Types of transdermal patches a) Reservoir b) Matrix c) Drug-in-adhesive and d) Micro reservoir systems [6]

Methods of Preparation of Transdermal Drug Delivery Systems (TDDS) [7, 8]

Several techniques are employed to fabricate transdermal patches, depending on the nature of the drug, polymers used, and desired release characteristics. The commonly used preparation methods include:

A. Solvent Casting Technique

Transdermal patches can be prepared using the solvent casting method, a widely adopted technique for developing matrix-type drug delivery systems. In this process, a polymer solution is prepared by dissolving suitable film-forming polymers in an appropriate organic solvent system, often using continuous stirring to ensure uniformity. To enhance flexibility and mechanical strength of the film, a plasticizer is incorporated, while a permeation enhancer may also be added to facilitate drug transport through the skin. The active pharmaceutical ingredient is then gradually introduced into the polymeric solution and mixed thoroughly to achieve a homogeneous dispersion. This final solution is

carefully poured into pre-fabricated molds placed on a flat surface. To control the rate of solvent evaporation and ensure uniform film formation, the molds are covered with an inverted funnel or similar device. The solution is allowed to dry at room temperature for an extended period, typically 24 hours. Once dried, the formed films are carefully removed and cut into uniform patches of desired dimensions. These patches are kept in a desiccator to protect them from absorbing moisture before they are used. A thin layer of hypoallergenic adhesive may be applied to the outer surface to promote effective adhesion between the patch and the skin.

B. Asymmetric TPX Membrane Method

In this technique, a prototype transdermal patch is constructed using a heat-sealable polyester film (e.g., 3M type 1009) with a concave area (1 cm diameter) acting as the backing membrane. The drug formulation is applied within this concavity and sealed with an asymmetric TPX membrane; a polymer made of poly(4-methyl-1-pentene) using an adhesive.

Preparation of Asymmetric TPX Membrane: These membranes are fabricated using a dry/wet inversion technique. TPX is dissolved in a solvent mixture (cyclohexane and non-solvent additives) at 60°C. After 24 hours of stabilization at 40°C, the solution is cast on a glass plate and partially dried at 50°C for 30 seconds. The cast film is then immersed in a coagulation bath maintained at 25°C. After 10 minutes, the membrane is removed and dried in a circulating oven at 50°C for 12 hours.

C. Circular Teflon Mould Method

A polymer solution is prepared by dissolving the polymer in an organic solvent using different polymer ratios. The solution is split into two portions: one containing the drug and the other containing permeation enhancers. After combining both parts, a plasticizer (e.g., Di-n-butyl phthalate) is added. The mixture is stirred for 12 hours and then poured into a circular Teflon mold placed on a flat surface. An inverted funnel is used to regulate solvent evaporation under a laminar airflow (0.5 m/s). The films are dried for 24 hours and stored at 25 ± 0.5°C in a desiccator containing silica gel for another 24 hours to eliminate aging effects.

D. Mercury Substrate Method

In this method, the drug and plasticizer are mixed into a polymer solution and stirred for 10–15 minutes to achieve a consistent blend. The resulting dispersion is poured over a level mercury surface and covered with an inverted funnel to control the evaporation of the solvent.

E. Using IPM Membranes Method

The drug is mixed into a water-based system containing propylene glycol and Carbomer 940, then stirred with a magnetic stirrer for 12 hours to ensure uniform dispersion. The dispersion is then neutralized with triethanolamine to increase viscosity. For drugs with poor water solubility, a pH 7.4 buffer may be used to form a gel. The final gel is incorporated into IPM (Isopropyl Myristate) membranes to form the transdermal patch.

Components of transdermal drug delivery systems

1. Drug;

2. Polymer matrix;

3. Permeation enhancers;

4. Pressure-Sensitive Adhesives;

5. Backing membrane;

6. Release linear.

Drug

The drug is the central active ingredient in a transdermal drug delivery system, responsible for producing the intended therapeutic effect upon administration through the skin. For successful transdermal delivery, the drug must possess certain physicochemical properties that allow it to penetrate the skin barrier and reach systemic circulation efficiently.

- Extensive first pass metabolism.
- Narrow therapeutic window.
- Short half-life leads to the need for frequent dosing, which can result in poor patient compliance.
- Low molecular weight (less than 500 Daltons).
- Adequate solubility in oil and water (log P in the range of 1-3).
- Low melting point (less than 200°C).[9]

Polymer Matrix

Polymers form the structural foundation of transdermal drug delivery systems (TDDS) and play a vital role in ensuring their performance and safety. They are broadly classified into three categories: natural, semisynthetic, and synthetic. The selection of an appropriate polymer is a critical step in formulation development, as the properties of the polymer largely determine the drug release profile, stability, and overall efficiency of the system. [10]

Permeation Enhancers

Permeation enhancers are chemical compounds employed to increase the permeability of the stratum corneum in order to achieve effective therapeutic drug levels. These agents function by interacting with the structural components of the skin barrier, primarily proteins and lipids, thereby modifying their arrangement and reducing the barrier resistance. Such alterations in the lipid–protein matrix of the stratum corneum facilitate greater drug penetration. [7,8]

Pressure-Sensitive Adhesives

Pressure-sensitive adhesives (PSAs) play a crucial role in keeping the transdermal patch firmly adhered to the skin. They are designed to adhere with light finger pressure, maintain strong and consistent tackiness, and provide firm adhesion throughout the application period. Importantly, they should also be removable from the skin or other smooth surfaces without leaving behind any sticky residue.[8]

Backing membrane

The backing layer in a transdermal patch is selected based on its appearance, flexibility, and occlusive properties. A crucial factor in its design is the chemical resistance of the material, as it must withstand interaction with other components over the product's shelf life. It is also important to ensure compatibility with excipients, since continuous contact may lead to leaching of additives from the backing material or diffusion of the drug, permeation enhancers, or other excipients through the layer. [6]

Release Liner

The release liner serves as a protective covering for the transdermal patch during storage and is peeled off just before the patch is applied to the skin. Although it is not involved in drug delivery,

it is considered part of the primary packaging material due to its close contact with the patch components. Because it comes into direct contact with the drug matrix, the release liner must meet specific standards, particularly in terms of chemical stability and resistance to interaction with the drug, permeation enhancers, and moisture.[9]

MATERIALS AND METHODS

MATERIALS

Table1. List of equipment used

S. No	Instrument	Make	Model
1.	Analytical balance	Mitutoyo, Japan	ALE-223
2.	UV Spectrophotometer	Shimadzu	UV 1800
3.	Micropipette	Remi equipment Pvt ltd	Super plus Model
4.	Vernier Callipers	Vibration Meter Suppliers	EJS Model
5.	Magnetic stirrer	Remi equipment Pvt ltd	EIE-223ML
6.	Compact FT-IR Spectrometer	Bruker, US	ALPHA II

Table.2. List of materials used in the formulation and their category.

S No.	Materials	Category	Source
1.	Quetiapine fumarate	API	Aurobindo Pharma
2.	Hydroxy propyl methyl cellulose	Polymer	Research-Lab Fine Chem Industries
3.	Ethyl cellulose	Polymer	Bangalore Fine Chem
4.	Carboxy Methyl cellulose Sodium salt	Polymer	Research-Lab Fine Chem Industries
5.	Methanol	Solvent	Honeywell International
			India Pvt.Ltd
6.	Dimethyl Sulfoxide (DMSO)	Permeation Enhancer	S D Fine Chem Limited
7.	Polyethylene glycol 400	Plasticizer	Finar Reagents
8.	Glycerine	Humectant	Finar Reagents
9.	Sodium Hydroxide	Component of Phosphate Buffer	Sisco Research Laboratories Pvt.Ltd
10.	Potassium dihydrogen phosphate	Component of Phosphate Buffer	Avra Synthesis

METHODOLOGY:

UV spectrophotometric method

Preparation of standard stock solution

An accurately weighed 10 mg of Quetiapine Fumarate was placed into a 10 ml volumetric flask, and the volume was brought up to the mark using methanol as the solvent, resulting in a final concentration of 1000 µg/ml.

Preparation of working solution & Determination of λmax using UV spectrophotometer

- 1ml of standard solution was taken in 100ml volumetric flask and final volume was made up to 100ml using Methanol (10 µg/ml).
- The λmax of drug sample was determined by scanning 10ppm standard stock solution in the range from 200-400nm using Shimadzu-1800 UV spectrometer.

Construction of calibration curve by UV spectroscopy

From the working solution 2ml, 4ml, 6ml, 8ml and 10 ml i.e., a range of concentrations of 2-10 µg/ml were prepared and scanned using UV Spectrophotometer. Absorbance was measured at 208 nm.

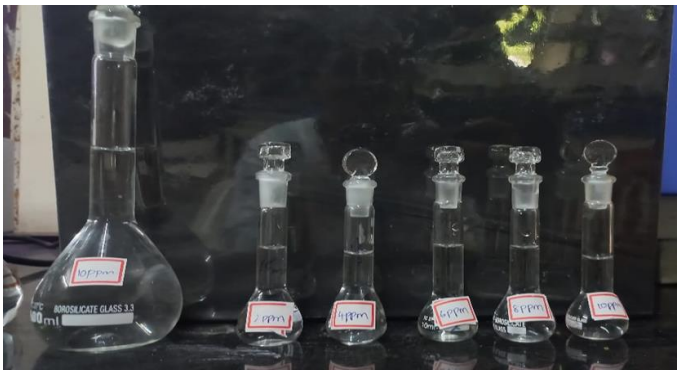

Fig.10. Picture showing working solution and range of concentrations of 2-10 µg/ml

Drug-excipient compatibility studies

- FTIR spectroscopy was performed to evaluate potential interactions between the pure drug Quetiapine fumarate and excipients incorporated in the optimized transdermal patch formulation. Precisely weighed quantities of both the pure drug and the patch formulation were dispersed in a minimal volume of liquid paraffin using a clean china dish and ground with a mortar and pestle to ensure homogeneity.

- A thin layer of the resulting dispersion was carefully applied onto clean, dry potassium bromide (KBr) or sodium chloride (NaCl) discs using a capillary tube. The discs were allowed to stand undisturbed until the solvent evaporated, leaving a uniform film of the sample on the disc surface.

- The prepared discs were then mounted in the sample holder of the FTIR spectrophotometer. The spectral data were obtained within a wavenumber range of 4000 to 400 cm^{-1}, using a resolution of 4 cm^{-1}.A background spectrum was recorded before scanning each sample to ensure precision.

- The recorded FTIR spectra were analyzed for the appearance, disappearance, or shifting of characteristic functional group peaks. These spectral variations were assessed to determine the presence of any drug–excipient interactions or entrapment of Quetiapine fumarate within the formulation matrix, indicative of a matrix-type transdermal patch structure.

Fig.11. Compact FT-IR Spectrometer

Preparation of Placebo patches

- To evaluate the film-forming properties, physical characteristics, and compatibility of different polymers for transdermal patch formulation prior to drug loading, placebo patches were prepared.

Materials Used:

- Polymers: HPMC 15 cps, Ethyl Cellulose (EC), Sodium Carboxymethyl Cellulose (Na CMC)
- Solvents: Methanol, Distilled Water

Formulation Trials:

1. Individual Polymer Films

- HPMC alone (in water)

2. Combination Films

- HPMC + EC
- HPMC + EC + Na CMC

Table.3 Formulation table of Placebo Patches

S.No	Ingredients	P1	P2	P3	P4	P5
1.	HPMC 15cps (mg)	355	205	250	200	200
2.	Ethyl cellulose (mg)	-	60	105	100	60
3.	Sodium carboxy methyl cellulose (mg)	-	-	105	50	30
4.	Methanol (ml)	-	5	5.0	5	5
5.	Water (ml)	12	5	8.50	10	10

Method of preparation of transdermal patch of quetiapine fumarate

Transdermal patches of Quetiapine fumarate were prepared using the solvent casting technique.

1. **Polymer Solution Preparation:** Required quantities of polymers — HPMC (15 cps), ethyl cellulose and sodium carboxymethyl cellulose — were accurately weighed and dissolved in a solvent mixture of methanol and water in a 1:2 ratio while continuously stirring using a magnetic stirrer to achieve a uniform solution.

2. **Drug and Excipient Incorporation:** Quetiapine fumarate was dissolved in the polymeric solution along with suitable excipients including Dimethyl sulfoxide (DMSO), Polyethylene glycol 400 (PEG 400)

and Glycerine. The solution was stirred thoroughly to achieve homogeneity. The prepared solution was kept aside overnight for removal of air bubbles.

3. **Casting:** The resulting solution was poured into a clean, leveled glass petri dish and allowed to dry at room temperature (or in a hot air oven at a controlled temperature if used) until the solvent completely evaporated.

4. **Patch Removal and Storage:** The dried film was carefully peeled off and stored in a desiccator until further evaluation.

Table.4. Formulation Table of Quetiapine fumarate transdermal patch

S.No	Ingredients	F1(%w/w)	F2(%w/w)	F3(%w/w)	F4(%w/w)	F5(%w/w)	F6(%w/w)
1.	Drug (mg)	25	25	25	25	25	25
2.	HPMC (15 cps) (mg)	10	8.75	10	10	10	10
3.	Ethyl cellulose(mg)	5	2.5	5	3	3.25	3.25
4.	Sodium carboxy methyl cellulose(mg)	0.75	1.5	1.6	1.5	1.6	1.6
5.	Dimethyl sulfoxide (ml)	-	-	-	0.075	0.1	0.125
6.	Polyethylene glycol 400 (ml)	0.06	0.06	0.05	0.04	0.025	0.025
7.	Glycerine (ml)	0.025	0.025	0.025	0.025	0.025	0.025
8.	Methanol: Water (1:2) (ml)	0.7	0.7	0.7	0.75	0.7	0.7

Evaluation tests for the prepared transdermal patches

- Thickness: The film's thickness was assessed at three distinct locations using a digital vernier caliper, and the average thickness was subsequently computed.

- Weight Consistency: For every formulation, three patches were chosen at random. During the weight variation assessment, three films from each batch were weighed separately, and the mean weight was determined.

- Folding Endurance: The folding endurance of the film was assessed by continuously folding a small strip of film (2cm x 2cm) at the identical spot until it fractured. Folding endurance was tested by determining the number of repeated folds the film could withstand at the same spot without tearing or cracking.

- Percentage Moisture Content: The films were weighed individually and placed in a desiccator containing fused calcium chloride at room temperature for 24 hours. After this period, the films were reweighed, and the percentage moisture content was calculated using the following formula:

% Moisture content = [(Initial weight - Final weight) / Final weight] * 100.

- Drug content determination: The uniformity of drug content of the transdermal film was determined, by means of a UV/VIS spectrophotometer method. A designated area (4 cm2) of the patch was excised and dissolved in 50 ml of phosphate buffer at pH 7.4 within a beaker, subsequently, the sample was placed in a shaking incubator for a period of 4 hours. Then, 1 ml of the solution was pipette out and transferred into a volumetric flask, with the volume adjusted to 10 ml using methanol. Appropriate dilutions were made using phosphate buffer (pH 7.4), filtered and analyzed for drug content using UV spectrophotometer.

In-vitro Drug release studies:

- An in vitro drug release study was conducted utilizing a setup similar to a Franz diffusion cell.
- The study was conducted using an eggshell membrane, as it closely mimics the human stratum corneum due to its high keratin content.
- The eggshell membrane is positioned in such a way that it can come into contact with the buffer present in the beaker. The membrane was properly prepared and stored in a phosphate buffer solution with pH 7.4 until use. This same pH 7.4 phosphate buffer was employed as the diffusion medium, filling the receptor compartment during the study. Then the 2*2 sq.cm patch was positioned within the egg shell membrane by placing the patch inside it.
- The receptor media was continuously agitated using a magnetic stirrer.
- Samples were withdrawn from the receptor compartment at fixed time intervals.
- Each time, 5 ml of the solution was collected and immediately replaced with an equal volume of fresh phosphate buffer (pH 7.4) to maintain sink conditions.
- The sampling schedule was at 5,10,15,30,45,60,120,180,240,300,360,480,600 and 720 minutes i.e., for 12 hrs.
- The collected samples were analyzed using U.V Spectrophotometer.

Fig.12. Arrangement similar to Franz Diffusion cell for In vitro drug release studies

RESULTS AND DISCUSSION

Determination of λ_{max} using UV-Spectrophotometer

The λ_{max} of Quetiapine fumarate in methanol was found to be 208 nm.

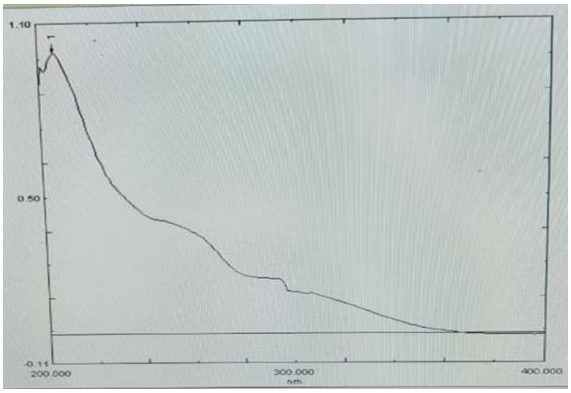

Fig.13.Spectrum of Quetiapine fumarate

Calibration curve of Quetiapine fumarate

Standard graph of Quetiapine fumarate was plotted using Methanol at 208 nm by taking Concentration on X-axis and Absorbance on Y-axis.

The R^2 was found to be 0.998.

Table.5 Calibration data of Quetiapine fumarate at 208 nm

Concentration (µg/ml)	Absorbance
2	0.267±0.021
4	0.476±0.020
6	0.648±0.022
8	0.825±0.020
10	0.988±0.017

n=3

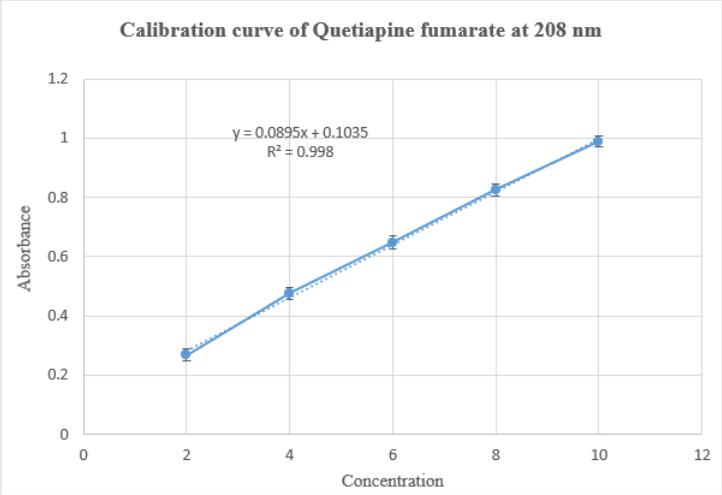

Fig.14. Calibration curve of Quetiapine fumarate at 208 nm (n=3)

Drug-Excipient compatibility studies

Table 6. FTIR Spectral Interpretation of Quetiapine Fumarate and Its Formulation

Wavenumber (cm^{-1})	Assignment	API	Patch formulation (F4)	Interpretation
~3410	O–H / N–H stretching (hydroxyl/amine)	3413	3417	Broad band retained; slight shift/broadening → hydrogen bonding with excipients / moisture; no loss of functional group.

2920–2850	Aliphatic C–H stretching (–CH_2/–CH_3)	2922, 2855	2923, 2854	Peaks preserved with negligible shift → aliphatic environment unchanged.
~1640–1630	C=O stretching (fumarate) / aromatic C=C	1632	1645	Small shift and broadening → interaction (H-bonding) with matrix; carbonyl remains intact (no chemical degradation).
~1250–1100	C–N / C–O / ether stretches (piperazine, ethoxy groups)	1162, 1079	1017–1162 (broad)	Intensity changes and band overlap with polymer C–O signals → drug peaks masked/partially merged indicating encapsulation/dispersion in polymer matrix.
~975–720	Out-of-plane aromatic C–H / ring deformations	976, 724	952, 721	Aromatic ring features retained → core aromatic/thiazepine structure preserved.
~650–500	C–S / ring skeletal vibrations	656–503 (multiple)	657–501 (multiple)	Skeletal and C–S bands present → thiazepine ring integrity maintained.

DISCUSSION:

- The FTIR spectra of Quetiapine fumarate and its optimized transdermal patch formulation revealed the retention of all major characteristic peaks of the drug, including O–H/N–H stretching, aromatic C–H, C=O (fumarate group), and C=C vibrations.
- Only slight shifts and peak broadening were observed in the formulation, particularly in the hydroxyl and carbonyl regions, which can be attributed to hydrogen bonding or weak physical interactions between the drug and excipients.
- Importantly, no new peaks or disappearance of major bands were detected, indicating the absence of chemical incompatibility.
- These results confirm that Quetiapine fumarate is successfully entrapped within the polymeric matrix without undergoing structural modification, supporting the suitability of the selected excipients for transdermal patch development.

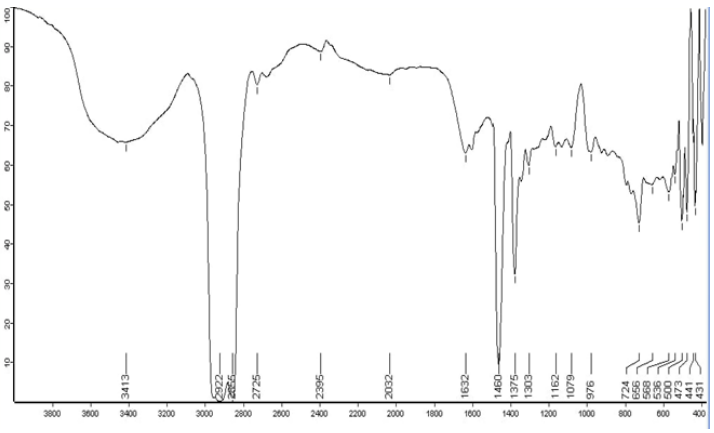

Fig.15. FTIR Spectra of Quetiapine fumarate API

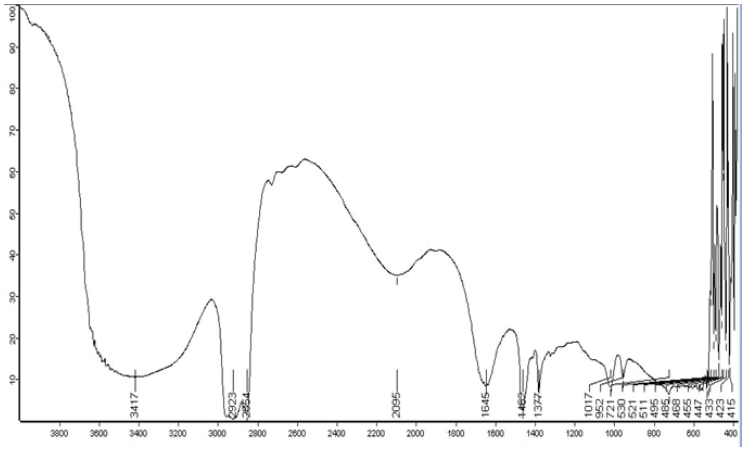

Fig.16. FTIR spectra of Quetiapine fumarate transdermal patch formulation

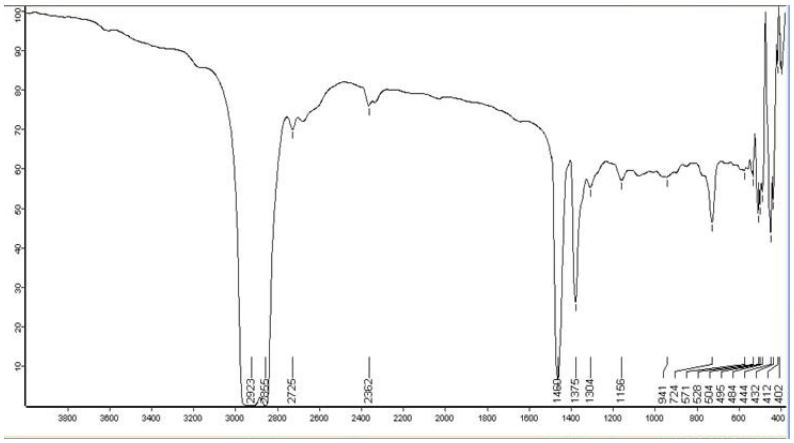

Fig.17. FTIR spectra of Hydroxy propyl methyl cellulose (15 CPS)

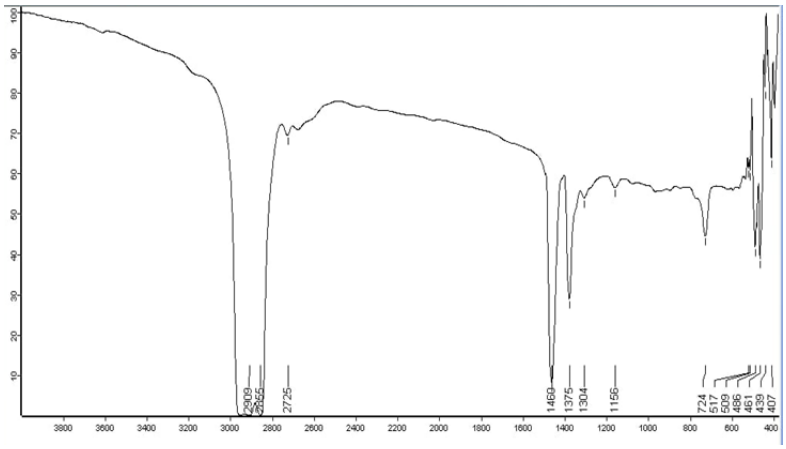

Fig.18. FTIR spectra of Ethyl cellulose

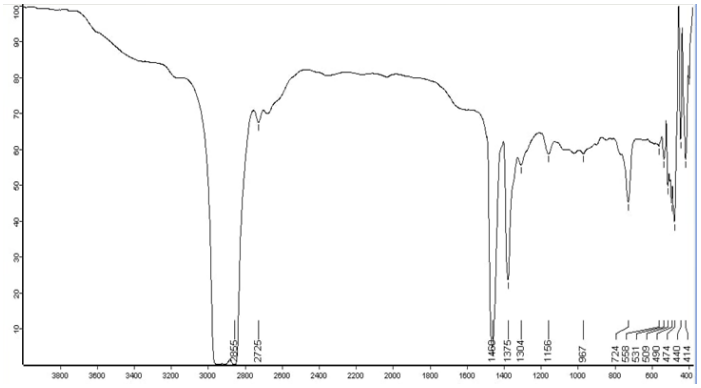

Fig.19. FTIR spectra of Sodium carboxy methyl cellulose

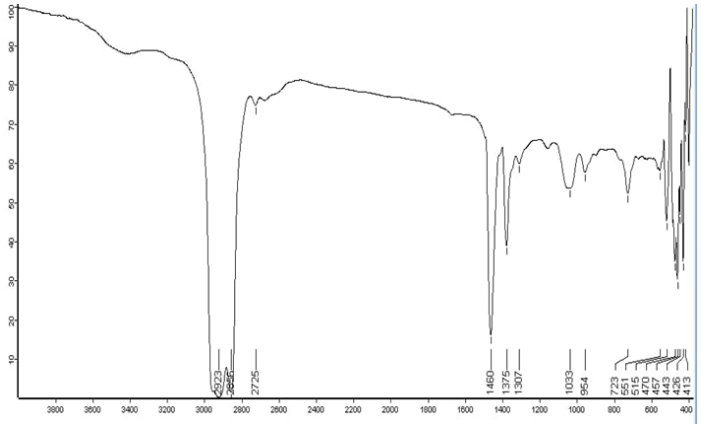

Fig.20. FTIR spectra of Dimethyl sulfoxide

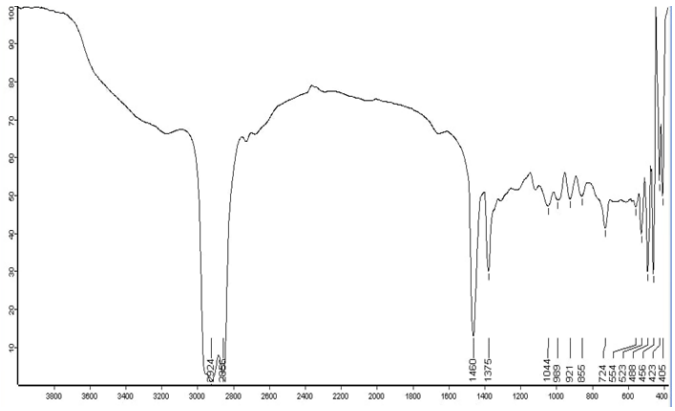

Fig.21. FTIR spectra of Glycerin

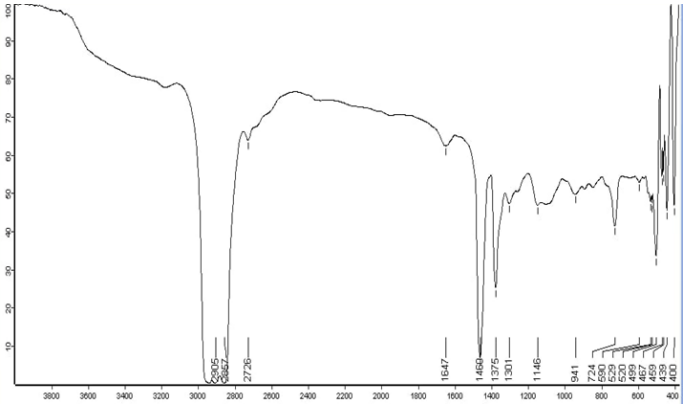

Fig.22.FTIR spectra of Polyethylene glycol 400

Fig.23. Optimized formulation (F4) transdermal patch

Evaluation of Quetiapine fumarate transdermal patch

Table.7 Evaluation tests

Formulation code	Weight variation(mg) (mean± SD)	Thickness(mm) (mean ± SD)	Folding Endurance (times)	Moisture content (%)	Drug content (%)
F1	80.6±0.027	0.35±0.012	>250	2.66±0.133	43.788±0.030
F2	79.3±0.021	0.21±0.015	>250	4.61±0.17	38.06±0.050
F3	61.6±0.020	0.29±0.010	>250	1.51±0.16	61.43±0.035
F4	88.6±0.022	0.22±0.010	>250	1.13±0.11	90.02±0.026
F5	92.1±0.011	0.32±0.012	>250	1.51±0.14	76.02±0.030
F6	116±0.016	0.26±0.016	>250	3.27±0.15	57.414±0.025

n=3

In-vitro drug release studies for Optimized Formulation (F4)

Table.8 In-vitro drug release studies (n=3)

S. No	Time (min)	% CDR
1	5	7.4808±1.10
2	10	9.4144±1.35
3	150	10.512±1.13
4	30	12.132±1.39
5	45	17.8392±1.62

6	60	20.5496±1.35
7	120	22.588±1.83
8	180	28.816±1.76
9	240	36.008±1.67
10	360	47.4024±1.96
11	480	57.7472±2.59
12	600	68.8896±1.69
13	720	82.1136±1.45

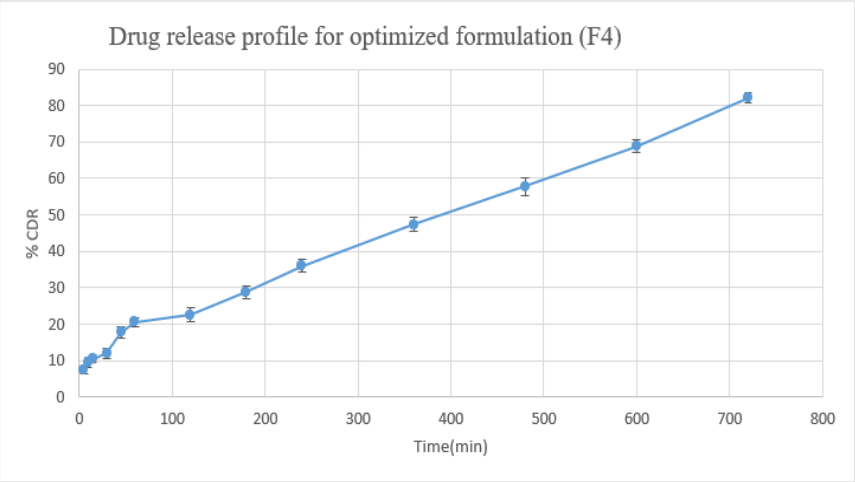

Fig.24. Graph showing Drug release profile for optimized formulation (F4) (n=3)

Kinetic Modelling of the Data obtained from Diffusion studies of Optimized Formulation(F4)

Table.9. Kinetic Modelling of Drug Release Data for Optimized Formulation (F4)

Model	Regression coefficients' (R^2)	Slope	Intercept
Zero order kinetics	0.9928	0.0997	10.461
First order kinetics	0.9595	-0.0009	1.9807
Higuchi model	0.9674	2.8358	- 2.7574
Hixson Crowell model	0.9825	-0.0024	4.5273
Korsemeyer Peppas model	0.9698	0.4752	0.4632

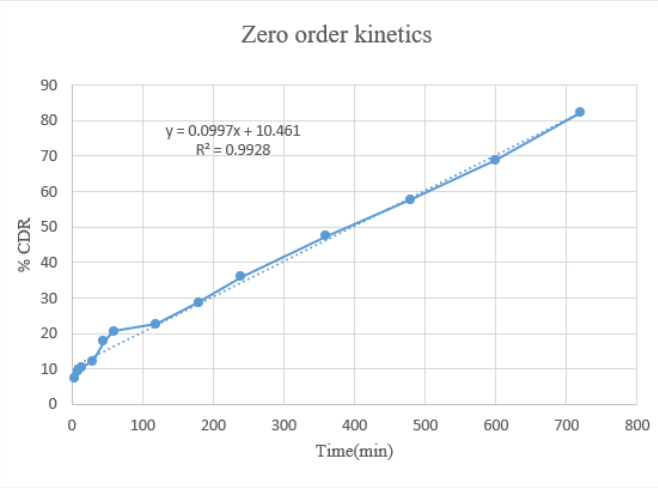

Fig.25. Graph showing Zero order kinetics

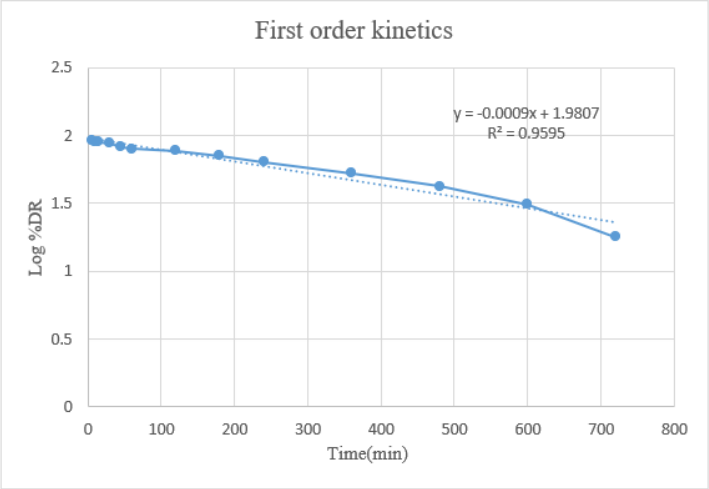

Fig.26. Graph showing First order kinetics

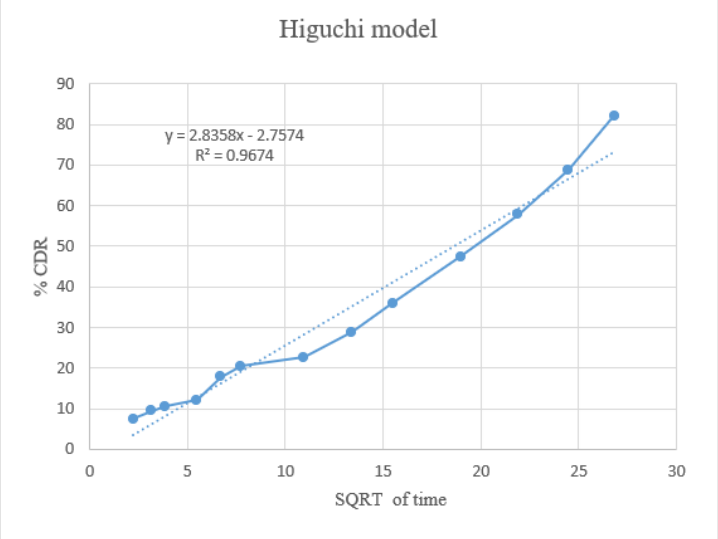

Fig.27. Graph showing Higuchi model

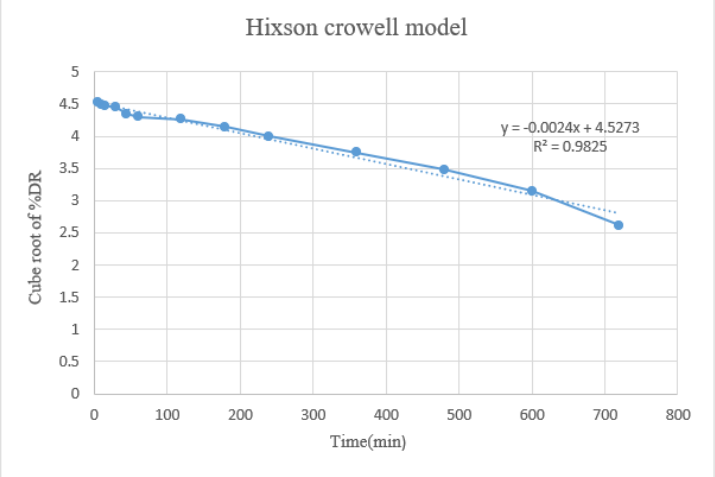

Fig.28. Graph showing Hixson Crowell model

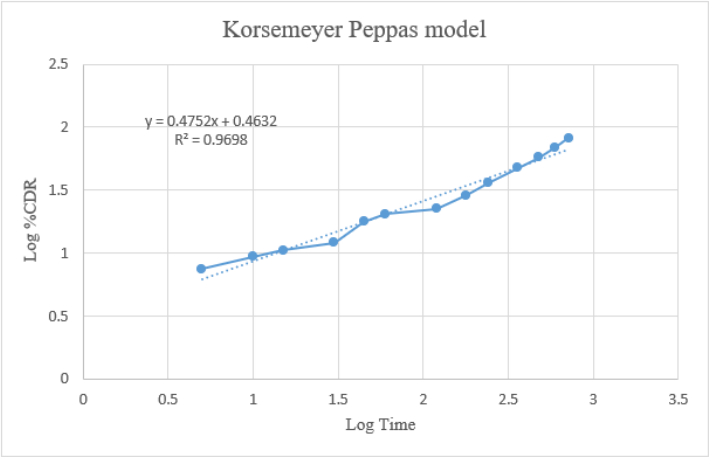

Fig.29.Graph showing Korsemeyer Peppas model

Stability studies for Optimized Formulation (F4)

Stability evaluation of formulation F4 was carried out under accelerated conditions of 40 °C and 75% relative humidity.

Table.10. Stability evaluation of formulation F4

Duration	Weight variation(mg) (mean± SD)	Thickness(mm) (mean ± SD)	Folding Endurance (times)	Moisture content (%)	Drug content (%)	In-vitro diffusion (CDR at 12 h) (%)
Initial (0)	88.6 ± 0.022	0.22 ± 0.010	>250	1.13 ± 0.11	90.02 ± 0.026	82.0 ± 1.2
1st month	88.4 ± 0.025	0.22 ± 0.011	>250	1.25 ± 0.12	88.40 ± 0.030	80.5 ± 1.4
2nd month	88.2 ± 0.028	0.23 ± 0.012	>250	1.34 ± 0.14	86.90 ± 0.036	78.2 ± 1.7
3rd month	88.0 ± 0.030	0.23 ± 0.013	>250	1.41 ± 0.15	85.70 ± 0.040	75.6 ± 1.9

n=3

CONCLUSION:

Quetiapine fumarate, an antipsychotic drug with low oral bioavailability due to extensive first-pass metabolism, was formulated as a transdermal patch to provide sustained drug release and improve therapeutic effect. Patches were prepared by solvent casting technique using a combination of HPMC 15 cps, ethyl cellulose, and sodium carboxymethyl cellulose as polymers, with PEG 400 and glycerine as plasticizers and DMSO as a permeation enhancer. A calibration curve of the drug in methanol showed a λ_{max} of 208 nm and with a regression coefficient of 0.998, ensuring accurate measurement of drug content. A total of six formulations were developed and tested for physicochemical properties, drug content, and in vitro drug release. FTIR studies confirmed that there were no chemical interactions between the drug and excipients. Among the formulations, F4 was found to be the best, showing uniform thickness, flexibility, 90% drug content, and a cumulative drug release of 82% over 12 hours. The drug release followed both the Higuchi (R^2 = 0.9674) and Hixson–Crowell (R^2 = 0.9825) models, indicating controlled release through

diffusion and erosion mechanisms. The study concludes that the optimized Quetiapine fumarate patch can deliver the drug effectively through the skin, improve bioavailability, reduce the frequency of dosing, and increase patient compliance, making it a promising alternative to oral tablets.

REFERENCE

1. Rana R, Saroha K, Handa U, Kumar A, Nanda S. Transdermal Patches as a tool for permeation of drug through skin. Journal of Chemical and Pharmaceutical Research. 2016;8(5):471-81.
2. Reddy P. TRANSDERMAL DRUG DELIVERY SYSTEMS.
3. Pontrelli, Giuseppe & de Monte, Filippo. (2015). mathbio 2014.
4. Shinde N, Manikpuriya S, Sanap G. REVIEW OF TRANSDERMAL DRUG DELIVERY SYSTEM.
5. Patel AV, Shah BN. TRANSDERMAL DRUG DELIVERY SYSTEM: A REVIEW. Pharma Science Monitor. 2018 Jan 1;9(1).
6. Rastogi V, Yadav P. Transdermal drug delivery system: An overview. Asian Journal of Pharmaceutics (AJP). 2012;6(3).
7. Sharma N. A brief review on transdermal patches. Organic & Medicinal Chemistry International Journal. 2018;7(2):58-62.
8. Saroj AK, Khan R, Sharma B. Transdermal drug delivery system (Patch). World Journal of Pharmaceutical Research. 2019 Jun 25;8:325-43.
9. Patel D, Kavitha K. Formulation and evaluation aspects of transdermal drug delivery system. J Pharm Sci. 2011;6:1-2.
10. Jayaprakash R, Hameed J, Anupriya A. An overview of transdermal delivery system. Asian J Pharm Clin Res. 2017;10(10):36-40.
11. Garud A, Garud N, Namdeo A. Development and Evaluation of Transdermal Patches of Quetiapine fumerate for the treatment of psychosis. International Journal of Drug Delivery. 2012 Oct 1;4(4):470.
12. Quetiapine Fumarate : A Review of Analyatical methods
13. Effect of Polymers and Permeation Enhancers in the Release of Quetiapine Fumarate Transdermal Patch through the Dialysis Membrane
14. Gore SA. A Systematic Review on Transdermal Patch. Int. J. Pharma Sci. Rev. Res. 2017;45(2):36-47.
15. Patel HK, Shah CV, Shah VH, Upadhyay UM. Design, development and in vitro evaluation OF controlled release gel for topical delivery of quetiapine using box-behnken design. International Journal of Pharmaceutical Sciences and Research. 2012 Sep 1;3(9):3384.
16. Arora P, Mukherjee B. Design, development, physicochemical, and in vitro and in vivo evaluation of transdermal patches containing diclofenac diethylammonium salt. Journal of pharmaceutical sciences. 2002 Sep 1;91(9):2076-89.
17. Soni R, Jain AK, Jain UK. Formulation and evaluation of Transdermal Patch of Antipsychotic Drug to Overcome Nervous Emotional Disease. Asian Journal of Pharmaceutical Research and Development. 2025 Feb 15;13(1):15-20.
18. Sairam TD, Babu GK, Babu PS. Fabrication, Characterisation and Evaluation of Rivastigmine Loaded Transdermal Films for the Patients Enduring with Alzheimer's disease. Indian Journal of Research in Pharmacy and Biotechnology. 2015 Nov 1;3(6):443.
19. Parambil AN, Palanichamy SE, Kuttalingam AR, CHITRA V. Preparation and characterization of trifluoperazine loaded

transdermal patches for sustained release. Int J Appl Pharm. 2021;13(6):186-91.

20. Malaiya MK, Jain A, Pooja H, Jain A, Jain D. Controlled delivery of rivastigmine using transdermal patch for effective management of alzheimer's disease. Journal of Drug Delivery Science and Technology. 2018 Jun 1; 45:408-14.

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