INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: https://www.ijpsjournal.com

OPEN ACCESS

Research Paper

Formulation And Evaluation of Transdermal Patches of Curcumin

Ramanamma L*, K.P.R Bavana², Sravya Sri P. R., Navya Jyothi CH, Shivangi Dimple B., Sravani N.

Department of Pharmaceutics, Raghu College Of Pharmacy, Visakhapatnam, Andhra Pradesh, India.

ARTICLE INFO

Published: 07 May 2026
Keywords:
Wound healing, Transdermal drug delivery system, Curcumin ,Skin permeation,Controlled drug release ,Antioxidant activity,FTIR studies,Folding endurance, Drug–polymer compatibility
DOI:
10.5281/zenodo.20064595

ABSTRACT

Wound healing is a multifaceted biological process crucial for restoring the skin's integrity and normal function after an injury. It takes place through a series of well-coordinated phases, which include inflammation, proliferation (the formation of new tissue), and remodeling. Successful wound management necessitates the maintenance of a moist environment along with sufficient oxygen and nutrient supply to facilitate cellular activities and tissue regeneration. In recent times, transdermal drug delivery systems have gained attention as a promising method to enhance wound healing because of their non-invasive characteristics, ease of use, and ability to provide controlled and sustained release of drugs.Curcumin, the main bioactive compound from turmeric (Curcuma longa) of the Zingiberaceae family, has notable anti-inflammatory, antioxidant, and wound healing effects. Yet, its clinical effectiveness is hampered by poor oral bioavailability.Due to rapid metabolism and low systemic absorption, there are certain limitations to be addressed. To tackle these challenges, the current study aims to create transdermal patches that incorporate curcumin to enhance therapeutic effectiveness.The transdermal patches were created using a blend of polymers, specifically polyvinyl pyrrolidone (PVP) and methyl cellulose, which were shown to significantly improve the permeation of curcumin through the skin. This combination of polymers aids in better drug dispersion, allowing curcumin to enter systemic circulation and reach effective therapeutic levels. The patches developed provide benefits such as the elimination of gastrointestinal side effects and avoidance of hepatic first-pass metabolism, in addition to increased patient adherence.The patches that were formulated undergone various evaluation criteria to measure their quality and functionality, including folding endurance, weight variation, Fourier Transform Infrared (FTIR) analysis, and moisture content assessment.The findings revealed that the patches showed acceptable physical characteristics, stability, and compatibility with the drug. In summary, the research suggests that transdermal patches loaded with curcumin offer a

***Corresponding Author:** Ramanamma L.
Address: *Assistant professor, Department of Pharmaceutics, Raghu College of Pharmacy, Visakhapatnam, Andhra Pradesh, India*
Email ✉: ramanivarahalu@gmail.com

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

promising and effective method for delivering medication to improve wound healing and treatment results...

INTRODUCTION

Wounds are breaks in the skin that need to heal properly to restore the skin's normal function. Wound healing happens in stages: inflammation, new cell growth, and tissue remodeling . Good wound care includes keeping the area moist and supplying enough oxygen and nutrients.

Transdermal patches (medicine patches that go on the skin) are a new and effective way to deliver drugs. They are easy to use, avoid stomach-related side effects, and allow steady drug release. Curcumin (from turmeric) has poor absorption when taken by mouth, so using it in a patch is a better option.

Curcumin is the principal curcuminoid of the popular Indian spice turmeric which is member of family [Zingiberaceae] Transdermal patches are traditionally uses a patch containing drug substances pressed onto the skin, is non- invasive , convenient and painless and avoid gastrointestinal toxicity and hepatic first pass metabolism .In this page we can see preparing of transdermal patches by using of combination polyvinyl pyrrolidine and methyl cellulose most strongly enhanced the permeation of curcumin transdermal patch which permeated through the skin could effectively pass into the systemic circulation and attend therapeutic concentration. And it includes evaluation tests like folding endurance , weight variation ,FTIR studies and moisture level .

FORMULATION CONSIDERATIONS:

1.ACTIVE PHARMACEUTICAL INGREDIENTS:

Various categories of drugs can be used in the formation of transdermal patches. By maintaining a steady release of the API over a specified period , patches ensure the patients receive the correct dosage at the right intrevals, minimizing fluctuations in drug levels in the body. Some drugs include such as ,

Anti inflammatory , antipyretic, anti bacterial,anti emetics,anti analgesics and anti allergics etc..,

2.POLYMERS:

Polymers are large molecules composed of repeating units. They are used in various formulations to form different pharmaceutical products.They are can be natural , synthetic or semisynthetic .The process of linking of monomers together to form a polymer is called polymerization.

Key Properties of Polymers:

Polymers exhibit a wide range of properties, including:

Strength: Some polymers are very strong and durable.

Elasticity: Some polymers can stretch and return to their original shape.

Chemical Resistance: Some polymers are resistant to chemicals and corrosion.

Electrical Insulation: Some polymers are good insulators of electricity.

Examples such as polyvinyl pyrrolidine , propylene glycol,

3.PENETRATION ENHANCERS:

Penetration enhancers, also known as permeation enhancers or absorption enhancers, are substances that facilitate the passage of active pharmaceutical ingredients (APIs) through biological membranes, particularly the skin. They do this by increasing the permeability of the membrane, allowing drugs to penetrate more easily. Penetration enhancers primarily achieve their goal by affecting the structure and properties of the stratum corneum, the outermost layer of the skin, which acts as a barrier to drug absorption. They can do this in a few ways:

●Disrupting the stratum corneum:
●Enhancers can disrupt the tightly packed structure of the stratum corneum, creating more space for drugs to move through.
●Increasing drug solubility:
Some enhancers can increase the solubility of drugs in the lipid layers of the stratum corneum, making them easier to move across the membrane.

Modifying lipid fluidity:
Enhancers can also increase the fluidity of the lipids within the stratum corneum, allowing for easier movement of drugs.
Increasing thermodynamic activity:
In some cases, enhancers can increase the thermodynamic activity of the drug, making it more likely to move across the membrane.
Examples of Penetration Enhancers:
Solvents: Examples include alcohols (like ethanol), glycols (like propylene glycol), and sulfoxides (like dimethyl sulfoxide).
Surfactants: These can disrupt the lipid layers and enhance drug penetration.
Other compounds: Examples include azone, fatty acids (like oleic acid), and terpenes.

4.PLASTICIZERS:
Plasticizers are additives, usually liquids, that are mixed with polymers to increase their flexibility, elasticity, and workability. They effectively make materials softer and more pliable, allowing them to be used in a wider range of applications.
Increase flexibility: Plasticizers create space between polymer chains, allowing them to move more freely, which leads to a softer, more flexible material.
Improve processability: They can reduce the viscosity of the polymer melt, making it easier to mold, cast, and extrude.
Lower the glass transition temperature : This means the material becomes flexible at a lower temperature.
Increase impact strength: They can help the material withstand impact and stress without breaking.
Improve workability: Plasticizers can make materials easier to shape and manipulate, according to Special Chem.

5. SOLVENT:
A solvent is a substance that dissolves another substance (the solute) to form a solution, a homogeneous mixture. Solvents are typically liquids, but they can also be solids, gases, or supercritical fluids. The solvent is the component present in the largest amount in the solution and dictates the solution's physical state (solid, liquid, or gas).

Types of Solvents:
1. Organic solvents: Carbon-based solvents, such as chloroform, ethanol, and acetone.
2. Aqueous solvents: Water-based solvents, such as water and saline solutions.

Properties of Solvents:
1. Solubility: Ability to dissolve other substances.
2. Volatility: Tendency to evaporate quickly.
3. Polarity: Ability to interact with polar or nonpolar substances.

Applications of Solvents:
1. Pharmaceuticals: Solvents are used in formulation development, extraction, and purification.
2. Cosmetics: Solvents are used in product formulation, such as in skincare and haircare products.
3. Industrial processes: Solvents are used in manufacturing, cleaning, and extraction processes.
Examples of Solvents:
1. Chloroform: Used in pharmaceuticals, adhesives, and extraction processes.
2. Ethanol: Used in pharmaceuticals, cosmetics, and beverages.

3. Water: Used in various industries, including pharmaceuticals, cosmetics, and food processing.

Safety Considerations:

1. Toxicity: Some solvents can be toxic or hazardous to human health.
2. Flammability: Some solvents can be flammable or explosive.
3. Environmental impact: Solvents can have environmental implications, such as air and water pollution.

Solvents play a crucial role in various industries, but their use requires careful consideration of safety and environmental factors.

TRANSDERMAL PATCHES:

A transdermal patch is a medicated adhesive patch that is placed on the skin to deliver a specific dose of medication through the skin and into the bloodstream. An advantage of a transdermal drug delivery route over other types of medication delivery (such as oral, topical, intravenous, or intramuscular) is that the patch provides a controlled release of the medication into the patient, usually through either a porous membrane covering a reservoir of medication or through body heat melting thin layers of medication embedded in the adhesive. The main disadvantage to transdermal delivery systems stems from the fact that the skin is a very effective barrier; as a result, only medications whose molecules are small enough to penetrate the skin can be delivered by this method.

ADAVANTAGES:

1.Patches offer variable drug delivery routes.
2.Easy to use.
3.Transdermal delivery is a revolutionary method that bypasses the first pass effect.
4.Reducing the risk of under- and overdosing.
5.Consistent drug levels.
6.Easily halted by removing the patch.
7.No restriction on patient activity.

DISADVANTAGES:

1. Irritating the skin while attached.
2. Damaging the skin upon removal.
3. Getting waterlogged/not being waterproof.
4. Falling off too early.
5. Blocking the delivery of the medicine.

TRANSDERMAL PATCHES PREPARARTION TECHNIQUES:

1.Solvent Evaporation Method:

1. Dissolving and Mixing:

The drug, polymers (like HPMC, PVP), and other excipients are dissolved or dispersed in a suitable solvent (like ethanol, water, or a mixture).

2. Coating:

The solution is poured onto a substrate, such as a petri dish or a backing membrane, and covered with a funnel to control solvent evaporation.

3. Drying:

The solvent is allowed to evaporate, either by air drying or in an oven.

4. Cutting and Packaging:

Once the patch is dried, it is cut into the desired shape and size, and then packaged for storage and application.

Other Methods:

2.Mercury Substrate Method:

1.Drug and Polymer Dissolution: The drug and plasticizer are dissolved in a polymer solution.
2. onto Mercury: The solution is poured onto a leveled mercury surface.
3.Solvent Evaporation: The solvent is allowed to evaporate, leaving a dried film on the mercury.
4.Backing Membrane: The dried film is then carefully lifted and adhered to a backing membrane.

3. Using IPM Membranes:

1.Drug and Polymer Mixture: The drug is dispersed in a mixture of water and polymer (e.g., propylene glycol containing Carbomer 940).

2.Neutralization and Viscosity Adjustment: The mixture is neutralized and made viscous by adding triethanolamine.
3.IPM Membrane: The mixture is then applied to an IPM membrane.
4.Drying: The solvent is evaporated, forming the transdermal patch.

LITERATURE REVIEW: -

1. Gadekar.R, et al.2012 [1]

The aim of this study was to investigate the feasibility of Curcumin patches formulation (CPF) as a transdermal therapeutic system for wound healing potential. A combination of Poly Vinyl Pyrrolidone (PVP) and Ethyl Cellulose (EC) most strongly enhanced the permeation of Curcumin patch which permeated through the skin could effectively pass into the systemic circulation and attend therapeutic concentration. All formulation showed good physicochemical properties like thickness, weight variation, drug content, folding endurance, moisture content.The drug release through the transdermal patches of Curcumin follows first order kinetics with diffusion controlled mechanism. The results showed wound healing and repair is accelerated by applying CPF-1 formulation of the wound area by an organized epidermis. Study on animal models showed enhanced rate of wound contraction and drastic reduction in healing time than control, which might be due to enhanced epithelialization. The animals treated with Vicco-turmeric Cream and CPF-1 Formulation showed significant (* $p < 0.01$) wound healing results when compared with control groups. The treated wound after nine days itself exhibit marked dryness of wound margins with tissue regeneration. Group treated with CPF-1 formulation showed better wound closure compared to control group. Histopathological studies of Curcumin patches showed well-organized collagen fibers, increased in fibroblast cells and new blood vessels formation as compared to control group.

2. Bowler PG, et al. 2001 [2]

One effort at eliminating some of the problems of traditional dosage forms is the transdermal delivery system. Oral administration of drugs initially through powders extracts, and liquids has been around since before recorded history and through tablets and capsules. Transdermal delivery systems are specifically designed to obtain systemic blood levels and have been used in the US since the 1950s. Transdermal permeation or percutaneous absorption can be defined as the passage of a substance, such as a drug, from the outside of the skin through its various layers into the bloodstream. Oils and sweat from the glands of the skin, along with extensive flexing of the skin make it difficult for the transdermal delivery system to remain on certain sites for the duration of therapy. In the development of transdermal delivery systems, a series of interrelated elements must be taken into consideration.

3. Mani H, et al. 2002 [4]

Transdermal patches of metoclopramide hydrochloride were prepared using polyvinylalcohol and polyvinylpyrrolidone for the treatment of vomiting and nausea. The physicochemical parameters like thickness, drug content, weight variation, moisture content, moisture uptake and drug permeation studies (through dialysis sac and rat skin) were evaluated for the prepared patches. The formulations exhibited uniform thickness and weight, good drug content and little moisture content and uptake. In the in vitro drug permeation studies, the formulations showed burst release of the drug in initial hours and thereafter drug was released slowly upto 12 h. The drug release mechanism from the patches was found to be diffusion dominated. The stability studies indicated that all patches maintained good physical appearance and drug content for 6 months at 40°/75% RH.

4.inesh Kumar DK, et al. [5]

Delivery of drugs through the skin has been always a challenging area for research due to barrier properties exhibit by the outermost layer of skin stratum corneum. In the last two decades, the transdermal drug delivery system has become a proven technology that offers significant clinical benefits over other dosage forms. Because transdermal drug delivery offers controlled as well as predetermined rate of release of the drug into the patient, it able to maintain steady state blood concentration. It's a desirable form of drug delivery because of the obvious advantages e.g.convenient and pain-free self-administration for patients, avoidance of hepatic first-pass metabolism and the GI tract for poorly bioavailable drugs over other routes of delivery. The outlook for continued growth of the TDD market is very optimistic.Transdermal drug delivery has made an important contribution to medical practice, but has yet to fully achieve its potential as an alternative to oral delivery and hypodermic injections. This review emphasizes the three generations of transdermal drug delivery which start a new era of delivery of drug.

5. Pathi R, et al. 2012 [6]

Turmeric is a spice derived from the rhizomes of Curcuma longa, which is a member of the ginger family (Zingiberaceae). Rhizomes are horizontal underground stems that send out shoots as well as roots. The bright yellow color of turmeric comes mainly from fat-soluble, polyphenolic pigments known as curcuminoids. Curcumin, the principal curcuminoid found in turmeric, is generally considered its most active constituent. Other curcuminoids found in turmeric include demethoxycurcumin and bisdemethoxycurcumin. In addition to its use as a spice and pigment, turmeric has been used in India for medicinal purposes for centuries. More recently, evidence that curcumin may have anti-inflammatory and anticancer activities has renewed scientific interest in its potential to prevent and treat the disease. Key words: Anti-Inflammatory, Anti-H. pylori, curcumin.

6. Clearly GW, 2019 [7]

An attempt was made to formulate and evaluate the curcumin transdermal drug delivery system.Preformulation studies on the drug curcumin were done which included description, solubility and compatibility studies. The transdermal patches were made which were of matrix diffusion control system. Solvent casting technique was used to prepare the transdermal patches. Three formulations were made with 20mg of curcumin and by using polymers namely hydoxy propyl methyl cellulose, ethyl cellulose at various ratios and the yield was noted. Curcumin was physically examined for color and odour. Solubility was determined in water, phosphate buffer pH -7.4, Ethanol, DMSO and Tetra hydro furan. Interaction of drug and polymer was confirmed by UV – Visible interaction and FTIR studies. Based on this further evaluation was carried out.Invitro drug diffusion stuy was also carried out using modified Franz diffusion cell. Transdermal patches were evaluated for the weight, thickness, percentage moisture uptake, percentage flatness, folding endurance, water vapor transmission rate, and in-vitro release studies. This was done for three formulations F1, F2, F3. It was found that formulation F1 showed the best compatibility on the basis of all tests performed.

7. Vyas SP, et al. 2002 [8]

Curcumin, a yellow pigment from Curcuma longa, is a major component of turmeric and is commonly used as a spice and food-coloring agent. It is also used as a cosmetic and in some medical preparations. The desirable preventive or putative therapeutic properties of curcumin have also been considered to be associated with its antioxidant and anti-inflammatory properties. Because free-radical-mediated peroxidation of membrane lipids

and oxidative damage of DNAand proteins are believed to be associated with a variety of chronic pathological complications such as cancer, atherosclerosis, and neurodegenerative diseases, curcumin is thought to play a vital role against these pathological conditions

8. Saxena M, et al. 2006 [9]

Transdermal patches are now widely used as cosmetic, topical and transdermal delivery systems. These patches represent a key outcome from the growth in skin science, technology and expertise developed through trial and error, clinical observation and evidence-based studies that date back to the first existing human records. This review begins with the earliest topical therapies and traces topical delivery to the present-day transdermal patches, describing along the way the initial trials, devices and drug delivery systems that underpin current transdermal patches and their actives. This is followed by consideration of the evolution in the various patch designs and their limitations as well as requirements for actives to be used for transdermal delivery. The properties of and issues associated with the use of currently marketed products, such as variability, safety and regulatory aspects, are then described. The review concludes by examining future prospects for transdermal patches and drug delivery systems, such as the combination of active delivery systems with patches, minimally invasive microneedle patches and cutaneous solutions, including metered-dose systems.

9. Das M, et al. 2006 [10]

This review discusses the impact of curcumin-an aromatic phytoextract from the turmeric (Curcuma longa) rhizome-as an effective therapeutic agent. Despite all of the beneficial health properties ensured by curcumin application, its pharmacological efficacy is compromised in vivo due to poor aqueous solubility, high metabolism, and rapid excretion that may result in poor systemic bioavailability. To overcome these problems, novel nanosystems have been proposed to enhance its bioavailability and bioactivity by reducing the particle size, the modification of surfaces, and the encapsulation efficiency of curcumin with different nanocarriers. The solutions based on nanotechnology can improve the perspective for medical patients with serious illnesses. In this review, we discuss commonly used curcumin-loaded bio-based nanoparticles that should be implemented for overcoming the innate constraints of this natural ingredient. Furthermore, the associated challenges regarding the potential applications in combination therapies are discussed as well.

10. Nayak BS, et al. 2007 [11]

Transdermal drug delivery is a multibillion-dollar industry, with an average of one transdermal being approved by the Federal Drug Administration every 2.2 years. The first transdermal drug patch was approved by the Food and Drug Administration approximately 40 years ago, meriting a systematic review of the technology, industry and products. Patches are a unique technique offering the ability for transdermal drug delivery systems on demand. The limiting factors for transdermal delivery systems are the physicochemical and pharmacokinetic properties of an active drug enabling delivery across the skin. An overview of the skin anatomy and natural barrier it presents for pharmaceuticals to be administered transdermally is presented in this study. The clinical trials, patents, commercialization, advantages and limitations of the technology are examined. Finally, 3D printing technologies are discussed, emphasizing the tailorable transdermal system, enhancing bioavailability and revolutionizing current ‘one size fits all’ manufacturing approach with capabilities that are utilized throughout the drug development timeline.

11. Suguna L, et al. 1996 [12]

Curcumin (diferuloylmethane) is a polyphenol derived from the Curcuma longa plant. Curcumin has been used extensively in Ayurvedic medicine, as it is nontoxic and exhibits a variety of therapeutic properties, including antioxidant, analgesic, anti-inflammatory and antiseptic activities. Recently, certain studies have indicated that curcumin may exert anticancer effects in a variety of biological pathways involved in mutagenesis, apoptosis, tumorigenesis, cell cycle regulation and metastasis. The present study reviewed previous studies in the literature, which support the therapeutic activity of curcumin in cancer. In addition, the present study elucidated a number of the challenges concerning the use of curcumin as an adjuvant chemotherapeutic agent. All the studies reviewed herein suggest that curcumin is able to exert anti-inflammatory, antiplatelet, antioxidative, hepatoprotective and antitumor activities, particularly against cancers of the liver, skin, pancreas, prostate, ovary, lung and head neck, as well as having a positive effect in the treatment of arthritis.

12. Sadaf F, et al. 2006 [13]

Hydrogels are three dimensionally crosslinked polymeric network which can retain a huge amount of water but do not dissolve in water. Polyvinylpyrrolidone (PVP) is a synthetic polymer with good biocompatibility and transparency and with the action of different stimuli (radiation, heat, pressure, chemicals, etc.) undergoes crosslinking, and can form hydrogels. Due to their tissue compatibility and tissue like consistency, PVP hydrogels are very promising for different biomedical applications. However, because of inferior swelling capacity and poor mechanical property, the use of pure PVP hydrogels is limited. To overcome this problem, PVP is blended with different polysaccharides or other polymers according to requirement and from the standpoint of applications. This review article mainly focuses on different kinds of PVP based hydrogels; their modes of synthesis, properties and a range of applications of these blend hydrogels. Keywords: Biomaterial, crosslinking, drug delivery, hydrogel, PVP, radiati.

13. Rashed AN, et al. 2003 [14]

This study was conducted to formulate curcumin nanoparticles transdermal patches and to evaluate their physical characterization. Methods: Curcumin nanoparticles transdermal patches were formulated by the casting evaporation method. Transdermal patches were made using combinations of hydroxypropyl methylcellulose (HPMC) and ethyl cellulose (EC) at ratios of 4.5:1.5 for Formula 1 (F1), 4:1 for Formula 2 (F2), 3.5:1.5 for Formula 3 (F3), 3:2 for Formula 4 (F4), and 2.5:2.5 for Formula 5 (F5). Physical characterization evaluation (organoleptic properties, pH, weight uniformity, thickness uniformity, percent moisture content, and tensile strength) was then performed. The permeation of curcumin nanoparticles into the skin was evaluated using Franz diffusion cells. Results: Curcumin nanoparticles transdermal patches could be formulated by the casting evaporation method with the organoleptic properties characterized as smooth, dry, yellow in color, having menthol odor, and transparent. The pH values ranged between 5.0 and 6.0. The thickness of the patches ranged from 0.1 to 0.2 mm. The average of the patches' weight was 0.7 g, and the percent moisture content ranged from 1.0 to 6.0%. The tensile strength values were 1.0 to 2.0 N/mm. Curcumin nanoparticles could penetrate into the skin with flux values being 1.271 µg. cm-2 (F1), 0.938 µg. cm-2 (F2), 0.775 µg. cm-2 (F3), 0.837 µg. cm-2 (F4), and 0.569 µg. cm-2 (F5). Conclusion: All patches met the requirement of the physical characterization for the transdermal patch.

14. Akram M, et al. 2010 [15]

This review covers the preparation, characterization, properties, and applications of methylcelluloses (MC). In particular, the influence

of different chemical modifications of cellulose (under both heterogeneous and homogeneous conditions) is discussed in relation to the physical properties (solubility, gelation) of the methylcelluloses. The molecular weight (MW) obtained from the viscosity is presented together with the nuclear magnetic resonance (NMR) analysis required for the determination of the degree of methylation. The influence of the molecular weight on the main physical properties of methylcellulose in aqueous solution is analyzed. The interfacial properties are examined together with thermogelation. The surface tension and adsorption at interfaces are described: surface tension in aqueous solution is independent of molecular weight but the adsorption at the solid interface depends on the MW, the higher the MW the thicker the polymeric layer adsorbed. The two-step mechanism of gelation is confirmed and it is shown that the elastic moduli of high temperature gels are not dependent on the molecular weight but only on polymer concentration. Finally, the main applications of MC are listed showing the broad range of applications of these water soluble cellulose derivatives.

15. Saraswathi R, et al.[16]

Various drugs are available these days, which may either require long term administration via multiple doses or may be susceptible to enzymes and first pass-metabolism or all the above. One way to administer such drugs is through the transdermal route. After a transdermal delivery system is designed, it is important to evaluate it for various essential parameters that help us determine how effective it is, i.e. its physiochemical parameters, which describe the physical and some of the chemical properties of the patch and it's in-vitro parameters, which would mimic how the patch would behave on exposure to real time conditions On the body. This article briefly reviews the ideal characters for choosing this mode of drug delivery, its advantages and provides an in-depth analysis of the techniques used to physio-chemically evaluate the delivery system's important parameters and also the conditions that help understand the systems behavior in a real time scenario.

16. Menon VP, et al. 2007 [17]

Excipients play an important role in formulating a dosage form. These are the ingredients which along with Active Pharmaceutical Ingredients make up the dosage forms. Excipients act as protective agents, bulking agents and can also be used to improve bioavailability of drugs in some instances, the following review discusses the various types and sources of excipients along with their uses, and these can be used for different activities. Specific excipients are best suited for a particular dosage form; the selection criterion for excipients and various interactions that an excipient can undergo during its course of stay in formulation has been discussed in this review. Some excipient interactions can be detrimental and need to be avoided. This has been detailed out in the interaction section. Excipients as like other active pharmaceutical ingredients need to be stabilized and standardized; the following review gives brief information about standardization and stabilization process alongwith the safety evaluation parameters of the excipients.

17. Gosain A, et al. 2004 [3]

Controlled-release systems regulate drug plasma concentration after administration through pre-determined patterns over a fixed period. The release rate should determine drug absorption and concentration. These formulations reduce daily dosing frequency. This article discusses ideal requirements, advantages, properties, and approaches for developing controlled-release formulations to improve drug delivery. This involves delivering drugs at a pre-set rate for a limited period, either locally or systemically. This method, utilizing drugencapsulating devices, offers advantages over traditional methods,

including tailored release rates, drug protection, and increased patient comfort. Controlled-release drug delivery systems maintain a uniform plasma concentration within the therapeutic range, minimizing side effects and administration frequency. Oral sustained-release products optimize drug properties, reducing dosing frequency and ensuring maximum drug utility, reduced side effects, and quicker cure or control conditions. Technological advancements have revolutionized medication methods with controlled drug delivery systems, offering benefits like multiple dosing and single dosing.

MATERIALS AND METHODS:-

TABLE 1 : MATERIALS INVOLVED IN THE FORMULATION OF CURCUMIN TRASDERMAL PATCHES

INGREDIENTS	FORMULATION
CURCUMIN	2mL
POLYVINYL PYRROLIDINE	300mg
METHYL CELLULOSE	100mg
PROPYLENE GLYCOL	0.5mL
DIMETHYL SULFOXIDE	0.1mL

METHOD:-

1. The casting solutions were prepared by dissolving polymers in suitable solvent of chloroform .
2. accurately weighed polyvinly pyrrolidine, methyl cellulose were dissolved in choloroform and mix until dissolved with stirrer and curcumin was weighed and dissolved in choloroform completely .
3. Then these mixtures are combined and mixed gently with stirrer for uniform mixture.Now add Dimethyl sulfoxide and polyethylene to the mixture and make a uniform mixture .
4. Formed bubbles are removed from solution by using ultra sonicator or vaccum degasser .
5. This solution is poured in a glass plate and kept under room temperature for 24 hours .
6. After 24 hours patches were removed and cut into 2*2 and 1*1 by using sharp blade and scale for accurate measurement .
7. After the patches are covered with aluminium foil and kept in descicator

for further drying.

Curcumin extract:

Small amount of turmeric was taken and dissolved in ethanol and kept aside for two days, after two days top most layer of solution was used as curcumin extract.

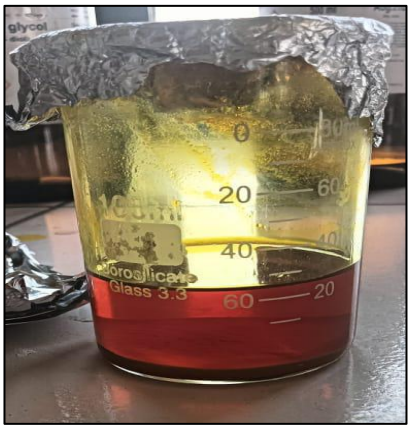

Figure no1 : curcumin extract

1. METHYL CELLULOSE:

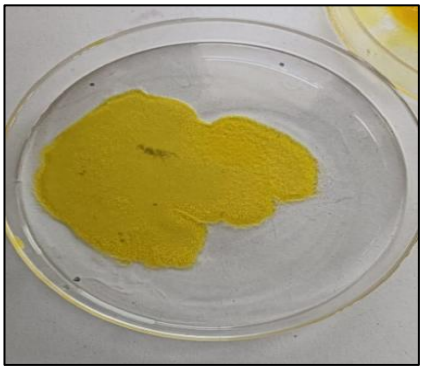

FIG.2: (FILM-1)

FIG.3: (FILM -2)

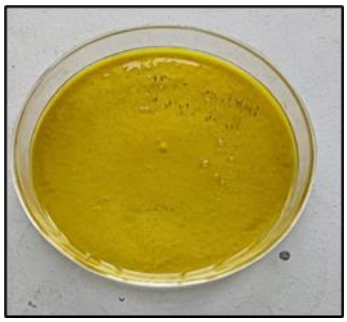

FIG.4: (FILM-3)

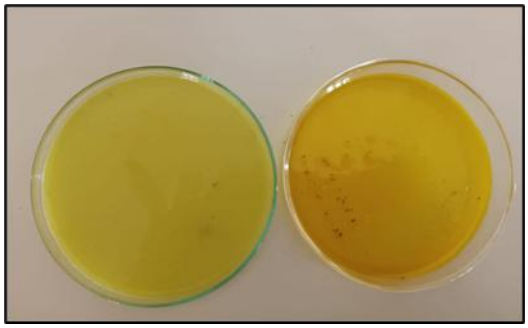

FIG.5: (FILM-4&5)

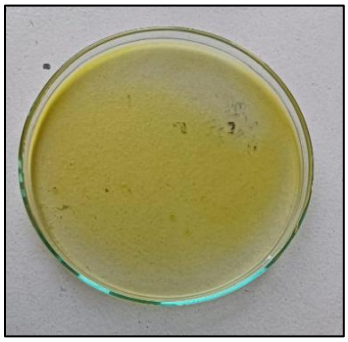

FIG.7: (2*2)

FIG.8: (HPMC)

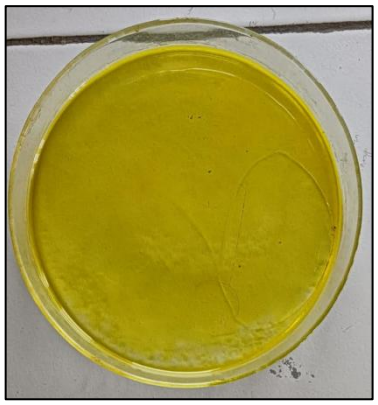

FIG.9: (GUAR GUM)

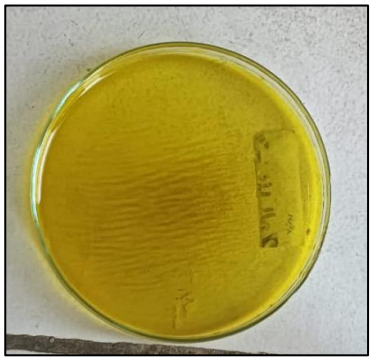

FIG.10: (CHITOSAN)

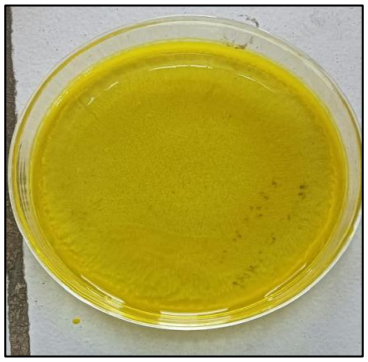

FIG.11: (STARCH SOLUBLE)

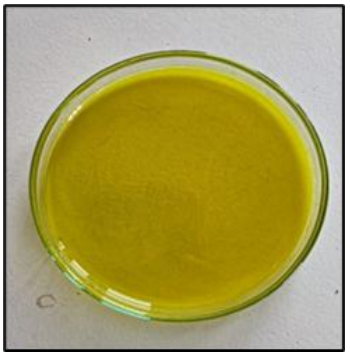

FIG.12: (ETHYL CELLULOSE)

Standard curve:

Standard curve of curcumin of different concentrations is obtained. A concentration dependent increases in absorbance was achieved in accordance with Beer Lamberts law and a standard curve of curcumin at various concentration was generated. The resulted curve is displayed below.

TABLE 2 : CALIBRATION CURVE

X-axis	Y-axis
0	0
2	0.400
4	0.777
6	1.210
8	1.671
10	2.01

Standard curve of curcumin:

Procedure: Choose a suitable solvent, such as methanol, ethyl acetate, or phosphate buffer, depending on the application. Prepare a stock solution of curcumin by accurately weighing a known amount of curcumin and dissolving it in the chosen solvent. The concentration of the stock solution will depend on the desired concentration range for the standard curve.Create a series of standard solutions by diluting the stock solution with the chosen solvent to achieve a range of concentrations. Ensure that the concentrations are accurately known, ideally with a range of 2-10 µg/ml or 1-7 µg/ml.

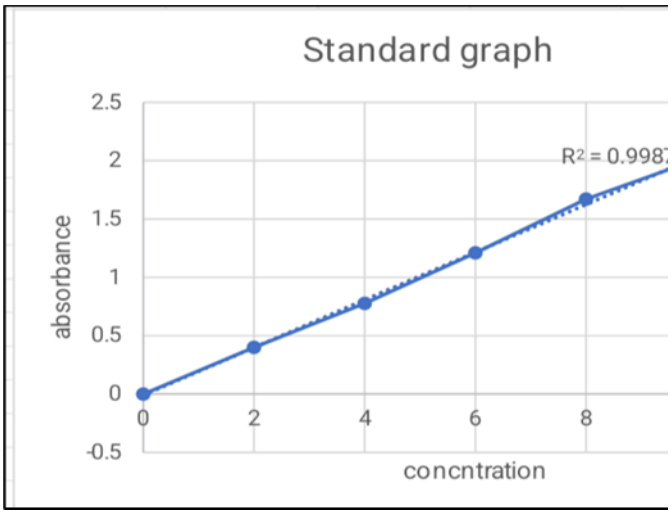

FIG NO 13 : STANDARD CURVE OF CURCUMIN

1. Morphological Properties :

Homogeneity - Patches were found to be homogenous

Colour - yellow in colour

Surface of the oral films - Smooth

2.Patch Weight And Thickness :

The weight of three patches was examined by using digital balance . The weights were found to be ,

Weight of patch (W1) =205 mg

Weight of patch (W2) =215 mg

Weight of patch (W3) = 209mg

The average weight of three patches is 209.66 mg

3.Folding Endurance :-

A Patch of 2×2cm is taken and folded at same position. Cracks were not appeared even after 300 folds. It ensures the good folding endurance.

Result- crakes appear at 356 folds.

4.Percentage Moisture Absorption :

The percentage moisture absorption of the patch was found to be 4.16 Percentage

5. In-vivo dissolution studies:

From Standard Curve

Y=mx+c

X=y-c/M

X=concentration×dilution factor×900/1000

Zero order:

RESULTS AND DISCUSSION:-

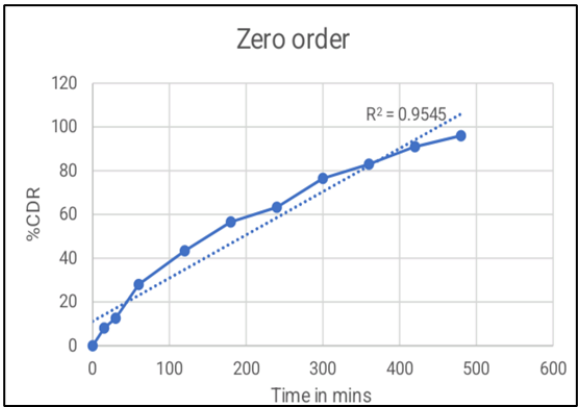

FIG NO 14: ZERO ORDER

TABLE NO 3 : ZERO ORDER

X-axis	Y-axis
0	0
15	8.1
30	12.6
60	28
120	43.4
180	56.6
240	63.3
300	76.5
360	83
420	91
480	96

X-axis	Y-axis
0	2
15	1.96
30	1.94
60	1.85
120	1.75
180	1.63
240	1.56
300	1.37
360	1.23
420	0.95
480	0.60

TABLE 4 : FIRST ORDER (R^2:0.9549)

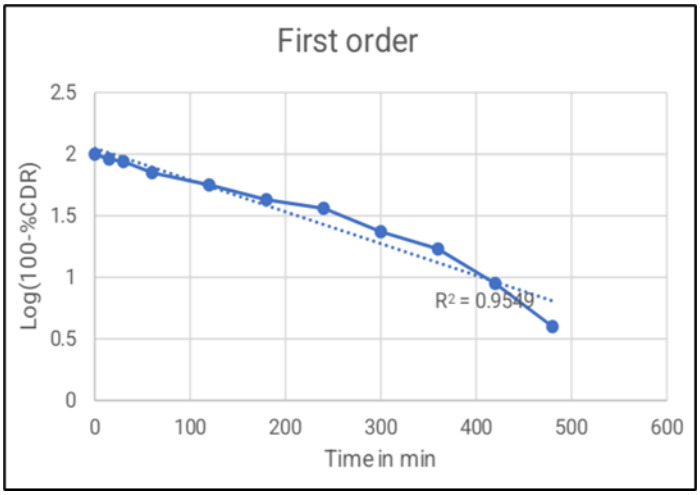

FIG NO 15: FIRST ORDER GRAPH

6. FTIR studies:

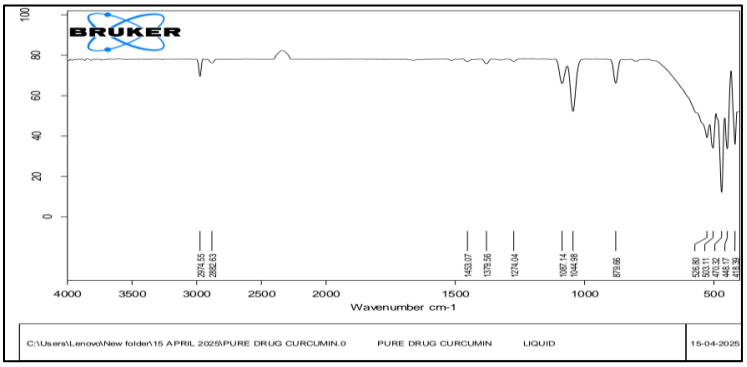

FIG NO 16: FTIR OF CURCUMIN

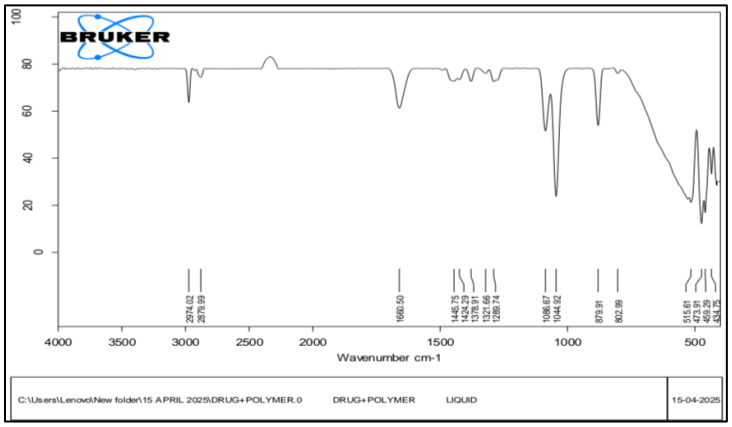

FIG NO 17: FTIR OF DRUG AND POLYMER

The FTIR spectra of pure curcumin and the drug–polymer mixture were analyzed to assess potential interactions between curcumin and the polymer.

Pure curcumin spectrum shows characteristic peaks at:

~2924 and ~2852 cm^{-1} (C–H stretching)

~1627–1453 cm^{-1} (aromatic C=C stretching)

~1274 cm^{-1} (C–O stretching)

~1044 and ~1067 cm^{-1} (C–O–C and C–OH bending)

~879 cm^{-1} and lower frequencies for various bending vibrations.

Drug–polymer mixture spectrum retains most of these characteristic curcumin peaks with slight shifts:

~1660 cm^{-1} (possibly indicating H-bonded C=O)

Other curcumin peaks are still present but show minor shifts or changes in intensity (e.g., ~1442, ~1326, ~1086 cm^{-1}), suggesting interaction with polymer groups.

FTIR-Conclusion:

There is no disappearance of major characteristic peaks of curcumin in the mixture, indicating no chemical interaction or degradation. However, slight shifts and changes in intensity of some peaks suggest possible physical interactions, such as hydrogen bonding or Van der Waals forces, between curcumin and the polymer. This supports successful incorporation of the drug into the polymer matrix without altering its chemical structure

CONCLUSION

The formulation and evaluation of curcumin transdermal patches through the solvent casting method was the emphasis of this work with the target of creating a controlled-release device for wound healing. Out of the several prepared formulations, the most promising of them was

Formulation 4, which proved to have superior physical properties as well as reproducible drug content.The preparation exhibited fine uniformity of drug distribution within the patch matrix, a prerequisite for the consistent and effective delivery of the drug. Physicochemical tests demonstrated that Formulation 4 possessed optimal thickness and had low weight variation, testifying to uniform casting and reproducibility. The folding endurance was exceptionally high, which speaks well of mechanical strength and flexibility, prerequisites for patient compliance and extended wearability.Surface pH evaluation validated that the patch is in the physiological acceptance range, thereby reducing the danger of skin irritation and ensuring applicability in a transdermal mode. The critical observation, however, is that the drug release profile for curcumin in an in vitro study depicted first-order drug release kinetics, indicating that release is dependent upon concentration and indicative of a consistent therapeutic action with time.The application of polymers like polyvinylpyrrolidone (PVP) and methyl cellulose (MC) was found to be a suitable combination in establishing structural integrity along with effective drug release. Compatibility between curcumin and excipients was validated by FTIR studies, and no chemical interaction was observed, maintaining the active pharmaceutical ingredient stability

ACKNOWLEDGEMENT

We sincerely thank our esteemed guide for their constant encouragement, guidance, and kind support throughout the completion of this article titled ***"Formulation and Evaluation of Transdermal Patches of curcumin***. We express our special gratitude to our Instructor L.Ramanamma for their continuous support, motivation, and valuable encouragement, which greatly helped us to stay involved and focused during the preparation of this work.

REFERENCES

1. Gadekar R, Saurabh MK, Thakur GS, Saurabh A. Study of formulation, characterisation and wound healing potential of transdermal patches of curcumin. Asian J Pharm Clin Res. 2012;5(4):225-30
2. Bowler PG, Duerden BI, Armstrong DG. Wound microbiology and associated approaches to wound management. Clinical microbiology reviews. 2001 Apr 1;14
3. Gosain A, DiPietro LA. Aging and wound healing. World journal of surgery. 2004 Mar;28:321-6.
4. Mani H, Sidhu GS, Kumari R, Gaddipati JP, Seth P, Maheshwari RK. Curcumin differentially regulates TGF-β1, its receptors and nitric oxide synthase during impaired wound healing. Biofactors. 2002;16(1-2):29-43.
5. Dinesh Kumar DK, Tripathi HC, Tandan SK, Jawahar Lal JL, Malik JK. Ethnoveterinary phytomedicines used in India and Nepal in the treatment of fractures, wounds and allied disorders: an update.
6. Parhi R, Suresh P, Mondal S, Mahesh Kumar P. Novel penetration enhancers for skin applications: a review. Current drug delivery. 2012 Mar 1;9(2):219-30.
7. Cleary GW. Transdermal controlled release systems. InMedical applications of controlled release 2019 Jun 4 (pp. 203-252). CRC Press.
8. Vyas SP, Khar RK. Controlled drug delivery concepts and advances. vallabh prakashan. 2002;1:411-
9. Saxena M, Mutalik S, Reddy MS. Formulation and evaluation of transdermal patches of metoclopramide hydrochloride. Indian drugs. 2006;43(9):740-5.
10. Das M, Bhattacharya A, Ghosal S. Transdermal delivery of trazodone hydrochloride from acrylic films prepared

from aqueous latex. Indian journal of pharmaceutical sciences. 2006 Jan 1;68(1).
11. Nayak BS, Anderson M, Pereira LP. Evaluation of wound-healing potential of Catharanthus roseus leaf extract in rats. Fitoterapia. 2007 Dec 1;78(7-8):540-4.
12. Suguna L, Sivakumar P, Chandrakasan G. Effects of Centella asiatica extract on dermal wound healing in rats. Indian Journal of Experimental Biology. 1996 Dec 1;34(12):1208-11.
13. Sadaf F, Saleem R, Ahmed M, Ahmad SI. Healing potential of cream containing extract of Sphaeranthus indicus on dermal wounds in Guinea pigs. Journal of Ethnopharmacology. 2006 Sep 19;107(2):161-3.
14. Rashed AN, Afifi FU, Disi AM. Simple evaluation of the wound healing activity of a crude extract of Portulaca oleracea L.(growing in Jordan) in Mus musculus JVI-1. Journal of ethnopharmacology. 2003 Oct 1;88(2-3):131-6.
15. Akram M, Shahab-Uddin AA, Usmanghani KH, Hannan AB, Mohiuddin E, Asif M. Curcuma longa and curcumin: a review article. Rom J Biol Plant Biol. 2010;55(2):65-70.
16. Saraswathi R, Krishnan PN, Dilip C, Ali TS. Formulation and evaluation of transdermal patches of curcumin
17. Menon VP, Sudheer AR. Antioxidant and anti-inflammatory properties of curcumin. The molecular targets and therapeutic uses of curcumin in health and disease. 2007 Sep:105-25.
18. Pastore MN, Kalia YN, Horstmann M, Roberts MS. Transdermal patches: history, development and pharmacology. British journal of pharmacology. 2015 May;172(9)
19. Zielińska A, Alves H, Marques V, Durazzo A, Lucarini M, Alves TF, Morsink M, Willemen N, Eder P, Chaud MV, Severino P. Properties, extraction methods, and delivery systems for curcumin as a natural source of beneficial health effects. Medicina. 2020 Jul 3;56(7):336
20. Bird D, Ravindra NM. Transdermal drug delivery and patches—An overview. Medical Devices & Sensors. 2020 Dec;3(6):e10069.
21. Perrone D, Ardito F, Giannatempo G, Dioguardi M, Troiano G, Lo Russo L, De Lillo A, Laino L, Lo Muzio L. Biological and therapeutic activities, and anticancer properties of curcumin. Experimental and therapeutic medicine. 2015 Nov;10(5):1615-23.
22. Roy N, Saha N. PVP-based hydrogels: Synthesis, properties and applications. Hydrogels: Synthesis, Characterization and Applications. 2012 Sep:227-52.
23. Putri FR, Adjeng AN, Yuniar NA, Handoyo MU, Sahumena MA. Formulation and physical characterization of curcumin nanoparticle transdermal patch. International journal of applied pharmaceutics. 2019;11(6):217-21
24. Nasatto PL, Pignon F, Silveira JL, Duarte ME, Noseda MD, Rinaudo M. Methylcellulose, a cellulose derivative with original physical properties and extended applications. Polymers. 2015 Apr 24;7(5):777-803.
25. Lakhani P, Bahl R, Bafna P. Transdermal Patches: Physiochemical and in-vitro evaluation methods. Int. J. Pharm. Sci. Res. 2015 May 1;6(5)
26. Chaudhari SP, Patil PS. Pharmaceutical excipients: a review. Int J Adv Pharm Biol Chem. 2012 Jan;1(1):21-34.

HOW TO CITE: Ramanamma L, K.P.R Bavana., Sravya Sri P. R., Navya Jyothi CH, Shivangi Dimple B., Sravani N., Formulation And Evaluation of Transdermal Patches of Curcumin, Int. J. of Pharm. Sci., 2026, Vol 4, Issue 5, 1339-1354, https://doi.org/10.5281/zenodo.20064595