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A Research on Formulation and Evaluation of Polyherbal Transdermal Eye Patch for Under Eye Care

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Abstract: *The periorbital region is one of the most delicate and aesthetically sensitive areas of the human face, frequently affected by cosmetic and pathological conditions such as dark circles, puffiness, fine lines, wrinkles, and under-eye bags. These conditions are increasingly prevalent due to modern lifestyle stressors, sleep deprivation, prolonged screen exposure, and nutritional deficiencies. Conventional approaches to under-eye care, including creams, gels, and serums, often suffer from poor retention, limited penetration through the thin periorbital skin, and the risk of ocular irritation.*
The present study aimed to formulate and evaluate a polyherbal transdermal eye patch incorporating bioactive extracts of Green Tea (Camellia sinensis), Cucumber (Cucumis sativus), Aloe vera (Aloe barbadensis), and Potato (Solanum tuberosum) for effective under-eye care. The patch was designed to provide sustained, controlled release of phytoconstituents, minimize irritation, and improve patient compliance..

Keywords: Transdermal Drug Delivery Systems.

I. INTRODUCTION

Transdermal Drug Delivery Systems (TDDS) are a major breakthrough in pharmaceutical technology. They provide an alternative way to deliver bioactive compounds into the system or locally by avoiding first-pass metabolism in the liver. These systems apply directly to intact skin and offer controlled, sustained release of drugs or plant compounds into the bloodstream or targeted tissue. This improves bioavailability, makes it easier for patients to stick to their treatment, and reduces how often they need to dose. Transdermal delivery is not limited to regular medicines; it also extends into the cosmeceutical field. Here, topical patches are used for localized effects on the skin, subcutaneous tissue, and surrounding structures. Eye patches are a type of specialized transdermal delivery device. They are designed to be placed on the skin around the eyes to deliver active ingredients that address concerns under the eyes. The thin nature of periorbital skin also offers advantages for transdermal delivery, as it presents lower diffusional resistance compared to thicker regions. However, the proximity to the eye demands careful formulation to avoid irritation, allergic reactions, and ocular toxicity [1].

Herbal medicine offers a variety of plants with proven benefits for under-eye care. These include antioxidant, anti-inflammatory, skin-lightening, anti-swelling, collagen-boosting, and skin-conditioning effects. A formulation that combines several herbs can take advantage of the interactions between different plant ingredients. This may lead to better results at lower individual amounts than those found in single-herb products [2].

This research project aimed to develop and characterize a polyherbal transdermal eye patch utilizing solvent-casting technique with biocompatible polymers (HPMC, sodium alginate) and a plasticizer (glycerin). The formulation was designed to ensure optimal skin adhesion, flexibility, controlled moisture content, appropriate pH, and sustained release of herbal bioactives over 6-8 hours. Comprehensive physicochemical, phytochemical, and in vitro evaluations were conducted to establish the formulation as a viable cosmeceutical and therapeutic product.

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WHAT IS TRANSDERMAL EYE PATCH ?

An eye patch is a small piece of material or film that goes over or around the eye. It protects the area or delivers helpful ingredients to the skin. People use it for skincare, healing, or addressing under-eye issues like dark circles, puffiness, and wrinkles[3].

PARTS OF AN EYE PATCH:

1. Backing layer:

It is an outer protective layer which gives strength and shape to the patch. Usually made of flexible polymer or fabric.

2. Drug or Herbal Reservoir or matrix:

It contains the active ingredients which active pharmaceutical drug or herbal extract. It is responsible for releasing ingredients to the skin.

3. Rate-control membrane:

It controls the release rate of the herbal drug.

4. Adhesive layer:

It helps the patch stick to the skin and it must be safe, non-irritating, and gentle. Sometimes it mixed with the drug.

5. Release Linear:

It is protective layer removed before application. It protects the adhesive and herbal material until use.

6. Herbal active ingredients:

a. Aloe Vera

b. Green tea extract

c. Potato extract

7. Permeation enhancer:

Improve drug absorption through skin. Ex: glycerin, essential oils

8. Plasticizers or Excipients:

Improve flexibility and comfort[4].

DIAGRAMATIC REPRESENTATION OF COMPONENTS OF PATCH:

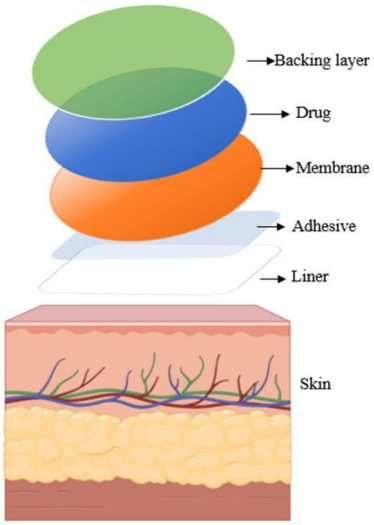

Fig.1.Differents components of transdermal patch.

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ADVANTAGES OF TRANSDERMAL EYE PATCH :

1. Non-invasive and convenient application.
2. Prolonged contact time with periorbital skin compared to creams/gels.
3. Controlled and sustained release of active ingredients.
4. Avoidance of ocular irritation if properly formulated.
5. Precise dose delivery to target area.
6. Improved patient compliance and ease of use.
7. Suitable for overnight application.
8. Cost-effective and scalable manufacturing.
9. Reduced systemic side effects.
10. Combination of multiple actives in a single delivery system[5].

DISADVANTAGES OF TRANSDERMAL EYE PATCH :

1.Limited drug permeation through skin. 2.Possibility of skin irritation or sensitization. 3.Unsuitability for high-dose drugs.

4. Variability in drug absorption.
5. Risk of accidental eye exposure.
6. Slow onset of action.
7. Stability issues of herbal components.
8. Adhesion problems[6].

LITERATURE REVIEW :

Transdermal Drug Delivery-A Historical Perspective :

Transdermal drug delivery has come a long way since the days of simple poultices and plasters in ancient medicine. Things really changed in 1979 when the FDA approved the first scopolamine patch for motion sickness Transderm Scop opening a new chapter for transdermal systems. After that, patches for nitroglycerin, nicotine, estrogen, testosterone, and fentanyl hit the market. Over the years, these advances turned transdermal patches into a serious option in pharmaceuticals[7].

Barry (2001) extensively reviewed the mechanisms of percutaneous absorption and the role of enhancers in overcoming the stratum corneum barrier, establishing foundational principles for transdermal formulation[8] Subsequent research by Williams & Barry (2004) on penetration enhancers provided comprehensive mechanistic insights that continue to guide formulation scientists[9].

Periorbital Skin: Anatomical and Physiological Considerations :

Freitag & Cestari (2007) conducted a systematic analysis of periorbital discoloration and proposed a clinical classification based on underlying etiology: vascular, pigmentary, structural, and mixed. This classification has been widely adopted in both clinical and research settings[10].

Verschoore et al. (2014) demonstrated that the stratum corneum of periorbital skin is significantly thinner (approximately 4-5 cell layers) compared to other facial regions (7-8 layers), making it more permeable to topically applied ingredients but also more susceptible to irritation. These findings support the rationale for targeted transdermal delivery to the periorbital region[11].

Huang et al. (2019) used optical coherence tomography to characterize in vivo periorbital skin structure, confirming reduced epidermal thickness and increased vascular density compared to the cheek and forehead regions[12].

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Pathophysiology of Dark Circles and Periorbital Conditions :

Malakar et al. (2007) investigated the clinicopathological correlation of periorbital melanosis in 100 patients and identified post-inflammatory pigmentation, UV exposure, and genetic predisposition as the most significant etiological factors. Histopathological examination revealed increased dermal melanophages and melanin deposition in the papillary dermis[13].

Sarkar et al. (2004) classified periorbital hyperpigmentation into four types based on pathogenesis: pigmented, vascular, structural, and mixed, and proposed a treatment algorithm for each type. This work highlighted the multifactorial nature of dark circles and the need for multi-targeted therapeutic approaches[14].

Roh & Youn (2004) demonstrated that oxidative stress plays a central role in the genesis of periorbital hyperpigmentation by upregulating melanocyte-stimulating hormone (MSH) and tyrosinase activity, establishing a mechanistic basis for the use of antioxidant-rich herbal extracts in under-eye care products[15].

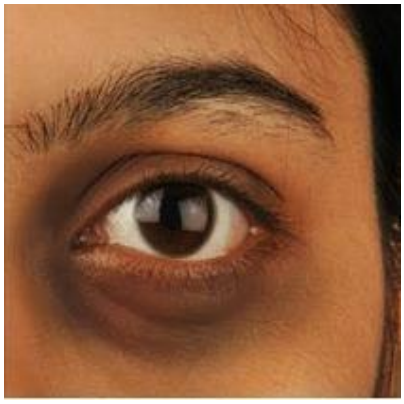

Fig.2.The eyes with dark circules

Green Tea (Camellia sinensis) in Dermatology :

Green tea polyphenols, particularly EGCG, have been extensively studied for their dermatological applications. Elmets et al. (2001) demonstrated in a placebo-controlled study that topical application of green tea extract significantly reduced UV-induced erythema, DNA damage, and oxidative stress in human skin. The study attributed these effects primarily to the free-radical scavenging and photoprotective properties of EGCG[16].

Hsu (2005) reviewed the mechanisms by which EGCG inhibits melanogenesis, demonstrating that it downregulates tyrosinase gene expression through inhibition of the MITF (microphthalmia-associated transcription factor) pathway. This mechanism supports the potential of green tea extracts in treating periorbital hyperpigmentation[17].

Saric & Sivamani (2016) conducted a systematic review of randomized controlled trials investigating green tea for skin conditions, concluding that green tea polyphenols demonstrate significant anti-inflammatory, antioxidant, and anti-aging effects relevant to cosmeceutical applications[18].

Aloe vera (Aloe barbadensis Miller) in Dermatology :

Surjushe et al. (2008) reviewed the therapeutic applications of Aloe vera in dermatology, cataloguing its constituents including anthraquinones (aloin, emodin), polysaccharides (acemannan), vitamins (C, E, B12), enzymes (alliinase, alkaline phosphatase), minerals, and amino acids. The anti-inflammatory mechanism was attributed to inhibition of the bradykinin-kinin system and complement pathway[19].

Choi & Chung (2003) demonstrated that aloesin, a C-glycosylated chromone isolated from Aloe vera, inhibits tyrosinase and DOPA oxidase activity, thereby reducing melanin synthesis. This depigmenting property supports the use of Aloe vera extracts in formulations targeting periorbital hyperpigmentation[20].

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Dal'Belo et al. (2006) demonstrated in a clinical study that moisturizers containing Aloe vera significantly improved skin hydration and elasticity compared to vehicle control over 4 weeks, supporting its skin-conditioning role in cosmeceutical formulations[21].

Potato (Solanum tuberosum) in Skin Care :

Potato has been used in traditional medicine for centuries to alleviate dark circles and skin discoloration. The depigmenting activity is attributed to the enzyme catecholase (polyphenol oxidase), which acts as a competitive inhibitor of melanogenesis by occupying melanin synthesis pathway intermediates. The presence of vitamin C (ascorbic acid) provides additional antioxidant and tyrosinase-inhibitory activity[22].

Kumar et al. (2012) investigated the anti-inflammatory properties of Solanum tuberosum extracts in carrageenan-induced paw edema models, demonstrating significant inhibitory activity attributable to quercetin and caffeic acid content. These findings support the potential role of potato extract in reducing periorbital edema[23].

Cucumber (Cucumis sativus) in Skin Care :

Mukherjee et al. (2013) provided a comprehensive phytochemical profile of Cucumis sativus, identifying caffeic acid, cucurbitacins, flavonoids, vitamin C, beta-carotene, and mineral silica as principal bioactive compounds relevant to skin care. The authors reviewed evidence supporting its anti-inflammatory, hydrating, and astringent properties, attributing these to the high water content (96%) and flavonoid-mediated antioxidant activity[24].

Stahl et al. (2012) studied the effect of topically applied cucumber extract on periorbital puffiness in 25 female volunteers using optical profilometry. The study reported a statistically significant reduction in puffiness ($p < 0.05$) attributed to the vasoconstrictive effect of caffeic acid and the anti-edema action of cucurbitacins[25].

Main Polymers Used in Transdermal Patch Formulation :

HPMC (Hydroxypropyl Methylcellulose): HPMC is a semi-synthetic, biocompatible, non-ionic cellulosic polymer widely used as a film-forming agent and matrix former in TDDS. Its hydroxyl groups confer hydrophilic properties, facilitating drug release through hydrationmediated swelling. Different viscosity grades (K4M, K15M, K100M) offer tunable release profiles. Studies by Patel et al. (2011) demonstrated that HPMC K15M films exhibited excellent mechanical properties, uniform thickness, and predictable release kinetics for bioactive compounds[26].

Glycerin (Glycerol): As a plasticizer, glycerin reduces the glass transition temperature of polymeric films, improving their flexibility and folding endurance without compromising mechanical integrity. Glycerin also acts as a humectant, drawing moisture to the skin and reducing transepidermal water loss (TEWL), which is particularly beneficial in the thin periorbital skin[27].

PLANT PROFILE :

1. Green Tea Leaves :

Fig 3.Green Tea Leaves.

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Green tea is a natural herbal product prepared from the unfermented leaves of Camellia sinensis. It contains bioactive compounds such as polyphenols, catechins, flavonoids, caffeine, and antioxidants that provide medicinal and cosmetic benefits.

In a transdermal eye patch, green tea extract acts as an antioxidant and anti-inflammatory agent. It helps reduce dark circles, puffiness, eye fatigue, and under-eye swelling. The catechins present in green tea protect the skin from free radical damage and improve the appearance of the periorbital skin[28].

BENEFITS :

1. Rich in antioxidants such as catechins and polyphenols.
2. Helps reduce dark circles around the eyes.
3. Possesses anti-inflammatory activity that decreases puffiness and swelling.
4. Provides a soothing and cooling effect to tired eyes.
5. Helps protect skin from free radical damage and premature aging.
6. Improves skin elasticity and firmness around the under-eye area.
7. Contains caffeine which may help tighten skin and reduce fluid retention.

2. Aloe vera :

Fig.4.Aloe Vera

Scientifically known as Aloe barbadensis Miller is a well-known medicinal plant widely used in pharmaceutical and cosmetic formulations. Aloe vera contains several bioactive constituents such as polysaccharides, vitamins, amino acids, enzymes, and phenolic compounds that contribute to its therapeutic properties.

In herbal transdermal eye patches, Aloe vera plays an important role as a natural hydrating and soothing agent that helps reduce skin irritation, puffiness, and inflammation around the eye area. It also improves skin hydration and provides comfort during patch application, thereby enhancing the overall effectiveness of the formulation[29].

BENEFITS :

1. Excellent moisturizing and hydrating agent.
2. Soothes irritated and sensitive skin.
3. Possesses anti-inflammatory and healing properties.
4. Helps maintain skin elasticity and smoothness.
5. Promotes collagen production and skin repair.
6. Provides cooling sensation and comfort to eyes.
7. Contains vitamins and minerals beneficial for healthy skin.
8. Helps reduce fine lines and dryness around the eyes.

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3. Potato Juice :

Fig.5.Potato Juice

Potato juice is obtained from the potato plant, scientifically known as Solanum tuberosum. Potato juice is rich in starch, vitamins (especially vitamin C), minerals, and antioxidant compounds that provide soothing and skin-protective effects. It is widely used in herbal and cosmetic formulations because of its cooling, anti-inflammatory, antioxidant, and skin-brightening properties.

In a herbal transdermal eye patch, potato juice acts as a natural soothing and depuffing agent that helps reduce dark circles, puffiness, irritation, and tiredness around the eyes. Its cooling effect provides comfort to the skin, while the antioxidant components help protect skin cells from damage and improve the appearance of the under-eye area[30].

BENEFITS :

1. Contains natural bleaching enzymes that may lighten dark circles.
2. Helps reduce puffiness and swelling around the eyes.
3. Provides a cooling and soothing effect.
4. Rich in starch and antioxidants that protect skin cells.
5. Helps improve skin brightness and complexion.
6. May reduce inflammation and irritation.
7. Supports rejuvenation of tired under-eye skin.

4. Cumcumber Juice :

Fig.No.6.Cumcumber Juice

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Cucumber juice comes from the fresh fruit—cucumbers, or Cucumis sativus if you want to get technical. It's loaded with water, vitamins, minerals, antioxidants, and some really soothing compounds that cool and hydrate your skin.When it comes to Transdermal Drug Delivery Systems, or TDDS, people usually add cucumber juice for its moisturizing and calming effects. You'll see it a lot in herbal eye patches and cosmetic patches. Cucumber juice keeps the skin hydrated and makes wearing these patches more comfortable. Because it's packed with antioxidants and has a cooling feel, it can help with puffiness, irritation, and skin stress—especially around the eyes.

The best part? It's gentle, refreshing, and doesn't irritate. That's why so many herbal and cosmetic TDDS formulas include cucumber juice—to boost comfort and protect your skin.

BENEFITS :

1. Provides excellent cooling and refreshing effect.
2. Helps reduce under-eye puffiness and irritation.
3. Hydrates and moisturizes delicate under-eye skin due to high water content.
4. Contains antioxidants and vitamins that nourish the skin.
5. Helps soothe tired and strained eyes.
6. May assist in reducing mild pigmentation and dark circles.
7. Gives a calming effect and improves skin softness.

INGREDIANTS :

1. HPMC [Hydroxypropyl Methylcellulose] :

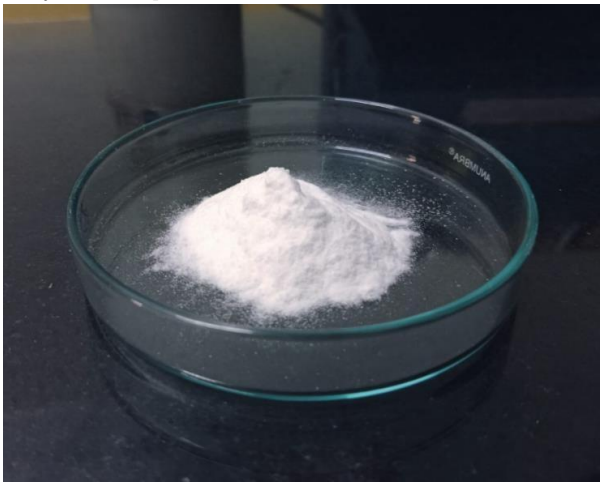

Fig.7. HPMC [Hydroxypropyl Methylcellulose]

HPMC is an important polymer in transdermal drug delivery systems because of its excellent film-forming, controlled drug release, moisture retention, and biocompatible properties. It improves patch quality, stability, flexibility, and therapeutic effectiveness, making it highly suitable for herbal transdermal eye patches.

Hydroxypropyl methylcellulose (HPMC) plays an important role in transdermal eye patches as a film-forming and controlled-release polymer. It helps in forming smooth, flexible, and stable patches while improving drug diffusion, moisture retention, and patch adhesion. Due to its biocompatibility, non-toxicity, and sustained drug release properties, HPMC is widely used in transdermal drug delivery systems for better therapeutic effectiveness[31].

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2. Glycerin :

Fig.8.Glycerin

Glycerin, or glycerol, is a clear and colorless liquid with no smell and a sweet taste. You see it everywhere in pharmaceuticals and cosmetics. Chemically, it's a trihydroxy alcohol—$C_3H_8O_3$—and it mixes well with water. What makes it really useful is its ability to draw in and hold moisture. In transdermal drug delivery systems (TDDS), people use glycerin as a plasticizer and humectant. It keeps the patches flexible and soft, stops them from cracking, and maintains just the right amount of moisture. That means the patch feels comfortable against your skin and sticks better.

Glycerin does more than just hold things together—it actually boosts drug diffusion and helps transdermal patches work better. Because it hydrates the top layer of your skin, it makes it easier for medicine to get through. Plus, it improves the texture, elasticity, and consistency of the patch film. That way, patches stay in place longer. Since glycerin is safe and non-toxic, you'll find it in all kinds of herbal and pharmaceutical patches, including eye patches and medicated films[32].

3. Methyl Paraben :

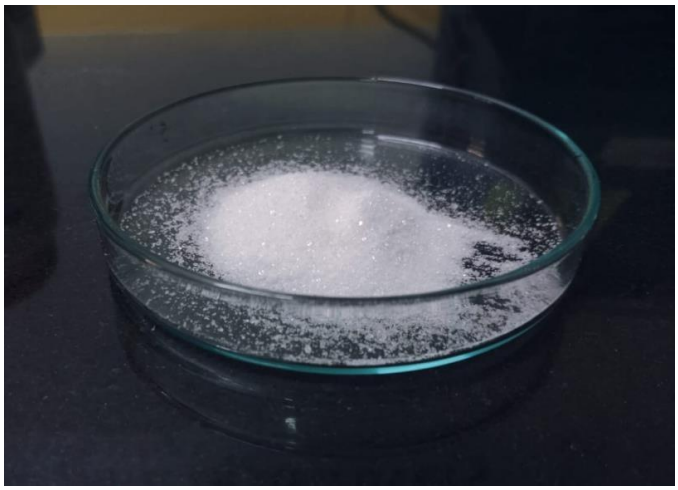

Fig.9.Methyl Paraben

Methyl Paraben shows up just about everywhere as a preservative in pharmaceuticals, cosmetics, and even food. Chemically, it's the methyl ester of p-hydroxybenzoic acid, which is just a fancy way of saying it's a white, crystalline powder that dissolves nicely in alcohol and stays stable over time.When it comes to Transdermal Drug Delivery Systems (TDDS), like patches you stick on your skin, methyl paraben gets added to stop bacteria and fungi from moving in while the patch sits around in storage or while you're using it. These patches often have water, plant extracts,

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and polymers, which can attract microbes. Once contaminated, the patch isn't as stable or safe, so methyl paraben steps in to keep things in check and keeps the patch doing its job for longer.

What's nice about methyl paraben is that you don't need much of it; at low doses, it keeps microbes away without messing up how the drug releases from the patch. Plus, it doesn't cause irritation if used properly and mixes well with common excipients like HPMC and PVA. Beyond just safety, it helps the patches last, keeping their look, feel, and effectiveness intact even after sitting on the shelf for a while.Honestly, because methyl paraben works against a wide range of microbes and won't break the bank, you find it in all kinds of transdermal products, from herbal patches to medicated ones—even cosmetic and eye patch formulas use it to stay fresh[33].

4. Propyl Paraben :

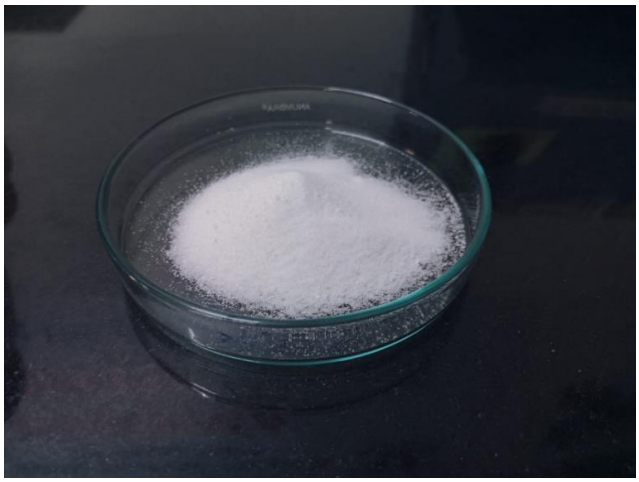

Fig.10.Propyl Paraben

Propyl Paraben is a popular antimicrobial preservative you'll find in a lot of pharmaceutical and cosmetic products. Chemically, it's just the propyl ester of p-hydroxybenzoic acid—a white powder that's pretty stable and does a solid job as a preservative. It really stands out against molds and fungi, which is why manufacturers typically mix it with methyl paraben to cover a broader range of microbes.When it comes to transdermal drug delivery systems—those patches that deliver medicine through your skin—propyl paraben is key. It stops microbes from contaminating any water-based or plant-based ingredients, plus it protects the polymers used in the formula. So, it keeps the patch safe, extends its shelf life, and helps maintain overall quality.

In these patches, propyl paraben doesn't just fight off germs; it also keeps the patch looking and feeling right. No weird changes in texture, no breakdown of important ingredients. It works at low doses, mixes well with other common excipients like HPMC and PVA, and, as long as you stick to safe levels, it's generally not a concern for users. That preservative power means transdermal patches—including the herbal or medicinal kinds, and even eye patches—stay stable and reliable for people who need them[34].

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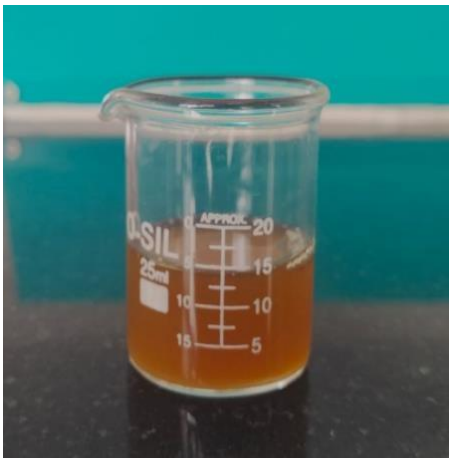

Fig.No.11.Powder of green tea leaves Fig.No.12.Extraction of green tea leaves Fig.No.13.Final extract of green tea leaves

Preparation Of Herbal Extract :

1. Gerren Tea Leaves :

Procedure :

1. First fresh green tae leaves were plucked by hands and collected in a container.
2. The collected fresh green tea leaves were washed with distilled water to remove impurities.
3. The washed green tea leaves were spreaded on drying tray and sun-dried.
4. The green tea leaves were dried for 2 to 3 days until they were completely dry.
5. Once dried, a sufficient quantity of green tea leaves were crushed into a coarse powder using a electric grinder.
6. The fine and coarse powder of green tea leaves is obtained.
7. Then the 10 gm powder of green tea leaves is mixed with the 100 ml of distilled water in a conical flask.
8. The mixture were properly mixed to obtain a uniform mixture.
9. The mixture is kept for 24 hours at room temperature.
10. Then after 24 hours the mixture is filtered out using filter paper.
11. Then finally we get the extract of green tea.

2. Potato Extract :

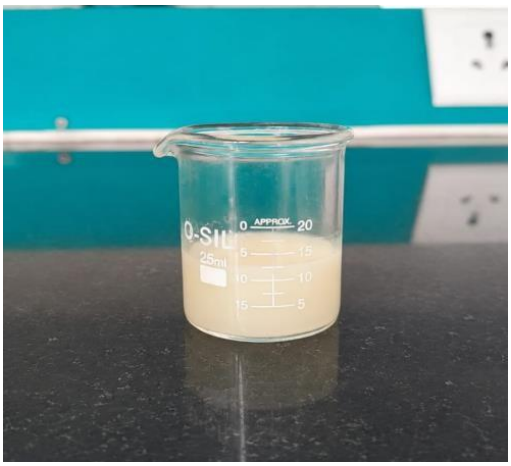

Fig.14.Potato Extract

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Procedure :

1. Fresh potatoes were collected and washed thoroughly with distilled water to remove dirt and impurities.
2. The potatoes were peeled and cut into small pieces.
3. The pieces were crushed or blended with a small quantity of distilled water to form a slurry.
4. The slurry was filtered using muslin cloth or filter paper to separate the liquid from solid residues.
5. The filtrate was allowed to stand undisturbed for some time so that the starch settled at the bottom.
6. The supernatant liquid was carefully decanted, and the settled starch was collected.

3. Cumcumber Extract :

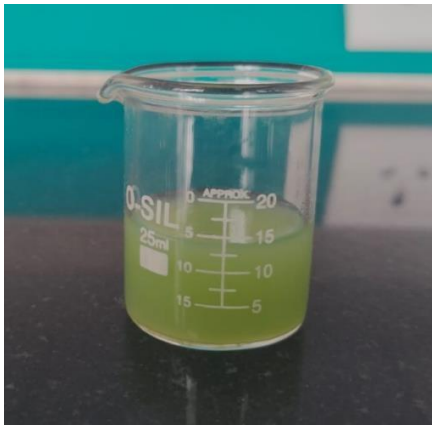

Fig.15.Cumcumber Extract

Procedure :

1. Fresh cucumbers were collected and washed thoroughly with distilled water to remove dirt and impurities.
2. The cucumbers were peeled (if required) and cut into small pieces.
3. The pieces were crushed or blended using a grinder to obtain a pulp.
4. A small quantity of distilled water was added to facilitate extraction.
5. The pulp was filtered using muslin cloth or filter paper to separate the liquid extract from solid residues.
6. The obtained filtrate was collected as cucumber extract.

4. Aloe Vera Extract :

Fig.16.Aloe Vera Extract

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Procedure :

1. Fresh Aloe vera were collected and washed thoroughly with distilled water to remove dirt and impurities.
2. The thorny edges were removed carefully using a clean knife.
3. The outer green peel was cut open, and the transparent inner gel was collected.
4. The obtained Aloe vera gel was blended or crushed to obtain a uniform mixture.
5. The gel was filtered using muslin cloth or filter paper to remove fibrous materials and impurities.
6. The filtrate obtained was collected as Aloe vera extract.

Fig.17.Fltration Processes

FORMULATION DEVELOPMENT OF PATCH :

Procedure for Preparation of Polyherbal Under-Eye Patch/Formulation :

1. Preparation of HPMC Solution :

Accurately weighed 2.5 g of HPMC and dissolved it in 36 ml of distilled water with continuous stirring until a clear and uniform solution was obtained.

2. Preparation of Preservative Solution :

Accurately weighed 0.05 g of methyl paraben and dissolved it in 1 ml of warm water. Similarly, 0.01 g of propyl paraben was dissolved separately in 1 ml of warm water.

3. Preparation of Herbal Extract Mixture :

Measured quantities of herbal extracts were taken as follows:

Green tea extract – 2 ml Potato juice – 3 ml Cucumber juice – 3 ml Aloe vera juice – 5 ml

All the extracts were mixed properly to obtain a uniform herbal mixture.

4. Addition of Ingredients :

The prepared herbal extract mixture was added slowly into the HPMC solution with continuous stirring.

Then, 1.5 ml of glycerin was added to the mixture as a plasticizer and humectant.

5. Addition of Preservatives :

The prepared methyl paraben and propyl paraben solutions were added into the formulation and mixed thoroughly.

6. Mixing of Formulation :

The entire mixture was stirred continuously until a smooth, homogeneous, and bubble-free solution was obtained.

7. Casting of Patch/Formulation :

The prepared formulation was poured carefully into a clean petri dish and spread uniformly.

8. Drying :

The petri dish was kept undisturbed at room temperature for drying until a flexible film/patch was formed.

9. Storage :

The dried formulation was carefully removed and stored in an airtight container for further evaluation and use.

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Fig.18.Transdermal Polyherbal Eye Patch

EVALUATION TEST'S OF PATCH :

1. Organoleptic Characteristic:

The organoleptic parameters include its nature, colour,feel and consistency which were evaluated manually for its physical properties .

• Colour:

Observe the colour (e.g, white, yellowish, brown , green, pale green) Check for uniformity or discoloration

• Odour:

Smell the patches and describe the aroma (e.g,characteristics, aromatic ,distinctive)

• Appearance:

Appearance evaluation is the visual examination of the polyherbal transdermal eye patch to assess its color, texture, smoothness, clarity, flexibility, and overall physical uniformity.

• Surface:

Surface evaluation is the examination of the smoothness, uniformity, and texture of the polyherbal transdermal eye patch to ensure it is free from defects and suitable for application.

• Texture/Feel:

Rub a patch between fingers. Describe the texture , some times simple microscope are also use (e.g. Fine, gritty , coarse, sticky , smooth)

• PH:

Transdermal patches, dissolve or disperse the patch in 100 ml of distilled water, stir, and measure the pH using a calibrated pH meter or pH paper.

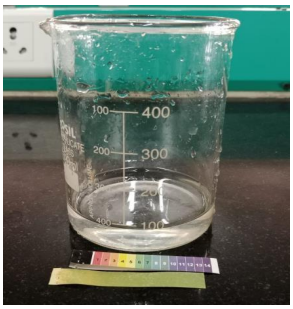

Fig.19. ph test

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Parameter	Result
Appearance	Smooth and flexible
Colour	Light green to pale yellow
Odour	Characteristic herbal odour
Texture	Soft and non-sticky
Surface	Uniform and smooth
Ph	6.2-6.8

Table No.1.Organopleptic Test's Of Patch

2. Thickness :

Thickness of patch was measured using vernier caliper in different places on the plaster and average thickness was calculated.

Trial	Result
1	0.1mm
2	0.2mm
3	0.1mm

Table No.2. Thickness Of Patch

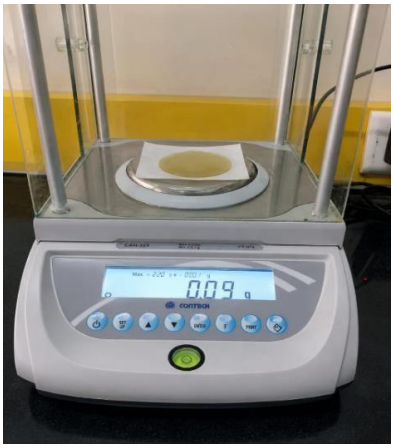

Fig.20. Thickness Of Patch

3. Weight

Weight of individual patches was determined using an electronic balance with sensitivity of 0.1mg and the average weight was calculated.

Trial	Result
1	0.09gm
2	0.08gm
3	0.09gm

Table No.3. Weight Of Patch

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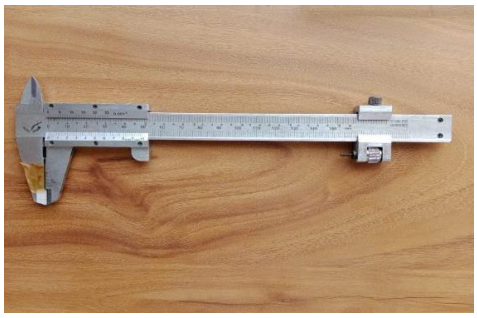

Fig.21.Weight Of Patch

4. Weight Uniformity Test :

The weight uniformity of randomly selected patches from each formulation was checked by digital weighing balance in triplicate. Every triplicate gave uniformity in weight and the average value was similar to an individual patch. So the mean value is zero in almost all the formulations and the patches showed minimum deviation in weight.

Trial	Result
1	0.09gm
2	0.08gm
3	0.09gm

Table No.4.Weight Uniformity Test

5. Moisture Content :

The prepared patch was out and weighed again,% moisture content was measured and calculated with the help of following equation.

Calculation Of Moisture Content :

Formula :

Moisture Content [%]=Initial weight-Final weight/Initial weight*100

Given :

Initial weight of patch[W1]=0.518g

Final weight of patch[W2]=0.487g

Calculation :

Moisture Content[%]=0.518-0.487/0.518*100

=0.031/0.518*100

=0.0598*100

=5.98%

Final Value = 5.98%

Trial	Result
1	6.5%
2	6%
3	5.98%

Table No.5.Moisture Content Of Patch

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6. Folding Endurance :

A particular area of the strip(1x1cm) was cut uniformly and folded over and over until it broke. The value of folding endurance was determined by the number of times the film was folded at the same location either to break the film or to develop visible cracks.

Trial	Result
1	10
2	12
3	11

Table No.6.Foldind Endurance Of Patch

7. Skin irritation test:

Before applying the patch, the dorsal skin of a volunteer was washed with 70% ethanol. The patches were applied on right forearm for 24hrs. After 24 hours, the patches were removed and the forearms were cleansed with saline. The cutaneous responses were assessed by observing skin allergy and irritation at 15 minutes, 1 hour and 24 hours after the test patch was removed.

Sr.No.	Parameter	15 Minute	1 Hour	24 Hour
1	Irriation	No	No	No
2	Redness	No	No	NO

Table No.7.Skin Irritation Test Of Patch

8. Stability Studies:

Stability testing of prepared formulation was conducted by storing at different temperature conditions for the period of one month. The packed formulation stored at different temperature conditions viz. Room temperature, 20°C and 40°C and were evaluated for physical parameters like Colour, Odour, pH, Appearance Texture.

Parameter	25	40
Appearance	Smooth/Uniform	Slightly Affected
Colour	Pale green	Pale green
Odour	No changes	No changes
Texture	Sticky/Smooth	Slightly Variation
Ph	6.2-6.8	6.2-6.8

Table No.8.Stability Testing Of Patch

9. UV ABSORBANCE OF PATCH :

PROCESS :

Principle :

The UV spectrophotometric method was used to determine the absorbance of the polyherbal transdermal patch by measuring the intensity of light absorbed at a specific wavelength (λmax).

Procedure

1. A small piece of the optimized polyherbal transdermal patch was accurately cut and weighed.
2. The patch sample was transferred into a beaker containing a distilled water for extraction of active constituents.
3. The solution was stirred properly until complete extraction of herbal constituents from the patch was achieved.
4. The obtained solution was filtered using filter paper to obtain a clear filtrate.
5. A blank solution containing only solvent was prepared.
6. The UV spectrophotometer was switched on and stabilized.
7. The instrument was calibrated using the blank solution.
8. The sample solution was analyzed at the selected wavelength (λmax).

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9. The absorbance value obtained for the optimized patch formulation was 0.2.

Observation Table :

Parameter	Observation
Sample	Polyherbal Transdermal Patch
Method	UV Spectrophotometry
Absorbance Obtained	0.2
Appearance Of Obtained	Small Visible Peak Observed
Result	Uniform distribution of herbal constituents confirmed.

Table No.9.Observation of UV

GRAPH :

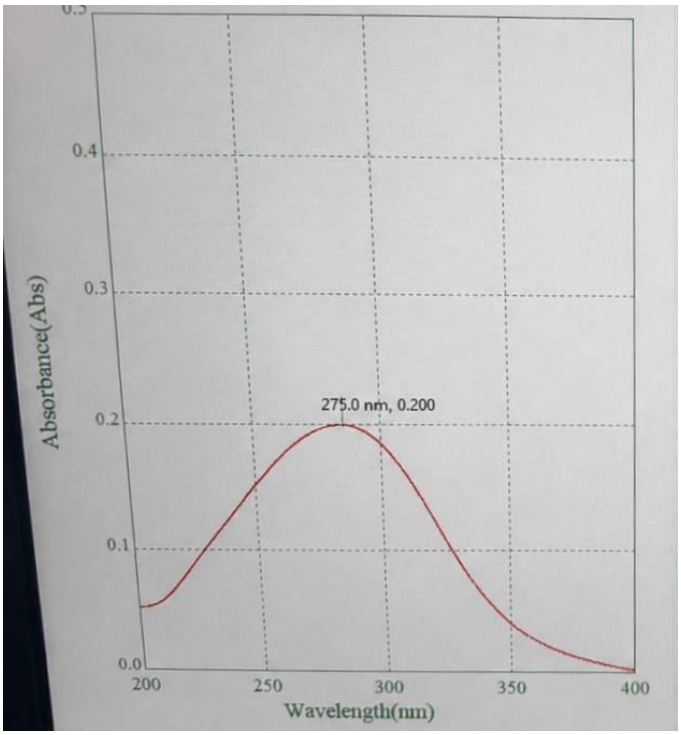

Fig.No.22.Graph of UV absorbance

Result :

The optimized polyherbal transdermal patch showed an absorbance value of 0.2 in UV spectrophotometric analysis, indicating satisfactory incorporation and uniform distribution of active herbal constituents within the formulation.

Precaution's Should Be Taken :

1. Apply the patch only on clean and dry skin.
2. Do not apply on cuts, wounds, rashes, or irritated skin.
3. Avoid direct contact of herbal extract with the eyes.

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4. Perform a patch test before first use to check allergy.
5. Wash hands before and after applying the patch.
6. Use the patch only for the recommended time duration.
7. Remove the patch immediately if redness, itching, or burning occurs.
8. Store the patches in a cool and dry place away from sunlight.
9. Do not share the patch with others to avoid contamination.
10. Avoid using expired or damaged patches.
11. Keep the patch away from children.
12. Consult a doctor if the user has severe eye disease or skin sensitivity.

FINAL RESULT :

Fig.23.No.Final picture of patch

FINAL RESULT OF PATCH AFTER APPLICATION :

Fig.24.No.Final patch after application

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OPTIMAZATION CHART :

Trial No.	Problem Identified	Modifiaction Made	Result Obtained
Trial 1	Patch was very thin and lacked proper film formation.	Increased the quantity of HPMC to improve thickness and film integrity.	Patch thickness improved, but further optimization was required.
Trial 2	Patch became excessively sticky due to higher plasticizer content.	Reduced the quantity of glycerine to decrease stickiness.	Stickiness was reduced and patch characteristics improved.
Trial 3	Balanced thickness, flexibility,and non-sticky nature achieved.	Optimized concentration of HPMC and glycerine maintained.	Ideal polyherbal transdermal patch obtained with satisfactory appearance and physical properties.

Table No.10.Optimization of chart

Result :

The formulated polyherbal transdermal eye patch containing Green tea, Cucumber, Potato, and Aloe vera was successfully prepared and evaluated for various physicochemical parameters. The prepared patches were smooth, flexible, and uniform in appearance without cracks or air bubbles. Thickness and weight variation were found to be uniform, indicating consistency in formulation. The moisture content of the patches was within acceptable limits, showing good stability of the formulation. Folding endurance studies demonstrated good flexibility and mechanical strength of the patches. The formulated eye patches showed satisfactory adhesion on the skin surface and remained intact during the application period.

Skin irritation studies revealed that the formulation was non-irritant and safe for topical application around the under-eye area. The eye patches produced a cooling and soothing effect after application. Improvement in skin hydration, reduction in puffiness, and mild reduction in dark circles were observed due to the combined action of herbal ingredients. The overall evaluation indicated that the prepared polyherbal transdermal eye patch possessed good stability, safety, and effectiveness for under-eye care applications.

Sr.No.	Parameter	Result
1	Appearance	Smooth / Uniform
2	Colour	Pale green
3	Odour	Distinctive
4	Texture	Soft and flexible
5	Ph	6.2-6.8
6	Thickness	0.1mm
7	Surface	Uniform and smooth
8	Weight	0.09gm
9	Weight Uniformity	0.09gn
10	Moisture Content	5.98%
11	Folding Endurance	11
12	Skin Irritation	Nil
13	Stability Study	Stable
14	UV Absorbance	0.2

Table No.11.Result Of All Test's

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Discussion :

The present study focused on the development and evaluation of a polyherbal transdermal eye patch using natural herbal ingredients known for their beneficial effects on skin and under-eye conditions. The successful preparation of smooth and flexible patches indicates proper compatibility between the herbal extracts and polymeric base used in the formulation. The acceptable moisture content suggests that the patches possess suitable stability and reduced risk of brittleness or microbial growth. Good folding endurance values indicate adequate flexibility and durability, which are essential for convenient application on the delicate under-eye skin.

The antioxidant and anti-inflammatory properties of green tea helped in reducing puffiness and protecting the skin from oxidative damage. Cucumber contributed a cooling and hydrating effect, which provided relaxation and improved skin moisture. Potato extract showed beneficial effects in reducing pigmentation and dark circles due to its natural skin-lightening properties. Aloe vera enhanced skin hydration, soothing action, and skin repair activity. The combined use of multiple herbal ingredients produced a synergistic effect, enhancing the overall therapeutic and cosmetic benefits of the formulation. The absence of skin irritation confirmed the safety of the formulation for topical use.

Based on the obtained results, the developed polyherbal transdermal eye patch can be considered a promising herbal cosmetic formulation for managing under-eye puffiness, fatigue, dryness, and dark circles. Further clinical studies may help in establishing its long-term efficacy and commercial potential.

II. CONCLUSION

The polyherbal transdermal eye patch for under-eye care was successfully formulated and evaluated. The developed product represents a novel, non-invasive, patient-friendly, and cost-effective cosmeceutical approach to managing under-eye conditions including dark circles, puffiness, and signs of periorbital aging. The formulation harnesses the synergistic benefits of four complementary herbal ingredients delivered in a controlled, sustained manner through a biocompatible polymer matrix.The research validates the proof of concept for polyherbal transdermal eye patches and lays the groundwork for further investigations including ex vivo skin permeation studies, clinical trials, and scale-up manufacturing. Future work may also explore the incorporation of permeation enhancers, nanoencapsulation of herbal actives, and the development of biopolymer-based biodegradable matrices for enhanced sustainability.

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