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Formulation And Evaluation Of Polyherbal Transdermal Patches For Wound Healing

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Abstract : The present research project focuses on the formulation, development, and testing of herbal transdermal patches containing Tridax procumbens, Tamarindus indica, and Semecarpus anacardium extracts for therapeutic applications. These medicinal herbs are known for their anti-inflammatory, antioxidant, and wound-healing qualities, making them ideal for transdermal drug administration. The patches were created utilizing a solvent casting approach with appropriate polymers and plasticizers to ensure proper flexibility, adhesion, and drug release. Phytochemical examination of the extracts confirmed the presence of bioactive ingredients such as flavonoids, tannins, alkaloids and saponins. The created patches were tested for physicochemical properties such as thickness, weight fluctuation, moisture content, elasticity, and drug content consistency. Skin irritation tests were conducted to assess the efficacy and safety of the formulations. The results demonstrated that the developed patches exhibited satisfactory mechanical properties, sustained drug release, and minimal skin irritation. This research highlights the potential of herbal-based transdermal systems as a safe and effective alternative for topical and systemic drug delivery.

Key Words: Herbal transdermal patches, Tridax procumbens, Tamarindus Indica , Semecarpus anacardium, Flavonoids, Wound healing, Safe , Effective.

INTRODUCTION

Herbal plants have been an integral part of traditional medicine and natural healing practices for centuries. They are rich sources of bioactive compounds, including alkaloids, flavonoids, terpenes, and phenolic acids, which contribute to their medicinal properties. Various civilizations, such as Ayurveda, Traditional Chinese Medicine (TCM), and Indigenous healing systems, have relied on herbal plants for treating ailments, enhancing immunity, and promoting overall health[1].

Medicinal plants have played a vital role in traditional and modern medicine due to their rich bioactive compounds and therapeutic properties. Among them, Tridax procumbens, Tamarindus indica, and Semecarpus anacardium are widely known for their medicinal significance in various healing practices, including Ayurveda and traditional folk medicine.

1.1 Tridax procumbens

Tridax procumbens L., generally appertained to as" coat buttons," is a ongoing plant that belongs to the Asteraceae family and is presently set up in tropical and tropical regions worldwide. Starting in tropical America, the factory has spread to tropical Africa, Asia, Australia, and India. It's an Wild condiment distributed each over India.. It's an largely precious factory with an inconceivable quantity of medicinal action[2].

It historically was used to treat bronchial catarrh, dysentery, malaria, stomachaches, diarrhea, and high blood pressure. It is also used to stop bleeding from wounds, bruises, and cuts, as well as to stop hair[4].

Fig.1.1.1: Tridax procumbens leaves

1.2 Tamarindus Indica:

Tamarindus indica The Ayurvedic medical system generally refers to the Linn. family Caesalpiniaceae as Chincha. Its fruit, delicate leaves, and blossoms are encyclopedically employed in food medications10. nearly every element of this plant has some operation in the fields of medicine, nutrition, business, or the terrain. It's therefore considered as a multipurpose tree[7].

Maximum tropical countries, including Bangladesh, Nigeria, India, and Sudan, use T. indica as a traditional medicine. compared to specifics, it's constantly freely and easily accessible. Under the Amla Varga(group of sour specifics) headed, it has been described under the names" Amleeka" in the Caraka Samhita, Susruta Samhita, and Ashtanga Sangraha[6,7].

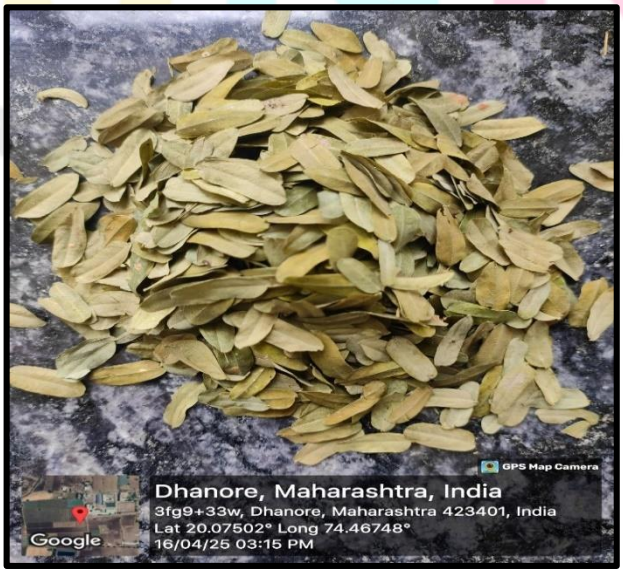

Fig.1.2.1: Tamarindus Indica leaves

1.3 Semecarpus Anacardium:

Semecarpus anacardium, commonly known as the marking nut, is a medicinal tree belonging to the Anacardiaceae family. Native to India and Southeast Asia, it is widely used in Ayurvedic and traditional medicine for treating various ailments. The tree produces kidney-shaped black resinous fruits with an edible fleshy receptacle[8].

Rich in flavonoids, phenolics, tannins, and alkaloids, its fruit exhibits antimicrobial, anti-inflammatory, antioxidant, and wound-healing properties. Despite its medicinal benefits, the fruit contains toxic resin, which requires careful processing before use[8].

Fig.1.3.1: Semecarpus Anacardium

2. Introduction to wounds :

A wound is a break or damage to the skin or other body tissues, usually caused by injury, trauma, or surgery. Wounds can vary in severity, size, and depth, and they are often classified based on their cause and the layers of tissue involved.[9]

Types of Wounds:

1. Acute Wounds: These are wounds that heal in a normal, predictable manner, such as cuts, abrasions, or surgical incisions[10].
2. Chronic Wounds: These are wounds that do not heal as expected and persist for a long period. Examples include diabetic ulcers, pressure ulcers, and venous ulcers[10,11].

2.1 General Structure of Wound:

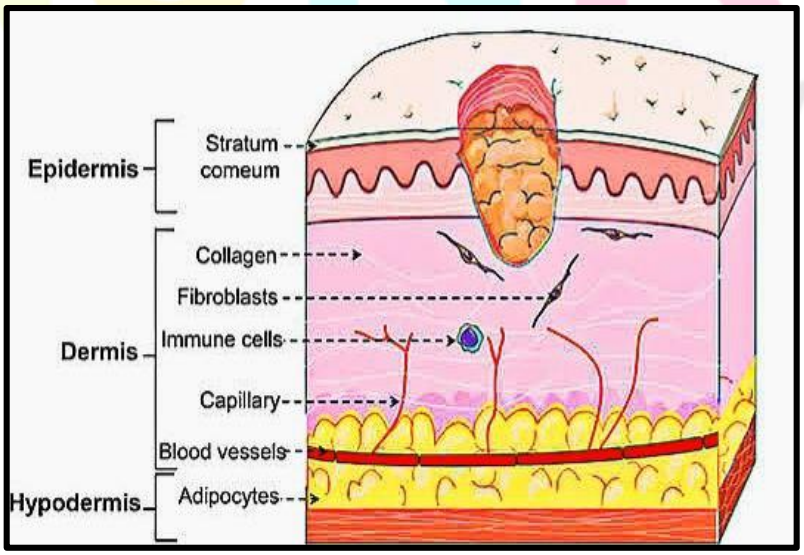

Fig. 2.1.1 General Structure of Wound

3. Transdermal Drug Delivery System :

• Transdermal medicine delivery systems(TDDS), also known as " patches, " are capsule forms designed to deliver a therapeutically effective quantum of medicine across a case's skin.
• TDD is a royal system of delivering medicines systemically by applying a medicine expression onto complete and healthy skin.
• The medicine originally penetrates through the stratum corneum and also passes through the deeper epidermis and dermis without medicine accumulation in the dermal estate.
• When medicine reaches the dermal estate, it becomes available for systemic immersion via the dermal microcirculation[13].

3.1 Route of Skin Penetration :

The main route of transport for water-answerable tittles is transcellular. It involves the passage through the cytoplasm of corneocytes and lipid arrangement of the stratum corneum. The pathway of transport for lipid answerable tittles is intercellular; it implicates the passage putatively through the endogenous lipid within the stratum corneum. The transcellular and intercellular route is each around known as trans- epidermal route[14].

3.2 Mechanism of Permeation:

The drug released from the patch passes through the skin via:

1) Transcellular route (through skin cells)

2) Intercellular route (between skin cells)

3) Appendageal route (via sweat glands or hair follicles – minor route)

4. NEED OF THE STUDY.

- To explore a non-invasive, sustained-release drug delivery system using herbal extracts.
- To enhance the therapeutic potential of traditional medicinal plants through modern formulation techniques.
- To minimize the side effects and first-pass metabolism associated with oral administration.
- To improve patient compliance and ease of application using transdermal technology.
- To develop a synergistic herbal formulation for targeted topical or systemic relief.

5. RESEARCH METHODOLOGY

- To extract and characterize active constituents from Tridax procumbens , Tamarindus indica, and Semecarpus anacardium .
- To formulate a transdermal patch incorporating the herbal extracts with suitable polymers and permeation enhancers.
- To evaluate physicochemical properties of the patch: thickness, weight, moisture content, folding endurance, and surface pH.
- To perform skin irritation and compatibility tests on human/animal skin models.
- To analyze the patch's therapeutic efficacy through anti-inflammatory, antimicrobial, or wound-healing activity models.

6. Materials and Methods :

Extraction Process

• For Tridax Procumbens

Materials:

Tridax procumbens leaves, Ethanol, water, filter paper, water bath, measuring cylinder, conical flask, beaker, etc.

• For Tamarindus indica

Materials:

Tamarindus indica leaves, Ethanol, water, sludge paper, water bath, measuring cylinder, conical beaker, teacup, etc.

6.1 Methods of Extraction :

(Extract both Tridax procumbens and Tamarindus Indica independently.)

- Fresh leaves of Tridax procumbens and Tamarindus Indica were collected, washed completely with distilled water to remove dust and debris, and shade- dried at room temperature for 7 – 10 days. The dried leaves were base into a fine powder.
- About 10 g of shade- dried and coarsely powdered leaves of Tridax procumbens or Tamarindus indica were taken in a clean glass vessel.
- The powder was soaked in 100 mL of hydroalcoholic solvent(ethanolwater, 7030) and kept at room temperature for 72 hours with occasional shaking.
- After maceration, the admixture was filtered through muslin cloth and Whatman No. 1 filter paper.
- The filtrate was also concentrated using a water bath at 40 – 50 °C until asemi-solid extract was attained.
- The dried extract was stored in an watertight vessel for farther use[6].

6.2 Transdermal patch Process:

Formulation of Transdermal Patch:

Sr.No.	Ingredients	Role
1.	Tridax Procumben Extract	Active herbal components
2.	Tamarindus Indica Extract	Active herbal components
3.	Semecarpus Anacardium fruit pulp	Active herbal components
4.	Hydroxypropyl methyl cellulose(HPMC)	Film forming polymer
5.	Methyl cellulose	Thickning agent
6.	Glycerine	Plasticizer
7.	Propylene Glycol	Permeation enhancer
8.	Menthol	Soothing effect
9.	Ethanol	Solvent
10.	Distilled water	Solvent

Table:6.2.1 Formulation of Transdermal Patch

6.3 Method of Preparation of Patch :

(Solvent evaporation method)

The solvent evaporation complex is a everyday approach used in pharmaceutical expression to prepare colorful medicine delivery systems, including transdermal patches. This system involves the dissolution of the active pharmaceutical ingredient(API) and other excipients in a unpredictable solvent, followed by the disposal of the solvent to form a solid dosage form.

1. Prepare Polymer Solution:
   Dissolve named polymers in ethanol or a suitable solvent. Add plasticizers for inflexibility.
2. Incorporate Drug Extract :
   Mix the extract into the polymer solution for the asked dosage.
3. Cast the Patch:
   Pour the solution onto a flat surface to form a steady film.

4. Dematerialize Solvent:
   Allow the solvent to dematerialize, forming a solid patch structure.
5. Dry and Cure:
   Remove residual moisture and freely cure the patches for bettered properties.
6. Cut and Package:
   Cut patches to asked sizes, place them on backing membranes, and seal them in packaging[16].

Fig. 6.3.1 Formulation before evaporation

Fig. 6.3.2 Formulation after evaporation

7. Evaluation Test:

7.1 Phytochemical Screening of Herbal plant extract:

1.Flavonoids-

a) Alkaline reagent test:
Add 2ml of extract , add few drops of 10% NaOH solution. A yellow color appears which disappears upon adding dilute HCL, indicating presence of Flavonoids.

b)Lead acetate test:
Add a few drops of 10% lead acetate solution to 2ml of extract. Formation of a yellow color indicates presence of Flavonoids.

c)Shinoda test:
2ml of extract , add small piece of magnesium ribbon , followed by a few drops of conc HCL. Pink , red or orange color appears which indicates presencs of flavonoids[15,16].

2.Alkaloids:

a) Mayer's test:
Add few drops of Mayer's reagent into plant extract. Formation of white or creamy precipitation indicates presence of alkaloids.

b)Wagner's test:
Add Wagner's reagent into plant extract. A reddish brown precipitation forms if alkaloids are present.

c)Dragendroff's test:
Add Dragendroff's reagent into plant extract. An orange or brown precipitate confirms alkaloids[15].

3.Tannins:

a)Ferric Chloride test:

Add few drops of 1% ferric chloride solution to 2ml of plant extract. Blue-black or green-black color indicates presence of tannins.

4.Saponins:

a)Foam test:

Shake 1ml of extract with 10ml of distilled water in a test tube vigorously for 30 seconds. Persistant foam that last for 10 min indicates presence of saponins[15].

7.2 Evaluation of Transdermal Patch:

1.Physical characteristics:

Visual Inspection of patches to check uniformity in size, shape, color , surface smoothness and transparency[17].

2.Thickness Measurement:

Measure the thickness of each patch using a micrometer / ruler. Ensure the thickness falls within a specified range (e.g. 0.2 - 0.3 mm)[18].

3.Weight Variation:

Weigh 10 patches individually and calculate the average weight to assess uniformity. Ensure weight variation does not exceed a certain percentage (e.g. ±5%)[19].

4.Folding Endurance:

Repeatedly fold the patch at the same place until it breaks or cracks. It indicates the flexibility[20].

5.Tensile Strength Test:

Stretch the patch by hand and note resistance to breaking[21].

6.pH Testing:

Moisten a piece of pH paper with distilled water and press it against the adhesive side for 1 minute , then observe the color change. The pH should be close to skin's natural pH. (4.5-6.5)[22].

7.Moisture content:

A known weight of each freshly prepared patch was taken & recorder as initial weight (w_1). The patches were then placed in a clean and dry petri dish and transferred to a hot air oven maintained at 60^0 C. The patches were dried in the oven for 1 hr. After drying period , the patches were removed from the oven , allowed to cool in a desiccator , then weighed again and recorded as final weight (w_2)[22].

Percentage moisture content was calculated using the formula:

Moisture Content(%) = (W_1-W_2)/W_1 × 100

8.Antimicrobial and Drug release test:

a)Agar Diffusion Test:

Pour sterile nutrient agar into petri dish and let it solidify. Spread bacterial suspension on agar. Cut a small $1cm^2$ piece of the patch. Place it onto agar surface. Incubate at 37^0C for 24 hours. Look for a clear zone (Inhibition zone) around the patch. Larger clear zone = better drug release and antimicrobial effect[16,21].

IV. RESULTS AND DISCUSSION

8.1 Phytochemical screening of herbal plant extract:

Fig.8.1.1: Phytochemical screening of herbal plant extract

Sr.No.	Test	Observation	Result + Present, -Absent
1)Flavonoids	a)Shinoda test	Pink, Red or Orange color appears	+
	b)Alkaline reagent test	Yellow color disappear by adding dil HCL	+
	c) Lead acetate test	Yellow color appears	-
2)Alkaloids	a) Dragendroff's test	Reddish brown or orange ppt	+
	b) Wagner's test	Reddish brown ppt	-
	c) Mayer's test	White or creamy ppt	+
3)Tannins	a)Ferric Chloride test	Blue black or green black color	+
4)Saponins	a)Foam test	Formation of foam	+

Table.8.1.1: Phytochemical screening of herbal plant extract

8.2 Evaluation of Transdermal Patch:

Sr. No.	Parameter	Acceptance criteria	Result
1.	**Physical Characteristics**	Uniform colour , size, shape, surface smoothness & transparecy	Pale yellow colour, Uniform size & shape, smooth surface & Transparent
2.	**Thickness measurement**	0.2 – 0.3 mm	0.23mm
3.	**Weight variation**	±5%	125mg
4.	**Folding Endurance**	Indicate flexibility	Flexible
5.	**Tensile strength test**	16-22%	3.0 $kgcm^{-2}$
6.	**Skin adhesion test**	Strong adhesion	Strongly adhered
7.	**Skin irritation test**	No irritation	No irritation
8.	**pH Testing**	4.5 – 6.5	6.1
9.	**Moisture content**	3-5%	4%
10.	**Stability test**	Stable for 3 month	Stable
11.	**Antimicrobial & Drug release test**	Clear zone	8-10mm clear zone against E.Coli.

Table 8.2.1 : Evaluation of Transdermal Patch

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