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FORMULATION AND EVALUATION OF ACTIVATED CHARCOAL BASED CREAM FOR PSORIASIS MANAGEMENT

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ABSTRACT

Excessive keratinocyte growth and scaling are hallmarks of psoriasis, a chronic inflammatory skin condition. The purpose of this project is to develop and assess a topical activated charcoal cream intended to treat psoriasis symptoms. Activated charcoal possesses absorptive, detoxifying, and anti-inflammatory properties that help remove impurities, reduce irritation, and soothe inflamed skin. The optimized formulation showed a smooth texture, appropriate pH, and non-irritant nature, making it suitable for topical use. The finding suggested that activated charcoal cream can serve as an effective and safe alternative therapy for managing psoriasis and improving skin comfort. To examine the efficacy of a charcoal-based cream in managing psoriasis symptoms and improving skin health through topical application. Activated charcoal and other excipients were used to prepare various cream formulations, which were evaluated for pH, spreadability, viscosity, washability, and antimicrobial activity using standard pharmaceutical techniques. Five trial formulations were developed and evaluated, with formulation F3 demonstrating optimal physical, chemical, and antimicrobial properties. Antimicrobial testing showed significant inhibition against Staphylococcus aureus and Candida albicans. The optimized charcoal-based cream shows promise as an effective topical therapy for psoriasis management.

KEYWORDS: Psoriasis, Activated charcoal, Topical cream, Anti-microbial activity, Formulation, and evaluation.

INTRODUCTION

Pharmaceutical semisolid formulations, which are primarily intended for topical application on the mucous membranes (such as the eye, rectal or vaginal) are dose forms that fall in between solids and liquids. Long-term contact and regulated drug release are made possible by their viscosity. Certain products, such as nitroglycerin ointments, might have systemic effects through skin absorption even though they are mostly utilized for local effects. Because they can effectively distribute both hydrophilic and lipophilic medications, these formulations are essential in dermatology, cosmetics, and transdermal delivery. The success of these formulations depends on the base composition, viscosity, and drug release behavior.[1-2]

Eg: ointments, creams, gels, jellies, poultices.

CREAMS

A cream is a semi-solid emulsion (oil-in-water or water r-in-oil) containing medical agents for external use. It combines oil and water phases stabilized by emulsifiers, resulting in a smooth, spreadable texture. Creams provide cooling, soothing, and protective effects, enable quick drug absorption, and are non-sticky and pleasant compared to ointments. Common ingredients include water, oils (e.g., mineral oil, lanolin), emulsifiers (e.g. cetostearyl alcohol), preservatives, and humectants (Glycerin) for moisture retention.

Eg: Hydrocortisone cream.

Fig. 1: Schematic representation of cream.

COMMON USES OF CREAMS

Applied for the treatment of bacterial skin infections like impetigo and boils. (e.g. neomycin cream).

Utilized for addressing fungal infections such as ringworm and athlete's foot. (e.g. ketoconazole cream).

Used for viral skin infections like herpes simplex (e.g. acyclovir cream).
Helps to reduce inflammation, redness, and swelling in allergic or inflammatory conditions (e.g. Betamethasone cream).

Provide relief from itching caused by insect bites, rashes, eczema (e.g. calamine cream). Gives local pain relief in muscle pain, arthritis, or sprains (e.g. Capsaicin cream).

Prevents infection in minor cuts, wounds, or burns (e.g. povidone-iodine cream). Used to numb the skin before injections or minor procedures (e.g. prilocaine cream).

Treats parasitic skin infestations such as scabies and lice (e.g. Benzyl benzoate cream). Helps to manage psoriasis by reducing scaling and inflammation (e.g. coal tar cream).[3-4]

SKIN

The skin is the body's largest organ, representing roughly 16% of total body weight. It serves as a protective barrier and helps maintain internal stability (homeostasis).; It protects against mechanical injury, microorganisms, chemicals, and UV radiation while also regulating temperature, enabling sensation, excreting waste through sweat, synthesizing vitamin D, and preventing bacterial growth through its acidic ph. The skin also plays an immune role via Langerhans cells and the skin microbiome, and modern research explores advanced therapies such as regenerative medicine and nanotechnology for skin treatment.

The skin consists of three primary layers: the epidermis, the dermis, and the subcutaneous tissue. The epidermis serves as a protective shield and contains specialized cells like keratinocytes and melanocytes. On the other hand, the dermis offers strength and flexibility, provides nourishment, houses blood vessels, stores energy, and absorbs impact.

Functionally the skin regulates heat through sweating and blood flow changes, controls evaporation to prevent water loss, stores fat and blood, synthesizes essential substances like vitamin D and keratin, and aids in excretion. It acts as a selective permeable barrier, allowing limited absorption of substances such as transdermal drugs. Increased permeability, due to damage or enhancers can be beneficial for drug delivery but May also increases infection risk.

Additionally, the skin controls the interaction of nanoparticles, serving both as a protective shield and a gateway for advanced therapeutic applications.[5]

STRUCTURE OF SKIN

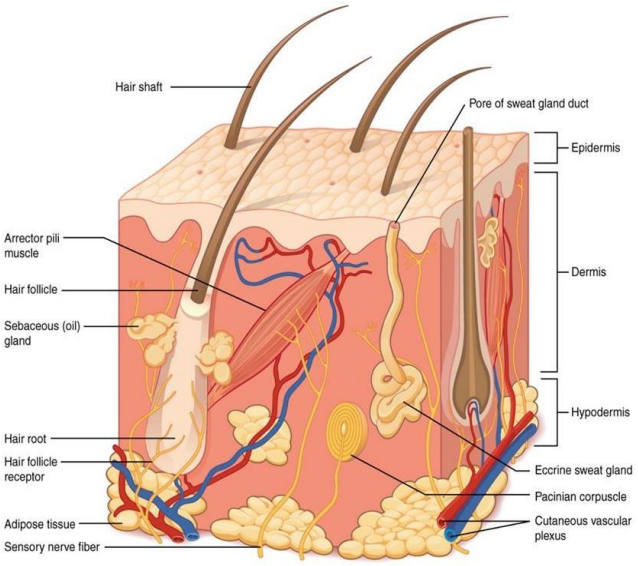

Fig.2: Schematic representation of skin.

PSORIASIS

Psoriasis is a chronic, immune -mediated inflammatory skin disorder affecting about 2-3% of the population, characterized by rapid keratinocyte proliferation leading to thick, scaly, and red plaques. It is a multifactorial disease involving genetic susceptibility, immune dysregulation (Th1/Th17 pathways), environmental triggers and now recognized as a systemic condition associated with arthritis, cardiovascular disease, and psychological distress.

Historically psoriasis was described in ancient Egyptian and ayurvedic texts but was long confused with leprosy until the 18-19 centuries. When it was identified as a distinct, non-contagious disease. Modern research established its immunological basis, leading to advanced therapies, including biologics targeting TNF Alpha, IL-17, IL-23.

Psoriasis presents in several forms, including plaque (most common), guttate, inverse, pustular, erythrodermic, nail, palmoplantar and scalp psoriasis. Its development and flare-ups are influenced by immune dysfunction, genetics, infections, stress, medication, skin injury, climate, and lifestyle factors.

Psoriasis is a complex autoimmune disorder characterized by immune system dysfunction that accelerates the skin cell life cycle, resulting in excessive accumulation of cells and the

formation of thick, scaly plaques. Genetic factors are significant, as people with a family background of psoriasis have an increased likelihood of experiencing the condition. Various triggering factors, including infections, psychological or physical stress, hormonal fluctuations, and the use or withdrawal of certain medications, can initiate or exacerbate psoriasis by influencing immune and inflammatory pathways.

Environmental and lifestyle factors further contribute to disease severity and progression. Skin trauma such as cuts, burns, insect's bites, or tattoos may induce lesions through the Koebner phenomenon. Cold and dry weather conditions often worsen symptoms, whereas exposure to sunlight may provide symptomatic relief. Additionally, lifestyle habits such as smoking, alcohol consumption, and obesity are associated with increased severity of psoriasis, emphasizing the importance of comprehensive management approaches that include lifestyle modification.[6-7]

CAUSES OF PSORIASIS

GENETIC FACTORS: Psoriasis has a hereditary basis. Individuals with a family history are more prone due to inherited genes affecting immune and skin cell regulation.

IMMUNE SYSTEM DYSFUNCTION: psoriasis is an autoimmune disease where overactive T-cells release inflammatory cytokines, leading to rapid skin cell proliferation and chronic inflammation.

ENVIRONMENTAL FACTORS: cold climate, dry weather, and low sunlight exposure can trigger or worsen psoriasis by causing skin dryness and immune system imbalance.

INFECTIONS: Streptococcal throat infections commonly trigger guttate psoriasis, especially in children and young adults.

STRESS: Psychological stress increases inflammatory mediators and immune activation, which can initiate psoriasis or worsen existing lesions.

SKIN INJURY (KOEBENER PHENOMENON): Trauma such as cuts, burns, surgery, or insect bites can induce psoriasis lesions at the site of skin injury.

DRUGS AND MEDICATIONS: Certain drugs like beta-blockers, lithium, anti-malarial, NSAIDs, and sudden corticosteroid withdrawal can trigger or exacerbate psoriasis.[8-9]

METHODOLOGY

Methods and Materials

Activated charcoal was acquired from the Carbanio India pvt.ltd. All other chemicals were purchased from sigma Aldrich India.

INGREDIENTS TABLE

Table 1: Ingredients used in the formulation of activated charcoal cream.

S. NO	INGREDIENTS	F1	F2	F3	F4	F5	USES
1.	Activated charcoal (g)	0.30	0.60	0.90	1.20	1.50	Adsorbent/detoxifier
2.	Salicylic acid(g)	0.15	0.30	0.45	0.60	0.75	Keratolytic agent
3.	Urea(g)	0.30	0.45	0.60	0.75	0.90	Moisturizer, keratolytic
4.	Methyl paraben(g)	0.06	0.06	0.06	0.06	0.06	preservative
5.	Stearic acid(g)	2.10	2.25	2.40	2.55	2.70	Emulsifying agent, thickener
6.	Potassium hydroxide(g)	0.15	0.18	0.21	0.24	0.27	Neutralizer, soap formation
7.	Sodium benzoate(g)	0.06	0.06	0.06	0.06	0.06	preservative
8.	Ceto stearyl alcohol(g)	1.20	1.33	1.50	1.65	1.80	Emollient, stabilizer
9.	Glycerin(g/ml)	1.19	1.19	1.19	1.19	1.19	Humectant, skin hydration
10.	Almond oil(g/ml)	3.26	3.26	3.10	2.93	2.77	Emollient, nourishing oil
11.	Lavender oil(%w/w)	0.10	0.25	0.50	0.75	1.00	Flavoring agent
12.	Distilled water(g/ml)	21.2	20.2	19.4	18.6	17.9	Vehicle, solvent

PROCEDURE FOR PREPARATION OF ACTIVATED CHARCOAL CREAM: STEP 1: PREPARATION OF OIL PHASE

a) Weight the stearic acid, cetostearyl alcohol, almond oil, and a small portion of potassium hydroxide.

b) Heat this oil phase gently on a water bath to around 70-75^{0}C until all solids melt completely. Stir continuously to ensure uniform blending.

STEP 2: PREPARATION OF AQUEOUS PHASE

a) In another beaker, take distilled water and heat it to 70^{0}C.

b) Dissolved urea, glycerine sodium benzoate, and methyl paraben, in the hot water.

c) Gradually add the remaining portion of potassium hydroxide, ensuring it dissolves completely.

d) Add salicylic acid (if poorly soluble, dissolve it first in a small amount of warm glycerine or ethanol).

STEP 3: EMULSION FORMATION

a) Slowly add the hot aqueous phase into the oil phase with continuous stirring.

b) Maintain the temperature at 70^{0}C while mixing.

c) Stir until a uniform emulsion forms, then continue stirring while allowing it to cool to

room temperature.

STEP 4: INCORPORATION OF ACTIVATED CHARCOAL

a) Once the cream base reaches about 40^0C, add activated charcoal that has been finely powdered and sieved.
b) Mix thoroughly using a homogenizer or mechanical stirrer to ensure even dispersion of the charcoal. At the same temperature, add the required quantity of lavender oil and mix gently until a homogeneous cream is obtained.
c) Avoid vigorous stirring that may introduce air bubbles.

STEP 5: FINAL ADJUSTMENT

a) Check the ph (should be around 5-6) and adjust, if necessary, with a small amount of dilute potassium hydroxide or citric acid solution
b) Allow the cream to stand to remove entrapped air.
c) Fill the prepared cream into sterile, labelled containers.(35-39)

EVALUATION TEST

1. Appearance and colour

The appearance of the cream is checked visually for its colour, texture, smoothness, and uniformity. A small amount of cream is placed on a glass slide or Petri dish and observed under normal light. The cream should appear smooth, homogenous, greyish- black (due to charcoal) and free from lumps, grittiness, or oil separation. A uniform appearance indicates proper emulsification and ingredient distribution.

2. Odour

The odour of the cream is examined by smelling a small quantity. It should have mild, pleasant, or characteristic smell and should not show any rancid or unpleasant odour. A rancid smell indicates oxidation of oils or poor preservative stability.

3. PH measurement

The pH level of the cream is tested to ensure it is suitable for the skin (as the natural skin pH ranges from 5.5 to 7). In this test, 1 gram of cream is dissolved in 10 ml of distilled water, and the pH is determined using a digital pH meter that has been calibrated with standard buffer solutions at pH 4 and 7. An ideal pH range of 5.0 to 6.0 helps prevent irritation and supports skin health.

4. Viscosity

Viscosity determines the consistency and flow properties of the cream, which influence spreadability and stability it is measured using a Brookfield viscometer fitted with an appropriate spindle (e.g. spindle no. 64) at 25^0C and a fixed rotation speed (commonly 10 rpm) stable, moderately viscous creams (20000-50000cps) are consider ideal for topical application as they spread easily yet remain stable during storage.

5. Spreadability

Spreadability indicates how easily the cream can be applied on the skin surface. The slip and drag method are used for this test.

1gm of the cream is placed between two glass slide and a 100 g weight is placed on the upper slide for 5 mins to provide uniform spreading. The time required for the upper slide to move a fixed distance when pulled by a specific weight is recorded.

Spreadability (S) is calculated by the formula S =(WL) /T.

Where W= weight tied to the upper slide, L= length moved and T= Time taken.

A higher spreadability value means the cream spreads easily more easily on the skin.

6. Homogeneity

Homogeneity ensures even distribution of ingredients and uniform consistency. A small quantity of cream is rubbed gently between fingers or observed under a glass slide. The texture should be smooth and uniform without gritty particles or phase separation. A homogenous cream ensures consistent drug delivery and appearance.

7. Determination of emulsion type

This test confirms whether the formulation is an oil-in-water (O/W) or water-in-oil (W/O) emulsion. Two simple tests are used

Dye test: A small quantity of cream is mixed with water and a drop of Sudan 3 (oil-soluble dye) is added. Under a microscope, red-colored droplets dispersed in a colorless medium indicate an O/W emulsion.

Dilution test: The cream is mixed with water. If it mixes easily, it is O/W TYPE; If not, it is W/O type. Activated charcoal creams are typically O/W emulsions, making them easily

washable and non-greasy.

8. Washability

This determines how easily the cream can be removed from the skin. A small quantity of cream is applied on the hand and then rinsed under running tap water. The ease with which it gets washed off indicates its emulsion type. O/W creams (like this one) are easily washable compared to W/O type.

9. Stability studies

Stability testing ensures the formulation maintains its physical, chemical, and microbiological integrity during storage. Samples of each formulation are stored at three different conditions:
25 ± 2°C (room temperature).
40 ± 2°C (accelerated condition).

4 ± 1°C (refrigerated condition). Observations are made at intervals of 0,15, 30, 60, and 90 days for changes in color, odor, pH, viscosity, and phase separation. A stable formulation shows no significant changes after the testing period.

10. Drug content Uniformity

This test determines if the active ingredients (activated charcoal, salicylic acid, and urea) are evenly distributed throughout the formulation. One gram of cream is accurately weighed and dissolved in ethanol or a suitable solvent, filtered, and analyzed using a UV-Visible spectrophotometer at the drug's max (around 296 nm for salicylic acid). The drug concentration is calculated from a calibration curve. Uniform content between 95-105% of the label claim indicates good uniformity.

11. Skin irritation test (Patch test)

This test ensures the safety of the cream for topical application. A small quantity (about 0.5 g) of the cream is applied to a 1-inch patch of skin (usually the forearm or behind the ear) of 10 healthy volunteers. The area is covered with gauze and observed after 24 hours for any redness, itching, or swelling. A non-irritant formulation shows no visible reactions.

12. Microbial Load Test

This test ensures the cream is free from harmful microbial contamination and that the preservative (sodium benzoate) is effective. About 1g of cream is spread on nutrient agar plates (for bacteria) and Sabouraud dextrose agar plates (for fungi). Plates are incubated at 37^{o}C

bacteria and 25°C for fungi for 48-72 hours. Colonies are counted and compared with pharmacopeial limits (not more than 10^2 cfu/g). Absence of colonies indicates excellent microbiological stability.[10]

RESULTS

Table 2: Evaluation tests of activated charcoal cream.

S.NO	PARAMETER	F1	F2	F3	F4	F5
1.	Appearance	Smooth, Greyish	Smooth, Pale white	Smooth, Pale white	Thick, Pale white	Very thick, greyish
2.	Odour	Pleasant	Mild	Pleasant	Mild	Slight oily
3.	pH(25°C)	5.8	5.7	5.6	6.2	6.1
4.	Viscosity (cps)	32,500	30,200	28,000	27,100	26,200
5.	Spreadability	6.3	6.8	7.9	7.3	6.5
6.	Homogeneity	Good	Excellent	Excellent	Good	Fair
7.	Type of emulsion	O/W	O/W	O/W	O/W	O/W
8.	Washability	Easily washable	Easily washable	Easily washable	Moderate	moderate
9.	Phase separation (after 30 days)	None	None	None	Slight	Slight
10.	Drug content	94.8	96.2	98.6	97.7	95.3
11.	Skin irritation (patch test)	No reaction	No reaction	No reaction	Mild redness	Mild redness
12.	stability	Stable	Stable	Stable	Mild changes	Slight separation

DISCUSSION

Psoriasis is a multifactorial, immune – mediated dermatological disorder marked by chronic inflammation, abnormal keratinocyte proliferation, erythema, scaling, and recurrent relapses. Although several systematic and topical therapies are available, long-term use of conventional agents such as corticosteroids and immunosuppressants is associated with adverse effect. Hence, the development of safer topical formulations with supportive and adjunctive therapeutic benefits is of significant clinical. In the present study an activated charcoal- based cream was formulated and evaluated to explore its potential role in the topical management of psoriasis.

Rational for activated charcoal in psoriasis: activated charcoal possesses high surface area and strong adsorptive properties, enabling it to bind toxins, allergens, microbial products, and inflammatory mediators present on the skin surface. In psoriatic lesions, the accumulation of scales, bacterial colonization, and inflammatory exudates aggravates symptoms such as itching and erythema. The incorporation of activated charcoal into a topical cream is expected to facilitate detoxification of the lesion surface, reduce irritation, and promote symptomatic relief.

Additionally, charcoal contributes to gentle exfoliation, which may assist in reducing excessive scaling.

CONCLUSION

The study focused on the formulation and evaluation of an activated charcoal cream intended for the supportive management of psoriasis. Activated charcoal was chosen for its adsorptive, detoxifying, anti-inflammatory, and skin cleansing properties, which are useful in reducing scaling, erythema, and irritation associated with psoriasis. The formulated creams exhibited satisfactory physical and cosmetics characteristics, including good appearance, homogeneity suitable ph, spreadability, viscosity, washability, and uniform drug content, ensuring skin compatibility and patient acceptability. Among the prepared formulation, the F3 batch showed optimal stability and consistency, with no significant changes observed during stability studies. The cream was easy to apply and spread evenly which is important for patient compliance in chronic conditions like psoriasis.

Declaration of competing Interest

Authors declare that there is no conflict of interest.

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