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Formulation and Evaluation of Polyherbal Cream for Depigmentation

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Abstract: *Depigmentation disorders and uneven skin tone are common dermatological concerns that may affect an individual's appearance and self-confidence. The present study focuses on the formulation and evaluation of a polyherbal cream for depigmentation using natural plant-based ingredients known for their skin-lightening, antioxidant, and anti-inflammatory properties. The herbal extracts selected for the formulation were incorporated into a cream base prepared by the emulsification method. The prepared cream was evaluated for various physicochemical parameters, including appearance, color, odor, pH, spreadability, viscosity, washability, homogeneity, and stability. The formulation was designed to reduce hyperpigmentation by inhibiting melanin synthesis while providing nourishment and protection to the skin. Herbal ingredients rich in flavonoids, phenolic compounds, and vitamins contribute to antioxidant activity, helping to minimize oxidative stress associated with excessive pigmentation. The evaluation results demonstrated that the formulated cream possessed satisfactory physical characteristics, good spreadability, appropriate pH for topical application, and acceptable stability under different storage conditions. The cream showed excellent homogeneity without any signs of phase separation or irritation. The use of natural herbal ingredients offers a safer alternative to synthetic depigmenting agents, which may produce adverse effects during long-term use. Therefore, the developed polyherbal cream has the potential to serve as an effective, safe, and economical topical preparation for managing skin hyperpigmentation and promoting an even skin complexion. Further clinical studies are recommended to establish its therapeutic efficacy and long-term safety in human subjects.*

Keywords: Polyherbal cream, Depigmentation, Hyperpigmentation, Herbal formulation, Skin lightening, Antioxidant activity, Topical preparation, Melanin inhibition, Herbal cosmetics, Evaluation studies

I. INTRODUCTION

Depigmentation refers to the lightening of the skin and mucosa, which can result from local or systemic conditions. This may lead to either partial or complete loss of pigment. While lighter skin patches may not be a major concern for some individuals, they can be significant for those with naturally darker skin tones. Depigmentation is also sought after as a cosmetic treatment, particularly for individuals with conditions like vitiligo. Those who undergo depigmentation treatments may experience mixed emotions about their new appearance. Many people invest in cosmetic procedures such as laser treatments, chemical peels, and specialized skincare products to achieve an even skin tone.[1]

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Fig 1: De pigmentation (loss of pigments)

Certain forms of depigmentation develop due to external factors rather than genetic inheritance. These include vitiligo and skin discoloration caused by inflammation. Some common inflammatory conditions leading to hypopigmentation are post-inflammatory skin changes, pityriasis alba, sarcoidosis, hypopigmented mycosis fungoides, lupus erythematosus, and lichen sclerosus et atrophicus. Infections such as tinea versicolor and leprosy can also result in loss of skin pigment. Exposure to chemicals or the use of certain medications, including strong steroids, may cause depigmented patches on the skin. Additionally, physical injuries such as burns, laser treatments, or abrasions can lead to hypopigmentation. Some individuals also experience other unexplained forms of pigment loss, such as idiopathic guttate hypomelanosis and persistent macular hypomelanosis.[2]

Both hereditary and acquired conditions contribute to depigmentation. Genetic disorders such as albinism, piebaldism, tuberous sclerosis, Hermansky–Pudlak syndrome, Chédiak–Higashi syndrome, and Waardenburg syndrome are well-documented examples of inherited conditions that result in pigment loss. Understanding the causes and effects of depigmentation is essential in managing and treating these conditions effectively.[3] Around 2200 BC, the earliest known written account of a human pigmentation disorder, likely vitiligo, was documented, marking the beginning of the history of research into human pigmentation. The origins of human skin color have puzzled researchers for 4,000 years, leading to a number of misconceptions. Even after European doctors started studying various skin types and comparing darker and lighter skin, the roots of skin and hair pigmentation were often the subject of inaccurate speculation. The understanding of human pigmentation advanced with the discovery of melanocytes in the 19th century.

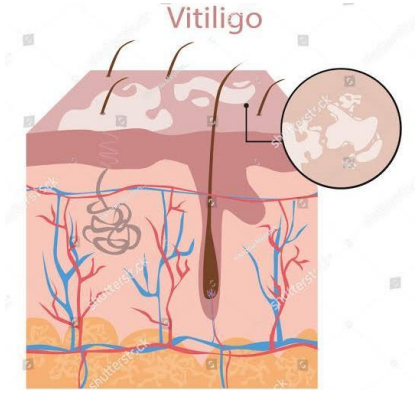

Fig 2: Skin Vitiligo Depigmentation

Causes of Depigmentation: Skin pigmentation is a prevalent condition that can result from various factors. The three primary contributors to skin pigmentation are heredity, exposure to sunlight, and specific medications. Gaining insight into the main causes of skin pigmentation will aid in treating and preventing it.[4]

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• **Genetics**: Genetics play a significant role in the occurrence of depigmentation/ Certain inherited conditions such as albinism and vitiligo, lead to the loss of melanin in the skin.
• **Autoimmune Disorders:** In vitiligo, the immune system targets melanocytes leading to the loss of pigments in affected areas.
• **Environmental and chemical fa**ctors: Exposure to certain environmental factors and chemicals can damage melanocytes. Prolonged exposure to UV radiation from the sun or chemotherapy drugs can also lead to reduced melanin production.[5]
• **Hormonal imbalances**: Conditions like melisma and cholasma which are triggered by pregnancy or oral contraceptive use result in patches of darker skin due to an overproduction of melanin.[6]
• Nutritional Deficiencies: Deficiencies of essential nutrients like Vitamin B12, folic acid, copper can impair the synthesis of melanin leading to depigmentation.

Types of Pigmentation Disorder
1. **Hypopigmentation**: Hypopigmentation occurs when the body produces melanin, the pigment responsible for skin color, in lower amounts. The most common reason for reduced melanin levels (hypopigmentation) is previous skin injuries, including sores like blisters, infections, burns, exposure to chemicals, and other forms of damage.[7]
2. **Hyperpigmentation**: It is caused by an increase in melanin production. The most common cause of hyperpigmentation is sun exposure, which significantly boosts melanin production. Two examples of hyperpigmentation influenced by hormones are chloasma and melasma.

Treatment for pigmentation disorders:
1. Topical Therapies:

Fig 3: Vitamin C (Ascorbic Acid) Cream

• **Hydroquinone** – A widely used skin-lightening agent that suppresses melanin production, commonly prescribed for melasma and dark spots.[8]
• **Retinoids** (Tretinoin, Adapalene) – Stimulate skin cell renewal and fade pigmentation over time.[9]
• **Vitamin C** (Ascorbic Acid) – Acts as an antioxidant that helps brighten skin and combat oxidative damage.[10]

2. Chemical Peels:

Fig 4: Glycolic Acid Peel

• Glycolic Acid Peel – Exfoliates the upper layers of the skin, diminishing pigmentation.[11]
• Salicylic Acid Peel – Suitable for acne-related pigmentation.[12]
• Lactic Acid Peel – A mild exfoliant beneficial for sensitive skin.[13]

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• Trichloroacetic Acid (TCA) Peel – Used for deeper pigmentation concerns.[14]

3. Laser-Based Treatments:

Fig 5: Intense Pulsed Light (IPL) Therapy

• Q-Switched Laser – Targets and breaks down excessive pigmentation, treating melasma, freckles, and sunspots.[15]
• Fractional CO2 Laser – Encourages skin regeneration and improves deep pigmentation and acne scars.
• Intense Pulsed Light (IPL) Therapy – Reduces superficial pigmentation and sun-induced discoloration.

4. Exfoliation Procedures:

Fig 6: Microdermabrasion

• Microdermabrasion – A gentle skin-resurfacing treatment that removes the outermost pigmented layer.
• Dermabrasion – A deeper exfoliation technique that helps in treating persistent pigmentation.

Salient Features of Polyherbal De-Pigmentation Cream

1. Papaya leaf contains papain enzyme, which gently exfoliates dead skin cells, promoting a brighter complexion.[16]
2. Green tea is rich in polyphenols and catechins, which protect the skin from oxidative stress and premature aging. [17]
3. The herbal extracts provide essential hydration, keeping the skin soft, supple, and nourished. [18]
4. Green tea and liquorice soothe the skin, reducing redness, irritation, and inflammation.
5. Liquorice root extract helps protect the skin from UV-induced pigmentation and sun damage.
6. Absorbs quickly into the skin without clogging pores, making it suitable for all skin types.
7. Regular use helps fade hyperpigmentation, dark spots, and uneven skin tone, giving a natural glow
8. Free from harsh chemicals like parabens, sulfates, and artificial fragrances, ensuring skin safety.[19]
9. Gentle formulation ideal for dry, oily, sensitive, and combination skin.[20]

Advantages:

1. Liquorice root extract inhibits melanin synthesis, aiding in the reduction of dark spots and hyperpigmentation.[21]
2. Papaya leaf extract, rich in papain enzyme, gently removes dead skin cells, facilitating a brighter complexion.
3. Green tea contains polyphenols and catechins that protect against oxidative stress and premature skin aging.
4. The herbal ingredients provide essential moisture, improving skin texture and softness.

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5. The soothing effects of liquorice and green tea help reduce redness, irritation, and inflammation.Disadvantages:
1. The effectiveness of herbal de-pigmentation creams may take longer compared to chemical alternatives.
2. Some users may experience mild allergic reactions, such as irritation or redness.
3. While it reduces pigmentation, it does not offer full sun protection, necessitating additional UV protection.
4. The formulation is more effective for mild to moderate pigmentation and may not completely treat severe melasma.
5. Natural ingredients may cause batch-to-batch variations in consistency and fragrance.

Plant Profile

1. Papaya Leaf (Carica papaya)

Fig 7: Papaya leaves

Synonyms: Pawpaw leaf, Melon tree leaf, Kates leaf.[22]

Description: Papaya is a fast-growing, short-lived tropical tree with a single, unbranched stem and large, deeply lobed leaves. The leaves are arranged spirally at the top of the trunk and are supported by long petioles. The plant produces a milky latex when cut. The leaves have a bitter taste and are rich in bioactive compounds.

Biological Source: Papaya leaf is obtained from Carica papaya L.

Family Name: Caricaceae.

Chemical Constituents:

• Alkaloids: carpaine, pseudocarpaine.• Flavonoids: quercetin, kaempferol.
• Enzymes: papain, chymopapain.
• Phenolic compounds.
• Vitamins A, C, and E.
• Saponins and tannins.

Uses:

• Used in traditional medicine for improving platelet count, especially in dengue fever.
• Supports digestion and alleviates bloating and constipation.
• Acts as an immune booster due to its rich vitamin content.
• Exhibits anti-malarial and anti-cancer properties.
• Used in skin care for its wound-healing and anti-aging effects.

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2. Licorice Root (Glycyrrhiza glabra)

Fig 8: Liquorice Root Synonyms: Liquorice, Sweet root, Mulethi.[23]

Description:

Licorice is a herbaceous perennial plant that grows up to 1 meter in height. It has pinnate leaves with 9-17 leaflets and purple to bluish flowers arranged in axillary spikes. The roots are long, cylindrical, and brownish on the outside, with a yellow interior. The root has a characteristic sweet taste due to glycyrrhizin, which is 50 times sweeter than sugar.

Biological Source: Licorice root is obtained from Glycyrrhiza glabra L.

Family Name: Fabaceae (Leguminosae).

Chemical Constituents:

- Triterpenoid saponins: glycyrrhizin, glycyrrhetinic acid.
- Flavonoids:liquiritin, isoliquiritigenin.
- Coumarins.
- Polysaccharides.
- Essential oils.

Uses:

- Used for treating gastric ulcers, acid reflux, and indigestion.
- Acts as a natural cough remedy and expectorant.
- Supports adrenal health and helps in stress management.
- Exhibits antimicrobial properties and is used in oral care.
- Used in traditional medicine for skin disorders like eczema and psoriasis.

3. Green Tea (Camellia sinensis)

Fig 9: Green Tea Synonyms: Unfermented tea, Chinese tea, Japanese tea.[24]

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Description:

Green tea is derived from the leaves of Camellia sinensis and is known for its minimal oxidation during processing. The leaves are typically green, lanceolate, and slightly serrated. The tea is made by steaming or panfrying fresh leaves, preventing fermentation and preserving its natural antioxidants. It has a light green color and a slightly bitter, grassy flavor.

Biological Source: Green tea is obtained from the leaves of Camellia sinensis L.

Family Name: Theaceae.

Chemical Constituents:

• Polyphenols: catechins, epigallocatechin gallate..
• Alkaloids: caffeine, theobromine, theophylline.[25]
• Amino acids: L-theanine.
• Vitamins: B-complex, C, and E
• Minerals: potassium, manganese, magnesium.

Uses:

• Helps in weight management by boosting metabolism and fat oxidation.• Acts as a powerful antioxidant to prevent oxidative stress and aging.
• Supports cardiovascular health by reducing cholesterol levels.[26]
• Enhances brain function and reduces the risk of neurodegenerative diseases.
• Strengthens the immune system and has antibacterial properties.
• Aids in digestion and supports gut health.

MATERIAL PROFILE

1. Beeswax: Beeswax is a natural wax produced by honeybees and widely used in cosmetic formulations for its emollient and thickening properties. In creams, beeswax helps to create a protective barrier on the skin, preventing moisture loss and enhancing hydration. It also contributes to the cream's texture and consistency, making it thicker and more stable. Beeswax has mild anti-inflammatory and antibacterial properties, which can benefit sensitive or irritated skin. Its natural origin makes it a popular choice in herbal and organic skincare products.

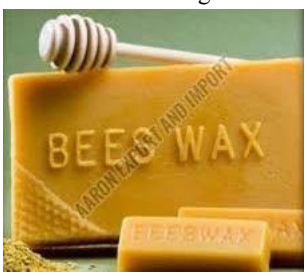

Fig 10: Beeswax

2. Borax: Borax, also known as sodium borate, is a naturally occurring mineral compound used in cream formulations primarily as an emulsifying agent. When combined with fatty acids like stearic acid or beeswax, borax helps form a stable oil-in-water emulsion. This stabilizes the cream and prevents phase separation. Borax also imparts mild antiseptic properties, aiding in the preservation of the cream.

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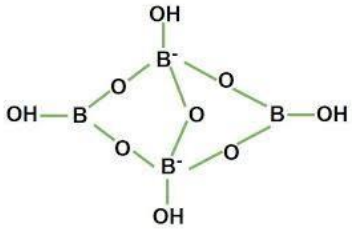
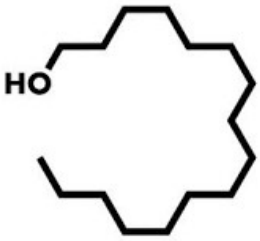


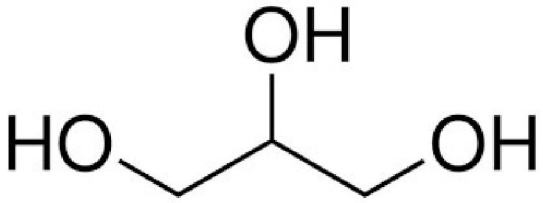
3. Cetyl Alcohol: Cetyl alcohol is a fatty alcohol derived from coconut or palm oil, used as an emollient and stabilizer. It helps to soften and smooth the skin by forming a barrier that locks in moisture. It also acts as a thickening agent and improves the stability and texture of the cream.



4. Mineral Oil: Mineral oil is a clear, odorless oil derived from petroleum, widely used in skin care formulations. In cream formulations, it acts as an occlusive agent, forming a protective layer on the skin to prevent moisture loss. It helps keep the skin hydrated, smooth, and soft.

Fig 11: Mineral Oil

5. Glycerin: Methyl paraben is a widely used preservative in cosmetic and pharmaceutical products. It is used in creams to prevent the growth of bacteria, yeast, and mold, thereby extending the shelf life and ensuring the safety of the product during storage and use.



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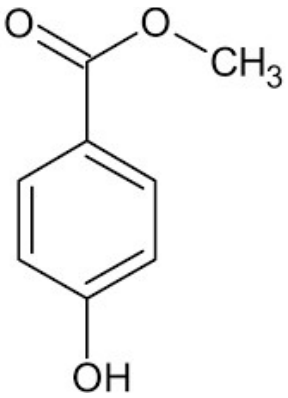
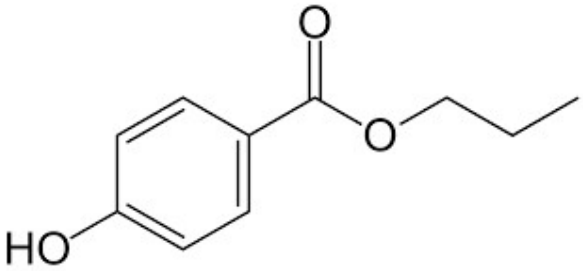
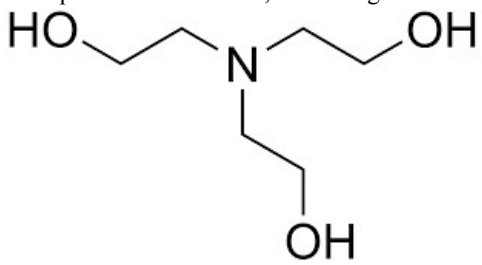


7. Propyl Paraben: Propyl paraben is another preservative commonly used along with methyl paraben for broad-spectrum antimicrobial activity. It helps to protect the cream from microbial contamination, especially against fungi, and contributes to the overall preservation and stability of the formulation.



8. Triethanolamine: Triethanolamine is an organic compound used to balance the pH of cosmetic formulations and aid in emulsification. In cream formulations, it helps to neutralize fatty acids (like stearic acid), forming stable emulsions. It also ensures the pH of the cream is compatible with the skin, enhancing comfort and effectiveness.



9. Distilled Water: Distilled water is a purified water that is free from impurities, minerals, and microorganisms. It is used as the main solvent in cream formulations, helping to dissolve water-soluble ingredients and form the aqueous phase. It provides hydration and acts as a base that supports the delivery of active ingredients to the skin.

Objective of the study

Aim: Formulation and evaluation of polyherbal de pigmentation cream.

Objective: The objective of this study is to formulate and evaluate a polyherbal depigmentation cream aimed at addressing hyperpigmentation disorders effectively. This research aims to develop a stable and efficacious topical formulation using a blend of herbal extracts known for their skin-lightening properties, evaluating its safety, stability, and skin penetration capabilities through comprehensive in vitro and in vivo studies. The findings will contribute to the advancement of dermatological treatments targeting skin pigmentation abnormalities, offering a potential alternative to conventional therapies.

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Method of Preparation

1. Extraction of Papaya leaves constituents: The extraction of papaya leaves constituents is done with the help of Soxhlet apparatus, and the procedure is given as:

Fig 12: Soxhlet Extraction of Papaya Leaves

Extraction Process:

1. Collection and Preparation of Plant Material:

• Fresh papaya leaves were collected and washed thoroughly with clean water to remove dirt and impurities.

• The leaves were then shade-dried at room temperature for several days until completely dry.

• Once dried, the leaves were crushed and powdered using a grinder to obtain a coarse powder.

2. Extraction Procedure:

• About 50–100 grams of the powdered papaya leaves were weighed and placed into a filter paper thimble.

• The thimble was inserted into the main chamber of the Soxhlet extractor.

• A suitable solvent such as ethanol or methanol (250–300 ml) was poured into a round-bottom flask, which was then connected to the Soxhlet apparatus.

• The entire setup was assembled and placed on a heating mantle.

• The solvent was heated, evaporated, and condensed into the extractor chamber, where it repeatedly came in contact with the solvent.

• The solvent extracted the active phytoconstituents from the papaya leaves, and once the chamber filled, it siphoned back into the flask.

• This process continued for 4-5 hours until the solvent in the siphon tube appeared colorless, indicating the completion of extraction.

3. Concentration of Extract:

• After extraction, the solvent containing the papaya leaves extract was collected and concentrated using a rotary evaporator or by gentle heating on a water bath to remove excess solvent.

• The obtained concentrated extract was then dried and stored in an airtight container for further use in formulation and evaluation.

2. Extraction of Liquorice: 50 gm of dried powdered of liquorice root were moistened with150ml of 10% Ammonia & then percolated three times with 80% ethanol (3×300ml) each for 24hrs. at room temp. The ethanolic extract was conc. till dryness.

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3. Extraction of Green tea leaves: Measured about one teaspoon of the leaves per cup of water. Heated the water to a temperature between 80°C to 85°C (176°F to 185°F), as boiling water can damage the delicate components of the green tea. Placed the leaves in a teapot or infuser and pour the hot water over them.
Allowed the leaves to steep for 1 to 3 minutes.

Formulation of De-pigmentation Cream

S No.	Pharmaceutical Ingredient	Quantity used
1.	Papaya leaves extract	2 ml
2.	Green Tea leaves extract	1 ml
3.	Liquorice root extract	1 ml
4.	Beeswax	4 gm
5.	Borax	0.4 gm
6.	Mineral oil	4 ml
7.	Methyl paraben	0.2 gm
8.	Propyl paraben	0.18gm
9.	Triethanolamine	0.02gm
10.	Distilled water	q.s

Instruments Used:

S No.	Instruments	Company Name
1.	Beaker	Boroglass
2.	Glass Rod	ZOOM Scientific World
3.	Thermometer	GERA Research
4.	Heating Mantle	LAB Care (skks410)
5.	Measuring Cylinder	ReliGlas INDIA
6.	Weighing Machine	Digital Scale (SF400A)

Methodology:

1. Preparation of the Oil Phase:

Fig 13: Oil Phase

• The oil phase was prepared by accurately weighing the quantity of beeswax, and mineral oil using a digital weighing balance. These ingredients were transferred into a clean and dry 250 ml beaker.

• The beaker containing the oil-soluble ingredients was then placed on heating water bath and gently heated to a temperature of 70°C to 75°C. A thermometer was used to monitor the temperature continuously to ensure that it did not

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exceed the specified range, as overheating could degrade sensitive components. The stirring was done in a gentle but consistent manner to avoid the formation of bubbles.

• Once a uniform oil phase was obtained with all the components fully dissolved, the beaker was removed from the heating mantle and kept warm until it was ready to be combined with aqueous phase in the emulsification step.

2. Preparation of the Aqueous Phase

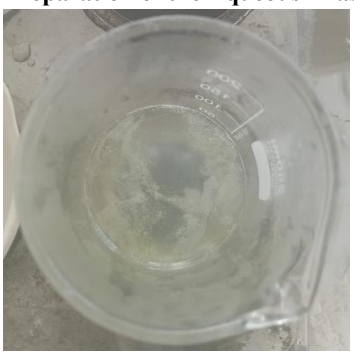

Fig 14: Aqueous Phase

• The aqueous phase was prepared by measuring 95 ml of distilled water with measuring cylinder and poured into a 250 ml beaker and then added borax and placed on the heating water bath and the temperature was gradually increased to about 70°C similar to oil phase to maintain compatibility during the emulsification step.

• Once a clear and homogeneous solution was achieved, it was kept at 70°C, ready for the next step of emulsification formation.

Step 3: Emulsification Process

Fig 15: Mixing of Oil and Water phase

• In this step, the gradual mixing of the two phases at a controlled temperature, followed by the addition of herbal extracts was done.

• Firstly, the aqueous phase was slowly added to the oil phase gradually and with continuous stirring using a glass rod to promote uniform mixing and to initiate emulsification. Then the mixture was stirred continuously with mechanical stirrer. After emulsion reached a lukewarm temperature (40°C), the herbal extracts such as papaya leaf extract, green tea extract and liquorice extract were added one by one.

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• Finally, preservatives, perfumes and ph adjusters was added to form and stirred and allowed to cool to form a smooth, semi-solid cream with a pleasant texture .The final cream was then transferred into clean, airtight containers for storage and further evaluation..

Evaluation Parameters of Cream Formulation

1. Physical Appearance:

The formulated cream was checked visually for uniformity in color and texture. Cream was found to be free from any lumps, air bubbles or phase separation, indicating proper emulsification and ingredient distribution.

2. Color and Odor:

The color and odor of the cream were evaluated visually and organoleptically. The formulated cream observed appearance was found to be slight greenish in color due to papaya leaf extract. The cream has mild, pleasant and non-irritating odor. The presence of herbal extract was expected to contribute to a natural fragrance, which is not too strong or unpleasant.

3. pH Measurement:

The pH of the cream was determined using a digital pH meter. A small amount of cream(1gm) was dispersed in 10 ml of distilled water and mixed well. The pH value was found to be 5.8 which lies with within acceptable range to ensure compatibility with the skin, as the ideal pH for the topical products is generally between 4.5-6.5 to avoid skin irritation.

Fig 16: pH meter

4. Spreadability:

Spreadability was tested by placing 1 gm of cream between two glass slides and applying a weight for a fixed time. The diameter of the spread cream was then measured. Better spreadability ensures easier and more uniform application on the skin.

5. Washability:

A small quantity of cream was applied on the skin and left for a few minutes. It was then washed with water to observe if any greasy residue remained. A washable cream is preferred for ease of removal evaluates how easily the cream can be removed from the skin.

6. Irritancy Test:

A patch test was conducted on a small area of hand to check for any sign of redness, itching or irritation after 24 hours. The test ensured that cream is safe for topical use and does not cause adverse skin reaction, especially important for products intended for facial application.

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Fig 17: Irritancy test on hand

7. Homogeneity:

The cream was tested for homogeneity by visual inspection. It appeared to be uniform in texture without any lumps or air bubbles.

8. Viscosity:

The viscosity of the cream was measured using a Brookfield viscometer to determine the cream's thickness and flow characterstics. The cream exhibit moderate viscosity which ensures the ease of application and good skin adherence.

Fig 18: Brookfield Viscometer

II. CONCLUSION

The present study was successfully carried out with the aim of formulating and evaluating a polyherbal cream for depigmentation using natural extracts of Papaya leaves, Green Tea leaves, and Liquorice root. These herbal ingredients were selected due to their known skin-lightening, antioxidant, and anti-inflammatory properties.

The formulation process was conducted in a systematic manner, incorporating stearic acid, cetyl alcohol, mineral oil, triethanolamine, preservatives, and distilled water along with the active herbal extracts. The cream was prepared by the emulsification method, and the final product exhibited a smooth texture, uniform consistency, and a pleasant herbal fragrance.

The prepared cream underwent several evaluation tests to assess its quality, safety, and performance. Parameters such as physical appearance, pH, spreadability, washability, homogeneity, viscosity, and stability were found to be within acceptable limits. The cream showed no signs of irritation in the patch test, indicating its suitability for topical use.

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Based on the findings, it can be fds concluded that the polyherbal cream formulation was physically stable, nonirritant, and potentially effective in managing hyperpigmentation. The combination of herbal extracts worked synergistically to offer skin brightening and protective benefits, making this formulation a promising natural alternative to synthetic depigmentation products.

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