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Formulation and evaluation of anti-pigmentation bio-ferment cream for cosmetic skincare applications

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Abstract
The rising demand for safe, effective, and natural skincare solutions has led to a surge in herbal-based cosmetic formulations. This study presents the development and evaluation of a novel anti-pigmentation cream utilizing herbal bioferments**.** A cutting-edge approach that enhances the efficacy of traditional plant extracts through microbial fermentation. Unlike conventional creams that rely on raw herbal extracts, this formulation incorporates fermented liquorice, turmeric, rice water, and green tea**,** each selected for their proven depigmenting, antioxidant, and anti-inflammatory properties.
Fermentation, carried out using *Lactobacillus plantarum* or *Saccharomyces cerevisiae*, transforms these botanicals into smaller, bioavailable molecules, improving skin penetration and reducing irritation. The cream is formulated through a standard emulsification process, combining an oil phase (shea butter, almond oil, glyceryl monostearate, cetyl alcohol) with an aqueous phase (purified water, glycerin, aloe vera juice), followed by the incorporation of active bioferments and supportive additives like panthenol, vitamin E, and Geogard ECT preservative. Evaluation parameters include organoleptic properties**,** pH, stability**,** spreadability and irritancy under various conditions.

Keywords: Anti-pigmentation, liquorice, herbal formulation, skin repair, antioxidant

Introduction
Facial hyperpigmentation is more common in people with darker skin tones and can be distressing. One type is melasma (chloasma)**,** a stubborn condition causing brown or grey patches on the face, most often in women, especially during pregnancy. Another type is post-inflammatory hyperpigmentation (PIH), which appears after skin injury or inflammation and affects all ages and sexes equally [1].
Hyperpigmentation is a common skin concern caused by excess melanin, leading to dark spots and uneven tone. It can be triggered by sun exposure, hormones, inflammation, or scarring. While traditional treatments use agents like hydroquinone or kojic acid, these may cause irritation or side effects. As a result, the skincare industry is turning to safer, natural bioactive alternatives (Fig. 1) [2, 3].
Creams are semi-solid preparations made up of oil and water, and are classified as:

- **Oil-in-Water (O/W) creams:** They contain tiny droplets of oil that are dispersed in a continuous water phase. These are more comfortable and cosmetically acceptable, as they are less greasy and can be easily removed with water.
- **Water-in-Oil (W/O) creams:** They contain tiny droplets of water dispersed in a continuous layer of oil. They are harder to use, but they keep the skin more moisturized because the oil layer slows the leakage of water from the outer layer of the skin.

Fig 1: Types of hyperpigmentation

This study focuses on the development of a bioferment-based antipigmentation cream, integrating fermented botanical extracts known for their skin-brightening, antioxidant and anti-inflammatory properties. Fermentation enhances the bioavailability of phytochemicals, reduces molecular size for better skin absorption, and minimizes allergenic potential. Ingredients such as liquorice root, rice water, green tea, and turmeric are fermented using probiotic strains like *Lactobacillus* or *Saccharomyces*, unlocking potent compounds that regulate melanin synthesis.

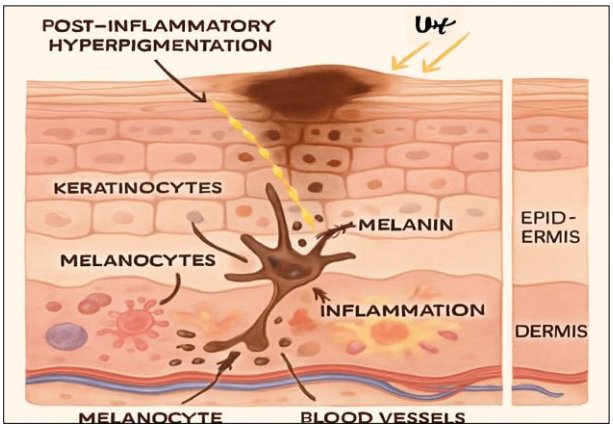

Fig 2: Anatomy of hyperpigmented skin

Hyperpigmented skin (Fig. 2) results from excess melanin production in the epidermis or dermis, often triggered by sun exposure, hormonal changes, or inflammation. Anatomically, melanocytes in the basal layer of the epidermis overproduce melanin, which is transferred to keratinocytes, leading to darker, uneven skin tone and visible pigmented patches. Combining traditional herbs and modern fermentation, it enhances effectiveness and soothing properties, offering a natural yet advanced solution for pigmentation, radiance, and overall skin wellness.

Common causes and risk factors of hyperpigmentation are [4, 5]

- **Excessive Sun Exposure:** UV rays stimulate melanin production, leading to sunspots or solar lentigines.
- **Hormonal Changes:** Conditions like melasma are triggered by pregnancy, oral contraceptives, or hormone therapy.
- **Post-Inflammatory Response:** Skin trauma from acne, eczema, burns, or cuts can cause dark patches as the skin heals.
- **Genetic Predisposition:** Family history of melasma or freckles increases susceptibility.
- **Skin Aging:** Age-related changes in skin metabolism and sun exposure history contribute to age spots.

Key Risk Factors (Fig. 3)

- **Gender:** Women are more prone to melasma due to hormonal fluctuations.
- **Skin Type:** Medium to darker skin tones are more susceptible to visible pigmentation.
- **Age:** Older adults are more likely to develop age-related pigmentation.
- **Inflammatory Skin Conditions:** Acne, dermatitis, or psoriasis can trigger post-inflammatory hyperpigmentation.

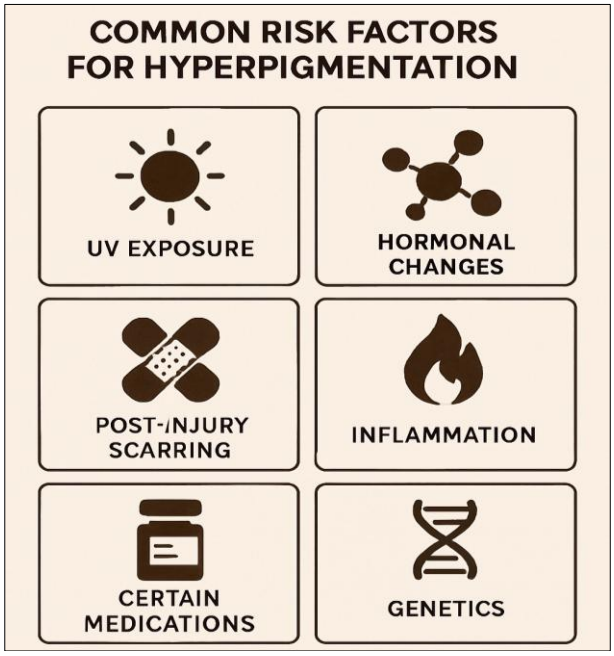

Fig 3: Common risk factors for hyperpigmentation

In my study the following crude drugs were used for the preparation of anti-pigmentation bio-ferment cream

Black Turmeric

Curcuma caesia, commonly known as black turmeric (Fig. 4) or Kali Haldi in Hindi, is a unique medicinal herb known for its bluish-black rhizomes.

- **Synonym:** Kali Haldi (Hindi), Black Zedoary, Nalla Pasupu (Telugu)
- **Chemical constituents:** Curcumin:2-4%, α-Pinene: 2-3%, β-Pinene: 1-2%, Sabinene: 1-2%, Caryophyllene:0.5-1%, Camphor: 28-31%, Ar-turmerone: 10-15%.
- **Geographical source:** In India it is particularly found in Odisha, West Bengal, Chhattisgarh, Assam, North-East India and also found in some parts of Thailand, Indonesia and Nepal.
- **Uses:** Fermented black turmeric reduces pigmentation, prevents new spots, and soothes inflammation. Rich in antioxidants, it protects against environmental damage, promotes skin regeneration, and improves tone offering a natural glow and even complexion without harsh chemical agents.

Fig 4: Freshly harvested Black Turmeric

Liquorice

Glycyrrhiza glabra (Fig. 5) is a potent skin-brightening and anti-inflammatory botanical. Its actives, glabridin and liquiritin, inhibit tyrosinase and reduce melanin, fading dark spots and uneven tone. Fermentation enhances bioavailability and antioxidant power, making it ideal for gentle, effective bioferment creams that target pigmentation while promoting skin health, radiance, and soothing benefits.

- **Synonym:** Mulethi (Hindi), Liquorice (English).
- **Biological Source:** The dried peeled or unpeeled roots, stolons, and subterranean stems of the plant *Glycyrrhiza glabra* Linn., which belongs to the family Leguminosae (Fabaceae) [6].

Fig 5: Liquorice stem

Taxonomic Classification

- **Kingdom:** Plantae
- **Phylum:** Angiospermae
- **Class:** Dicotyledoneae
- **Order:** Fabales
- **Genus:** *Glycyrrhiza*
- **Species:** *Glabra*

Chemical Constituents: Glycyrrhizin 4%-20%, Liquiritin~0.8% & Glabridin ~0.5%, Herniarin & Umbelliferone, Polysaccharides10%, Tannins~3%.

Geographical Source: India-Sub-Himalayan tracts and Baluchistan, Spain, Sicily, England, China, Turkey, Iran, Iraq, Japan, and Kurdistan [7, 8].

Uses: Liquorice reduces hyperpigmentation by blocking melanin and fading dark spots. Glabridin protects from sun damage. Fermentation boosts absorption, making it ideal for gentle, effective skin-brightening creams.

Green Tea Extract

- **Synonyms:** Hari chai (Hindi), light tea or green tea (English).
- **Biological Source:** Green tea extract (Fig. 6) is obtained from *Camellia sinensis* leaves and belongs to the Theaceae Family.

Fig 6: Green tea extract

Chemical Constituents: 15-20% proteins, 1-4% amino acids like theanine and glutamic acid, 4-6% caffeine, 40% carbohydrates including cellulosic fiber, and 4% lipids, Catechins, which make up nearly 30-42% of the dry leaf weight.

Geographical Source: Green tea is produced in countries with rich tea cultures such as China, Japan, India, Sri Lanka, Vietnam, and Korea. China leads with famous varieties, Japan offers Matcha and Sencha, India provides Assam and Darjeeling, and Sri Lanka produces lighter teas [9].

Uses: Green tea reduces dark spots by controlling melanin, while EGCG fights free radicals. It protects from sun damage, soothes redness, supports repair, and improves tone for a radiant, clear complexion.

Aloe Vera

Aloe vera (Fig. 7) soothes and hydrates while reducing melanin with aloin and aloesin, helping fade dark spots. Fermentation boosts its bioavailability, antioxidant, and anti-inflammatory effects, promoting healing, even tone, and brighter, healthier skin [10, 11].

Synonyms: Kummari (Hindi).

Biological Source: It is obtained from the leaves of *Aloe*, which belongs to the Liliaceae family.

Fig 7: Aleo vera leaves

Chemical Constituents: 97.4% moisture, making it highly hydrating and soothing, remaining constituents are ash (16.88%), crude fiber (73.35%), crude protein (6.86%), crude lipid (2.91%), ascorbic acid (0.004%), Vitamins (A, B1, B2, B4, B6, B12), Enzymes (amylase, catalase, lipase).

Geographical Source: India: Commonly found in Rajasthan, Gujarat, Tamil Nadu, Maharashtra, and Kerala. Also cultivated in some parts Africa and Mexico.

Uses: Aloe vera aids in wound healing, soothes irritation, and offers anti-inflammatory effects. In bioferment creams for hyperpigmentation, it helps inhibit melanin synthesis through aloesin and aloin, while supporting skin brightening and antioxidant protection.

Almond Oil

Almond oil (Fig. 8) nourishes and evens skin tone, reducing dark spots with vitamin E and healthy fats. It moisturizes, softens, supports healing, and enhances absorption of actives, making bioferment creams more effective for brightening and calming.

Biological source: Almond comes from the seeds of the tree *Prunus amygdalus*. Are of two types: sweet almond (*var. dulcis*) and *bitter almond* (*var. amara*).

Fig 8: Almond oil

Taxonomic Classification

- **Kingdom:** Plantae
- **Phylum:** Magnoliophyta
- **Class:** Magnoliopsida
- **Order:** Rosales
- **Genus:** *Prunus*
- **Species:** *dulcis*

Chemical constituents: It is rich in monounsaturated fatty acids, with oleic acid about (60-76%), linoleic acid (15-25%), palmitic acid (6-8%) & stearic acid (1-2%), linolenic and palmitoleic acids (less than 1%) [12, 13, 14].

Geographical source: Almonds are primarily cultivated in Mediterranean regions such as Spain, Italy, Syria, Iran, and North Africa, with California producing nearly 80% of the global supply.

Uses: Almond oil lightens dark spots, deeply moisturizes, and softens skin. Rich in vitamins (B_2, B_3, B_7, B_9, E) and fatty acids (Polysaturated, Monosaturated), it repairs and improves tone.

Shea Butter

- **Synonyms:** Shea butter (English), Karité butter (French).
- **Biological Source:** Shea butter (Fig. 9) is a natural fat from the nuts of the shea tree (*Vitellaria paradoxa*), native to West Africa. It's extracted from the kernel and used for its emollient properties. Two main types exist: the firmer, stearic acid rich *V. paradoxa* from West Africa, and the softer, oleic acid rich *V. nilotica* from East Africa.
- **Chemical Constituents:** Shea butter is primarily composed of fatty acids, Oleic acid 40-60%, Stearic acid 20-50%, Palmitic acid 2-9%, Linoleic acid 3-11%, & Arachidic acid <1%, Tocopherols (vit. E), Triterpenes, Catechins, and Phytosterols [15, 16].

Fig 9: Shea Butter

Uses: Shea butter supports hyperpigmentation treatment by soothing inflammation, deeply hydrating, and repairing the skin barrier. Its rich nutrients enhance bioferment and depigmenting actives, helping reduce melanin production and improve skin texture and tone [17, 18].

Panthenol (Vit. B5)

Panthenol (provitamin B5) hydrates, soothes, and heals in hyperpigmentation creams. It converts to Vitamin B5, attracts moisture, strengthens the barrier, calms irritation, and supports repair. It also boosts absorption of niacinamide and kojic acid, improving skin texture, tone, and clarity. The passage has been shortened to 50 words as requested [19].

Uses: It is a key ingredient in anti-pigmentation bioferment creams, providing hydration, barrier repair, and anti-inflammatory effects. Converted to pantothenic acid in skin, it improves moisture retention and soothes redness. It stabilizes the skin barrier, enhances fermented actives, and boosts absorption of niacinamide, kojic acid, and liquorice, benefiting sensitive, pigmentation-prone skin [20, 21].

Cetyl Alcohol

Cetyl alcohol, a fatty alcohol from coconut or palm oil, is a gentle multifunctional ingredient in bioferment creams for hyperpigmentation. Unlike harsh alcohols, it emulsifies oil and water, creating a smooth, silky texture. As an emollient, it softens skin, aids spreadability, and enhances absorption of actives like niacinamide, kojic acid, and fermented extracts. It also reduces water loss and irritation, supporting barrier health while boosting stability and effectiveness of bioferments for improved skin tone [22].

Uses: Cetyl alcohol is a gentle fatty alcohol that supports hyperpigmentation bioferment creams by stabilizing emulsions, softening skin, and enhancing texture. It blends oil and water phases, adds creaminess, and improves spreadability. As an emollient and barrier supporter, it reduces water loss, soothes sensitivity, and enhances absorption of actives like niacinamide, kojic acid, and fermented extracts. While not depigmenting, it provides a stable, skin-friendly base that boosts tolerance and effectiveness of bioferments in improving tone and reducing pigmentation.

Vitamin-E

Vitamin E (Fig. 10), also known as tocopherol, is safe, effective, and suitable for all skin types. It shows good compatibility with other ingredients commonly found in creams, such as beeswax, aloe vera, and almond oil.

Uses: Vitamin E helps reduce hyperpigmentation by protecting skin from oxidative stress, improving moisture retention, and enhancing the effectiveness of bioferment actives.

Fig 10: Vitamin E soft gel capsules

Rice Water

Fermented rice water (Fig. 11) brightens, hydrates, and protects skin with bioavailable amino acids, B vitamins, and ferulic acid. It reduces dark spots, evens tone, supports renewal, strengthens the barrier, and works synergistically with bioferments like *Galactomyces* or *Lactobacillus* [23, 24].

Biological Source: Rice used in fermented rice water formulations is *Oryza sativa L.*, a cereal crop. Widely cultivated across Asia and other tropical regions, *Oryza sativa* is rich in starch, amino acids, and antioxidants.

Fig 11: Fermented rice water separated in glass jar

Taxonomic Classification

- **Kingdom:** Plantae
- **Phylum:** Magnoliophyta
- **Class:** Liliopsida
- **Order:** Poales
- **Genus:** *Oryza*
- **Species:** *sativa*

Chemical constituents: Rice grains consist of carbohydrates 73-81%, in the form of starch, Proteins 6-12%, Moisture 10-14% influencing texture and shelf life, Fat 0.4-3.2%, concentrated in the bran layer-rice contains crude fiber 0.2-3.2%, Ash 0.8-2.0% representing mineral matter such as iron and zinc, and trace amounts of vitamins including thiamine, riboflavin, and niacin [25].

Geographical source: It is mainly grown in Asia, especially in countries like India, China, Indonesia, and Thailand, which are major producers and exporters.

Uses: Fermented rice water, rich in inositol, ferulic acid, amino acids, and B vitamins, brightens skin, fades dark spots, and gently exfoliates with lactic acid. It protects from UV damage, hydrates, supports the barrier, and complements actives like niacinamide.

Glycerine Liquid

Glycerine (Fig. 12) is a natural humectant used in hyperpigmentation bioferment creams to retain moisture, enhance skin softness, and improve active ingredient absorption. It supports skin barrier repair, reduces dryness, and boosts the delivery of biofermented actives like rice water. Its soothing and hydrating properties make it ideal for gentle, effective pigmentation control in cosmetic formulations [26].

Fig 12: Glycerine in glass bottle

Use: Glycerine hydrates skin by attracting moisture, improving texture and enhancing absorption of bioferments like niacinamide. It soothes irritation, supports barrier repair, and creates a stable base, making it ideal for hyperpigmentation creams targeting uneven tone and post-inflammatory pigmentation.

Glyceryl Monostearate (GMS)

Glyceryl monostearate (GMS), a non-ionic emulsifier from glycerin and stearic acid, is key in bioferment creams for stability and texture. It blends oil and water phases, creating a

smooth base for actives like fermented rice water or niacinamide. GMS enhances spreadability, forms a light occlusive layer to reduce water loss, and supports effective delivery of bioferments and pigmentation-reducing ingredients while improving hydration and overall cream performance.

Use: Glyceryl monostearate (GMS) acts as an emulsifier, stabilizing oil-water blends for even bioactive delivery. It enhances texture, spreadability, and moisture retention, while conditioning skin. GMS also adds opacity, protects light-sensitive ingredients, and supports stability, ensuring effective performance of bioferments and depigmenting actives.

Essential Oil (ROSE)

Rose essential oil (Fig. 13), derived from *Rosa damascena*, is valued in bioferment creams for its brightening, antioxidant, and soothing properties. It helps in fading dark spots, neutralizes free radicals, calms irritation, and reduces redness. Additionally, it supports hydration, barrier repair, and regeneration, improving overall tone, texture, and pigmentation concerns effectively [27].

Biological Source: Rose oil is mainly obtained from the petals of Rosa damascena (Damask rose), valued for high quality and yield. Other sources include Rosa centifolia and Rosa gallica. The oil is extracted by steam distillation, and sometimes by solvent or enfleurage methods. Major cultivation occurs in Bulgaria, Turkey, Iran, India, and Morocco, with favorable climates for production.

Fig 13: Essential oil of rose

Use: Rose essential oil from *Rosa damascena* benefits hyperpigmentation creams by brightening skin, reducing dark spots, and evening tone. Its antioxidants protect against oxidative stress, while anti-inflammatory effects calm irritation. It also promotes cell renewal, improves texture, and adds a soothing, luxurious scent for an enhanced skincare experience.

Materials and Methods

Materials

All the crude drugs were purchased from the local market of Aminabad, Lucknow, Uttar Pradesh. Listed crude drugs (Table 1) were authenticated with the reference no. IU/PHAR/HRB/25/12 by Dr. Mohd. Arif (Associate Professor, Department of Pharmacy, Integral University Lucknow).

Table 1: List of ingredients used in hyperpigmentation bioferment cream

S. No.	Ingredient	Form	Quantity
1.	Shea butter	Solid	5 gm
2.	Almond oil	Liquid	4.5 ml
3.	Cetyl alcohol	Liquid	1.5 ml
4.	Glyceryl monostearate (GMS)	Solid	3 gm
5.	Purified water	Liquid	(~68) qs.
6.	Glycerin	Liquid	2.5 ml
7.	Aloe vera juice	Liquid	5 ml
8.	Fermented liquorice extract	Liquid	2 ml
9.	Fermented turmeric extract	Liquid	1 ml
10.	Fermented rice water	Liquid	3 ml
11.	Fermented green tea extract	Liquid	1 ml
12.	Panthenol (vit. B5)	Solid	1 gm
13.	Vitamin E	Liquid	1 ml
14.	Preservative (geogard ECT)	Liquid	1 ml
15.	Essential oil (rose)	Liquid	0.5 ml

Method for the fermentation of active ingredients

Fermented Liquorice Extract (10 g) [28]

Materials

Liquorice root powder - 10 g, Distilled water - 20 mL, Glucose - 0.2 g (1% w/v), *Lactobacillus plantarum* culture - 1% inoculum, Sterile conical flask, cotton plug, magnetic stirrer.

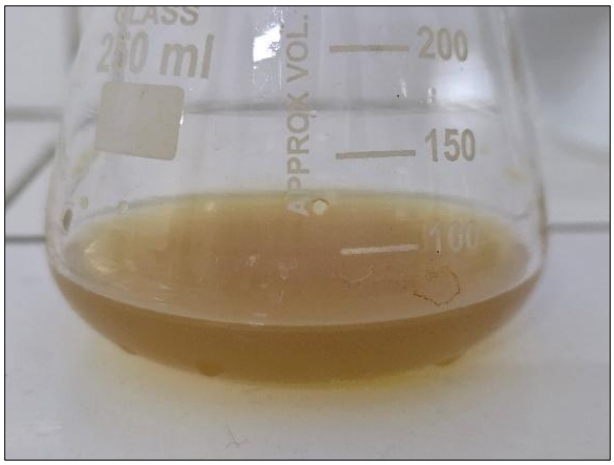

Fig 14: Fermented liquorice extract

Procedure

- Prepared aqueous extract by mixing licorice powder with distilled water. Heat gently (60 °C) for 15 min, then cool.
- Added glucose and adjusted pH to 6.1 using sodium citrate.
- Inoculated with *L. plantarum* (1% v/v).
- Incubated at 37 °C for 72 hours with gentle shaking every 12 hours.
- Filtered through Whatman paper and stored in conical flask (Fig. 14).

Fermented Turmeric Extract (10 g) [29]

Materials

Turmeric rhizome powder - 10 g, Ethanol: Water (30:70) - 20 mL, Rice starch solution - 1% w/v, *Saccharomyces cerevisiae* culture - 1% inoculum, Anaerobic flask, cotton plug.

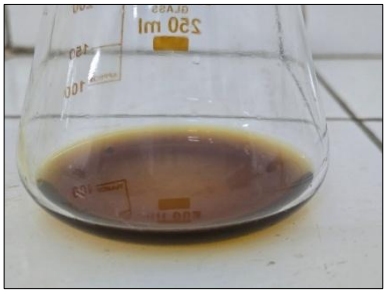

Fig 15: Fermented turmeric extract

Procedure

- Extracted turmeric using ethanol: water mixture. Stirred for 30 min, then filtered.
- Mixed extract with rice starch solution and adjusted pH to 5.5.
- Inoculated with *S. cerevisiae* (1% v/v).
- Incubated anaerobically at 30 °C for 48 hours.
- Centrifuged at 3000 rpm for 10 min. Collected supernatant and stored in sterile conical flask (Fig. 15).

Fermented Rice Water (10 g) [30]

Materials

Freshly boiled rice water - 10 g, *Lactobacillus plantarum* - 1% inoculum, Sterile glass jar, breathable cover.

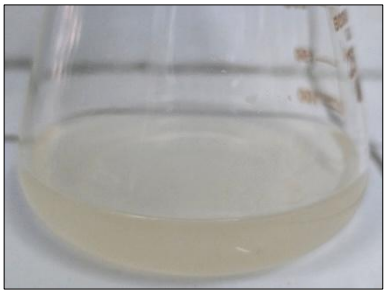

Fig 16: Fermented rice water

Procedure

- Collected rice water after boiling white rice (1:3 ratio). Cooled to room temp.
- Added *L. plantarum* (1% v/v) directly.
- Covered loosely with sterile gauze to allow gas exchange.
- Incubated at 30 °C for 72 hours and filtered & stored in sterile conical flask (Fig. 16).

Fermented Green Tea Extract (10 g) [31]

Materials

Green tea leaves - 10 g, Hot distilled water - 20 mL, Sucrose - 0.2 g (1% w/v), *Saccharomyces cerevisiae* - 1% inoculum, Sterile flask, magnetic stirrer.

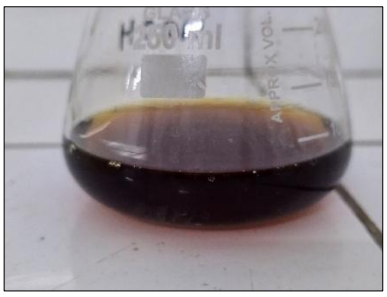

Fig 17: Fermented green tea extract

Procedure

- Prepared infusion by steeping green tea in hot water (80 °C) for 10 min then cooled.
- Added sucrose and adjusted pH to 6.
- Inoculated with *S. cerevisiae* (1% v/v).
- Incubated at 35 °C for 48 hours with light stirring every 8 hours.
- Filtered and stored in sterile conical flask (Fig. 17).

Methods for preparing 100 g Anti-pigmentation Bio-fermentation Cream [32, 33]

STEP-1 Preparation of oil phase

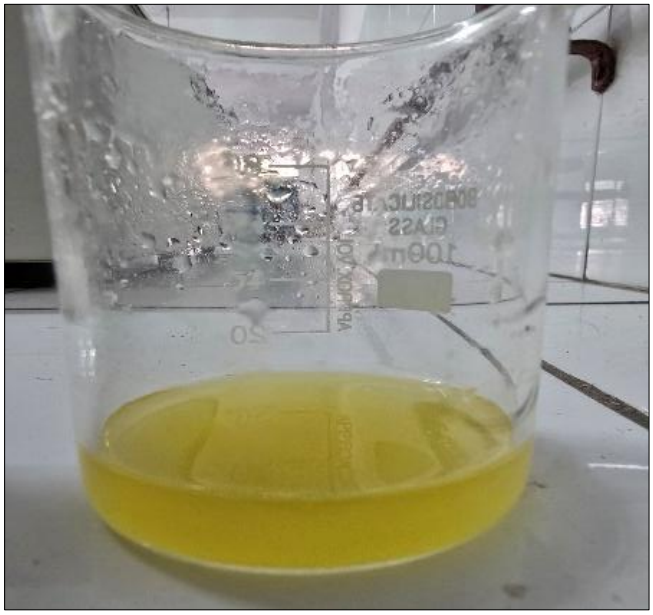

Fig 18: Oil phase mixture

In a clean beaker, weighed and added:
Shea butter (5 g), Almond oil (4.5ml), Glyceryl monostearate (3 g), Cetyl alcohol (1.5 ml).

- Heated the mixture to 75 °C using a water bath.
- Stirred continuously until all solids are melted and a clear oil phase is formed (Fig. 18).
- Keep covered to avoid evaporation & contamination.

STEP-2 Preparation of aqueous phase

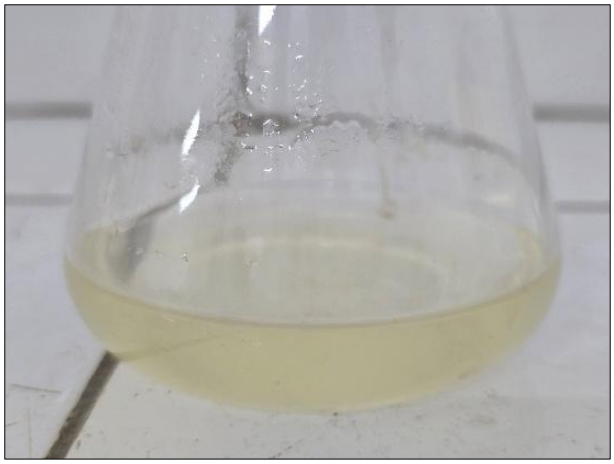

Fig 19: Aqueous phase mixture

In a separate beaker, mixed:

Purified water, Aloe vera juice, Glycerine.

- Heated this mixture to 75 °C.
- Stirred gently to ensure uniformity.
- Maintained temperature for 10 minutes to ensure microbial safety.
- Aqueous phase mixture was formed (Fig. 19).

STEP-3 Combined the oil and aqueous phases (Emulsification)

- Slowly poured the aqueous phase into the oil phase while stirring continuously with a propeller stirrer.
- Maintained temperature at 70 °C during mixing for 5 minutes.
- This forms a stable oil-in-water emulsion.
- Begined gradual cooling while continuing to stir to avoid separation.

STEP-4 Added active ingredients and preservatives

Fig 20: Added active ingredient and preservative in emulsified mixture

Cooling Phase (Below 40 °C)

- Once the emulsion cools below 40 °C, added:
  - Fermented liquorice extract (2 ml)
  - Fermented turmeric extract (1 ml)
  - Fermented rice water (3 ml)
  - Fermented green tea extract (1 ml)
- Then added:

Panthenol, Vitamin E (1 ml), Geogard ECT (1 ml), Essential oil - Rose (Fig. 20).
Mixed gently but thoroughly until the cream is smooth and uniform.

STEP-5 Final Adjustments

Checked and adjusted pH to 6.1 using:
Citric acid solution for lowering pH & Sodium citrate solution for raising pH.

STEP-6 Packaging

- Transferred the formulation into sterilized cosmetic containers to prevent oxidation and microbial contamination.
- Labelled with batch number, date, and storage instructions.

STEP-6 Storage

- Transferred the formulation into sterilized cosmetic container.
- Then it was kept in a cool and dry place, protected from direct sunlight and moisture.

How to use the Anti-pigmentation Bio-ferment Cream

STEP-1 Cleanse the area

Start by washing the affected skin area gently with a mild cleanser to remove dirt, oil, and impurities. This prepares the skin for better absorption of the cream.

STEP-2 Dry softly with a cloth

After cleansing, pat the skin dry using a soft, clean towel. Avoid rubbing to prevent irritation, ensuring the skin is slightly damp but not wet before applying the cream.

STEP-3 Apply the cream

Take a small amount of the bio-ferment cream on your fingertips. Apply it evenly over the affected areas with hyperpigmentation, ensuring full coverage without over-application.

STEP-4 Massage gently

Using circular motions, gently massage the cream into the skin until fully absorbed. This improves circulation and helps penetrate the active ingredients deeply for maximum effectiveness.

Evaluation of cream

a. **Organoleptic properties:** The physical characteristics of all formulations including appearance, color and texture were evaluated through visual inspection. To assess texture, a small quantity of each cream and gel was gently pressed between the thumb and index finger. Consistency and the presence of coarse particles were key indicators used in this evaluation. Additionally, the immediate tactile sensation upon application was examined, focusing on parameters such as stiffness, grittiness, and greasiness.
b. **Spreadability:** It was determined by taking 1g of anti-pigmentation cream and placing it on a circle glass plate of 1cm diameter, another glass plate was placed on it and a certain weight was applied on the upper plate for 5 min. Spreadability was measured by the spread of cream uniformly and there should be no unmixed particles.
c. **Washability:** A small amount of the prepared cream was applied evenly to a specified area of the skin and then exposed to running water for a fixed duration. The ease with which the cream was removed on the skin surface after rinsing was observed and recorded.
d. **Determination of pH:** A solution was prepared from the cream by weighing 1g of cream and dissolved in 10 ml of water. When a proper solution was prepared pH was determined by using a pH paper.
e. **Irritancy test:** The formulated cream was applied to the required area of the skin. After 1 hr the skin was checked for any irritancy, redness or inflammation on the skin.

Results and Discussion

a. Organoleptic Properties

All the formulations exhibited desirable organoleptic characteristics. The creams were smooth, homogenous, and free from coarse particles or phase separation. Upon application, the formulations spread evenly without sigs of grittiness or greasiness, confirming good texture and aesthetic appeal. Such properties are essential as they directly influence patient compliance.

b. Spreadability

The spreadability studies showed uniform distribution of the cream without unmixed particles. The average spread diameter indicated good spreadability, suggesting that the formulation can be easily applied with minimal effort. An ideal topical formulation should have sufficient spreadability to ensure even coverage, which was observed in this study.

c. Washability

The formulations demonstrated excellent washability, as the cream was easily removed under running water. This property ensures convenience for users while maintaining effective adherence during the period of application.

d. pH Determination

The pH values of the formulations were found to be 6.7, which is close to the skin's natural pH. This indicates that the cream is skin-friendly and minimizes the risk of irritation or disruption of the skin barrier. Maintaining near-neutral pH is particularly important for long-term topical use.

The prepared herbal anti-pigmentation cream exhibited satisfactory physical characteristics (Table 2) with a smooth texture and yellow colour. The pH of the formulation was found to be 6.7, confirming its skin-friendly and non-irritant nature. The cream showed good spreadability, was non-greasy, and easily washable with water. The combined effects of Aloe vera, Black Turmeric, Shea butter, Liquorice, and Almond oil contributed to moisturizing and healing properties. Overall, the formulation was found to be stable, effective, and suitable for the management of Hyperpigmentation.

Table 2: Observation of evaluation parameters for the herbal crack heel cream

Parameter	Result
Colour	Yellow
Smell	Characteristic
Texture	Smooth
Irritancy	No
Washability	Washable
Emulsion Type	O/W
pH	6.7
Spreadability	Spreadable
Phase separation	No phase seperation

Conclusion

The development of anti-pigmentation bio-ferment cream using natural actives such as green tea, aloe vera, and almond oil represents a promising and safe approach to effective skin brightening. Through bio fermentation, the bioavailability of these key ingredients is enhanced, allowing for deeper skin repair, reduction in melanin production, and potent antioxidant protection. The cream's anti-inflammatory properties help soothe irritated and sensitive skin, making it ideal for pigmentation-prone individuals. Evaluation studies have shown noticeable improvements in skin texture, hydration, and a visible reduction in pigmentation with consistent use over time. This formulation offers a gentle and clean alternative to harsh chemical treatments, meeting the rising demand for sustainable and natural skincare options. Looking ahead, future research could focus on optimizing advanced delivery systems and conducting broader clinical trials to validate and maximize the cream's therapeutic benefits.

Conflict of interest

The authors declare no conflicts of interest and agree to the publication of this work.

Author's Contribution

All the authors are equally contributed in this research work.

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