Herbal Anti-Tanning Cream: Development, Optimization, and Evaluation Using Nutmeg Extract

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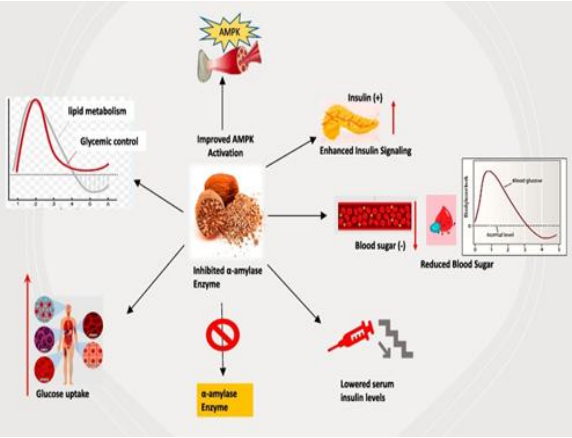
***Abstract*—The creation and assessment of a herbal anti-tanning face cream with nutmeg (*Myristica fragrans*) extract as the main active ingredient are the main objectives of this study. Nutmeg is a useful natural component in cosmetic formulations because of its well-known anti-inflammatory, antibacterial, exfoliating, and anti-pigmentation qualities. Shea butter, liquid paraffin, borax, methyl paraben, and rose water were used as supporting ingredients in the cream's preparation to help with emulsification, stability, moisturization, and scent. 96% ethanol was used to macerate the nutmeg extract, which was then evaporated to produce a thick, concentrated extract. Physicochemical and sensory criteria, such as color, odor, pH, texture, irritancy, washability, spreadability, and phase stability, were assessed for three formulations (F1, F2, and F3). Every formulation had favorable qualities, including a smooth texture, a nice scent, a pale-yellow color, and no indications of phase separation or discomfort. Excellent spreadability, neutral pH, and ease of washing were all displayed by the optimized formulation. The study's overall findings support the safety, stability, and efficacy of nutmeg-based herbal cream in enhancing skin hydration and minimizing tanning, providing a natural substitute for artificial cosmetics.**



Graphical abstract of herbal anti-tanning face cream with nutmeg extract.

***Index Terms*—Nutmeg, musky nut, anti-tanning, cream, maceration**

I. INTRODUCTION

The skin, which makes about 15% of the body weight, is the largest and most vital organ. Thus, it is always trying to maintain and restore itself. Numerous factors, including pollution and UV rays, can create dry patches of skin. Furthermore, wearing makeup while you sleep can irritate your skin or trigger an allergic reaction [1]. Numerous skin care products, such as gel, sunscreen lotion, face wash, skin serum, and anti-pigmentation creams, are available globally to protect the skin.

This study's objective was to create and assess a herbal cosmetic cream that would nourish, moisturize, and lighten skin. Nutmeg powder tightens pores and exfoliates skin to help balance oily skin. Additionally, nutmeg powder hydrates the skin from the inside out, resulting in a more even complexion and tone, and it helps to lessen skin irritation and inflammation. Even people with sensitive skin can benefit from using nutmeg powder. It is well known that nutmeg can balance out pigmentation and discolorations on the face. Antioxidants, which are abundant in nutmeg, can help prevent catastrophic illnesses including cancer, heart disease, and liver disease as well as the indications of aging.

Since the beginning of time, women have dressed themselves to enhance their own beauty. Even now, many people still favour natural remedies (plant extracts) over traditional cosmetics, especially in rural areas. Cosmetics are products used to improve and cleanse the skin. These products contain active ingredients that promote the possibility of therapeutic and medicinal benefits. Herbal cosmetics are still used by a tiny portion of women to improve their skin. The

best selling point of a herbal cosmetic is that it is made entirely of herbs and shrubs. These herbal remedies provide the body with vitamins and other healthy minerals, but the natural ingredients in plants have no harmful impact on human health.

However, there is now more scientific evidence that plants contain a wide range of complex active compounds (photochemicals) that can actively restore, cure, and protect skin in addition to soothing or smoothing it [2,3].

History

The Portuguese made the discovery of nutmeg in 1512, and it originated in Indonesia (Banda Islands). The Dutch spread awareness of the nutmeg seed's significance. The Latin term nux muscatus, which means "musky nut," is where the name nutmeg originates [4].

Taxonomical classification

Nutmeg, which is a member of the Myristicaceae family, is scientifically known as *Myristica fragrans*. It goes by a number of synonyms or popular names. In the UK, it's called mace or nutmeg; in Indonesia, it's called bunga pala; in Germany, it's called nuez moscada; in France, it's called muscadier; in India, it's called jaiphal; in Uruguay or Spain, it's called Muskatbaum; and in Arabic, it's called jawzat altayib. Table 1 displays the taxonomic categorization of nutmeg derived from the Integrated Taxonomic Information System [5]. In Southeast Asia and a number of other nations, such as Indonesia, Malaysia, Grenada, Sri Lanka, India, and Vietnam, the M. fragrans tree is widely grown [6,7,8,9]. The Banda Islands, often called the Spice Islands in Indonesia, are where the tree originated. These 9–12-meter-tall, fragrant, tropical evergreen trees have sporadic branches. The tree displays distinct male and female flowers on the same tree since it is dioecious. The dark green leaves, which vary in length from 5 to 15 cm and breadth from 2 to 7 cm, are arranged alternately along the branches. The flowers are pale yellow, bell-shaped, meaty, and waxy. After six years, the tree begins to bear fruit, and it can do so continuously for 20 to 75 years [10,11]. The fruit resembles an apricot or peach and is fleshy, green, or yellow in color (Fig. 1).

Fig. 1: Nutmeg tree

The fruit, known as Mace, splits in half when it ripens, revealing a glittering purplish brownie seed encased in a crimson aril.

The taxonomic classification of *Myristica fragrans* Houtt. (nutmeg) is displayed in Table 1. The Integrated Taxonomic Information System 2023 [5] provided the information.

Kingdom	Plantae-Plantae
Subkingdom	Tracheobionta
Phylum	Tracheophyta
Super division	Spermatophyta - Seeds
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Magnoliidae
Order	Magnoliales
Family	Myristicaceae
Genus	Myristica Gronov
Species	Myristica fragrans Houtt

Table no.1: Taxonomical classification

Nutmeg seed description

The dried seed of *Myristica fragrans*, or nutmeg, has a unique sweet flavor and pleasant scent. The seed is light brown in color and has an elongated oval form with a wrinkled surface. The ripe nutmeg seed is pale in color, solid and meaty, with red-brown streaks crossing it diagonally. It is encircled by a bright red, fleshy cover called scarlet aril, or mace (Fig. 2). After being dried and utilized as spices, the nutmeg seeds and maces are handled differently.

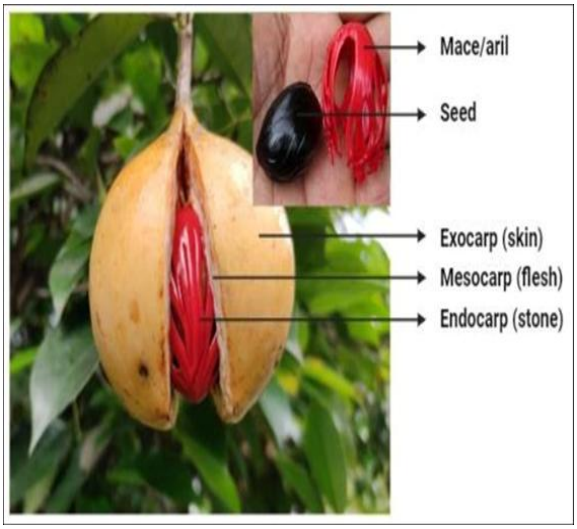


Fig. 2 : Nutmeg seed description

Composition of nutmeg seed (*Myristica fragrans*)

Knowing an oil's composition provides thoughtful knowledge about its potential uses in a variety of fields. Additionally, it offers a deeper comprehension of its function in health and its application as a remedy for numerous illnesses. Thirty to fifty-five percent of raw nutmeg seeds are oily, while forty-five to sixty percent are solid, including cellulose. The nutmeg oil is made up of several oleoresins, an essential oil that makes up 8%–15%, and a crude fixed oil called nutmeg butter that makes up 20%–40%. Due to the presence of an aromatic group, this nutmeg butter has a strong aroma [12]. Additionally, protein, fats, and carbohydrates are found in nutmeg. Nutmeg oleoresin is a common substitute for dry nutmeg seeds in a variety of industries, including food and medicines, due to its potent and unique flavor and aroma [10]. As a result, nutmeg's butter, essential oil, and oleoresin are regarded as great alternatives to whole nutmeg and are readily available. Fixed oil is often extracted by Soxhlet extraction or hydraulic extraction, which involves applying pressure and heat. Nutmeg butter, an aromatic orange extract with a semi-solid texture, is produced using both techniques. The chemical components of the yield and essential oils are greatly influenced by the extraction process [13,14]. Supercritical extraction produced 38.8% of the nutmeg, while Soxhlet extraction produced 34% [9]. On the other hand, steam distillation is used to extract nutmeg's essential oil. The final result is either a colorless oil or a pale yellow liquid with a nutmeg flavor and aroma [15]. It needs to be kept in a closed container because it is sensitive to light and air and soluble in alcohol but insoluble in water.

Chemical properties

Confirmation and standardization depend on the chemical components of an extract being characterized [16]. Numerous identification methods, such as GC and GCMS, HPLC, and GCTOFMS, were used to determine the chemical components of nutmeg. Ibrahim and Al-Rawi (1918) used GC–TOFMS to report the chemical makeup of supercritical nutmeg extract. Compared to butter or fixed oil, nutmeg essential oil has been the subject of greater investigation in recent years. Its popularity increased dramatically even though its concentration was smaller than that of the fixed oil in nutmeg seeds. This is probably due to the fact that essential oil possesses the vital useful components for industrial products in addition to its other pharmacological properties. Numerous investigations have identified the primary components of nutmeg essential oil [17, 18, 19, 20, 21]. The chemical composition of nutmeg seed essential oil was published by Muchtaridi et al. Subaddarage et al. [22, 23] have also documented the chemical and physical characteristics of Sri Lankan nutmeg oil (1985). Nonetheless, the presence and concentration of these chemical components can be used to evaluate the quality of nutmeg extracts. Nutmeg generally contains six primary classes of chemical compounds (FAO, 1994) [24], as Table 2 illustrates.

Sr. no	Six major groups present in nutmeg
1.	Myristicin, safrole, eugenol, methyl iso-eugenol, methoxy eugenol, iso-eugenol, methyl eugenol, elemicin, and iso-elemicin are examples of aromatic ethers.
2.	Alpha and gamma-terpinene, terpinolene, alpha and beta-pinene, alpha and beta-phellandrene, alpha-thujene, delta3-carene, myrcene, camphene, uinonene, dipentene, and sabinene are all included in the terpene group

3.	Alpha-terpineol, beta-terpineol, geraniol, citronellol, terpineol, caryophyllene, sesquiterpene, and linalool are all classified as monoterpene alcohols.
4.	Terpinic esters, which include bornyl acetate, geranyl acetate, and linalyl acetate.
5.	Toluene and p-cymene are examples of aromatic hydrocarbons.
6.	Acids: octanoic, butyric, formic, and acetic acids are included in this category.

Table no. 2: Nutmeg's six main groups (FAO, 1999) [24].

➢ Drug profile

Nutmeg

Synonyms: Myritica fragrans

Family: Myristicaceae

Uses: Nutmeg and its oil are used as carminatives, flavourings, and stimulants. In cases of chronic rheumatism, expressed fatty oil and volatile oil have been used externally. Effects: When consumed in small quantities as a spice, nutmeg has no discernible physiological or neurological effects. However, when consumed in large quantities, both freshly ground nutmeg from kernels and nutmeg oil have psychoactive effects that seem to be caused by myristicin and elemicin's anticholinergic-like hallucinogenic mechanisms.

Fig.3 : Nutmeg

Shea butter

It has been demonstrated that shea butter can lighten skin. Vitamins A and E, two of shea butter's active constituents, aid to improve the complexion overall and lessen the appearance of dark spots. In African nations, nuts that grow on shea trees produce shea butter, a creamy fat. Shea butter is solid at room temperature but melts when it comes into contact with skin. Although it is edible and used in many African recipes, it is mostly available in skin and hair care products in the US. You can safely apply shea butter to your face, lips, and body. Shea butter is also included in several body scrubs and hair conditioners for its hydrating properties.

Fig.4 : Shea butter

Liquid paraffin

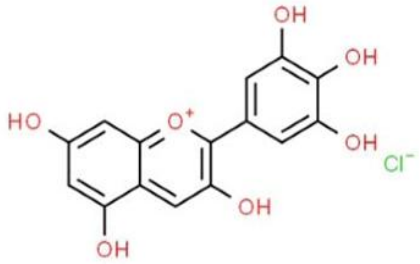


Fig.5 : Liquid Paraffin

Synonyms: paraffinum liquidum, paraffin oil, liquid paraffin oil or Russian mineral oil

Uses: In medicine, liquid paraffin is mostly used as a laxative for children and is a common remedy for encopresis with constipation. The medication is easy to synthesize due to its simple titration. It acts mainly as a stool lubricant, hence it is not linked to flatulence, diarrhea, or cramping in the abdomen. Electrolyte imbalances, tolerance to prolonged use, adverse effects, and stimulant laxatives frequently engender (though recent research indicates that these might still happen). The medication works by easing the stool and creates an oily layer in the colon, which lessens

the discomfort brought on by specific ailments. Like hemorrhoids, or piles. Because of these characteristics, the medication is suitable for persistent infantile constipation and encopresis, when prolonged use or high dosages are required.

Borax

Synonyms: sodium borate, sodium pyroborate, sodium tetraborate

Uses: Borax is most commonly used as a cleaning, but it is also an ingredient in many other household products, such as:

- Cosmetics like lotions, skin creams, moisturizers, sunscreen, and acne care products
- Ceramic glaze and paint
- Specialty mouthwashes and toothpastes
- Herbicides

Borax health risks: Health hazards associated with borax: If consumed alone, borax can induce nausea, vomiting, and diarrhea; excessive doses can result in shock and renal failure. Food goods in the United States are prohibited from using it. Inhaling it might cause harm to your nose, throat, and lungs in addition to irritating your skin and eyes. It may harm male reproductive systems and produce rashes if you are exposed to it frequently.

Methyl Paraben

IUPAC name: Methyl 4hydroxybenzoate

Other names: Methyl paraben

Chemical Formula: $C_8H_8O_3$

Molar mass: 152.15 g·mol−1

Uses: A number of cosmetics and personal hygiene items contain methyl paraben, an antifungal ingredient. It serves as a food preservative as well. In Drosophila food medium, methyl paraben is frequently employed as a fungicide. Water (2.5 g/l at 25° C), benzene (somewhat soluble), carbon tetrachloride (slightly soluble), ethanol, ether, acetone, DMSO, methanol, warm oil (25 g/l), and warm glycerol (1 g/70 ml) are all soluble.

Description

The formal condensation of the carboxy group of 4-hydroxybenzoic acid with methanol yields methylparaben, a 4-hydroxybenzoate ester. In cosmetics, it is the most often used antibacterial preservative. It is found naturally in a number of foods, including blueberries. It functions as an antifungal, neuroprotective, antimicrobial food preservative, and plant metabolite.

Rose water

Synonyms: attar of roses; attar; atar; athar; ottar.

Botanical Name: Rosa damascena

Solubility: Soluble in alcohol and oils.

Uses:

1. Eases Pain

Children who had surgery inhaled either rose oil or almond oil in a 2015 research. Patients in the rose oil-inhaling group reported much less pain. The "feel-good" hormone endorphins may have been released by the brain as a result of the rose oil, according to researchers.

2. Relief from menstrual discomfort

Abdominal massages were given to patients experiencing menstruation pain in order to ease their suffering. One group received a massage using only almond oil, a carrier oil; the other group received a massage using both almond and rose oils. After the massage, the rose oil group reported feeling less cramping than the almond oil group.

Ingredients table:

Sr. no.	Ingredients	Role
1.	Nutmeg	Anti-tanning, remove dark spot, anti-inflammatory, anti-fungal, anti-bacterial
2.	Shea butter	Emulsifying agent, moisture, gives thickness to the cream, high conc. of vitamin c
3.	Borax	Alkaline agent which react with emulsifying agent
4.	Methyl paraban	Preservative
5.	Liquid paraffin	Lubricating agent
6.	Rose water	Fragrance

Table no.3: Ingredients and their role

II. METHOD OF PREPARATION AND EVALUATION OF ANTI-TANNING FACE CREAM

Extract Preparation

Maceration, which involves soaking plant components (leaves or powders) in a container with a cold solvent and letting it sit at room temperature for at least three days while stirring often, was one of the most important procedures. The processing was intended to soften and break the plant's cell wall in order to release the soluble phytochemicals. After three days, the filtration process presses or strains the mixture.

1. A thousand grams of powdered nutmeg were acquired.
2. For five days, 96% ethanol was mixed with nutmeg powder and macerated. After that, the mixture was filtered through flannel to produce a thin filtrate. After that, the aqueous filtrate is evaporated on the water bath until all of the ethanol has been removed, creating a thick filtrate.

A. Cream formulation

- Procedure

1. In a borosilicate glass beaker, heat liquid paraffin and shea butter while maintaining the oil phase. Borax and methyl paraben should be dissolved in distilled water in a separate beaker and heated to produce a clear solution. (Phase of water).
2. Next, gradually incorporate this watery phase into the heated oily phase.
3. Stir vigorously until a smooth cream develops after adding a determined amount of extract.
4. As a scent, add a few drops of rose water.
5. Place this cream on the slab, add a few drops of distilled water if needed, and stir the cream in an ageometric fashion to ensure that all the ingredients are thoroughly mixed and the cream has a smooth texture. This method of making cream is known as the asslab technique or the spontaneous method.

- Formula for cream preparation

Sr. no.	Ingredients	Formulations(F1)	Formulations(F2)	Formulations(F3) optimized
1.	Nutmeg extract	4ml	3.5ml	4ml
2.	Shea butter	3.5gm	3.2gm	3.2gm
3.	Borax	0.4gm	0.2gm	0.3gm
4.	Methyl paraben	0.112gm	0.05gm	0.02gm
5.	Liquid paraffin	10ml	20ml	14ml
6.	Rose water	QS	QS	QS
7.	Distilled water	QS	QS	QS

Table no. 4: Formula for cream preparation

B. Evaluation test

1) Physical evaluation:

In this

Sr.no.	Ingredients	Formulations(F1)	Formulations(F2)	Formulations(F3) optimized
1.	Colour	Pale yellow	Pale yellow	Pale yellow
2.	Odour	Pleasant	Pleasant	Pleasant
3.	State	Semi-solid	Semi-solid	Semi-solid
4.	Texture	Smooth	Smooth	Smooth

Table no.5: Physical evaluation

2) Irritancy

Mark the area (1 cm2) on the left-hand dorsal surface. Then the cream was applied to that area and the time was noted. Then it is checked for irritancy, erythema, and oedema any for an interval up to 24 hand reported.

Sr. no.	Irritant effect	Erythema		Oedema
1.	Nil	Nil		Nil
2.	Nil	Nil		Nil
3.	Nil	Nil		Nil

Table no.6: Irritancy observation

3) Wash ability

Sr. no.	Formulation	Wash ability
1.	F1	Easily washable
2.	F2	Easily washable
3.	F3	Easily washable

Table no.7: Wash ability observation

4) pH

Sr. no.	Formulation	pH
1.	F1	7.5
2.	F2	7.9
3.	F3	7.2

Table no.8: pH observation

5) Phase separation

Sr. no.	Formulation	Phase separation
1.	F1	No phase separation
2.	F2	No phase separation
3.	F3	No phase separation

Table no.9: Phase separation observation

6) Spread ability

Sr. no.	Formulation	Time	Spread ability
1)	F1	9	21.7
2)	F2	6	31.7
3)	F3	12	13.25

Table no.10: Spread ability observation

III. RESULT

It was discovered that the prepared cream had a lovely smell and was pale yellow in colour. The cream that was created was smooth, uniform, and homogenous. This product has been shown to be safe after numerous studies because it contains herbal extracts, doesn't contain any dangerous ingredients, and isn't synthetic. Because of its neutral pH, it is compatible with the pH of skin. During or after this cream's testing, no allergic irritation was seen. The herbal cream under investigation exhibited good organoleptic physico-chemical properties. Additionally, it improves skin hydration without altering the pH of the skin.

Sr. no.	Evaluation test	Observation
1.	Colour	Pale yellow
2.	Odour	Pleasant
3.	State	Semi-solid
4.	Texture	Smooth
5.	pH	7.2
6.	Irritant effect	Nil

7.	Wash ability	Easily washable
8.	Phase separation	No separation
9.	Spread ability	13.25

Table no.11: Result of nutmeg tan removal cream

IV. CONCLUSION

The creation and testing of a nutmeg extract-based herbal anti-tanning face cream showed that natural plant-based compounds can be useful substitutes for artificial cosmetic formulations. The study emphasizes the many advantages of nutmeg, which is abundant in antioxidants, essential oils, and phytochemicals with anti-inflammatory, antibacterial, exfoliating, and depigmenting properties. Because of these qualities, it is a great choice for skin care applications, especially when it comes to tanning, uneven skin tone, and skin irritation. The maceration process of nutmeg extraction guaranteed the highest possible retention of active phytoconstituents, which enhanced the final formulation's overall efficacy. Liquid paraffin improved lubrication and smooth application, while shea butter added further moisturization, nutrition, and emulsification. Rose water added aroma and calming properties, methyl paraben guaranteed product preservation, and borax supported emulsification as an alkaline agent. These components worked together to produce a stable, balanced, and skin-friendly formulation. The developed formulations showed favorable qualities in every evaluation. The cream had a semi-solid consistency, a pleasant scent, a smooth texture, and a pale yellow color—all excellent qualities for cosmetic items. Crucially, the pH levels stayed close to neutral, guaranteeing compatibility with human skin and reducing the possibility of irritation. Even after extended monitoring, the irritancy tests revealed no symptoms of erythema, oedema, or pain, further confirming the product's safety. Additionally, the improved formulation demonstrated exceptional spreadability, allowing for simple application and even skin covering. The emulsion's stability is demonstrated by the lack of phase separation, indicating that the cream may continue to be consistent and effective throughout time. Additionally, the cream was simple to wash, which is crucial for everyday use and consumer convenience. Because nutmeg contains bioactive components, the results collectively confirm that the"nutmeg-based anti-tanning cream is not only safe but also beneficial in improving skin hydration and possibly minimizing tanning and black patches. This formulation is a viable substitute that fits with contemporary tastes for natural skincare products, as people favor herbal and chemical-free cosmetics more and more.

In summary, the study successfully shows that functional skincare advantages can be obtained without the use of harsh chemicals by using natural constituents like nutmeg in cosmetic formulations. The results support the use of nutmeg as a major component in natural cosmetic formulations and motivate more research into its potential in dermatological applications. To further confirm the formulation's commercial potential, further research may concentrate on long-term stability, consumer acceptability, and comparative efficacy.

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