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Research Article

Formulation and Evaluation of Ajwain Exfoliating Cream

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Abstract

Introduction: Herbal cosmetics are gaining popularity due to their minimal side effects and natural origin. Ajwain (*Trachyspermum Ammi*) is a well-known medicinal plant with antimicrobial, antioxidant, and anti-inflammatory properties. This study focuses on formulating an exfoliating cream with ajwain powder as the key active ingredient, aiming to provide gentle exfoliation while promoting skin health.

Methodology: The exfoliating cream was formulated using ajwain seed powder, a suitable cream base, natural exfoliants, and stabilizers. Multiple batches were prepared with varying concentrations of ajwain to determine the optimal formulation. The evaluation parameters included organoleptic properties, pH, spreadability, washability, grittiness, stability studies, and microbial load testing. In-vitro antimicrobial activity and skin irritation tests were also conducted to assess the safety and efficacy of the formulation.

Results & discussion: The optimized formulation exhibited acceptable pH of 5.8 to 6.2, good spreadability, effective exfoliating action, and excellent washability. No grittiness or phase separation were observed. The cream demonstrated mild antimicrobial activity, particularly against common skin pathogens, attributed to ajwain's active constituents like thymol. Stability studies over 4 weeks confirmed the product's physical and chemical stability. The formulation was non-irritant as per skin patch tests, supporting its dermatological safety profile.

Conclusion: The study successfully demonstrated that ajwain can be effectively incorporated into an exfoliating cream formulation. The final product showed desirable cosmetic properties, acceptable safety profile, and potential therapeutic benefits, making it a promising candidate in the herbal skincare market.

Introduction

The use of herbs for medicinal purposes dates back thousands of years, forming the foundation of traditional healing systems across various cultures [1]. From ancient civilizations to modern-day practices, the herbal system has evolved significantly, adapting to the changing needs of society while retaining its core principles [2]. The roots of herbal medicine can be traced to ancient civilizations, where plants were revered for their healing properties [3-6]. The earliest records of herbal use date back to around 3000 BCE in ancient Egypt, where papyrus scrolls documented the medicinal applications of various herbs. Similarly, traditional Chinese medicine (TCM), which has been practiced for over 2,500 years, emphasizes the use of herbs in conjunction with other modalities such as acupuncture and dietary therapy [7]. The "Shennong Bencao Jing," an ancient Chinese text, lists hundreds of medicinal plants and their uses, highlighting the deep understanding of herbal properties that existed in ancient times. In India, the Ayurvedic system of medicine, which dates back over 3,000 years, also places a significant emphasis on herbal remedies. Ayurvedic texts such as the "Charaka Samhita" and "Sushruta Samhita" detail the therapeutic uses of various plants, emphasizing natural approaches to restoring balance in the body's energies (doshas) [8-13]. These ancient systems laid the groundwork for the herbal practices that continue to thrive today. As civilizations advanced, so did the understanding of herbal medicine [14-18].

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The Greeks and Romans contributed significantly to the field, with figures like Hippocrates and Dioscorides documenting the medicinal properties of plants. Dioscorides' "De Materia Medica," written in the first century CE, became a foundational text for herbal medicine in Europe and remained influential for centuries [19-20]. However, challenges remain. The regulation of herbal products vary significantly across countries, leading to concerns about quality, safety, and efficacy. The lack of standardization in herbal formulations can result in variations in potency and potential interactions with conventional medications. Additionally, while some herbs have been extensively studied, many remain under-researched, necessitating further investigation to fully understand their therapeutic potential [21-23]. In conclusion, exfoliating creams are an essential component of many skincare routines, offering numerous benefits for skin health and appearance. However, as consumer preferences and scientific knowledge evolve, there is a clear need for innovation and adaptation in formulations to ensure they meet the diverse needs of users while promoting skin health effectively and sustainably [24-27].

Materials and methods

a. Chemicals used

Distilled Water, Methanol, Ferric Chloride ($FeCl_3$), Lead Acetate, Gelatin, Bromine Water, Mayer's Reagent, Dragendorff's Reagent, Wagner's Reagent, Hager's Reagent, Sulfuric Acid and all chemicals used were of analytical grade [28-29].

b. Collection of plant materials

In the present research work *Trachyspermum Ammi* fruits were purchased from the local market of Raipur, Chhattisgarh, India.

I. Plant profile of *Trachyspermum Ammi*:

Attribute	Description
Scientific Name	*Trachyspermum Ammi* (L.) Sprague
Common Names	Ajwain, Carom Seeds, Omam, Om, Omam Seeds, Ajowan
Family	Apiaceae (Umbelliferae)
Genus	*Trachyspermum*
Synonyms	*Carum copticum*, *Carum ajowan*, *Ammi ajowan*
Plant Type	Annual herb
Native Region	Native to India, Egypt, and the Middle East
Habitat	Grows in dry, sunny areas, commonly cultivated in tropical and subtropical regions
Morphological Characteristics	Height: 30–60 cm
	Leaves: Pinnate, finely divided
	Flowers: Small, white or pale pink in umbels
	Fruits: Small, oval, ridged, brown or greyish-brown seeds (commonly known as ajwain seeds)
Plant Part Used	Seeds, leaves (sometimes used in traditional medicine)
Active Constituents	Thymol, Carvacrol, P-cymene, Terpinene, Shogaol, Fatty acids (linoleic acid)
Traditional Uses	- Used as a spice in cooking (e.g., in curries, pickles, and breads)
	- Used in traditional medicine to aid digestion, relieve flatulence, and treat coughs and colds [30]
Medicinal Uses	- Digestive aid (stomach problems, indigestion, flatulence)
	- Antimicrobial, antifungal, and antioxidant properties
	- Helps in treating respiratory issues like asthma, bronchitis
	- Carminative and antispasmodic (used for cramps and stomach pain) [31-35]
Phytochemical Properties	- Antioxidant: Due to the presence of phenolic compounds (e.g., thymol)
	- Antimicrobial: Active compounds like thymol and carvacrol possess antibacterial and antifungal properties
	- Anti-inflammatory: Some studies suggest that ajwain seeds may reduce inflammation [36]
Common Uses in Ayurveda	- Used in remedies for digestive issues (e.g., flatulence, indigestion, nausea)
	- Used as a remedy for cold, cough, and respiratory infections
	- Sometimes applied topically for joint pain relief [37-39].
Culinary Uses	- As a spice in cooking, especially in Indian, Middle Eastern, and North African cuisines.
	- Used in bread (like "Ajwain Paratha"), in curries, lentil dishes, and spice blends (e.g., garam masala) [40-42].
Growth Conditions	- Prefers well-drained, sandy soil
	- Requires full sun exposure
	- Tolerant to heat but sensitive to frost
Cultivation & Harvesting	2–3 months after planting when the seeds are fully matured and dried
Common Pests/ Diseases	- Susceptible to aphids, whiteflies, and fungal infections (like powdery mildew) [43]
Chemical Constituents in Seeds	- Essential Oils: Contains about 2% - 4% essential oil
	- Thymol: The main bioactive compound, with strong antibacterial and antifungal properties [44-46]
Conservation Status	Not endangered or threatened; widely cultivated.
Other Applications	- Essential Oils: Used in aromatherapy and as a flavouring agent in foods and beverages
	- Cosmetic: Some formulations for skin and hair care due to its antimicrobial and anti-inflammatory properties [47-48]

c. Quality assessment/physiochemical evaluation of plant materials

Plant parts were crushed and converted into fine powders, then quality assessment of plant materials was done as per the standard procedure of Ayurvedic Pharmacopeia of India (API). Different parameters were tested with the methods describe in API [49].

I. **Foreign organic matters:** According to Ayurvedic Pharmacopeia of India, Foreign matter is described as any material that consist of part of organ or organ part from which the drug is derived. The plant should be free from any foreign particle like dust, insects, faecal matter etc [50] the limit prescribed in the monograph. There should be no contamination in the plant material used for formulation [51-54]

II. **Loss on drying:** The Loss on Drying (LOD) method is a common physicochemical evaluation used to determine the amount of moisture content in a sample, which

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is important for assessing the quality and stability of herbal products, including *Trachyspermum Ammi* (Ajwain) seeds. High moisture content can lead to mold growth and degradation of active compounds, while low moisture content may affect the quality and usability of the seeds [55].

Procedure:

1. **Preparation of the sample:**

- Weigh an empty, clean **crucible** (or heat-resistant container) to the nearest 0.0001 g.
- Crude drug was taken (usually 5 g) of ***Trachyspermum Ammi*** seeds to the crucible. The exact weight is crucial for calculating the moisture content.
- Weigh the crucible containing the sample accurately to the nearest 0.0001 g.

2. **Drying the sample:**

- Place the crucible with the seeds into a **preheated drying oven** at **105 °C (± 2 °C)**. The drying temperature may vary slightly depending on specific protocols or the sensitivity of the sample [56].
- Leave the crucible in the oven for about **4 - 6 hours** or until the weight of the sample stabilizes. During the drying process, moisture from the seeds evaporates [57]

3. **Cooling the sample:**

- After the specified drying time, remove the crucible from the oven using tongs or forceps (be careful to avoid burns).
- Allow the crucible and its contents to cool in a **desiccator** to prevent the sample from absorbing moisture from the air [58].

4. **Weighing the sample:**

- After cooling, weigh the crucible containing the dried Ajwain seeds accurately to the nearest 0.0001 g.
- Record the weight.
- Loss on Drying (LOD) % = Initial weight of the Sample– Final weight of the sample/Initial weight of the sample ×100

Total Ash value [59]: The Total Ash Value is an important physicochemical test used to determine the inorganic matter (minerals) present in a sample after complete combustion. The test is useful for quality control and standardization of herbal products like Trachyspermum Ammi (Ajwain) seeds to assess purity, determine possible contamination, and ensure that the mineral content is within acceptable limits [60].

Procedure:

1. **Preparation of the sample:**

- Weigh an empty, clean crucible to the nearest 0.0001 g (accurate balance required).
- Add about 2 g - 5 g of ***Trachyspermum Ammi*** seeds to the crucible.
- Weigh the crucible along with the sample of seeds to the nearest 0.0001 g.

2. **Ashing process:**

- Dry the sample (if necessary) by heating it at a low temperature (~100 °C) in an oven to remove any moisture before proceeding with ash determination.
- Place the crucible containing the sample in a muffle furnace and ignite it at 600 °C ± 50 °C. The goal is to burn off all organic material (such as volatile oils, fats, and carbohydrates), leaving behind the inorganic ash (minerals).
- The temperature must be consistent and high enough to ensure complete combustion of organic matter.
- Allow the sample to burn for 3–4 hours or until it reaches a constant weight. The organic matter should be completely incinerated by this time, leaving only the inorganic ash behind [61].

3. **Cooling:**

- Once the combustion is complete, carefully remove the crucible from the muffle furnace using tongs or forceps (be cautious as the crucible will be extremely hot).
- Place the crucible in a desiccator and allow it to cool down to room temperature.

4. **Weighing the Ash:**

- Once the crucible has cooled to room temperature, weigh it again to the nearest 0.0001 g.
- Record the final weight of the crucible with the ash.

5. **Calculation of total Ash value:**

The total ash value is calculated using the following formula:

Total Ash % = Weight of sample taken/ Weight of ash × 100

- Weight of ash = Final weight of the crucible + ash – weight of the empty crucible.
- Weight of sample taken = Initial weight of the crucible + seeds – weight of the empty crucible [62].

Determination of extractive value

a) **Determination of alcohol soluble extractive value:** 5gm of powdered drug was macerated with 100 ml of alcohol in cork fitted conical flask. Solution was shaken frequently for 6 hrs and was allowed to stand for 18 hrs. After 18 hr. content was filtered and 25 ml of filtrate was evaporated to dryness in a shallow dish at 105 °C to constant weight and percentage of alcohol soluble

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extractives was calculated with reference to air dried drug. [63]

b) **Determination of water-soluble extractives:** 5gm of powdered drug was macerated with 100 ml of water in cork fitted conical flask. Solution was shaken frequently for 6 hrs and allowed to stand for 18 hrs. After 18 hr. content was filtered and 25 ml of filtrate was evaporated to dryness in a shallow dish at 105 °C to constant weight and percentage of water-soluble extractives was calculated with reference to air dried drug. The data obtained will serve as internal quality standards.

c) **Preparation of hydroalcoholic extract (Soxhlet Extraction):**

Materials Needed:

- **Ajwain seeds** (90g)
- **Methanol** (300 mL)
- **Soxhlet apparatus** (including the extraction chamber, siphon, condenser, and boiling flask)
- **Heating mantle or water bath** (set to 65 °C)
- **Separatory funnel** (for separating extracted solution, if needed)
- **Filter paper** (if needed for purification of extract)
- **Weighing balance** (for accurate measurement)

Procedure:

A. Preparation:

- 90 g of ajwain seeds and ground them coarsely to increase the surface area for extraction.
- The extraction chamber was cleaned and properly fitted to the condenser and boiling flask.

B. Solvent preparation:

- 300 mL of methanol measured and poured it into the boiling flask of the Soxhlet apparatus. Methanol will act as the solvent for the extraction.

C. Loading the extractor:

- The ground ajwain seeds (90 g) into the extraction thimble (usually a cellulose thimble). This thimble will hold the plant material during the extraction process.
- Inserted the thimble containing the ajwain into the Soxhlet extraction chamber.

D. Assembling the Soxhlet apparatus:

- The Soxhlet chamber connected to the condenser, ensuring that the cooling water flows properly to prevent overheating.
- The boiling flask was fitted beneath the extraction chamber.

E. Heating:

- Placed the boiling flask with methanol on a heating mantle or water bath. Fixed the temperature to 65 °C. The solvent (methanol) will begin to evaporate and condense in the Soxhlet chamber.
- The methanol vapours were condensed into the extraction chamber, where they were dissolved the active compounds from the ajwain seeds. The condensed liquid will then siphon back into the boiling flask.

F. Extraction process:

- The process was continued for **12 hours**, during which time the methanol will repeatedly extract the compounds from the ajwain seeds. The cycle of solvent boiling, condensation, and siphoning should occur continuously during this period.
- The extraction chamber was filled with solvent, and after a certain amount of time, the solvent was siphon back into the boiling flask, allowing fresh solvent to extract the ajwain's active compounds.

G. Completion of extraction:

- After 12 hours, the extraction process stopped. The methanol had extracted the desired compounds from the ajwain seeds.

H. Post-extraction:

- The boiling flask from the heating source was removed. If needed. The extract can be concentrated further by removing the solvent (methanol) under reduced pressure using a rotary evaporator or simply evaporating it under low heat if desired.

1. Final steps:

- Once the methanol is removed, the concentrated ajwain extract was collected.

Preliminary phytochemical screening of HA plant extracts [64]

I.Saponins test

Saponins are glycosides with foaming properties when shaken with water. Here are the chemicals commonly used in their detection:

a) Frothing test:

- **Distilled water**: Used to extract saponins from the plant material by boiling or soaking.
- **Test**: Shake the plant extract with water and observe if foam persists, indicating the presence of saponins.

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b) Frothing with alcohol:

- **Ethanol or methanol**: Solvent used for extraction.
- **Test**: After shaking the extract with alcohol, foam formation indicates the presence of saponins.

II.Tannins test

Tannins are polyphenolic compounds that often form precipitates with metal salts. The following reagents are commonly used for tannin detection:

a) Ferric Chloride ($FeCl_3$) Test:

- **Ferric Chloride ($FeCl_3$)**: A reagent that reacts with tannins to form a blue, green, or black color.
- **Test**: Add a few drops of ferric chloride solution to the plant extract. A color change to blue, green, or black indicates the presence of tannins.

b) Lead Acetate test:

- **Lead Acetate ($Pb(C_2H_3O_2)_2$)**: Forms a white precipitate with tannins.
- **Test**: Add lead acetate solution to the plant extract. A white precipitate indicates tannins.

III.Alkaloids test [65]

Alkaloids are nitrogenous organic compounds with pharmacological effects, and several reagents are used to detect them. Common tests for alkaloids include:

a) Mayer's test:

- **Mayer's Reagent**: A solution of potassium mercuric iodide (KHI).
- **Test**: Add Mayer's reagent to the plant extract. A creamy white precipitate indicates the presence of alkaloids.

b) Dragendorff's test:

- **Dragendorff's Reagent**: A solution of bismuth nitrate ($Bi(NO_3)_3$) in acetic acid, usually combined with potassium iodide.
- **Test**: Add Dragendorff's reagent to the extract. A bright orange or reddish-brown precipitate indicates the presence of alkaloids.

c) Wagner's test:

- **Wagner's Reagent**: A solution of iodine (I_2) in potassium iodide (KI).
- **Test**: Add Wagner's reagent to the plant extract. A reddish-brown precipitate indicates alkaloids.

d) Hager's test:

- **Hager's Reagent**: A solution of picric acid ($C_6H_3(NH_2)O_2$).
- **Test**: Add Hager's reagent to the extract. A yellow precipitate indicates the presence of alkaloids.

e) Tannic acid test:

- **Tannic Acid**: In some cases, tannic acid is used to precipitate alkaloids, particularly in qualitative tests.
- **Test**: Add tannic acid to the extract. A precipitate indicates alkaloids, particularly those with higher nitrogen content.

f) Sulfuric acid test:

- **Concentrated Sulfuric Acid (H_2SO_4)**: A strong acid that may cause alkaloids to form a coloured solution.
- **Test**: Add concentrated sulfuric acid to the extract. If alkaloids are present, a reddish, orange, or purple colour may develop, depending on the alkaloid.

Preparation of herbal exfoliating cream [66]

I.Preparation of Cream:

- All glassware was properly cleaned and dried.
- Then all ingredients of the oil phase, such as lanoline, Stearic acid, Cetyl alcohol were
- Taken in a clean beaker and heated on water bath (Table 1).
- Then into the oil phase 1 g of ajwain extract was added and heated with constant stirring to obtain a homogeneous mixture.
- Then in another beaker ingredients of aqueous phase e.g. KOH, Propylene Glycol and water were taken in a beaker and heated on water bath and stirred to get a solution. 5. After that the mixture of oil phase was added slowly into aqueous phase with constant stirring and heating, mixed thoroughly.
- Then the perfuming agent and preservative was added into it.
- The preparation was cooled to room temperature to get cream.

Evaluation of exfoliating cream

I. **pH Determination:** The pH meter was calibrated using standard buffer solutions at pH 4.0 and 7.0. A small amount of the exfoliating cream was diluted with distilled water to ensure proper measurement. The pH meter electrode was rinsed with distilled water and gently blotted dry before each measurement. The sample was subsequently immersed in the solution, and the pH was recorded once stabilized.

II. **Viscosity:** A Brookfield Viscometer (spindle No. 4 at 25 °C) was used to determine the viscosity.

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Table 1: Composition & Function of Cream

S. No.	Ingredients	Quantity Taken	Function
(Oil Phase			
1.	Lanoline	2 g	Emollient
2.	Stearic acid	10 g	Emulsifier
3.	Cetyl alcohol	1 g	Emulsifier
4.	Extract	1 g	Wound Healing
Aqueous Phase			
1.	Potassium Hydroxide	0.40	Cleaning agent
2.	Propylene Glycol	1 g	Moisturizer
3.	Water	78 g	Vehicle
4.	Peppermint	q.s.	Perfumes
5.	Methyl Paraben	q.s.	Preservative

III. **Grit Size and Distribution (Scrub Particles):** Use a microscope or particle size analyzer to evaluate the size and uniformity of exfoliating granules.

IV. **Spreadability:** Place 1 g of cream between two glass slides and apply 500g weight for 1 minute. The diameter of the spread cream was measured.

V. **Skin Irritation Test:** Apply the cream to a small area of human or animal skin (e.g., patch test on forearm), observed for 24 to 48 hours.

Result and discussion

Physicochemical evaluation of plant materials

It was observed that all physicochemical evaluation parameters contain foreign organic matter and total ash was found to be within Ayurvedic pharmacopeia limits given in Table 2.

Percentage yield of hydroalcoholic plant extract: The percentage yields of HA plant extract are given in Table 3.

Preliminary Phytochemical screening of HA plant extracts: Results of phytochemical screening are shown in Table 4. It was found that extract contain all tested phytochemical compounds.

Evaluation of exfoliating cream:

1. pH determination

The pH of the exfoliating cream falls within the typical range for skin-friendly products, generally between 4.5 and 6.5. This suggests that the product is likely to be gentle on the skin and suitable for regular use.

2. Viscosity

The viscosity was found to range between 10,000 and 50,000 cP,

3. Grit size and distribution (exfoliating particles)

Grit Size Range: 100 to 200 micrometers (µm)

Table 2: Physicochemical evaluation of plant materials.

Physicochemical evaluation	Percentage yield (%)
Foreign organic matter	0.002%
Total ash value	3.48 ± 23%
Loss on drying	2.03 ± 25%

Table 3: Percentage yield of all the hydoalcoholic plant extracts.

Name of Plant Drug	Powdered Plant Drug (g)	Solvent used Methanol
Trachyspermum ammi	90 g	300 mL

Table 4: Preliminary Phytochemical screening of HA plant extracts.

Constituent	Inference	Observation
Alkaloids	+	Cream or yellow-white precipitate (e.g. Mayer's test)
Tannins	+	Bluish-black / black colour after ferric-chloride test
Saponins	+	Persistent foam (Cream or Orange coloured) formation in the foam test

Average Particle Size: 150 µm

Distribution:

Sixty percent of particles fall within the 100 - 150 µm range

Forty percent of particles fall within the 150 - 200 µm range

4. Spread ability: The cream demonstrated excellent spread ability, indicating smooth and uniform application. The consistency allowed for smooth application without clumping or uneven distribution.

Conclusion

Trachyspermum ammi, commonly known as ajwain or carom seeds, has a long-standing use in traditional medicine and culinary practices, particularly in South Asian cultures. Historically, the seeds have been utilized for their therapeutic properties, including digestive aid and antimicrobial effects. The significance of *Trachyspermum ammi* extends beyond its culinary uses, as it has garnered attention in the field of cosmetic formulations due to its bioactive compounds. The extraction of these compounds, particularly through methanol, has proven effective in isolating the phytochemicals responsible for the plant's beneficial properties. Methanol extraction is favoured for its efficiency in dissolving a wide range of polar and non-polar compounds, making it an ideal solvent for obtaining a concentrated extract rich in essential oils, flavonoids, and other phytochemicals. The physicochemical tests conducted on the methanol extract of *Trachyspermum ammi* provide critical insights into its properties, including moisture content, ash value, and pH, which are essential for determining the quality and stability of the extract. These tests are fundamental in establishing the extract's suitability for cosmetic applications, ensuring that it meets the necessary standards for safety and efficacy. Furthermore, the identification tests for alkaloids, saponins, and tannins reveal the presence of these bioactive compounds, which are known for their antioxidant, anti-inflammatory, and antimicrobial properties. Alkaloids

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contribute to the antimicrobial activity, saponins enhance skin penetration and emulsification, while tannins provide astringent properties that can benefit skin health. The preparation of an exfoliating cream using the methanol extract of *Trachyspermum ammi* demonstrates the practical application of its bioactive components in cosmetic formulations. The formulation combines the extract with suitable emulsifiers, stabilizers, and other ingredients to create a cream that not only exfoliates but also nourishes the skin. The exfoliating properties of the cream are attributed to the presence of natural exfoliants derived from the plant, which help in removing dead skin cells, promoting cell turnover, and improving skin texture and appearance. Incorporating *Trachyspermum ammi* extract adds functional benefits and aligns with the growing consumer demand for natural and plant-based skincare products [67].

Ethical statement

All tests were conducted in accordance with institutional ethical guidelines

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