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Seed of Ajwain (Trachyspermum Ammi): Taxonomy, Phytochemistry, Pharmacology and Medicinal Uses

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ABSTRACT

INTRODUCTION: This review paper gathers studies conducted on Trachyspermum Ammi, aiming to present collective research data on the plant (seed). It aims to consolidate data on Taxonomy, Phytoconstituents, pharmacology, and medicinal uses to facilitate future research.

OBJECTIVE: Our project aims to explore various facets of Ajwain, from its taxonomic classification to its pharmacological and medicinal attributes. By integrating information on its chemical constituents, therapeutic potential and cultural contexts, we aim to offer a nuanced understanding of this botanical entity.

METHODOLOGY: We collected this information from various platforms and literature sources. It delves into Ajwain's bioactive compounds, particularly thymol, and conducts a thorough examination of its phytochemistry, pharmacological properties, and traditional uses.

RESULTS: The diverse uses of T. Ammi stem from its rich composition of active constituents. Phytochemical analyses reveal the presence of Saponins, flavonoids, alkaloids, glycosides, fixed oils, thymenes, cumenes, tannins, amino acids, p-cymene, and c-terpene steroids. Furthermore, pharmacological studies underscore its anti-inflammatory, antimicrobial, and antifungal properties, aligning with its traditional uses.

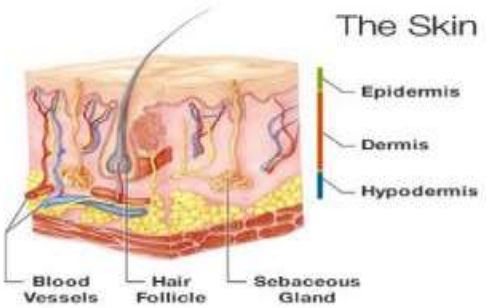
CONCLUSION: This paper provides an in-depth review of literature, pharmacological properties, phytochemical studies, and recent research on T. Ammi. It also documents traditional uses of the herb, as well as recommendations from Indian communities and tribes across the country.

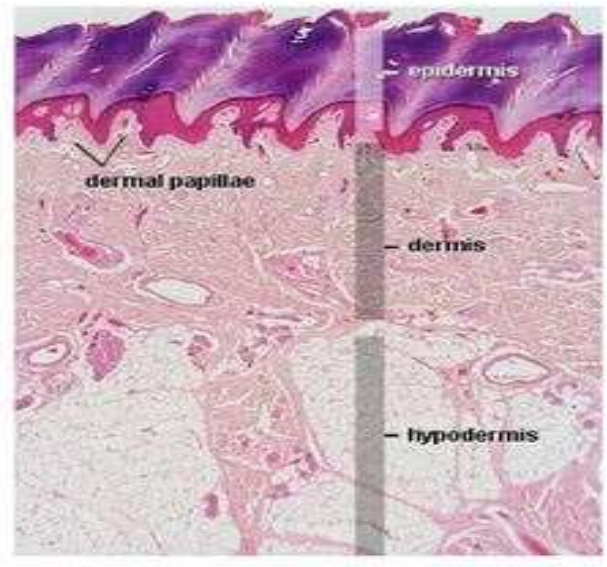
KEYWORDS: Trachyspermum Ammi, Taxonomy, Pharmacological Properties, Medicinal Uses, Phytochemistry, Ajwain, Anti-scar

Skin Anatomy, Physiology, and Healing Process

INTRODUCTION:

The skin, our body's largest organ, serves as a crucial protective barrier, shielding us from external elements. Its vital functions encompass regulating body temperature, shielding against harmful UV rays, preventing injuries, warding off pathogens and toxins, and maintaining immune surveillance. Additionally, the skin facilitates sensory perception, regulates fluid balance, and contributes to overall bodily homeostasis. [1]





STRUCTURE:

1. The skin consists of three main layers: the epidermis, the dermis, and the subcutaneous tissue, with the epidermis being the outermost layer, followed by the dermis, and the deepest layer being the subcutaneous tissue.
2. Serving as the outermost layer of the skin, the epidermis acts as a protective barrier against water and contributes to determining skin tone.
3. Positioned beneath the epidermis, the dermis is composed of connective tissue and houses structures such as hair follicles, blood vessels, lymphatic vessels, and sweat glands.

The Epidermis

It consist of five layers, the epidermis is free from blood vessels. Its thickness varies depending on the area of the body, being thickest on the heels and thinnest on the eyelids. [2]

Five layers of the epidermis:

1. **Stratum corneum**

Comprising 15 to 30 layers of keratinocytes known as squamous or corneocytes, the stratum corneum consists of dead keratinocytes. These cells contain a high amount of keratin, which serves to create a waterproof barrier for the skin, hair, and nails. [2]

2. **Stratum lucidum**

It is exclusively located in regions of dense skin, such as the palms of the hands and the soles of the feet. It is commonly found in calluses. [2]

3. **Stratum granulosum**

This stratum harbors the highest density of free nerve endings emanating from the dermis. These nerve endings are general in the skin and relay sensory signals related to pain, temperature (both hot and cold), and gentle touch. [2]

4. **Stratum spinosum**

Comprising Langerhans cells and lymphocytes, the Stratum spinosum serves a vital role in the immune system's functionality. [2]

5. **Stratum basale**

This layer is unique in its constant mitotic activity, continually generating new cells. [2]

Keratinocytes, the predominant cell type in the skin, are perpetually produced within the basal layer. They are crucial in wound healing, serving as both structural components and key contributors to immune responses. [2] Situated beneath the epidermis. It also Contain the blood vessels and nerves that furnish the epidermis with nutrients through capillary loops and sensory feedback via free nerve endings. [2]

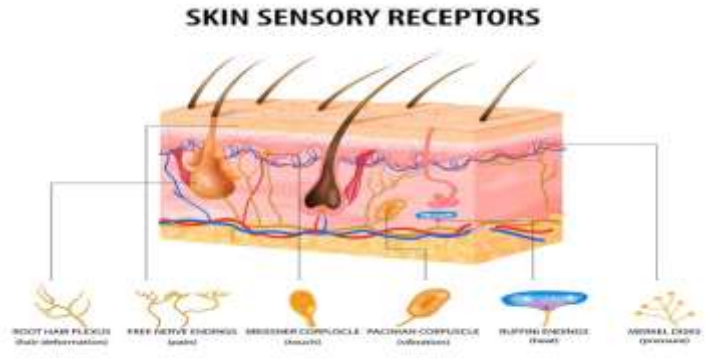
THE DERMIS

The dermis is positioned beneath the epidermis which contains the blood vessels and nerves that provide nourishment and sensation to the epidermis through capillary loops and free nerve endings.

It comprises two distinct layers. [3]

Papillary Layer:

1. Interlink with the epidermis, forming a close connection between the two skin layers.
2. The distinctive ridges of this layer contribute to the formation of fingerprints, making each person's fingerprints unique.[4]
3. Fibroblasts within this layer are responsible for producing collagen, elastin, and various proteins, which give the skin its strength and flexibility.[4]
4. Mast cells located in the papillary layer produce heparin and histamine, essential for blood clotting and the body's inflammatory response.[4]
5. Macrophages, also found in this layer, play crucial roles in immune defense; wound healing, protection against cancer, maintenance of salt balance, and regeneration of hair follicles. They eliminate foreign invaders through phagocytosis, engulfing and digesting foreign and dead cells.[4]
6. Additionally, leukocytes present in the papillary layer are vital for initiating the inflammatory response following skin injury. They help clear infections and facilitate proper wound healing.[4]



The reticular layer:

1. It is situated between the papillary layer and the subcutaneous layer, also known as the hypodermis.[5]
2. It is comprises collagen, blood vessels, nerve endings, T-cells, hair follicles, and glands.[5]
3. Hair follicles house stem cells that generate keratinocytes, crucial for hair formation, and contribute epithelial cells for wound closure, aiding in wound healing.[5]
4. T-lymphocytes, present in this layer, play a pivotal role in combating pathogens and malignant cells.[5]
5. Nerves distributed throughout the dermis are responsible for detecting sensations like itching, touch, pressure, vibration, pain, and temperature.[5]
6. Injuries penetrating the dermis can cause pain due to nerve exposure or damage. Complete destruction or severance of nerves by an injury results in the absence of pain.[5]

THE FUNCTIONS OF THE SKIN INCLUDE:

1. The skin serves as the body's primary defense mechanism, safeguarding against microorganisms, dehydration, ultraviolet light, and physical abrasions from the external environment. [6]
2. Integral to sensory perception, the skin initiates the perception of pain, temperature, touch, and deep pressure. [6]
3. Facilitating mobility, the skin enables smooth movement of the body, contributing to its flexibility and range of motion. [6]
4. Through exocrine activity, the skin plays a crucial role in bodily functions, releasing substances such as water, urea, and ammonia. Additionally, it produces sebum, sweat, and pheromones, while also contributing to immunological responses by secreting bioactive compounds like cytokines. [6]
5. The skin actively participates in the development of immunity against pathogens, bolstering the body's defense mechanisms against harmful invaders. [6]
6. Essential for thermal regulation, the skin regulates body temperature by either conserving or dissipating heat. Furthermore, it helps maintain the body's water balance and overall homeostasis.[6]

Normal tissue healing

It is a highly intricate process involving numerous body systems and complex mechanisms. There are four fundamental mechanisms through which healing occur:

1. **Continuous cell cycling:**

In this process, normal intact skin is regenerated as keratinocytes are produced in the stratum basale and migrate upwards through the epidermal layers. [7]

2. **Cell proliferation:**

Healthy cells undergo mitosis to repair damage, resulting in the formation of granulation tissue. [7]

3. **Regeneration:**

Certain tissues in the human body, such as the liver, kidney, gastrointestinal tract, and epidermis, have the ability to regenerate, replacing damaged tissue with healthy cells. [7]

4. **Fibro proliferative healing:**

This type of healing occurs when lost tissue is replaced by a fibrous scar. It is often observed in deep wounds, cases of persistent inflammation, and fibro proliferative diseases. [7]

Four stages of the healing process are:

Hemostasis or Clot Formation:

1. Blood vessels react to injury promptly by constricting to minimize blood loss and further tissue damage.[8]
2. Platelets and fibrin are recruited to the injury site to form a clot, which acts as a temporary barrier against the external environment.[8]
3. Once dried, these clots form a scab, serving as the body's temporary wound dressing to prevent blood loss and shield the wound from external factors while tissue repair and healing occur beneath the surface.[8]

This phase initiates within seconds of injury and persists for the initial 12 hours afterward.

Inflammatory Phase:

1. In this initial phase, the body focuses on eliminating pathogens, removing debris and necrotic tissue, and promoting the growth of new blood vessels.
2. Key players in this phase include neutrophils, mast cells, and macrophages, which contribute significantly to the process.
3. Typically occurring within the first 24 hours post-injury and lasting about a week, the inflammatory phase manifests clinically as redness, swelling, heat, and pain. While crucial for acute wound healing, prolonged inflammation can lead to complications.

Proliferative Phase:

1. This phase is characterized by the formation of new blood vessels, growth of connective tissue, and regeneration of skin cells, along with ongoing debris clearance.

2. While neutrophils, mast cells, and macrophages continue to play roles, fibroblasts and endothelial cells become predominant. Initially producing type three of collagen, fibroblasts contribute to the formation of weaker and less organized tissue compared to the original.
3. Granulation tissue, composed of collagen, elastin, and blood vessels, fills the wound cavity, appearing bright red and beady.
4. Re-epithelization initiates shortly after injury, with existing keratinocytes migrating upward. Cell proliferation through mitosis follows within days.
5. The closure time of a wound varies based on its size and depth. If re-epithelialization takes longer than three to four weeks, a visible scar may result.
6. Beginning four to six days post-injury and lasting from three weeks to two months, the proliferative phase progresses until the wound is fully healed, even if it appears closed after re-epithelialization.

Remodeling phase

1. During the remodeling phase, the wound undergoes contraction, granulation tissue matures, blood circulation returns to normal levels, and the wound's tensile strength progressively improves.
2. Myofibroblasts play a pivotal role in wound contraction, while fibroblasts, myofibroblasts, endothelial cells, and macrophages are the predominant cellular components. Their numbers gradually decrease as the remodeling phase advances.
3. Type III collagen is gradually replaced by type I collagen, leading to enhanced tensile strength of the wound tissue.
4. The remodeling phase typically commences approximately two weeks post-injury and may extend up to two years. Despite the appearance of healing, this process continues beyond visible recovery.
5. By about six weeks post-injury, the wound achieves approximately half of its eventual tensile strength. Upon completion of the remodeling phase, the healed area typically recovers around 80% of its original strength.

INTRODUCTION:

Trachyspermum Ammi commonly known as “Ajwain” is a native of Egypt and is cultivated in Iraq, Iran, Afghanistan, India[18] Ajwain is a traditional potential herb and is widely used for curing various diseases in humans and animals.[18] In India, it is cultivated in Madhya Pradesh Uttar Pradesh, Gujarat, Rajasthan, Maharashtra, Bihar and West Bengal.[19] Trachyspermum Ammi L. belonging to family (Apiaceous) is a highly valued medicinally important seed spice.[20] The main component of this compound is thymol, Seeds contain an essential oil containing about 50% thymol which is a strong germicide, anti-spasmodic and fungicide, Thymol is also used in toothpaste and perfumery.[21]

LITERATURE REVIEW

1) **Arch Dermatol Res. (2015);**

This paper conducts an analysis of validation scenarios (LOE) for various treatments, focusing on topical treatments such as Imiquimod, Mitomycin C, and plant extracts like onion extract, green tea, Aloe Vera, vitamin E and D. These treatments are applied to repair injuries, mature scar tissue, or fibrotic scars resulting from revision surgery. They are often used alone or in combination with established treatments like steroid injections and silicone. Numerous trials, including regular reviews, randomized controlled trials, and observational studies, have evaluated different topical treatment options for wound healing, normal scarring, burns, keloid, and hypertrophic scars. Each study was assessed on a case-by-case basis, considering outcome measures that demonstrated the benefits or drawbacks of the topical interventions compared to standard treatments. Evaluation criteria included the quality and characteristics of the resulting scar as determined by relevant scar scales, particularly in the case of keloid scarring where considerations also included recurrence rates following surgery.

2) **Am J Transl Res. (2023)**

They conducted an experimental investigation to evaluate the comparative effectiveness of various topical treatments for reducing scarring. Our study focused on individuals with facial scars following suturing. Eligible participants were categorized into four groups: those treated with silicone medication (SP), onion extract (OE), asiaticoside (AC), and a control group receiving no treatment (BC). Data analysis encompassed both overall outcomes and specifically focused on scars in the zygomatic region. A total of 127 qualifying individuals were included in our study. Results indicated that the SP, OE, and AC treatment groups exhibited narrower scars and lower scar scale scores compared to the control group. The participants, all of whom had facial scars resulting from surgical suturing, were recruited between January and December 2019 from the Department of Plastic Surgery. Data collection procedures were meticulously conducted to ensure the reliability of our findings throughout the trial.

3) **Hong-Xu e Shi (2013)**

Studies have explored the anti-scarring effects of basic fibroblast growth factor (bFGF) in wound healing. We investigated the therapeutic potential of bFGF on hypertrophic scar (HTS) animal models and human scar fibroblasts (HSF). Results showed that bFGF promoted wound healing, reduced scar size, and improved scar appearance in rat and rabbit models. This suggests a promising new treatment strategy for HTS. Scar elevation and epidermal thickness were significantly reduced. Additionally, bFGF inhibited the TGFβ1/SMAD-dependent pathway, leading to decreased fibronectin, collagen I, and collagen III levels, while increasing MMP-1 expression and apoptosis. These findings indicate that bFGF has beneficial effects on hypertrophic scars both in vitro and in vivo, offering potential as an effective therapy for HTS and keloids.

4) **Chun-Ye Chen (2017)**

In this study on the cutaneous scars of wound healing, various agents were investigated and identified as potential anti-scarring agents. These agents include silicone-based products, Imiquimod, corticosteroids, 5-fluorouracil, bleomycin, Mitomycin, as well as plant extracts such as onion extract, asiaticoside, aloe Vera, and vitamin E. The study provides valuable insights into their effectiveness in scar management. Additionally, the study outlines a novel combined approach for managing cutaneous scars, drawing from clinical experience, particularly for hypertrophic scars and keloids. It emphasizes the importance of topical anti-scarring agents in scar management, highlighting their effectiveness in addressing adverse cosmetic concerns and avoiding the need for surgical interventions. Furthermore, the study includes a comprehensive list of popular products available in the commercial market, along with pertinent information about each product. This information serves as a valuable resource for clinicians and patients seeking effective scar management solutions

5) **Megan Molteni (22April, 2021)**

Researchers have made significant breakthroughs in reprogramming skin cells, transforming them into a different cell type capable of fully regenerating skin. This innovative approach has shown promising results in mice, as they were able to heal from injuries without leaving scars. Additionally, scientists have identified a medication that has been sought after for two decades to treat certain eye conditions. These findings hold the potential for easily accessible treatments and the prospect of a future without scars. In 1971, a pediatric surgeon observed that injuries in fetal patients healed without scarring. Over the next 20 years, scientists replicated this remarkable ability in various animals, including lambs, rats, mice, ferrets, and monkeys. Furthermore, researchers manipulated injury pressure in mice and observed similar outcomes. They found that increased pressure led to the production of more YAP (Yes-associated protein) by fibroblasts, suggesting its role in the scar less healing process.

6) **Sara, Wilgus, Traci A. 30 sept (2020).**

Human studies on hypertrophic scar cases have confirmed the following observations. It has been noted that mast cells are evident in hypertrophic scars, potentially due to the activation of the TGF-β1/Smad signaling pathway, as chymase promotes fibroblast proliferation and collagen accumulation. In 38 cases, an increased number of mast cells were observed in hypertrophic scars compared to normal skin. Elevated mast cell counts have also been observed during normal cutaneous wound healing, peaking around days 2 to 3 and gradually returning to normal levels over time. However, this decrease in mast cell numbers during normal healing differs from hypertrophic scars, where mast cell numbers have been found to increase and persist permanently, as indicated by various studies. Several human studies have shown an increased number of mast cells in keloids, and further research suggests that decreased numbers of activated mast cells are associated with inflammation as a critical factor in keloid formation. The effects of another mast cell stabilizer, disodium cromoglycate (DSCG), which inhibits mast cell degranulation and histamine release, have been investigated in mouse models. Administration of DSCG resulted in reduced inflammation, decreased scar size, and increased collagen reorganization in mice. In a study using C57BL/6J mice with implanted mesh, DSCG was found to reduce inflammation and fibrosis. Another study demonstrated that mast cell tryptase and chymase levels were significantly reduced with epigallocatechin gall ate (EGCG) compared to placebo, coinciding with a statistically significant reduction in scar firmness and an increase in scar smoothness with topical EGCG treatment.

7) **Bayat, A. (2015)**

This study conducted several trials exploring various topical treatments, including Imiquimod, Mitomycin C, and natural extracts such as onion, green tea, Aloe Vera, as well as vitamins E and D. These treatments were applied to heal wounds, mature scars, or fibrotic scars resulting from surgical modifications, either alone or in combination with established treatments like steroid injections and silicone. A total of 39 papers encompassing 1703 cases were analyzed, conducted in diverse settings. In summary, there remains a significant clinical need for effective interventions in skin scarring, necessitating more comprehensive long-term randomized trials and the establishment of standardized treatment protocols to address all facets of scarring.

8) **Clement D. Marshall, (1 Feb 2018)**

Several experimental works on scar less fetal skin wound healing; scar less wound healing in fetal skin, aiming to translate these findings to adult human cases. Fetal and adult skin exhibit distinct differences, particularly in the realm of growth factors, cytokines, and extracellular matrix components, which have been harnessed to promote scar less healing in adults. However, no single remedy, pathway, or cell subtype has proven adequate to fully support scar less wound healing in adult skin. Recent advancements include the introduction of products mimicking fetal and adult uninjured dermis, showing promising clinical outcomes in wound healing applications. Evaluating these remedies' efficacy in clinical use is essential to determine their potential as regenerative therapeutics or wound healing agents. Early studies dating back to 1971 documented rapid and minimal scarring in fetal wounds, a phenomenon replicated in various animal models such as rabbits, rats, and mice. More recently,

experimental models for scar less wound healing in human fetal tissue have been developed, further validating the feasibility of achieving scar less healing in adult skin.

TAXONOMY OF AJWAIN:

Ajwain is scientifically known as Trachyspermum .It belongs to the family Apiaceous (formerly known as Umbelliferae). Ajwain is native to the Mediterranean region and is cultivated in various parts of the world such as Uttar Pradesh, Madhya Pradesh, Uttar Pradesh Gujarat, Maharashtra, Bihar and West Bengal. [18]

Kingdom	**Plantae plant**
Sub-kingdom	**Tracheophyte , vascular plants**
Super division	**Spermatophytes ,seed plants**
division	**Magnoliophyta ,flowering plants**
class	**Magnoliopsida ,dicotyledons**
order	**Apiales**
family	**Apiaceous**
Genus	**Trachyspermum**
species	**T. Ammi**

Synonyms for Ajwain

- Ammi copticum L.
- Carom copticum
- Trachyspermum
- Copticum
- Sison Ammi L.

Morphology characters	
Odour	Characteristics spicy ,Aromatic
Taste	Bitter, aromatic ,pleasant
Color	Greyish, light brown
Surface	tubular surface
Shape	Ovoid, oval-shaped
Size	1.7 to 3mm long




PHYTOCHEMISTRY OF AJWAIN

Analysis of Ajwain seeds has revealed their composition to include fiber (11.9%), carbohydrates (38.6%), tannins, glycosides, moisture (8.9%), protein (15.4%), fat (18.1%), Saponins, flavones, and mineral matter (7.1%) comprising calcium, phosphorus, iron, and nicotinic acid. Ajwain fruits yield approximately 2% to 4% brownish essential oil, with thymol being the major constituent (35% to 60%). The non-thymol portion, also known as thymenes, comprises para-cymene, γ-terpinene, α- and β-pinenes, dipentene, α-terpinene, and carvacrol.

Additionally, minute amounts of camphene, myrcene, and α-3-carene have been detected in the plant. Alcoholic extracts contain highly hygroscopic Saponins. Isolation from the fruits has yielded a yellow, crystalline flavone and a steroid-like substance, including 6-O-β-glucopyranosyloxythymol, glucoside, and oleoresin comprising 25% volatile oil (thymol, γ-terpinene, para-cymene, α- and β-pinene). The principal oil constituents of T. Ammi are carvone (46%), limonene (38%), and dillapiole (9%).

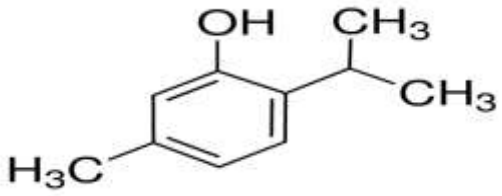
- **THYMOL**

This is the major bioactive compound in Ajwain contain (50% to 60%) include γ-terpinene, and p-cymene, along with α- and β-pinene, α-thujen, myrcene, 1, 8-cineole, and carvacrol.[26]

Thymol has revealed various biological properties such as immunomodulatory, antifungal, antibacterial, antioxidant, anti-nociceptive, and ant inflammatory, which shows a significant increase in the proliferation of splenocytes and has proved to be a good mitogen.[27] Thymol improves metabolism rate during digestion, which attenuates respiratory problems and inhibits menstrual cramping.[28] Commercial products currently using thymol include Cool Mint antiseptic mouthwash,

Thymovar for veterinary medicine and Astrigum gum paint. [29]

STRUCTURE OF THYMOL



5-methyl-2-propan-2-isopropylphenol

(Thymol)

•**Limonene**

(1-16%): Contributes to the aromatic scent of Ajwain and possesses antioxidant properties. and dillapiole (9%) [30]

•γ-terpinene (1-10%), and p-cymene (50-55%), along with α-(2-16%) and β-pinenes (4-5%), α-thujen (1-5%), myrcene (1-5%), 1, 8-cineole, and carvacrol (11%), camphene (1-5%)[32]

These compounds are extracted from Ajwain seeds and can be incorporated into ointments for their potential benefits. [33]

PHYTOCHEMICAL CONSTITUENTS OF TRACHYSPREMUM AMMI [34]

Sr no	**Phytoconstituent**	**Water**
1	Alkaloids	
	a.Dragendorff's test	+
	b. Hager's test	+
	c.Wagner's test	+
	d.Mayer's test	-
2	. Carbohydrates	
	a.Anthrone test	-
	benedict's test	+
	c.Fehling's test	+
	(free reducing sugars)	
	d.Molisch's test	+
	e.Barfoed test	+
	(monosaccharides)	
	d.Fehling's test	+
	(reducing sugars)	
3	Flavonoids	
	a.Shinoda test	+
	b.Ferric chloride test	+
	c.Lead ethanoate test	+
	d.Alkaline reagent test	+
4	Glycosides	
	a.Borntrager's test (Antraquinones glycosides)	-

	b.Keller killaini	-
	(Cardiac glycosides)	
5	Resins	+
6	Steroids	
	a.Liebermann-Burchard's test	+
	Terpenoids	
	b. Salkowski test	+
7	Tannins	
	a.Lead actetate test	+
	b. Ferric chloride test	+
8	Starch	-
9	Inorganic acids	
	a.Sulphate test	+
	b. Carbonate test	+
10	Organic acids	
	a.Malic acid test	-
	b. Oxalic acid test	-
11	Ascorbic acid	+
12	Phenolic compounds	
	a.Lead acetate test	+
	b.ferric chloride test	+
13	Amino acids	
	a.Millons test	-
	b. Ninhydrin test	-
14	Protein	
	a.Biuret test	-
	b.Millons test	-
15	Coumarins	+
16	Phelobotanins	-
17	Antraquinones	-

Key: +=present and - = absent

PHARMACOLOGICAL PROPERTIES:

ANTIMICROBIAL:

Thymol and carvacrol boast potent antimicrobial properties against a range of bacteria and fungi, making them valuable in preventing wound infections. [35] Thymol's efficacy extends even to bacteria resistant to common antibiotics, including third-generation and multi-drug-resistant pathogens. [36] Studies indicate that thymol, with its high content, inhibits both gram-positive and gram-negative bacteria and viruses. [37] Phenolic compounds like thymol disrupt cell membranes, alter pH levels, and affect ion homeostasis, thereby acting as effective antimicrobial agents. [38]

ANTI-INFLAMMATORY:

Thymol and other compounds exhibit anti-inflammatory effects, potentially alleviating inflammation at injury sites, which can help soothe skin irritation and redness. [39] While inflammation is a natural response to injury, excessive inflammation may lead to scar formation. [40] Anti-scar ointments with anti-inflammatory properties could help regulate inflammation at scar sites, contributing to better scar management. [41]

ANTIOXIDANT:

The presences of antioxidants like limonene and ethanoic acid in Ajwain aids in protecting cells from oxidative damage, facilitating healing and tissue regeneration. [42] Antioxidants in anti-scar ointments play a crucial role in shielding skin cells from oxidative stress, which can impede the healing process and contribute to scar formation. [42]

MODULATION OF COLLAGEN SYNTHESIS:

Thymol inhibits elastase activity, a marker for collagen degradation, and prevents inflammatory cell invasion at injury sites by blocking Ca2+ channels. [43] Collagen plays a pivotal role in scar formation, and anti-scar ointments may influence collagen synthesis, promoting the production of organized and less conspicuous collagen fibers. [44]

WOUND HEALING:

Ajwain's bioactive compounds contribute to accelerated wound healing by promoting tissue repair and regeneration, facilitating a faster recovery process. [45]

SCAR REDUCTION:

While direct studies on Ajwain's effects on scar reduction may be limited, its antimicrobial and anti-inflammatory properties indirectly aid in mitigating excessive scar formation, thereby contributing to scar reduction. [46]

ANTIFUNGAL:

Ajwain seeds contain thymol and carvacrol, potent antifungal agents that inhibit the growth of various fungi, including Candida species responsible for yeast infections. [47] Their broad-spectrum action makes them suitable for topical application, making them beneficial in treating fungal infections on the skin, nails, or mucous membranes. [48]

MEDICINAL USES:

WOUND HEALING AND SCAR PREVENTION:

Ajwain's antimicrobial properties can help prevent infections in wounds, cuts, and abrasions. [49] Its anti-inflammatory effects might aid in reducing inflammation at the wound site, promoting proper healing and potentially minimizing scar tissue formation. [50] Applying Ajwain-infused oil or ointment to minor wounds can support the healing process. [51]

ACNE TREATMENT:

The antimicrobial and anti-inflammatory properties of Ajwain make it a potential remedy for acne-prone skin. [52] Applying diluted Ajwain oil or using Ajwain-based face masks could help reduce acne-causing bacteria and soothe inflammation. [53]

SKIN CLEANSER:

Ajwain's antibacterial properties could contribute to its use as a natural skin cleanser. [54]

ITCH RELIEF:

For insect bites, stings, or skin irritations, Ajwain's anti-inflammatory and soothing properties might offer relief. [55] Applying Ajwain-infused oil topically can help alleviate itching and discomfort. [56]

SKIN TONING:

Ajwain water can be used as a toner to help tighten the pores and balance the skin's pH. [57] Boil Ajwain seeds in water, let it cool, and use it as a toner after cleansing. [58]

SKIN HYDRATION:

Proper hydration is essential for healthy skin. [59] Ajwain helps maintain the moisture balance of the skin, preventing dryness and flaking, which are common skin problems. [59]

REMOVING PIMPLE SCARS:

In addition to helping get rid of acne scars, Ajwain is also effective in treating scars and marks caused due to pimples. [60] It lends a fresh and clear look to your face by eliminating such scars. [61] You can apply a paste made out of soaked Ajwain seeds in the impacted area for 10-15 minutes to lighten the

marks. [62] You can also make a paste with yogurt and Ajwain powder and apply it to the impacted area in a similar fashion. [63] Wash off after leaving for 10-15 minutes and practice this regularly for quick and best results. [64]

PREVENTS SKIN INFECTION & TREATS WOUNDS:

Thymol, an active compound present in Ajwain, has antiseptic properties. [65] This makes Ajwain effective as a fungicide and a germicide and effective in treating cuts and wounds. [66] Simple cuts that are on the skin surface and not serious or chronic can be treated with Ajwain. Minor skin irritations can be treated with a similar application. [67]Make sure that the wound is not deep and chronic as in those cases a professional medical help would be needed to dress the wound. [68] The Ajwain seeds can be used as a home remedy for only minor cuts and inflammation. [69]

PAIN RELIEF:

Ajwain oil is sometimes used topically to alleviate pain and inflammation in joints and muscles. [70]

SKIN AILMENTS:

Ajwain's antimicrobial and anti-inflammatory properties could be applied to skin ailments and wounds, possibly aiding in scar prevention. [71]

CONCLUSION:

These literature review highlights the taxonomy of Ajwain (Trachyspermum Ammi), its phytochemical composition showed that the presence of alkaloids, carbohydrates, flavonoids, triterpenoids, steroids, tannins, phenolic compounds, coumarins, resins, Saponins, oils and fats ,inorganic acid and ascorbic acid were extract in water , and the pharmacological properties that have potent antimicrobial activity and can be used for pharmacological evaluation, drug discovery, and treatment of various infectious diseases it has been found that the seeds contain alkaloids, carbohydrates, glycosides, flavonoids, proteins, Terpenoids, tannins, and phenols which have the high medicinal purpose that make it a valuable candidate for diseases prevention .The review also explores relevant studies on the wound healing, anti-inflammatory, antimicrobial, anti-fungal and antioxidant effects of Ajwain's bioactive compounds. Additionally, it discusses traditional uses of Ajwain and its potential benefits in skincare.

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