Available online on 15.08.2026 at <http://jddtonline.info>

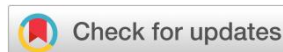
Journal of Drug Delivery and Therapeutics

Open Access to Pharmaceutical and Medical Research

Copyright © 2026 The Author(s): This is an open-access article distributed under the terms of the CC BY-NC 4.0 which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use provided the original author and source are credited



Open Access Full Text Article



Review Article

Phytoestrogenic Potential of *Linum usitatissimum* (Flaxseed): Pharmacological Mechanisms and Therapeutic Perspectives

Dr. Yusra Qureshi ^{1*}, Dr Mohd. Faizan ², Prof. Ismath Shameem ³

¹National Institute of Unani Medicine, Ilmul Qabalat wa Amraze Niswan NIUM kotigepalye magadi road, NIUM girls' hostel, Bengaluru, Karnataka, 560091.

²School of Unani Medical Education and Research, Jamia Hamdard, New Delhi – 110062, India

³National Institute of Unani Medicine, Ilmul Qabalat wa Amraze Niswan NIUM kotigepalye magadi road, Bengaluru, Karnataka, 560091.

Article Info:



Article History:

Received 13 May 2026

Reviewed 29 June 2026

Accepted 24 July 2026

Published 15 August 2026

Cite this article as:

Qureshi Y, Faizan M, Shameem I, Phytoestrogenic Potential of *Linum usitatissimum* (Flaxseed): Pharmacological Mechanisms and Therapeutic Perspectives, Journal of Drug Delivery and Therapeutics. 2026; 16(8):157-169 DOI: <https://doi.org/10.22270/jddt.v16i8.7901>

For Correspondence:

Dr. Yusra Qureshi, National Institute of Unani Medicine, Ilmul Qabalat wa Amraze Niswan NIUM kotigepalye magadi road, NIUM girls' hostel, Bengaluru, Karnataka, 560091.

Abstract

Linum usitatissimum Linn. (flaxseed; Tukhm-e-Katan) is an important medicinal and nutraceutical plant widely described in both classical Unani literature and contemporary biomedical research. Classical Unani physicians, including Ibn Sina and Zakariya al-Razi, documented its therapeutic utility in inflammatory disorders, respiratory ailments, and female reproductive conditions. In Unani medicine, Tukhm-e-Katan is recognized for its nutritive, demulcent, anti-inflammatory, and restorative properties, contributing to the maintenance of humoral balance. Phytochemical investigations have identified flaxseed as a rich source of lignans, particularly secoisolariciresinol diglucoside (SDG), along with α -linolenic acid, dietary fibre, proteins, mucilage, vitamins, and minerals. These bioactive constituents exhibit significant phytoestrogenic, antioxidant, anti-inflammatory, cardioprotective, hypolipidemic, antidiabetic, and anticancer activities. Experimental and clinical studies suggest beneficial effects of flaxseed in menopausal symptoms, hormone-dependent disorders, hyperlipidemia, polycystic ovarian syndrome, osteoporosis, and gastrointestinal dysfunctions. Emerging evidence also supports its role in women's health through modulation of estrogenic pathways and oxidative stress. The present review highlights the pharmacological, nutraceutical, and phytoestrogenic potential of *Linum usitatissimum* while integrating evidence from modern scientific literature with traditional Unani perspectives, thereby emphasizing its therapeutic relevance in integrative and preventive medicine.

Keywords: Flaxseed, *Linum usitatissimum*, Phytoestrogenic activity, Menopause, Atrophic Vaginitis; Phytochemicals.

INTRODUCTION

Linum usitatissimum Linn., commonly known as flax or linseed, is an annual herb that typically grows between 60 and 120 cm in height. The plant bears small, delicate flowers that may appear blue, bluish-violet, or occasionally white, arranged in terminal panicles. Its fruit is a capsule divided into five compartments, each containing two seeds.¹ The botanical name *Linum usitatissimum* was first assigned by Carl Linnaeus in his

monumental work *Species Plantarum*.² The Latin term *Linum* refers to “fibre” while *usitatissimum* means “most useful”, reflecting the plant's immense economic and medicinal significance. Flaxseed has been recognised as both a food and a medicine for centuries and is now classified as a functional food owing to its rich composition and health-promoting properties. It is particularly valued for its abundance of omega-3 fatty acids, lignans, and dietary fibre, which collectively account for its wide array of therapeutic effects.^{1,3}

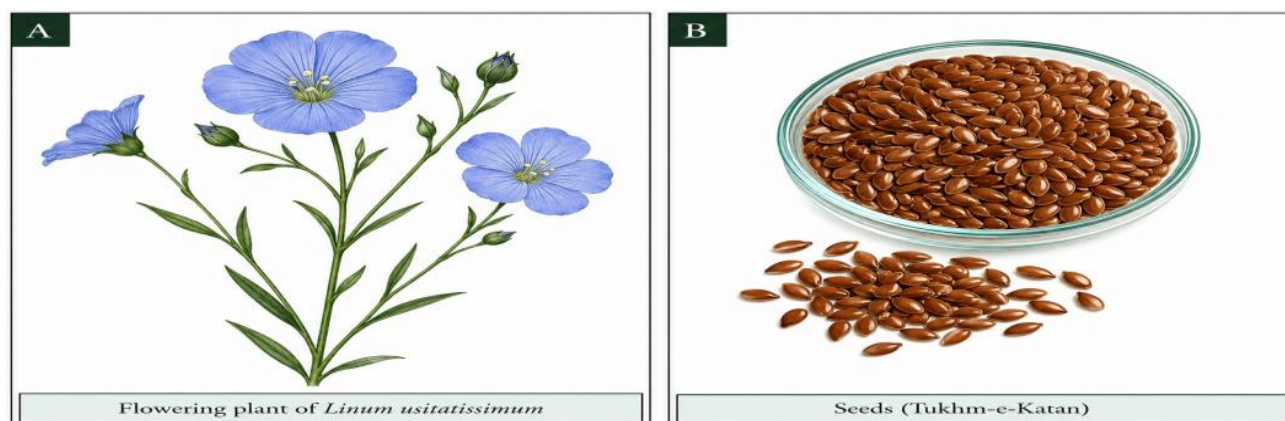


Figure 1. Tukhm-e-Katan (*Linum usitatissimum*): (A) flowering plant and (B) seeds. Redrawn based on botanical information from Reference 1.¹

HISTORICAL BACKGROUND:

Flaxseed is among the earliest domesticated plants in human history, with evidence of its use dating back thousands of years. Ancient Egyptians used flax fibers in weaving, and depictions of linen cloth have even been found in the wrappings of mummies (circa 200 BC).^{1,4-5} Archaeological excavations of Swiss lake dwellings have revealed flax seeds and fibers, highlighting their early role in food, textiles, and medicine.⁶⁻⁸ Beyond its nutritional applications, flaxseed oil, expressed from the seeds, found utility in the production of paints, varnishes, and related industries.^{1-7,9-11} The residual oil cake served as a highly nutritious cattle feed. The plant's phloem fibers, familiarly known as flax fibers, were valued for their strength and fineness, being widely employed in surgical dressings and textile manufacturing.^{4,12-13} Furthermore, the straw of the flax stem was processed into pulp for the paper industry. These historical uses not only illustrate flaxseed's versatility but also underscore its enduring importance as both a therapeutic agent and an industrial raw material.^{2,14}

Taxonomy: 1-15

- Kingdom: Plantae
- Subkingdom: Tracheobionta
- Super-division: Spermatophyta
- Division: Magnoliophyta
- Class: Magnoliopsida
- Subclass: Rosidae
- Order: Linales
- Family: Linaceae
- Genus: *Linum* L.
- Species: *Linum usitatissimum* L.

Synonyms: 1-15

- *Linum crepitans* (Boenn.) Dumort.
- *Linum humile* Mill.
- *Linum indehiscens* (Neilr.) Vavilov & Elladi

Vernacular Names: 1,3-6,9-14

- Arabic: *Bazrul Katan, Buzruk, Bazen, Katan*
- Assamese: Tisi, Tusi
- Behar: Chikna, Tisi
- Bengali: Masina, Tisi, Alasi
- Bombay: Alasi, Javasa, Javas
- Kashmir: Alish, Kenu.
- Malayalam: Agastha, Cheruchana-Vittintevilta, Alashi, Javas.
- Oriya: Atushi, Peso.
- Persian: *Bazarug, Kuman, Tukhm-e-Katan, Zaghir, Zaghu.*
- Punjabi: Alish, Alsi, Tisi.
- Russian: Len, Lyon.
- Sanskrit: Atasi, Atima, Chanaka, Devi, Haimwati, Kshauma, Kshaumi, Kshuma, Madagandha.
- English: Blaebows, Common Flax, Flax, Flix, Flaxseed, Lint Bells.
- French: Lin chaud, Lin commun, Lin cultivate, Grins de Lin.
- German: Flachs, Haarlinsen, Lein, Saatlein.
- Greek: Linon.
- Gujarati: Alshi, Arasi.
- Hindi: Alsi, Tisi.
- Italian: Lino.
- Kannada: Agasebeeja, Semeegara, Agasi, Kain Atish, Agashi.
- Spanish: Lino.
- Suryani: Bari Aala.
- Tamil: Alshi.
- Telugu: Atasi, Madanginjal, Ullusulu.
- Turki: Ziggar.

- Turkish: Keten.
- Unani: *Lisfermoon, Lifertus*.
- Urdu: *Alsi, Katan*.

Unani Description of Tukhm-e-Katan:

Mahiyat (Morphology)

The Alsi plant is characterized by its slender stems, branches, and leaves, and typically grows to a height of approximately 0.9 meters.¹⁶⁻¹⁷ Its fruit is roughly the size of a chickpea (nakhood), while the flower is about the size of lajaurad.¹⁸⁻²¹ The fruit contains numerous small, shiny seeds that are either red or black in color.^{18-19,22-23} These seeds are flat, oblong pointed at both ends, and oily in nature, often possessing a strong and

unpleasant odor. Both the seeds and the oil extracted from them are widely used for medicinal purposes. Tukhme Katan (flaxseed) is available in multiple forms and colors.¹⁶⁻¹⁹ The term “Katan” specifically denotes cloth made from the plant, whereas “Band” refers to flaxseed oil. For this reason, its black and red varieties are commonly known as Alsi.^{16-19,21-22,24} Pure flaxseed oil is naturally transparent and colorless when extracted without heat; however, the oil commonly available in the market is dark yellowish-brown. This is because it is often mixed with other oils or derived from seeds of plant species that are cultivated alongside flaxseed.^{1,16-23,25}

Table 1: Description in Unani Medicine

Unani Concept	Description in Unani Medicine	Modern Pharmacological Correlation	References
Mizāj (Temperament)	Seeds: Hot 1°, Dry 1° Oil: Hot 1°, Moist 1°	The seeds and oil are rich in α-linolenic acid (omega-3 fatty acid), lignans, dietary fibre, and mucilage, which may contribute to anti-inflammatory, lipid-modulating, metabolic, and gastrointestinal effects.	16, 18–20
Miqdār-e-Khurāk (Dosage)	Seeds: 5–7 g Ripe seeds: 3–6 g Oil: 5–10 mL	Modern clinical studies have evaluated higher doses, including approximately 20–40 g/day of whole or ground flaxseed and 15–30 mL/day of flaxseed oil, with reported benefits in lipid metabolism and cardiovascular risk parameters.	18–20, 24
Muḍirr (Adverse Effects)	May cause indigestion and gastrointestinal discomfort in individuals with weak digestion. Traditional texts also describe adverse effects related to vision and blood health.	Excessive intake or inadequate preparation may cause gastrointestinal discomfort. The presence of cyanogenic glycosides in raw flaxseeds warrants appropriate dosage and preparation. Phytate content may also interfere with the absorption of certain minerals, including iron, particularly with excessive or prolonged intake.	18, 19, 21, 23, 24, 26
Mušliḥ (Correctives)	Shahd (Honey), Kishneez (Coriander), and Sikanjabeen (Oxymel).	These substances may function as digestive adjuvants and may help reduce gastrointestinal discomfort and flatulence associated with the use of certain medicinal substances.	18–20, 24
Badal (Substitutes)	Tukhm-e-Hulba (Fenugreek) and Bāqlā (Broad bean).	Fenugreek possesses lipid- and glucose-modulating properties and may share certain therapeutic applications with flaxseed, particularly in metabolic disorders.	18–20, 24

PHARMACOLOGICAL ACTIONS (Afa'al):

The drug possesses multiple pharmacological actions. It is described as the Primary action, and secondary actions follow as Table No. 2&3.

Table 2: Primary Action ^{16-25,33-37}

Unani Afa'al/Action (Naf-e-Khaas)	Description in Unani Medicine	Modern Pharmacological Correlation
Muḥallil-i-Awrām (Anti-inflammatory)	Resolves swelling/inflammation	Omega-3 & lignans reduce CRP, TNF-α, IL-6
Musakhkhin-i-Alam (Analgesic)	Relieves pain	Omega-3 reduces arthritic & neuropathic pain
Nāfi'Qurūḥ (Anti-ulcer)	Heals ulcers	Mucilage coats the gastric mucosa and prevents ulcers
Mulattif / Murkhī (Demulcent, Relaxant)	Softens, soothes	High mucilage provides an emollient, laxative, and throat-soothing effect
Mudirr-i-Bawl (Diuretic)	Increases urine output	Mild diuretic activity confirmed in animal studies
Mudirr-i-Labn (Galactagogue)	Enhances milk production	Phytoestrogens may regulate prolactin and support lactation
Mufaṭṭit-i-Ḥaṣāt (Lithotriptic)	Breaks kidney/bladder stones	Diuretic & anti-urolithic effects reported in animal models
Muqawwī-i-Qalb / Mufarriḥ al-Qulūb	Cardiotonic, exhilarant	Clinical studies: flax lowers LDL, BP, and triglycerides, improves vascular compliance
Mulayyin (Laxative)	Relieves constipation	High fiber & mucilage regulate bowel movement
Qābiḍ (Astringent)	Roasted seeds tighten tissues	Heat-treated seeds increase tannins → binding effect
Musakkin-i-Su'āl (Antitussive)	Relieves cough	Mucilage acts as a natural cough suppressant
Muqawwī-i-Bāh (Aphrodisiac)	Improves sexual vigor	Lignans may affect hormonal balance & fertility
Antilipidemic	Reduces excessive fat	Supported by clinical studies: lowers LDL & total cholesterol

Table 3: Secondary Actions:

Other Unani action	English Action	References
Muḥallil al-Waram	Anti-inflammatory	17,19–20,22–24,33
Musakhkhin al-Alam	Analgesic	18–26,33
Nāfi' al-Qurūḥ	Anti-ulcer	16–17, 19,33–34
Muḥallil wa Mulayyin al- Salabāt	Resolvent & Laxative of Hardness	16–17,19,33
Mundij al-Waram	Concoction of Swellings	18–20,23, 24,33
Mulattif	Attenuant	18–19,23–26
Mughalliz al-Manī	Semen Inspissator	16–17, 19,33
Mufajjir al-Waram	Suppurative Inflammations	16–17, 19,33
Mufarriḥ	Exhilarant	16–17, 19,33–34
Ḥābis al-Dam	Haemostyptic	16–17,19
Mudirr al-Bawl	Diuretic	18–21,23,33
Mundij	Concoctive	21,24

Muqī	Emetic	24,33
Mudirr al-Laban	Galactagogue	18-20
Jālī	Detergent / Cleansing	19-22
Mukhrij al-Balgham	Phlegmagogue	18-21
Nāfi' al-Nafkh	Antiflatulent	18,20,23,33-24
Musakhkhīn al-Kird wa al-Kamar	Renal & Lumbar Warmative	16-17,33
Murkhī	Relaxant / Demulcent	16-26, 33
Rādi'	Repellent	16,18-20,33-34
Mufarriḥ al-Qulūb	Cardiac Exhilarant	19,16-17,33
Muqawwī al-Qalb	Cardiotonic	19,16-17,33
Sākīn al-Awjā'	Pain Relieving	16-19,24
Ḍu'f al-Ishāl al-Balghamī	Weakness in Phlegmatic Diarrhoea	19-20,22, 33-34
Ḍu'f al-Su'āl al-Yābis	Weakness in Dry Cough	34
Mu'addil al-Balgham	Phlegm-Alternative	14,16,24
Dāfi' Zīq al-Nafas	Antiasthmatic	14,16,24,33-34
Mufattiḥ al-'Urūq	Deobstruent of Vessels	24,33-34
Qābiḍ	Astringent	19-20,22, 33-34
Dāfi' al-Baṭīnī al-Waram	Remover of Visceral Inflammation	34
Musakkin al-Qay	Antiemetic	18-20, 23-26, 33-34
Musakkin al-Su'āl	Antitussive	23-24
Mufattit al-Ḥṣāt	Lithotriptic	16-17
Murkhī	Demulcent	16-26, 33-34
Mumallis	Emollient	16-26, 33-34
Mulayyin	Laxative	16-26, 33-34
Munaffith al-Balgham	Expectorant	19-21,22, 33-34
Muqawwī al-Bāh	Aphrodisiac	19-21,22, 33
Qābiḍ (Roasted Seeds)	Astringent	16-19,21-26,33-34
Mulayyin (Roasted Seeds)	Laxative	16-17,19-26, 33-34
Muḥallil al-Waram (Roasted Seeds)	Anti-inflammatory	16,18-26, ,33-34
Murkhī (Roasted Seeds)	Demulcent	16-18,20-26,33-34
Mudirr al-Bawl (Roasted Seeds)	Diuretic	16-26,33
Mumallis (Roasted Seeds)	Emollient	16-17,20-26,34
Antilipidemic	Lipid-lowering	16-24
Munaffith al-Balgham (Roasted Seeds)	Expectorant	16-24,33

Therapeutic Uses of *Tukhme Katan* (Flaxseed) in Various Systems

1.Integumentary System (Amrāz-i-Jild)

Tukhme Katan has a wide range of dermatological applications:

✓ Acts as a soothing agent in inflamed areas; beneficial for boils, cysts, abscesses, and carbuncles, providing pain relief ^{19-20,28}.

✓ *Alsi Zimād* (poultice with water) is effective in Qūbā (ringworm) ^{20,28}

✓ A combination of *Alsi*, *Bora Armani*, and *Teen* is prescribed for acne and the reduction of blemishes.¹⁹

✓ Powdered seeds mixed with flaxseed oil are useful in alopecia.¹⁹⁻²⁰

✓ *Marham Alsi* is applied in arthritis, pleurisy, bronchitis, pneumonia, and peritonitis; its counter-irritant effect increases with mustard powder.^{19-20,23-26}

✓ Topical preparations are effective in Kalaf (melasma), Qarah-e-Shahedia (herpes lesions), Da'ad (ringworm), Sa'fa (baldness), and Buṭhūr Labāniya (acne vulgaris). A mixture with *Sirka* (vinegar) is used as Tilā (ointment) in acne and chloasma.¹⁶⁻²³

✓ Application of paste benefits nail disorders; dusting of charred bark stops bleeding and aids wound healing.^{16-23,26}

✓ A classical burn remedy consists of equal parts flaxseed oil and lime water.¹⁶⁻²⁶

2. Cardiovascular System (Amrāz-i-Qalb)

✓ *Safūf Alsi* functions as Muhallil (anti-inflammatory).^{23,26}

✓ *Joshanda Alsi* and *Huqna Alsi* act as Mulayyin (resolvent) and Jālī (detergent).

✓ *Safūf* prepared from *Alsi* flowers serves as Mufarriḥ al-Qulūb (cardiac exhilarant) and Muqawwī-i-Qalb (cardiotonic).^{16-26,33,38}

3. Genitourinary System

✓ *Safūf Alsi* acts as a diuretic, emmenagogue, and galactagogue.^{4,23}

✓ *Huqna* with *Joshanda Alsi* expels morbid matter from the uterus and intestine.^{16,19}

✓ Mild diuretic action makes it useful in kidney/bladder wounds and gonorrhea.¹⁶⁻²⁶

✓ *Joshanda Alsi* (10 g) is effective in renal calculi.³⁴

✓ Combination with *Filfil Siyāh* and honey acts as a sexual tonic, enhancing libido.¹⁹

✓ Increases menstrual blood flow and may act as an abortifacient.^{18-20,25}

✓ Enhances lactation and increases micturition frequency.^{16,19}

✓ *Abzan/Huqna* with *Alsi* reduces uterine and intestinal inflammation.^{18-19,23-27}

4. Gastrointestinal System

✓ Daily intake of *Alsi Biryān* reduces intestinal colic.^{16,19-20} acts as an astringent,^{22,24,29,31} but may cause constipation.^{4,23}

✓ *Pichkari/Huqna* is beneficial in intestinal ulcers and splenic inflammation.²³⁻²⁴

✓ *Alsi* with honey helps in splenitis and splenomegaly.²³⁻³⁰

✓ A combination of *Alsi*, honey, and olive oil (with water) is used for balghami awrām (phlegmatic swellings).¹⁶⁻³⁰

✓ Local application with ash and *Bora Armani* reduces hemorrhoid size.^{20,23}

5. Musculoskeletal System

✓ Massage (*Dalak*) with *Roghan Alsi* acts as Musakhkhin (warming agent) and Muhallil (resolvent), relieving joint pain and swelling.¹⁶⁻³⁰

✓ Flaxseed powder with its oil alleviates generalized body pain.¹⁶⁻²⁴

✓ A combination of *Isapghol* and *Alsi* relieves joint pain of various types.²¹

6. Respiratory System

✓ *Joshanda Alsi* acts as Mulattif-i-Balgham (demulcent of phlegm) and benefits throat infections.²³⁻³⁰

✓ Seeds act as expectorants, useful in asthma.^{18-21,28}

✓ Local application helps in pneumonia, pleurisy, and peritonitis, more potent with *Safūf Rai*.^{16,18,20,28}

✓ *Safūf Alsi* with honey relieves Surfa-i-Balghami (productive cough) and Zeequn-Nafas (dyspnea/asthma).^{16,19-20,28}

7. Head and Neck

✓ *Barg wa Chāl Alsi* (leaves and bark) act as Mulattif (attenuant), clearing brain blockages, reducing cold/cough, and eliminating excess nasal secretions.^{19-20,23,30}

✓ *Āab-i-Alsi* is beneficial in periorbital inflammation.^{19,23-30}

✓ Seed mucilage can be used as eye drops or *Tilā* around the eyes to reduce redness and discomfort.¹⁸⁻²⁶

Shelf life- Two years.^{12-14,18-20,24-26,33-34}

Murakabat (Compound formulation):^{13-20,30}

✓ *Qayrūtī*, *Qayrūtī-Muhallil*, *Qayrūtī-Ardjāwālī*, *Qayrūtī-Bazr-al-Katan*, *La'ūq-e-Katan*, *Ḥabb-e-Su'āl*, *Dimād-e-Kibrīt*, *Sharbat-e-Sadr*, *Marham-e-Dākhiliyūn*, and *Dimād-e-Khanāzīr*

ETHNOBOTANICAL DESCRIPTION

Flaxseed (*Linum usitatissimum* L.) is an annual, upright herbaceous plant that produces corymbose branches above its main stem. It is a hermaphrodite species with self-fertility, though insects contribute to pollination^{12,15}. The plant develops a slender taproot, which in light soils may extend up to 90–120 cm, branching into fibrous rootlets.^{13,20-25}

✓ Leaves: Simple, sessile, linear-lanceolate, with entire margins, borne alternately on the stem and branches.^{11,14,19,25,33}

✓ Flowers: Hermaphroditic, hypogynous, borne on long erect pedicels. Each flower consists of five sepals, five petals (white, pink, or blue), five stamens, and a pistil with five carpels separated by a false septum. Inflorescence is a terminal raceme or cyme, blooming during June–July.^{11,14,33}

✓ Fruits: Capsule-shaped, composed of five carpels, typically containing about 10 seeds.²⁵

✓ Seeds: Small, oval, and lenticular, measuring 4–6 mm in length, with a smooth, shiny surface and color ranging from brown to golden. Seeds contain 20–17% protein and 35–40% oil, maturing in August–September.^{11,25,33}

Macroscopic Characters

✓ Color: Brown^{14,19,20,30,34}

✓ Taste: Mucilaginous and bland^{19-20,23-24}

✓ Odor: Non-specific^{16,18-20,22}

✓ Seed Features: Shiny, flat, 4–6 mm long, 2–2.5 mm wide, with a light hilum depression enclosing the micropyle. The embryo nearly fills the seed and consists of two yellowish-white cotyledons and a radicle. Seeds are oily, mucilaginous when soaked, and possess a characteristic taste when chewed^{13,18-20,23-27,30}.

Microscopic Characters

A transverse section of the seed shows:

✓ Testa: Isodiametric mucilaginous cells.

✓ Middle layer: Collenchymatous cells, raw sienna-colored, 120–190 µm long and 14–17 µm wide, lignified with pitted walls.

✓ Pigment layer: Single layer of polygonal cells with reddish-brown content.

✓ Endosperm & Cotyledons: Contain abundant oil globules, aleurone grains (up to 20 µm with globoid and ✓

crystalloid inclusions), and occasional starch grains^{1,14,39}

Habitat and Distribution

✓ Origin: Believed to be native to Egypt^{16,18-20,22,35}

✓ Global Cultivation: Widely cultivated across Asia, Africa, Europe, and the Americas. In India, it is grown predominantly in Madhya Pradesh, Uttar Pradesh, Maharashtra, Bihar, Rajasthan, and the Western Himalayas, with Uttar Pradesh and Madhya Pradesh contributing over 55% of national production^{1,12,18-20,27,30}

✓ Exclusions in India: Rare in Kerala, Tamil Nadu, Delhi, Manipur, Tripura, and the Andaman & Nicobar Islands.

TRADITIONAL AND FUNCTIONAL USES^{18-20,33,39}

Traditionally cultivated for fiber and oil, flaxseed has significant nutritional and industrial value:

✓ Oil is used in paints, varnishes, and linoleum, due to its drying/hardening properties.

✓ Veterinary use: Flaxseed oil serves as a purgative for horses and sheep.

✓ Animal feed: Flaxseed meal is used in cattle and poultry feed, enhancing omega-3 fatty acid content in eggs.

✓ Functional food: Recognized as a functional ingredient with potential to prevent or manage chronic diseases.

Table 4: Constituents and Mechanism of Action

Constituent	Composition	Key Bioactive/Health Properties	Mechanism of Action	References
Lipids	30–40% fixed oil; α-linolenic acid (51–55%), linoleic acid (11–15%), oleic acid (19%), stearic acid (3%), palmitic acid (5%); n-6:n-3 ≈ 0.3:1	Cardioprotective, anti-inflammatory, reduces atherosclerosis risk	Competes with arachidonic acid → reduces pro-inflammatory eicosanoids; forms anti-inflammatory resolvins & protectins; incorporates into membranes; improves endothelial function; lowers triglycerides; anti-thrombotic	1,9,12,14,30,38
Proteins & Amino acids	16–31% (globulins: linin, colinin; glutelins; albumin absent) Lysine, tyrosine, threonine, methionine, cysteine, leucine, isoleucine, valine.	Prevent neurodegeneration, regulate blood pressure	Provide amino acids for repair; some peptides act as ACE inhibitors → antihypertensives, and improve immune response via cytokine modulation.	7,9-10
Flavonoids	apigenin, luteolin, herbacetin)	Antioxidant, antiangiogenic	Antioxidant (inhibits xanthine oxidase); antiangiogenic (blocks tumor blood vessel growth); improves vasodilation and endothelial function.	1,3,38

Dietary Fiber	24–28% (soluble + insoluble); mucilage 3–10% in seed coat	Improves gut health, lowers cholesterol, aids weight management	Soluble fiber forms gel → slows gastric emptying, lowers glucose absorption; binds bile acids → reduces cholesterol; increases fecal bulk → laxative effect.	10,17
Lignans	The richest source of SDG (secoisolariciresinol diglucoside), converted to enterolignans	Phytoestrogenic, antioxidant, anti-cancer, hormone-modulating	Converted to enterolactone & enterodiols by gut microbiota; weak estrogen receptor binding (ER- α , ER- β); reduces aromatase activity (anticancer); antioxidant (scavenges ROS); improves lipid metabolism and insulin sensitivity via PPAR- γ activation.	7,17,33,38
Cyanogenic Glycosides	Linustatin, neolinustatin	Trace compounds; potential toxicity if excessive	Release hydrogen cyanide after hydrolysis; detoxified by rhodanese enzyme in liver → thiocyanate; toxic at high doses, negligible at dietary intake.	1,3,7,11,33
Phenolics & Sterols	Linustitamarin, cholesterol, campesterol, stigmasterol, sitosterol, cycloartenol	Antioxidant, cholesterol-lowering	Antioxidant (ROS scavenging); anti-inflammatory (inhibits NF- κ B, COX-2); anticancer (induces apoptosis in tumor cells).	17,38
Vitamins & Minerals	Tocopherols (Vit. E), niacin, thiamine, riboflavin, pantothenic acid, carotene, calcium, phosphorus, iron	Antioxidant, neuroprotective, maintains bone and blood health		7,17,30,38

PHYTO-CHEMISTRY

The composition of flaxseed exhibits considerable variability depending on genetic factors, growing environment, seed processing, and the method of analysis employed.^{9,17,31,38} Flaxseed is particularly valued for its content of bioactive compounds with well-documented functional properties, including polyunsaturated fatty acids (PUFA) of the omega-3 family, soluble dietary fibers, lignans, proteins, and carbohydrates.^{9,17,31,33,39} Typically, flaxseed comprises 5–45% oil by weight, of which α -linolenic acid (ALA) constitutes 51–55%, and linoleic acid accounts for 11–15% [1–11]. It is also the richest known source of the lignan secoisolariciresinol diglucoside (SDG).^{1–11,17,27} Nutritionally, flaxseed contains moisture, 6.6% protein, 20.3% fatty oil, 9.1% carbohydrates, 24.8% fiber, 4.8% mineral matter, 2.4% calcium, 0.17% phosphorus, and 0.9% iron (2.7 mg/100 g). In addition, it provides carotene, thiamine, riboflavin, niacin, pantothenic acid, choline, and vitamin E.^{1,38–39} The seed epidermis contains 3–10% mucilage, composed primarily of arabinoxylans, galectins, and rhamnogalacturonans. Mucilage is largely present in the form of calcium salts of acidic polysaccharides, including flaxseed acid.^{1,10,33} The seeds also contain 30–40% fixed oil, approximately 6% mucilage, 17% protein, and trace amounts of

cyanogenic glucosides such as linamarin and lotaustralin^{10,17,27,30} Protein content ranges between 16–31%, with globulins being the predominant fraction. Two major globulins—lin and colin—have been isolated, along with glutelin, while albumin appears to be absent. Notably, non-protein nitrogen constitutes 21.7% of the total nitrogen content.^{1,3,10} Flaxseed oil further contains octadecanoic acid, hexadecanoic acid, and heptadecanoic acid, along with small quantities of crystalline wax and water-soluble resinous matter^{17,33,38–40}

Chemical Composition and Bioactive Constituents of Flaxseed^{7–10,17–19,22,33}

Lignans: Flaxseed is the richest source of lignans, which are both antioxidants and phytoestrogens.^{7,17–19} Flaxseed lignans are nonsteroidal phytoestrogens that have a chemical structure that resembles mammalian estrogens, and hence produce estrogen-like effects in mammals.^{1,4–17} Flaxseeds are the richest dietary source of lignan precursors. When ingested, lignan precursors are converted to the enterolignans, enterodiols and enterolactone, by bacteria that normally colonize the human intestine. The principal lignan precursor found in flaxseed is secoisolariciresinol diglucoside. The flaxseed lignan secoisolariciresinol (SECO) and its

diglucoside Secoisolariciresinol Diglucoside (SDG) have several health benefits. On ingestion, SDG is converted to enterolignans (enterodiol and enterolactone) by the intestinal microflora, and these metabolites are phytoestrogens.^{17,33} Prasad K. *et al.* 2013 investigated if SDG from flaxseed could be an alternative to Angiotensin-Converting Enzyme (ACE) in the treatment of hypertension.^{9,38} The fiber-rich plant foods containing hormone-like compounds such as lignans and iso-flavonoids, also known as phytoestrogens, may influence estrogen metabolism and reduce the incidence of breast and colon cancer and possibly other diseases. Flaxseed lignans are reported to have antioxidant properties and may be the possible reason for their anti-cancerous activity.³³⁻³⁸

Omega 3 fatty acid: Out of all lipids in flaxseed (approximately 30%), 53% are α -linolenic acid (ALA), 17% linoleic acid (LA), 19% oleic acid, 3% stearic acid, and 5% palmitic acid, which provides an excellent n-6: n-3 fatty acid ratio of approximately 0.3:1.^{1-11,14,38} Alpha-linolenic acid is the main functional component of flaxseed.^{1,3-15,17,21,30-33,38-39} Fatty acids have been shown to reduce the risk of cardiovascular disease.³⁸ Omega-3 fatty acid supplementation reduces the production of inflammatory mediators and leukotriene B₄ and hence suppresses atherosclerosis.^{7,30,38}

Amino acid: Flaxseeds contain amino acids like lysine, tyrosine, and threonine.^{9,17,21,30-33,38} They contain Sulphur amino acids like methionine, cysteine, and also branched amino acids, namely leucine, isoleucine, and valine.^{1,38}

Cyanogenic compound: Linustain and neolinustatin – isolated and characterised as 2-[(6-O- β -D-glucopyranosyl- β -D-glucopyranosyl)oxy]-2-methylpropanenitrile and (2R) [(6-O- β -D-glucopyranosyl- β -D-glucopyranosyl)oxy]-2-methylbutanenitrile, respectively.^{1,3,7,11,14,33}

Phenylpropanoid glucoside: Linustitamarin– isolated from defatted seeds and its structure elucidated. Cholesterol, campesterol, stigmasterol, sitosterol, 5-

dehydroavenasterol, cycloarteol, and 6-methylenecycloartanol (2%) in seeds were characterised by GC-MS. Plant contained HCN (0.0486%), isolation of oleic, linoleic and linoleic acids and iso-fecosterol from seeds.^{17,38}

Protein: The protein content of flaxseed varies from 16 to 31%. The principal proteins of flaxseed are the globulins.^{1,9-10} Flaxseed protein prevents neurodegenerative disease, controls blood pressure.⁷

Carbohydrates: Flaxseed is low in carbohydrates (sugars and starches), providing only 1g of carbs in 100g of flaxseeds.³⁸ The two main parts of flaxseed polysaccharide are acidic (rhamnogalacturonan 17%) and neutral (arabinoxylan 75%). L-rhamnose, D-galactose, D-galacturonic acid, and L-fucose acid make up the rhamnogalacturonan, while xylose, arabinose, and galactose make up the arabinoxylan.^{1,3,38}

Vitamins: Flaxseeds are a great source of many vitamins.^{1,3-5,9,12-21,30-33,38} The most abundant vitamins constituting flaxseed are tocopherols (α -, β -, and γ -forms) and niacin.^{3-5,9,30-33,38} Vitamin E, a fat-soluble vitamin, is present in flaxseed. Vitamin E protects cell constituents from the damaging effects of free radicals. Vitamin E promotes sodium excretion in the urine, which helps to lower blood pressure, lower the risk of heart disease and some types of cancer, and Alzheimer's disease.^{7,17}

Lipids: 53% of the total lipids in flaxseeds are α -linolenic acid, followed by linoleic acid 17%, oleic acid 19%, stearic acid 3%, and palmitic acid 5%.³⁸

Dietary Fiber (mucilage or gum): Flaxseed is a rich source of dietary fiber, both soluble as well as insoluble fibers. Insoluble fiber consists of cellulose, hemicellulose, and lignin.^{10,17-19} Flaxseed mucilage, associated with the hull of flaxseed, is a gum-like material composed of acidic and neutral polysaccharides.¹⁷ The neutral fraction of flaxseed contains xylose (62.8%). The acidic fraction of flaxseed is comprised mainly of rhamnose (54.5%), followed by galactose.^{33,35,38}

Table 5: Mechanism of action of phytochemical constituents ^{2-10,14-17,21,38-39}

Constituent	Chemical Class	Major Pharmacological Mechanisms/ Biological Actions
Secoisolariciresinol diglucoside (SDG)	Lignan (Phytoestrogen)	Metabolised by gut microbiota into the enterolignans enterodiol and enterolactone. These metabolites exhibit weak estrogenic and anti-estrogenic activity through interactions with estrogen receptors (ER α and ER β). SDG and its metabolites also possess antioxidant and anti-inflammatory properties and may influence estrogen metabolism, lipid homeostasis, and glucose metabolism.
α-Linolenic acid (ALA)	Plant-derived omega-3 polyunsaturated fatty acid	Serves as a precursor to longer-chain omega-3 fatty acids and may modulate inflammatory lipid mediators. ALA may influence membrane composition, endothelial function, platelet activity, and lipid metabolism, thereby contributing to potential cardioprotective and anti-inflammatory effects.

Proteins and Bioactive Peptides	Protein fractions and peptides	Provide essential amino acids and may contribute to nutritional and tissue-repair processes. Certain flaxseed-derived peptides have demonstrated potential angiotensin-converting enzyme (ACE)-inhibitory, antioxidant, and immunomodulatory activities in experimental studies.
Dietary Fibre	Soluble and insoluble polysaccharides	Soluble fibre increases intestinal viscosity and may delay gastric emptying and glucose absorption. It can also bind bile acids and contribute to cholesterol metabolism. Insoluble fibre increases stool bulk and promotes intestinal motility, thereby supporting bowel regularity.
Cyanogenic Glycosides (Linamarin, Linustatin, and Neolinustatin)	Cyanogenic glycosides	May release hydrogen cyanide (HCN) following enzymatic hydrolysis. The released cyanide is detoxified primarily through conversion to thiocyanate by endogenous detoxification pathways, including rhodanese-mediated reactions. Toxicological risk is primarily associated with excessive intake of improperly processed seeds; appropriate preparation and dosage are therefore important.
Phenolic Acids (Ferulic Acid, <i>p</i>-Coumaric Acid, and Caffeic Acid)	Phenolic compounds	Exhibit antioxidant activity through free-radical scavenging and modulation of oxidative stress. These compounds may also exert anti-inflammatory effects through regulation of inflammatory signalling pathways and may contribute to the overall cytoprotective potential of flaxseed.
Flavonoids (Apigenin, Luteolin, and Herbacetin)	Flavonoid polyphenols	Possess antioxidant and anti-inflammatory activities and may modulate cellular signalling pathways involved in oxidative stress, inflammation, vascular function, and cellular proliferation. Their potential effects include modulation of endothelial function and other pathways relevant to cardiometabolic health.

PHARMACOLOGICAL ACTIVITIES

Phytoestrogenic activity: Dietary flaxseed exhibits a protective effect against menopausal symptoms.^{17,30,39} Several studies have examined the effects of flaxseed or its bioactive ingredients on the quality of life and the frequency and severity of hot flashes in postmenopausal women.³⁸ Lignans are often referred to as phytoestrogens, may possess estrogen receptor agonist or antagonist properties.^{1,3,10,38} A rich nutritional source of the lignan secoisolariciresinol diglycoside (SDG) is flaxseed.^{1,10,38} The intestinal metabolism of enterolactone and enterodiol, which are derived from flaxseed, may slow down the growth of cells and inhibit the activity of aromatase, 5- α -reductase, and 17- β -hydroxysteroid dehydrogenase.¹⁰ These actions may lower the risk of developing hormone-sensitive cancers, such as breast, prostate, and other cancers.^{6,17} Additionally, lignans have been proven to boost the production of globulins that bind sex hormones.⁸ Postmenopausal women are at an increased risk of osteoporosis.^{9,12-21,30-33,38}

Polyendocrine Metabolic Ovarian Syndrome: In a prospective, open-label, interventional study, supplementing with flaxseed has resulted in a significant reduction in volume and number of follicles in polycystic ovaries, enhancing menstrual cycle frequency, and does not affect blood sugar, body weight, or hirsutism. The reduction in insulin, testosterone, oestrogen, and LH levels that aid in follicular maturation and an anti-inflammatory effect that reduces ovarian volume may be the cause of flaxseed powder's (FSP)

beneficial effects. Considering the improvement in ovarian function and menstrual cycle, flaxseeds appear to be an alternative source of future drug development for PMOS.^{7,19,30}

Antibacterial activity: Evidence suggests that Flaxseed ethanol and chloroform extracts exhibit antibacterial activity against *S. typhii*, *E. coli*, *S. aureus*, *Enterococcus*, and *Bacillus subtilis*. Antimicrobial activity against each of the five bacteria was demonstrated using chloroform extracts. However, when tested against *E. coli*, the ethanol extract exhibits no antibacterial action.^{17,27-35}

Antifungal activity: Narender B. *et al* reported antibacterial and antifungal activity of flax seeds due to the presence of a special blend of multiple phenylpropanoid components. Hence, flaxseed extract serves as a useful source of antibacterial substances and an effective replacement for microorganisms used in antibiotic therapy.⁷

Antipyretic activity: The antipyretic activity of flaxseed oil was evaluated by testing against typhoid-paratyphoid A/B vaccine-induced pyrexia in rats. It was observed that the oil had a particular antipyretic property when given intraperitoneally at a dose of ≥ 1 ml/kg. Appreciable reduction in temperature was noted within the 2nd and 4th hour of oil administration. Antipyretic activity of flaxseed oil at a 3ml/kg dose was comparable to aspirin.¹¹

Anti-cancerous activity: Dietary flaxseed has a significant protective effect against breast cancer.^{6-8,30,38-39} A systematic review of ten human trials

concluded that dietary flaxseed reduces tumour growth in breast cancer patients, provides protection against primary breast cancer, and decreases the risk of death in breast cancer patients.³⁹ The structure of flaxseed lignans is almost like that of endogenous sex steroid hormones; thus, it acts *in vivo* to change hormone metabolism and reduce subsequent cancer risk in postmenopausal women.^{8,30} Besides estrogenic activity, flaxseed can interfere with steroid metabolism and bioavailability, and also inhibit enzymes, such as tyrosine kinase and topoisomerase, which are crucial to cellular proliferation and hence may contribute to lowering the incidence of prostatic adenocarcinoma.³⁹ Not only breast cancer, even cancer of the prostate gland, lung, colon, ovary, endometrium, hepatocellular, and cervix have been inhibited by flaxseed.^{6-8,30}

Antioxidant properties: Secoisolariciresinol diglycoside (SDG), a plant lignan found in flaxseed, has been found to possess antioxidant properties.^{1-21,30-33,38} A study was conducted to evaluate the antioxidant activity of secoisolariciresinol diglycoside (SDG), a plant lignan which was separated from flaxseed. The substance that would prevent polymorph nuclear leucocytes from releasing oxygen radicals is platelet-activating receptor antagonists.³ In another study, the antioxidant activity of *Linum usitatissimum* EE-LU (100, 200, 300, 400, and 500 µg/ml) ethanolic extract was examined in an *in vitro* environment. The outcome showed that EE, LU, and α -tocopherol effectively inhibited the DPPH radical, reduced power, scavenged superoxide anion radicals, scavenged hydroxyl radicals, chelated metal, and scavenged hydrogen peroxide.^{3-6,38}

Anti-inflammatory: Flaxseed and flaxseed oil possess anti-inflammatory properties due to the presence of ALA, which, when converted to EPA and DHA, inhibits human neutrophil inflammatory responses.^{11,31} Kopaei M. *et al.* evaluated the analgesic and anti-inflammatory properties of *Linum usitatissimum* L. in Balb/c mice. The analgesic properties of *Linum usitatissimum* L. are similar to those of morphine.³¹

Antidepressant activity: Pradhan D. *et al.* studied antidepressant activity of flaxseed extracts in Wistar albino rats by locomotor activity, forced swimming test, and tail suspension test. Flaxseeds are found to possess smaller antidepressant activity as compared to plain fluoxetine, chlorpromazine, and imipramine. Antidepressant activity of *Linum usitatissimum* L. seeds

extract may be due to the presence of omega-3 fatty acids.³⁸

Antidiabetic activity: Supplementing with flaxseed lowered blood glucose levels in individuals with prediabetes and type 2 diabetes. Gum derived from flaxseed and lignan supplements also reduced individuals' blood sugar levels.^{19,30,33}

Antihypertensive activity: Evidence reported that a relationship exists between lower blood pressure and higher levels of omega-6 fatty acid in human adipose tissues; an increase of 1% in omega-6 fatty acid was associated with a 5 mmHg drop in mean arterial blood pressure.^{7,9,18-19,30}

Anti-cholesteric activity: It has been reported that defatted flaxseed (equivalent to the fibre component of flaxseed) can significantly reduce levels of total cholesterol and low-density lipoproteins (LDL).^{6,18,33} The fiber portion of flaxseed has been projected to exert lipid-lowering effects by enhancing gastric emptying time, altering transit time, interfering with bulk-phase diffusion of fat, and increasing excretion of bile acids. flaxseed may exert a favorable effect on atherosclerotic plaque formation due to the antioxidant properties of lignans.^{8,18,38}

Anti-ulcer activity: Flaxseed oil and mucilage significantly protected against ethanol-induced stomach ulcers.¹⁰ The outcome shows that pre-treating rats with flaxseed oil and mucilage greatly lowered the number and duration of ethanol-induced gastric ulcers.^{8,10,31,38}

Laxative activity: Flaxseed has laxative activity by increasing peristalsis because of stretch reflexes and increasing fecal weight and volume. Flaxseed doesn't appear to be affected by gastric acid or intestinal alkaline conditions.^{3,8,19,30,35,38-39}

Hair Growth: Beroual K. *et al.* reported flaxseed consumption improves hair diameter and hair density slightly, whilst increasing hair length by 26% in an *in vivo* study on a rabbit model.^{19,30-33,39}

Bone Development: Bone development can be influenced by lignans present in Flaxseed. In a study on rats exposed to 88 or 177.3 mg SDG/kg of body weight/day had higher bone strength than the basal diet on post-natal day 50. However, on post-natal day 11, no differences in bone strength, bone mineral density were observed. Exposure to SDG did not harm bone strength.^{3,7,19,26,39}

Table 6: Pharmacological activities of flax seeds in tabulated form 2-10, 13-14,18-39

System/Category	Modern Functions	Unani Functions
Digestive / GIT	Laxative, anti-ulcer, improves bowel movement, reduces colic	Mulayyin (laxative), Muhallil-i-Awrām (anti-inflammatory), Mulaṭṭif (attenuant), Muqī (emetic)
Cardiovascular	Hypolipidemic, antihypertensive, cardioprotective, anti-atherosclerotic	Muqawwī-i-Qalb (cardiotonic), Mufarriḥ al-Qulūb (cardiac exhilarant)
Endocrine/ Hormonal	Phytoestrogenic (relieves menopausal symptoms, reduces risk of hormone-sensitive cancers, useful in PCOS)	Mughalliz-i-Manī (inspissates semen), Muqawwī-i-Bāh (aphrodisiac), Mudirr-i-Labn (galactagogue), Musakkin-i-Su'āl (cough suppressant)

Renal / Urinary	Diuretic, lithotriptic (breaks kidney stones)	Mudirr-i-Bawl (diuretic), Mufattit-i-Ḥaṣāt (lithotriptic), beneficial in renal/bladder inflammation
Reproductive	Enhances fertility, supports ovarian function, and increases libido	Muqawwī-i-Bāh (aphrodisiac), increases menstruation, abortifacient, galactagogue
Respiratory	Expectorant, useful in asthma, bronchitis, and pleurisy	Munaffith-i-Balgham (expectorant), Musakhkhin-i-Alam (analgesic), Musakkin-i-Qay (antiemetic)
Musculoskeletal	Anti-inflammatory, analgesic, useful in arthritis and joint pain	Muhallil-i-Awrām (anti-inflammatory), Musakhkhin awja (analgesic), Murkhī (demulcent)
Skin / Topical	Soothes burns, wounds, boils, abscesses, acne, and eczema	Useful in Quba (ringworm), Sa'fa (baldness), Qarha (ulcers), Muhallil-i-Awrām
Metabolic / General	Antioxidant, antidiabetic, anticancer, antidepressant	Mu'addil-i-Balgham (phlegm-alterative), Mufarriḥ (exhilarant), Jālī (detergent)

DISCUSSION

The therapeutic significance of *Tukhm-e-Katan* (Flaxseed) in Unani medicine is deeply rooted in its balanced temperament (*mizaj*)—hot and moist in the first degree—which supports its role as a softening demulcent, and solvent agent. Classical Unani scholars, including Ibn Sina and Zakariya al-Razi, emphasized its utility in conditions involving inflammation, respiratory congestion, and reproductive dysfunctions. This traditional understanding correlates remarkably with modern pharmacological findings that attribute flaxseed's actions to its diverse chemical composition, particularly its phytoestrogenic lignans. Among its constituents, secoisolariciresinol diglucoside (SDG) is the principal lignan responsible for phytoestrogenic effects, acting through estrogen receptor modulation and antioxidant pathways. SDG and its metabolites (enterodiol and enterolactone) mimic endogenous estrogens by binding selectively to estrogen receptors (ER- α and ER- β), thereby exerting agonist or antagonist activity depending on the hormonal milieu. This mechanism explains its beneficial role in menopausal symptoms, polycystic ovarian syndrome (PCOS), osteoporosis, and hormone-dependent malignancies such as breast and prostate cancer. Such effects align with the Unani concept of restoring humoral equilibrium (*ta'dil-e-mizaj*) and supporting reproductive vitality (*quwwat-e-tanasul*). In addition to lignans, flaxseed's α -linolenic acid (ALA) and linoleic acid provide anti-inflammatory and cardioprotective actions by influencing prostaglandin synthesis and lipid metabolism. The protein fraction (comprising globulins, linin, and colinin), dietary fibre, and mucilage polysaccharides contribute to its hypolipidemic, laxative, and demulcent effects, supporting gastrointestinal health, an essential domain in Unani systemic healing. The vitamins (E, B₁, B₂, niacin, choline) and minerals (calcium, phosphorus, iron) further enhance its nutritive and restorative capacity, corroborating its classification as a Muqawwi (tonic) and Ghiza-e-Dāfi-ul-Amrāz (nutritional preventive agent) in Unani pharmacopeia. Modern biomedical studies complement these traditional insights by confirming flaxseed's antioxidant,

antidiabetic, antihypertensive, and dermatoprotective properties. Its topical applications in Unani formulations for skin inflammation, ulcers, and burns are consistent with its mucilaginous and antioxidant-rich profile. Notably, the synergistic interplay of lignans and essential fatty acids distinguishes flaxseed as a holistic remedy that addresses both structural nourishment and hormonal balance—a concept central to the Unani philosophy of integrated bodily harmony. Overall, the evidence suggests that *Tukhm-e-Katan* functions not only as a source of nutrition but also as a therapeutic phytoestrogenic agent capable of harmonizing endocrine and metabolic processes. Its dual identity as a Unani drug and functional food reflect a perfect confluence of ancient theory and modern science, underscoring its continued relevance in integrative, preventive, and gender-specific medicine.

CONCLUSION

Tukhm-e-Katan (Flaxseed, *Linum usitatissimum* Linn.) bridges Unani medicine and modern phytotherapy through its diverse and potent biochemical constituents. Rich in lignans—especially secoisolariciresinol diglucoside (SDG)—it exhibits strong phytoestrogenic, antioxidant, and hormone-balancing effects. Its nutrients, including α -linolenic acid, proteins, mucilage, fibre, vitamins, and minerals, underpin anti-inflammatory, cardioprotective, and dermatoprotective properties. Within the Unani framework, its *mizaj* (temperament) and *quwwat* (therapeutic potency) support applications in reproductive, hormonal, and postmenopausal health. Thus, *Tukhm-e-Katan* stands as a symbol of harmony between classical Unani wisdom and contemporary evidence-based medicine.

Conflict of Interest: The authors declare no conflict of interest related to this study.

Funding: The authors received no specific grant or financial support from any funding agency in the public, commercial, or not-for-profit sectors.

Disclaimer (Artificial Intelligence): The authors hereby declare that no generative artificial intelligence technologies, including large language models or AI-assisted image generation tools, were employed in the

conceptualization, writing, editing or preparation of this manuscript.

Ethical approval: Not required

REFERENCES

- Anonymous. The Wealth of India: A Dictionary of Indian Raw Materials and Industrial Products. Vol 6. New Delhi: Publication and Information Directorate, CSIR; 1962:119-140.
- Hussain MS, Kaur G, Mohapatra C. Nutritional composition and functions of flaxseed (*Linum usitatissimum* Linn.). *Food Ther Health Care*. 2021;3(4):88-91. <https://doi.org/10.53388/TCR20210010>
- Khan ZJ, Khan NA, Naseem I, Nami SA. Therapeutics, phytochemistry and pharmacology of Tukhm-e-Katan (*Linum usitatissimum* L.). *Int J Adv Pharm Med Bio Allied Sci*. 2017; 111:1-5.
- Soni RP, Katoch M, Kumar A, Verma P. Flaxseed-composition and its health benefits. *Res Environ Life Sci*. 2016;9(3):310-316.
- Umer KH, Zeenat F, Ahmad W, Ahmad I, Khan AV. Therapeutics, phytochemistry and pharmacology of Alsi (*Linum usitatissimum* L.): An important Unani drug. *J Pharmacogn Phytochem*. 2017;6(5):377-383.
- Waldschläger J, Bergemann C, Ruth W, Effmert U, Jeschke U, Richter DU, et al. Flaxseed extracts with phytoestrogenic effects on a hormone receptor-positive tumour cell line. *Anticancer Res*. 2005;25(3A):1817-1822.
- Amin T, Thakur M. A comparative study on proximate composition, phytochemical screening, antioxidant and antimicrobial activities of *Linum usitatissimum* L. (flaxseeds). *Int J Curr Microbiol Appl Sci*. 2014;3(4):465-481.
- Cotterchio M, Boucher BA, Kreiger N, Mills CA, Thompson LU. Dietary phytoestrogen intake-lignans and isoflavones-and breast cancer risk (Canada). *Cancer Causes Control*. 2008; 19:259-272. <https://doi.org/10.1007/s10552-007-9089-2> PMID:17992574
- Ward WE, Yuan YV, Cheung AM, Thompson LU. Exposure to purified lignan from flaxseed (*Linum usitatissimum*) alters bone development in female rats. *Br J Nutr*. 2001;86(4):499-505. <https://doi.org/10.1079/BJN2001429> PMID:11591237
- Dugani A, Auzzi A, Naas F, Megwez S. Effects of the oil and mucilage from flaxseed (*Linum usitatissimum*) on gastric lesions induced by ethanol in rats. *Libyan J Med*. 2008;3(4):1-5. <https://doi.org/10.3402/ljm.v3i4.4787>
- Di Bonaventura M, Luo X, Moffatt M, Bushmakina AG, Kumar M, Bobula J. Association between vulvovaginal atrophy symptoms and quality of life among postmenopausal women in the United States and Western Europe. *J Womens Health (Larchmt)*. 2015;24(9):713-722. <https://doi.org/10.1089/jwh.2014.5177> PMID:26199981
- Quattrocchi U. CRC World Dictionary of Medicinal and Poisonous Plants. Vol 5. Boca Raton, FL: CRC Press; 2012:2297.
- Khare CP. Indian Medicinal Plants: An Illustrated Dictionary. New York, NY: Springer Science & Business Media; 2008:669-670. <https://doi.org/10.1007/978-0-387-70638-2> PMID:PMC2705749
- Qadry JS. Pharmacognosy. 16th ed. New Delhi, India: CBS Publishers & Distributors Pvt Ltd; 2014:126.
- Asgharpoor H, Hadizadeh-Talasaz F, Rahmani R, Rakhshandeh H, Rahmati Z. Effect of Citrus aurantium vaginal cream on vaginal atrophy in postmenopausal women: A quasi-experimental study. *Int J Community Based Nurs Midwifery*. 2024;12(1):32. <https://doi.org/10.30476/IJCBNM.2023.98670.2251>
- Khan HA, Simmler C, Yuan Y, Anderson JR, Chen SN, Nikolić D, et al. Evaluation of estrogenic activity of licorice species in comparison with hops used in botanicals for menopausal symptoms. *PLoS One*. 2013;8(7):e67947. <https://doi.org/10.1371/journal.pone.0067947> PMID:23874474
- Najjarzadeh M, Charandabi SMA, Mohammadi M, Mirghafourvand M. Comparison of the effect of hyaluronic acid and estrogen on atrophic vaginitis in menopausal women: A systematic review. *Post Reprod Health*. 2019;25(2):100-108. <https://doi.org/10.1177/2053369119830818> PMID:30798700
- Kabiruddin M. Maghzenul Mufaridat. New Delhi, India: Idara Kitabus Shifa; 2007:75-76.
- Ghani N. Khazinul Advia. New Delhi, India: Idara Kitabus Shifa; 2010:258-260.
- Usmani MI. Tanqihul Mufradat. New Delhi, India: Famous Offset Press; 2008:38-40.
- Sadeghi M, Namjouyan F, Cheraghian B, Abbaspoor Z. Impact of Glycyrrhiza glabra (licorice) vaginal cream on vaginal signs and symptoms of atrophy in postmenopausal women: A randomized double-blind controlled trial. *J Tradit Complement Med*. 2020;10(2):110-115. PMID:PMC7109473 <https://doi.org/10.1016/j.jtcme.2019.02.005> PMID:32257873
- Hamdani SKH. Usool-e-Tibb. 1st ed. New Delhi, India: Qaumi Council Braye Farogh Urdu Zaban; 2011:46, 56-58, 450-472.
- Qadry JS. Pharmacognosy. 16th ed. New Delhi, India: CBS Publishers & Distributors Pvt Ltd; 2014:126.
- Khan HA. Qanoone Asri. New Delhi, India: CCRUM; 2009:91-102.
- Hussain MS, Kaur G, Mohapatra C. Nutritional composition and functions of flaxseed (*Linum usitatissimum* Linn.). *Food Ther Health Care*. 2021;3(4):88-91. <https://doi.org/10.53388/TCR20210010>
- Sina I. Al Qanoon Fit Tib. (Urdu trans. by Kantoori GH). Vol 2. New Delhi, India: Idara Kitabus Shifa; 2007:1103-1105.
- Kabeeruddin M. Advia ki do Takseem. Hyderabad, India: Daftarul Malih Bazar Noorulmrah; YNM:96-98.
- Tarique NA. Tajul Mufradat. New Delhi, India: Idara Kitabus Shifa; 2010:5-8.
- Bughdadi IH. Kitabul Mukhtar Fil Tibb. (Urdu translation) Vol 4. New Delhi, India: CCRUM; 2005:191-194, 207-211.
- Khan MA. Al Akseer. Vol 2. New Delhi, India: Idara Kitabus Shifa; 2003:1356-1358.
- Kopaei MR, Shakiba A, Sedighi M, Bahmani M. Analgesic and anti-inflammatory activity of *Linum usitatissimum* in Balb mice. *J Evid Based Complement Altern Med*. 2017;22(4):892-896. <https://doi.org/10.1177/2156587217717416> PMID:28750553
- Lateef A. Tawzihat Kulliyat Advia. 3rd ed. Aligarh, India: Ibn Sina Academy of Medieval Medicine & Sciences; 2010:241.
- Kirtikar KR, Basu BD. Indian Medicinal Plants. Vol 2. New Delhi, India: Jayyed Press; 1975:409-410.
- Khan MA. Muhite Azam. (Urdu translation) Vol 1. New Delhi, India: CCRUM; 2013:404-406.
- Anonymous. National Formulary of Unani Medicine. Part 2, Vol 1. New Delhi, India: CCRUM, Ministry of Health & Family Welfare; 2007:150.
- Anonymous. The Unani Pharmacopoeia of India. Part 1, Vol 1. New Delhi, India: CCRUM, Ministry of Health & Family Welfare; 2007:50-53.
- Nadkarni KM. Indian Materia Medica. 3rd ed. Bombay, India: Popular Prakashan Pvt Ltd; 1976:1229-1232.
- Bernacchia R, Preti R, Vinci G. Chemical composition and health benefits of flaxseed. *Austin J Nutr Food Sci*. 2014;2(8):1045.
- Thompson LU, Chen JM, Li T, Strasser-Weippl K, Goss PE. Dietary flaxseed alters tumor biological markers in postmenopausal breast cancer. *Clin Cancer Res*. 2005;11(10):3828-3835. <https://doi.org/10.1158/1078-0432.CCR-04-2326>