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Review Article

Applicability of Katan (Flaxseed) according to Unani Perspective and Scientific Insight: A comprehensive Review

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Abstract

This review comprehensively examines *Linum usitatissimum* (flaxseed) through the dual lenses of classical Unani medicine and contemporary biomedical research. It highlights flaxseed's extensive therapeutic potential, including antioxidant, anti-inflammatory, hepatoprotective, hypolipidemic, antidiabetic, neuroprotective, bone-strengthening, anticancer, wound-healing, immunomodulatory, and gut microbiota-modulating effects. The integration of traditional Unani concepts such as Mizāj (temperament) and Akhlāṭ (humors) with modern pharmacological findings underscores the convergence of ancient humoral theory and molecular science. Key bioactive constituents—lignans, α-linolenic acid, mucilage polysaccharides, bioactive peptides, phenolic acids, and phytosterols—mediate these effects through synergistic mechanisms involving oxidative stress reduction, inflammation modulation, lipid metabolism regulation, and immune support. Clinical evidence supports flaxseed's safety and efficacy within recommended doses, though variability in outcomes and limited large-scale trials highlight the need for further rigorous research. Emphasizing integrative approaches that incorporate Unani diagnostic frameworks, this review positions flaxseed as a valuable model for evidence-based integrative medicine and nutraceutical development.

Keywords: Flexseed, Katan, Unani Medicine, *Linum usitatissimum*, Pharmacology.

Introduction

Flaxseed (*Linum usitatissimum* Linn.), known in Unani medicine as Alsi, has been valued since ancient times for its wide-ranging medicinal and nutritional properties. Esteemed Unani physicians like Dioscorides, Ibn Sina, and Zakariya Razi have described Alsi as a powerful agent with mulattif (demulcent), musakkin (sedative), muhallil (resolvent), and mushil (laxative) qualities.[1,2] Traditionally, it has been recommended for ailments such as sudda (obstruction), waja' al-mafasil (joint pain), sual (cough), and zahar al-jild (skin disorders). These traditional accounts demonstrate a deep empirical understanding of its therapeutic potential, long before the advent of modern phytochemical and pharmacological sciences. [3,4]

In recent decades, flaxseed has attracted significant attention in modern biomedical research due to its rich composition of omega-3 fatty acids (α-linolenic acid), lignans (secoisolariciresinol diglucoside), dietary fiber, and high-quality plant protein.[5–7] These bioactive constituents have demonstrated anti-inflammatory, antioxidant, hypolipidemic, antidiabetic, and anticancer effects in various experimental and clinical studies. Such findings not only validate several Unani claims but also open new avenues for evidence-based integration of flaxseed into modern healthcare systems. [7–9] Flaxseed contains natural substances that help protect the body by reducing inflammation, combating harmful molecules (antioxidants), and supporting heart health. Due to these benefits, flaxseed is regarded as a health-promoting food that may aid in the prevention or management of chronic illnesses such as heart disease, diabetes, and cancer. [5,6,10–12]In recent years, scientists have conducted more detailed studies on flaxseed because it contains important nutrients like omega-3 fatty acids, lignans, fiber, and high-quality plant protein. These components have been proven in various studies to reduce inflammation, lower harmful blood lipids, regulate blood sugar, and even combat cancer. [13–15]

These scientific findings support traditional medicine claims about flaxseed and suggest its broader application in modern healthcare. This review aims to bridge classical Unani perspectives with contemporary scientific insights, analyzing flaxseed's pharmacological actions, therapeutic applications, and safety profile through both traditional and modern lenses. By exploring its phytoconstituents, mechanisms of action, and relevance to Unani principles of temperament (Mizāj) and humoral balance (Akhlāṭ), this paper seeks to highlight flaxseed as a promising example of how ancient wisdom aligns with modern scientific validation.

Material and Methods

This review was conducted through a comprehensive literature search and critical analysis to integrate classical Unani medicine perspectives with contemporary biomedical research on *Linum usitatissimum* (flaxseed). Relevant scientific articles, clinical trials, and pharmacological studies published between 2019 and 2025 were identified using academic databases and repositories focusing on phytochemistry, pharmacology, and traditional medicine. Key search terms included "Linum usitatissimum," "flaxseed," "Unani medicine," "phytoconstituents," "therapeutic effects," "bioactive compounds," and related pharmacological activities such as antioxidant, anti-inflammatory, hepatoprotective, hypolipidemic, antidiabetic, neuroprotective, anticancer, wound healing, immunomodulatory, and gut microbiota modulation.

Classical Unani texts and pharmacopeias were reviewed to extract traditional knowledge regarding flaxseed's medicinal properties, therapeutic categories, and humoral concepts such as Mizāj (temperament) and Akhlāṭ (humors). The review synthesized data from both traditional sources and modern experimental and clinical evidence to elucidate mechanisms of action, therapeutic applications, and safety profiles.

Studies were selected based on relevance, methodological rigor, and recency, emphasizing those that provided mechanistic insights or clinical validation aligned with Unani principles. Data extraction focused on bioactive constituents, pharmacodynamics, clinical outcomes, and safety considerations. The integration aimed to highlight convergences and gaps between Unani medicine and modern science, proposing directions for future integrative research.

Antioxidant & Anti-inflammatory Activity

Flaxseed (Linum usitatissimum) has been extensively investigated in recent years for its potent antioxidant and anti-inflammatory properties, attributed primarily to its α-linolenic acid (ALA), lignans (notably secoisolariciresinol-diglucoside), phenolics, and soluble fiber content.[10,16,17] A meta-analysis of randomized controlled trials demonstrated significant reductions in high-sensitivity C-reactive protein (hs-CRP) and tumor necrosis factor-α (TNF-α) following flaxseed supplementation, though results for IL-6 and conventional CRP remained inconsistent[18–20]. Further evidence from dose–response analyses confirms that flaxseed oil and lignan fractions effectively modulate inflammatory and lipid biomarkers, particularly at doses up to 30 g/day. [6,21]Preclinical models corroborate these findings, showing marked decreases in malondialdehyde and cytokine levels, indicating strong antioxidant potential. Mechanistically, ALA competes with linoleic acid within eicosanoid pathways, reducing pro-inflammatory prostaglandins, while lignans exert radical-scavenging and cytokine-modulating actions.[22–24]

From an Unani medicine perspective, flaxseed—traditionally recognized as Alsi or Bazar-ul-Katan—has long been described for its demulcent, anti-inflammatory, and humoral balancing properties. Modern pharmacological findings thus substantiate classical Unani concepts of temperament modulation and systemic detoxification. [1,5,7,25,26]Despite robust mechanistic evidence, clinical heterogeneity and modest effect magnitudes underscore the need for large-scale, Unani-contextualized clinical validation to support its integration into evidence-based Unani therapeutics.[27–29]

Hepatoprotective & Hypolipidemic Effects

Recent evidence from 2019–2025 substantiates the hepatoprotective and hypolipidemic potential of *Linum usitatissimum* (flaxseed), attributed to its rich composition of α-linolenic acid, lignans, and soluble fibres. Clinical and experimental investigations demonstrate significant reductions in total cholesterol, LDL-C, and triglycerides following flaxseed supplementation, particularly in its whole-seed or lignan-enriched forms.[10,30,31] The hypolipidemic action is mediated via inhibition of hepatic lipogenesis, enhanced bile acid excretion, and modulation of lipid metabolism genes[31–33]. Concurrently, preclinical models reveal hepatoprotective effects wherein flaxseed protein and lignans attenuate oxidative stress, restore hepatic architecture, and normalize serum transaminases against ethanol- and paracetamol-induced injury [34–36]. In clinical contexts such as non-alcoholic fatty liver disease (NAFLD), flaxseed supplementation has been shown to improve hepatic steatosis and reduce ALT and AST levels, supporting its protective influence on hepatocellular integrity[30,37–39]. These effects are largely ascribed to antioxidant, anti-inflammatory, and lipid-modulatory pathways acting synergistically[10,40]. Within the framework of Unani medicine, flaxseed (Katan) is classified as Musakkin-e-Kabid (hepatosupportive) and Mufatteh-e-Sudud (deobstruent), traditionally prescribed for hepatic and biliary disorders. The modern findings provide mechanistic corroboration of these classical claims, suggesting that the hepatoprotective and lipid-lowering benefits of flaxseed align with the Unani doctrine of temperamental balance and detoxification[5,41,42]. Collectively, flaxseed emerges as a promising adjunct for the management of dyslipidemia and hepatic dysfunction, warranting further standardised clinical evaluation within integrative frameworks.

Antidiabetic and Metabolic Syndrome Modulation Effects of Flaxseed

Flaxseed (*Linum usitatissimum* L.), known as Katan in Unani medicine, has long been valued for its Mufatteh Sudad (deobstruent) and Mushil Balgham (phlegmagogue) properties that support metabolic balance. Recent evidence from 2019–2025 underscores its potent antidiabetic and metabolic-syndrome-modulating effects through multifaceted mechanisms. Several randomized controlled trials have shown that daily intake of ground flaxseed (15–30 g/day) significantly lowers fasting glucose, HbA1c, and postprandial glycemia in type 2 diabetic patients[43–45]. These improvements are largely attributed to its bioactive components—α-linolenic acid, lignans, and soluble fibers—that delay glucose absorption, enhance insulin sensitivity, and ameliorate oxidative stress [21,46,47]. Meta-analytical data further confirm significant reductions in HbA1c and modest improvement in lipid and inflammatory markers among subjects receiving flaxseed supplementation[6,20,22,48]. Animal and in-vitro investigations revealed additional mechanisms including α-glucosidase inhibition, pancreatic β-cell preservation, and modulation of gut microbiota leading to increased production of beneficial short-chain fatty acids[49,50]. Collectively, these findings highlight flaxseed's broad metabolic benefits, encompassing glycemic regulation, lipid correction, and inflammatory balance. In the context of Unani medicine, such effects resonate with the classical concepts of Tahleel-e-Riyah (resolution of metabolic derangements) and Muqawwi Jigar (strengthening of hepatic functions), reflecting a holistic correction of Sue Mizaj-e-Jigar and Imtila. Thus, flaxseed represents a scientifically validated adjunct to modern and traditional therapeutic regimens targeting diabetes and metabolic syndrome.

Neuroprotective & Bone Health Effects of Flaxseed

Flaxseed (Linum usitatissimum L.), traditionally referred to as Katan in Unani medicine, exhibits promising neuroprotective and bone-strengthening potential supported by recent experimental and limited clinical evidence. Neuroprotective effects of flaxseed oil and lignan fractions have been attributed to α-linolenic acid (ALA) and secoisolariciresinol diglucoside (SDG), which modulate neuroinflammation, enhance antioxidant defense, and activate Nrf2 signaling pathways, leading to the preservation of neuronal integrity[22,25,51–53]. Studies in animal models of neurotoxicity have reported improved brain histology and reduced oxidative damage following flaxseed oil supplementation[54,55]. Although human data remain sparse, preliminary findings indicate potential cognitive and mood benefits linked with dietary ALA and lignan intake [56]. Regarding bone health, flaxseed lignans exert mild phytoestrogenic actions, improving bone mineral density and trabecular architecture in ovariectomized and glucocorticoid-induced osteoporotic models through anti-inflammatory and calcium-regulatory effects[32,57]. Limited clinical trials in postmenopausal women have shown modest improvements in bone turnover markers with regular flaxseed consumption, though evidence remains inconclusive (ClinicalTrials.gov NCT03036722). In the Unani framework, such properties correspond to Muqawwi Aʻsab (nerve tonic) and Muqawwi Azam (bone-strengthening) actions of Katan, reflecting its holistic role in maintaining the balance of Asbab-e-Sitta Zarooriya and humoral stability. Collectively, flaxseed demonstrates a strong biological rationale and preclinical support for neuroprotective and osteoprotective benefits, warranting further translational and clinical validation.

Anticancer and Tumour-Modulating Activity of Flaxseed

Flaxseed (*Linum usitatissimum* L.), known as Katan in Unani medicine, has been classically mentioned by Ibn Sina in Al-Qānūn fī al-Ṭibb and by Razi in Kitab al-Hawi as Mufatteh Sudad (deobstruent), Mushil Balgham (phlegmagogue), and Munaqqi Badan (detoxifier of morbid humors) useful in chronic Awrām (swellings/tumours)[58,59]. These descriptions align remarkably with its contemporary anticancer and tumour-modulating activities reported between 2019–2025. Recent studies demonstrate that flaxseed bioactives—α-linolenic acid (ALA), secoisolariciresinol diglucoside (SDG), enterolactone, enterodiol, and polyphenols—possess strong antiproliferative, anti-inflammatory, and pro-apoptotic properties [60–62]. SDG and its metabolites downregulate NF-κB signaling, inhibit angiogenesis, and induce apoptosis or pyroptosis in tumour cells [63–65]. Animal studies in mammary, cervical, and colorectal cancers revealed significant tumour suppression and reduced oncoprotein expression [64,66], while limited human data indicate inverse associations between plasma enterolactone levels and breast cancer risk [67–69]. From the Unani viewpoint, these mechanistic effects resonate with Tahleel-e-Awrām (resolution of swellings), Tanqiya-e-Badān (detoxification), and Taʻdil-e-Mizāj (restoration of humoral balance), as cited in Makhzan al-Advia and Khazain-ul-Advia, where Katan is prescribed for Suda al-Dimāgh, Awrām-e-Kabid, and Awrām-e-Rahem (inflammatory and tumorous conditions).[70,71] Thus, both Unani classics and modern biomedical data converge on the tumour-modulating, detoxifying, and homeostatic actions of flaxseed, highlighting its potential as an integrative adjuvant in modern oncotherapy.

Wound Healing & Mucosal Protective Activity

Linum usitatissimum (flaxseed, Tukhme Alsi) has been traditionally esteemed in Unani medicine for its mulayyin (demulcent), mudammil-e-quruh (wound-healing), and mu'allij-e-qarah-e-mida (mucosal protective) actions, attributed to its ratb wa lateef mizaj (moist and subtle temperament) which softens tissues and promotes regeneration. Contemporary pharmacological research (2019–2025) corroborates these traditional claims. Experimental and formulation studies demonstrate that flaxseed oil, mucilage, and polysaccharide fractions accelerate wound contraction, enhance fibroblast proliferation, angiogenesis, and collagen deposition, while reducing oxidative stress and inflammatory cytokines [72–74]. Flaxseed mucilage forms a mucoadhesive gel layer, protecting oral and gastrointestinal mucosa and supporting epithelial repair[73,75]. These actions parallel the Unani descriptions of Jalā-daur (anti-inflammatory) and Mudammil-e-Quruh effects noted by Ibn Sina (Al-Qanun fil Tibb) and Najibuddin Samarqandi (Sharah Asbab wa Alamat). The antioxidant, anti-inflammatory, and barrier-protective mechanisms of flaxseed now provide a molecular rationale for its traditional use in ulcers, fissures, and mucosal erosions. However, despite extensive preclinical evidence, clinical validation remains limited, warranting controlled human studies to substantiate its therapeutic efficacy within both modern and Unani frameworks.

Immunomodulatory & Gut-Microbiota Effects of *Linum usitatissimum* (Flaxseed)

Recent investigations (2019–2025) reaffirm *Linum usitatissimum* L. as a potent immunonutrient that modulates gut microbial ecology and systemic inflammation. Experimental and translational studies demonstrate that flaxseed polysaccharides, lignans, and α-linolenic acid collectively remodel the gut microbiota, enhancing Lactobacillus and Bifidobacterium abundance while reducing pro-inflammatory taxa, thereby improving intestinal barrier integrity and reducing endotoxemia[14,22,25,76]. In murine high-fat-diet and LPS-challenge models, flaxseed and its oil fractions down-regulated TNF-α, IL-6, and NF-κB pathways while elevating anti-inflammatory IL-10, correlating with improved mucosal tight-junction proteins and elevated short-chain fatty acids [77,78]. Human supplementation trials have also shown favorable modulation of CRP and IL-6 levels, though results vary with formulation and dose[79–81]. These findings support flaxseed as a prebiotic and immunoregulatory agent, consistent with its Unani characterization as Tukhme-Alsi, possessing mulayyin, mufattit, and mudammil-e-quruh properties that balance deranged humours (akhlaat) and strengthen the digestive faculties (quwwat-e-hazima). Ibn Sina in Al-Qanun fil Tibb and Najibuddin Samarqandi in Sharah Asbab wa Alamat extolled its role in soothing inflammation and promoting gut harmony—attributes now mechanistically validated by modern immunological and microbiome research. Thus, flaxseed exemplifies a convergence of classical Unani wisdom and contemporary molecular nutrition, warranting further controlled human trials to define its precise immunomodulatory and gut-restorative potential.

Bioactive Compounds of *Linum usitatissimum* (Flaxseed)

The seeds of *Linum usitatissimum* L. are a rich repository of diverse bioactive compounds that confer its multifaceted pharmacological profile. Among these, lignans—notably secoisolariciresinol diglucoside (SDG)—and its mammalian metabolites enterodiol and enterolactone are credited with potent antioxidant, anti-inflammatory, and hormone-modulating activities[5,23,82]. The omega-3 fatty acid α-linolenic acid (ALA), abundant in flaxseed oil, regulates eicosanoid biosynthesis and attenuates pro-inflammatory signaling[83]. Mucilage polysaccharides, composed primarily of rhamnose, arabinose, and galacturonic acid residues, exhibit prebiotic, demulcent, and muco-protective properties that stabilize intestinal barrier function [72,84]. Additionally, bioactive peptides and cyclolinopeptides (linusorbs) demonstrate immunomodulatory, anti-hypertensive, and anticancer potentials through modulation of NF-κB and oxidative pathways [85,86]. Flavonoids, phenolic acids, and sterols further contribute to the seed's radical-scavenging and lipid-modulating effects, creating synergistic biochemical interactions[87,88]. These cumulative findings corroborate the Unani depiction of Tukhme Alsi as mulayyin (demulcent), mufattit (softening), and muqawwī-e-hazima (digestive-tonic), described by Ibn Sīnā and Najībuddīn Samarqandī as a remedy for inflammatory and degenerative disorders. The moist temperament (ratb mizāj) and tissue-restorative action (mudammil-e-quruh) outlined in Unani literature resonate with modern molecular insights into its antioxidant and immunonutrient properties. Thus, flaxseed stands as a paradigm where traditional humoral theory and modern phytochemistry converge, validating its therapeutic promise across both classical and contemporary medical paradigms.

Table 1: Bioactive Compounds of *Linum usitatissimum* and Their Pharmacological & Unani Correlation

Bioactive Compound / Class	Major Modern Pharmacological Actions (PubMed 2019–2025)	Representative Studies (2019–25)	Corresponding Unani Action / Concept	Classical References
1. Lignans (Secoisolariciresinol diglucoside – SDG, SECO, Enterolactone, Enterodiol)	Potent antioxidant and anti-inflammatory; modulates estrogenic activity; reduces oxidative stress and cytokines; exhibits anticancer potential via NF-κB and ERK pathways.	Mueed et al., 2022; Nowak et al., 2023	Mudammil-e-Quruh	Ibn Sīnā; Samarqandī
2. α-Linolenic acid (ALA, ω-3 fatty acid)	Cardioprotective; immunomodulatory; suppresses eicosanoid synthesis (PGE_2, LTB_4); improves lipid profile; neuroprotective.	Al-Madhagy et al., 2023; Nowak et al., 2023	Mufattit	Ibn Sīnā; CCRUM Pharmacopoeia
3. Mucilage (Flaxseed Polysaccharides: rhamnose, arabinose, galactose, galacturonic acid)	Prebiotic and demulcent; forms viscous gel; protects mucosal barrier; enhances SCFA production; anti-ulcer and gut-protective effects.	Kučka et al., 2024; Chand et al., 2024	Mulayyin	Samarqandī; CCRUM Pharmacopoeia
4. Bioactive Peptides and Cyclolinopeptides (Linusorbs)	ACE-inhibitory; antioxidant; anti-hypertensive; immunomodulatory; apoptosis-inducing in tumor models.	Fojnica et al., 2023	Muqawwī-e-Aʿdā	Ibn Sīnā; Kabiruddin
5. Phenolic Acids & Flavonoids	Radical-scavenging; lipid peroxidation inhibition; antimicrobial; support endothelial function.	Puligundla et al., 2022; Nowak et al., 2023	Dāfi-e-Tafun	Ibn Sīnā; Kabiruddin
6. Phytosterols & Tocopherols	Hypocholesterolemic, antioxidant, hepatoprotective; stabilize membranes and lipids.	Al-Madhagy et al., 2023	Muqawwī-e-Kabid	Samarqandī; CCRUM
7. Proteins and Amino Acids	Nutritional, reparative, immunonutritive; promote tissue regeneration.	Nowak et al., 2023; Mueed et al., 2022	Muʿidd-e-Numu	

Dosage and Safety Considerations of *Linum usitatissimum*

Recent clinical and experimental evaluations (2019–2025) confirm that flaxseed is generally safe and well tolerated when consumed within recommended dietary ranges. Most randomized controlled trials have employed whole or ground flaxseed at 15–30 g/day for 8–12 weeks or flaxseed oil at 10–30 mL/day, demonstrating metabolic and anti-inflammatory benefits without major adverse events[48,89,90]. Acute ingestion of 15 g flaxseed has been shown to attenuate postprandial glycemia in healthy subjects[16,91], while longer interventions improved lipid indices and reduced hs-CRP and IL-6 levels[16,17,20,91]. The principal side effects are mild gastrointestinal disturbances—bloating, flatulence, and increased bowel motility—which resolve with hydration and dose adjustment[21,91,92]. Flaxseed contains phytic acid and cyanogenic glycosides, yet thermal or enzymatic processing markedly diminishes cyanide potential, ensuring safety in practical intakes[93,94]. Caution is advised in pregnancy and lactation, where limited and conflicting data necessitate supervised use [95–97]. Interactions with anticoagulants and drugs with narrow absorption windows have been reported sporadically due to mucilage-induced alterations in gastrointestinal transit [98–100]. From the Unani perspective, Tukhme-Alsi is described as ratb-ul-mizaj (moist temperament) and mufattit (softening), warranting temperament-specific dosage adjustment and co-administration with musaffi-e-dam or muqawwī-e-hazima agents to avoid excess ratubat (moisture). Classical authorities such as Ibn Sīnā and the CCRUM Pharmacopoeia emphasize moderation and individualized prescription—principles now echoed by modern safety data advocating personalized, well-processed formulations and prudent dosing within physiological limits.

Discussion

The comprehensive review of *Linum usitatissimum* (flaxseed) underscores its multifaceted therapeutic potential, bridging classical Unani medicine with contemporary biomedical research. The convergence of traditional knowledge and modern pharmacology highlights flaxseed's broad spectrum of bioactivities, including antioxidant, anti-inflammatory, hepatoprotective, hypolipidemic, antidiabetic, neuroprotective, bone health-promoting, anticancer, wound healing, immunomodulatory, and gut microbiota-modulating effects.

Modern studies validate many Unani claims, particularly the seed's role in humoral balance and temperament modulation, reflecting a sophisticated understanding of systemic homeostasis in classical medicine. The bioactive compounds such as lignans (SDG), α-linolenic acid, mucilage polysaccharides, bioactive peptides, phenolic acids, and phytosterols collectively contribute to these effects through synergistic mechanisms involving oxidative stress reduction, inflammation modulation, lipid metabolism regulation, and immune system support.

Clinical evidence supports flaxseed's safety and efficacy within recommended dosages, with mild gastrointestinal side effects being the most common. However, variability in clinical outcomes and the need for larger, well-designed trials—especially those contextualized within Unani principles—are evident. This gap underscores the importance of integrative research approaches that combine traditional concepts like Mizāj and Akhlāṭ with rigorous pharmacological and clinical methodologies.

The pharmacological actions of flaxseed align with Unani therapeutic categories such as Musakkin-e-Kabid, Mufatteh-e-Sudud, Muqawwi-e-Aʿsab, and Mudammil-e-Quruh, exemplifying how ancient humoral theories can inform and enrich modern drug discovery and nutraceutical development. Furthermore, its immunomodulatory and gut microbiota effects open promising avenues for managing inflammatory and metabolic disorders through diet-based interventions.

In conclusion, flaxseed represents a valuable model for integrative medicine, where empirical traditional wisdom is substantiated by molecular and clinical evidence. Future research should prioritize standardized formulations, dose optimization, and robust clinical trials that incorporate Unani diagnostic frameworks to fully harness flaxseed's therapeutic potential in both traditional and modern healthcare systems.

Conclusion

Linum usitatissimum (flaxseed) exemplifies a profound convergence of classical Unani medicine and contemporary biomedical science, demonstrating a wide array of therapeutic effects mediated by its diverse bioactive compounds. The synergistic actions of lignans, α-linolenic acid, mucilage polysaccharides, bioactive peptides, phenolic acids, and phytosterols underpin its antioxidant, anti-inflammatory, hepatoprotective, hypolipidemic, antidiabetic, neuroprotective, bone-strengthening, anticancer, wound-healing, immunomodulatory, and gut microbiota-modulating properties. Clinical evidence affirms its safety and efficacy within recommended dosages, though variability in outcomes and limited large-scale trials highlight the need for more rigorous, integrative research.

Aligning flaxseed's pharmacological profile with Unani therapeutic categories such as Musakkin-e-Kabid, Mufatteh-e-Sudud, Muqawwi-e-Aʿsab, and Mudammil-e-Quruh illustrates the enduring relevance of humoral theory in informing modern drug discovery and nutraceutical development. Its immunomodulatory and gut microbiota effects further open promising avenues for managing inflammatory and metabolic disorders through dietary strategies.

To fully harness flaxseed's therapeutic potential, future research must prioritize the development of standardized formulations, dose optimization, and well-designed clinical trials that incorporate Unani diagnostic frameworks like Mizāj and Akhlāṭ. Such integrative approaches will enable a holistic understanding and application of flaxseed in both traditional and modern healthcare systems, establishing it as a valuable model for evidence-based integrative medicine.

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