

Available online on 15.07.2025 at <http://jddtonline.info>

Journal of Drug Delivery and Therapeutics

Open Access to Pharmaceutical and Medical Research

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Review Article

The therapeutic benefit of lemon with its history, phytochemistry, pharmacological, experimental and clinical studies: A comprehensive review with Unani perspectives

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Article Info:



Article History:

Received 26 April 2025

Reviewed 08 June 2025

Accepted 30 June 2025

Published 15 July 2025

Cite this article as:

Sabir B, Usmani S, Sehar N, The therapeutic benefit of lemon with its history, phytochemistry, pharmacological, experimental and clinical studies: A comprehensive review with Unani perspectives, Journal of Drug Delivery and Therapeutics. 2025; 15(7):217-224 DOI: <http://dx.doi.org/10.22270/jddt.v15i7.7271>

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Abstract

Background: Lemon (*Citrus limon*), a widely used fruit from the Rutaceae family, has been valued since ancient times for its nutritional and medicinal properties. In Unani medicine, it is recognized for both its therapeutic and protective effects across various body systems. Today, lemon is gaining renewed attention for its pharmaceutical, cosmetic, and culinary applications. This review aims to present a comprehensive overview of its biological activities and therapeutic potential, backed by scientific evidence.

Methodology: This paper compiles information from classical Unani texts and modern scientific literature, covering the history, types, physical traits, active constituents, and pharmacological effects of lemon. Given the vast data available, we focused on aspects most relevant to clinical practice.

Observations and Conclusion: *Citrus limon* shows a wide range of therapeutic effects antidiabetic, anti-obesity, cardioprotective, antiparasitic, anti-allergic, hepatoprotective, and neuroprotective with a favorable safety profile. These findings support its value as a medicinal plant and its potential for future use in pharmaceutical and nutraceutical development.

Keywords: *Citrus limon*, Unani medicine, therapeutic potential, pharmacological activity, lemon juice.

Introduction

Lemon (*Citrus limon*), a hybrid species of the Rutaceae family, is a widely valued medicinal plant that originates from the tropical and subtropical regions of Southeast Asia¹. It features evergreen leaves and bright yellow edible fruits, with its juice and essential oil serving as primary therapeutic components^{1,2}. Historically, prior to the discovery of vitamin C, lemon juice was extensively used to prevent and treat scurvy². In the Unani system of medicine, this fruit is referred to as "Lemon" or more specifically "Kaghzi Lemu," which is the variety most commonly used for medicinal and dietary purposes^{3,4}. Lemon is globally recognized for its nutritional benefits and therapeutic properties, and it holds significant relevance within both Unani and contemporary medical systems^{4,5}. Structurally, the fruit is a segmented berry with distinct aromatic features. Among its medicinal properties are its anticancer potential, kidney stone prevention, antipyretic effects, and ability to regulate bodily pH⁵. *C. limon* is known for its versatile pharmaceutical, cosmetic, and dietary applications⁶. The plant owes much of its biological efficacy to its rich

content of phenolic compounds, such as flavonoids diosmin, hesperidin, and limocitrin and phenolic acids like ferulic, synapic, and p-hydroxybenzoic acid¹. Its essential oil contains significant levels of bioactive monoterpenoids, including D-limonene, β -pinene, and γ -terpinene^{1,6}. Scientific evaluations have established that *C. limon* possesses a wide range of therapeutic properties, including anti-inflammatory, antimicrobial, anticancer, and antiparasitic activities⁷.

Furthermore, its essential oil has widespread applications in the food industry, where it enhances both the safety and sensory profile of processed foods⁸. These oils exhibit antioxidant capacity by neutralizing free radicals and demonstrate antimicrobial activity by inhibiting spoilage and pathogenic microorganisms⁸. Lemon also plays a therapeutic role in managing conditions such as asthma, cough, liver ailments, fever, diphtheria, and rheumatism⁹. Its immunomodulatory effect is attributed to its ability to enhance white blood cell production and stimulate antibody formation, thereby protecting against infections⁹. Additionally, lemon acts as a natural antioxidant, offering protection

against diseases such as stroke, cardiovascular disorders, and cancer, and is known to help lower blood pressure while increasing HDL cholesterol levels ¹⁰.

Mutardif Naam (Vernacular Names):^{3-4, 11-12}

Language	Vernacular Names
Arabic	Laimonhamidh, Lemu, Qalambak
Bengali	Bara Nebu, Gora Nibu
English	Indian Lemon, Lemon, Citron, Lime
Urdu	Limu, Neebu
Telugu	Madiphalamu, Peddanimma
Tamil	Periya-Yelumichai
Greek	Fisamoon
Gujarati	Motu Limbuz
Hindi	Pahari Nibu, Bara Nibu, Limbe
Kannada	Byopura, Bijori
Malayalam	Ganapalinarkam
Sanskrit	Matulunga, Jamvira

Description According to Unani Classical Literature ^{4, 13-15}

Lemon (*Citrus limon*) is widely recognized in Unani medicine for its notable antibacterial and antiseptic properties. Several varieties of lemon are described in traditional texts, with *Kaghzi Leemu* commonly referred

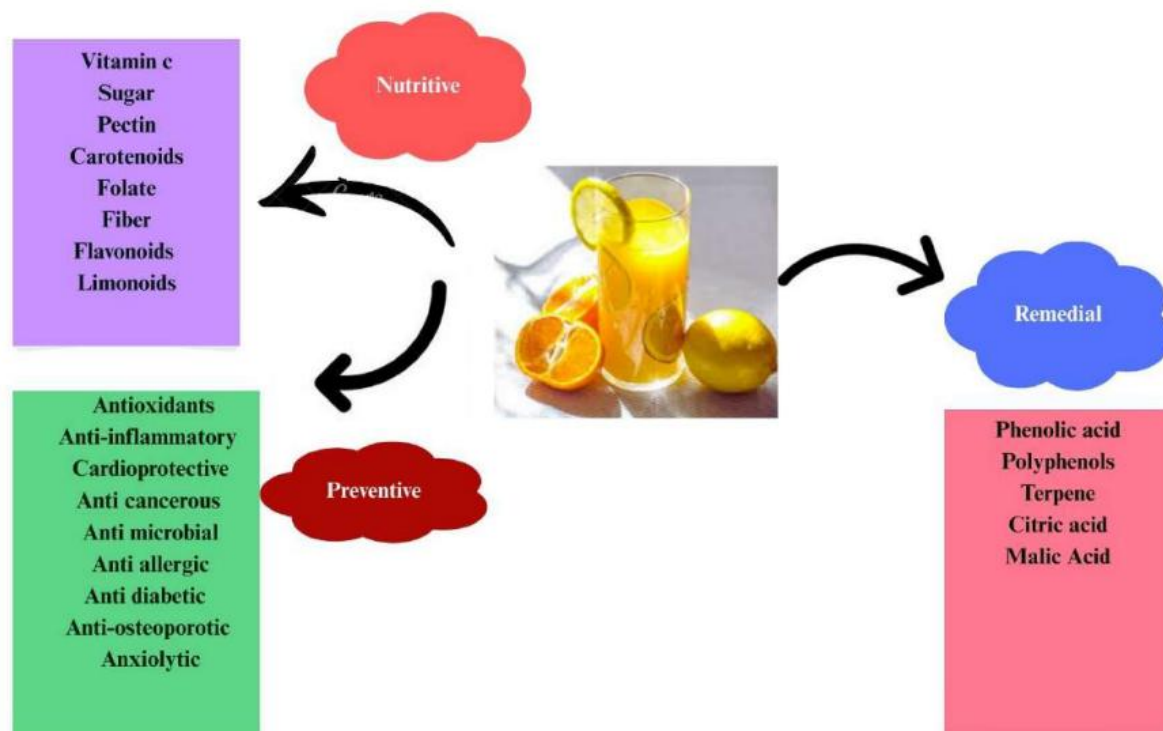
to as the “absolute lemon” being the most preferred type for medicinal and dietary use. Various parts of the lemon plant are employed therapeutically, including the juice (*Aab-e-Leemu*), seeds (*Tukhm-e-Leemu*), peel (*Post-e-Leemu*), and the entire fruit skin. The lemon tree itself is medium in height, resembling a shrub, with small, round leaves and fragrant white flowers. The fruit is generally small, round, and covered with a thin, paper-like rind when unripe, which is the basis for its name *Kaghzi Leemu*. In Unani formulations, lemon is used in preparations such as *Sikanjabeen Khaam*, a mixture of lemon juice and sugar syrup, and *Sikanjabeen Lemuni*, a variant specifically made by blending lemon juice with sugar to produce a refreshing and therapeutic beverage.

Parts Used: ^{3-4, 11}

- Seeds
- Peel
- Fruit
- Lemon oil
- Leaves
- Expressed juice (ripe fruit)

Mizaj/Temperament: ^{3-4, 11}

Compound	Temperament (Mizaj)
Aab-e-Lemu	Barid Yabis
Tukhm-e-Lemu	Harr Yabis



Afaal (Actions) ^{3-5, 16-23}

Afaal (Action)	Modern Equivalent / Function
Mubarrid wa Mufarreh	Refrigerant and exhilarant
Dafi-e-Qai-Al-Haml	Antiemetic (during pregnancy)
Dafi-e-Ghisyan	Antiemetic and anti-nausea
Hazim	Digestive
Muqawwi-e-Meda	Stomachic (strengthens stomach)
Mushtahi	Appetizer
Muqtai wa Mulattif Akhlate Ghaliza	Resolvent and attenuant of thick humours
Dafi-e-Tip	Antipyretic
Dafi-e-Hiddate Safra	Reduces bile heat
Dafi-e-Samoom	Antidote
Musakkin	Sedative
Dafi-e-Attish	Antithirst
Jali	Detergent (cleansing agent)
Locomotor activity	Enhances movement or muscle tone
Antiescorbutic	Prevents scurvy (Vitamin C related)
Antimigraine	Relieves migraine
Anticancerigenous	Anticancer
Aromatherapy	Used for mental well-being
Canker Sores	Heals mouth ulcers
Diuretic effect	Promotes urine flow
Anti-inflammatory activity	Reduces inflammation
Antimicrobial activity	Inhibits bacterial growth
Antifungal activity	Inhibits fungal growth

Mawaqa-e-Istemaal (Therapeutic Uses) ^{3-5, 11-15}

Condition (Unani Term)	Modern Interpretation / Use
Nausea, Vomiting	Gastrointestinal disturbances
Humma Wabai	Infectious fevers
Ufoonat	Septic or putrefactive conditions

Condition (Unani Term)	Modern Interpretation / Use
Zoaf-e-Hazam	Weak digestion
Ghalba-e-Safra	Predominance of bile
Hiddat-e-Safra	Excessive bile heat
Bars wa Bahaq	Leucoderma and vitiligo
Suda Khumari	Hangover-related headache
Basoor Safravi	Biliary pimples or acne
Warm-e-Meda	Gastric inflammation
Warm-e-Ama	Intestinal inflammation
Zoaf-e-Isteha	Loss of appetite
Food Preservative	Used for preservation in diet and medicine

Muzir/Toxic ^{3-4, 11}**Muzir (Adverse Effect)**

Sard Mizaj (Cold temperament)

Asab (Nervous system)

Musleh/Corrective: ^{3-4, 11}**Musleh (Corrective Agent)**

Shakkar Safaid (Refined Sugar)

Shahad Khalis (Pure Honey)

Badal/Substitute: ^{3-4, 11}**Badal (Substitute)**

Narangi (Orange)

Miqdare Khorak/Dosage: ^{3-4, 11}

Component	Dosage
Aab-e-Lemu (Lemon Juice)	6 masha / 5.832 mL
Post wa Tukhm-e-Lemu (Peel and Seed)	1 masha / 0.972 mL

Nafa Khas/Important function: ^{3-4, 11}

Musakkin Safra wa Hiddatae Khoon/
Daf-e-Qai/Anti-emetic
Muqavvi Meda/Strengthening of GIT
Tiryaqe Sumoom/Antidote

Famous Formulations⁵

Satte Lemun, Sikanjabeen, Sharbat Lemun

Habit and Habitat

It is a garden plant primarily grown for its valuable fruit, commonly cultivated in the Khasi Hills, the southwestern regions of India, and some parts of northern India.²⁴

Botanical Description

Citrus limon (L.) Burm. f. (lemon) is a small, evergreen tree that typically reaches a height of 2.5 to 3 meters. It has lance-shaped leaves and bears fragrant, bisexual flowers that are white with a hint of purple along the edges of the petals. These flowers appear singly or in small clusters in the leaf axils. The fruit is a green, elongated, oval-shaped berry with a pointed tip, turning bright yellow as it ripens. Inside, the juicy pulp is divided into segments, similar to that of an orange. The outer layer of the fruit, or pericarp, includes a thin, waxy exocarp and the outer mesocarp (flavedo), which contains oil glands and carotenoid pigments. Beneath this lies the albedo, the inner part of the mesocarp, which is soft, white, and spongy in texture.²⁵ *Citrus limon* thrives in sunny locations and prefers loamy, well-drained, and moist soils with a broad pH tolerance.⁽¹⁾ The *Citrus* genus as a whole includes evergreen shrubs or trees ranging from 3 to 15 meters tall. Their leaves are tough and leathery, usually ovoid or elliptical, and may bear thorns. The flowers emerge singly from leaf axils and typically have five petals, which may be white or tinged with red. The fruits are classified as hesperidium berries. *Citrus* species naturally grow in warm, mild climates most commonly in the Mediterranean and are generally sensitive to frost.²⁵

Phytochemistry

Citrus limon (lemon) is particularly rich in flavonoids, which play a significant role in its biological activity. Key flavonoids found in the fruit and juice include flavanones such as hesperidin, hesperetin, naringin, and eriodictyol; flavones like apigenin and diosmin; and flavonols such as quercetin. The whole fruit also contains other flavonoids like limocitrin, spinacetin, orientin, and vitexin. Compounds like neohesperidin and naringin are especially characteristic of lemons. Among citrus species, *C. limon* has the highest content of eriocitrin.²⁶ In addition to flavonoids, lemons are a rich source of phytochemicals, including polyphenols, terpenes, and high levels of citric acid (approximately 47 g/L of juice). The essential oil derived from lemon has a complex composition, dominated by limonene (around 70%), along with other monoterpenes, citral, linalool, and small quantities of coumarins. The peel, which constitutes about 45% of the fruit, contains over 200 volatile and non-volatile compounds, making it a valuable source of bioactive ingredients.²⁷

Chemical Constituents:

Flavonoids (hesperidin, naringin), Limonoids, Phenolic acid, Carboxylic acids, Coumarins, Furanocoumarins, Amino acids, Carbohydrates, Vitamins and

their metabolites (vitamin C, choline, pantothenic acid, trigonelline), Mineral (Calcium (Ca), magnesium (Mg), phosphorus (P), potassium (K) and sodium (Na))⁶

Scientific Studies:

Antioxidant Activity:

Studies have shown that the antioxidant activity of flavonoids found in *Citrus limon*, particularly hesperidin and hesperetin, goes beyond simple free radical scavenging. These compounds also enhance the body's antioxidant defenses by activating the ERK/Nrf2 signaling pathway.²⁸ Additionally, vitamin C in lemons plays a vital role in preventing free radical formation and protecting DNA from mutations. Research further indicates that lemon-derived compounds can reduce lipid peroxidation, as observed in experimental models of seizures and status epilepticus induced by pilocarpine in adult rats.²⁹

Anticancer Activity:

Nanovesicles derived from *Citrus limon* juice have been successfully isolated using ultracentrifugation followed by purification with a 30% sucrose gradient in an in vitro setup. These nanovesicles, at a concentration of 20 µg/mL, were found to inhibit the proliferation of various cancer cell lines by triggering TRAIL-mediated apoptotic cell death. Moreover, in vivo studies demonstrated that *C. limon* nanovesicles can suppress the growth of chronic myeloid leukemia (CML) tumors by selectively targeting the tumor site and activating the same apoptotic pathway.³⁰

In another study, an extract made from lemon seeds using an 80:20 methanol-to-water ratio was shown to induce apoptosis in human breast adenocarcinoma (MCF-7) cells, significantly inhibiting their proliferation. Among several solvent extracts tested including ethyl acetate, acetone, and methanol the methanol-water extract showed the highest inhibitory effect (29.1%) in an MTT assay. These findings suggest that limonoid and flavonoid compounds, both in aglycone and glycoside forms, present in the extract, may hold promise as chemopreventive agents for breast cancer.³¹

Anti-Inflammatory Activity:

Several in vitro and in vivo studies have investigated hesperidin metabolites and their synthetic derivatives for their ability to reduce inflammation. These compounds have shown effectiveness in targeting key inflammatory markers such as NF-κB, iNOS, and COX-2, as well as other indicators of chronic inflammation.²⁸

Additionally, *Citrus limon* essential oil, administered orally at doses of 10 or 30 mg/kg, demonstrated significant anti-inflammatory activity in mice during the formalin-induced inflammation test. The oil reduced cell migration, cytokine production, and protein extravasation triggered by carrageenan. Similar anti-inflammatory effects were observed with pure D-limonene, suggesting that the high D-limonene content in *C. limon* essential oil is primarily responsible for these therapeutic effects.³²

Antimicrobial Activity:

Citrus limon extracts and essential oils have shown notable antimicrobial properties. Acetone extracts effectively inhibited both Gram-positive (*Enterococcus faecalis*, *Bacillus subtilis*) and Gram-negative bacteria (*Salmonella typhimurium*, *Shigella sonnei*) with a MIC of 0.01 mg/mL.³³ The essential oil also displayed antibacterial activity against *Bacillus subtilis*, *Staphylococcus capitis*, *Micrococcus luteus*, *Pseudomonas fluorescens*, and *E. coli*, with MICs ranging from 2–4 mg/mL and 100% inhibition in the case of *E. coli*.³⁴ It also inhibited *Streptococcus mutans* (MIC 4.5 mg/mL), reducing bacterial adherence and glucosyltransferase activity in a dose-dependent manner.³⁵ In terms of antifungal activity, key components like D-limonene, β -pinene, and citral inhibited *Aspergillus niger*, *Saccharomyces cerevisiae*, *Candida parapsilosis*, and completely suppressed *Candida albicans* growth.^{36–37}

Antidiabetic Effect

In a study on streptozotocin-induced diabetic rats, oral administration of ethanol extracts from *Citrus limon* peel (400 mg/kg daily for 12 days) led to reduced blood glucose levels, accelerated wound healing, and enhanced tissue growth, collagen synthesis, protein, and hydroxyproline levels.³⁸ Another study evaluated the antidiabetic potential of D-limonene in similar diabetic models. Administered orally at 50, 100, and 200 mg/kg for 45 days, D-limonene significantly lowered blood glucose, with the most effective dose being 100 mg/kg. It also modulated key metabolic enzymes reducing gluconeogenic activity (glucose 6-phosphatase, fructose 1,6-bisphosphatase) and glucokinase activity alongside a decrease in liver glycogen. These effects were comparable to those of the standard drug glibenclamide (600 μ g/kg).³⁹

Anti-Obesity Activity

In one study, a low-calorie "lemon detox diet" consisting of 2 liters of a mixture containing 140 g of lemon juice, 140 g of 'Neera' syrup, and 2 liters of water daily led to a significant reduction in serum high-sensitivity C-reactive protein (hs-CRP) compared to placebo and normal diet groups. Haemoglobin and haematocrit levels remained stable in participants on the lemon diet, while they declined in the other groups.⁴⁰

Other research has shown that D-limonene, when administered at 400 mg/kg daily for 30 days, improves lipid and glucose profiles in male rats with dyslipidemia and hyperglycemia. It lowers LDL cholesterol, reduces lipid accumulation, and helps regulate blood sugar levels. Its antioxidant properties further support these effects, and supplementation may help reverse liver and pancreatic damage, offering potential in obesity prevention.⁴¹

Cardioprotective Activity

A study involving 100 middle-aged women from an island near Hiroshima found that daily intake of *Citrus limon* juice, combined with regular walking over five months, was associated with reduced systolic blood pressure. Both lemon juice consumption and physical

activity showed significant negative correlations with blood pressure, suggesting a beneficial effect.⁴² Further in vitro and in vivo research in rabbits confirmed that lemon juice (0.4 mL/kg) influences blood pressure and coagulation factors. In vitro, it significantly increased thrombin time and activated partial thromboplastin time, while reducing fibrinogen levels though prothrombin time remained unaffected. In vivo studies showed prolonged bleeding and thrombin times, increased levels of protein C and thrombin-antithrombin complexes, and changes in hematological parameters such as erythrocyte count, hemoglobin concentration, and mean corpuscular haemoglobin.⁴³

Antiparasitic Effect

The antiparasitic effect of *Citrus limon* essential oil against *Sarcoptes scabiei* var. *cuniculi* was assessed both in vitro and in vivo. In vitro, 10% and 20% lemon oil (diluted in water) achieved 100% mite mortality within 24 hours. In vivo, weekly topical application of 20% lemon oil on infected rabbits for four weeks resulted in complete recovery, with no visible clinical signs or mites detected microscopically from the second week onward.⁴⁴

Anti-Allergic Effect

Aqueous extracts from *Citrus limon* peel were studied for their effect on histamine release from rat peritoneal exudate cells (PECs). The extracts significantly inhibited histamine release triggered by the calcium ionophore A23187, with inhibition reaching up to 80%. Interestingly, heating the extract at 100 °C for 10 minutes enhanced this effect. In animal models, the extract also reduced inflammation in mice, showing anti-inflammatory activity comparable to indomethacin.³⁸

Hepatoregenerating Effect

Studies have shown that *Citrus limon* essential oil can support liver detoxification by activating cytochrome P450 and enhancing liver enzymes such as glutathione S-transferase, particularly in cases of chronic liver toxicity.⁴¹

Effects on the Digestive System

Studies have shown that D-limonene enhances gastric motility and helps reduce nausea, neutralize stomach acid, and relieve symptoms of gastric reflux.⁴¹

Influence on the Nervous System

The effect of *Citrus limon* juice on memory was evaluated in mice using the Harvard Panlab Passive Avoidance test, which measures the delay in entering a dark compartment as an indicator of memory. Mice given lemon juice at doses of 0.2, 0.4, and 0.6 mL/kg showed significantly increased latency times after both 3 and 24 hours compared to controls, suggesting enhanced short- and long-term memory.⁴⁵ Additionally, studies have shown that D-limonene, the main component of *C. limon* essential oil, has calming and anxiolytic effects when inhaled at concentrations of 0.5% and 1.0%. These effects are attributed to the activation of serotonin and dopamine receptors. D-

limonene also demonstrated pain-relieving properties similar to indomethacin and hyoscine.⁴⁶

Influence on Skeletal System

Research has highlighted the potential of nomilin, a compound found in Citrus limon, to inhibit osteoclastogenesis in vitro. Using mouse RAW264.7 macrophages and bone marrow-derived macrophages (BMMs), cell viability was assessed with the Cell Counting Kit. Nomilin significantly reduced the number of TRAP-positive multinucleated cells, indicating decreased osteoclast formation. At non-toxic concentrations, it also suppressed bone resorption activity and downregulated osteoclast-specific genes like NFATc1 and TRAP, alongside inhibition of the MAPK signaling pathway. These findings suggest nomilin's potential for preventing bone metabolic disorders such as osteoporosis.⁴⁷

C. limon as Corrigent in Pharmacy

In addition to its medicinal benefits, Citrus limon essential oil is widely used in pharmaceutical and cosmetic formulations as a flavoring and aromatic agent, as well as a natural preservative, thanks to its proven antibacterial and antifungal properties.⁴¹

Plant Biotechnological Studies on C. limon

In vitro studies on Citrus limon have primarily focused on developing micropropagation protocols by optimizing plant growth regulators (PGRs) for shoot and root induction. In 2012, researchers at SKN Rajasthan Agricultural University, India, propagated shoot cultures from nodal explants on Murashige and Skoog (MS) medium using various PGRs. The highest shoot regeneration was observed with low concentrations of 6-benzyladenine (BA, 0.1 mg/L) or kinetin (0.5 mg/L). Combinations of BA and 1-naphthaleneacetic acid (NAA) at 0.1 mg/L each also promoted shoot proliferation, although higher BA levels reduced regeneration. Root induction occurred on MS basal medium or MS supplemented with 1.0 mg/L indole-3-butyric acid (IBA)^{48,49}. Another biotechnological study conducted at the Department of Citriculture in Murcia, Spain, examined organogenesis and histological characteristics of mature nodal explants from two key C. limon cultivars Verna 51' and 'Fino 49'. The MS medium yielded the highest number of buds per explant compared to Woody Plant Medium.⁵⁰⁻⁵¹

Aromatherapy

Lemons offer benefits for both skin and mental well-being.⁵² Consuming lemons or inhaling their aroma has been shown to elevate mood and reduce stress, anxiety, and fatigue. The scent of lemon is also believed to enhance concentration, which is why it is commonly used in air fresheners and cooling systems. Some individuals even inhale lemon-scented drops on a handkerchief to improve focus.

Discussion

This study aimed to explore the therapeutic potential of lemon (*Citrus limon*) within the framework of Unani medicine. Our findings confirm that lemon possesses

notable medicinal properties that are in line with traditional Unani concepts. These observations are supported by existing scientific literature, which has extensively documented lemon's therapeutic effects. Gaining a deeper understanding of lemon's role in Unani medicine is essential for bridging the gap between traditional wisdom and modern clinical approaches. The therapeutic effects noted in this study are largely consistent with those recognized in contemporary medicine, highlighting lemon's broad medicinal relevance. However, our research also indicates that its effectiveness may be limited in certain conditions, challenging some prevailing assumptions. These insights offer a more nuanced view of lemon's place in Unani healing and lay the groundwork for future research and clinical applications. Importantly, this study suggests that lemon could enhance the efficacy of Unani treatments. Still, practitioners should be cautious when recommending it to individuals with citrus allergies or those taking medications that may interact with citrus compounds. By systematically evaluating lemon's role in Unani practice, this research contributes to a relatively underexplored field and opens new avenues for integrative medical use.

Conclusion:

This review highlights the therapeutic value of *Citrus limon* (lemon), showing strong alignment between Unani medicine and modern scientific research. Lemon demonstrates a wide range of health benefits antioxidant, anti-inflammatory, antimicrobial, and antidiabetic that support its traditional uses in Unani healing. It also shows promise in improving mood, memory, and metabolic health. Overall, lemon presents a valuable natural remedy with the potential to enhance Unani treatments and support integrative healthcare.

Funding: This research received no external funding.

Conflict of Interest: The authors declare no conflict of interest

Acknowledgements: Author would like to thank everyone for their support and cooperation.

References:

- Goetz P. Citrus limon (L.) Burm. f. (Rutacées). Citronnier. Phytotherapie. 2014; 12:116-121. <https://doi.org/10.1007/s10298-014-0854-6>
- Mabberley D.J. Citrus (Rutaceae): A review of recent advances in etymology, systematics and medical applications. Blumea J. Plant Taxon. Plant Geogr. 2004; 49:481-498. <https://doi.org/10.3767/000651904X484432>
- Ghani N. KhazainulAdvia. Idara Kitab us Shifa New Delhi. 2011.
- Kabeeruddin A. MakhzanulMufradat. Idara Kitab us Shifa New Delhi. 2014: 371-372.
- Anjum A. Fathima K. Review Of Leemu(Citrus Limon) With Unani Perspective And Modern Pharmacology. International Journal of Scientific Research. 2020;9(7):20-23.
- Klimek-Szczykutowicz M, Szopa A, Ekiert H. Citrus limon (Lemon) Phenomenon-A Review of the Chemistry, Pharmacological Properties, Applications in the Modern Pharmaceutical, Food, and Cosmetics Industries, and Biotechnological Studies. Plants (Basel). 2020 Jan 17;9(1):119. <https://doi.org/10.3390/plants9010119> PMID:31963590 PMCID:PMC7020168

7. Mabblerley D.J. Citrus (Rutaceae): A review of recent advances in etymology, systematics and medical applications. *Blumea J. Plant Taxon. Plant Geogr.* 2004;49:481-498. <https://doi.org/10.3767/000651904X484432>
8. Pandey AK, Kumar P, Singh P, Tripathi NN, Bajpai VK. Essential Oils: Sources of Antimicrobials and Food Preservatives. *Front Microbiol.* 2017 Jan 16;7:2161. <https://doi.org/10.3389/fmicb.2016.02161> PMID:28138324 PMCID:PMC5238431
9. Chaturvedi D, Nidhi SRRS. Basketful benet of citrus lemon. *International research journal of pharmacy.* 2016; 7(6): 1-4. <https://doi.org/10.7897/2230-8407.07653>
10. Priya MM, Ramaswamy L, Rajendra R. Health and medicinal properties of lemon. *International Journal of Ayurvedic and Herbal Medicine.* 2013: 1095-1100.
11. Baitar I. *Al Jamiulmufradat, al-adviya-wa-al-agziya.* Vol 4th. New Delhi: CCRUM; Department of AYUSH, Ministry of health & family welfare, Gov. of India. 2003. 269-275
12. Tafseer MB, Latif A, Rauf A. Leemu (Citrus limonLinn.): A Review. *International Journal of Universal Pharmacy and Biosciences.* 2016; 5(4): 141-145.
13. AH B. *Kitabul Mukhtarat Fit Tibb.* Vol. II. New Delhi: Central Council of Research in Unani Medicine. 2005; 183.
14. Hakeem A. *Bastanal Mufradat.* New Delhi: Idara Kitab-ul-shifa.2002;528
15. Ali S. *Unani Adviya Mufaredah.* Edition 10th. New Delhi:CCRUM.1979;248
16. Al-Qudah TS, Zahra U, Rehman R, Majeed MI, Sadique S, Nisar S, Tahtamouni R, Tahtamouni RW. Lemon as a source of functional and medicinal ingredient: A review. *Int. J. Chem. Biochem. Sci.* 2018;14:55-61.
17. Garg P, Awasthi S, Horne D, Salgia R, Singhal SS. The innate effects of plant secondary metabolites in preclusion of gynecologic cancers: Inflammatory response and therapeutic action. *Biochimica et Biophysica Acta (BBA)-Reviews on Cancer.* 2023 Jul 1;1878(4):188929. <https://doi.org/10.1016/j.bbcan.2023.188929> PMID:37286146
18. Krishna PS, Bhaskar D, Sathyamurthy B. In vitro studies on the effect of Citrus limon Linn in neuroblastoma Sh-Sy5y cell lines. *J Med Plants Stud.* 2017;5:197-202.
19. Sawamura M, Son US, Choi HS, Kim MS, Phi NT, Fears M, Kumagai C. Compositional changes in commercial lemon essential oil for aromatherapy. *International Journal of Aromatherapy.* 2004 Jan 1;14(1):27-36. <https://doi.org/10.1016/j.ijat.2004.02.001>
20. Boukhatem MN, Ferhat MA, Kameli A, Saidi F, Kebir HT. Lemon grass (*Cymbopogon citratus*) essential oil as a potent anti-inflammatory and antifungal drugs. *Libyan Journal of Medicine.* 2014 Oct 7;9(1). <https://doi.org/10.3402/ljm.v9.25431> PMID:25242268 PMCID:PMC4170112
21. Dhanavade MJ, Jalkute CB, Ghosh JS, Sonawane KD. Study antimicrobial activity of lemon (*Citrus lemon L.*) peel extract. *British Journal of pharmacology and Toxicology.* 2011 Aug;2(3):119-22.
22. Hanif MA, Bhatti HN, Jamil MS, Anjum RS, Jamil A, Khan MM. Antibacterial and antifungal activities of essential oils extracted from medicinal plants using CO₂ supercritical fluid extraction technology. *Asian journal of chemistry.* 2010 Nov 30;22(10):7787.
23. Akinkunmi EO, Oladele A, Esho O, Odusegun I. Effects of storage time on the antimicrobial activities and composition of lemon grass oil. *Journal of Applied Research on Medicinal and Aromatic Plants.* 2016 Sep 1;3(3):105-11. <https://doi.org/10.1016/j.jarmap.2016.02.005>
24. Nadkarni AK. [*Indian materia medica*]; Dr. KM Nadkarni's *Indian materia medica: with Ayurvedic, Unani-Tibbi, Siddha, allopathic, homeopathic, naturopathic & home remedies, appendices & indexes.* 1. Popular Prakashan; 1996.
25. Mabblerley D.J. Citrus (Rutaceae): A review of recent advances in etymology, systematics and medical applications. *Blumea J. Plant Taxon. Plant Geogr.* 2004;49:481-498. <https://doi.org/10.3767/000651904X484432>
26. Robards K., Antolovich M. Analytical chemistry of fruit bioflavonoids. A review. *Analyst.* 1997; 122:11-34. <https://doi.org/10.1039/a606499j>
27. Rauf A, Uddin G, Ali J. Phytochemical analysis and radical scavenging profile of juices of Citrus sinensis, Citrus anrantifolia, and Citrus limonum. *Organic and medicinal chemistry letters.* 2014 Dec; 4:1-3. <https://doi.org/10.1186/2191-2858-4-5> PMID:25024932 PMCID:PMC4091952
28. Parhiz H., Roohbakhsh A., Soltani F., Rezaee R., Iranshahi M. Antioxidant and anti-inflammatory properties of the citrus flavonoids hesperidin and hesperetin: An updated review of their molecular mechanisms and experimental models. *Phyther. Res.* 2015;29:323-331. <https://doi.org/10.1002/ptr.5256> PMID:25394264
29. Xavier S.M., Barbosa C.O., Barros D.O., Silva R.F., Oliveira A.A., Freitas R.M. Vitamin C antioxidant effects in hippocampus of adult Wistar rats after seizures and status epilepticus induced by pilocarpine. *Neurosci. Lett.* 2007;420:76-79. <https://doi.org/10.1016/j.neulet.2007.04.056> PMID:17512118
30. Raimondo S., Naselli F., Fontana S., Monteleone F., Lo Dico A., Saieva L., Zito G., Flugy A., Manno M., Di Bella M.A., et al. Citrus limon-derived nanovesicles inhibit cancer cell proliferation and suppress CML xenograft growth by inducing TRAIL-mediated cell death. *Oncotarget.* 2015;6:19514-19527 <https://doi.org/10.18632/oncotarget.4004> PMID:26098775 PMCID:PMC4637302
31. Kim J., Jayaprakasha G.K., Uckoo R.M., Patil B.S. Evaluation of chemopreventive and cytotoxic effect of lemon seed extracts on human breast cancer (MCF-7) cells. *Food Chem. Toxicol.* 2012;50:423-430. <https://doi.org/10.1016/j.fct.2011.10.057> PMID:22056335
32. Amorim J.L., Simas D.L.R., Pinheiro M.M.G., Moreno D.S.A., Alviano C.S., Da Silva A.J.R., Fernandes P.D. Anti-inflammatory properties and chemical characterization of the essential oils of four Citrus species. *PLoS ONE.* 2016;11:1-18. <https://doi.org/10.1371/journal.pone.0153643> PMID:27088973 PMCID:PMC4835072
33. Otang W.M., Afolayan A.J. Antimicrobial and antioxidant efficacy of Citrus limon L. peel extracts used for skin diseases by Xhosa tribe of Amathole District, Eastern Cape, South Africa. *S. Afr. J. Bot.* 2016;102:46-49. <https://doi.org/10.1016/j.sajb.2015.08.005>
34. Espina L., Somolinos M., Ouazzou A.A., Condón S., García-Gonzalo D., Pagán R. Inactivation of *Escherichia coli* O157: H7 in fruit juices by combined treatments of citrus fruit essential oils and heat. *Int. J. Food Microbiol.* 2012;159:9-16 <https://doi.org/10.1016/j.ijfoodmicro.2012.07.020> PMID:22906601
35. Liu Y., Zhang X., Wang Y., Chen F., Yu Z., Wang L., Chen S., Guo M. Effect of citrus lemon oil on growth and adherence of *Streptococcus mutans*. *World J. Microbiol. Biotechnol.* 2013;29:1161-1167. <https://doi.org/10.1007/s11274-013-1275-7> PMID:23381618
36. Lamine M., Rahali F.Z., Hammami M., Mliki A. Correlative metabolite profiling approach to understand antioxidant and antimicrobial activities from citrus essential oils. *Int. J. Food Sci. Technol.* 2019;54:2615-2623. <https://doi.org/10.1111/ijfs.14173>
37. Guerrini A., Rossi D., Grandini A., Scalvenzi L., Rivera P.F.N., Andreotti E., Tacchini M., Spagnoletti A., Poppi I., Maietti S., et al. Biological and chemo-diverse characterization of Amazonian (Ecuador) Citrus petitgrains. *J. Appl. Bot. Food Qual.* 2014;87:108-116.
38. Tsujiyama I., Mubassara S., Aoshima H., Hossain S.J. Anti-histamine release and anti-inflammatory activities of aqueous extracts of citrus fruits peels. *Orient. Pharm. Exp. Med.* 2013;13:175-180. <https://doi.org/10.1007/s13596-012-0093-z>

39. Mohanapriya M., Ramaswamy L., Rajendran R. Health and medicinal properties of lemon (*Citrus limonum*) Int. J. Ayurvedic Herb. Med. 2013;1:1095-1100.
40. Kim M.J., Hwang J.H., Ko H.J., Na H.B., Kim J.H. Lemon detox diet reduced body fat, insulin resistance, and serum hs-CRP level without hematological changes in overweight Korean women. Nutr. Res. 2015;35:409-420. <https://doi.org/10.1016/j.nutres.2015.04.001> PMID:25912765
41. Millet F. Huilesessentielles et essence de citronnier (*Citrus limon* (L.) Burm. f.) Phytotherapie. 2014;12:89-97. <https://doi.org/10.1007/s10298-014-0857-3>
42. Kato Y., Domoto T., Hiramitsu M., Katagiri T., Sato K., Miyake Y., Aoi S., Ishihara K., Ikeda H., Umei N., et al. Effect on blood pressure of daily lemon ingestion and walking. J. Nutr. Metab. 2014;2014. <https://doi.org/10.1155/2014/912684>
PMid:24818015 PMCID:PMC4003767
43. Riaz A., Khan R.A., Mirza T., Mustansir T., Ahmed M. In vitro/in vivo effect of *Citrus limon* (L. Burm. f.) juice on blood parameters, coagulation and anticoagulation factors in rabbits. Pak. J. Pharm. Sci. 2014;27:907-915.
44. Aboelhadid, S.M.; Mahrous, L.N.; Hashem, S.A.; Abdel-Kafy, E.M.; Miller, R.J. In vitro and in vivo effect of *Citrus limon* essential oil against sarcoptic mange in rabbits. Parasitol. Res. 2016, 115, 3013-3020. <https://doi.org/10.1007/s00436-016-5056-8> PMID:27098160
45. Khan, R.A.; Riaz, A. Behavioral effects of *Citrus limon* in rats. Metab. Brain Dis. 2015, 30, 589-596. <https://doi.org/10.1007/s11011-014-9616-2> PMID:25227172
46. Lima, N.G.P.B.; De Sousa, D.P.; Pimenta, F.C.F.; Alves, M.F.; De Souza, F.S.; MacEdo, R.O., et al. Anxiolytic-like activity and GC-MS analysis of (R)-(+)-limonene fragrance, a natural compound found in foods and plants. Pharmacol. Biochem. Behav. 2013, 103, 450-454 <https://doi.org/10.1016/j.pbb.2012.09.005> PMID:22995322
47. Kimira, Y.; Taniuchi, Y.; Nakatani, S.; Sekiguchi, Y.; Kim, H.J.; Shimizu, J.; Ebata, M.; Wada, M.; Matsumoto, A.; Mano, H. Citrus limonoid nomilin inhibits osteoclastogenesis in vitro by suppression of NFATc1 and MAPK signaling pathways. Phytomedicine 2015, 22, 1120-1124. <https://doi.org/10.1016/j.phymed.2015.08.013> PMID:26547535
48. Goswami, K.; Sharma, R.; Singh, P.K.; Singh, G. Micropropagation of seedless lemon (*Citrus limon* L. cv. Kaghzi Kalan) and assessment of genetic fidelity of micropropagated plants using RAPD markers. Physiol. Mol. Biol. Plants 2013, 19, 137-145. <https://doi.org/10.1007/s12298-012-0148-0> PMID:24381445 PMCID:PMC3550687
49. Murashige, T.; Skoog, F. A revised medium for rapid growth and bioassays with tobacco tissue cultures. Physiol. Plant. 1962, 15, 473-497. <https://doi.org/10.1111/j.1399-3054.1962.tb08052.x>
50. Navarro-García, N.; Morte, A.; Pérez-Tornero, O. In vitro adventitious organogenesis and histological characterization from mature nodal explants of *Citrus limon*. In Vitro Cell. Dev. Biol.-Plant 2016, 52, 161-173. <https://doi.org/10.1007/s11627-015-9743-4>
51. Lloyd, G.; McCown, B. Commercially-feasible micropropagation of mountain laurel, *Kalmia latifolia*, by use of shoot-tip culture. Comb. Proc. Int. Plant Propagators Soc. 1982, 30, 421-427
52. Sawamura M, Son US, Choi HS, Kim MS, Phi NT, Fears M, Kumagai C. Compositional changes in commercial lemon essential oil for aromatherapy. International Journal of Aromatherapy. 2004 Jan 1;14(1):27-36. <https://doi.org/10.1016/j.ijat.2004.02.001>