Review Article

Lokāt (*Eriobotrya japonica*): A fruit with nutritional and medicinal properties, in the light of Unani Medicine and scientific studies

ABSTRACT

Eriobotrya japonica Lind. named as *loquat*, is a subtropical fruit, which is well known medicinal plant originated in Japan and China. Various parts, like leaves, peels and fruits have been shown to possess various useful health benefits. In Unani medicine, it is vastly utilized in many illnesses, like Fevers, Nausea, De-arranged sanguinous humour, Indigestion, Liver diseases, Vomiting, Dysentery, Wounds, inflammations etc. Loquat plant contains many active constituents, such as glycosides, flavonoids, polyphenolic compounds, tannin etc. and nutritional and mineral compounds like, carotenoids, vitamins, starch, amino acids, sugar and others. According to various pharmacological studies it is found that the plant has many biological effects like antitussive, anti-melanogenic, anti-diabetic, anti-inflammatory, anti-mutagenic, antioxidant, antimicrobial, antitussive, kidney protective, hepatoprotective and hypolipidemic activity. This review aims to shed light on the therapeutic applications of *loquat* based on both traditional Unani literature and scientific studies conducted on different parts of the plant.

Keywords: *Eriobotrya japonica* Lind.; loquat, Lokāt; Flavonoids; Unani Medicine; Hepatoprotective

1. INTRODUCTION

Eriobotrya japonica (Thunb.) Lindl. is a fruit tree of medium sized that belongs to the family Rosacea. It is usually named Loquat. It has been implanted for more than two thousand years, and is native to Japan and China but has recently implanted commercially worldwide in over 30 countries, such as Japan, Turkey, Iraq, Spain, Italy, Syria, and othe The history of loquat cultivation is more than 2000 years old, dating from the Chinese Han dynasty (100 B.C.) [3]. It up to 6 meters or more in height, with thick and evergreen oval-oblong leaves. Fruit is yellow to orange, pear-shaped, with seeds 3 to 4 cm long, and sweet taste [1,2]. Among other fruits, unusually loquat flowers in early winter or autumn, and its fruit ripens in early spring or late winter [4]. Mainly its fruits are eaten but also have been utilized in jam, chutney, and jelly preparation. [5] Loquat is planted~~implanted~~ mostly for fruit production, and in the Unani medicine "Loquat" is commonly known as "*Lokāt*" and has also been utilized for various medicinal purposes like treatment of nausea, vomiting, indigestion, dysentery, liver diseases, wounds, inflammations etc. Based on pharmacological studies, both oleanolic acid and ursolic acid have been proven to have bioactivities such as anti-inflammatory, diuretic, anti-tumor [6], hepatoprotective [7], and anti-HIV. [8] This review is compiled to gather the scattered information related phytochemicals, medicinal uses and scientific researches on Lokāt ~~Loquat~~ fruits and other parts of the tree.

2. METHODOLOGY

A comprehensive literature review was conducted by searching all available classical textbooks using key terms such as Lokāt, in the context of Unani medicine. Additionally, electronic databases including Google Scholar, Research Gate; Scopus and PubMed indexed journals were explored using keywords like *Eriobotrya japonica*, *Lokāt*, Loquat, Unani Medicine, etc. The search included both classical Unani terms and botanical nomenclature. Review articles and experimental studies were carefully considered for data collection and subsequent analysis. This meticulous approach

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aimed to gather relevant information from both traditional Unani sources and contemporary scientific literature, providing a comprehensive overview of the therapeutic applications and properties associated with *Eriobotrya japonica* in the context of Unani medicine and scientific researches.

3. Observations

3.1 Distribution

E. japonica Lindl. is widely found in subtropical regions of Japan, China, India, and the Mediterranean area [10]. In India it grows in Kashmir and Bengal. [9]

3.2 Botanical description:

E. japonica Lindl. is a large, evergreen 5–10 meters (16–33 feet) tall but is often smaller, shrub or small tree with a rounded crown, a short trunk, and woolly new twigs. Flowers appear in the autumn or early winter, and the fruits are ripe at any time from early spring to early summer. The flowers are 2 cm (3/4 in) in diameter, white, with five petals, and produced in stiff panicles of three to ten flowers. They have a sweet, aroma. The color of loquat fruit shows a marked change from green to yellow during its developmental and maturation period and become yellow to deep orange when ripen. The fruit begins to ripen from spring to summer, depending on the temperature in the area. The leaves are dark green, simple, alternate, 10–25 cm long, tough, and leathery in texture, with a serrated margin. [11]

3.3 Taxonomic classification

Kingdom:	Plantae
Division:	Tracheophyta
Class:	Magnoliopsida
Order:	Rosales
Family:	Rosaceae
Genus:	Eriobotrya
Species:	*Eriobotrya japonica* (Thunb.)
Synonyms:	*Mespilus japonica*, *Photinia japonica*, *Foliumeriobotrriya*.[3]

Fig 1. Lokāt tree ***a, b,*** tree with flowers & dried leaves ***c, d***, fruits ***e, f*** and seeds***g***.

3.4 Description in Unani Literature:

Lokāt is a tree introduced in India by English people. It reached to a height of *Qalmī Ām* (mango tree). Leaves are big with dentate margins; fruits and flowers appear in clusters. The fruits are green when unripe and yellow when ripened. The size of the fruit is a pigeon's egg. Unripe fruits are citrus in taste, and ripe fruits are sweat in the teste. Fruits have 4-5 seeds which look like the seeds of *Sharīfa* (*Annona squamosa* L.) or *Khīrnī* (*Mimosops elengi* L.) seeds, but are larger in comparison. [9] Mainly its fruits and juice (*Āb-i-Lokat*) are recommended by the Unani physicians.

***3.5 Mutarādifāt* (vernacular names):**

Urdu:	Lakhota
Hindi:	Lukat, Logat, Latku
English:	Loquat
Kashmiri:	Lokāt
Bengali:	Lakhot
Sanskrit:	Luttak
Kannad:	Lakkote
Marathi:	Lokat
Gujrati:	Logat
Tamil:	Alakota
Malayalam:	Nespali
English:	Loquat

***3.6 Mizāj* (temperament):**

Cold and dry and some says cold and moist. [12]

***3.7 Af'ālwaKhawās* (actions and uses):**

Qāti'-i-Ṣafrā' (anti-bilious), *Musakkin Ḥiddat-i-Khūn* (blood heat moderator), *Dāfi' Qay'* (antiemetic), *Mufarriḥ* (exhilarant), *Dafi' Ḥumma* [12,13], *Musakkin-i-Atash* (thirst quencher) [14].

Where is 3.8

***3.9 ~~Tarkīb-i-Iste'māl~~ (~~method of administration~~) Traditional uses and dosage forms of* Lokāt**

Various parts of the plant are used to treat respiratory and digestive disorders and also to cure inflammations, wound and *Diabetes mellitus* etc. The uses are mentioned bellow:

***3.9.1 Amrāḍ-i-Ri'a* (*Respiratory diseases*)**

- For the treatment of cough, leaves, flowers and fruits of Lokāt are used in the form of decoction in a quantity of 10-20 ml. [9]

***3.9.2 Amrad-i-Nizām-i-Haḍm* (*Digestive disorders*)**

- Its fruit is taken to cure indigestion, vomiting, and dysentery.[9] The juice of Lokāt increases appetite and treats indigestion [9].
- The decoction of its leaves is useful for the treatment of liver diseases [9]

3.9.3 Inflammation and wounds

- Powder of its dried leaves, are applied locally to heal wounds. [9]

***3.9.4 Dhayābītus* (*Diabetes mellitus*)**

- *Safūf-i-Sandal Dhayābītus wala* is taken with *Ab-i-Lokāt* for the treatment of *Diabetes.* [15]

***3.10 Maḍarrat* (toxicity, side effect or adverse effect, contraindication):**

The fruit is contraindicated for the person having cold and phlegmatic temperament. [13]

3.11 Musleh (Corrective):

To counter its side effects due to over use, *Mirch Siyāh* (black piper) and *Namak* (salt) can be used as correctives. [13]

3.12 Badal (Substitute or Alternative):

Paniyāla (*Flacourtia jangomas* (Lour.) Raeusch.), having similar properties, so recommended as a substitute of Lokāt. [13]

3.13 Miqdār Khūrāk (Dosage):

2-4 pieces are taken therapeutically. [13]

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3.14 Compoundformulations: In Unani medicineAb-i-Lokāt is used for above mentioned medical conditions.

3.15 Phytoconstituents:

In loquat, a broad range of phytochemical compounds like phenols, alkaloids, cardiac glycosides, flavonoids, mucilage, gums, and phytosterols have been reported, [16] that are responsible for various biological activities. [17] By using high performance liquid chromatography, flavones like quercetin derivatives, hydroxycinnamic acid derivatives like chlorogenic acid along with other pcoumaric acid and caffeic acid derivatives, have been identified in the leaves, fruit, and flower of loquat. [18] The presence of bioactive and nutritional compounds in various parts of the plant is mentioned in **Table 1**.

Table 1. Showing bioactive and nutritional compounds in different parts of the Lokāt tree.

S.N	Parts of the plant	Bioactive compounds	Nutritional compounds
1	Fruit	In fruits presence of flavonoids, phenols, [19], caffeic acid, 4-o-caffeoylquinic acid, neochlorogenic acid, and chlorogenic acid, together with 4-hydroxybenzoic acid, protocatechuic acid, coumaric acid, ellagic acid and ferulic acid have been reported [20].	The fruit contains sugars: levulose and sucrose; citric acid, tartaric acid, succinic acid, cryptoxanthin, β-carotene, neo-β carotene. The seeds contain amygdalin and fatty oil, [30], starch [19], Carbohydrates,protein, amino acids [16],Vitamins, carotenoid [19]. The kernel of loquat is rich with starch, minerals and proteins [21,22].
2	Kernel	The kernel of loquat is rich with tannins, [21,22], amygdalin, a cyanogenetic glycoside [23].	
3	Flowers	Flavonoids and phenolic compounds [24], oleanolic and ursolic acids are reported in loquat flowers. [20] 15 aromatic compounds are present in the flowers, and the most potent aromatic compound in fresh loquat is phenylacetaldehyde. Additionally, other aroma such as, hexanal, (E)-2-hexenal, hexanoic acid, and β-ionone are also important also have been reported. [25] presence of amygdalin is also reported. [26] Flowers possess a higher content of quercetin and chlorogenic acid derivatives than new and old leaves. [18]	

4	Leaves	In the leaves of loquat, phenolic acids like p-coumaric, gallic, caffeic, ellagic acid, tormentic acid, and flavonoids like quercetin, epicatechin, and catechin have been identified [27,28] in addition to tannins, sesquiterpenes, triterpenes and megastigmane glycosides [24,29]. The isomeric pentacyclicoleanolic acid and ursolic acid are predominant triterpenoids found in *E. japonica* leaves [30]. Amygdalin, a cyanogenetic glycoside, also present in in considerable amounts [23]. The new leaves possess phenolic and caffeic acid derivatives [18]	
5	Stem	In stem four flavonoids, kaempferol 3-O-β-glucoside, quercetin, quercetin 3-O-α-rhamnoside, naringenin, and three triterpene acids, ursolic, corosolic, and oleanolic acids, were reported. [24]	
6	Stem bark	Stem bark contains catechin, β-sitosterol, β-sitosterol-3-O-β-D-glucopyranoside, oleanolic acid, cinchonainIIb, lyoniresinol, and lyoniresinol 2-a-O-β-Dxylopyranoside [1].	

3.16 Pharmacological activities ~~Studies~~ of *Eriobotrya japonica*

Pharmacological activities of Lokāt in Unani medicine

Other pharmacological activities of Loquat

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3.16.1 Cytotoxic activity

According to a study of loquat juice on cancer cell lines revealed that it contains polyphenolic compounds that stimulate glutathione-S-transferase enzymes (GSTs). These GSTs act as antioxidants, promoting cellular detoxification and apoptosis in cancer cells [32]. Alwash (2017) reported that, loquat fruit juice exhibited a pronounced anticancer effect on rhabdomyosarcoma (RD) and human cervical cancer (HeLa) cells [2].

3.16.2 Anti-Diabetic activity

Shafi et al. reported (2019) that in streptozotocin induced diabetic rat, the ethanol loquat fruit extract showed good anti-diabetic effect. [33]. Also, study done on maltose-loaded Sprague–Dawley rats, combination of green tea leaves and loquat leaves exhibited a reduction of blood levels of glucose and a corresponding decrease in serum secretion of insulin [34].

3.16.3 Effect on kidney function

Diabetes mellitus is a metabolic disease differentiated by hyperglycemia and several complications, such as neuropathy, retinopathy, angiopathy, nephropathy etc. [35] Shafi et al. (2018) reported that, ethanolic extract (50%) of seeds and fruits of *Eriobotrya japonica* displayed renal effects in alloxan induced diabetic rats, which was evaluated by estimating serum total proteins, serum creatinine and urea levels. The results showed a nonsignificant elevation in level of total proteins and reduction in levels of serum urea, creatinine and also had effects on levels of serum glucose [36].

3.16.4 Anti-hyperlipidemic activity

Shafi et al. (2019) also reported that in streptozotocininduced diabetic rat, the ethanolic extract of fruit *Eriobotrya japonica* showed significant hypolipidemic activity [36]. In high-fat diet mice, ethanolic extracts of loquat exhibited hypolipidemic activity as it decreased white adipose tissue (WAT) weights (include visceral fat, mesenteric, peri-renal, and epididymal WAT), body weight gain, hepatic tri-acylglycerol, and adipocyte size in the visceral depots [37,38]. Fermented tea product (leaves mixture of both green tea and loquat) inhibited the synthesis of hepatic fatty acids and postprandial hypertriacylglycerolemia by inhibition of pancreatic lipase, exhibiting anti-obesity action.[39] The aqueous extract of loquat leaves exhibited an anti-atherosclerotic effect in a hypercholesterolemic zebra fish model and in cellular assays [40].

3.16.5 Anti-inflammatory activity

Maher et al. study (2015) reported the ethyl acetate-ethanol (1/2) extract and the dichloromethane methanol (0:1) fraction of loquat suppressed the phospholipase A2 group IB (pG-IB) secreted in pig and the human secreted phospholipase A2 group IIA (hG-IIA) [41]. The N-butanol fraction of leaves of loquat demonstrated anti-inflammatory property by inhibiting the expression of nitric oxide synthase and production of NO, also down-regulated cyclooxygenase-2 expression, pro-inflammatory cytokine secretion such as interleukin-6 and tumor necrosis factor-α (TNF-α) in the LPS-activated murine peritoneal macrophage model [42]. Seong et al (2019) reported that in lipopolysaccharide-induced RAW 264.7 macrophage cells, the ethanolic extract of loquat leaves showedan anti-inflammatory effect by suppressing TNF-α production and NO expression [43]. Zar et al. (2013) reported that in lipopolysaccharide-induced RAW 264.7 cells, aqueous extract of loquat leaves extracted by boiling for 15 minutes at 100°C, exerted an anti-inflammatory effect via inhibiting PGE2 and COX-2 production. The new bioactive phenolic compounds in loquat tea may be responsible for its anti-inflammatory potency [44]. Loquat tea water extract prepared by boiling it for 15 minutes at 100°C showed inhibitory effects on the expression of TNF-α, interleukin-6, nitric synthase, and NO through the downregulation of pathways of the TGF-β-activated kinase-mediated NF-κB and MAPK [45]. This was observed in macrophage-like RAW 264.7 cells used in the mouse paw edema model [45,46].

3.16.6 Antitussive and expectorant activity

Wu et al. (2018) reported that the ethanolic and aqueous extracts of loquat leaves showed expectorant and antitussive effects.Aqueous extracts of growing leaves had a higher expectorant effect, which may be related to their higher flavonoid content, such as quercetin, isoquercitrin, hyperoside, rutin, and others. Meanwhile, ethanolic extracts of fallen leaves demonstrated better antitussive effects, which may be related to their higher triterpenoids content, such as tormentic acid, corosolic acid, maslinic acid, ursolic acid, and others.
[46]

3.16.7 Anti-melanogenic activity

Seong et al. (2019) stated that ethanolic leaf extract of loquat showedanti-melanogenic activity because of its anti-inflammatory and anti-oxidant activities.Theethanolic extract has a higher concentration of quercetin and other polyphenols that limit the creation of melanin, it shows protection of human skin from oxidative stress and inflammation. Since melanin is crucial in preventing the generation of UV-stimulated ROS, ethanolic extract can control melanin formation. It also exhibits strong anti-inflammatory and antioxidant properties. [43,47].In B16 melanoma cells, the methanolic leaf extract of *Eriobotrya japonica* exerted dose-dependantmelanogenesis suppression[43,47,48].Further more, 70% and 30% loquat leaf ethanolic extracts inhibited mushroom tyrosinase for having whitening effects [49].

3.16.8 Hepatoprotective activity

The study conducted by Shahat et al. (2018) shown that the methanolic extract (80%) of loquat leaves, as well as its butanol, aqueous, and ethyl acetate fractions, had hepatoprotective effects in rats with hepatotoxicity induced by CCl4.

It significantly reduced biochemical parameter levels in rats like aspartate transaminase (AST), gamma-glutamyl transferase, alanine aminotransferase (ALT), bilirubin, and alkaline phosphate levels but did not influence lipid profiles. Administration of butanol and ethyl acetate fractions significantly suppressed CCl4-stimulated depletion of total protein and the reduced levels of nonprotein sulfhydryl groups (NP-SH). [50].

3.16.10 Antimicrobial activity

Rashed et al. (2014) reported that the methanolic extract (80%) of stems of loquat extracted by macerationprocess,demonstrated an antimicrobial effect against bacterial and fungal strains linked to the presence of triterpenes and flavonoids. It was found to be more effective against Candida albicans, indicating that it can be used to treat fungal infections and has no effect on other strains of bacteria or fungus. [24].
The presence of flavonoids [51], tannins [52], and kaempferol 3-O-β-glucoside [53] in the methanolic extract of loquat stems are responsible for its strong antibacterial and antioxidant properties.

3.16.11 Antiosteoporosis activity

Methanolic leaf extract of loquat showed antiosteoporotic effects in the model of ovariectomized mice [54]. Ursolic acid was isolated from loquat leaves and displayed an inhibitory effect on osteoclast differentiation
Ursolic acid was found to suppress the development of osteoclasts by targeting exportin 5 (XPO5), a nuclear exporter protein, to decrease osteoclast development.
[55].

3.16.12 Antifibrosis activity

In a rat model of bleomycin-induced pulmonary fibrosis, triterpenic acids from an ethanolic extract of loquat leaves (prepared by cold technique, 2 hours) showed antifibrotic efficacy by reducing lung fibrosis and enhancing lung architecture. Rats with pulmonary fibrosis had lower levels of TGF-β1 and TNF-α production in their macrophages, both in terms of mRNA and protein.[56].

3.16.13 Antioxidant activity

Alwash (2017) reported that the fruit juice of E. japonica shown antioxidant properties [2]. By contributing their H atoms, the plant's juice can scavenge DPPH free radicals [57]. The phenolic compounds found in E. japonica fruit juice, particularly flavonoids, have the capacity to cause this reaction [17]. Their efficacy as antioxidants depends on the location and quantity of OH groups on the basic flavonoid structure; an increase in the number of hydroxyl groups is directly associated with an increase in antioxidant activity [1].

4. CONCLUSION

Lokāt (*Eriobotrya japonica*) emerges as a remarkable fruit with a rich profile of nutritional and medicinal properties, validated by both the ancient wisdom of Unani Medicine and contemporary scientific research. Traditionally, Unani practitioners have long valued Lokāt for its diverse therapeutic applications, including its potential to improve digestive health, support respiratory function, and regulate blood sugar levels. These traditional uses are increasingly supported by modern studies that highlight the fruit's abundance of essential nutrients, antioxidants, and bioactive compounds. Recent scientific investigations have shed light on loquat's capacity to combat oxidative stress, reduce inflammation, and provide protective effects against chronic diseases such as diabetes, cardiovascular ailments, and certain types of cancer. The convergence of Unani Medicine insights with cutting-edge research underscores Lokāt's ~~loquat's~~ potential as a functional food with significant health benefits. As the global interest in natural and holistic health solutions grows, Lokāt stands out as a valuable addition to the repertoire of nutraceuticals. Its integration into modern dietary practices could offer a natural means to enhance health and well-being. Future research should continue to explore and substantiate the therapeutic claims, ensuring a comprehensive understanding of this multifaceted fruit. In conclusion, Lokāt exemplifies the harmonious blend of traditional knowledge and modern science, reaffirming its place as a fruit with profound nutritional and medicinal promise. By embracing both historical perspectives and contemporary findings, we can fully appreciate and harness the potential of Lokāt for improving human health.

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COMPETING INTERESTS

Nil

AUTHORS' CONTRIBUTIONS

'Author A' designed the study, wrote the first draft of the manuscript. 'Author B' and C manage the literature search. All authors read and approved the final manuscript."

ETHICAL APPROVAL

Not applicable

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