

## Lemon as a source of functional and medicinal ingredient: A review

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### Abstract

We still understand the collaboration between herbs, medicines and food today. Because of their small side effects, suitability, and effect, herbal medicines are consumed for many years. The citrus is a fluid plant of the Rutaceae family. Approximately 140 genera and 1300 species are present in the genus citrus. The lemon's term comes from ancient French called "limon". Many other lemon fruit names are available. Flavonoids, acids, caffeine, pectin and minerals are the primary elements of the chemical composition. Essential citrus oil includes many ingredients and limonene is the major ingredient in its odor. Lemon possesses numerous characteristics, such as antimicrobial, antifungal, anti-inflammatory, anti-cancer, depurative and antiscorbutic etc. Especially in pregnancy, nursing and radiation exposure, lemon essential oil is poisonous. Researchers have discovered the healing capacity of this plant because it is still not acknowledged by more remedial belongings.

**Key words:** Flavonoids, Rutaceae, Essential oil, Toxicity, Anticancerigenous

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### 1. Introduction

A tiny evergreen tree from Asia, is known as *Citrus limon* (lemon). The lemon has a number of different species and has yellow ellipsoidal fruit. It is the most important species after oranges and mandarins of citrus fruit. The "term" lemon comes from ancient French called "limon." The term "limone," Arabic "lamun" or "Imun" and Persian "Imun" have distinct names in Italy too. Generic word 'lime' to citrus fruit is connected to Sanskrit nimbu. Lemon is a flowering plant of the Rutaceae family. Approximately 140 genes and 1300 species are present in the genus citrus [1]. It originated first from Southeast Asia and then spread into north-eastern India, Burma and China. Citrus fruit have been grown worldwide since ancient times. The following are the best types of lemon, such as Lisbon, Eureka and Meyer. The range of the citrus tree from Lisbon tolerates heat, cold, and windy situations, as well as produces several plants each year, by proper care. The lemon tree "Lisbon" is 30 feet long, with a 25 feet broad canopy. The 'Eureka' is growing all year round. It is also referred to as 'Four Seasons' (*Quatre saisons*), as it is capable of producing fruit and flowers all year round. The product is also accessible to national clients as a factory. There is also the pink Eureka

fruit that has an exterior peel that is variegated by green and yellow stripes. This fruit's zest is high in lemon oils. It is the traditional species used in *limoncello* production. The 'Meyer' was named after Frank N. Meyer, who initially brought it to the United States in 1908, when it is a cross between lemons, perhaps an orange or a mandarin. Meyer lemons involve greater care and are not commercially cultivated, as are slightly less slim-skinned and acidic than Lisbon and Eureka lemons. Lemons of Meyer are often mature in yellow orange. They are rather more tolerant to frost than other citrus fruits. The tree is tiny with shiny, leathery, alternate, generally evergreen leaves with oil glands. The stems are usually winged and connected with the leaves most of the moment. The smell of flowers is powerful and sweet. The fruit has the form of spherical or egg. It has 8/14 juicy areas with wide white or greenish seeds. Lemon is traditionally used as an additive to soothe the sore throats of our foods [2]. The lemon's alkaloid features are also popular. Cross extracts from several citrus parts have shown anti-cancer and antibacterial features against bacterial strains of clinically significant importance. It is mainly used to decrease blood pressure, mental health, respiratory problems, arthritis and rheumatism. By using

them, the kidney stones are prevented. Citrus fruits and vegetables are also used to soothe the flaccid pulp, headache and asthma symptoms. Cultivation of limon is one of Oman's most famous crops.

Large acid and juice content is present in the Omani lemon variety. The most popular varieties are offered in the Batinah region, for the Sohar and Saham mandate, etc. [3]. The acidic substance called citric acid and carboxylic acid contained in the chemical composition of lemon peel other also water [4]. Citrusia is split into distinct groups. Citruses are cultivated in diverse amounts and sweet oranges, mandarins, grapes, lemon and lime. Citrus is cultivated commercially. In nations with tropical or subtropical climate, citrus cultivars are cultivated in diverse amounts. Citrus is first among the tree fruits worldwide in region and manufacturing. The most significant fruit crop also growing in Pakistan is citrus fruit (lemon), with an annual output of 1.5 MMT, in an region of 160,000 hectares. Citrus fruit was cultivated in all four of Pakistan's regions. The Punjab production is above 95% due to its larger population, favourable increasing conditions and sufficient water. The Pakistani, six-year-old citrus fruit tree generated 966 fruits and produced 3173 fruits at the age of 9.

## 2. History/origin of lemon

The origins of the Lemon are not known although it is believed that the first lemons were cultivated in Assam (in north-eastern India), northern Burma or China. A lemon genetic origin research has shown that it is hybrid from bitter orange to lemon (sour orange) [5]. In the earliest century AD Lemons reached European countries close to southern Italy, in the period of Ancient Rome. Later, around AD 700 were launched in Persia and then in Iraq and Egypt. The citrus was first reported in literature in early Islamic gardens in an Arabic farming treaty of the 10th century. It was commonly spread between 1000 and 1150 in the Arab world and the Mediterranean area. In Genoa in the center of the 15th century, the first significant cultivation of lemons started in Europe. In 1493, when Christopher Columbus brought Hispaniola lemon seeds on his trips, it was later introduced to the Americas. Spain's conquest helped spread lemon seeds throughout the New World. It has been used primarily as an ornamental and medicinal herb. In Florida and California, lemons were planted more and more in the 19th century. In 1747, James Lind's studies with scurvy were about the addition of citrus juices to their diets, although the use of vitamin C was still unknown [5].

## 3. Botany, Morphology, Ecology

Citrus trees with comparatively few big branches have open development. In a distinctive, outstanding manner, the bigger lateral branches develop in a flattened limb. On the smaller hand of the branches, the exchange activity is increased, so that the rings of development are obviously eccentric [6]. The fresh shots are primarily produced in the near-end leaf axles of pre-spring or summer

vegetative development. In cool weather only 2 flushes appear each year, but in hotter, subtropical areas there are three to five flushes. Under most circumstances the development of tropical shoots takes place continuously, throughout the year. Citrus still maintain its tropical nature in cooler climates and fresh shoots appear all year round. The most significant is the spring flush, which contains vegetative and reproductive shoots. The mid-summer and subsequent flushes are usually vegetative, with fewer, however longer shootings and bigger leaves [7]. The leaves are wide and green light. However, the petioles are decreased and wings free in lemon in most Citrus species. Lemon leaf blades are oval to oblong in shape. The morphology of the leaf depends on the vigor of the tree. Laminae are big and ovate and develop with pronounced ties along the apical leaf margins. As shoots mature, the laminae again become ovate and lanceolate with clamped marges. Newly formed leaves are purple but green when the laminae are mature.

Most of these Citrus species are tap-rooted, including the lemon. The root first appears during germination and grows quickly to form a well-defined taproot. On the taproots of young seedlings and on pioneer roots of old plants fibrous roots happen in tiny bunches 20-30 cm long. Branches from the primary root of the fibrous bunch are lower than the primary root and are further lowered by sub-branches from the primary branches.

A network of powerful, lateral roots, not far from the earth's surface, offers the supporting structure for a thick fibrous root mat. A more or less vertical layer of narrower sides and fibrous roots arises from the crown. The fresh development in early spring gives rise to citrus flowers. Lemon trees have two greatest periods of flowering in Mediterranean climates but tend to continue to bloom year-round in cool and coastal environments, with trees producing multiple plants each year. The flowers with mature citrus are 1.5-3 cm long, with a pedicel. The cup with five sepals is similar to the calyx. The petals, dense and brilliant to maintain reflection on, are interlocking marginal papillae. The stamens show 20-40 filaments partly united, each with a yellow, four-lumped anther. The pistil is surrounded by others at or near the point of stigma. The florside disc secretes the stomach from watery nectar. The ovary is subglobous, different from a tight style, like in orange or subcylindric, fusion in the fashion like in citrus. The pistil is made up of 8-14 carpet ovary. Lemon flowers are full and flawless and have the same overall properties as other commercial citrus species. Purple white flowers are petals. The flowers are narrower than those of grapefruit, but they are comparable to the flowers of mandarin. Typically they are carried in clusters. A unique berry form called hesperidium is the citrus fruit. It is an authentic fruit and consists of a variable amount (usually eight and nine in lemon) of radially arranged carpets. Citrus is comprised of

the two primary areas: pericarp and endocarp, which are morphologically different. Pericarp, which is the edible fruit part, is called the rind or peel and the endocarp is referred to as a pulp. The outside colored portions of the flavedo are epicarp, generally called flavedo, whereas the inside white layer is mesocarp, generally known as albedo; is also distinguished within a peel. The flavedo consists of a cuticular-covered epidermis and some neighboring compact parenchyma cell layers. The flavedo is filled with essential oils. Essential oils are generally characterized by GC-MS analysis [8-10]. The ovarian pulp comprises of sections enclosed in a locomotive membrane filled with juice bags. The citrus fruit is typically oval to elliptical with distinctive necks and nipples. The flavedo is a dark green, but the skin is yellow at maturity during its early phases of fruit growth. It has prominent oil glands and differs in thickness and surface texture. The pulp is pale and acidic in stroke. The lemon is more or less susceptible to cold than orange because it is more or less constant in development and can recover less from cold lesions. Tree defoliation is 22° to 24° F (-5.56 degrees-4.44° C). A fall in temperature down to 20° F (-6.67° C) will harm wood significantly, unless the weather has slowed down for a couple of days. Flowers and young fruits have 29° F (-167° C) murdered and almost mature fruits under 28° F (-2.22° C) are severely harmed. The lemon reaches its highest value, however, in coastal regions where winters are too cool to mix oranges and grapefruit properly. The variety of climate of the lemon is therefore comparatively restricted. The fruit is scarred and the tree easily defoliated by wind, and the benefits are protected against windbreaks. Lemon is cultivated in both dry and wet environments, the latter being a major disadvantage in curing and storing procedures. The citrus tree has an infertile, very bad soil reputation. Soils with elevated water permeability and elevated drainage are recommended for sand, clay and sandy-clay depth. Black soils are also appropriate if the calcareous soil is not lying on them. Between 5.5 and 6.5 should be Ph. In case of high acidity, lime must be used to reach the optimum level. In square systems with spacing of 5 to 8 m depending on species and rootstocks, lemon is usually plant in 50 x 50 x 50 cm or 75 x 75 cm pits. A wider range of 5x 5 m is suitable for rough lemon or karana khatta.

#### 4. Chemical compositions

There were distinct elements to the essential oil of the leaves and peel of the citrus limon. In both essential oils, limonene is the primary element. Leaf oil was recognized with  $\beta$ -pinene, myrcene, neral, geranial, neryl acetate, geranyl and  $\beta$ -caryophyllene. Peel oil had  $\mu$ -terpinene,  $\beta$ -pinene, myrcene [11]. In lemon, there are certain flavonoids, like hesperidoside, limocitrine, in Spanish lemon pericarp. Citric acid, ascorbic acid, and caffeic acid in the lemon flower are the acids found in citrus. Caffeine is present in flowers and lemon tree leaves. Lemons are supposed to be of some

health advantages and contain quantities of distinct chemicals. Lemons are extremely important for human health and are high in vitamin C (ascorbic acid). A citrus juice of 100 milliliters includes about 50 milligram vitamin C and about five gram of citric acid. (55% of the daily value advised) However, after squeezing the lemon, vitamin C will be lost fast; after just eight hours, a 20 percent loss will take place at room temperature or 24 hours in a fridge. It also includes Na, K, Ca, Cu, Fe, Mg, Zn and P. Mineral products. Levels of 755.5, 8600, 8452.5, 4.94, 147.65, 1429.5, 13.94 and 6656 mg/100 g are observed at Na, K, Ca, Cu, Fe, Mg, Zn and P. Iron, copper, zinc and manganese are vital for the nutritional sector and are commonly used in health, environmental science and health [12]. K was at its highest (8600 $\pm$ 0.028 mg/100 g) concentration. Since Sidney Ringer pointed out its significance in 1883, K has always been acknowledged as an essential nutrient in animal food. For life, K is vital. Young pets will not develop and die in just a few days, when K's diet is highly poor. Ca is concentrated 8452.5 $\pm$ 0.050 mg/100 g in lemon peel samples. The bone formation is Ca accountable. Ca controls several cell procedures and plays significant structural functions in living organisms [13]. For all livestock, phosphorus is also a vital nutrient. There have been reports that Mg participates in keeping the nerve electrical potential and activating some enzyme systems.

#### 4.1. Phytochemistry

Various phytochemicals, like polyphenols and terpenes are present in lemons. As with other citrus fruits, they are highly concentrated in citric acid (around 47g / L juice) [14]. Lemons contain various phytochemical substances, including polyphenols and terpenes. Essential oil of complicated structure: limonene, flavonoids, vitamin C, carotenoids, mucilages, calcium oxalates, citric, citrain, terpeneol, camphenium, fellander. Pectin, sugar, citric acid, malic acid and flavonoids are abundant.

The rind, which makes up around 45 percent of the lemon, is obtained from *citrus limon* (lemon) essential oil. Over 200 volatile and non-volatile compounds are found in the lemon peel. Lemon oil includes some 70% limonene and some 20% monoterpenes. Limonene is an important element of lemon oil. This oil also includes about 6% coumarin-concentration aldehydes, alcohols and esters, including citral and linalool, with less than 1 % concentration of coumarins.

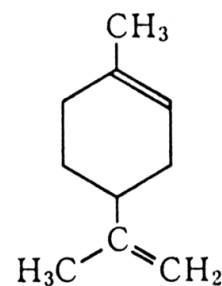


Figure.1. Chemical structure of Limonene

## 5. Postharvest technology

Lemons are harvested according to the weather. Choosing a lemon (*Citrus limo*) will offer you a fruit filled with juice at the correct moment. The lemon may be dry and pithy when you grab it at the incorrect moment. The three primary kinds of lemons, "Eureka," "Lisbon" and "Meyer," each have their proper season for harvest. Lemons are prepared to be selected when they appear yellow or yellow green and firm. The size of the fruit is 2 to 3 inches. Waiting for the correct size and not worrying so much about colour, is better than expecting them to be totally yellow. Citrus fruit ready for picking is also mildly bright. Citrus is better at choosing too soon than too late. If lemons are yellow-greenish, they will ripen off the tree more than probably. You've been waiting too long if they're squishy. It's not difficult to choose lemons from a tree as long as you don't harm the tree. Take the full fruit into your hand and slightly twist it until it gets out of the tree. Clean and sharp hand nippers can also be used if it's simpler. Place all the lemons in the cooler, where no bumping or squishing is required, for optimal storage. Devote a drawer or a lounge to lemons ideally.

## 6. General Uses of lemon

The essential oils of Lemon have much to do with the health and delightful and distinctive aroma of the person. It's a very versatile solution for the whole body. The essential oils, taken internally, diluted, or topically used for various conditions, can be used in the following manner, inhaled as aromas.

### 6.1. Locomotor activity

Studies by the State University of Ohio have shown that lemon oil-exposed topics have constantly been influenced by enhanced and positive mood results. Indeed, the concentrations of the sensational chemical norepinephrine transmitter were boosted when lemon was inhaled, demonstrating a real mental and physical effect within the brain.

### 6.2. Antiscorbutic and vitaminic

Very rich in vitamin C, so it has potassium and calcium antiscorbutic characteristics. It is very much desirable to reinforce body defenses and prevent numerous illnesses because of its capacity for regeneration of white corpuscles.

### 6.3. Antimigraine

In addition to being a stimulant, caffeine relieves headache, which is particularly important for migraine by constricting the pericranial blood vessel.

### 6.4. Depurative property

It provides purifying characteristics of ascorbic acid and limonene to provide an outstanding remedy against rheumatism, arthrosis, gout, cholesterol, arteriosclerosis, and uric acid.

### 6.5. Diuretic effect

As caffeine and ascorbic acid stimulation force, it can be used as a diuretic in obesity treatment by enhancing

the miction that removes unwanted water. Lemon has elevated citric acid content. This has shown that this acid can dissolve or stop the development of small kidney stones. It protects us from eating this sort of fruit forming fresh kidney stones. It is also a preventive remedy to prevent inflammation of the gallbladder.

### 6.6. Anticancerigenous

The primary parts of lemon essential oil have cancer or antitumor characteristics, prevent cancer and help the body not become metastasized when the disease has emerged [3-15-16].

### 6.7. Improve energy and alertness

Lemons can also improve brain function, boost alarm, mental care and clarity. The revitalizing effects of lemon oil are caused by the high and energizing fragrance. Lemon oil can also be taken internally to boost energy.

### 6.8. Astringent effects

Lemon oil enables to dissolve oils and decrease skin and hair oil output, making acne therapy a useful option. The lightening impacts of lemon oil are also possible on skin or in hair.

### 6.9. Lemons Help with Acne

Lemons have been shown to work well for acne patients with citric acid and C vitamin. Lemons also destroy many types of acne-causing types of bacteria as an alkaline fruit. Drinking citrus juice with water every morning is the simplest way for people with worse case acne to tap into these healing characteristics. It has been proven efficient that one portion of lemon juice is mixed with a portion of rose or melon water and placed on skin regions with acne. The solution should be left for half an hour on the skin and washed with water. This is a twice weekly operation. Fresh citrus juice should be applied directly with a cotton ball or swab and left overnight in the impacted zones. In the morning, the solution should be washed. Because this is the least diluted solution, it tends at first to combustion, but is regarded the most efficient way to treat acne with citrus fruits.

### 6.10. Aromatherapy

Lemons are not only good for the skin, but apparently also good for the psyche. Lemon consumption or even inhalation of the aroma (aromatherapy) has shown that mood and tension, nervousness, anxiety, exhaustion, swelling and fatigue have been improved and even reduced [17]. Lemons are also expected to increase concentration, so many air spray and cooling machines are scented with lemon. Some individuals even squeeze some lemon drops and inhale to assist concentrate on a handkerchief.

### 6.11. Treat Canker Sores

Lemons have antiviral and antibacterial characteristics that have proven scientifically. Cure cancer sores were demonstrated three times a day by a glass of tidal lemon juice mixed with water swollen around the mouth. As carcinogens are open wounds, some burning can occur at the

beginning, but this is anticipated until sterilizing of the wounds.

#### **6.12. Lemons Cure Fevers**

Lemons also helped with fever, a spring from the calming effects of the fruit, for a long time. Mixed hot water, lemon juice and honey is a wonderful fever option. Consume until the fever falls every two hours.

#### **6.13. Colds and the Flu**

Colds and influenza have double positive effects. Vitamin C helps the inner infection, while the lemon's antiviral characteristics can assist the mucous membranes of your neck and mouth.

#### **6.14. Help Relieve Eczema**

It's best to start treating a cold or flu and flooding your system with as much Vitamin C as you can from citrus fruits. Freshly squeeze the lemon juice and blend it with the tidy water. Each two hours, consume. Lemon juice can be taken as a gargle and juice to assist with cold and grip issues. Combine with a small amount of ocean salt for a sore throat. Eczema patients discovered lemon wrap relief. Dilute in lukewarm water a tiny quantity of vital lemon oil and honey. In this solution, soak a linen towel, squeeze the additional solution and position the towel in a corporal region impacted by eczema, 3 times daily, for 15 minutes at a moment.

#### **6.15. Lemons Fight Fatigue**

Long-distance runners and walkers are known to just stick a straw in the top of a citrus. Lemon juice looks more efficient than water alone to quench thirst, and the aroma and taste seem to increase the mind and help to combat fatigue. It also enables battle fatigue to give a much-needed mental boost.

#### **6.16 Lemon Peel Can Reduce Cholesterol**

Various researches showed that eating lemon peel can reduce cholesterol effectively [18]. This is not because of lemon peel pectin level, but because of various active ingredients in the peel.

#### **6.17. Anti-inflammatory activity**

Essential citric oil is used in traditional medicine as an anti-inflammatory agent [19]. One or more of these parts may have anti-inflammatory effects of lemon essential oils. There are powerful anti-inflammatory effects to linalool, linalylate, limonene, and alpha-pinene.

#### **6.18. Antimicrobial activity**

The research demonstrates that the peel of lemon is also a useful antimicrobial agent as well as an astringent [20]. This is a significant finding because sebum, in particular when it is secreted in excess (in one individual), may cause pure skin infections in certain skin flora, such as *Pseudomonas* and *Micrococcus*. In other skin infections, such as acne, it may be a predisposing factor for some moment. Simple application of citrus juice can deter these kinds of diseases and assist to keep the skin safe and good.

#### **6.19 Antifungal activity**

Essential oils extracted from the various plants showed strong antibacterial and antioxidant activities [21-25]. Lemon oil may be used to regulate the development of mold in certain foods directly or to produce inhibiting impacts in the scheme by acting in the packaged product with the setting [26].

#### **7. Non-culinary uses of lemon**

In history, lemon was used as an epilepsy remedy, an invisible ink and bleaching agent for a number of non-culinary purposes. Citrus fruits and essences are processed to extract. In perfumes, cosmetics and furniture polish, lemon oil or vital oil are used. A Japanese aromatherapy research has discovered that vital citrus oil in vapor form reduces stress in mice. Commercial pectin is made using the lemon peel.

A common school experiment involving lemons is that electrodes are attached and used as a light battery. The produced electricity can also be used to power an engine to move the lemons, as a vehicle or a truck. They also use other fruits such as apples and potatoes.

#### **8. Toxicity of lemon**

All of the citrus species have phototoxic, irritating essential oil [27-28], generating responses to the high-violet (high-mountain) rays exposed. In the lip or dermatitis pockets in the internal areas of the body which come into contact with the juice are among these responses. It is therefore advisable not to drink citrus juice if we are subjected to powerful radiation or if we are allergic. Also during pregnancy and nursing the vital oil is contraindicated. The citric juice is hazardous for your teeth because it attacks and can yellow the dental plaque. A nice way to prevent this is to have a painting

#### **9. Conclusion**

We still understand the collaboration between herbs, medicines and food today. Because of their small side effects, suitability, and effect, herbal medicines are consumed for many years. The citrus is a fluid plant of the Rutaceae family. Approximately 140 genera and 1300 species are present in the genus citrus. The lemon's term comes from ancient French called "limon." Many other lemon fruit names are available. Flavonoids, acids, caffeine, pectin and minerals are the primary elements of the chemical composition. Essential citrus oil includes many ingredients and limonene is the major ingredient in its odour. Lemon possesses numerous characteristics, such as antimicrobial, antifungal, anti-inflammatory, anti-cancer, depurative and antiscorbutic etc. Especially in pregnancy, nursing and radiation exposure, lemon essential oil is poisonous. Researchers have discovered the healing capacity of this plant because it is still not acknowledged by more remedial belongings.

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