



Review Paper

Wide Spectrum Biological Activity of Lemon Peel: A Review

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Abstract

Medicinal plants have always attracted a lot of interest in the scientific community with a prime focus towards the extraction, isolation, identification and study of antimicrobial compounds and various types of secondary metabolites. The peel of *Citrus lemon* has been found most effective against different food spoiled bacteria and fungus. The lemon peel extracts are a rich source of many polymethoxylated flavones and flavanones. The lemon is also rich source of 'vitamin c'. Many phytochemical studies have demonstrated that compounds present in the peel extract play multiple roles in physiology hence making them important from the ecologically important. Also, the flavonoids reported in the extracts of lemon peel have antifungal, antibacterial, antiviral, antidiabetic and anticancer activities which make them commercially important and applicable in pharma and food industries.

Keywords: Extraction, antimicrobial, flavanones, antibacterial, antifungal, antidiabetic, anticancer, antiviral.

Introduction

Citrus lemon (Fam: Rutaceae) commonly known as "lemon", is a globally important crop native to South Asia with. The name "lemon" has been derived from French word "Limon". Lemon plant is known to originate from hot subtropical or tropical regions of the world¹. It is a small evergreen plant; about 5m height with dense and irregular branches. The fruits are globose and avoid, and their colour varies from green to yellow with maturity. With about 140 genera in the family Rutaceae, the genus citrus contains 1300 species. *Citrus lemon* is the 3rd most important species and a major processed crop in the world. In India it is largely grown in Andhra Pradesh, Bihar, Gujarat, Maharashtra, Rajasthan and Tamilnadu. Lemon peel has tremendous natural medicinal properties; is rich in nutrients and contains majority of phytochemicals. This plant has large number of medicinal values because of presence of various chemical substances. These chemicals include phenolic, oleoresins, resins, sesquiterpene, flavonoids, saponins, alkaloids, glycosides, fats and oil². The medicinal properties of lemon can be attributed to the presence of citral, limonene, and terpineol. Lemon peel is particularly rich in flavonoids. Traditionally, lemon peel is used to treat various diseases. It is used as astringent, mosquito bite repellent, antifungal, antiviral, diuretic, for the treatment of stomach ailments etc. Lemon peel is nutrient rich and is used also in drugs and dietary foods, these products are easily available, low cost and have little side effects.

Lemon peel has abundant uses and has been traditionally used as medicine hence from ancient years. The lemon peel is used as

antimicrobial agent along with an astringent property. It is also used to for the treatment of kidney stones, bring down fever and balance the pH disturbances. Lemon peel extract shows antimicrobial activity, anti-dermatophytic activity, anti-urolithic and nephroprotective roles².

It also has great impact on LDL-Cholesterol in plasma, reduces liver cholesterol, improves immune status and is a source of pectin, oligosacharrides. In the Indian subcontinent lemon peel has been used since ancient times for eye care, skin care, improving digestion, relieving constipation, weight loss, treating scurvy, gout, piles, peptic ulcers, respiratory and urinary disorders³.

Review of literature

Kawaii *et al.*⁴ investigated the extracts of lemon flower, leaf, roots and stem against different bacterial strains and cancer cell lines and reported that lemon has antibacterial and anticancer properties because of presence of alkaloids.

Keles *et al.*⁵ demonstrated the presence of protopine and corydaline alkaloids, acyclic sesquiterpenes, lactones, polyacetylene, hypericin and pseudohypericin compounds and essential oils and studied their action against various bacteria. The results show that the activities of lemon peel against various microbes is directly related to the components of various extracts. The presence of bioactive compounds such as terpenes, aldehydes, alcohols and esters in the essential oils contribute towards and can also enhance the overall antimicrobial effects of lemon peel extracts.

Lario *et al.*⁶ studied the raw residues from lemon juice and found that the physicochemical properties of these residues depend on their chemical composition which in turn is determined solely by the biogeography and quality and raw material.

Camacho-Corona MR, *et al.*⁷ experimentally proved the antibacterial activity of *C. aurantifolia* against Mycobacterium tuberculosis strains that were resistant to isoniazid and attributed this antibacterial activity to the presence of certain major phytochemical contents like palmitic acid and linoleic acid.

Boshtam M, *et al.*⁸ studied the antioxidant properties of *C. aurantifolia* in an *in vitro* model. In this study, both peel extract and fresh juice of *C. aurantifolia* showed antioxidant properties and protected against LDL oxidation.

Dhanavade *et al.*² revealed that the lemon peel has significant antimicrobial agent along with an astringent property.

Dhanavade M J, *et al.*² subjected various extracts (methanol, ethanol and acetone) of lemon peel extracts to standard antibacterial assays with the aim to evaluate the potential of phytochemicals on standard microorganism strains. Their findings demonstrate that the ethanolic extracts of lemon peel have significantly higher antimicrobial activity in comparison to methanol and acetone extracts against the studied microbes.

Barkatullah *et al.*⁹ investigated on lemon peel and demonstrated the practical importance of herbal oils and the importance of studying their physicochemical characteristic in daily life.

Cho *et al.*¹⁰ investigated incidence of numerous phytochemicals including alkaloids, saponin, sterols, Steroids, and terpenoids found on studying Citrus limon peel methanolic extracts.

Hindi and Chabuck¹¹ tested the effects of aqueous extracts of lemon peel against 8 Gram -ve bacteria and 6 Gram +ve bacteria using agar well-diffusion method and reported their antimicrobial properties.

Najimu Nisha *et al.*¹² studied that lemon peels can be utilized to make tremendous antibiotics by using natural biological reducing agents of low cost.

Halima and Allem¹³ evaluated the antimicrobial properties of algerian lemon (*Citrus limon* L.). n seeds and peel extracts using disk diffusion method against six pathogenic bacteria and fungal strains. They reported that both peel and seeds of Citrus contain quercetin, a well known antimicrobial flavonoid.

Kumari *et al.*¹⁴ studied the antimicrobial potential of methanolic extracts of young and mature leaves of lemon plant along with 1mg/ml tetracycline and 1mg/ml streptomycin against *E. coli* using agar plate diffusion technique.

Sridhara *et al.*¹⁵ isolated the active principle involved in lemon peel extracts showing anti-lithogenic properties and reported that it can be used to reduce the incidence of formation of calcium oxalate stones (CaO_x).

Saeb *et al.*¹⁶ studied the antimicrobial effects of fresh leaf extracts of *C. grandis*, *C. reticulata* and *C. limon* and reported that they were effective against *Escherichia coli*, *S. aureus*, *Bacillus subtilis* and *Salmonella typhi*. Shade dried (room temperature, 72 hours) leaves were used in this study.

Shetty *et al.*¹⁷ evaluated the in-vitro antimicrobial potential from *Citrus sinensis* peel extract using agar well diffusion method and the extracts were found effective against *Streptococcus mutans* and *Lactobacillus acidophilus*.

John *et al.*¹⁸ evaluated the antioxidant and antimicrobial properties from the peel of citrus lemon Fresh lemons were collected, their peels were carefully isolated after washing and kept for 4-5 days at room temperature. After that they pulverized the dried peel using an electric blender and used it for preparing methanol and acetone extracts. Henderson *et al.*¹⁹ reported that ethanolic extract of *Citrus limon* peels are effective against *E. coli* and can be used to treat GI tract infections.

Yashaswini and Arvind²⁰ determined the antimicrobial properties and phenolic gratified of the orange (Kinnow) against the pathogenic bacteria. They estimated the antimicrobial potential Agar well diffusion manner against different bacteria such as *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella pneumoniae* and *Staphylococcus*.

Irfan S *et al.*²¹ reviewed the presence of bioactive compounds and pharmacological properties and activities of lemon peel as a natural medicine. They highlighted the presence of high amounts of phytochemicals due to which lemon peel has antimicrobial and antioxidant property, anti-dermatophytic activity, and nephroprotective roles from various studies.

Roop R *et al.*²² compared various extraction methods and explored the correlation of antimicrobial potential of citrus peel and leaf extracts with various methods of extraction. They observed that Citrus peel contains a very good amount of flavonones including several polymethoxylated flavones. They also reported that the essential oil from blood orange results the great amount of antimicrobial properties which are used against the bacteria *E. coli*, *B. aureus*, *S. typhimurim*, *L. monocytogene* and *E. faecalis*. The extracts also contain D-limonene (70-90%), antioxidants, antimicrobial, insect repellent and some medicinal properties.

Expected outcomes at national and international level

Over a long time period, naturally occurring constituents are used which have abundant potential for yielding new drugs and

the constituents contain biologically active substance with proven benefits for human health. According to WHO, the medicinal plants are mostly utilized in therapeutic purpose. They are also used as initiating the semi-synthetic chemical drugs manufacture. Majority of the world's population (about 80%) relies on the herbal medicine for treatment of their illnesses. However their usage in the developed countries is less compared to developing countries²³. The naturally occurring lemon peel contains antimicrobial substances and can be used in plant based chemotherapy for treatment of various metabolic disorders and microbial infections.

Globally, Spain is a leading exporter country of lemon. The fruit contains high amounts of nutrients (i.e., Vitamin C, dietary fiber, minerals ascorbic acid, citric acid, potassium, limonoids, carotenoids, flavonoids and essential oils) and provides wider range of health benefits. Many phytochemical and pharmacological studies have unveiled the biological potential and activities (like antidiabetic, antibacterial, anticancer, antifungal, anticancer and antiviral activities) of citrus peels²⁴. Apart from this, the peels can be utilized to reduce the solid waste handling and also in value added forms using several feasible ways^{25,26}.

Due to the worldwide application of lemon in food products, lemon peel is an important bio process byproduct or waste in most of the food processing industries all over the globe and hence available globally. Recent studies highlight its nutritional and medicinal value. Lemon peels are also a major source of flavanones and many poly-methoxylated flavones present rarely in other plants. These compounds are known to play potent ecological and physiological roles apart from being applicable commercially in food and pharmaceutical industries.

Conclusion

Globally, lemon and lemon products are an important product of almost all major food processing industries. It is widely cultivated, and the fruits along with peels are processed into juices, like lemon, lime and orange. Annually, the processing of the citrus fruits results in the huge amount of biodegradable wastes and by-products with lemon peels as its major under-utilized component which contain high amounts of flavanones and several important poly-methoxylated compounds compared to various other plant species. Due to their bioactive properties lemon peels have high potential with respect to their medical application and can serve as sources of chemotherapeutic agents. But their medicinal usage is restricted at households or mostly locally. Studies show that they can be used in the treatment of blood lipid levels, obesity, cardiovascular disease, diabetes, cancer and neurological disorders owing to its bioactive nature. Hence, we can conclude that the usage of lemon peel should be promoted at a global scale because it has significant potential of medicinal applications and is also available globally as well economically as a waste from food processing applications.

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