Chemical Composition and Antimicrobial Activity of *Citrus limon*

Dr. Udai Pratap Singh

Assistant Professor, Department of Chemistry, D.A.V. College, Kanpur, Uttar Pradesh, India

How to cite this paper: Dr. Udai Pratap Singh "Chemical Composition and Antimicrobial Activity of Citrus limon" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-3 | Issue-3, April 2019, pp.1934-1939, URL: https://www.ijtsrd.com/papers/ijtsrd23158.pdf

IJTSRD23158

ABSTRACT

The *Citrus limon* (L.) Burm., popularly known as the lemon tree is a species from the Rutaceae family, native to Asia. Lemon fruit is a rich source of nutrients, a key to a healthy diet, and provides health benefits. Lemons are an interesting source of flavonoids, vitamins, minerals, dietary fibers, essential oils, organic acids, and carotenoids. In this chapter, the lemon is presented as a rich source in different nutrients and unique flavor that can improve the health of consumers. Besides that, there is an overview on topics including harvest, postharvest, genotypes, production characteristics, and productivity. The nutritional composition, bioactive compounds, antioxidant properties, and other factors, such as antinutritional compounds and contaminants that may enter the fruit production chain, such as pesticides and heavy metals.

KEYWORDS: *Citrus limon, fruit, lemon, chemical composition, antimicrobial, bioactive, nutritional, dietary*

INTRODUCTION

Lemon (*Citrus limon*) contains high levels of flavonoids, especially flavanones and flavone glycosides. Flavonols, flavone aglycones, and polymethoxyflavones are also present but at lower concentrations than those of flavanones and flavones .The main flavanones and flavones detected are eriocitrin, hesperidin, *C*-glycosides of diosmetin and apigenin, and diosmetin 7-*O*-rutinoside (diosmin)[1,2] .Two isomers of hesperidin (neohesperidin and homoeriodictyol 7-*O*-rutinoside) as well as low amounts of naringin, narirutin, flavonols (mainly rutin), and flavone aglycones (quercetin and luteolin) have also been detected. Other phenolic compounds such as hydroxycinnamic acids (caffeic, *p*-coumaric, ferulic, and sinapic acids) in addition to hydroxybenzoic acids (protocatechuic, *p*-hydroxybenzoic, and vanillic acids) are also known to be present in very low concentrations. Lemon (*Citrus limon* (L.) Burm.) a yellow or pale yellow prolate fruit with five to 10 seeds, botanically a berry, is known throughout the world, and is used in numerous foodways and cuisines. The juice of the fruit is commonly used as a food ingredient in both commercial and home recipes, and is valued for its tart, tangy, and fresh character. The exceptionally fragrant rind is used as a garnish and flavoring and is a major source of commercial essential oil and aroma compounds. The lemon flower is sweetly scented, with an aroma similar to other citrus flowers. The essential oils from the flowers, twigs, and fruit can be distilled or otherwise extracted to obtain materials suitable for use in flavors and fragrances.[3,4]

The lemon tree is a small, thorny tree that grows well throughout the tropical and subtropical regions of the world. Lemons are cultivated in modest amounts for home use almost everywhere that citrus trees can survive, but large-scale commercial production is limited to the subtropical regions since more humid tropical environments enhance pest and disease problems for both fruit and tree. Lemon trees grow to about 3–6 m and are sparsely foliaged. Compared to orange and grapefruit, the trees are rather cold-sensitive. Because of the lemon's lower sugar content, the fruit can freeze at temperatures that would not affect other citrus.

The lemons has existed for so long that its true origin is not known, although experts believe it was probably a hybrid of the citron (*C. medica*). The first recorded habitat of the lemon was South-east Asia (Myanmar, and southern China); from there, it was introduced to Persia and the Middle East, were it was well established by the twelfth century. Around 1150, Arabs took the lemon to Spain and North Africa. The lemon traveled from the Mediterranean to the New World with Columbus on his second voyage in 1493. Lemon culture spread from Haiti through the West Indies and then to South and North America. Plantings existed in Florida by the 1500s and were established in the mission gardens of California and Baja California by the mid-eighteenth century.[5,6]

Lemon (*Citrus limon* (L.)

Discussion

In a fast-growing scenario of environmental decay and resource depletion, the need to reuse industrial wastes has become urgent. Lemon (*Citrus limon*) seeds constitute the main by-product of industrial processing for the production of juice, pulp slices, and essential oil. In 2016 alone, the global production of lemon fruits was 17.3 million metric tons. The economic and ecological importance of the reutilization of lemon seeds in order to transform waste into a resource can be easily derived. In the past, lemon wastes were basically destined for cattle feed or agricultural fertilization. Nonetheless, the literature reports some studies on lemon seed oil, dating back to the early 1900s, [7,8] where it was already emphasized that lemon by-products, such as seeds, could be a source of prosperity as well as their parent fruits. Soon after, new reports by oil chemists appeared, with preliminary investigations on the chemical and physical properties of lemon seed extracts and oil. Besides a considerable fraction of oil (around 45%), mainly consisting of beneficial lipids, lemon seeds have been demonstrated to contain nutrients such as proteins, minerals, limonoids, and glucoside derivatives. Therefore, in view of the increasing demand for new sources of edible oils, lemon seed oil has successfully entered the global market of seed oils, but remains a niche product.

Lemon is a rich source of vitamin C, providing 64% of the Daily Value in a 100 g reference amount. Other essential nutrients are low in content.Lemons contain numerous phytochemicals, including polyphenols, terpenes, and tannins. Lemon juice contains slightly more citric acid than lime juice (about 47 g/L), nearly twice the citric acid of grapefruit juice, and about five times the amount of citric acid found in orange juice. Lemon juice, rind, and peel are used in a wide variety of foods and drinks. The whole lemon is used to make marmalade, lemon curd and lemon liqueur. Lemon slices and lemon rind are used as a garnish for food and drinks. Lemon zest, the grated outer rind of the fruit, is used to add flavor to baked goods, puddings, rice, and other dishes. [9,10]

Juice

Lemon juice is used to make lemonade, soft drinks, and cocktails. It is used in marinades for fish, where its acid neutralizes amines in fish by converting them into nonvolatile ammonium salts. In meat, the acid partially hydrolyzes tough collagen fibers, tenderizing it. In the United Kingdom, lemon juice is frequently added to pancakes, especially on Shrove Tuesday.

Lemon juice is also used as a short-term preservative on certain foods that tend to oxidize and turn brown after being sliced (enzymatic browning), such as apples, bananas, and avocados, where its acid denatures the enzymes.

Peel

In Morocco, lemons are preserved in jars or barrels of salt. The salt penetrates the peel and rind, softening them, and curing them so that they last almost indefinitely. The preserved lemon is used in a wide variety of dishes. Preserved lemons can also be found in Sicilian, Italian, Greek, and French dishes.

The peel can be used in the manufacture of pectin, a polysaccharide used as a gelling agent and stabilizer in food and other products.

Oil

Lemon oil is extracted from oil-containing cells in the skin. A machine breaks up the cells, and uses a water spray to flush off the oil. The oil/water mixture is then filtered and separated by centrifugation. [11,12]

Leaves

The leaves of the lemon tree are used to make a tea and for preparing cooked meats and seafoods.

Industrial

Lemons were the primary commercial source of citric acid before the development of fermentation-based processes.

Aroma

Lemon oil may be used in aromatherapy. Lemon oil aroma does not influence the human immune system, but may contribute to relaxation.

Other

One educational science experiment involves attaching electrodes to a lemon and using it as a battery to produce electricity. Although very low power, several lemon batteries can power a small digital watch. These experiments also work with other fruits and vegetables.

Lemon juice may be used as a simple invisible ink, developed by heat.

Lemon juice can be used to increase the blonde colour of hair, acting as a natural highlight after the moistened hair is exposed to sunlight. This is due to the citric acid that acts as bleach.

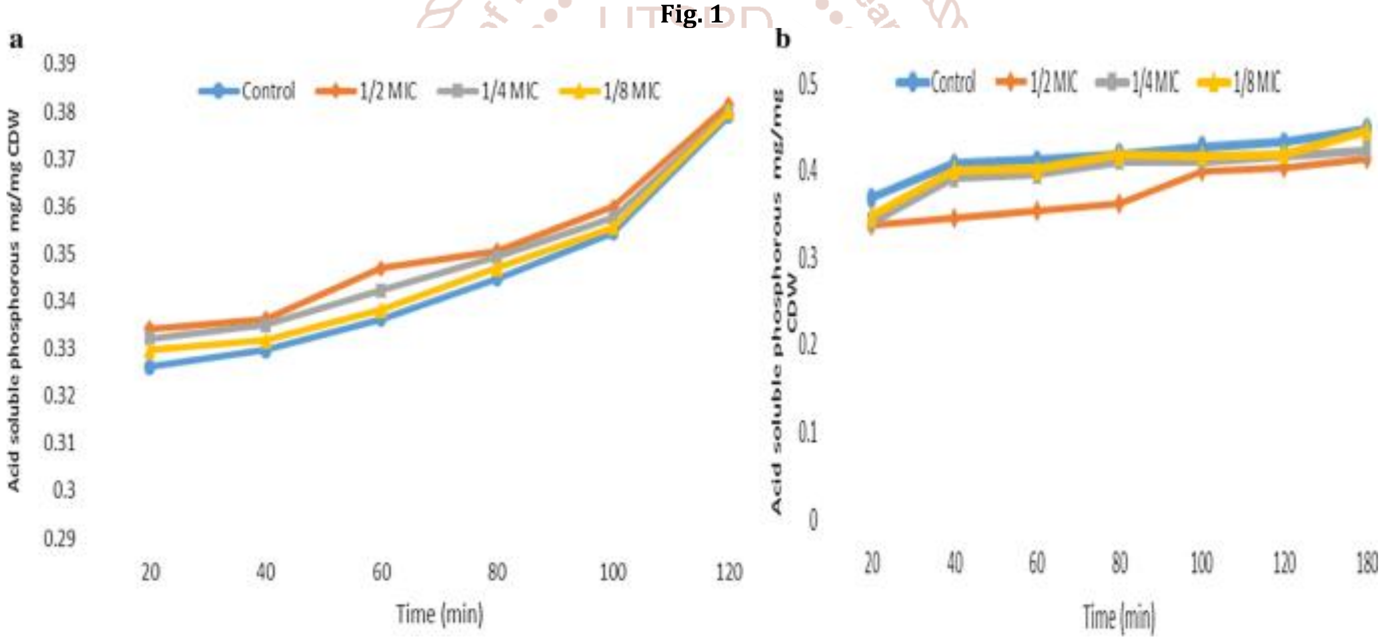
Results

Many people still depend to a large extent on traditional herbs such as *Citrus limon* for the treatment of skin diseases. The aim of this study was therefore to screen the acetone and ethanol extracts of *C. limon* for its antioxidant potential and antimicrobial efficacy agents against a panel of microbes implicated in skin diseases. The highest antibacterial activity was obtained with the acetone extract of *C. limon* against *Enterococcus faecalis* and *Bacillus subtilis*, and the most susceptible bacteria based on the overall mean inhibition diameters were the gram-negative *Salmonella typhimurium, Shigella sonnei* and the gram-positive *E. faecalis* and *B. subtilis.* Both extracts were active against *Candida glabrata.* The DPPH scavenging activity of the acetone extract was not significantly different from those of vitamin C and rutin. Nitric oxide scavenging activity was lowest in the ethanol extract of *C. limon.* The reducing ability of both plant extracts was significantly lower than that of vitamin C and rutin. The fact that both extracts of *C. limon* exhibited a broad spectrum of antibacterial activity and comparable efficacy to the synthetic antioxidants highlights the medicinal value of *C. limon* as a potential source for drug development amidst the obvious dearth of effective and safe antibacterial drugs, and also validates the ethno therapeutic claim of the plant.[13]

Bacteria are responsible for increasing the mortality rates in many developing countries; about 50,000 people died every day as a result of infections .Disease caused by microbes that had become resistant to drug therapy was an increasing problem of public health. Many researchers have been interested in developing modern antimicrobial reagents with the emergence of antibiotic-resistant microbes, which increases the cost of healthcare. Agriculture crops (fruits) produce large amount of wastes or by-products every year. These wastes included pruning materials and juice production wastes of different industrial nutritional companies. *Citrus lemon* contains about 5% citric acid that gives lemons pH 2–3, and it is used as antibacterial due to the low pH. The same finding was revealed by researchers who also reported that the extract of pulp revealed the presence of carbohydrates, alkaloids, fixed oils, tannins, proteins, cardiac glycosides, sterols, phenols, and flavonoids. Also, The juice of *Citrus lemon,* contained: flavonoids, alkaloids, steroids, saponins, terpenoids, reducing sugars, and cardiac glycosides. This investigation suggested that this juice had beneficial antimicrobial roles which could be controlled by the unwanted microbial growth. To determine antimicrobial susceptibility *in vitro*, various methods were commercially available, and microbiology clinical laboratories choose an instrument or manual-based method for performing routine antimicrobial activity testing. The commonly used methods include disk diffusion broth micro-dilution and rapid automated instrument-based methods. In many countries, the disk diffusion method was the commonly used method in clinical laboratories. This test provided the greatest flexibility and cost-effectiveness in which the test took 24 h. [17,18] Therefore, this work aimed to estimate the *C. lemon* leaves oil constituents and its potential as a novel antibiotic against pathogenic bacteria, and the effect on the DNA, RNA, lipids, and protein biosynthesis in *Staphylococcus aureus* and *Pseudomonas aeruginosa* cells.

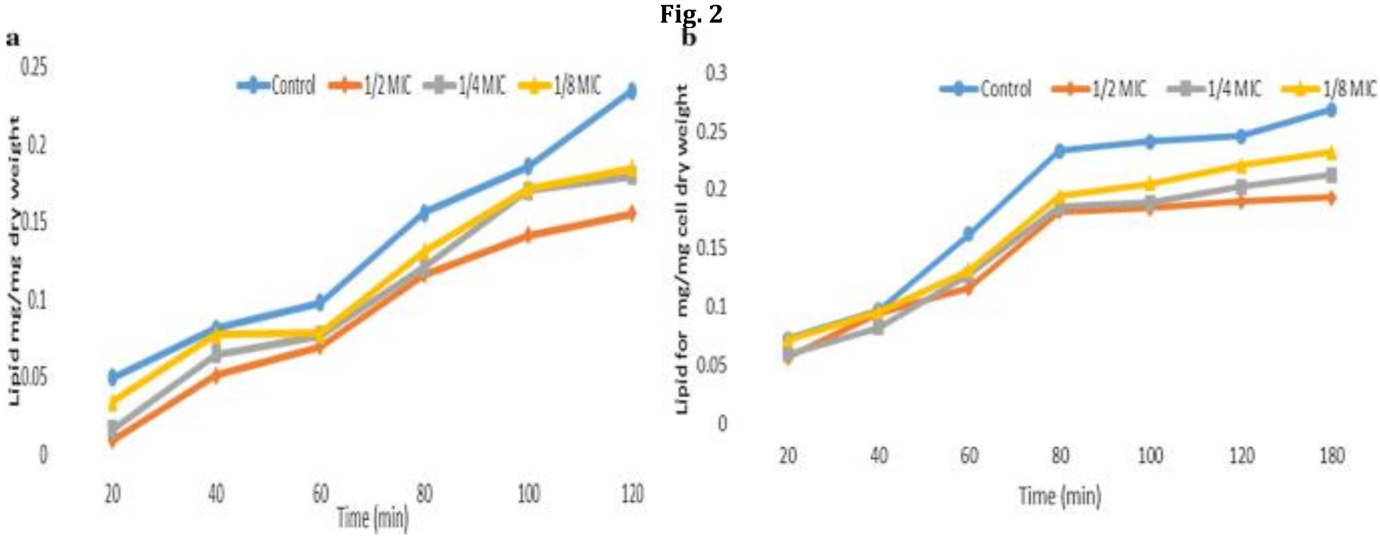
The different concentrations of *C. lemon* leaves oil impact on the total lipids, acid soluble phosphorus, protein, RNA, and DNA biosynthesis in the *S. aureus* and *P. aeruginosa* cells were studied, and the data are presented in Figs. 1, 2, 3, 4 and 5. It was found that *Citrus lemon* leaves oil had a strong effect on the total lipids in cells of *P. aeruginosa* indicated in Fig. 2a, whereas it had a trivial effect on acid-soluble phosphorus, protein, RNA, and DNA biosynthesis indicated in Figs. 1a, 3a, 4a and 5a and this is the best state. In the case of *S. aureus* cells, the *C. lemon* leaves oil had a strong effect on acid-soluble phosphorus, lipid, protein, DNA, and RNA biosynthesis (Figs. 1b, 2b, 3b, 4b and 5b). This impact increased with the increasing of incubation period and concentration [14]

Fig. 1



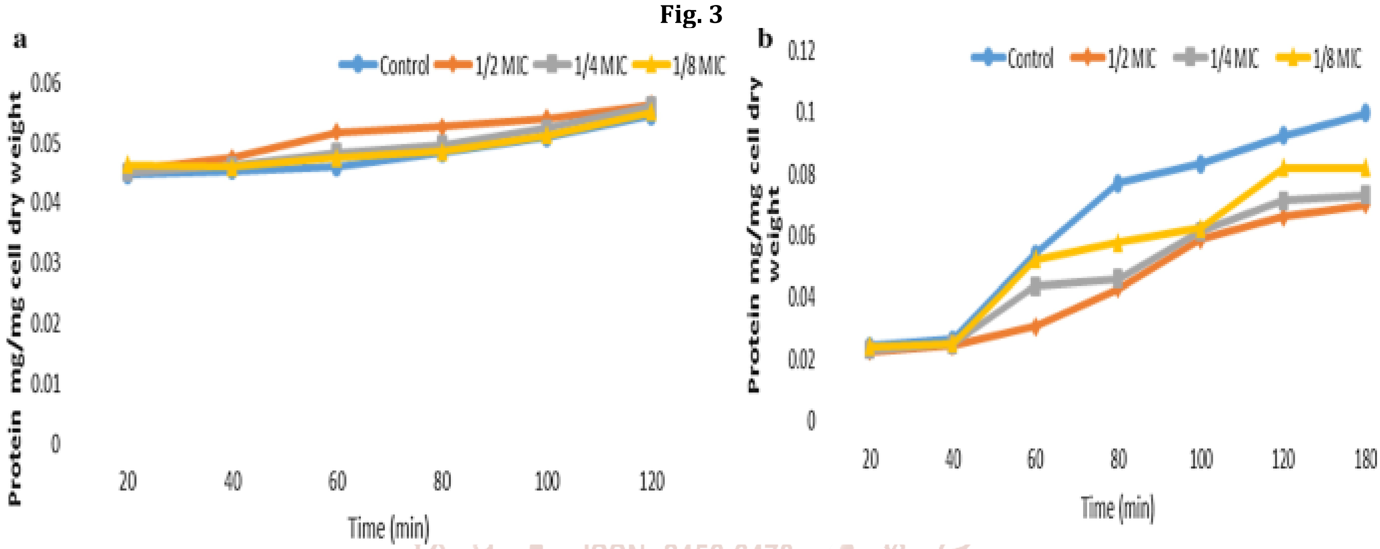
Effect of different of *Citrus lemon* leaves oil on the acid soluble phosphorous biosynthesis in cells of *P. aeruginosa* (**a**) *S. aureus* (b)

Fig. 2



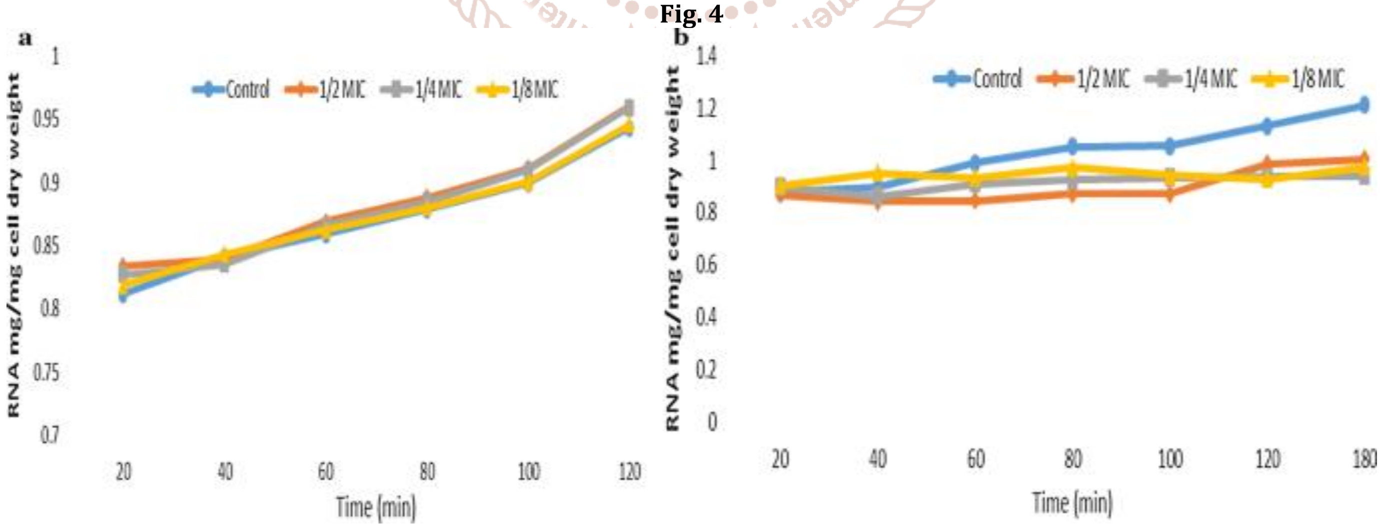
Effect of different *Citrus lemon* leaves oil on the total lipids biosynthesis in cells of *P. aeruginosa* (**a**), *S. aureus* (**b**)

Fig. 3



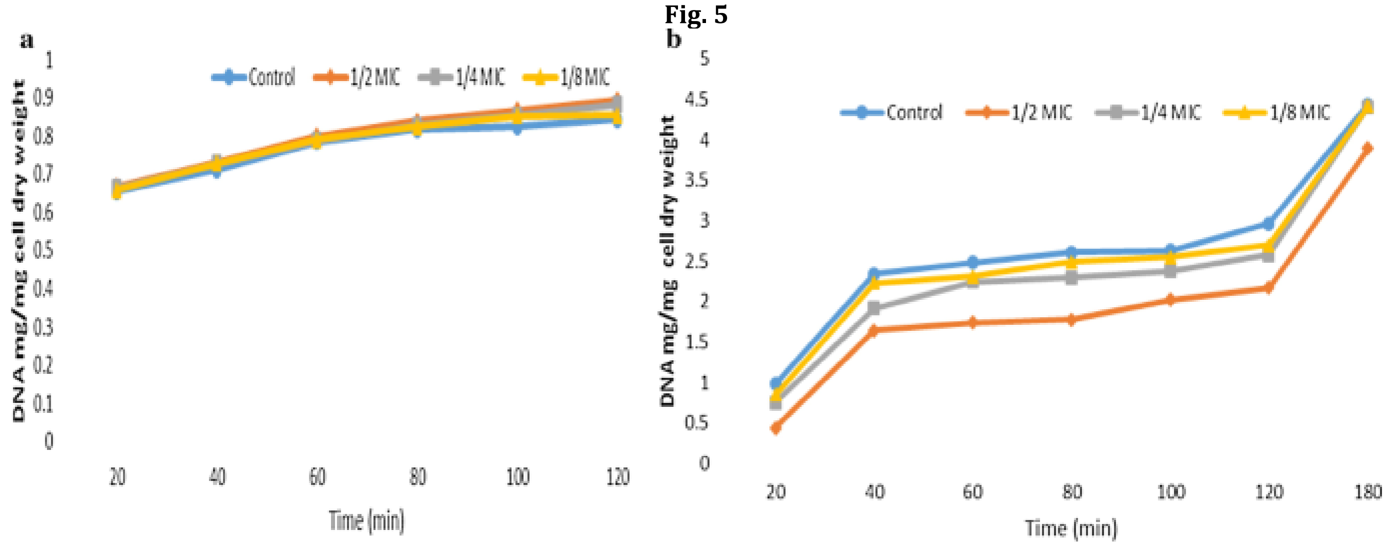
Effect of different *Citrus lemon* leaves oil on the proteins biosynthesis in cells of *P. aeruginosa* (**a**), *S. aureus* (**b**)

Fig. 4



Effect of different *Citrus lemon* leaves oil on the RNA biosynthesis in cells of *P. aeruginosa* (**a**), *S. aureus* (**b**)

Fig. 5



Effect of different *Citrus lemon* leaves oil on the DNA biosynthesis in cells of *P. aeruginosa* (**a**), *S. aureus* (**b**)

Conclusions

Food rich in antimicrobial activity had become a significant approach for a lot of consumers, to obtain their requirements to decrease the health problem risk or a specific disease and to treat minor disease. [15,16] The antimicrobial development and description of in agricultural products and novel food were demanded to provide scientific proof for improving of the human diet nutritional value and quality. This was also important for improved the agricultural and food products using. Knowledge of the composition, functional properties and analysis of lemon will aid in identifying the medicinal, industrial and nutritional applications of it. It can be concluded that the *C. lemon* seems to be a well source of antibiotic agent. *C. lemon* essential could be nutritionally considered as a non-conventional supply for edible purposes, pharmaceutical industries, and provide health benefits to the consumers specially when these essential oils were extracted from a waste product like pruning process. The *C. lemon* had potential applications as natural food preservatives inhibiting bacterial growth against *P. aeruginosa*.[19]

References

[1] Goetz P. *Citrus limon* (L.) Burm. f. (Rutacées). Citronnier. *Phytotherapie.* **2014**;12:116–121. doi: 10.1007/s10298-014-0854-6. [CrossRef] [Google Scholar]

[2] 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. doi: 10.3767/000651904X484432. [CrossRef] [Google Scholar]

[3] Papp N., Bartha S., Boris G., Balogh L. Traditional uses of medicinal plants for respiratory diseases in Transylvania. *Nat. Prod. Commun.* **2011**;6:1459–1460. doi: 10.1177/1934578X1100601012. [PubMed] [CrossRef] [Google Scholar]

[4] Clement Y.N., Baksh-Comeau Y.S., Seaforth C.E. An ethnobotanical survey of medicinal plants in Trinidad. *J. Ethnobiol. Ethnomed.* **2015;**11:1–28. doi: 10.1186/s13002-015-0052-0. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

[5] Bhatia H., Pal Sharma Y., Manhas R.K., Kumar K. Traditional phytoremedies for the treatment of menstrual disorders in district Udhampur, J&K, India. *J. Ethnopharmacol.* **2015;**160:202–210. [PubMed] [Google Scholar]

[6] Balogun F.O., Ashafa A.O.T. A review of plants used in South African Traditional Medicine for the management and treatment of hypertension. *Planta Med.* **2014;**85:312–334. doi: 10.1055/a-0801-8771. [PubMed] [CrossRef] [Google Scholar]

[7] 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. doi: 10.1016/j.sajb.2015.08.005. [CrossRef] [Google Scholar]

[8] 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. doi: 10.1002/ptr.5256. [PubMed] [CrossRef] [Google Scholar]

[9] 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. doi: 10.1016/j.fct.2011.10.057. [PubMed] [CrossRef] [Google Scholar]

[10] Bhavsar S.K., Joshi P., Shah M.B., Santani D.D. Investigation into hepatoprotective activity of *Citrus limon*. *Pharm. Biol.* **2007;**45:303–311. doi: 10.1080/13880200701214995. [CrossRef] [Google Scholar]

[11] 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. [PubMed] [Google Scholar]

[12] Abad-García B., Garmón-Lobato S., Berrueta L.A., Gallo B., Vicente F. On line characterization of 58 phenolic compounds in *Citrus* fruit juices from Spanish cultivars by high-performance liquid chromatography with photodiode-array detection coupled to electrospray ionization triple quadrupole mass

spectrometry. *Talanta.* **2012**;99:213–224. doi: 10.1016/j.talanta.2012.05.042. [PubMed] [CrossRef] [Google Scholar]

[13] García-Salas P., Gómez-Caravaca A.M., Arráez-Román D., Segura-Carretero A., Guerra-Hernández E., García-Villanova B., Fernández-Gutiérrez A. Influence of technological processes on phenolic compounds, organic acids, furanic derivatives, and antioxidant activity of whole-lemon powder. *Food Chem.* **2013**;141:869–878. [PubMed] [CrossRef] [Google Scholar]

[14] Russo M., Bonaccorsi I., Costa R., Trozzi A., Dugo P., Mondello L. Reduced time HPLC analyses for fast quality control of citrus essential oils. *J. Essent. Oil Res.* **2015**;27:307–315. doi: 10.1080/10412905.2015.1027419. [CrossRef] [Google Scholar]

[15] Talon M., Gmitter F.G. *Citrus* genomics. *Int. J. Plant Genomics.* **2008;** 1–17. doi: 10.1155/**2008**/528361. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

[16] Jing L., Lei Z., Zhang G., Pilon A.C., Huhman D.V., Xie R., Xi W., Zhou Z., Sumner L.W. Metabolite profiles of essential oils in citrus peels and their taxonomic implications. *Metabolomics.* **2015;**11:952–963. doi: 10.1007/s11306-014-0751-x. [CrossRef] [Google Scholar]

[17] Citrus Page. [(accessed on 28 August **2011**)]; Available online: http://citruspages.free.fr

[18] Hagerty M. Mongraph on the Oranges of Wen-chou, Chekiang. *Leiden Brill EJ.* **1923**;2:63–69. [Google Scholar]

[19] Herbert S., Webber J. History and development of the *Citrus* Industry, Revised by Reuther W and Berkley HWL. *Univ. Calif.* **1943**;1:1–3. [Google Scholar]