IJBAF, October, 2019, 7(10): 185-194

ISSN: 2320 – 0774

International Journal of Biotechnology and Allied Fields (IJBAF)

www.ijbaf.com

' Connecting Researchers... '

LEMON PEEL: A NATURAL MEDICINE

SHAFEEQA IRFAN, MUHAMMAD MODASSAR ALI NAWAZ RANJHA, SHAHID MAHMOOD*, WAJIHA SAEED AND MUHAMMAD QAMROSH ALAM

Institute of Food Science and Nutrition, University of Sargodha, Sargodha, Pakistan

***Corresponding Author: Shahid Mahmood: E Mail: Shahid.mustafa@uos.edu.pk;**

Phone Number: +92304-8697033

Received 14th Nov. 2018: Revised 16th Dec. 2018: Accepted 14th Jan. 2019: Available online 1st Oct. 2019

ABSTRACT

Citrus limon (lemon) is native to South Asia and is an evergreen small tree belongs to family rutaceae and is well familiar nutritional and medicinal property. In world, C. *limon* is the 3rd most important specie of the citrus and a major processed crop that ends in the larger quantity of wastes and byproducts which found major source of various bioactive compounds (like pectin, water soluble and insoluble antioxidants and essential oils). Traditionally, lemon is used in medicine for known abundant significant effects such as anti-cancer activity, prevent kidney stones, bring down a fever, balance pH because it contains citral, limonene, terpineol, geranyl acetate, linalyl. Lemon peel contains the high presence of phytochemicals and has the greater antimicrobial and antioxidant activity. The lemon peel is a significant antimicrobial agent along with an astringent property. This review compiles the antioxidant activity, antimicrobial activity, anti-dermatophytic activity, anti-urolithic and nephroprotective role, impact on LDL-Cholesterol, impact on plasma and liver cholesterol, impact on immune status, source of pectic-oligosaccharides, source of pectin, adsorbent capacity and Kinetic Analysis of lemon peel extract.

Keywords: *Citrus limon* (lemon), antioxidant activity, antimicrobial activity, anti-dermatophytic activity, anti-urolithic and nephroprotective role

INTRODUCTION

In the health of individuals and communities' medicinal plants has the vital roles. The medicinal values of these plants is because of numerous chemical substances lied in them including phenolic compounds, oleoresins, resins,

sesquiterpene, flavonoids, saponins glycosides, alkaloids, fats and oils, on human body produce physiological action [1].

Over a long time period, naturally occurring constituents are used which has the abundant potential for yielding new drugs and the constituents contain biologically active substance that demonstrate the biological activity for human health. The naturally occurring antimicrobial substances has the greater significant values and got more importance in plant chemotherapy [2].

In accord to WHO, the medicinal plants are mostly utilized in therapeutic purpose. Also, used as initiating the semi-synthetic chemical drugs manufacture [3]. For the treatment of illness/sickness majority of the world population about 80% rely on the herbal medicine and in statistical study their use is less in the developed countries and maximum in developing countries [4].

Citrus limon is a potent medicinal plant belonging to family *Rutaceae* originated from the tropical and subtropical Southeast-Asia [5], is the 3rd most beneficial citrus specie next to orange and mandarin [6]. The genus citrus consists of about 1300 species and 140 genera[7]. Globally, the citrus production is about 105 million metric tons per year [8]. According to FAO, Spain (the European country) globally ranked 1st lemon producer and has the highest production because of its mild climate (FAO 2007). In the Mediterranean Basin, Spain (main lemon producer and leading exporter) has 961,000 tones lemon production exceeding Italy and Turkey and in 2009, more than 558000 tons were produced by Spain [9]. Globally, Spain is also 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 when consumed as juice[6], [10].

Fruits from citrus species, widely cultivated and processed into juice, like lemon, lime and orange [11]. Every year, during the processing of the citrus fruits into juices results in the huge amount of wastes and by- products [12]. Abroad spectrum of biological activity (like antidiabetic, antibacterial, anticancer, antifungal, anticancer and antiviral activities) are unveiled by citrus peels[13], [14]. In several feasible ways, the peels can be utilized to reduce the solid waste handling and in value added forms[15].

In the lemon juice industry, the processing of lemons leads to huge amount of lemon-peel waste around 50 percent weight of the processed fruit [16]. Mainly the cultivation

of lemon is done for the alkaloids which possesses the anticancer activities and the antibacterial activities in crude lemon-parts (such as flowers, roots, stems and leaves) extract and alkaloids also exhibit clinically noteworthy in bacterial-strains. Lemon peel has the unique berry which is internally splits into segments [1], [17]. Currently, the interest in the vital use of agro-industrial wastes is increasing [18]. Additionally, in cosmetics, perfumes and food industry, the essential oil from lemon peel is utilized in the products[10]. Moreover, globally, lemon leaves because of their potent biological activity utilized in the manufacturing of in traditional medicine which are used in the treatment of blood lipid levels, obesity, cardiovascular disease, diabetes, cancer and brain disorders [6], [10].

MATERIALS AND METHODS

Article was written by reviewing literature from Google Scholar and PubMed.

RESULTS AND DISCUSSION

Antioxidant Activity

A study was carried out to find the antioxidants activity of the lemon peel. For liquid and solid phase of system lemon peel ethanol in water solutions the extraction kinetics investigation was done. The influence of the solvent concentration and particle size was predicted, and found on the total extract yield there was dependence on the sieve fraction and almost negligible influence of solids and the ethanol concentration respectively. From extracts obtained total polyphenols content and antioxidant activity determined and found that in both quantities there is no direct dependence. Hence, lemon peel for food and cosmetic industries found promising source of natural antioxidants when compared to three medicinal plants [19].

Antimicrobial Activity

The study showed the citrus limon peel has very good antimicrobial activity, by utilizing disk diffusion method the antibacterial activity of lemon peel (dried fruit of Citrus limon) was judged by evolving selected microorganisms such as Gram- positive, S. aureus and Gram-negative E. coli and fungus like *C. albicans*, and *T. rubrum*, as use of antibiotic increases the capacity of the microorganisms of rapidly developed antibiotic resistance increases. The incidence of numerous phytochemicals including alkaloids, saponin, sterols, Steroids, and terpenoids was found on studying Citrus limon peel methanolic extract [20].

A study revealed that the lemon peel is a significant antimicrobial agent along with an astringent property. In certain persons, it is an important research that when sebum is secreted in excess, skin flora like

Pseudomonas, Micrococcus grow and cause the purulent skin infections, in some cases also act as predisposing aspect for other kinds of skin infections as for acne. Lemon juice simply prevents such infections and could keep the skin healthy and good with personal hygiene, exercise and a good diet [1].

Anti-dermatophytic activity

A study showed that the lemon peel has the ability to extracellularly reduce the silver nanoparticles which follow the green chemistry methodology (that's without any physical or harmful chemicals simple, rapid and eco-friendly method) and found fairly stable in the solutions, and such nanoparticles formed are nontoxic, cost-effective, reproducible and stable, and possess good medicinal uses due to significant anti-microbial activities. Conversely, lemon peels can be utilized to make tremendous antibiotics by using natural biological reducing agents of low-cost [21].

Anti-urolithic and Nephroprotective Role

A study exhibited that extract of lemon peel is significant in the prevention of kidney stones and progression of disease can be cured. In serum, lemon peel extract efficiently reduces calcium, oxalate, citrate and phosphate excretion. In urea, extract reduces the gathering of creatinine and urea. The deposition of the calcium-oxalate crystals leads to the tubular damage. Histological examinations show that this damage can be reduced because lemon peel extract contain bio-flavonoids which evade the deposition of CaOx crystal and membrane integrity is maintained. Crude lemon extract peel has the significant anti-urolithic and nephron-protective role in managing urolithiasis and aforementioned findings are the evidence of it. Conversely, more studies are required to discover and isolate active principle involved in lemon peel extracts' anti-lithogenic role. In human, That will be used to reduce the CaOx stone formation incidence [22].

The results from another study showed curative-study recommends that from the renal system preformed crystals can be exterminated from citrus bioflavonoids and lemon peel extract. However, preventive-study supports their feasible efficacy in evading recurrence. The comparison in the efficiency of citrus bioflavonoids and lemon peel extract, due to endogenous citrate matter found biased towards lemon peel extract. Both citrus bioflavonoids and lemon peel extract are efficient in the management of urolithiasis [23].

Impact on LDL-Cholesterol

In a study to investigate the impact of lemon peel extract a triple-masked-randomized-controlled trial of four week

was carried out on 60 obese adolescents which were divided in two groups who daily received equal number of capsules containing lemon powder or placebo. Also, before and after administration of medication and placebo their fasting blood sugar, lipid profile, ICAM-1, VCAM-1, systolic and diastolic blood pressure were compared. The results showed that in 60 joined patients, lemon and control groups 30 and 29 patients respectively completed the study. The results were not much different in the studied variable when compared between the groups. However, in the lemon group the body mass index, Low density lipoproteins-Cholesterol and systolic blood pressure were slightly reduced. Hence, lemon peel extract on childhood obesity has some positive effects but no significant effect was found on biochemical and anthropometric measures but further studies are highly recommended of longer follow-up [24].

Impact on plasma and liver cholesterol

The study exhibited that in hamsters the waste stream of lemon peels & lemon peels found as significant to reduce the liver and plasma cholesterol, as peel-extracted pectin. Also, it was found that compounds other than pectin of citrus peel are accountable to lower cholesterol [25].

Impact on Immune Status

The study exhibited the outcome of dietary dehydrated lemon peel over a period of thirty days, on the gilthead seabreams' growth, immune and antioxidant status which was the sub-product of the lemon industry. For fifteen days, Gilthead seabream (*Sparus aurata* L.) was fed on the diets that were 1.5% and 3% enriched with dehydrated lemon peel, it exposed better growth and both the cellular (which is the ability of head kidney leucocytes' peroxidase activity & phagocytic) and humoral (which is the seric immunoglobulin M) immunity, and some immune-related genes' expression were improved (*nkefa, il1*β*, igth and* csfr1). Conversely, it was observed that after 30 days trial the growth promotion was decreased. Also, found that in the liver by diet the activity of antioxidant enzymes and several antistress & antioxidants genes-expression were not improved. In Gilthead seabream (*Sparus aurata* L.) diets, for immune-stimulant effects of dehydrated lemon peel the possible inclusion was examined [26].

Source of Pectic-oligosaccharides

A study showed that the refined mixtures of oligosaccharides derivatives of pectin were obtained through a process implicating water extraction of free sugars by employing lemon peel wastes which was used as a substrate, and for the remaining

solids and the liquors autohydrolysis and membrane processing done respectively. A value of 31 g/L of the oligomer concentration extended at 160°C (R_0= 326 min) under non-isothermal situations when the treatment of water-extracted lemon peel wastes was done. For oven-dry lemon peel wastes, at worldwide yield being of 14 kg per 100 kg, the several steps of diafiltration and concentration were employed for liquor to achieve the significantly increased purity up to 98 g oligomers per 100 g dry product of the target products. Study resulted that in the final product, the major reaction products noticed which include variable degree of methylation, arabino-oligosaccharides and oligogalacturonides in range of, with DP 2-8 and DP 2-18 respectively. It was based on samples gained by HPAEC-PAD and semi-preparative chromatography [27].

Source of Pectin

A study revealed that pectin from lemon peel is supposed as waste or by product and for extraction of pectin method has been developed. Fourier Transform Infrared Spectroscopy (FTIR) analysis must be employed to find the structure of pectin from lemon peel (LP) because it has properties, moisture content, ash content, equivalent weight, methoxyl content, degree of esterification and intrinsic viscosity that are comparable to commercially available pectin and within range of pectin testified in the literature. But the pectin yield range lies between 1.08 - 2.218 % which found unsatisfactory compared to range mentioned in the literature. And the yield found maximum from 95% ethanol than other precipitating agent such as 95% methanol and isopropanol and MW (molecular weight) found too low and unacceptable as real. This study suggest the utilization of lemon peel, into useful products, that is waste and may cause the problems in the environment[28].

Adsorbent capacity

A study revealed that using carbonization methods for lemon and banana peels by examining the result of pH, time, adsorbent dosage and particle size the removal of organic substance from waste-water were studied. The carbonization method for both lemon and banana peels found more effectual in removal of organic substance with the highest percentage. As carbon has the easy absorbing power for organic substances to its surface because of unique pore-structure and being strong oxidant, that's why carbonization method is considered to be well. As lemon peel has more adsorption-capacity, as it contain fiber that contain extra hydroxyl radicals and this characteristic made the lemon peel more resourceful than the banana peel. The

optimum pH ranged 6-8, optimum time for carbonization method at 100 min, optimum adsorbent dosage at 0.35g and optimum particle size at 300µm for both methods lemon and banana peel [29].

Kinetic Analysis

A study presented that by the kinetic analysis on lemon peel; the initial pH mainly by *A. flavipes* FP-500,influence the pectinase production, whereas the fungal growth was favored by supreme substrate concentrations. The presence of reducing sugars also found sensitive to exo-pectinases, on the previous action of exo-pectinases, the endo-pectinases seemed to be dependent. Growth phase found enlarged by pulsed fed-batch and it also favored the substrate consumption. Moreover, above 200h to rise the titer of both enzymes were observed under operational condition by the uninterrupted induction of exo-pectinase and endo-pectinase. Conversely, for both pectinolytic systems' productivity improvement it requires an optimizated process of fed-batch [30].

CONCLUSION

It is concluded that citrus all over the world is famous for its nutritional and medicinal worth, and their peels are major origin of flavanones and many poly-methoxylated flavones that are very rarely available in other plants. These compounds play potent ecological and physiological role and also of commercial importance because of the usage in food and pharmaceutical industries.

Lemon peel contains the high presence of phytochemicals and has the greater antimicrobial and antioxidant activity. The lemon peel is a significant antimicrobial agent along with an astringent property. The lemon peels are more efficient than the banana peels in the exclusion of impurities from wastewater. The carbonization method is found to be more efficient for both lemon and banana peels, the lemon peel considered to be more effectual with the uppermost percentage elimination of BOD. The lemon peel is effectual to cure the kidney stone disease, lower liver and plasma cholesterol and in preventing their reoccurrence. lemon peel has the ability to extracellularly reduce the silver nanoparticles which follow the green chemistry methodology. Consumption of lemon peel extract on childhood obesity has some positive effects.

ACKNOWLEDGMENT

No sponsorship and financial support.

REFERENCES

[1] M. J. Dhanavade, C. B. Jalkute, J. S. Ghosh, and K. D. Sonawane, "Study Antimicrobial Activity of Lemon (*Citrus lemon* L.) Peel Extract Study Antimicrobial Activity of Lemon

(*Citrus lemon* L .) Peel Extract," *Br. J. Pharmacol. Toxicol.*, vol. 2, no. 3, pp. 119–122, 2011.

[2] N. K. Kadhim Hindi and Z. A. Ghani Chabuck, "Antimicrobial activity of different aqueous lemon extracts," *J. Appl. Pharm. Sci.*, vol. 3, no. 6, pp. 74–78, 2013.

[3] B. Jafari, A. Ebadi, B. Mohammadiaghdam, and Z. Hassanzade, "Effects of antibacterial activities methanol ofextract and lemon grass essence on pathogenic bacteria," *World Appl. Sci. J.*, vol. 28, no. 11, pp. 1796–1801, 2013.

[4] H. J. Cho *et al.*, "Short Vegetative Phase (SVP) protein negatively regulates miR172 transcription via direct binding to the pri-miR172a promoter in Arabidopsis," *FEBS Lett.*, vol. 586, no. 16, pp. 2332–2337, 2012.

[5] S. Sadat, F. Janati, and H. R. Beheshti, "Chemical Composition of Lemon (Citrus Limon) and Peels Its Considerations as Animal Food (in English)," *GIDA*, vol. 37, no. 5, pp. 267–271, 2012.

[6] E. González-Molina, R. Domínguez-Perles, D. A. Moreno, and C. García-Viguera, "Natural bioactive compounds of Citrus limon for food and health," *Journal of Pharmaceutical and Biomedical Analysis*, vol. 51, no. 2. pp. 327–345, 2010.

[7] J. V Hemayatkhah, M. Farajmand, S. Azhdari, S. Ghaedi, M. Farzam, and J. H. Kargar, "Effect Of Hydroalcoholic Extract Of Citrus Aurantifolia Peel On Serum Level Of Testosterone , Fsh , Lh And Testis Tissue In Adult Male Rats," *Int. J. Biol. Pharm. Allied Sci.*, vol. 2, no. 6, pp. 1307–1315, 2013.

[8] F. Anwar, R. Naseer, M. I. Bhanger, S. Ashraf, F. N. Talpur, and F. A. Aladedunye, "Physico-chemical characteristics of citrus seeds and seed oils from Pakistan," *JAOCS, J. Am. Oil Chem. Soc.*, vol. 85, no. 4, pp. 321–330, Apr. 2008.

[9] S. Gorinstein *et al.*, "Comparison of some biochemical characteristics of different citrus fruits," *Food Chem.*, vol. 74, no. 3, pp. 309–315, 2001.

[10] H. Bouzenna *et al.*, "The protective effect of Citrus limon essential oil on hepatotoxicity and nephrotoxicity induced by aspirin in rats," *Biomed. Pharmacother.*, vol. 83, pp. 1327–1334, 2016.

[11] A. M. Olaniyan, "Development of a small scale orange juice extractor," *J. Food Sci. Technol.*, vol. 47, no. 1, pp. 105–108, 2010.

[12] J. A. Manthey and K. Grohmann, "Phenols in citrus peel byproducts. Concentrations of hydroxycinnamates and polymethoxylated flavones in citrus peel molasses," *J. Agric. Food Chem.*, vol. 49, no. 7, pp. 3268–3273, 2001.

[13] S. Burt, "Essential oils: Their antibacterial properties and potential applications in foods - A review," *International Journal of Food Microbiology*, vol. 94, no. 3. pp. 223–253, 2004.

[14] A. Ortuño *et al.*, "Citrus paradisi and Citrus sinensis flavonoids: Their influence in the defence mechanism against Penicillium digitatum," *Food Chem.*, vol. 98, no. 2, pp. 351–358, 2006.

[15] C. Palma, E. Contreras, J. Urra, and M. J. Martínez, "Eco-friendly technologies based on banana peel use for the decolourization of the dyeing process wastewater," *Waste and Biomass Valorization*, vol. 2, no. 1, pp. 77–86, 2011.

[16] V. Hernández-Montoya, M. A. Montes-Morán, and M. P. Elizalde-González, "Study of the thermal degradation of citrus seeds," *Biomass and Bioenergy*, vol. 33, no. 9, pp. 1295–1299, 2009.

[17] S. Kawaii *et al.*, "Quantitative study of flavonoids in leaves of citrus plants.," *J. Agric. Food Chem.*, vol. 48, no. 9, pp. 3865–71, Sep. 2000.

[18] J. Concha Olmos and M. E. Zúñiga Hansen, "Enzymatic depolymerization of sugar beet pulp: Production and characterization of pectin and pectic-oligosaccharides as a potential source for functional carbohydrates," *Chem. Eng. J.*, vol. 192, pp. 29–36, 2012.

[19] S. Diankov, M. Karsheva, and I. Hinkov, "Extraction of natural antioxidants from lemon peels. kinetics and antioxidant capacity," *J. Univ. Chem. Technol. Metall.*, vol. 46, no. 3, pp. 315–319, 2011.

[20] H. J. Cho *et al.*, "SHORT VEGETATIVE PHASE (SVP) protein negatively regulates miR172 transcription via direct binding to the pri-miR172a promoter in Arabidopsis," *FEBS Lett.*, vol. 586, no. 16, pp. 2332–2337, 2012.

[21] S. Najimu Nisha *et al.*, "Lemon peels mediated synthesis of silver nanoparticles and its antidermatophytic activity," *Spectrochim. Acta - Part A Mol. Biomol. Spectrosc.*, vol. 124, pp. 194–198, 2014.

[22] B. Sridharan, S. T. Michael, R. Arya,

S. Mohana Roopan, R. N. Ganesh, and P. Viswanathan, "Beneficial effect of Citrus limon peel aqueous methanol extract on experimentally induced urolithic rats," *Pharm. Biol.*, vol. 54, no. 5, pp. 759–769, 2016.

[23] B. Sridharan, Y. Mehra, R. N. Ganesh, and P. Viswanathan, "Regulation of urinary crystal inhibiting proteins and inflammatory genes by lemon peel extract and formulated citrus bioflavonoids on ethylene glycol induced urolithic rats," *Food Chem. Toxicol.*, vol. 94, pp. 75–84, 2016.

[24] M. Hashemipour, M. Kargar, A. Ghannadi, and R. Kelishadi, "The effect of Citrus Aurantifolia (Lemon) peels on cardiometabolic risk factors and markers of endothelial function in adolescents with excess weight : A triple-masked randomized controlled trial," 2016.

[25] A. H. M. Terpstra, J. A. Lapré, H. T. De Vries, and A. C. Beynen, "The hypocholesterolemic effect of lemon peels, lemon pectin, and the waste stream material of lemon peels in hybrid F 1 B hamsters," *Eur. J. Nutr.*, vol. 41, no. 1, pp. 19–26, 2002.

[26] J. M. García Beltrán, C. Espinosa, F. A. Guardiola, and M. Á. Esteban, "Dietary dehydrated lemon peel improves the immune but not the antioxidant status of gilthead seabream (Sparus aurata L.)," *Fish Shellfish Immunol.*, vol. 64, pp. 426–436, 2017.

[27] B. Gómez, B. Gullón, R. Yáñez, J. C. Parajó, and J. L. Alonso, "Pectic oligosacharides from lemon peel wastes: Production, purification, and chemical characterization," *J. Agric. Food Chem.*, vol. 61, no. 42, pp. 10043–10053, 2013.

[28] M. A. Salam, N. Jahan, M. A. Islam, and M. M. Hoque, "Extraction of Pectin from lemon peel: Technology development," *J. Chem. Eng. IEB*, vol. ChE27, no. 2, pp. 25–30, 2012.

[29] 2017 R.subasree, "Treatment of Wastewater using Banana and Lemon Peels as Adsorbents," vol. 4, no. 9, pp. 1289–1291, 2017.

[30] V. E. Wolf-Márquez, E. García-García, M. García-Rivero, G. Aguilar-Osorio, and M. A. M. Trujillo, "Batch and Pulsed Fed-Batch Cultures of Aspergillus flavipes FP-500 Growing on Lemon Peel at Stirred Tank Reactor," *Appl. Biochem. Biotechnol.*, vol. 177, no. 6, pp. 1201–1215, 2015.