Iraqi Lemon Peel Extract (Citrus limon) as Antibacterial and Antioxidant Agent

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Abstract: The plants are rich of metabolites that can be enter many fields of life, called phytochemicals. The most important features of phytochemicals are shown in human health. The natural components of plants can exhibit anti-diabetic, anti-inflammation, anti-viral, antifungal, antibacterial, antioxidant, and other properties with benefits to the human health. The bacterial resistance to the traditional drugs has opened the area of research to overcome this serious problem. Another contributor to health problems is oxidative stress, which is caused by an inadequate supply of antioxidants to counteract the free radicals. Lemon (*citrus limon*) has shown to contain wide spectrum of phytochemicals with therapeutic behavior. Our study was designed to investigate two types of lemon peels extract on microbes growth and free radical scavenging, one as pure peel oil, and the other is an extract by methanol. Our findings demonstrate that an extract of Iraqi lemon peel is an effective microbicidal agent, with significant growth suppression against Escherichia coli, Klebsiella sp., Staphylococcus epidermidis, Staphylococcus aureus, as well as Candida albicans. The ethanolic extract of the lemon peels has shown to be more effective against the growth of microbes. Furthermore, Iraqi lemon peel extract of both oil and ethanolic have exhibited an antioxidant activity comparable to the pure ascorbic acid. This features of lemon peels make it a very good candidate for natural therapeutic medicine.

Keywords: Lemon peels, antibacterial, antioxidants, antifungal.

1. Introduction

Treatment of infectious diseases with antimicrobial treatments has been shown in multiple studies [1, 2] to result in a significant rise in the prevalence of adverse effects, as well as the resistance which pathogenic bacteria build against numerous medicines. Nevertheless, extracts and physiologically active chemicals extracted from species of plants used in herbal therapy to treat infections have lately received attention [3, 4].

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Many different drug discovery projects have used plant extracts as a source of medicinal compounds, and many important medications have been identified and created from plants. Purifying the active ingredients of a drug or lead chemical requires a bioassay screening and otherwise pharmacological assessment to guide the isolation procedure [5].

Although several new medicines have been created by the pharmaceutical industry during the past three decades, antibiotic resistance among microorganisms has grown. Drug resistance is a desirable trait in a therapeutic agent, and it may be transferred across bacteria through their shared genetic material [6]. For a very long time, plants have served as a reliable supply of natural compounds that benefit human health. Antibacterial properties have been demonstrated for both plant extracts and phytochemicals, making them valuable therapeutic tools [7]. Chemicals generated during the secondary metabolism of several plants have been used for their antibacterial effects. Products like essential oils and tannin, which contain phenolic components, are used as markers [8].

The Rutaceae family contains roughly 160 genera, with citrus being the most important [9]. It is grown on all continents. Antioxidants like ascorbic acid, flavonoids, as well as phenolic compounds are abundant in citrus fruits and drinks. Citrus peels are a potential source of essential oils as an agroindustrial waste [10]. Peel oil is a valuable product that may be produced by effective recycling of citrus fruit peel, which is where the essential oil is most concentrated [11].

Lemon, a member of the family Rutaceae, has therapeutic properties. Lemon is used mostly for its anticancer alkaloids, although antibacterial activity of crude extracts from several parts of the Lemon (leaves, stem, root, juice, peel, and flower) has been documented against clinically significant bacterial strains [12]. Citrus flavonoids contain antibacterial, antifungal, anti-diabetic, anticancer, as well as antiviral properties [13, 14]. The components in the peel extract are directly related to their antimicrobial action [15].

Extensive research has demonstrated the antibacterial efficacy of several natural substances, including essential oils, protopine and corydaline alkaloids, lactons, polyacetylene, acyclic sesquiterpenes, hypericin, and pseudohypericin [16, 17]. In addition, citrus fruit has long been utilized in traditional Asian medicine to cure indigestion also improve bronchial as well as asthmatic disorders [18]. According to Johann et al., there is a wide range of biological activities that can be triggered by the secondary metabolites found in citrus cultivars. [19] and Ghasemi et al. [20]. Our study's primary objective was to determine whether or not an extract of lemon peel from Iraq might be used to limit the growth of free radicals and certain bacteria.

2. Materials and Methods

2.1. Preparation of lemon peels extract

The lemons used in this recipe came from the Wasit, Iraqi market. The fruit was meticulously washed, the pits removed, and the peels chopped into tiny pieces. Lemon fruit peels were used to make two different extracts. In the initial extraction, no solvent was used. Grape fruit peel oil was extracted by processing 100 grammes of peel pieces in a fruit juicer (Silvercrest, Germany). For the second extract, 100 g of peel pieces were soaked in 250 mL of 90% ethanol (Merck, Germany), the beaker was sealed with glass sealer, and the mixture was incubated in a water bath at 37 °C for three days. The extract solution was then concentrated by filtering and evaporating the solution.

2.2. Antibacterial examination

Iraqi lemon peel extracts were tested against E. coli and Klebsiella sp. from the Gram-negative bacteria category, Staphylococcus epidermidis and Staphylococcus aureus from the

Gram-positive bacteria category, and Candida albicans from the fungus category (Candida albicans). The well diffusion technique was utilised in Petri dishes. After creating two wells within that agar medium with a 5mm radius and adding either 50µL or 100µL of each extract, we saw the results. Following a day of incubation at 37 °C, the plates were measured for the size of the inhibitory zones brought on by the extract solutions.

2.3. Antioxidant examination

Extracts of lemon fruit peels were tested for their ability to scavenge the reactive oxygen species Diphenyl-1-picrylhydrazyl (DPPH) using a spectrophotometric technique [21]. Grapefruit peel extract (in ethanol) was diluted to various quantities (5, 10, 20, 50, and 100 µg/mL) in methanol (Merck, Germany) using ascorbic acid (as a reference). The DPPH was dissolved in methanol at a concentration of 0.36 g per 4 mL. The DPPH solution was diluted to 0.15mL with 3mL of any one of the produced concentrations and with deionized water for comparison. After letting the tubes sit in the dark for 30 minutes, we measured their absorbance at 517 nm to find out how much light they let in. For each substance, we used the following formula to determine its activity:

% Activity = $(A_{DPPH} - A_{test}) / A_{DPPH}$

3. Results and Discussion

3.1. Antimicrobial activity

Growth of the strains utilised in this investigation was inhibited by extracts from the peel of Iraqi lemon fruits, as shown in Table 1. The extracts from both plants are effective in inhibiting the growth of Gram-positive and -negative bacteria, and others coliforms. *albicans*. When comparing the concentrated oil with the ethanol extract, the latter was shown to have stronger antibacterial properties due to the presence of the solvent. This diveasion of lemon peels extract may result from the effect of the solvent itself, as well as the extract phytochemicals. The most significant inhibition zone was obtained for *S. aureus* by using ethanolic extract of the Iraqi lemon peels.

A previous study was performed by Dhanavade *et al.* [17] has concluded that lemon peels showed a powerful antibacterial effects against *Pseudomonas aeruginosa*, *Salmonella typhimurium*, as well as *Micrococcus aureus*. Furthermore, Moosavy *et al.* [11] have reported significant reduction of *S. aureus* strain caused by the extracted oil from lemon peels. Other studies have demonstrated the antimicrobial effects of lemon peels [22, 23]. On the other hand, Hindi *et al.* [15] have reported that lemon peel extract did not show as microbicidal agent against *E.coli*, *S. epidermidis*, and *C. albicans*.

Table 1: Barriers erected by grapefruit peel extracts.

Type of microbe	**Concentrated lemon peel extract**		**Ethanolic lemon peels extract**	
	50µL	**100µL**	**50µL**	**100µL**
E. coli	8	12.5	10.3	14.5
klebsiella sp.	10	14.1	12.8	14.1
S. epidermidis	12.5	16.8	12.1	15
S. aureus	11.5	13.2	13.6	17.1
Candida albicans	8.9	10	10.3	15.4

3.2. Antioxidant activity

Ascorbic acid's ability to quench DPPH is seen in Figure 1. Finding an IC50 value of 37.69 µg/mL (the quantity needed to produce 50% inhibition of DPPH) was successful. In contrast, the IC50 value of 33.92 µg/mL demonstrates that an oil extracts of lemon fruit peels is an effective antioxidant. The ethanolic extract's (Figure 3) IC50 of 37.59 µg/mL demonstrates antioxidant activity nearly as strong as that of pure ascorbic acid.

Citrus has shown to contain a wide spectrum of antioxidant materials. There are several beneficial compounds in lemon peels, including flavonoids, vitamins, minerals, dietary fibres, essential oils, organic acids, and carotenoids [24]. Thus, the remarkable antioxidant properties that has seen in lemon peels extracts are attributed to the presence of these materials.

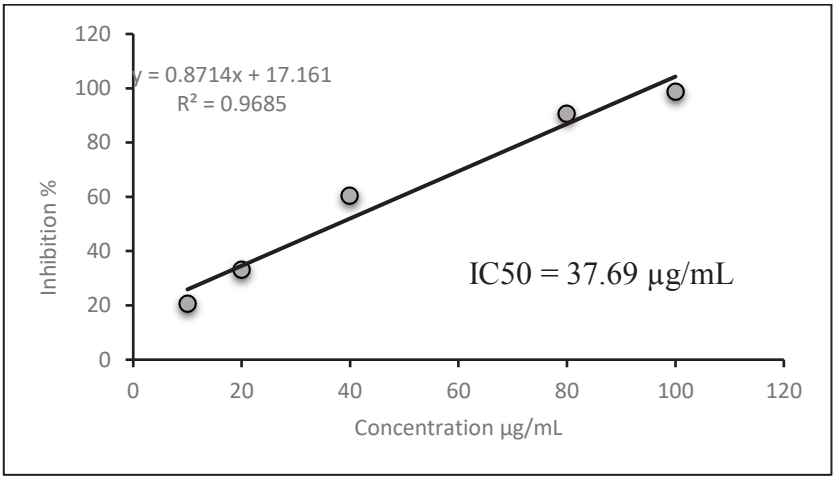

Figure 1: The effect of ascorbic acid against DPPH radicals.

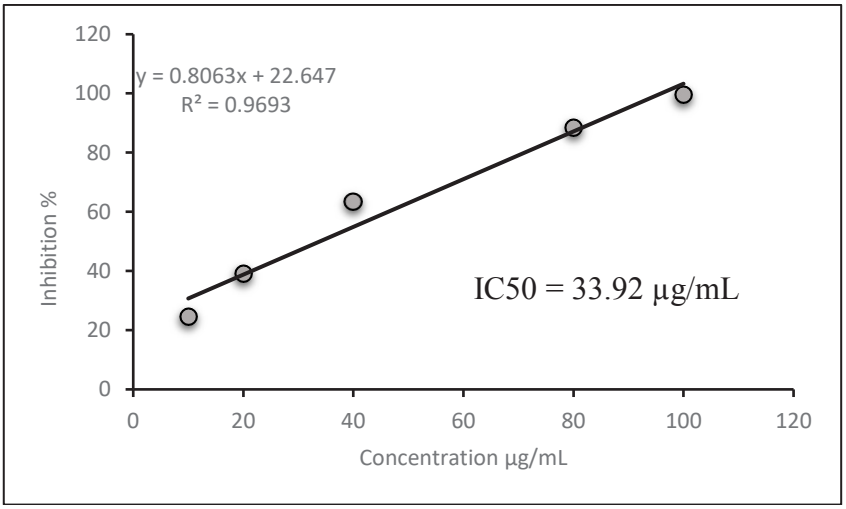

Figure 2: The effect of concentrated lemon peels oil against DPPH radicals.

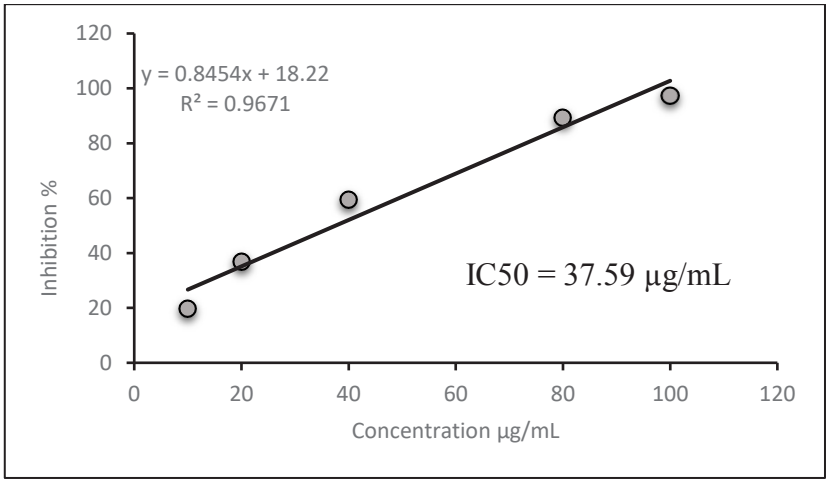

Figure 3: The effect of ethanolic lemon peels oil against DPPH radicals.

4. Conclusion

Our findings demonstrate that an extract of Iraqi lemon peel is an effective microbicidal agent, with significant growth suppression against Escherichia coli, Klebsiella sp., Staphylococcus epidermidis, Staphylococcus aureus, as well as Candida albicans. The ethanolic extract of the lemon peels has shown to be more effective against the growth of microbes. Furthermore, Iraqi lemon peel extract of both oil and ethanolic have exhibited an antioxidant activity comparable to the pure ascorbic acid. This features of lemon peels make it a very good candidate for natural therapeutic medicine.

5. Highlights

The study explores the therapeutic potential of phytochemicals in lemon peel that possess antimicrobial and antioxidant properties. The ethanolic extract of Iraqi lemon peel was effective against various microbes and showed antioxidant activity equivalent to ascorbic acid. The study suggests the potential of lemon peel as a natural therapeutic agent.

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