The Antimicrobial and Antioxidant Effects of Grapefruit (*Citrus paradise*) Peel Extract

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ABSTRACT

Phytochemicals are natural compounds found in different parts of the plant (seeds, fruit, peel, rout, etc.). Phytochemicals can exhibit a therapeutic property for many health problems including cardiovascular and metabolic disorders. Grapefruit (*Citrus paradise*) is one of the citrus family that are grown in different countries around the world. The documents have shown the abundance of many phytochemicals in the grapefruit including polyphenols, flavonoids, carotenoids, and vitamins. We have aimed to prepare two extracts of the grapefruit peels, one ethanolic extract and one concentrate oil of the peels. The antimicrobial and antioxidant properties of the two extracts were experimented. The peel extract of the fruit has shown a great potential in the inhibition of bacterial strains, fungus and scavenging the free radicals. The concentrate oil extract of the grapefruit peels has shown antioxidant properties that are close to the pure ascorbic acid with maximum inhibitory effect against *E. coli*, *S. epidermidis* and *S. aureus*. While the antioxidant properties of the ethanolic extract of grapefruit peel were much lower than the concentrate oil or ascorbic acid, it still a good choice with a best linear association. Furthermore, ethanolic extract has shown a maximum inhibitory effect against the growth of *klebsiella sp.* and *C. albicans* which may be attributed to the characteristics of the solvent.

Keywords: Citrus paradise, phytochemicals, DPPH, antibacterial

1. Introduction

The rising difficulties of antibiotic drug resistance by pathogenic organisms in recent decades has led to a continual search for novel antibiotic agents in natural plant products [1-4]. Many of these compounds are produced as secondary metabolites in plants and are frequently utilised by them to defend against microbial attack [4].

One of the most important members of the citrus genus is Citrus paradisi (Rutaceae). It's only found on the island of Barbados. Commercial grapefruit is grown in Spain, Morocco, Jordan, South Africa, Brazil, Mexico, Jamaica, and Asia [5]. Grapefruit cultivars were developed mostly in Florida and Texas, USA [6]. Citrus is a valuable fruit in the world's produce because of its nutritional worth. Citrus is a member of the Rutaceae family that originated in the subtropics and is recognized for its semi-sweet flavor. Numerous studies have been conducted to determine the chemical composition and antibacterial properties of essential oils extracted from the peel of various citrus species due to its nutraceutical and economic value [7].

Citrus fruits' peels are high in flavanones and polymethoxylated flavones, which are uncommon in other plants [8]. These chemicals are not only crucial for human health and the environment, but they also have a wide range of economic applications in the food as well as pharmaceutical industries. Naringin and hesperidin have a wide range of biological effects, including antioxidant, antimutagenic, analgesic, and anti-inflammatory properties. Star Ruby grapefruits (C. paradisi) and Sanguinelli oranges (C. sinensis) (Spain) were found to have antifungal properties against Penicillim digitatum [6].

Citrus essential oils have a wide range of biological actions, including antibacterial, antioxidant, anti-inflammatory, and anxiolytic properties [9, 10]. These antimicrobial capabilities have been proven to have a wide range of applications in the food business [11], for veterinary use [12, 13], human medicine [14, 15] and plants for agricultural production [16]. Our goal is to prepare two different extracts of grapefruit peels, one with ethanol as a solvent and the other without using solvent and investigate their antimicrobial and antioxidant effects.

2. Materials and Methods

2.1. Preparation of peel extracts

Iraqi grapefruit was purchased from the local market in Wasit – Iraq. The fruits were washed and cleaned perfectly, and the peel was removed and cut to small pieces. Two extracts from the peel pieces of the grapefruit were prepared. The first extract was without using any solvent. 100g of peel pieces were placed in the fruit juicer (Silvercrest, Germany) and a concentrated oil of the grape fruit peel was obtained. The other extract was prepared by adding 100g of peel pieces in 250mL 90% ethanol (Merck, Germany) and sealed the beaker with glass sealer, then the beaker was placed in the waterbath for 3h at 60 °C. The beaker was placed at the room temperature to cool dawn before opining the sealer.

2.2. Antimicrobial test

The extracts of grapefruit peels were examined against two Gram negative bacterial strains e*scherichia coli* and *klebsiella* sp, and two Gram positive bacterial strains *Staphylococcus epidermidis* and *Staphylococcus aureus*, as well as one fungi (*Candida albicans*). In Petri dishes, well diffusion method was used. Two wells in the agar medium were made in a radius of 5mm, and 20µL or 40µL of each extract were added to the corresponded wells. The plates were incubated at 37 °C for one day, and the inhibition zones were determined in mm.

2.3. Antioxidant activity

The activity of the grapefruit peels extracts to scavenge Diphenyl-1-picrylhydrazyl (DPPH) was determined in a spectrophotometric method [17]. A series of concentrations in methanol (Merck, Germany) of each of ascorbic acid (as a standard), concentrate grapefruit peel oil, and the ethanol grapefruit peel extract were prepared (5, 10, 20, 50, and 100 µg/mL). A weight of 0.36 g of DPPH was dissolved in 4mL methanol. 0.15mL of the DPPH solution was mixed with 3mL of each of the prepared concentrations, and with deionized water as control. The tubes were allowed to stand in dark for 30 minutes, then the absorbance of each tube was determine at 517 nm. The activity of each material was calculated from the following equation:

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

3. Results and Discussion

3.1. Antimicrobial activity

Table 1 contain the inhibition zones that created by the grapefruit peel extracts against the growth of the strains that have been used in this study. Both extracts have shown good inhibitory effects against Gram positive and negative bacteria, as well as *C. albicans*. There were differences between the concentrated oil and the ethanol extract. The maximum inhibition of *E. coli* was obtained by the concentrated oil extract at 40µL, this was observed for *S. epidermidis* and *S. aureus*. On the other hand, ethanolic extract of grapefruit peels was shown the maximum inhibitory effect against the growth of *klebsiella sp.* and *C. albicans*. Okunowo *et al.* have reported that peel oil extract of grapefruit have an antimicrobial effect against the growth of several Gram positive and Gram negative bacterial strains. The authors were also reported an antifungal effects of the extract

[18]. Al-Ogaili and Yasin have reported that Iraqi grapefruit peels exhibited an antimicrobial activity against the growth of *E. coli*, *S. epidermidis*, *S. aureus*, *klebsiella sp.*, and *C. albicans*. The authors have found that between all of the phytochemical components of the grapefruit peels, flavonoids were the most effective as antimicrobial agents [19]. Few other studies were reported an antimicrobial and antifungal activities of the grapefruits from different origins [7, 20, 21].

Table 1: Inhibition zones of the grapefruit peel extracts.

Type of microbe	Concentrated oil extract		Ethanol extract	
	20µL	40µL	20µL	40µL
E. coli	10.5	14.3	5.2	7.5
klebsiella sp.	8.5	12.4	10.4	13.2
S. epidermidis	9.1	13.5	9.5	10
S. aureus	11.2	14.8	7.6	10.5
Candida albicans	8.6	10.1	9.2	10.8

3.2. Antioxidant activity

Figure 1 shows the effect of ascorbic acid to scavenge DPPH. The IC50 (the concentration of the materials that required to cause 50% inhibition of DPPH) was obtained as 30.58 µg/mL. On the other hand, the concentrated oil extract of grapefruit peels (Figure 2) has shown to be a good antioxidant agent with an IC50 value 35.22 µg/mL. The ethanolic extract has shown the less activity among the three tested materials, in which the IC50 was obtained as 46.70 µg/mL.

The peels of the grapefruit has been documented to have many phytochemicals including flavonoids, carotenoids, and vitamin C and total phenolic compounds which all have an antioxidant activity [22, 23]. The grapefruit essential oil contained approximately 94% of limonene which possess an excellent antioxidant activity [24]. Several studies have reported the exhibition of good antioxidant properties from different extracts of grapefruit peels [25-28].

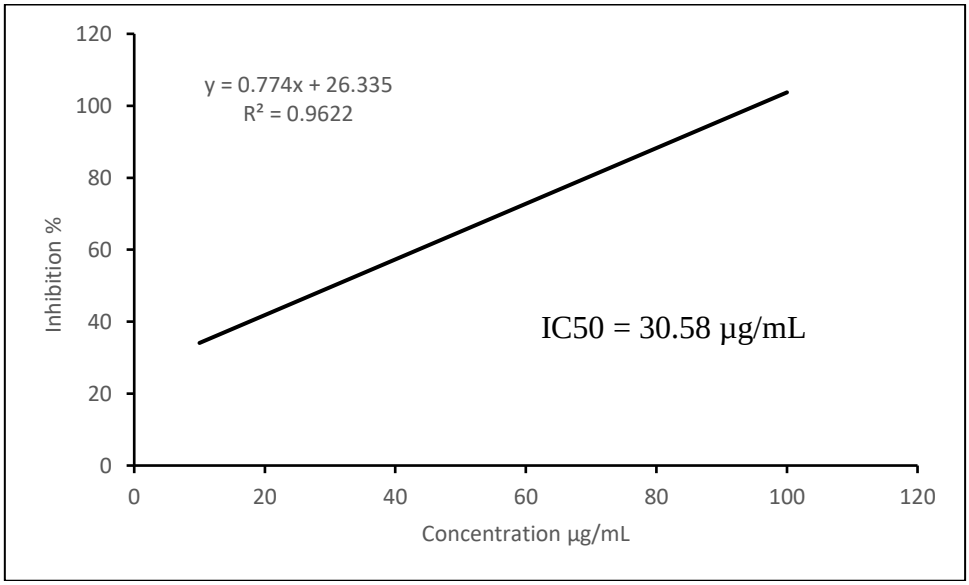

Figure 1: The antiradical activity percentage of ascorbic acid.

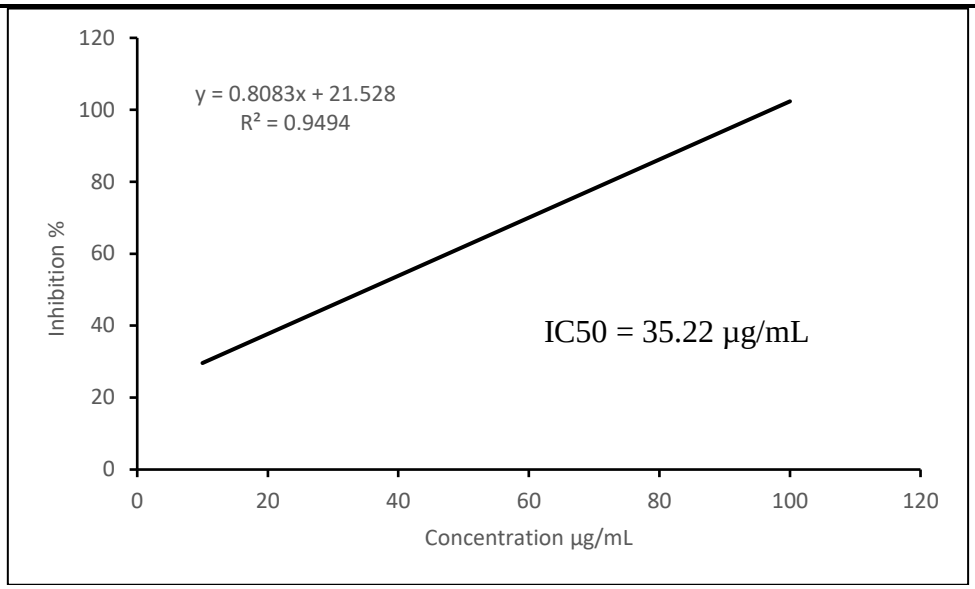

Figure 2: The antiradical activity percentage of concentrated oil.

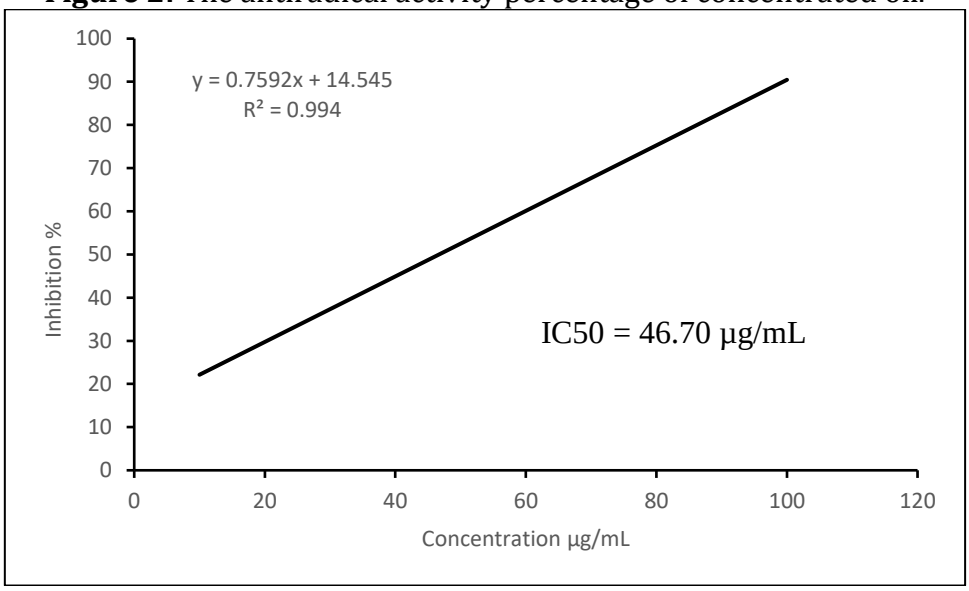

Figure 3: The antiradical activity percentage of ethanolic extract.

Conclusion

Grapefruit is full of phytochemicals with therapeutic potentials. The peel extract of the fruit has shown a great potential in the inhibition of bacterial strains, fungus and scavenging the free radicals. The concentrate oil extract of the grapefruit peels have shown antioxidant properties that are close to the pure ascorbic acid with maximum inhibitory effect against *E. coli*, *S. epidermidis* and *S. aureus*. While the antioxidant properties of the ethanolic extract of grapefruit peel were much lower than the concentrate oil or ascorbic acid, it still a good choice with a best linear association. Furthermore, ethanolic extract has shown a maximum inhibitory effects against the growth of *klebsiella sp.* and *C. albicans* which may attributed to the characteristics of the solvent.

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