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Evaluation of In-Vitro Antimicrobial Activity of *Coriandrum Sativum* and *Foeniculum Vulgare* Aqueous Extracts

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ABSTRACT

The present study has been designated to evaluate the antimicrobial activity of *Coriandrum sativum* and *Foeniculum vulgare* aqueous extracts. The antimicrobial activity of the extracts against five bacterial strains and two fungal strains were tested by using agar well diffusion method and minimal inhibitory concentration MIC values. Results showed that aqueous extracts of *C. sativum* and *F. vulgare* had antibacterial and antifungal effects against all the tested microorganisms, wherease Nystatin failed to show any effect against *C.cladosporides*. The range of MIC values was 0.7 to 6.2 mg/mL in the *F. vulgare* and *C. sativum* treatments. Therefore, results suggest that these extracts contain antimicrobial compounds that can be used in the future as antimicrobial agents in the new drugs for human microbial diseases.

Keywords: Antimicrobial activity, *Coriandrum sativum, Foeniculum vulgare*

Coriandrum Sativum ve *Foeniculum Vulgare* Sulu Ekstrelerinin İn Vitro Antimikrobiyal Aktivite Değerlendirilmesi

ÖZET

Bu çalışma *Coriandrum sativum* ve *Foeniculum vulgare* sulu ekstrelerinin antimikrobiyal aktivitesini değerlendirmek üzere tasarlanmıştır. Ekstrelerin antimikrobiyal aktivitesi beş bakteri suşu ve iki mantar suşuna karşı agar kuyu difüzyon metodu ve MİK (minimum inhibitör konsantrasyon) değerleri kullanılarak test edilmiştir. Sonuçlar, sulu *C. sativum* ve *F. vulgare* ekstrelerinin test edilen tüm mikroorganizmalara karşı antibakteriyel ve antifungal aktiviteye sahip olduğunu, Nystatin'in ise *C.cladosporides*'e karşı herhangi bir etki göstermediğini göstermiştir. *F. vulgare* ve *C. sativum* aktiviterlerinde MİK değerleri aralığı, 0.7 ile 6.2 mg/mL olarak tespit edilmiştir. Bu nedenle sonuçlar, bu bitki ekstrelerinin antimikrobiyal bileşikler içerdiğini önermektedir ve böylelikle gelecekte insan mikrobiyal hastalıkları için yeni antimikrobiyal ajanlar olarak kullanılabilecektir.

Anahtar kelimeler: Antimikrobiyal aktivite, *Coriandrum sativum, Foeniculum vulgare*

1. INTRODUCTION

In recent years, many drug resistance pathogenic microorganisms have been appeared due to the indiscriminate use of antimicrobial drugs that are common in the treatment of infectious diseases (Service, 1995). Both of *Coriandrum sativum* (in Arabic Kuzbarah) and *Foeniculum vulgare* (in Arabic Shbint or Shamar) belonging to the Apiaceae family. Traditionally used as carminative, stomachic, antispasmodic, diuretic, aphrodisiac and stimulant in Iraqi traditional medicine (Al-Rawi & Chaakravarty, 1964).

Recently, a number of researchers throughout the world has investigated the antimicrobial properties of these two plants. Essential oils extracted from the leaves and seeds of the of *C. sativum* demonstrated antimicrobial activity against the food-borne pathogenic bacteria (Rezaei, Karimi, Shariatifar, Mohammadpourfard, & Malekabad, 2016). AgNPs that are green synthesized by using *C. sativum* showed a big potential in biomedical applications like anti-acne, anti-dandruff and anti-breast cancer. (Sathishkumar et al., 2016). Aelenei and colleagues study showed synergistic interactions between linalool, coriander essential oil, and antibiotics against Methicillin-resistant Staphylococcus aureus and other Gram-positive bacteria, but also Gram-negative bacteria (Aelenei et al., 2019). Compounds like linoleic acid, oleic acid, 1,3-benzenediol, undecanal, and 2,4-undecadienal which isolated from *F. vulgare* var. dulce showed antimycobacterial activity against all tested strains (Esquivel-Ferriño et al., 2012). Different seed extracts of *F. vulgare* exhibit moderate to good inhibition against various bacterial strains (Salami, Rahimmalek, & Ehtemam, 2016). The essential oils derived from *F. vulgare* showed a promising anti-Candida effect (Khoram et al., 2019). The present study was designed to investigate antimicrobial activity of aqueous extract of the two plants seeds against five bacterial strains and two fungal strains.

2. MATERIALS AND METHODS

2.1. Plant Materials and Preparation of Aqueous Extract

Fresh *C. sativum* and *F. vulgare* seeds were purchased from the local markets of Tuzhurmato city in 2017. Voucher Specimens (No. 201782 and 201783, respectively) were deposited in the Herbarium of Faculty of Science, Tikrit University, Tikrit, Iraq. Aqueous extract of plants were prepared by Abdel-Barry and colleagues method (Abdel-Barry, Abdel-Hassan, Jawad, & Al-Hakiem, 2000). Dried seeds were grinded by electric grinder to a fine powder. Fifty grams of plant materials were suspended in 250 mL of distilled water and then stirred magnetically for 24 hours at 50 °C. Then suspensions were filtered (Whatman No.1) and evaporated to dryness under reduced pressure at 40 °C, to get dry residue 6.40 g (12.8%) and 7.05 g (14.1%), respectively.

2.2. Antimicrobial Activity

Microbial strains, namely *Staphylococcus aureus*, *Streptococcus pyogenes* (Gram-positive bacteria), *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae* (Gram-negative bacteria), *Candida albicans* and *Cladosporium cladosporides* (Fungi) were used in this study. The bacterial strains were grown in Muellar-Hinton Agar (MHA) at 37 °C (10^6 cells/mL). The fungal strains were cultured in Sabouroud Dextrose Agar (SDA) medium at 25 ± 2 °C (10^6 conidia /mL). The agar well diffusion method was performed for antimicrobial activity (Parthiban, Manivannan, Ramanibai, & Mathivanan, 2019), then 100 µl of different concentrations of (50, 75 and 100 µg/mL) plant extracts and standard antimicrobial

agents: Gentamycin (10 µg/mL) and Nystatin (0.25 µg/mL) were prepared using dimethyl sulphoxide (DMSO) as solvent. The inhibition zone was measured using zone scale after 24 h incubation at 25 °C for fungal strains and 37 °C for fungal strains. Tests were performed in triplicate and obtained values (average values) of the inhibition zones were expressed (Das, Livingstone, Veluswamy, & Das, 2018).

2.3. **MIC assay**

The minimal inhibitory concentration (MIC) can be expressed as the lowest concentration of a compound that inhibits the growth of microorganism (lower MIC value, higher antimicrobial efficacy). MIC values were determined by dissolving the samples in distilled water to give a final concentration of 625mg/mL. Then diluted serially to give concentrations of 1.22 to 625 mg/mL. From each concentration 100 µL was added to well (96-well microplate) already containing 100 µL of Mueller Hinton Broth (MHB) and 100 µL of inoculum, microbial suspensions adjusted to 0.5 McFarland turbidity standards (for bacteria 10^8 CFU/mL and for fungal strains 10^6 CFU/mL). Culture media (without microorganisms) was used as negative control. The plates were incubated at 37 °C for 24 hours for bacteria and for 72 hours for fungi. Microbial growth was assessed by measuring absorbance at 600 nm.

2.4. **Statistical Analysis**

The values are given as mean±SD. The data were analyzed by ANOVA followed by post hoc test using computerized software SPSS (Version 7.5). *P*-value less than 0.05 were defined as statistically significant.

3. **RESULTS**

The results showed that aqueous extract of *C. sativum* and *F. vulgare* have a dose dependent antibacterial and antifungal effects against all the tested microorganisms. The extracts have significantly higher effect in comparsion with Gentamicin, wherease Nystatin failed to show any effect against *C.cladosporides* (Table 1).

The range of MIC values was 0.7 to 6.2 mg/mL in the *C. sativum* and *F. vulgare* treatments. In the tested fungal strains, have the lowest recorded MIC (1.5 µg/mL) in the *F. vulgare*. For the bacterial strains the lowest recorded MIC (0.7 µg/mL) was for *E. coli* (Table 2).

Table 1. Antimicrobial activity of *Coriandrum sativum* and *Foeniculum vulgare*

Microbial strains	*C. sativum* (µg)			*F. vulgare* (µg)			Positive control
	50	75	100	50	75	100	
Candida albicans	15.1 ± 0.16 c	16.2 ± 0.37 b	17.0 ± 0.81 a	11.4 ± 0.21 c	11.2 ± 0.21 b	11.8 ± 0.38 a	12.2 ± 0.92 h
Cladosporium cladosporides	10.2 ± 0.29 bc	10.3 ± 0.16 ab	10.5 ± 0.64 a	11.1 ± 0.16 bc	11.5 ± 0.37 ab	11.4 ± 0.17 a	0.0 ± 0.0 k
Escherichia coli	10.4 ± 0.16 bc	10.6 ± 0.14 b	11.2 ± 0.24 a	9.2 ± 0.21 de	9.8 ± 0.12 d	10.3 ± 0.84 c	9.3 ± 0.18 e
Pseudomonas aeruginosa	10.2 ± 0.19 de	10.5 ± 0.24 d	11.2 ± 0.11 c	11.3 ± 0.84 bc	11.7 ± 0.37 b	12.2 ± 0.56 a	9.2 ± 0.49 fg
Klebsiella pneumoniae	11.4 ± 0.17 bc	11.5 ± 0.63 ab	12.3 ± 0.29 a	10.4 ± 0.33 ef	10.5 ± 0.16 de	11.0 ± 0.62 cd	9.5 ± 0.43 de
Staphylococcus aureas	11.2± 0.70 d	12.3 ± 0.17 bc	13.1 ± 0.21 a	10.5 ± 0.32 e	12.4 ± 0.16 c	12.7 ± 0.14 b	10.1 ± 0.28 f
Streptococcus pyogenes	8.1 ± 0.23 f	8.7 ± 0.11 d	9.2 ± 0.22 b	8.5 ± 0.74 e	9.2 ± 0.16 c	9.9 ± 0.14 a	8.3 ± 0.47 f

Horizontally: the different letters means there are statistically significant difference.

Table 2. Minimal inhibitory concentration (MICs) of *Coriandrum sativum* and *Foeniculum vulgare*

Microbial strains	**MIC (µg/mL)**	
	C. sativum	*F. vulgare*
Candida albicans	2.5	1.5
Cladosporium cladosporides	4.6	6.2
Escherichia coli	3.5	0.7
Pseudomonas aeruginosa	2.5	1.5
Klebsiella pneumoniae	1.5	1.5
Staphylococcus aureas	2.7	1.5
Streptococcus pyogenes	1.5	2.5

4. DISCUSSION

The antimicrobial activity of *F. vulgare* and *C. sativum* aqueous extracts were tested in the present study and its potency was evaluated by the presence or absence of inhibition zones, zone diameters and MIC values. The extract may be work by one or both of the following mechanisms: disrupt cytoplasmic membrane of the microorganisms by its effect on lipids and proteins (Rose, 2014) or penetration the active sites of specific enzymes inside the microorganisms which is imported for their multiplication (Al-Jasim & Barakat, 1973). The basis of varying degree of sensitivity of tested microorganisms of both bacteria and fungi to plant extract may be explained by the intrinsic tolerance of microorganisms and the phytocompounds types existed in the plant extracts. Essential oils, tannins, coumarins and glycosides were the major phytochemicals that detected in both plants (Rather, Dar, Sofi, Bhat, & Qurishi, 2016; Wei et al., 2019), these phytochemicals are known to have antimicrobial activity (Li, Aioub, Lv, Hu, & Wu, 2019; Matasyoh, Maiyo, Ngure, & Chepkorir, 2009). Therefore, these results suggest that these extracts possess compounds with antimicrobial properties that can be used as antimicrobial agents in new drugs for therapy of human microbial diseases. Further detailed scientific evaluation of these plants should be carried out on the base of active compounds, as well as the mechanism of antimicrobial activity.

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