Antimicrobial and Antioxidant Activities of the Essential Oils from Different Organs of Ferula Communis L. growing Wild in Algeria

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Abstract

Ferula communis, is an aromatic plants, widely used in Algerian traditional medicine. This study, examined for the first time, the antioxidant and the antimicrobial properties of essential oils (EOs) from diverse organs of this species growing wild in Algeria. The EOs were tested against six microorganisms using the disc diffusion method. The rhizome EO showed the highest antimicrobial activities, followed by seed EO. Inflorescence and leaf EOs were similarly active in the third position. The antioxidant activity was determined using the DPPH free radical scavenging system. The results showed that the EOs isolated from diverse organs of *F. communis* exhibited a weak DPPH radical scavenging activity. Therefore based on the good antimicrobial activities showed in this study, EOs from *F. communis*can be used as antimicrobial agent.

Keywords *Ferula communis*L., Essential oils, organs, Antimicrobial activity, Antioxidant activity.

1. Introduction

The genus *Ferula* is one of the most important taxa of the Apiaceae family and comprises around 170 species, distributed between central Asia and all Mediterranean regions includes North Africa[1]. In Algeria this genus is represented by five species: *F. lutea* (Poiret) Maire, *F. Cossoniana* Batt. etTrab., *F. communis* L., *F. tingitana* L. and *F. vesceritensis*Coss. etDur. [2].

Ferula communis, locally known as “Kechbour” or “Kalkha”, is a latex□containing perennial plant.The leaves arevery larges with narrowly linear, filiform segments, 0.5-0.8 mm wide, 2-4 cm long. The stem (2-3 meters high) is wide (3-7 cm in diameter), full, very robust and finely streaked. The terminal umbel is great and composed of fertile bright yellow flowers distributed in 20 to 30 rays. The fruit (mericarp), of variable length (7-15 mm), is ovoid or rectangle-ovoid highly compressed dorsally. The fruit (mericarp) is ovoid or rectangle-ovoid strongly compressed dorsally, the length is varied between 7 and 15 mm. *F. communis* has a well-developed, strong root system [2, 3].

F. *communis*is often used in traditional medicine as a treatment for skin diseases, rheumatism, helminthic diseases, joint pain, infertility, hysteria and dysentery. This species is also endowed with an antispasmodic, vermifuge, aphrodisiac effect and can be used as a depilatory, emetic, diuretic and analgesic. [3, 4]. However, despite the ethnopharmacological importance of *F. communis*, very few studies have been done on the antioxidant or antimicrobial power of its essential oils [5, 6] or extracts [7-10]. However, to the best of our knowledge after a careful literature search, no study or work has been reported on the biological activities of essential oils (EOs) isolated from the organs of *F. communis* growing in the wild in Algeria. Thus, the aim of this work is to evaluate the antimicrobial and antioxidant activities of EOs from different organs (rhizomes, leaves, inflorescences and seeds) of *F. communis*growing in Algiers.

2. Material and Methods

2.1. Plant material

The different plant organs (rhizomes, leaves, inflorescences and seeds) were collected during the flowering period and after flowering period for seeds (April-June 2015) from a wild population of *F. communis* grown in Bouzareah commune, Algiers, Algeria (Latitude: 3° 31′ 53″ N, Longitude: 5° 59′ 28″E, Altitude: 28 m above sea level).

The botanical authentication of plant was confirmed in the botanical department of National Height School of Agronomy (ENSA), Algiers, Algeria, where a voucher specimen was deposited in the national herbarium. After harvesting, the samples were dried in a shade at ambient temperature in a well-ventilated area and then they were carefully ground just before hydrodistillation.

2.2. Essential oil extraction

The EOs were obtained from powdered plant organs subjected to hydrodistillation in a Clevenger-type apparatus for 3 h. The oils were collected directly, without any solvent, dried over anhydrous sodium sulfate (Na_2SO_4) and stored in sealed vials at 4°C until used.

2.3. Antimicrobial activity

2.3.1. Tested microorganisms

Six microorganisms were tested including two bacterial strains: *Staphylococcusaureus* (ATCC 6538) and *Bacillussubtilis* (ATCC 9372), four strains of fungi including one potentially pathogenic yeast: *Candidaalbicans*(ATCC 10231) and three filamentous phytopathogenic fungi: *Aspergillus niger*(ATCC 2601), *Aspergillus fumigatus*, *Fusarium oxysporum*f. splini (n° Foln 3-5) (NRRL 1829). All the used microorganisms were provided by the laboratory of microbial systems (LBSM), ENS, Kouba, Algiers.

2.3.2. Antimicrobial test

The antimicrobial activities was determined using disk diffusion method [11]. The microorganisms were cultured on Muller Hinton (MH) agar media for bacteria and Sabouraud dextrose for yeasts and fungi. The inoculums were suspended in 10 mL sterile water (0.9% NaCl) and adjusted to a turbidity of 0.5 MacFarland standards (10^6 $CFUml^{-1}$). 100µL of these suspensions were prepared with 20 mL of agar media (Mueller Hinton or Sabouraud dextrose), and then poured into a Petri dish. Sterilized paper disks (6 mm in diameter) soaked with EO were deposited in the middle of each agar plate. Negative tests were set using similar solvent (methanol) utilized to dissolve the samples without EO. The plates were incubated at 37°C/24 h for bacteria and at 30°C/48 h for fungi and yeast. After incubation, the antimicrobial activity was estimated by measuring the inhibition zone diameter (mm) surrounding each disk (including disk diameter).

The sensitivity of a germ is zero for a diameter less than or equal to 8 mm. Sensitivity is limited for a diameter between 8 and 14 mm. It is average for a diameter between 14 and 20 mm. For a diameter greater than or equal to 20 mm, the germ is very sensitive [12].

2.4. Antioxidant activity

The antioxidant activity of the essential oil of different organs of *F. communis* was determined spectrophotometrically using DPPH (2,20-diphenyl-1-picrylhydrazyl) free radical scavenging method [13]. In this method, one milliliter of a freshly prepared ethanolic solution of DPPH (0.004%)was added to 1 mL of each essential oil, in a concentration of 2 mg/mL. The mixture was vigorously shaken and left to stand at room temperature for 30 min in the dark. The absorbance was measured against a blank at 517 nm. Inhibition of free radical by DPPH in percent (I %) was calculated following this formula:

$$I\,(\%) = [(AC - AS)/AC] \times 100$$

Where AC is the absorbance of control reaction (containing the equal volumes of DPPH solution and methanol without any sample) and AS is the absorbance of the sample (plant extracts or standards).

3. Results and discussion

3.1. Antimicrobial activities

The antimicrobial activity of the essential oils of different organs of *F. communis*was evaluated against a panel of six microorganisms and their potency was assessed by measuring of the inhibition zone diameters. Results obtained are given in Figure 1 and 2.

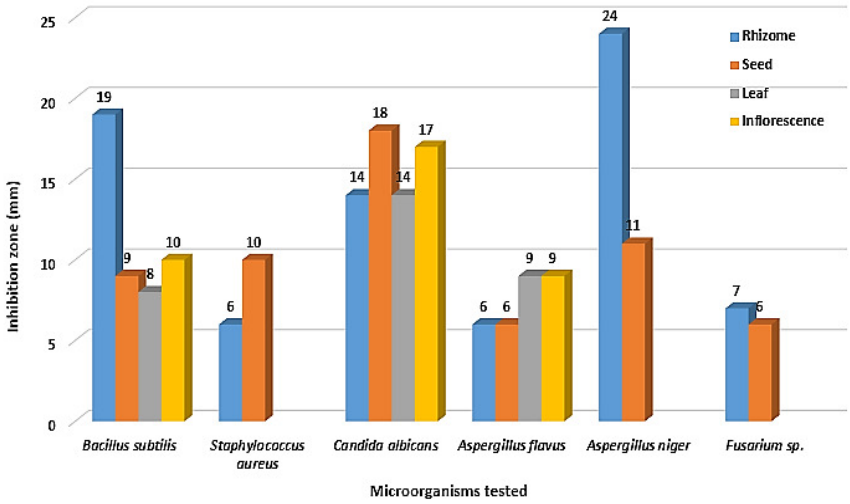

Fig. 1 Antimicrobialactivities (Inhibition zone in mm) of essential oils from different organs of *F. communis*

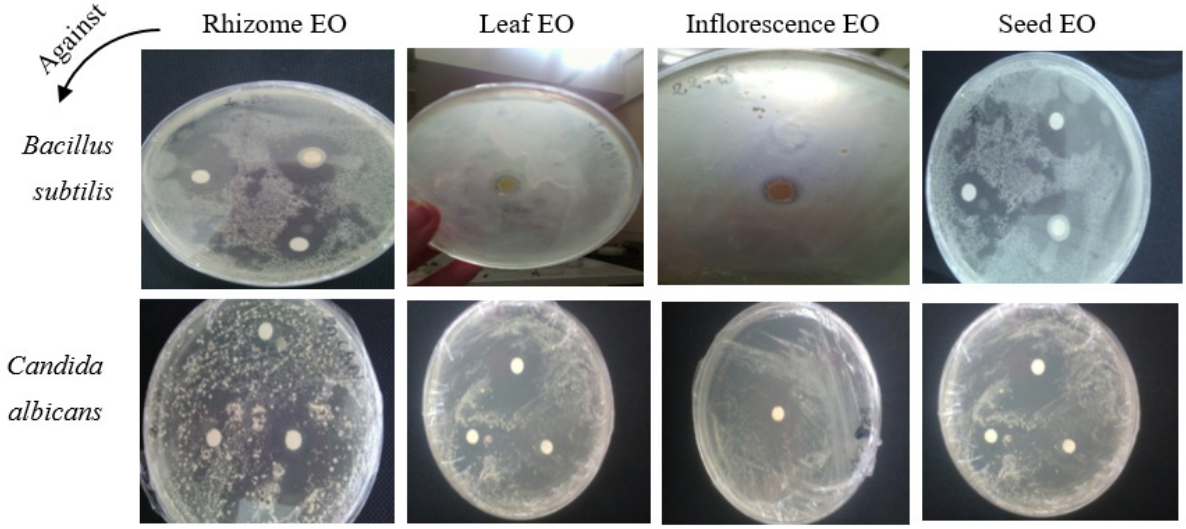

Fig. 2 Antimicrobial activities (Inhibition zone) on Petrie dishes of some selected essential oils of *F. communis*

As seen in Figure 1 and Figure 2 (for some selected EO) the four EOs were differentially effective against the target microorganisms. Inhibition zone values varying between 6 mm and 19 mm for bacteria, between 6 mm and 24 mm for filamentous fungi and between 14 mm and 18 mm for the single yeast studied. For a better illustration, figure 3 shows the cumulative inhibition zones of each EO of *F. communis* towards the six strains tested. According to this evaluation system, rhizomes EO was the most active with a cumulative area of 76 mm. Thus, seed EO is classified in second position with good inhibitory activity of an inhibition zone of 60 mm. While, inflorescence and leaf EOs were similarly active in the third position with cumulative zones of inhibition of 36 and 31 mm respectively.

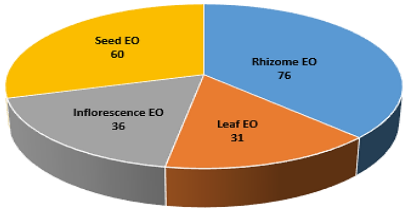

Fig. 3 Cumulative antimicrobial activities (inhibition zone in mm) of each EO of *F. communis* against the six target strains

Figure 4 shows the cumulative inhibition zones of the four EOs of *F. communis* on each of the strains of microorganism tested. The microorganisms studied did not show the same sensitivity to the EOs tested. The yeast *Candida albicans*, with a cumulative inhibition zone of 63 mm, was the most sensitive to the action of the EO, while the fungus *Fusarium* sp. and the bacterium *Staphylococcus aureus* have shown remarkable resistance (cumulative zone of inhibition = 13 and 16 mm, respectively). It should also be noted that the fungal strains tested showed a very variable vulnerability towards the four oils. The *Candida albicans*yeastwas the most sensitive (63 mm) and the fungus *Fusarium* sp. was the most resistant (13 mm).

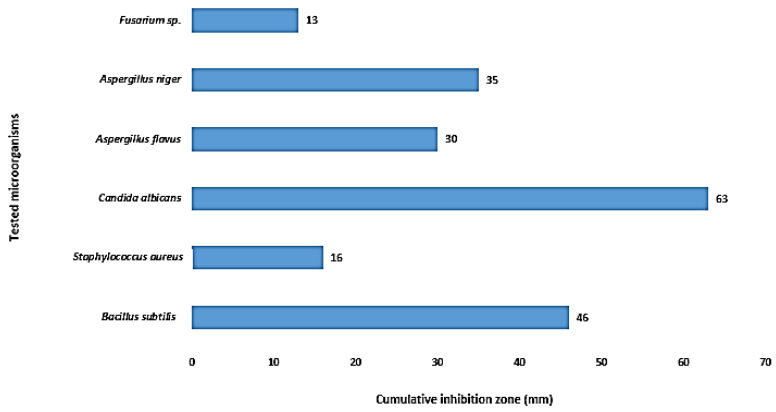

Fig. 4 Sensitivity/resistance (cumulative inhibition zones in mm) of the six target microorganisms towards the four EOs of *F. communis*

Dadasoglu*et al*. [6] have reported that the essential oil extracted from aerial parts of *F. communis*grown in Turkey has bactericidal power against several strains of Chryseobacteriumindologenes which are mainly bronchopulmonary pathogens. According to the literature survey on the antimicrobial activity of *F. communis* EOs from different organs, only one study has been published[5]. Neguir*et al*. [5] have asses the antibacterial activity of flowers, leaves, stems and roots of *F. communis* grown in Tunisia. They reported that in general the essential oils studied possessed extremely moderate activity potential and that the best results were revealed by the essential oil of the leaves towards*Pseudomonas aeruginosa.*The essential oils tested by these authors presented an important variety of sesquiterpenes, which could be the source of this antimicrobial activity [14-16]. Previous investigation [17] on Algerian *F. communis* demonstrated that its areal parts EO was rich in myrcene (52.5%), α-pinene (20.9%) and α-phellandrene (7%), which have been already reported to possess strong antimicrobial activities [18, 19]. Therefore, we can suggest that the good antimicrobial activity of our EOs is perhaps due to their richness in these compounds in parallel with other active components.

3.2. Antioxidant activity

The antioxidant activity of essential oils is another important biological power responsible for the preservation of the organic matter of food against oxidizing agents.In addition, essential oils that have the ability to scavenge free radicals can play an important role in the prevention against some current diseases such as cancer and heart disease[20]. Here free radical scavenging was measured by using DPPH system. The scavenging activity of the essential oils was tested at concentration of 2 mg/mL.Carvacrol and BHT were usedas standard and potential antioxidant agents. The highest DPPH radical scavenging activity (%) was shown by rhizome essential oil (24.69 %). Leaf, seed and inflorescence essential oils exhibited nearly the same radical scavenging activity (11.18, 10.2 and 11.99%, respectively) which was lower than the antioxidant activity of the standards (BHT and carvacrol, Figure 5). The results revealed that the essential oil isolated from diverse organs of *F. communis* exhibited a weak DPPH radical scavenging activity. The antioxidant activity of essential oils from different organs of Tunisian *F. communis*was determined by Neguir*et al*. [5] using three different technics: DPPH, ABTS (2,2'-azinobis-3-ethylbenzothiazoline-6-sulfonic acid) and reducing power assay. According to the ABTS assay results, the essential oils of the four parts of *F. communis*showed weak antioxidant activity. The antioxidant activity of *F. communis* stem EO showed moderate ability for scavenging DPPH free radicals, when compared to the reference (BHT). As well as, the same EO had the highest antioxidant capacity relative to leaves, flowers, and roots (which had the weakest activity against the three antioxidant assays), when measured through the reducing power's assay. Contrary to our results, Dadasoglu*et al.* [6] reported a potential DPPH radical scavenging activity of EO extracted from aerial part of *F. communis*grown in Turkey. Rahali*et al*. [9], evaluated the

antioxidant properties of different methanolic extracts from *F. communis*aerial organs using different experimental models. Their results showed that antioxidant activities vary widely among different organs. Flower exhibited higher DPPH scavenging capacity than stem and fruit. The same result was found with the other techniques used to assess the antioxidant activity. It was reported also in this previous study that flower extracts have the highest total phenolic content. Thus, the high antioxidant activity of flower extract could be due to the phenolic compounds present in the extracts.

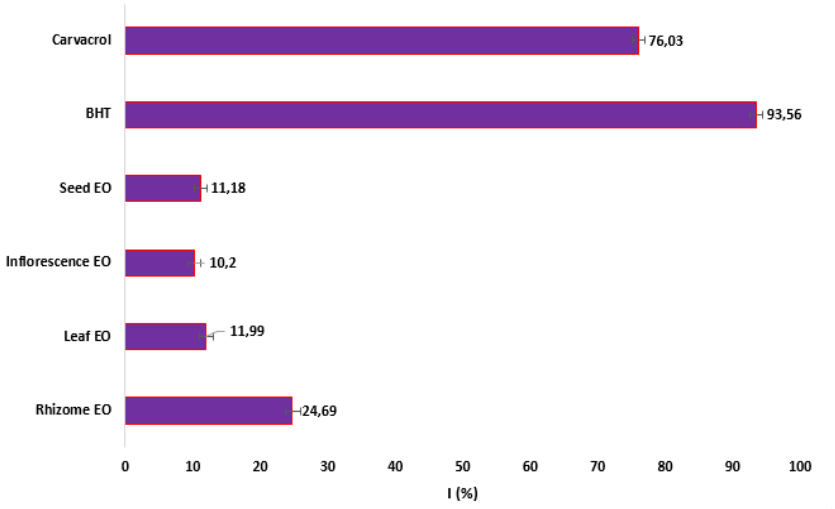

Fig. 5 Antioxidant activity (DPPH free radical scavenging activity) of EOs from different organs of *F. Communis* and standards (BHT and carvacrol).

EO = essential oil; BHT = butylated hydroxytoluene. Data are provided as the mean ± S. D. (n = 3)

4. Conclusion

Despite many scientific studies on *Ferula* genus, this study is the initialeffort to explore the antioxidant and antimicrobial effects of essential oils from diverse organs of *F. communis* grown wildly in Algeria. Unlike the antioxidant activity, this study highlighted the good antimicrobial effects of *F.communis* EOs and validated the traditional use of EOs of this species as an antiseptic drug. The results of this study suggest that this Algerian *Ferula* may be an encouraging model for further biological and pharmacological examinations.

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