Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/bjbas

Comparative chemical and antimicrobial study of nine essential oils obtained from medicinal plants growing in Egypt

Nashwa Tarek [a,*], *Hossam M. Hassan* [b], *Sameh M.M. AbdelGhani* [c], *I.A. Radwan* [d], *Ola Hammouda* [e], *Ahmed O. El-Gendy* [c]

[a] *Microbiology Department, College of Oral and Dental Medicine, Nahda University, Egypt*
[b] *Pharmacognosy Department, College of Pharmacy, Beni-Suef University, Egypt*
[c] *Microbiology & Immunology Department, College of Pharmacy, Beni-Suef University, Egypt*
[d] *Microbiology & Immunology Department, College of Veterinary, Beni-Suef University, Egypt*
[e] *Botany Department, College of Science, Beni-Suef University, Egypt*

ARTICLE INFO

Article history:
Received 2 April 2014
Accepted 7 May 2014
Available online 20 May 2014

Keywords:
Antimicrobial efficiency
Essential oil (EO)
Minimum inhibitory concentration (MIC)
Antibiotic susceptibility

ABSTRACT

Essential oils are one of interesting natural products group that are used in different aspects of life due to their various biological activities. This study investigate the antimicrobial activities of 9 herbal essential oils on survival and growth of selected pathogenic and spoilage microorganisms. Essential oils were obtained by hydrodistillation method and were analyzed using GC/MS technique. The oils were tested for their antimicrobial activity against 2 Gram +ve, *Staphylococcus aureus* (*S. aureus*) and *Listeria innocua* (*L. innocua*), 2 Gram −ve, *Pseudomonas aeruginosa* (*P. aeruginosa*) and *Salmonella Typhi* (*S. Typhi*) as well as 2 Fungi, *Aspergillus niger* (*A. niger*) and *Candida albicans* (*C. albicans*), using agar dilution method. Minimum inhibitory concentration (MIC) was determined. The antibiotic susceptibility test was performed against the test organisms by disc diffusion method. Results showed that Cinnamon oil was found effective against all the tested strains (MIC $\leq$ 1 µl/ml). Peppermint, lemon grass, caraway, anise, fennel and clove showed activity at (MIC $\leq$ 1 µl/ml) with all the tested organisms except for *P. aeruginosa*. Lavender oil exhibited antimicrobial activities against 4 strains (*S. aureus*, *L. innocua*, *A. niger* and *C. albicans*) with MIC ($\leq$1 µl/ml) while geranium oil was inhibitory at (MIC $\leq$ 1 µl/ml) against *S. aureus*, *S. Typhi*, *A. niger* and *C. albicans* and with MIC ~ 2 µl/ml against *L. innocua*. Although Gram −ve organisms had shown high resistance toward different essential oils, they were found to be susceptible to cinnamon oil even at lower concentration. Cinnamon oil is effective against drug resistant organisms. It can be suggested to use essential oils/constituents as potential natural preservatives and would be helpful in the treatment of various infections.

* *Corresponding author.*
E-mail address: ntarek88@yahoo.com (N. Tarek).
Peer review under the responsibility of Beni-Suef University

Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.bjbas.2014.05.009

1. Introduction:

Essential oils obtained from spices, herbs and medicinal plants by distillation, expression or solvent extraction are well-known in traditional medicine that are considered to be an area of interest as a potential source of antimicrobial agents. They are characterized by a broad-spectrum activity, including antifungal, antibacterial and antiviral activities. Besides, antimicrobial activities of essential oils, they used in food preservation, food industry as flavoring, pharmaceuticals, in cosmetics as fragrances and alternative medicine (Hussain et al., 2010). The proportions of the major and minor constituents specify the chemical composition of each EO and furthermore chemotypes can be recognized according to the levels of the major characterizing components. The antimicrobial effectiveness is not only assessed through the main component but also a synergistic effect may occur by the other components (Faleiro et al., 2003). EO is more efficient than various artificial antimicrobial agents that used for air disinfection due to its low toxicity level and high volatility specific property that is not found in other antimicrobial agents (Inouye et al., 2003). In addition to that, natural food preservatives has been widely used and accepted by the consumers, who prefer natural and healthy products with low synthetic additives (Militello et al., 2011).

EO antimicrobial efficiency of a same plant species is often affected with harvest time, weather conditions during growth and harvest, genotype and different geographic locations where plants are grown (Militello et al., 2011). The wrong and excessive dose of antibiotics is a serious problem in antimicrobial chemotherapy which causes resistance and ineffective antimicrobial treatment (Ang et al., 2004).

The antimicrobial activities of EOs are used by people all over the world for several years from popular commercially available herbal and medicinal plants: lemon grass (*Cymbopogon citrates*), Fennel (*Foeniculum vulgare*), peppermint (*Mentha piperita*), geranium (*Geranium dissectum*), caraway (*Carum carvi*), lavender (*Lavandula officinalis*), clove (*Syzygium aromaticum*), cinnamon (*Cinnamomum cassia*) and anise (*Pimpinella anisum*), those have been used to treat bacterial and fungal infections (Prabuseenivasn et al., 2006). In the present study antimicrobial potential of 9 different plant essential oils was assessed against pathogenic strains i.e., *Staphylococcus aureus* (*S. aureus*), *Pseudomonas aeruginosa* (*P. aeruginosa*), *Listeria innocua* (*L. innocua*), *Salmonella Typhi* (*S. Typhi*), *Aspergillus niger* (*A. niger*) and *Candida albicans* (*C. albicans*) in various antimicrobial assays.

The aim of the present study was to determine the chemical composition of essential oils obtained from 9 different plant species cultivated in Egypt and to evaluate their antimicrobial activity against 2 fungal and 4 bacterial species that may cause food poisoning and spoilage. Data obtained in this study could aid the identification of potential essential oils to be applied as food preservatives.

2. Material and methods

2.1. Plant material

Different plant organs mentioned in Table 1 used in this study was collected at May 2012 from different farming in Egypt. The systematic identification of the plant materials was kindly verified by Dr. Hossam M. Hassan, Faculty of Pharmacy, Beni-Suef University, Egypt. Plant materials were stored cool and in dry place for further investigation.

Table 1 – Plant species and main constituents of the respective essential oils.[a]

Common name	Botanical name	Family	Plant organ
Clove	*Syzygium aromaticum*	Myrtaceae	Flower bud
Cinnamon	*Cinnamomum cassia*	Lauraceae	Bark
Lavender	*Lavandula officinalis*	Lamiaceae	Flowers
Lemon grass	*Cymbopogon citrates*	Poaceae	Herb
Fennel	*Foeniculum vulgare*	Apiaceae (Umbelliferae)	Fruits
Caraway	*Carum carvi*	Apiaceae	Fruits
Anise	*Pimpinella anisum*	Apiaceae	Fruits
Peppermint	*Mentha piperita*	Lamiaceae	Leaves
Geranium	*Geranium dissectum*	Geraniaceae	Leaves

[a] All essential oils were obtained by hydrodistillation of the aerial parts of the plants.

2.2. Extraction of essential oils

Half kg of each sample were collected and then subjected to hydrodistillation using Clevenger apparatus for 4 h and evaporate the solvent under reduced pressure at 40 °C using rotary evaporator. The essential oils obtained were separately dried over anhydrous sodium sulfate and stored at low temperature (−20 °C) till analysis by gas chromatography–mass spectrometry (GC–MS) or their usage in bioassays (Bhuiyan et al., 2008). All the tested herbal oils or extracts were sterilized by filtration using Millipore cellulose filter membrane (0.45 μm pore diameter).

2.3. Analysis of volatile oil extracts

2.3.1. Chemical composition of volatile oils

The volatile oil samples were analyzed by using Gas Chromatography/Mass Spectrophotometer (GC/MS) Agilent 6890 apparatus.

2.3.2. Physical properties of volatile oils

2.3.2.1. *Specific gravity bottle*. For determination of specific gravity of the different oil samples.

2.3.2.2. *Abbe's refractometer*. For measuring the refractive indices of the different volatile oil samples.

2.4. Microbial strains and growth conditions

2.4.1. Preparation of inoculum

All bacterial isolates were subcultured on Brain Heart Infusion agar (B.H.I.A.) and incubated at 37 °C for 24 h. Three bacterial