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Full Length Research Paper

Chemical composition of *lavender* essential oil and its antioxidant activity and inhibition against rhinitis-related bacteria

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In this study we assessed the chemical composition, antioxidant and antibacterial activities of *Lavender* essential oil. The antioxidant and antibacterial capacity of test sample was assayed by a linoleic acid system and conventional method of bacterial growth inhibition. The results demonstrated that the essential oil consisted of 1,5-Dimethyl-1-vinyl-4-hexenyl but yrate as the most abundant component (43.73%), followed by 1,3,7-Octatriene, 3,7-dimethyl- (25.10%), Eucalyptol (7.32%), and Camphor (3.79%). *Lavender* essential oil display the stronger antioxidant activity against lipid peroxidation in a linoleic acid model system and good antibacterial activity against four rhinitis-related bacteria including *staphylococcus aureus*, *Micrococcus ascoformans*, *Proteus vulgaris* and *Escherichia coli*.

Key words: Antibacterial, *Lavender*; antioxidant, essential oil, extraction, rhinitis.

INTRODUCTION

The *Lavenders* are a genus of about 25 - 30 species of flowering plants in the mint family, Lamiaceae, native to the Mediterranean region south to tropical Africa and to the many regions of Asia. The genus includes annuals, herbaceous plants, subshrubs, and small shrubs (Piccaglia et al., 1993).

Lavender has been used for centuries as an herbal remedy. *Lavender* yields a highly effective essential oil with very sweet overtones, and can be used in balms, salves, perfumes, cosmetics, and topical applications. Internally, *Lavender* essential oil is believed to be of benefit for a multitude of problems, including stress, anxiety, exhaustion, irritability, headaches, migraines, insomnia, depression, colds, digestion, flatulence, upset stomach, liver and gallbladder problems, nervousness, loss of appetite, and as a breath freshener and mouthwash (Hamada and Yamaguch, 2001; Kim et al., 2007; Cassella et al., 2002; Tanida et al., 2006; Piccaglia et al., 1993; Hudson, 1996; Pedro et al., 2009; Katona et al., 2010).

The aim of this study was to examine the chemical composition, antioxidant and antibacterial activities of *Lavender* essential oil. Of particular interest was to evaluate the application of the essential oil in food preservation, and in medicine.

MATERIALS AND METHODS

Materials

Aerial parts of *Lavender* at full flowering stage were collected during summer (July 2006) from the botanical garden at the university. The specimens were dried at 30℃ in a hot air oven to constant weight.

Preparation of *Lavender* essential oil

The steam generator flask was filled with Milli-Q purified water and

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heated with a heating mantle. As the water vaporised, the steam passed to the distillation flask containing 4.0 g of plant and, then, through the cooled tube where it was condensed. The distillate (500 ml) was collected in the receiving flask after 4 h distillation.

Identification of components

For identification of components, A Hewlett-Packard gas chromatograph (model 5890; Hewlett-Packard, Avondal~PA) equipped with split/splitless injection port and flame~ionization detector and fitted with a 5 M × 0.5 mm WCOT Ultimetal HT SimDist CB column (Chrompack, Middelburg, The Netherlands) with 0.15 µm film was used.. Temperature was programmed from 50℃ for 5 min and programmed to reach 220℃ at the rate of 3℃/min. For GC/MS a CPWAX 52 fused silica CB column (50 m × 0.25 mm) was used with helium as carrier gas (flow rate 1 ml/min) and coupled to a HP mass spectrometer: ionization energy 70 eV. Temperature programming was from 50 - 240℃ at the rate 3℃/min. The samples were injected at injector temperature 240℃. The components were identified by comparing linear Kovatss indices (KI), their retention times (RT) and mass spectra with those obtained from the authentic samples and/or the MS library.

The percentage composition of the essential oil was computed from 6C peak areas without correction factors. Qualitative analysis was based on a comparison of retention times and mass spectra with corresponding data in the literature (Jin and Ha, 2005).

Antioxidant activity of the *Lavender* essential oil in a linoleic acid system

The antioxidant capacity of the essential oil on inhibition of linoleic acid peroxidation was assayed using the thiocyanate method (Yen et al., 2003). Linoleic acid emulsion was prepared with linoleic acid (0.2804 g) and Tween 20 (0.2804 g) in PBS (50 ml, 0.2 mol/l, pH 7.0). A reaction solution, containing different con-centrations of test compounds (essential oil) (0.5 ml), linoleic acid emulsion (2.5 ml) and PBS (2 ml, 0.2 mol/l, pH 7.0) were mixed with a homogeniser. The reaction mixture was incubated at 37℃ in dark to accelerate the oxidation process. To 9.7 ml of ethanol (75%), 0.1 ml of ammonium thiocyanate solution (300 g/l), 0.1 ml of sample solution and 0.1 ml of ferrous chloride solution (20 mmol/l in hydrochloric acid) were added in sequence. The solution was stirred for 3 min and its absorption value at 500 nm was taken as the peroxide value. The inhibition of α-tocopherol on linoleic acid peroxidation was also assayed at the same concentration for comparison. The solution without adding essential oil or α-tocopherol was used as blank. All the tests were performed in triplicate. The inhibition percentage was calculated as following:

$$\text{Inhibition (\%)} = [(A_0 - A_1)/ A_0] \times 100,$$

Where A_0 is the absorbance of the blank and A_1 is the absorbance of the test sample or α-tocopherol at 500 nm.

Antibacterial susceptibility test

The test microorganisms used for antimicrobial sensitivity testing included *Staphylococcus aureus*, *Micrococcus ascoformans*, *Proteus vulgaris* and *Escherichia coli*.

The broth dilution method described in the Manual of Clinical Microbiology (Jones et al., 1985) was used to assess the antibacterial activities of the essential oils. The concentrations of essential oil were 8.5, 17, 34 and 51 mg/ml. Three replicas were prepared in each case. The antibacterial activities were examined after incubation at 37℃ for 18 h. Minimum inhibitory concentration (MIC) was defined as the lowest concentration of test samples that resulted in a complete inhibition of visible growth in the broth.

RESULTS AND DISCUSSION

Chemical composition of the *lavender* essential oil

The chemical composition of *lavender* essential oil, which differed considerably with regard to the seasons of the year in Table 1 and Figure 1, is presented. A total of 47 compounds representing 98.4 - 99.7% of the oils were identified. 1,5-Dimethyl-1-vinyl-4-hexenylbutyrate was the main constituent of essential oil (43.73%), followed by 1,3,7-Octatriene, 3,7-dimethyl- (25.10%), Eucalyptol (7.32%), and Camphor (3.79%). Our results are in a good agreement to those of Shellie et al. (2002). The observed differences in the constituents of *lavender* essential oil across provinces may be due to different environmental and genetic factors, different chemotypes and the nutritional status of the plants.

Antioxidant activity on linoleic acid peroxidation

The antioxidant activity of essential oils and dried deodorised aqueous extracts of lavender have been assessed by the β-carotene bleaching test (Dapkevicius et al., 1998). In addition, Parejo et al. (2002) evaluated the antioxidant activity of spike lavender with radical scavenging activity, NBT/Hypoxanthine superoxide and OH/Luminol chemilumiescence methods. Morever, Economou et al. (1991) determined the antioxidant activity against oxidative deterioration of lard.

As shown in Figure 2, the percentage of inhibition of peroxidation in linoleic acid system of test compounds (*lavender* essential oil) at concentration of 0.0 and 4.0 mg/ml showed a similar trend during the entire incubation period and increased with the increasing concentration. The percentage of inhibition of peroxidation in linoleic acid system of test samples (essential oil) reached to 87.9%, when 4 mg/ml of essential oil were added. Maximum percentage of inhibition of control sample (VE) (82.4%) was obtained at the content of 1.5 mg/ml and after that the effect no longer obviously changed. In comparison with VE, essential oil of high concentration displays the stronger antioxidant activity against lipid peroxidation in a linoleic acid model system.

Antibacterial activity of the *Lavender* essential oil

Essential oils have various physiological effects on humans and other mammalian species when inhaled or ingested and have been used in aromatherapy for the treatment of various diseases. Of the essential oils available, lavender oil, the essential oil obtained from the aerial part of *L. angustifolia* Mill., is one of the most

Table 1. Chemical components in *lavender* essential oil.

NO.	Compound	Percentage (%)
1	α-Phellandrene	0.09
2	1S-α-Pinene	0.3
3	Camphene	0.27
4	1-Octen-3-ol	0.17
5	Bicyclo[3.1.0]hexane, 4-methylene- 1-(1-methylethyl)-	0.15
6	β-Pinene	0.43
7	Bicyclo[3.1.0]hex-2-ene, 4-methyl- 1-(1-methylethyl)-	0.39
8	Acetic acid, hexyl ester	0.25
9	3-Carene	0.16
10	Benzene, 1-methyl-4-(1-methylethyl)-	0.04
11	Benzene, 1-methyl-2-(1-methylethyl)-	0.19
12	D-Limonene	0.55
13	Eucalyptol	7.32
14	1,3,7-Octatriene, 3,7-dimethyl-	0.99
15	1,4-Cyclohexadiene, 1-methyl-4-(1- methylethyl)-	0.05
16	cis-β-Terpineol	0.13
17	Linalool oxide trans	0.30
18	1S-α-Pinene	0.34
19	1,3,7-Octatriene, 3,7-dimethyl-	25.10
20	Octen-1-ol, acetate	0.62
21	Butanoic acid, hexyl ester	0.12
22	Camphor	3.79
23	4-Hexen-1-ol, 5-methyl-2-(1-methylethenyl)-, (R)-	0.22
24	Borneol	1.54
25	3-Cyclohexen-1-ol, 4-methyl-1-(1-methylethyl)-	1.56
26	Butanoic acid, octyl ester	0.48
27	p-menth-1-en-8-ol	0.98
28	1,5-Dimethyl-1-vinyl-4-hexenyl but yrate	43.73
29	Bornyl acetate	0.17
30	2,6-Octadien-1-ol, 3,7-dimethyl-, acetate	1.42
31	4-Hexen-1-ol, 5-methyl-2-(1-methylethenyl)-, acetate	0.27
32	1H-Benzoimidazole, 5-amino-1-ethyl	0.07
33	4-Hexen-1-ol, 5-methyl-2-(1-methylethenyl)-, acetate	0.40
34	1,3,6,10-Dodecatetraene, 3,7,11-trimethyl-, (Z,E)-	0.06
35	Caryophyllene	4.38
36	Di-epi-.alpha.-cedrene	0.20
37	Isocaryophillene	0.05
38	α-Caryophyllene	0.11
39	1,6,10-Dodecatriene, 7,11-dimethyl -3-methylene-, (Z)-	0.58
40	1,6-Cyclodecadiene, 1-methyl-5-met hylene-8-(1-methylethyl)-, [s-(E,E)]-	0.68
41	1,6,10-Dodecatriene, 7,11-dimethyl -3-methylene-, (E)-	0.07
42	Spiro[5.5]undec-2-ene, 3,7,7-trime thyl-11-methylene-, (-)-	0.07
43	2,6-Octadien-1-ol, 3,7-dimethyl-, acetate, (E)-	0.20
44	Bicyclo[4.4.0]dec-1-ene, 2-isopropyl-5-methyl-9-methylene-	0.20
45	1-Methylene-2-vinylcyclopentane	0.05
46	Caryophyllene oxide	0.61
47	Copaene	0.17

commonly used and is known to have various physiological effects including relaxation, sedation (Cavanagh and Wilkinson, 2002), anti-conflict (Umezu, 2000), and altered motor activity (Linck et al., 2009;

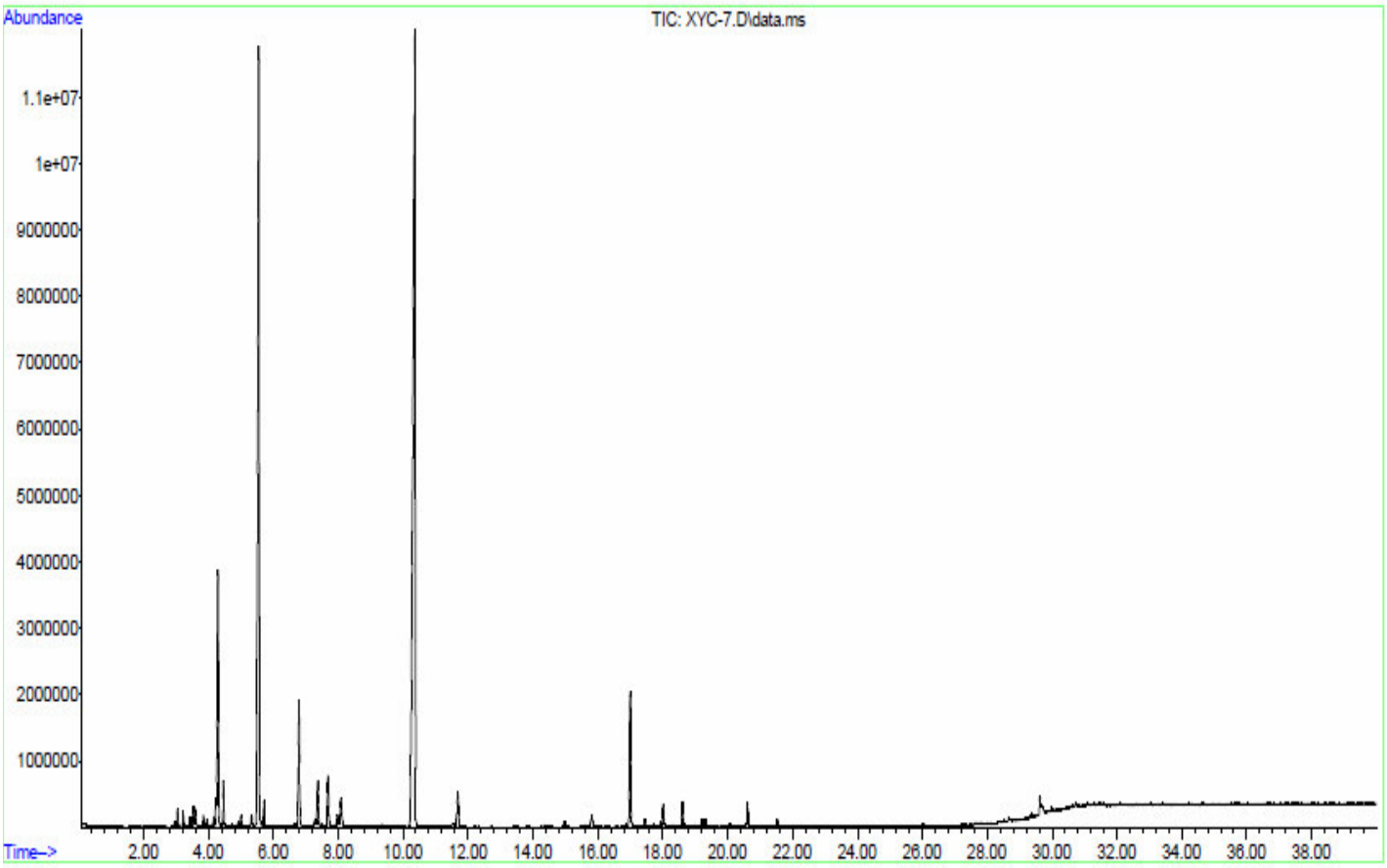

Figure 1. GC-MS of *lavender* essential oil.

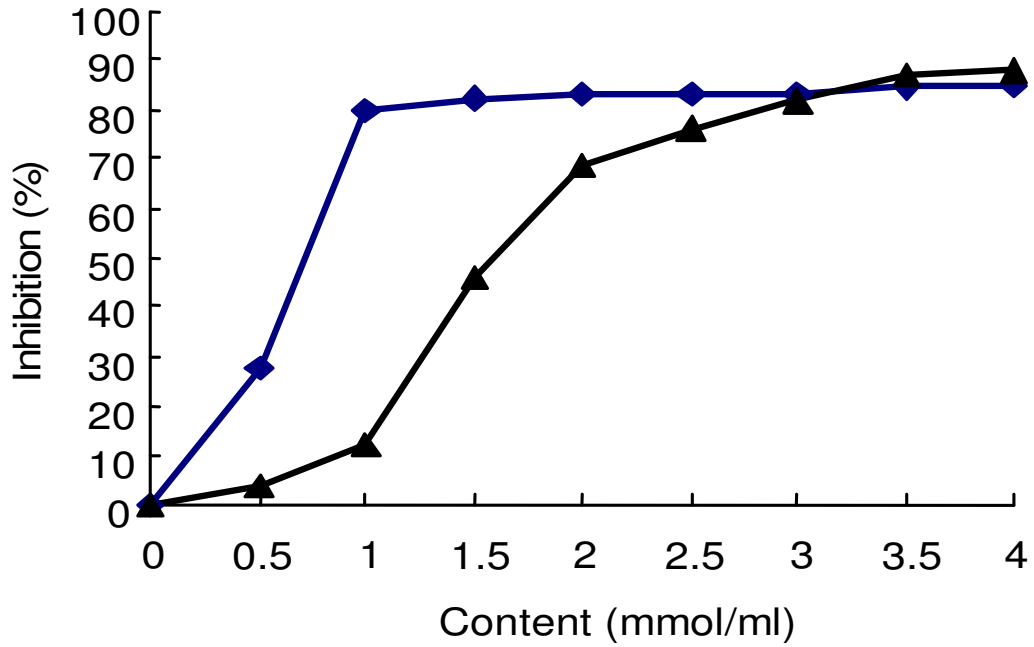

Figure 2. Effect of test samples (*lavender* essential oil and VE) in a linoleic acid system VE (—◆—), essential oil (—▲—).

Table 2. Anti-bacterial activities of *lavender* essential oil.

	8.5 mg/ml	17 mg/ml	34 g/ml	51 mg/ml
Staphylococcus aureus	+	+	+	-
Micrococcus ascoformans	+	+	+	-
Proteus vulgaris	+	+	+	-
Escherichia coli	+	+	+	-

Yavuz et al., 2010; Nuthong et al., 2009).

The essential oil was evaluated for antimicrobial activity against pathogenic strains. It was found to be active against all tested bacterias. The activity of the oil varies with its concentration. The ability of essential oil to disrupt the permeability barrier of cell membrane structures and the accompanying loss of chemiosmotic control are the mostly likely reasons for its lethal action. As shown in Table 2, when concentration of *lavender* essential oil was 51 mg/ml, all four test bacterias weren't detected.

As discussed above, *lavender* essential oil showed good antioxidant activities and broad activity against bacteria. The *lavender* essential oil could be utilized as potential natural medicine in treating rhinitis patients.

Conclusion

Lavender essential oil was analysed using GC-MS. A total of 47 compounds representing 98.4 - 99.7% of the oils were identified. 1,5-Dimethyl-1-vinyl-4-hexenylbutyrate was the main constituent of essential oil (43.73%), followed by 1,3,7-Octatriene, 3,7-dimethyl- (25.10%), Eucalyptol (7.32%) and Camphor (3.79%). *Lavender* essential oil displays the stronger antioxidant activity against lipid peroxidation in a linoleic acid model system and broad activity against bacteria. The *lavender* essential oil could be utilized as potential natural medicine in treating rhinitis patients.

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