Short Communication

Antimicrobial activities of the essential oils of four *Salvia* species from Turkey

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In the present study, antibacterial and antifungal activities of essential oils of four *Salvia* species against five bacteria and one fungus were evaluated at concentrations of 1/10, 1/20 and 1/30 and incubated for 24 h. Aqueous and hexane extracts of each plant were tested for their antibacterial and antifungal activity by using agar disc diffusion method. The result indicated that all essential oils exhibit antibacterial activity against *Bacillus subtilis*, *Escherichia coli* and *Staphylococcus aureus*. In addition, essential oils of *Salvia multicaulis* exhibit the antibacterial activity against *Pseudomonas aeruginosa*. Essential oils of *Salvia syriaca* exhibit antibacterial and antifungal activities against all micro-organisms.

**Key words:** Antimicrobial activity, *Salvia*, essential oils.

INTRODUCTION

Gram positive and gram negative bacteria, as well as fungi, cause different types of human infections. However, effective antimicrobials have been developed over the years; there has been increased development of antimicrobial drug resistance to presently available antimicrobials (Chopra, 2007). This has made the development of new antimicrobial drugs necessary. Since ancient times, the crude herbal extracts of aromatic plants have been in use for different purposes, such as food, perfumery, flavouring foods, beverages and for medication, they have also been considered very valuable for their usage as antimicrobials (Heath, 1981; Ozcan, 1998).

*Salvia*, the largest genus of the *Lamiaceae* family, includes about 900 species and is common throughout the world. Some of them are economically important since they have been used as spices and flavouring agents in perfumery and cosmetics. The analysis of the essential oil composition of several *Salvia* species indicates that 1,8-cineole (eucalyptol) and borneol are their main constituents (Ahmadi and Mirza, 1999; Baser et al., 1997; Haznedaroğlu et al., 2001; Perry et al., 1999; Sivropoulou et al., 1997). Turkey is regarded as an important gene-center regarding the family *Lamiaceae* (Labiatae). The family has 45 genera, 546 species and 730 taxa in Turkey. The rate of endemism in the family is 44.2% (Baser, 1993). The members of the *Lamiaceae* are generally found in the mountainous areas of the Mediterranean region of Turkey and the composition of their essential oils is detailed by Baser (1994). The gram positive bacteria, such as *Staphylococcus aureus* are primarily responsible for post-operative wound infections, toxic shock syndrome, endocarditis, osteomyelitis and food poisoning (Mylotte et al., 1987). *Escherichia coli*, which is the one of the gram negative bacteria, is present in human intestines and causes urinary tract infection, coclecystitis or septicemia (Singh et al., 2000). *Bacillus subtilis* is a rod-shaped aerobic bacterium and it has been found that they have some pathogenic role (Gorden et al., 1973). In the present study, a wide range of potentially pathogenic micro-organisms were used to evaluate antimicrobial activity of essential oil of *Salvia palaestina, Salvia multicaulis, Salvia syriaca* and *Salvia ceratophylla*.

MATERIALS AND METHODS

Plant materials and isolation of the essential oils

The aerial parts of four *Salvia* species were collected from South-eastern Anatolia in June 1998 -1999. Voucher specimens have been deposited in the Herbarium of the Department of Biology, Faculty of Science, Dicle University. Dry aerial materials of four plants were pulverized; essential oil of plants was extracted by Clevenger-type apparatus for 4 h. Results were recorded as
Table 1. Inhibition zones of essential oils at different concentrations (1/10, 1/20 and 1/30).

<table>
<thead>
<tr>
<th>Micro-organism</th>
<th>S. palaestina 1/30</th>
<th>S. ceratophylla 1/30</th>
<th>S. multicaulis 1/30</th>
<th>S. syriaca 1/30</th>
<th>Antibiotics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/20 1/10</td>
<td>1/20 1/10</td>
<td>1/20 1/10</td>
<td>1/20 1/10</td>
<td>AML SAM</td>
</tr>
<tr>
<td>B. subtilis</td>
<td>10 10 14</td>
<td>14 14 16</td>
<td>10 10 16</td>
<td>12 12 12</td>
<td>20 28</td>
</tr>
<tr>
<td>E. coli</td>
<td>12 12 14</td>
<td>14 14 14</td>
<td>12 14 20</td>
<td>10 12 12</td>
<td>22 22</td>
</tr>
<tr>
<td>S. aureus</td>
<td>10 12 16</td>
<td>12 12 14</td>
<td>10 12 10</td>
<td>10 10 12</td>
<td>16 16</td>
</tr>
<tr>
<td>S. pyogenes</td>
<td>- - -</td>
<td>- - -</td>
<td>- - 12</td>
<td>- - 10</td>
<td>22 22</td>
</tr>
<tr>
<td>P. aerogonisa</td>
<td>- - -</td>
<td>- - -</td>
<td>- - 14</td>
<td>- - 14</td>
<td>- -</td>
</tr>
<tr>
<td>C. albicans</td>
<td>- - -</td>
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<td>- - -</td>
<td>- - -</td>
<td>10 D D</td>
</tr>
</tbody>
</table>

(*) : Data are the mean values of two replicates (diameter of inhibition zone mm). (−) : Not zone diameter. D : Sensitive.

mL/100 g (%).

**Micro-organisms**

The micro-organisms used in this study were obtained from the Department of Biology, Faculty of Science, Dicle University. E. coli K12, Pseudomonas aeruginosa, S. aureus, Streptococcus pyogenes, B. subtilis and Candida albicans 74 were used in the study. The micro-organisms were grown on nutrient agar slants and maintained deep-freeze at -80°C. The inoculated agar slants were incubated at 37°C.

**Antibiotic discs and antimicrobial activity**

The antimicrobial activity was based on disc diffusion method (Thitilertdecha et al., 2008) using micro-organisms cell suspension whose concentration was equilibrated to a 0.5 McFarland standard. A 100 μl of each micro-organism suspension was spread on a Mueller-Hinton agar plate. Fifty microliters of dilution of essential oils were pipetted on sterile paper discs (6 mm in diameter), which were allowed to dry in an open sterile Petri dish in a biological safety cabinet vertical laminar flow. 1/10, 1/20 and 1/30 solutions of the essential oils in absolute hexane were applied to discs. Discs were placed on surface of the inoculated plates and incubated at 37°C for 24 h. Diameters (mm) of the zones of bacterial and fungal inhibition minus the discs diameter were recorded (Aurelli et al., 1992; İlçim et al., 1998). Discs with the hexane used for dissolution were used as negative control and 10 μg AML (Amoxicillin) and SAM (Sulbactam/Ampicillin 10/10 = 20 μ) antibiotic discs were used as positive control. The experiment was performed in duplicate and the results were expressed as average values.

**RESULTS AND DISCUSSION**

The essential oils from the four species of Salvia were inhibited the growth of all bacteria and these findings are summarized in Table 1. It has been shown that oils from different plants possessed a wide range of antibacterial spectrum. Because they inhibited the growth, the diameter of inhibition varied from 10 - 20 mm, depending on the susceptibility of the tested organism. In this study, among micro-organisms, most resistant is C. albicans. In addition, essential oils of S. ceratophylla and S. palaestina were ineffective against P. aeruginosa, S. pyogenes and C. albicans. Some essential oils at 1/30 decreased the inhibition zone against bacteria than those of 1/20 and 1/10. The lower rate of essential oil amount showed lower inhibition zone than the higher one. Essential oil of S. ceratophylla showed high inhibition zone against B. subtilis and E. coli at 1/30 (14 mm). The highest inhibition zones at 1/20 were obtained from S. multicaulis essential oil against E. coli (14 mm) and S. ceratophylla essential oil against B. Subtilis (14 mm), E. coli (14 mm) and S. aureus (12 mm). The highest inhibition zones at 1/10 were obtained from S. palaestina essential oil against E. coli, S. aureus (16 mm) and S. ceratophylla essential oil against B. subtilis (16 mm) and S. multicaulis essential oils against E. coli (20 mm).

Essential oil of S. syriaca at 1/10 was effective against all micro-organisms. Discs containing of 1/30 essential oils have not had any effects against S. pyogenes, P. aeruginosa and C. albicans. It is assumed that the rate of essential oils is not enough to affect this bacteria and fungus. As indicated in the table, it was seen that S. multicaulis essential oil effected E. coli as much as AML and SAM antibiotics. It was seen that S. palaestina essential oil effecte S. aureus as much as AML and SAM antibiotics. Although P. aeruginosa is resistant against AML and SAM antibiotics, it is important that it is affected from S. multicaulis and S. syriaca essential oils in 14 mm inhibition zone diameter. It can be said that 1/10 essential oils of S. multicaulis and S. syriaca are sufficient for P. aeruginosa.

It was reported that most Salvia species have terpenes, pinnen, lorneol and cineol are recommended for use as a diuretic and an antiseptic (Baytop, 1999). In addition, camphor and 1,8-cineole (eucalyptol) are well-known chemicals with their pronounced antimicrobial potentials (Pattnaik et al., 1997; Tzakou et al., 2001). The chemical composition of essential oils depends on climatic, seasonal, and geographic conditions, harvest period and distillation technique. In addition, their antibacterial activity depends on the type, composition and concentration of the essential oils, the type and concentration of the target micro-organism, the composition of the substrate, the processing and the storage conditions.
ious). The essential oils six Iranian Salvia species showed antibacterial and antifungal against six micro-organisms (Tepe et al., 2004). The essential oils of Salvia sivasica and Salvia anamurensis showed antibacterial activity but did not showed antifungal activity against C. albicans (Dulger and Gonuz, 2004). The essential oils six Iranian Salvia species showed antibacterial and antifungal against six micro-organisms (Javidnia et al., 2008). The antimicrobial activity of essential oils of Salvia species used in our study showed similar properties with earlier investigations. As a result the essential oils of S. multicaulis and S. syriaca showed antimicrobial activity against both bacteria and fungus. So, it can be used as an herbal medicine.

**Conclusion**

The results of this study suggest the possibility using the four species of Salvia essential oils which possess strong antibacterial activity. The result indicated that the oils may be used in the treatment of diseases caused by the micro-organisms tested.

**REFERENCES**


