

The Titles and Abstracts of Articles from Microbiology Group of Research Center of Barij Essence Pharmaceutical Company

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1. Mahboubi M, Feizabadi MM, Safara M. Antifungal activity of essential oil from *Zataria multiflora*, *Rosmarinus officinalis*, *Lavandula stoechas*, *Artemisia sieberi* Besser and *Pelargonium graveolens* against clinical isolates of *Candida albicans*. PHCOG Mag 2008; 15 (Suppl): 15S- 18S.

Plant-derived antimycotics are attracting the attention of mycologist because the increased resistance of fungi to azoles. The aim of this study was to investigate the anti-candidal activity of *Zataria multiflora* (thyme), *Pelargonium graveolens* (geranium), *Artemisia sieberi* Besser (Artemisia), *Rosmarinus officinalis* (rosemary) and *Lavandula stoechas* (lavender) oils against some clinical isolates of *C. albicans*. Disc diffusion method and macrobroth dilution assay were employed to evaluate the antifungal activity of these oils. Essential oils were analyzed by GC led to identification of these main components. Carvacrol (39.8%), citronellol (45.2%), α -pinene (23.7%), 1, 8-cineol (30.2%) and α -thujone (38.8%) are the main components of thyme, geranium, rosemary, lavender and artemisia oils, respectively. Thyme oil showed strong antifungal activity (34-50mm, MIC 62.5 μ g/ml), while geranium oil had good antifungal activity (12-29.5 mm, MIC>62.5 μ g/ml) but lavender, rosemary and artemisia oils showed only a moderate effect (zone inhibition<12mm). The inhibition Zone of thyme oil is larger than amphotericin B. Results showed that thyme and geranium oils may be useful in the clinical management of candidal infection. Further clinical trials are required to validate their use as therapeutic, alternatives for candidal infection.

2. Mahboubi M, Mohammadi-Yeganeh S, Bokae S, Dehdashti H, Feizabadi MM. Antimicrobial activity of essential oil from *Oliveria decumbens* and its synergy with vancomycin against *Staphylococcus aureus*. Herba Polonica 2007; 53(4): 69-76.

Oliveria decumbens Vent (*Umbelliferae*) is a shrub commonly found in the south-east of Iran. Its aerial section is extensively used in herbal medicine. The disk diffusion test and Microbroth dilution Assay were used to determine the antimicrobial activity of the essential oil from *Oliveria decumbens* Vent against *Staphylococcus aureus*. To detect synergy, vancomycin was added to Mueller-Hinton agar at sub-inhibitory concentrations and the inhibitory zones were recorded in millimeters. The main

components of oil were thymol (22%), carvacrol (22%) and p-cymene (19%). The *O. decumbens* oil exhibited strong antistaphylococcal activity (18.0 ± 0.86). Carvacrol was considerably more effective (29.8 ± 1.5) than thymol (17.2 ± 1.13) and p-cymene (0.0 ± 0.0) against *Staphylococcus aureus*. The oil presented strong synergism with vancomycin (24.9 ± 0.75 vs. 19.3 ± 0.54 , $p < 0.001$). However, further studies are required to evaluate its *in vivo* efficacy.

3. Mahboubi M, Feizabadi MM. Antifungal activity of essential oil from *Oliveria decumbens* Vent and its synergy with amphotricin B. International Journal of Essential Oil Therapeutics (IJEOT) 2008; 2: 26-28.

Many essential oil are known to possess antifungal activity and therefore potentially act as antimycotic agents. The essential oil of *Oliveria decumbens* Vent was isolated by hydrodistillation. The antifungal activity of this essential oil against 10 isolates of *C. albicans* and 2 isolates of *Aspergillus niger* and *Aspergillus flavus* was evaluated by disc diffusion method and micro broth dilution assay. The synergism between amphotricin B and essential oil was evaluated by checkerboard microtitre assay. This essential oil ($0.5 \mu\text{l}$) exhibited significant antifungal activity against tested fungi ($18\text{-}29$ mm) and showed synergism with amphotericin B against *C. albicans* (the fractional inhibitory concentration index was ≤ 0.5). The strong antifungal activity of this essential oil and its synergy with amphotericin B may be useful in treatment. However, further *in vivo* experiments are required to prove its usefulness in practice.

4. Mahboubi M, Feizabadi MM, Haghi G, Hosseini H. Antimicrobial activity and Chemical composition of essential oil from *Oliveria decumbens* Vent. Iranian Journal of medicinal and aromatic plants 2008; 24 (1): 56- 65.

Oliveria decumbens Vent. (Umbelliferae) is a shrub commonly found in the South East of Iran. Its aerial part is extensively used in herbal medicine. In this study, the antimicrobial activity of *O. decumbens* essential oil extracted from aerial parts of plant against a panel of microorganisms including gram positive, gram negative bacteria, yeast and fungi were assessed by disc diffusion method and micro broth dilution assay. The chemical constituents of this oil was analyzed by GC. The main components of essential oil are thymol (26.9%), carvacrol (0.25%), p-cymene (13.3%) and γ -terpinene (11%). This oil exhibited strong antifungal activity against filamentous fungi and yeast with average of inhibition zone (AIZ) 34.86 and $\text{MIC} \leq 0.25 \mu\text{l ml}^{-1}$. The effect of $2 \mu\text{l}$ of essential oil ($\text{IZ} \geq 27.3$ mm) is larger than Amphotricin B ($\text{IZ} \leq 17$) against fungi. The gram positive bacteria are more sensitive than gram-negative bacteria (21.9 Vs 18.4). Spore forming bacteria (*Bacillus* sp.) are resistant to essential oil and the effect of oil against *Bacillus* sp. had inhibitory effect ($\text{MIC} > 2 \mu\text{l ml}^{-1}$). *Pseudomonas aeruginosa* were more resistant than others ($\text{IZ} < 8$ mm). Thus, microorganisms differ in their resistance to *O. decumbens* oil, i.e. bacteria are more resistant than fungi and gram negative bacteria are more resistant than gram positive bacteria. These effects are more concerned to phenol components especially thymol. Therefore, further studies are required to evaluate *in vivo* efficacy.

5. Mahboubi M, Haghi G. Antimicrobial activity and chemical composition of *Mentha pulegium* L. essential oil. *Journal of Ethnopharmacology* 2008; 195(2): 325-27.

The flowering aerial parts of *Mentha pulegium* L. (Labiatae) has been traditionally used for its antiseptic properties for treatment of infectious diseases. In order to validate its antiseptic properties with respect to traditional uses, we have screened the antimicrobial activity of flowering aerial parts of *Mentha pulegium* L. essential oil against different microorganisms. This oil was obtained using hydrodistillation method and analyzed by GC and GC/MS. The antimicrobial activity was achieved using disc diffusion method and microbroth dilution assay. Analysis of the essential oil revealed the presence of piperitone (38.0%), piperitenone (33.0%), α -terpineol (4.7%), and pulegone (2.3%) as the major components. The results showed a significant activity against microorganisms especially Gram-positive bacteria with inhibition zones and minimal inhibitory concentration values in the range of 8–21mm and 0.25–4 μ l/ml, respectively, whereas the least susceptible were Gram-negative bacteria especially *Escherichia coli*. This investigation showed that the oil of *Mentha pulegium* L. has a potent antimicrobial activity and the Iranian *Mentha pulegium* L. oil belongs to piperitone/piperitenone type. Further research is required to evaluate the practical values of therapeutic applications.

6. Mahboubi M, Akbari M, Haghi G, Kazempour N. Antimicrobial activity of Respitol-B contains menthol and eucalyptus oil compared with mentofin, menthol, eucalyptus oil. *Iranian Journal of medical Microbiology* 2007; 1(1): 39- 46.

Some essential oils and their main components have antibacterial activity and used as an antiseptics. Respitol-B (Barijessence, Kashan, and Iran) which is similar to Mentofin, imported antimicrobial agents, contains menthol and eucalyptus oil. Both products are used as disinfectant in poultry farms following vaccination of broilers and pullets. In this study, the antimicrobial activity of Respitol-B and Mentofin, against bacteria, fungi and yeast was investigated. The antimicrobial activities of eucalyptus oil and mentho were also tested separately using disk diffusion test and macrobroth dilution assay. The gram-positive bacteria, yeast and fungi showed more susceptibility to Respitol-B than the gram negative bacteria. Antimicrobial activity of Respitol-B was the same as mentofin. Menthol is more potent than the eucalyptus oil. It enhanced the antimicrobial activity of Respitol-B. However *P. aeruginosa*, *E. coli* and *S. typhi* showed resistance to this compound. Eucalyptus oil had antimicrobial effect against *V. cholerae*, *A. flavus*, and *S. aureus* but had no effect on other tested microorganism. Respitol-B, a compound formulated by Barij Essence shows the same an antiseptic property as Mentofin and can be used for sanitary protocols in poultry farms.

7. Mahboubi M, Shahcheraghi F, Feizabadi MM. Bactericidal effects of essential oils from clove, lavender and geranium on multi-drug resistant isolates of *Pseudomonas aeruginosa*. *Iranian Journal of Biotechnology* 2006; 4(2): 137- 40.

The inhibitory effects of essential oils including clove, lavender and geranium extracted from *Eugenia caryophyllata*, *Lavandula officinalis* and *Pelargonium graveolens* on multidrug resistant isolates of *Pseudomonas aeruginosa* were investigated. The main constituents of clove, lavender and geranium oil were eugenol (80-90%), 1,8-cineol (13%) and citronellol (45%) respectively. Clove had the most effective essential oil against *P. aeruginosa*. A combination consisting of clove, lavender and geranium oils at a ratio of 3:1:1 showed the most inhibitory effect (32-64 µg/ml) and strong synergy with gentamicin. The essential oils from clove, lavender and geranium exhibited bactericidal activity against multi-drug resistant strains of *P. aeruginosa* and may be alternatives compounds against these strains in the future.

8. Mahboubi M, Farzin N. Antimicrobial Activity of *Artemisia sieberi* Essential Oil from central of Iran. *Iranian Journal of Microbiology* 2009, 1(2): 43-48.

The *Artemisia* genus of Asteraceae family is represented by 34 species in Iran. *Artemisia sieberi* grows wild in different regions of Iran and grows in desert and semi-desert climate and has forage value for animals and also medicinal properties for humans. In this study we examined the antimicrobial effects of *A. sieberi*. The antimicrobial activity of *A. sieberi* essential oil was evaluated against different microorganisms including Gram positive bacteria, Gram negative bacteria, yeast and fungi by disc diffusion method and micro broth dilution assay. The oil with main components of α - thujone, β - thujone and camphor showed antimicrobial activity against different microorganisms with varying types of pathogens. Gram positive bacteria and fungi were more sensitive than Gram negative ones. Among Gram positive bacilli, *Listeria monocytogenes* and *Bacillus cereus* and among Gram positive cocci, *Streptococcus mutans* were more sensitive than others. The antimicrobial properties of this oil showed that the *A. sieberi* essential oil has good potential use in the food and cosmetic industry.

9. Mahboubi M, Feizabadi MM. The antimicrobial activity of Thyme, sweet marjoram, savory and eucalyptus oils on *Escherichia coli*, *Salmonella typhimurium*, *Aspergillus niger* and *Aspergillus flavus*. *J. Herbal Medicine* 2009, 8 (30):36-43.

The presence of pathogenic microorganisms in aviculture threatens the health of fowl and humans. Thyme (*Zataria multiflora* Boiss), sweet marjoram (*Origanum majorana*), savory (*Satureja hortensis*) and eucalyptus (*Eucalyptus globules*) are Iranian herbal medicines that are used in folk medicines. The aims of this study were to evaluate the antimicrobial activity of these oils separately and in combination against *Escherichia coli*, *Salmonella typhimurium*, *Aspergillus niger* and *Aspergillus flavus* *in vitro*

condition. The antimicrobial activity of essential oils against different isolates of microorganisms was evaluated by disc diffusion and macro broth dilution assays. The results showed that the antimicrobial activity of thyme, sweet marjoram and savory oils against different bacteria and fungi were more than the eucalyptus oil. When ethanol was used as a solvent in comparison with dimethyl sulfoxide, the antimicrobial activity of oils was increased. The type of solvent creates meaningful discrepancy on effectiveness of oils ($p < 0.001$). In disc diffusion method, the fungi were sensitive than bacteria and *A. niger* was more sensitive than *A. flavus*. The sensitivity of bacteria was dependent to the type of bacteria and essential oil and the oils showed inhibitory effect against fungi and the fungicidal effect of oils were weaker than bactericidal effect. The antimicrobial activities of effective oils were related to thymol and carvacrol components in respect. Due to limitations in usage of chemical compounds in poultry and food industries, the essential oils look to be appropriate alternatives for some disinfectants to control the human and animal diseases in the future.

10. Mahboubi M, Avijgan M, Darabi M, Kasaiyan N. Anti candidal activity of *Echinophora platyloba* against *Candida albicans* and comparison with Amphotricin. J. Herbal Medicine 2009, 8 (30):137-144.

Increasing usage of medical plants for medical treatment made for this branch of complementary medicine a unique place. This study evaluated the anti candidal activity of *Echinophora platyloba* extracts and amphotricin B against *Candida albicans* by micro broth dilution assay and Disc diffusion method. The synergism between amphotricin B and ethanolic extract of *E. platyloba* was assessed by micro broth dilution assay. Amphotricin B was diluted at concentration between 16-0.125 $\mu\text{g ml}^{-1}$. Each tube contains 0.78 mg ml^{-1} *E. platyloba* extract. The MIC and MBC of Amphotricin B was recorded.

The MIC and MBC of ethanolic extract of *E. platyloba* and amphotricin B against *C. albicans* were 3125, 1560 $\mu\text{g ml}^{-1}$ and 2, 8 $\mu\text{g ml}^{-1}$ respectively. The MIC, MBC of amphotricin B decreased to 1, 2 $\mu\text{g ml}^{-1}$ when 0.78 mg ml^{-1} of extract was added. Amphotricin B is a potent antifungal agent and MIC and MBC of *E. platyloba* is 780, 390 times less potent than amphotricin B, but usage the amphotricin B and *E. platyloba* extract in combination increased the potency of amphotricin B which shows a synergistic effect.

11. Mahboubi M, Feizabadi MM. Antimicrobial activity of essential oils from 13 different plants against streptococci. International Journal of Essential Oil Therapeutics (IJEOT) 2009, 3: 40-44.

The aim of this study was to evaluate the antimicrobial activity of essential oils from 13 different plants from Lamiaceae family against different species of Streptococci using broth micro-dilution assay. The essential oils were identified using GC and GC/MS. *Zataria multiflora*, *Ziziphora tenuir*, *Satureja hortensis* showed the most antimicrobial activity against *Streptococcus* species. Conversely, *Zhumeria majdae*, *Salvia officinalis*, *Mentha spicata*, and *Rosmarinus officinalis* were less effective. *Perovskia abrotanoides*, *Mentha pulegium*, *Mentha piperita*, *Hyssopus officinalis*, *Ocimum basilicum* and

Lavandula stoechas showed moderate activity. An isolate of *Streptococcus mutans* was the most susceptible cocci to these compounds (MIC values ≤ 1 $\mu\text{l/ml}$). Conversely, with the exception of *Z. multiflora* oil (MIC values = 1 $\mu\text{l/ml}$), *Enterococcus faecalis* (group D streptococci) was resistant to all tested essential oils (MIC >2 $\mu\text{l/ml}$). The results suggest that the differences in antimicrobial activity of oils may be attributable to the major chemical components of the essential oils. The essential oils from *Zataria multiflora* and *Satureja hortensis* possessed antimicrobial properties against streptococci apparently related to their high phenolic content, particularly thymol and carvacrol. Further in vivo experiment should be done for confirmation of their potency in practical uses.

12. Mahboubi M, Qazian Bidgoli F. Chemical composition and antimicrobial activity of *Artemisia aucheri* essential oil. Iranian Journal of medicinal and aromatic plants 25(3): 2010, 429-440.

Artemisia aucheri Boiss. is a shrub from Asteraceae family that spread all over Iran. In traditional medicine, *A. aucheri* is a plant with astringent properties, disinfectant, antimicrobial, antiparasit and antitoxicant activity. The aim of this study was to evaluate, the antimicrobial activity of aerial part essential oil of *A. aucheri* against a large number of microorganisms including gram positive, gram negative bacteria, filamentous fungi, and yeast by disc diffusion and micro broth dilution assays. Fifty four components were identified by GC and GC/MS in the essential oil of *A. aucheri*, representing 98% of total oil. The major components were geranyl acetate (17.2%), α -citral (17.1%), linalool (12.7%), geraniol (10.7%) and Z-citral (10.5%). The antimicrobial activity of *A. aucheri* oil was dose dependent. Aerial part essential oil showed the best antifungal activity and this effect is more than the antibacterial activity. Gram negative bacteria were less sensitive than gram positive bacteria. Means average of inhibition diameters of oil against gram positive bacteria and fungi were more than vancomycin and amphotricin B, respectively and this effect was smaller than gentamycin in gram negative bacteria.

13. Mahboubi M, Qazian Bidgoli F. Biological activity of essential oil from aerial parts of *Artemisia aucheri* Boiss. from Iran. Herba Polonica 2009; 55 (4): 96-104.

Artemisia aucheri Boiss. is a shrub from Asteraceae family has been widespread in Iran. In traditional medicine, *A. aucheri* is used for its astringent, disinfectant, antimicrobial and antiparasitic properties. The aim of this study was to evaluate the chemical composition and antimicrobial activity of essential oil from aerial parts of *A. aucheri* against different microorganisms including Gram positive, Gram negative bacteria, filamentous fungi and yeast by disc diffusion and micro broth dilution assays. The antioxidant activity of *A. aucheri* essential oil was evaluated by DPPH free radical scavenging system. Fifty five components were identified by GC and GC/MS analysis and quantified from the essential oil of *A. aucheri*, representing 98% of total oil. The

major components were geranyl acetate (17.2%), E-citral (17.1%), linalool (12.7%), geraniol (10.7%), Z-citral (10.5%). The antimicrobial results showed that *Pseudomonas aeruginosa* was resistant to the oil and *Staphylococcus aureus* and *Candida albicans* showed the best sensitivity to the oil. The *A. aucheri* has powerful antioxidant activity than that of Trolox. Some investigations were be done for evaluating the efficacy of essential oil.

14. Mahboubi M, Kazempour N. *In vitro* antimicrobial activity of some essential oils from Labiatae family. Journal Essential Oil Bearing Plants JEOP 2009, 12 (4), 494 – 508.

Labiatae family is one of the few plant's families includes numerous genera species that uses as culinary vegetative, herbal medicine and also as great ornamental interest, extensively in planning of parks, gardens and the urban green areas. In present study, the *in vitro* antimicrobial activity of thirteen essential oils were tested against microorganisms including bacteria, fungi and yeast using disc diffusion and micro broth dilution assays. The essential oils were extracted from the whole aerial part of plants by hydro distillation method. In disc diffusion assay, *Zataria multiflora* and *Satureja hortensis* oils showed the most highly antimicrobial activity (means of Inhibition Zone (IZ) > 20 mm) and *Ziziphora tenuir*, *Ocimum basilicum*, *Mentha pulegium*, *Mentha piperita* and *Mentha spicata* exhibited moderate activity (means of IZ >10-20 mm) while *Hyssopus officinalis*, *Zhumeria majdae*, *Rosmarinus officinalis*, *Lavandula stoechas*, *Perovskia abrotanoides* and *Salvia officinalis* were least active against the tested organisms (means of IZ <10 mm). In micro broth dilution assay, almost of the MIC values of *Z. multiflora* and *S. hortensis* oils were lower than of 1 µl/ml. However, *Zataria multiflora*, *Satureja hortensis* and *Ziziphora tenuir* oils were potent antimicrobial agent than other essential oils. *Zataria multiflora* oil possesses the most potential bactericidal properties and it can be a good source of antimicrobial agents.

15. Mahboubi M, Kazempour N. The antimicrobial activity of essential oil from *Perovskia abrotanoides* Karel and its main components. Indian Journal of Pharmaceutical Sciences 2009; 71(3):343-347.

Perovskia abrotanoides is perennial herb growing wild in Iran. The antimicrobial activity of *Perovskia abrotanoides* essential oil and main components was evaluated against six microbial species, including gram-positive bacteria (*Staphylococcus aureus* and *Bacillus cereus*), gram-negative bacteria (*Escherichia coli* and *Pseudomonas aeruginosa*), yeast (*Candida albicans*), and fungus (*Aspergillus niger*) by disc diffusion and broth micro dilution assay. The antibacterial activity of *P. abrotanoides* oil and main components on viability of *S. aureus* was determined. Essential oil showed antimicrobial activity against gram positive bacteria and *C. albicans* with inhibition zones and minimal inhibitory concentration values in the range of 7.6 to 29 mm and 2 to 8 µl ml⁻¹ respectively, whereas the least susceptible were *A. niger* and gram negative bacteria. The minimal inhibitory and minimal fungicidal concentration values for fungi were smaller than gram negative bacteria. At the first, the antimicrobial activity of 1, 8-cineole was more than α-pinene and camphor but after 60 min this effect gradually

decreased and Ultimately MIC values of Camphor was smaller than α - pinene. 1, 8-cineol had a weak antimicrobial activity against all of the microorganisms. In addition, *S. aureus* was the more susceptible to essential oil than other tested microorganisms. In that, the antimicrobial activity of essential oil was presented the highest quantity of camphor and α - pinene.

16. Mahboubi M, Feizabadi MM. Antimicrobial activity of *Ducrosia anethifolia* essential oil and main component, decanal against methicillin-resistant and methicillin-susceptible *Staphylococcus aureus*. Journal Essential Oil Bearing Plants JEOP 12 (5) 2009; 574-579.

Ducrosia anethifolia Boiss is a member of Umbelliferae family. This study was evaluated the antimicrobial activity of *D. anethifolia* essential oil against clinical isolates *Staphylococcus aureus*, including methicillin resistant (MRSA) and methicillin susceptible of *S. aureus* (MSSA). The antimicrobial activity was investigated by the disc diffusion and broth dilution assays. Decanal or decyle aldehyde (57.0 %) and α -pinene (6.9 %) were the main constituents of the *D. anethifolia* essential oil. Essential oil showed antimicrobial activity against all of the tested clinical isolates, with inhibition zones and minimal inhibitory concentration (MIC) values in the range of 10.6 - 24.86 mm and 31.25-62.5 μgml^{-1} , respectively. The MBCs of this oil on different isolates were 62.5 to 250 μgml^{-1} . The essential oil also showed a strong synergy with methicillin. Decanal, the main component of essential oil alone had little effect on MRSA and MSSA strains and the MIC values were higher than of essential oil. One possible reason for these results could be synergistic action of constituents in oil. *D. anethifolia* oil has demonstrated antimicrobial activity against clinical isolates of *S. aureus* and should be further evaluated for its therapeutic value. The results can be used for potential formulation of a topical antimicrobial ointment against staphylococcal dermal infections.

17. Mahboubi M, Kazempour N. Antimicrobial activity of *Zhumeria majdae* Rech.F. & Wendelbo essential oil against different microorganisms from Iran. Pharmacognosy Magazine 5(9 Suppl.) 2009: 105-108.

The monotypic *Zhumeria majdae* Rech.F. & Wendelbo was recently described as the first member of new genus *Zhumeria* (*Lamiaceae*). In Iranian folk medicine, the leaves of plant were used for antiseptic properties. The antimicrobial activity of *Zhumeria majdae* essential oil was evaluated against a panel of microorganisms including gram negative, gram positive, yeast and fungi using disc diffusion method and micro broth dilution assay. Generally, the oil exhibited similar levels of antimicrobial activity against different microorganisms but some microorganisms appear to be more sensitive. In particular, oil showed significant power against *Klebsiella pneumoniae* followed by *Staphylococcus aureus*, *Staphylococcus saprophyticus*, *Vibrio cholera*, *Staphylococcus epidermidis* and *Bacillus cereus*. *Klebsiella pneumoniae* with MIC and MBC values 0.5, 1 μlml^{-1} was the most sensitive among the tested microorganisms. The oil showed

bactericidal activity against *Staphylococcus aureus*, *Bacillus cereus*, *Escherichia coli* and *Enterobacter aerogenes*. The oil showed inhibitory effect against *Bacillus subtilis*, *Proteus vulgaris*, *Aspergillus flavus* and *Aspergillus niger*. *Salmonella typhi* and *Pseudomonas aeruginosa* among Gram negative bacteria and *Bacillus subtilis* among Gram positive ones and *Aspergillus niger* among fungi and yeast were the most resistant to the essential oil.

18. Mahboubi M, Ghazian Bidgoli F. Anti staphylococcal activity of essential oil from *Zataria multiflora* and its synergy with vancomycin. *Phytomedicine* 2010; 17: 548-550.

Staphylococcus aureus is recognized as one of the major cause of infections in communities and hospitals. In this study, the chemical composition and antistaphylococcal activity of *Zataria multiflora* Boiss essential oil were evaluated, along with its synergistic activity with vancomycin. The essential oil was obtained by hydrodistillation from aerial parts of the plant and analyzed using GC and GC-MS. Thymol (38.7%), carvacrol (15.3%) and p-cymene (10.2%) were the main components of the oil. Antibacterial activity of the oil was evaluated by micro broth dilution assay against clinical isolates of methicillin-resistant (MR) and methicillin-sensitive (MS) strains of *S. aureus*. The oil showed high antibacterial activity against MRSA and MSSA with minimal inhibitory concentration (MIC) and minimal bactericidal concentration (MBC) values in the range of 0.25-1 and 0.5-2 µl/ml, respectively. The synergistic action was evaluated by microtitre assay. The essential oil exhibited synergism with vancomycin and displayed the ability to enhance the activity of vancomycin. This study showed that *Z. multiflora* oil has significant antimicrobial activity against clinical isolates of *S. aureus*, especially MRSA, and might be useful in controlling MRSA infections.

19. Mahboubi M, Ghazian Bidgoli F. *In vitro* synergistic efficacy of combination of Amphotericin B with the essential oil of *Myrtus communis* against clinical isolates of *Candida albicans*. *Phytomedicine* 2010; 17: 771-774.

In this study, we evaluated the antifungal activity of the essential oil from *Myrtus communis* (myrtle) leaves against *Candida albicans* (eight clinical isolates and one ATCC type strains) and different species of *Aspergillus* sp (*A. niger*, *A. parasiticus*, six isolates of *Aspergillus flavus*) using broth micro dilution assay. In addition, we evaluated the synergistic effect between the essential oil and the antifungal compound amphotericin B by checkboard micro titer assay. The essential oil was obtained from myrtle leaves by hydrodistillation method and the oil was analyzed by GC and GC-MS methods. Chemical analysis of oil revealed the presence of 70 components, representing 99.23% of the total oil. 1,8-cineole (36.1%), α -pinene (22.5%), linalool (8.4%), bornyl acetate (5.2%), α -terpineol (4.4%), linalyl acetate (4.2%) and limonene (3.8%) were found to be the major components of the oil. The antifungal evaluating showed that myrtle oil exhibited good antifungal activity against fungi. Myrtle oil showed significant antifungal activity when combined with amphotericin B.

- 20. Avijgan M, Mahboubi M, Darabi M, Saadat M, Sarikhani S, Kassaiyan N. Overview on *Echinophora platyloba*, a synergistic antifungal agent candidate. Journal of Yeast and Fungal Research 2010, 1(5): 88-94.**

Echinophora Platyloba DC. is one of the four native species of this plant in Iran. The aim of these five step study was to investigate the antimicrobial properties of this plant. Dried aerial parts of the plant were extracted by ethanol 70% in percolator. The antimicrobial activity of ethanolic extract was evaluated against dermatophytes, *Candida albicans* and gram positive bacteria by agar dilution method and microbroth dilution assay. Finally, the synergistic effect of Amphotericin B plus 5% ethanolic extract against *C. albicans* was determined by measuring MIC (minimum inhibitory concentration) and MLC (minimum lethal concentration) values. Gram positive bacteria were resistant to the extract according to measurement of zones of inhibition; *Trichophyton schenlaini* and *Trichophyton verucosum* were sensitive to concentrations >35 mg/ml, while other dermatophytes showed various susceptibilities to extract. MIC value of 5% ethanolic extract was 2 mg/ml against *C. albicans* using broth micro dilution method. In synergism assay, there was a 50% reduction in MIC and a 75% reduction in MLC values of the mixture of Amphotericin B and 5% ethanolic extract against *C. albicans* in comparison to Amphotericin B alone. Regarding this study, some degrees of synergy was recorded in the combination of Amphotericin B plus *E. platyloba* extract covering *C. albicans* which represented promising finding in antifungal therapy.

- 21. Mahboubi M, Kazempour N, Ghazian F. Chemical composition, antimicrobial and antioxidant activity of *Azilia eryngioides* essential oil. Biharean Biologist (2010): 4(2): 127-132.**

The essential oil from dried aerial parts of *Azilia eryngioides* (Umbelliferae) were obtained by hydrodistillation method and were analyzed by GC and GC/MS. Forty one components were identified in the *A. eryngioides* essential oil representing 97.9% of total constituents. α -pinene (63.8%) and bornyl acetate (18.9%) were the main components of essential oil. The antimicrobial activity was evaluated by micro broth dilution assay. The oil showed antimicrobial activity against *Staphylococcus aureus*, *Bacillus cereus*, *Klebsiella pneumoniae*, *Candida albicans*, *Aspergillus parasiticus* but it is less active against *Escherichia coli* and *Salmonella typhimurium*. The antioxidant activity of *A. eryngioides* oil was lower than that of BHT.

- 22. Mahboubi M, Kazempour N, Akbari H. Evaluation the antimicrobial activity of natural hand rub gel (Barij antimicrobial gel) in comparison to the chemical hand rub gel including 0.1% triclosan *in vitro* and *in vivo* conditions. The International Journal of Clinical Aromatherapy 2010; 7 (1): 11-18.**

The efficacy of natural alcohol based (Barij hand rub gel) and chemical (including 0.1% of triclosan) hand rub gels were evaluated to reduce the risk of infection transmission. The antimicrobial activity of the hand rub gels was tested according to the prEN 12504 suspension test using *Escherichia coli*, *Enterobacter aerogenes*, *Salmonella typhimurium*, *Listeria monocytogenes*, *Pseudomonas aeruginosa*, *Shigella dysenteriae*, *Staphylococcus aureus*, *Candida albicans* and *Aspergillus niger*. A cotton swab test was used for evaluating the efficacy on skin flora. The results of the in vitro study showed that the natural hand rub gel removed 99.9% of different microorganisms in 15 seconds. Concerning the skin flora, the natural hand rub gel reduced *Staphylococcus aureus* (69.6%), *S. epidermidis* (51.4%), *S. saprophyticus* (78.9%), *Micrococcus roseus* (100%), *Aspergillus niger* (83.3%) and *A. parasiticus* (50%) on the hands of volunteers while the chemical hand rub gel reduced *S. aureus* (50%), *S. epidermidis* (54.5%), *S. saprophyticus* (75%), *M. roseus* (100%), *A. niger* (100%) and *A. parasiticus* (100%). The antimicrobial activity of the natural hand rub gel was superior to the chemical hand rub gel on skin flora of the hands but these differences were not significant ($p > 0.05$).

23. Mahboubi M, Kazempour N, Mahboubi M. Antimicrobial activity of Rosemary, Fennel and Galbanum essential oils against clinical isolates of *Staphylococcus aureus*. Biharean Biologist 2011, 4-7.

The essential oils from rosemary (*Rosmarinus officinalis* L.), galbanum (*Ferula gummosa*), and fennel (*Foeniculum vulgare*) were obtained from Barij Essence Pharmaceutical Company and were analyzed by GC and GC-MS. The essential oils were evaluated for their anti-staphylococcal activities against Methicillin Sensitive (MSSA) and Resistant *S. aureus* (MRSA) by disc diffusion and micro broth dilution assays. GC-MS analysis of oils showed that β -pinene, α -pinene and trans-anethole as the major components of galbanum, rosemary and fennel oils, respectively. The Inhibition Zone diameters (IZ) of essential oils in disc diffusion assay increased in a dose dependent manner and in different concentrations of oils, the IZs were compatible with vancomycin (30 μ g). Altogether, antimicrobial evaluations exhibited that galbanum oil had the best antimicrobial activity against MRSA and MSSA, followed by fennel and rosemary oil, respectively.

24. Mahboubi M, Kazempour N, Khamechian T, Fallah MH, Memar Kermani M. Chemical composition and antimicrobial activity of *Rosa damascena* Mill essential oil. Journal of Biologically Active Products from Nature 2011, Journal Biologically Active Product from Nature 2011; 1(1): 19 - 26.

Rosa damascena Mill. a plant from Rosaceae family is traditionally used for treatment of many disorders especially against infectious diseases. The antimicrobial activity of *R. damascena* oil was determined against large number of microorganisms including Gram positive and Gram negative bacteria, yeast and fungi, by microbroth dilution assay. The oil was analyzed by GC and GC-MS. Chemical composition of oil revealed the presence of β -citronellol (48.2 %), geraniol (17.0 %), β -phenylethyl benzoate (5.4 %)

and phenyl ethyl alcohol (5.1 %) as the main components. The MIC values of oil were in the ranges of 0.125-1 μ l/ml. *Enterococcus faecalis*, *Enterococcus faecium*, *Salmonella typhimurium* and *Pseudomonas aeruginosa* were less sensitive to *R. damascena* oil. The oil exhibited the antimicrobial activity against a large number of microorganisms especially against *Proteus vulgaris* and *Klebsiella pneumonia*. This oil could be used as a natural antimicrobial agent in treatment of infectious diseases; more clinical studies should be done for demonstration of its efficacy.