

Antimicrobial Activity of Essential Oils of Aromatic Plants

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ABSTRACT: In this paper it was studied the antimicrobial activity of essential oils of the Azerbaijan aromatic plants. The antibiotic influence of essential oils can be different depending on both species of microorganisms and kind of essential oil. It was showed that, some of essential oils exert specific influence on microorganisms. So, essential oil of *Faeniculumvulgare* significantly inhibited only gram-positive bacteria, essential oil of *Rosmarinusofficinalis*- only gram-negative bacteria, essential oil *Thumustranscaucasicus* - both gram-positive and gramnegative bacteria, essential oils of *Mentapiperifae*, *Saliva officinalis* and *Saturealaxiflora* - gram-negative bacteria and yeasts.

KEYWORDS: Essential oils, antimicrobial activity, gram-positive and gram-negativbacteria, yeasts

I. INTRODUCTION

Nowadays the study of antimicrobial properties of biologically active substances of plant origin requires special attention. First of all, it depends on the quick adaptation of pathogenic microorganisms to individual antimicrobial preparation [5,8,12].

The essential oils occupy special place among the substances with antimicrobial properties of plant origin. The plants with essential oils are spread in all climatic zones of the world. Currently, 2500 species of plants are known to form essential oils, most of them are included in to the family of *Labiataeae*, *Apiaceae* and *Compositaeae* [2,10,11,13]. Essential oils from various plants have antibacterial, antifungal, antiviral, antiparasite, anti-inflammatory, antiallergic, antioxidant, immunostimulating and wound recovering properties. First of all, it is related to the synergetic effect of the substances in the composition of essential oils. The composition and properties of essential oils can be various depending on climate conditions and kind of plants [1,4,9,15].

More than 800 species of essential oil plants are spread in the territory of Azerbaijan Republic, among them representatives of the family of *Apiaceae* occupy the first place [6].

The antibacterial and antifungal properties of essential oils of plants: *Achilleamillefolium L.*, *Origanumvulgare L.*, *Salvia officinalis L.*, *Juniperussubina L.*, *Satureahortensis L.*, *Foeniculumvulgari Mill.*, *Pimpinella saxifrage L.*, *Ziziphora L.* and *Thymus L.* have been studied [7].

The aim of the present work was to study the antimicrobial activity of essential oils of the Azerbaijan aromatic plants.

II. MATERIALS AND METHODS

Essential oils were extracted from 10 species of aromatic plants: *Coriandrum sativum L.* (Coriander), *Foeniculumvulgare Mill.* (Fennel), *Mentapiperitae L.* (Peppermint), *Nepetacataria L.* (Catmint), *Ocimumbasilicum L.* (Sweet basil), *Rosmarinusofficinalis L.* (Rosemary), *Salvia officinalis L.* (Garden sage), *Saturealaxiflora C. Koch.*, *Thymus transcaucasicus Ronn.*, *Ziziforatenior L.* by hydrodistillation method [3].

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Antimicrobial activity of essential oils was determined using the dispersion- contact method. Essential oils have been used in the 6 dispersion forms. 96% ethyl alcohol diluted with distilled water in the ratio of 1:3, 1:4, 1:6, 1:7 and 1:8 for obtaining different dispersion forms (water-alcohol solution). Essential oils have been used in the form of the solution with ethyl alcohol. 1,9 ml each dispersion forms of water-alcohol solution poured in the test tube, then was added 0,1 ml solution of essential oil (2%) in the ethyl alcohol. As a result, we obtained 0,1% emulsion of essential oil in the different dispersions (1:3-1,8). Control variants (dispersion forms) which are chosen for comparison have been prepared by the same way, then 0,1 ml 96 % ethyl alcohol has been added, instead of the solution of essential oil in the alcohol, into 1,9 ml of water-alcohol solution. Test tubes which were prepared by the same way (control and experiment) were added 0,1 ml drop of different culture suspension.

From each species of bacteria and yeast separately, physiological solution (0,9 % NaCl solution) has been prepared for studying the influence of essential oils on the culture test. The number of cells in the suspension was determined by the number of generated colonies on the solid medium and expressed in the colony forming unit (CFU) [14].

The quantity of cells in the suspension which was prepared from bacterial culture test was 10^4 CFU/ml, while in the suspension which prepared from yeast culture test was 10^3 CFU/ml. The number of cells in the culture test was determined by the number of generated (forming) colonies on the solid medium which had been survived after direct contact with essential oil.

Cultures of gram-positive (*Bacillus anthracoides TU-1*, *Bacillus subtilis BDU-43*; *Staphylococcus aureus TU-4*), and gram-negative (*Escherichia coli TU-2*, *Pseudomonas aeruginosa TU-3*) bacteria and yeast (*Candida albicans BDU-47*, *Candida tropicalis BDU-30*) were used as a culture as a culture test in order to determine antimicrobial activity of essential oils. These cultures were taken from the culture collection of the department of Microbiology of Baku State University.

III. RESULTS AND DISCUSSION

The amount of dead cells which died 5 minutes later by the influence of 0,1% dispersion emulsion of essential oils on gram-positive bacteria *Bacillus anthracoides TU-1*, *Bacillus subtilis BDU-43* and *Staphylococcus aureus TU-4* was comparatively analyzed. The high antibiotic effect belongs to the essential oils of *Thymus transcaucasicus*, *Foeniculumvulgare* and *Salvia officinalis* and very weak antibiotic effect belongs to the essential oils of *Coriandrumsativum*, *Rozmarinusofficinalis* and *Nepetacataria*. 27, 37 and 51% cells, correspondingly, of *Bacillus anthracoides TU-1*, *B. subtilis BDU-43* and *Staphylococcus aureus TU-4* died 5 minutes later by the influence of essential oil of *Thymus transcaucasicus*; 23; 31 and 49%-died by the influence of the essential oil of *Foeniculumvulgare*; 15, 20 and 42%-died by the influence of the essential oil of *Salvia officinalis*; 7, 7 and 9%-died by the influence of the essential oil of *Coriandrumsativum*; 8,6 and 7,7 and 9%-died by the influence of the essential oil of *Ziziforatenior*; 4,4 and 10%-died by the influence of the essential oil of *Rozmarinusofficinalis* (fig.1).

The species of genus *Bacillus* have the same sensitivity against antibiotic impact of essential oil of *Coriandrumsativum*, *Rozmarinusofficinalis* and *Ziziforatenior*. However, the sensitivity can change depending on the kind of essential oils. The sensitivity of bacteria against essential oil of *Ziziforatenior* was 1,6 and 2,8 times more than- essential oils of *Coriandrumsativum* and *Rozmarinusofficinalis*. On the other hand, bacteria have the same sensitivity to different kind of essential oils. For example, the bacterium *Bacillus anthracoides TU-1* indicates the same sensitivity to essential oils of *Mentapiperitae*, *Foeniculumvulgare*, *Coriandrumsativum*, *Saturejalaxiflora*, *Ziziforatenior* and *Nepetacataria*; the bacterium *Bacillus subtilis BDU-43* indicates the same sensitivity to essential oils of *Mentapiperitae*, *Coriandrumsativum* and *Nepetacataria*; the bacterium *Staphylococcus aureus TU-4* shows the same sensitivity to essential oils of *Mentapiperitae*, *Foeniculumvulgare*, *Coriandrumsativum*, *Saturejalaxiflora*,

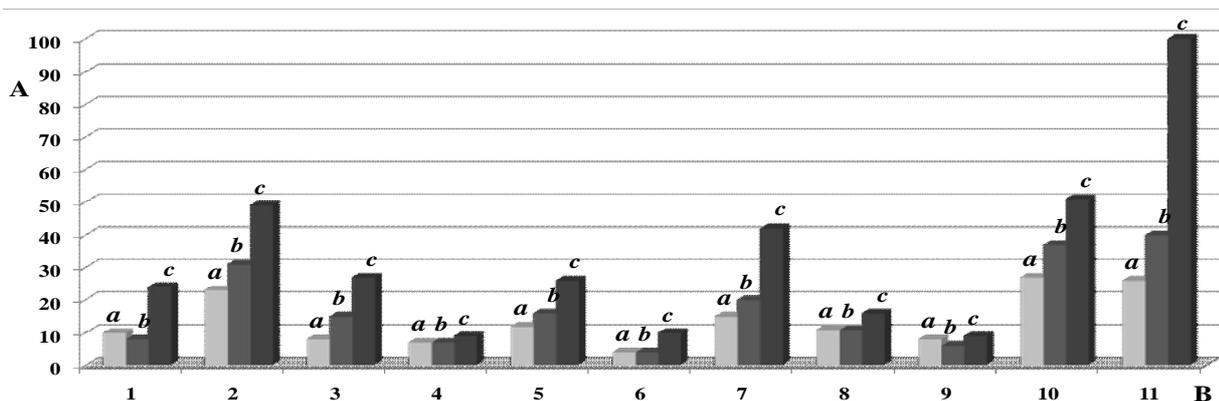


Fig. 1. Antibiotic effect of 1:3 dispersive emulsions of essential oils against gram-positive bacteria. A – the amount of killed bacterial cells, in 5 minutes impact, as compared with control, in%: a) *Bacillus anthracoides* TU-1; b) *Bacillus subtilis* BDU-43; c) *Staphylococcus aureus* TU-4; B – essential oils: 1-menta piperiate; 2-foeniculum vulgare; 3-ocimum basilicum; 4-coriandrum sativum; 5-saturea laxiflora; 6-rosmarinus officinalis; 7-saliva officinalis; 8-zizifora tenior; 9-nepeta cataria; 10-thymus transcaucasicus; 11-composition.

Thymus transcaucasicus, *Rozmarinusofficinalis* and *Nepetacataria* (fig.1). The essential oils can be divided into 3 groups according to the influence on *Staphylococcus aureus* TU-4. The essential oils of *Foeniculumvulgare* and *Thymus transcaucasicus* are concerned into the first group which has a high impact. To the second group is concerned the essential oils of *Mentapiperitae*, *Osimumbasilicum* and *Saturejalaxiflora* which have average degree of effect. Essential oils *Coriandrumsativum*, *Rozmarinusofficinalis* and *Nepetacataria* are the third group which has a very weak influence. Bactericidal influence of the first group was 1,8-2,1 and 4,9-5,7 times is more than, corresponding, second and third groups (fig.1).

Thus, it was determined that essential oils of *Foeniculumvulgare*, *Rozmarinusofficinalis* and *Thymus transcaucasicus*, have high antibiotic influence on gram positive bacteria. Maximal antibacterial activity was observed in the essential oil of *Thymus transcaucasicus*. Gram-positive nonspore-forming bacterium *Staphylococcus aureus* TU-4 shows high sensitivity to essential oil more than spore-forming *Bacillus anthracoides* TU-1 and *Bacillus subtilis* BDU-43. *Staphylococcus aureus* TU-4 has 2 times more sensitivity to antibacterial activity of essential oils composition than individual essential oils of *Rozmarinusofficinalis* and *Thymus transcaucasicus*.

The number of dead cells gram-negative bacteria *Escherichia coli* TU-2 and *Pseudomonas aeruginosa* TU-3 in 5 minutes influence of 0,1 % 1:3 dispersion emulsion of essential oils was comparatively studied (fig.2). It was determined that, the bacteria *Escherichia coli* TU-2 and *Pseudomonas aeruginosa* TU-3 were killed in full by the essential oils of *Salvia officinalis* and *Thymus transcaucasicus* and the composition of essential oils. Essential oils of *Mentapiperitae* and *Saturejalaxiflora* kill 100% of *Escherichia coli* TU-2 cells, but kill 88 and 61% of *Pseudomonas aeruginosa* TU-3 cells. Essential oil of *Foeniculumvulgare* could kill 46% of *Escherichia coli* TU-2 and *Pseudomonas aeruginosa* TU-3 cells, but essential oil of *Nepetacataria* - 9% cells. 20% cells of *Escherichia coli* TU-2 and 24% of *Pseudomonas aeruginosa* TU-3 were killed by the essential oil of *Ocimumbasilicum*. Essential oil of *Coriandrumsativum* killed 17% cells of *Escherichia coli* TU-2 and 12% cells of *Pseudomonas aeruginosa* TU-3. Essential oil of *Rozmarinusofficinalis* could kill 39% cells of *Escherichia coli* TU-2, 34% cells of *Pseudomonas aeruginosa* TU-3 and essential oil of *Ziziforatenior* could kill 92% cells of *Escherichia coli* TU-2 and 15% cells of *Pseudomonas aeruginosa* TU-3 (fig.2).

The antibiotic influence of essential oils on gram-negative bacteria can be different or similar depending on both species of bacteria and kind of essential oil. Essential oil of *Ocimumbasilicum*, *Salvia officinalis*, *Nepetacataria* and *Thymus transcaucasicus* show the same influence on both species of bacteria. However, the antibiotic influence may be

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 11, November 2016

very strong or weak depending on the types of essential oils. For example, this influence is observed 100% in the essential oils *Salvia officinalis* and *Thymus transcaucasicus*, 46%-in the *Foeniculumvulgare*

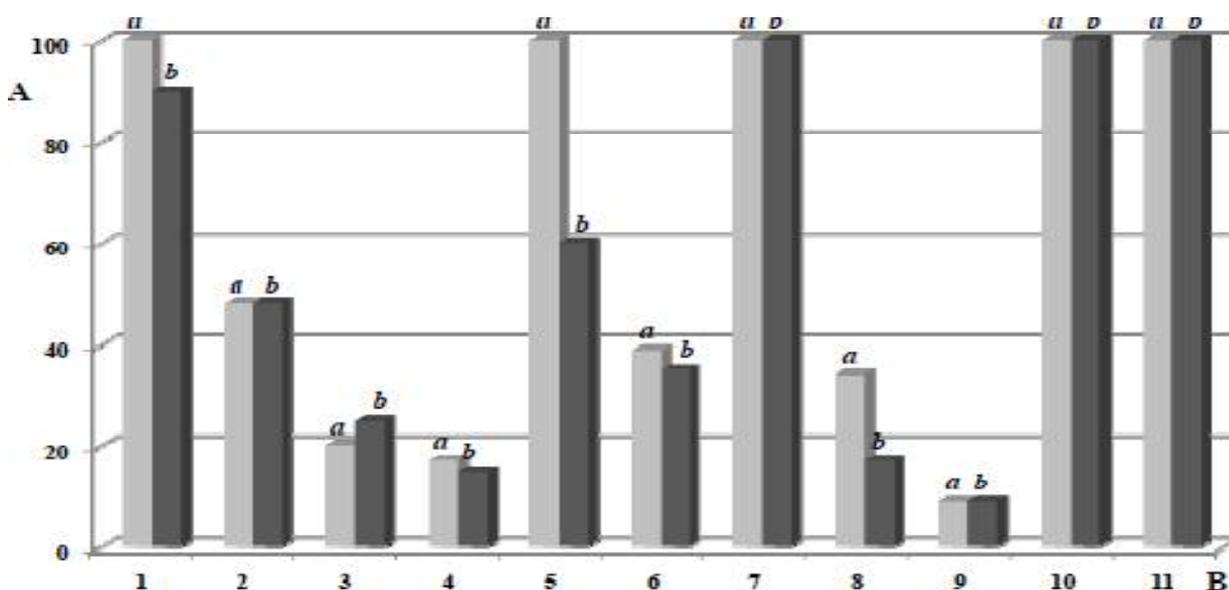


Fig. 2.Antibiotic effect of 1:3 dispersive emulsion of essential oils against gram-negative bacteria. A – the amount of killed bacterial cells, in 5 munites impact, as compared with control, in %: a) *Escherichia coli* TU-2; b) *Pseudo monas aeruginosa* TU-3. B – essential oils: 1 – mentapiperiate; 2 – foeniculumvulgare; 3 – ocimumbasiculum; 4 – coriandrumsativum; 5 – saturealaxiflora; 6 – rosmarinusofficinalis; 7 – saliva officinalis; 8 – ziziforatenior; 9 – nepetacataria; 10 – thymus transcaucasicus; 11 – composition.

and 90%-in the *Nepetacataria* (fig.2).

The sensitivity of bacterial species against essential oils of *Mentapiperitae*, *Ocimumbasilicum*, *Coriandrumsativum*, *Saturejalaxiflora*, *Rozmarinusofficinalis* and *Ziziforatenior* was different. Sometimes, *Escherichia coli* TU-2 shows more sensitivity to essential oils than *Pseudomonas aeruginosa* TU-3. So, the sensitivity of *Escherichia coli* TU-2 in the essential oil of *Mentapiperitae* was 1,14 times, in the essential oil of *Coriandrumsativum* was 1,42 in the essential oil of *Saturejalaxiflora* was 1,64, in the essential oil of *Rozmarinusofficinalis* was 1,15, in the essential oil of *Ziziforatenior* was 6,13 times more than *Pseudomonas aeruginosa* TU-3 (fig.2).

The antibiotic influence of essential oils on the gram-negative bacteria can be different depending on both species of bacteria and kind of essential oil. The bacteria species have the same sensitivity against antibiotic influence of essential oils of *Foeniculumvulgare*, *Salvia officinalis*, *Nepetacataria* and *Thymus transcaucasicus*.

Escherichia coli TU-2 has showed very much sensitivity to essential oils of *Mentapiperitae*, *Coriandrumsativum*, *Saturejalaxiflora*, *Rozmarinusofficinalis*, *Ziziforatenior*, but *Pseudomonas aeruginosa* TU-3 has showed the high sensitivity in the essential oil of *Coriandrumsativum* (fig.2).

The dead cells of yeast in 5 minutes influence of dispersion emulsion of essential oils were comparatively analyzed. So, 68 and 85%, correspondingly, of *Candida albicans* BDU-47 and *Candida tropicalis* BDU-30 cells were died by the influence of the essential oil of *Mentapiperitae*, 65 and 60%-died by the influence of the essential oil of *Saturejalaxiflora*, 73 and 76%-died by the influence of the essential oil of *Salvia officinalis* (fig.3).

The influence of essential oils of *Foeniculumvulgare*, *Ziziforatenior*, *Nepetacataria* and *Thymus transcaucasicus* on yeast was weak, but the influence of essential oils of *Osimumbasilicum*, *Rozmarinusofficinalis* and *Coriandrumsativum*

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 11, November 2016

was very weak. 5 and 6% of *Candida albicans* BDU-47 and *Candida tropicalis* BDU-30 cells were died by the influence of essential oil of *Osimumbasilicum*, 8 and 9%-were died by the influence of essential oil of *Coriandrum*

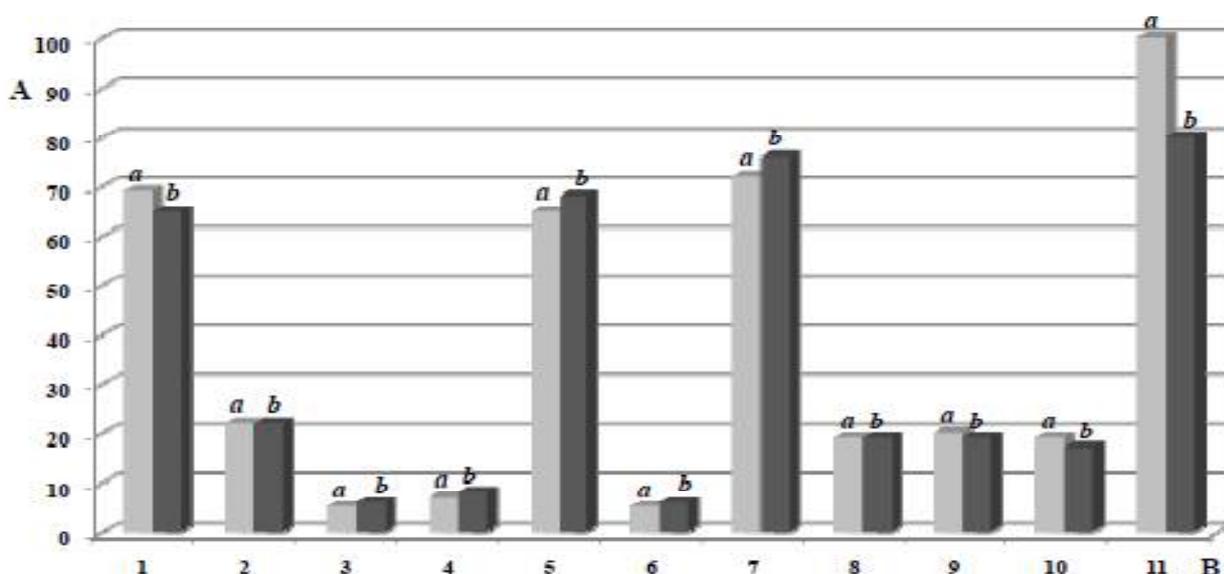


Fig. 3. Antibiotic effect of 1:3 dispersive emulsion of essential oils against yeast fungi: A – the amount of killed fungal cells in 5 minutes impact, as compared with control, in%: a) *Candida albicans* BDU-47; b) *Candida tropicalis* BDU-30; B – essential oils: 1-menta piperate; 2-foeniculum vulgare; 3-ocimum basilicum; 4-coriandrum sativum; 5-saturea laxiflora; 6-rosmarinus officinalis; 7-salvia officinalis; 8-zizifora tenior; 9-nepeta cataria; 10-thymus transcaucasicus; 11-composition.

sativum, 5 and 6%-were died by the influence *Rozmarinusofficinalis* (fig.3). It should be noted that antifungal influence of essential oils of *Mentapiperitae*, *Saturejalaxiflora* and *Salvia officinalis* on yeast was 8,1-15 times more than essential oils of *Osimumbasilicum*, *Rosmarinusofficinalis* and *Coriandrum**sativum*. 100% of *Candida albicans*BDU-47 cells and 80% of *Candida tropicalis* BDU-30 cells were died by the influence of essential oils composition. Consequently, yeast species significantly differ from each other the sensitivity to essential oils (fig.3).So, it was determined that *Candida albicans* BDU-47 and *Candida tropicalis*BDU-30 showed very high sensitivity against antifungal influence of essential oils of *Mentapiperitae*, *Salvia officinalis*and *Saturealaxiflora* and after 10 minutes alive cells died. The essential oil composition has very high antifugal property. In 5 minutes 100% of *Candidaalbicans* BDU-47 cells and 80% of *Candida tropicalis* BDU-30 cells were killed by this composition.

IV. CONCLUSION

It was showed that, some of essential oils exert specific influence on microorganisms. So, essential oil of *Foeniculumvulgare* significantly inhibited only gram-positive bacteria, essential oil of *Rosmarinusofficinalis*-only gram-negative bacteria, essential oil of *Thymus transcaucasicus*-both gram-positive and gram-negative bacteria, essential oils of *Mentapiperitae*, *Salvia officinalis* and *Saturealaxiflora*-gram-negative bacteria and yeasts.

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Vol. 5, Issue 11, November 2016

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