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EXPERIMENTAL PAPER

Antibacterial and antifungal effects of acetone extracts from fifty spice and herb plants

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Summary

Introduction: Chemical industry is obligatory to improve new chemically effective components. Spices are potential new antimicrobials.

Objective: The present study was designed to evaluate the antibacterial and antifungal activity of fifty aromatic spices and medicinal herbs obtained from Turkey.

Material and methods: *In vitro* antibacterial activities of a total of fifty acetone extracts from aromatic spices and medicinal herbs were studied by disc diffusion and agar diffusion method. The extracts were tested against three Gram-positive bacteria (*Listeria monocytogenes*, *Staphylococcus aureus*, *Bacillus cereus*), four Gram-negative bacteria (*Proteus vulgaris*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella typhimurium*) and two fungi (*Aspergillus niger*, *Candida albicans*).

Results: The highest antimicrobial activity was observed in the extract of *Alpinia officinarum* against *Salmonella typhimurium* and *Cassia angustifolia* against *Bacillus cereus*. Many of the extracts showed minimum inhibition concentration at even lowest dose.

Conclusion: The obtained results showed that aromatic spices and medicinal herbs may be used as natural antimicrobials against diseases.

Key words: ***antimicrobial, antibacterial, antifungal, spices***

Słowa kluczowe: ***działanie przeciwdrobnoustrojowe, przeciwbakteryjne, przeciwgrzybicze, przyprawy***

INTRODUCTION

Spices and herbs have been used in many cultures for thousands of years to increase the flavor and aroma of food [1]. More than 400 aromatic spices and herbs are used in different countries. Plant-derived antimicrobial compounds have been recognized for hundreds of years as means of hindering unwelcomed bacteria. Countless investigations and inquisitorial papers have defined the antimicrobial features of aromatic plants and plant extracts, like oregano, thyme and their essential oils (EOs), garlic and its extracts [2]. Spices used in small amounts have a little or no nutritive value, as compared to vegetables that contain great quantities of protein, carbohydrates, fat, starch, fiber, minerals and different vitamins. Aromatic plants specials spices and herbs such as cumin, garlic, and capsicum have vigorous antibacterial and antifungal effects and are used in hot climate regions [3, 4].

Antibacterial and antifungal substances exist in plants to ensure a natural defensive mechanism, and their wide activities against bacteria and fungi have led to the suggestion that they are used as natural preservatives in food [5, 6]. Extracts from many spice plants, e.g., thyme, pimento, garlic, rosemary, cassia, oregano, clove and sage [6-8] have been known for their antimicrobial activities. They have been used for ages for intestine, skin and throat infections [9].

The objective of this study was to detect the *in vitro* antibacterial and antifungal activities of fifty spices widely used in Anatolia for healing many diseases.

MATERIAL AND METHODS

Plant material

Fifty aromatic herb spices were purchased from a market of Turkish herbs and spices in Gaziantep, Turkey. The identifications were carried out using "Flora of Turkey" [10].

Preparation of extract

The extraction was prepared by Abdelaziz et al. [11] and Holopainen *et al.* [12]. Dried spices and medical herbs were extracted with acetone at room temperature. The crude extracts were stored at –20°C.

Microorganisms tested and culture media

Antimicrobial activities of crude extracts of 50 plants were assayed against three Gram-positive bacteria (*Staphylococcus aureus* (ATCC 25923), *Listeria monocytogenes* (ATCC 7677), *Bacillus cereus* (ATCC 10876)), four Gram-negative bacteria (*Escherichia coli* (ATCC 25922), *Proteus vulgaris* (ATCC 7829), *Pseudomonas aeruginosa* (ATCC 27853), *Salmonella typhimurium* (ATCC 14028)) and two fungi (*Candida albicans* (ATCC 10231), *Aspergillus niger* (ATCC 9642)). The concentration of suspensions were adjusted to 10^8 cells/ml in bacteria, and to 10^7 cells/ml in fungus.

Antibacterial assay

Antibacterial activity was determined in acetone extracts with disc diffusion method [13]. Inhibition zones were evaluated after the incubation in 37°C for 24 h. All tests were performed in triplicate. Ampicillin and cefazolin were used for positive control, yet acetone as negative control.

Antifungal assay

Antifungal activity was determined in acetone extracts with disc diffusion method [13].

Inhibition zones were evaluated after incubation in 37°C for 24 h. All tests were made in triplicate. Nystatin was used for positive control, acetone as negative control.

Minimum inhibition concentration

The agar dilution method was used [14] for minimum inhibition concentration. Each of the extracts was tested in concentrations of 10, 5, 2.5, 1.25 and 0.625 mg/ml. After the incubation period, the microbial growth was assessed by a stereo microscope.

Statistical analysis

Statistical analyses were calculated with SPSS for Windows (v. 15.0) software. The differences were tested with one-way Anova.

Ethical approval: The conducted research is not related to either human or animal use.

RESULTS AND DISCUSSION

The highest antimicrobial activity was observed in the extract of *A. officinarum* against *S. typhimurium* (29.33 mm) and *C. angustifolia* against *B. cereus* (29.00 mm) (tab. 1, 2). Many extracts showed minimum inhibition concentration at even lowest dose (0.625 mg/ml) (tab. 3). The Gram-positive bacteria were more sensitive than Gram-negative bacteria (tab. 1, 2). *S. typhimurium* was the most sensitive, while *P. aeruginosa* was the most resistant. The bacterial strains were more sensitive than *C. albicans* and *A. niger*. Gram-positive bacteria do not have this kind of an outer membrane and cell-wall construction for this reason antibacterial materials can readily demolish the bacterial cell-wall and cytoplasmic membrane which leads to a leakage of the cytoplasm and its coagulation [15-17]. For *A. niger* and *C. albicans,* the DIZ values just about of 17–20 extracts (accounting for 34% of the 50 tested extracts) were between 14.00 and 18.00 mm and those of 34 extracts (40%) were between 14.00 and 24.00 mm. In this study, the extracts of aromatic spices and medicinal herbs were significantly more active against Gram-positive bacteria and Gram-negative bacteria (MIC ranging from >0.625 to 10 mg/ml) than against yeast (MIC ranging from >1.25–5 to 10 mg/ml). Very good activity was also observed in the spices of *A. officinarum*, *C. longa* and *S. officinalis* which inhibited microbial growth from >1.25 to >0.625 mg/ml. Other spices extracts indicated only slight prevention of tested bacteria and fungi. The protective effects of herbs and spices has merely a short time since acceptable interest in the literature, where works have noticed that mycotoxin-producing molds may be hindered by some herbs and spices. Previous examinations have noticed that the antimicrobial agent of spices present in the essential oil, or oleoresin, fraction [17-19]. The restrictive influences of thyme, oregano and savory were discovered to be parallel to those of other spices and differentiation like essential oils, or oleoresins [18, 20]. Some decrease of the restrictive influences is perhaps because of evaporation from back cooler of their essential oils during boiling, inasmuch as, their components have antimicrobial activity. In contrast, other studies demonstrated the antimicrobial activity of these plants [21, 22]. These outcomes can be different because of varied bacterial strains. Moreover, some plants, such as thyme and sage, have different strains in distinct countries. Nevertheless, distinctions in extract type and concentration could lead to differences in conclusions.

CONCLUSION

The extracts which showed the highest antimicrobial activity such as *A. officinarum* and *C. angustifolia* could be used in natural preservation. This study is capable to get concious consumer perception for spices usage in Turkey. In addition, to the best of our knowledge, this is the first report regarding the antimicrobial activity of *Prunus mahleb*, *Gummi myrrhe*, *Terminalia citrina* and *Terebenthina communis*.

Conflict of interest: Authors declare no conflict of interest.

Table 1

Antimicrobial activity of fifty extracts from spice species against Gram-positive bacteria and fungi

Scientific name	Part tested	Inhibition zones [mm]				
		B.c.	*S.a.*	*L.m.*	*C.a.*	*A.n.*
Artemisia dracunculus L.	Flower	11.33±0.41	22.00±0.58	8.66±0.41	13.33±0.35	15.33±0.45
Anethum graveolens L.	Flover	23.00±0.44	15.33±0.45	11.33±0.42	12.33±0.35	9.33±0.42
Achillea millefolium L.	Leaf	18.33±0.45	16.33±0.42	19.33±0.45	15.66±0.38	13.00±0.43
Alpinia officinarum H.	Rhizome	27.33±1.02	21.33±0.44	17.33±0.46	9.33±0.41	11.33±0.44
Allium sativum L.	Root	13.66±0.51	17.66±0.47	15.00±0.41	11.00±0.38	8.00±0.51
Brassica nigra L.	Seed	14.33±0.50	18.00±0.55	10.33±0.40	11.33±0.39	13.33±0.52
Cassia angustifolia L.	Flower	29.00±0.44	18.33±0.52	19.33±0.34	14.00±0.42	13.33±0.47
Capsicum annuum L.	Fruit	13.00±0.41	16.00±0.51	10.33±0.35	11.33±0.45	13.33±0.35
Cuminum cyminum L.	Flower	13.33±0.42	15.66±0.48	11.00±0.54	12.33±0.44	14.00±0.45
Cannabis indica L.	Seed	16.00±0.46	18.33±0.44	17.33±0.45	13.33±0.41	11.33±0.25
Curcuma longa L.	Rhizome	17.00±0.48	16.66±0.45	16.33±0.48	16.66±0.54	19.33±0.54
Cocos nucifera L.	Fruit	15.66±0.45	14.66±0.44	11.33±0.51	12.66±0.35	10.66±0.22
Coriandrum sativum L.	Seed	15.33±0.51	12.33±0.41	14.66±0.47	10.00±0.45	12.33±0.45
Crocus sativus L.	Flower	10.66±0.55	25.00±0.42	10.33±0.47	18.33±0.42	19.66±0.52
Capsicum tetragonum M.	Fruit	6.00±0.00	9.00±0.39	9.66±0.45	14.00±0.48	15.66±0.54
Carthamus tinctorius L.	Flower	9.55±0.39	15.33±0.45	10.66±0.35	10.33±0.52	11.33±0.57
Cinnamomun zeylanicum L.	Bark	17.66±0.58	13.00±0.45	14.66±0.36	17.00±0.51	15.66±0.62
Elettaria cardamomum L.	Seed	16.33±0.47	14.33±0.44	13.33±0.41	12.66±0.54	13.33±0.63
Foeniculum vulgare M.	Flower	18.33±0.62	16.33±0.48	14.00±0.38	13.00±0.47	14.00±0.44
Glycyrrhiza glabra L.	Fruit	17.00±0.54	18.33±0.52	16.33±0.39	11.33±0.45	13.33±0.45
Gummi myrrhe L	Resin	13.00±0.44	16.33±0.48	16.33±0.42	12.33±0.46	13.33±0.39
Laurus nobilis L.	Leaf	16.33±0.38	17.33±0.44	12.33±0.44	10.33±0.42	13.66±0.38
Lepidium sativum L.	Leaf	17.00±0.58	13.33±0.47	10.00±0.45	12.00±0.51	6.00±0.00
Linum usitatissimum L.	Seed	19.00±0.62	17.33±0.42	11.00±0.47	6.00±0.00	10.00±0.52
Mentha piperita L.	Leaf	12.33±0.61	16.00±0.41	6.00±0.00	12.66±0.23	12.66±0.41
Nigella sativa L.	Seed	12.33±0.54	14.00±0.51	11.00±0.44	10.66±0.35	10.66±0.35
Ocimum basilicum L.	Leaf	14.66±0.55	15.00±0.53	16.00±0.36	14.00±0.34	14.33±0.33
Pimpinella anisum L.	Fruit	17.00±0.52	14.33±0.47	11.33±0.41	13.00±0.33	11.00±0.44
Piper cubeba L.	Fruit	9.33±0.47	14.00±0.48	14.66±0.52	11.33±0.38	15.33±0.35
Peganum harmala L.	Flower	14.66±0.55	14.33±0.35	14.66±0.44	6.00±0.00	14.66±0.45
Piper longum L.	Fruit	16.33±0.44	12.00±0.91	11.66±0.48	8.33±0.22	8.33±0.22
Prunus mahleb L.	Seed	13.00±0.48	15.66±0.54	13.00±0.38	12.66±0.35	15.00±0.54
Piper nigrum L.	Fruit	6.00±0.00	17.33±0.58	6.00±0.00	16.00±0.64	20.00±0.72
Pimenta officinalis L.	Fruit	15.00±0.53	17.55±0.62	17.33±0.47	12.66±0.24	11.33±0.45
Papaver somniferum L.	Seed	12.66±0.48	14.55±0.42	11.00±0.44	13.33±0.35	14.66±0.41
Rosa canina L.	Fruit	15.33±0.44	10.33±0.22	11.00±0.49	17.33±0.41	16.33±0.42
Rhus coriaria L.	Fruit	22.33±0.47	15.66±0.35	17.33±0.51	14.66±0.44	13.66±0.48
Rosmarinus officinalis L.	Flower	18.00±0.52	13.33±0.47	12.33±0.52	12.66±0.45	10.33±0.46
Syzygium aromaticum L.	Flower	19.33±0.38	18.33±0.48	19.33±0.64	15.33±0.44	16.00±0.39
Sesamum indicum L.	Seed	12.00±0.36	13.33±0.52	14.00±0.42	9.55±0.46	9.33±0.37
Salvia officinalis L.	Flower	17.33±0.38	15.66±0.61	18.33±0.58	9.55±0.28	11.00±0.42
Trigonella foenum-graecum L.	Seed	11.00±0.42	14.33±0.41	11.66±0.47	17.00±0.35	24.00±0.46
Theobroma cacao L.	Fruit	10.00±0.38	15.66±0.51	14.33±0.35	12.33±0.35	11.33±0.44
Terminalia citrina R.	Flower	11.33±0.32	24.33±0.78	13.33±0.65	10.33±0.41	11.00±0.78
Terebenthina communis L.	Seed	23.33±0.64	17.33±0.65	20.00±0.45	14.66±0.40	15.33±0.45
Thymbra spicata L.	Flower	16.66±0.51	15.66±0.57	20.00±0.48	14.00±0.42	14.66±0.55
Thymus vulgaris L.	Leaf	22.33±0.55	17.00±0.45	10.66±0.32	14.33±0.47	16.33±0.34
Urtica dioica L.	Leaf	13.66±0.42	14.00±0.42	12.66±0.41	14.66±0.42	8.00±0.25
Ziziphus zizyphus L.	Leaf	9.33±0.35	12.33±0.38	11.33±0.35	13.33±0.46	18.66±0.54
Zingiber officinale R.	Rhizome	15.66±0.45	17.00±0.52	10.00±0.38	14.33±0.52	12.33±0.41
Significance		***	**	***	**	***
Ampicillin		27.00±0.34	10.00±0.35	25.00±0.42	NT	NT
Cephazolin		23.00±0.0	6*.00±0.00	32.67±0.42	NT	NT
Nystatin		NT	NT	NT	16.67±0.42	15.33±0.44
Solvent (Acetone)		7.00±0.41	6*.00±0.00	7.00±0.41	6.33±0.36	6.66±0.22

The zone diameter of disk is 6 mm and the diameter of inhibition zone (DIZ) of negative control for each bacterium is also 6 mm. If the DIZ value is 6 mm (*), that means the extract has not inhibitory effect against tested microorganism. The differences between the means in the same column are not statistically significant, $p<0.05$ – no inhibition, NT – not tested, *B.c.: Bacillus cereus, S.a.: Staphylococcus aureus, L.m.*: *Listeria monocytogenes, C.a.*: *Candida albicans, A.n.: Aspergillus niger*

Table 2.

Antimicrobial activity of fifty extracts from spice species against Gram-negative bacteria

Scientific name	Part tested	Inhibition zones [mm]			
		P.v.	*E.c.*	*S.t.*	*P.a.*
Artemisia dracunculus L.	Flower	9.00±0.42	11.00±0.55	13.66±0.45	9.00±0.38
Anethum graveolens L.	Flover	9.33±0.35	19.66±0.56	19.00±0.44	6.00±0.00
Achillea millefolium L.	Leaf	14.00±0.52	15.33±0.45	14.00±0.54	18.00±0.41
Alpinia officinarum H.	Rhizome	13.00±0.54	20.66±0.44	29.33±0.52	15.33±0.45
Allium sativum L.	Root	13.33±0.52	11.33±0.42	20.00±0.48	14.00±0.47
Brassica nigra L.	Seed	12.00±0.41	11.00±0.33	17.00±0.44	10.00±0.52
Cassia angustifolia L.	Flower	25.33±0.36	10.00±0.35	27.33±0.47	12.33±0.52
Capsicum annuum L.	Fruit	14.33±0.42	14.33±0.42	11.66±0.39	6.00±0.00
Cuminum cyminum L.	Flower	13.66±0.45	15.33±0.48	13.33±0.54	11.33±0.33
Cannabis indica L.	Seed	17.33±0.44	17.33±0.47	9.00±0.58	15.00±0.55
Curcuma longa L.	Rhizome	19.33±0.47	13.00±0.44	22.33±0.61	19.66±0.45
Cocos nucifera L.	Fruit	13.33±0.52	17.66±0.35	13.66±0.54	6.00±0.00
Coriandrum sativum L.	Seed	19.00±0.55	19.66±0.42	6.00±0.00	14.33±0.41
Crocus sativus L.	Flower	16.00±0.54	15.33±0.51	15.33±0.45	11.66±0.45
Capsicum tetragonum M.	Fruit	10.33±0.48	14.00±0.35	10.33±0.44	6.00±0.00
Carthamus tinctorius L.	Flower	12.00±0.44	15.33±0.44	18.66±0.42	11.33±0.35
Cinnamomun zeylanicum L.	Bark	15.33±0.47	13.00±0.52	19.66±0.35	12.33±0.35
Elettaria cardamomum L.	Seed	14.00±0.52	16.33±0.47	20.66±0.45	10.00±0.47
Foeniculum vulgare M.	Flower	6.00±0.00	19.33±0.42	22.33±0.54	10.33±0.41
Glycyrrhiza glabra L.	Fruit	12.00±0.42	17.00±0.56	18.00±0.57	13.33±0.42
Gummi myrrhe L	Resin	15.66±0.51	9.00±0.35	20.00±0.62	10.33±0.41
Laurus nobilis L.	Leaf	16.33±0.55	19.33±0.54	22.33±0.40	10.66±0.45
Lepidium sativum L.	Leaf	10.00±0.41	18.00±0.65	18.66±0.58	10.33±0.38
Linum usitatissimum L.	Seed	19.00±0.41	11.33±0.65	25.66±1.12	16.00±0.56
Mentha piperita L.	Leaf	19.33±0.45	14.33±0.61	16.33±0.84	6.00±0.00
Nigella sativa L.	Seed	10.33±0.44	12.33±0.45	15.66±0.45	10.66±0.52
Ocimum basilicum L.	Leaf	15.33±0.47	17.00±0.52	17.66±0.52	15.66±0.54
Pimpinella anisum L.	Fruit	16.00±0.48	23.33±0.23	12.66±0.47	12.0±0.41
Piper cubeba L.	Fruit	16.33±0.52	15.33±0.35	25.33±0.77	14.33±0.42
Peganum harmala L.	Flower	19.33±0.51	17.66±0.36	26.33±0.82	13.66±0.47
Piper longum L.	Fruit	12.00±0.52	13.66±0.41	15.33±0.45	12.33±0.52
Prunus mahleb L.	Seed	15.33±0.45	9.00±0.42	18.00±0.56	13.33±0.51
Piper nigrum L.	Fruit	13.33±0.44	12.33±0.41	18.00±0.55	11.33±0.45
Pimenta officinalis L.	Fruit	14.33±0.35	21.33±0.78	18.33±0.51	12.66±0.41
Papaver somniferum L.	Seed	12.66±0.47	15.33±0.35	17.33±0.54.	10.00±0.45
Rosa canina L.	Fruit	11.33±0.22	12.00±0.44	12.66±0.42	11.33±0.44
Rhus coriaria L.	Fruit	16.00±0.51	18.66±0.45	21.66±0.45	14.33±0.45
Rosmarinus officinalis L.	Flower	14.33±0.35	16.33±0.47	26.00±0.47	10.00±0.48
Syzygium aromaticum L.	Flower	14.33±0.45	14.33±0.52	26.33±0.52	20.33±0.51
Sesamum indicum L.	Seed	21.66±0.52	14.00±0.55	15.33±0.44	11.33±0.47
Salvia officinalis L.	Flower	19.33±0.66	15.66±0.50	18.66±0.56	12.66±0.52
Trigonella foenum-graecum L.	Seed	14.00±0.45	15.00±0.39	15.66±0.54	13.66±0.38
Theobroma cacao L.	Fruit	9.66±0.22	12.33±0.41	26.66±0.62	11.33±0.38
Terminalia citrina R.	Flower	6.00±0.00	13.33±0.45	21.33±0.78	9.33±0.27
Terebenthina communis L.	Seed	17.00±0.58	11.00±0.48	25.00±0.82	20.66±0.75
Thymbra spicata L.	Flower	20.33±0.68	13.33±0.57	22.33±0.66	13.00±0.48
Thymus vulgaris L.	Leaf	13.33±0.44	18.66±0.52	10.00±0.33	11.00±0.44
Urtica dioica L.	Leaf	11.00±0.35	18.33±0.54	12.33±0.45	14.33±0.45
Ziziphus zizyphus L.	Leaf	15.33±0.41	14.66±0.47	17.66±0.58	11.33±0.47
Zingiber officinale R.	Rhizome	12.66±0.43	12.66±0.43	17.33±0.56	6.00±0.00
Significance		***	***	***	**
Ampicillin		28.00±0.34	15.33±0.44	28.00±0.34	28.00±0.34
Cephazolin		6*.00±0.00	15.33±0.44	22.00±0.44	24.00±0.00
Nystatin		NT	NT	NT	NT
Acetone		6.66±0.19	7.00±0.22	7.00±0.26	6.66±0.32

The zone diameter of disk is 6 mm and the diameter of inhibition zone (DIZ) of negative control for each bacterium is also 6 mm. If the DIZ value is 6 mm (*), that means the extract has not inhibitory effect against tested microorganism. The differences between the means in the same column are not statistically significant, $p<0.05$ – no inhibition, NT – not tested, *P.v. – Proteus vulgaris, E.c. – Escherichia coli, S.t. – Salmonella typhimurium, P.a. – Pseudomonas aeruginosa*

Table 3
Results of minimum inhibitory concentration (MIC) [mg/ml]

Samples	*P.v.*	*E.c.*	*B.c.*	*S.a.*	*S.t.*	*L.m.*	*P.a.*	*C.a.*	*A.n.*
A. dracunculus	10	10	10	0.625	10	10	10	5	2.5
A. graveolens	10	1.25	0.625	5	1.25	10	-	10	10
A. millefolium	5	5	2.5	5	5	1.25	1.25	5	5
A. officinarum	5	1.25	0.625	1.25	0.625	2.5	5	10	10
A. sativum	5	10	5	2.5	1.25	5	5	10	10
B. nigra	10	10	5	2.5	2.5	10	10	10	5
C. angustifolia	0.625	10	0.625	1.25	0.625	1.25	10	5	5
C. annuum	5	5	10	2.5	10	10	-	10	5
C. cyminum	5	5	5	5	5	10	10	10	5
C. indica	2.5	2.5	2.5	1.25	10	2.5	5	10	10
C. longa	1.25	10	2.5	2.5	0.625	2.5	1.25	2.5	1.25
C. nucifera	5	1.25	5	5	5	10	-	10	10
C. sativum	1.25	1.25	2.5	10	-	5	5	10	10
C. sativus	2.5	2.5	10	0.625	5	10	10	1.25	1.25
C. tetragonum	10	5+	-	10	10	10	-	5	2.5
C. tinctorius	10	5	10	5	1.25	10	10	10	10
C. zeylanicum	5	5	2.5	5	1.25	5	5	2.5	5
E. cardamomum	5	2.5	2.5	5	1.25	10	10	10	10
F. vulgare	-	1.25	1.25	2.5	0.625	5	10	5	5
G. glabra	10	1.25	2.5	1.25	1.25	5	5	10	5
G. myrrhe	5	10	5	2.5	0.625	2.5	10	10	5
L. nobilis	1.25	1.25	2.5	1.25	0.625	10	10	10	5
L. sativum	10	1.25	2.5	10	1.25	10	10	10	-
L. usitatissimum	1.25	5	1.25	2.5	0.625	10	5	-	10
M. piperita	1.25	5	10	2.5	2.5	-	-	10	10
N. sativa	10	10	10	5	5	10	10	10	10
O. basilicum	2.5	2.5	5	5	2.5	2.5	5	5	5
P. anisum	2.5	0.625	2.5	5	10	10	10	10	10
P. cubeba	2.5	5	10	5	0.625	5	5	5	2.5
P. harmala	1.25	2.5	5	5	0.625	5	10	-	5
P. longum	10	5	2.5	10	5	10	10	10	10
P. mahleb	2.5	10	10	5	2.5	10	10	10	2.5
P. nigrum	10	10	-	2.5	1.25	-	10	1.25	0.625
P. officinalis	5	0.625	2.5	2.5	1.25	2.5	10	10	10
P. somniferum	10	5	10	5	2.5	10	10	5	5
R. canina	10	10	5	10	5	10	10	2.5	2.5
R. coriaria	2.5	2.5	1.25	5	1.25	2.5	5	5	5
R. officinalis	5	2.5	1.25	5	0.625	10	10	10	10
S. aromaticum	5	5	1.25	1.25	0.625	1.25	0.625	2.5	2.5
S. indicum	0.625	5	10	5	5	5	10	10	10
S. officinalis	1.25	2.5	2.5	5	1.25	1.25	10	10	10
T. foenum-graecum	5	5	10	5	2.5	10	10	2.5	0.625
T. cacao	10	10	10	5	0.625	5	10	10	10
T. citrina	-	5	10	0.625	1.25	5	10	10	10
T. communis	2.5	10	0.625	2.5	0.625	1.25	1.25	5	5
T. spicata	0.625	5	2.5	5	0.625	0.625	10	5	5
T. vulgaris	5	1.25	0.625	2.5	10	10	10	5	2.5
U. dioica	10	1.25	5	5	10	10	5	5	10
Z. zizyphus	5	5	10	10	2.5	10	10	10	1.25
Z. officinale	10	10	5	2.5	2.5	10	-	5	10
Ampicillin	NT	NT	NT	NT	NT	NT	NT	NT	NT
Cephazolin	NT	NT	NT	NT	NT	NT	NT	NT	NT
Nystatin	NT	NT	NT	NT	NT	NT	NT	NT	NT
Acetone	NT	NT	NT	NT	NT	NT	NT	NT	NT

Microorganisms; *P.v.*: *Proteus vulgaris, E.c.*: *Escherichia coli, B.c.*: *Bacillus cereus, S.a.*: *Staphylococcus aureus, S.t.*: *Salmonella typhimurium, L.m.*: *Listeria monocytogenes,P.a.*: *Pseudomonas aeruginosa, C.a.*: *Candida albicans, A.n.*: *Aspergillus niger*. $p<0.05$, – no inhibition, NT – not tested

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