Review Article

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Review on composition and antimicrobial effects of Teucrium (Teucrium polium L.) grown in Iran and comparison with the around the world

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ABSTRACT

BACKGROUND AND OBJECTIVE: *Teucrium polium* plant from Lamiaceae family and evolvable in a range of climate types and used in traditional medicine to treat diseases and also has antimicrobial effects is significant. This paper was done to compare the antimicrobial effects *T. polium* plants grown in Iran with the around of the world.

METHODS: In this review study using keywords Essential oil, Medicinal Plants and Teucrium searching was done in the databases Pubmed, Science Direct, Elsevier, SID, Magiran, Google Scholar, Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO).

FINDINGS: A total of 269 articles were identified with the desired subject of who 86 were selected for further investigation. Failure to select other articles, was away from the goal the finding of this study showed that the α-Pinene, β-Pinene, Spathulenol, Verbenene, β-Myrcene were the main components of *T. polium* essential oil was grown in Iran. Amount of MIC, MBC value against pathogenic bacteria and inhibition diameter of *T. polium* was grown in Iran In comparison with the elsewhere in the world was not significant.

CONCLUSION: *T. polium* plant can be used as an effective antimicrobial compounds. The dose should be determined in various experiments and controlled manner taking the risk of toxicity occurs.

KEY WORDS: *Teucrium polium, Medicinal Plants, Essence.*

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Introduction

Food contaminated with pathogenic microorganisms often been described as the primary source of many diseases in humans. Growth and survival of microorganisms in food products will lead to corruption and loss of quality (1). Now 30 percent of the world's population in industrialized countries suffer from diseases of food origin of the food safety issue is very important in public health (2). Due to the adverse effects of chemical preservatives, particularly carcinogenic potential and toxicity to humans as well as antimicrobial agents abundant in plants there is a growing interest in the use of natural preservatives derived from natural sources (3-5).

Essential oils and plant extracts with varied combinations of biological and physiological compounds have very high potency for use as new medicinal compounds in the field of health and treatment of human diseases and animal and, also due to have antimicrobial compounds, especially against gram-positive pathogenic bacteria and gram-negative bacteria, anti-cancer, antioxidant and free radical agents are considered as an important source of natural scrubber for medical use and food items (6-17).

Teucrium plant belongs to the Labiatae family and is abundant in Southwest Asia, Europe and North Africa. Years ago it was used in various applications as a known medicinal plant and its application as a drug is estimated to the time of Hippocrates and Galen and as a diuretic, diaphoretic, tonic, analgesic, antipyretic and anorexia was used but now with growing knowledge other properties of Teucrium, including anti-spasmodic, anti-inflammatory, anti-hypertensive, hypoglycemic, anti-cancer, anti-microbial and anti-oxidant were revealed.

In addition, due to the impact of antibiotics in small quantities and at microgram against the pathogen, therefore in the plants will also try to determine antioxidant and antimicrobial activities by the screening and evaluation and those with stronger effects be identified and by the use of lower concentration of them, the specification applies and performance are used (28-18, 11, 3). One of the most important factors affecting the rate and the chemical composition of medicinal plants are geography, habitat, and weather conditions and the harvest season, therefore same plants grown in different geographical areas may be very different in the amount and type of active components(3). Teucrium plant as one of the most commonly used herbs in traditional medicine is widely used, the major effectiveness of this medicinal plant is more relevant to its flowering branches. Limited studies have been done regarding the effects and antimicrobial properties of essential oils and plant extracts of Teucrium, so we decided to review the composition and properties of the antimicrobial activity of this plant. In addition, what distinguishes this article with other articles, the antimicrobial properties of grown plant in Iran will be compared with the rest of the world.

Botany: Teucrium which is known in Arabic language as Hashishat-al-rih is belonged to the family of Lamiaceae, including more than 300 species. Its height is 10 to 30 cm with the appearance of white cotton, and is visible usually in areas of rocky and Sand prairie and this plant is evolvable in a range of climate types, including European countries, North Africa and Southwest Asia, including Iran (29, 6, 3).

The healing properties of this plant in last years has reported by Socrates and Galen, Teucrium is a perennial plants. This plant has more than 340 species worldwide and 12 species have been identified in Iran (30, 12).

Methods

In this simple review study, keywords including Teucrium, herbs, essential oils, Essential oil, Medicinal Plants and Teucrium and the databases such as Pubmed, Science Direct, Elsevier, SID, Magiran, Google Scoolar, Food and Agriculture Organization of the United Nations (FAO) and WorldHealth Organization (WHO) were used.

Results

A total of 269 papers on the subject were detected and articles reviewing components and the antimicrobial effect of essential oils and extract of TP using MIC (Minimum Inhibitory Concentration) method, MBC (Minimum Bactericidal Concentration) method and the inhibitory zone tested were selected which consisting of 86 paper. Failure to select other articles, being away from the goal and was unrelated to other models.

Plant oils of Teucrium: Teucrium derived compounds which were most frequent in various studies, as follows (40-31V 26, 16, 13, 3, 1): Verbenene, Beta – pinene, Beta – Myrcene, Benzene,1-methyl, Benzene, Bicyclogermacrene, 2,4 Heptadienal, Germacrene D,

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Germacrene B, Bicyclo [3.1.1] hept-3-en-2-one,4,6,6-trimthyl, 1,6,10-Dodecatriene,7,11-dimethyl-B-methylen, Sesquisabinene hydrate, Trans-Pinocarveol Bicyclo-heptanol, o-Menth-8-eno, Spathulenol, 1H-3a, 7-Methanoazulene, 1,3-Cyclooctadiene, Alpha-Pinene, Bicyclohexene, 4-methylene, Camphene-bicycle-heptane, Linalool, 7-Methanoazulene, Limonene, Camphor, Germacrene- 1,5-Cyclodecadiene, Filifolone, Carvacrol, Phenol, 2,3,3-trimethyl-3-cyclopentene acetaldehyde, Bicycloheptan-2-one, 6,6-dimethyl, 3-Cyclohexene-1-methanol,.alpha.,4-dimethul, Naphthalene, Menthone & Beta-bisabolene Cyclohexene.

According to studies, Teucrium plant can be used as an effective antimicrobial compounds. The dose should be determined in different experiments and in a controlled manner avoiding the risk of toxicity.

Effects of Teucrium: In this study, the effect of this plant on the transferred microbes from foods was tested (tables 1, 2).

Table 1. Minimum Inhibitory Concentration and Minimum Bactericidal Concentration growth of microbial strains against Teucrium oil

Source	antibiotic Zone diameter Growth inhibition	MBC (mg/ml)	MIC (mg/ml)	identified active compounds	Type of Compound	Tested microorganism
Tabatabaei Yazdi et al (41)(1392)	-* -	۳۲	۸	α-pinene, β-pinene & β-caryophyllene	Ethanolic extract	*Streptococcus pyogenes*
Tabatabaei Yazdi et al (41)(1392)	- -	۶۴	۱۶	α-pinene, β-pinene & β-caryophyllene	Ethanolic extract	*Staphylococcus epidermidis*
Tabatabaei Yazdi et al (41)(1392)	- -	۶۴	۱۶	α-pinene, β-pinene & β-caryophyllene	Ethanolic extract	*Staphylococcus aureus*
Tabatabaei Yazdi et al(41)(1392)	- -	۱۲۸	۳۲	α-pinene, β-pinene & β-caryophyllene	Ethanolic extract	*Escherichia coli*
Tabatabaei Yazdi et al(41)(1392)	- -	۱۲۸	۳۲	α-pinene, β-pinene & β-caryophyllene	Ethanolic extract	*Pseudomonas aeruginosa*
Tabatabaei Yazdi et al(41)(1392)	- -	۶۴	۱۶	α-pinene, β-pinene & β-caryophyllene	Watery extract	*Streptococcus pyogenes*
Tabatabaei Yazdi et al (41)(1392)	- -	۱۲۸	۳۲	α-pinene, β-pinene & β-caryophyllene	Watery extract	*Staphylococcus epidermidis*
Tabatabaei Yazdi et al (41)(1392)	- -	۱۲۸	۳۲	α-pinene, β-pinene & β-caryophyllene	Watery extract	*Staphylococcus aureus*
Tabatabaei Yazdi et al (41)(1392)	- -	۲۵۶	۶۴	α-pinene, β-pinene & β-caryophyllene	Watery extract	*Escherichia coli*
Tabatabaei Yazdi et al(41)(1392)	- -	۲۵۶	۶۴	α-pinene, β-pinene & β-caryophyllene	Watery extract	*Pseudomonas aeruginosa*
Nadimi et al (42)(2013)	- -	۸	۴	-*	Ethanolic extract	*Candida albicans* NCPF 3153
Nadimi et al (42)(2013)	- -	۸	۴	-	Ethanolic extract	*Candida albicans* ATCC 1677
Nadimi et al (42)(2013)	- -	۱۶	۸	-	Ethanolic extract	*Candida albicans* ATCC 62061
Nadimi et al (42)(2013)	- -	۳۲	۱۶	-	Watery extract	*Candida albicans* NCPF 3153
Nadimi et al (42)(2013)	- -	-*	-**	-	Watery extract	*Candida albicans* ATCC 1677
Nadimi et al (42)(2013)	- -	-	-	-	Watery extract	*Candida albicans* ATCC 62061
Samak et al (43)(2010)	- -	-	۱۶/۶۶	caffeic, ferulic & 4-hydroxybenzoic	TP essences from Vošac area	*Staphylococcus aureus* ATCC 6538
Samak et al	-	-	۱۶/۶۶	caffeic, 4-coumaric &	TP essences	*Staphylococcus*

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(43)(2010)		-			ferulic	from Vošac area	*aureus* ATCC 6538
Samak et al (43)(2010)		- -	-	۴/۱۶	Salicylic, gentisic & ferulic	TP leaf oil from Ucka area	*Staphylococcus aureus* ATCC 6538
Samak et al (43)(2010)		- -	-	۲۵	Salicylic, gentisic & ferulic	TP leaf oil from Ucka area	*Bacillus subtilis* NCTC 8236
Samak et al (43)(2010)		- -	-	۴/۱۶	Salicylic, gentisic & ferulic	TP leaf oil from Snjez˘nica area	*Bacillus subtilis* NCTC 8236
Samak et al (43)(2010)		- -	-	۱/۵۶	caffeic, 4-coumaric & ferulic	TP leaf oil from Šušanj area	*Bacillus subtilis* NCTC 8236
Samak et al (43)(2010)		- -	-	۵۰	Salicylic, gentisic & ferulic	TP leaf oil from Snjez˘nica area	*Bacillus subtilis* NCTC 8236
Darabpour et al (44)(2010)	VA ۲۲	TE Resistant	-	۴۰	-	Ethanolic extract	*Staphylococcus aureus*
Darabpour et al (44)(2010)	NB ۲۴	CL Resistant	-	۱۰	-	Ethanolic extract	*Bordetella bronchiseptica*
Darabpour et al (44)(2010)	NB ۱۲	CL Resistant	>۲۰۰	۴۰	-	Methanolic extract	*Salmonella typhi*
Darabpour et al (44)(2010)	ME ۲۳	OX Resistant	۱۰	۱۰	-	Methanolic extract	*Bacillus anthracis*
Balmaki et al (33)(2013)	SXT ۶	CL ۶	-	۵	Germacrene D, β-pinene &Carvacrol	Essence of TP	*Bacillus cereus* ATCC 11778
Balmaki et al (33)(2013)	SXT ۲۰	CL ۳۰	-	۵	Germacrene D, β-pinene &Carvacrol	Essence of TP	*Enterococcus faecalis* ATCC 29212
Balmaki et al (33)(2013)	SXT ۱۷	CL ۴۰	-	۴	Germacrene D, β-pinene &Carvacrol	Essence of TP	*Escherichia coli* ATCC 25922
Balmaki et al (33)(2013)	SXT ۶	CL ۶	-	-	Germacrene D, β-pinene &Carvacrol	Essence of TP	*Pseudomonas aeruginosa* ATCC 27853
Balmaki et al (33)(2013)	SXT ۱۶	CL ۲۳	-	۳	Germacrene D, β-pinene &Carvacrol	Essence of TP	*Staphylococcus aureus* ATCC 25923
Akin et al (45)(2010)		-	-	-	-	Essence of TP	*Bacillus cereus* ATCC 14579
Akin et al (45)(2010)		-	-	۱۰	-	Essence of TP	*Staphylococcus aureus* ATCC 25923
Akin et al (45)(2010)		-	-	۷	-	Essence of TP	*Salmonella typhimurium* ATCC 14028
Akin et al (45)(2010)		-	-	۳	-	Essence of TP	*Escherichia coli* ATCC 25922
Zare et al (3)(2011)		-	-	۶۲	Bicyclodecene, Iso aromadendrene epoxide &1,3-Cyclooctadiene	Essence of TP	*Salmonella typhimurium* ATCC 13311
Zare et al (3)(2011)		-	-	۳۱/۵۰	Bicyclodecene, Iso aromadendrene epoxide &1,3-Cyclooctadiene	Essence of TP	*Salmonella dublin* RTCC 1618
Zare et al (3)(2011)		-	-	۱۵/۲۵	Bicyclodecene, Iso aromadendrene epoxide &1,3-Cyclooctadiene	Essence of TP	*Salmonella entridis* ATCC 13076
Zare et al (3)(2011)		-	-	۳۱/۵۰	Bicyclodecene, Iso aromadendrene epoxide &1,3-Cyclooctadiene	Essence of TP	*Pseudomonas arizona* RTCC 1472
Zare et al (۳) (۲۰۱۱)		-	-	۷/۱۲	Bicyclodecene, Iso aromadendrene epoxide &1,3-Cyclooctadiene	Essence of TP	*Bacillus cereus* RTCC 1042
Zare et al (۳) (۲۰۱۱)		-	-	۶۲	Bicyclodecene, Iso aromadendrene epoxide &1,3-Cyclooctadiene	Essence of TP	*Escherichia coli* ATCC 43894
Shahba et al(۴۶) (۲۰۱۴)		-	۱۰	۳,۱۲	-	Watery extract	*Enterococcus faecalis*

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Shahba et al(۴۶) (۲۰۱۴)	-	۲۰	۱۰		-	Ethanolic extract	*Enterococcus faecali*
Shahba et al(۴۶) (۲۰۱۴)	-	۱۰	۲		-	Watery extract	*Pseudomonas*
Shahba et al(۴۶) (۲۰۱۴)	-	۲۰	۲۰		-	The ethyl acetate extract	*Pseudomonas*

***Not mentioned, ** Activity did not arise, NCTC: National Collection of Type Cultures, London, UK, ATCC: American Type Culture Collections, Rockville, USA, RTCC: Razi Type Culture Collection, PTCC: Pasture Type Culture Collection**

VA: Vancomycin 30 mcg; TE: Tetracycline 30 mcg; NB: Novobiocin 30 mcg; CL: Colistin 10 mcg; ME: Methicillin 5 mcg; OX: Oxacillin 1 mcg.

Table 2. The average zone diameter of growth inhibition of microbial strains in front of the essence of TP (mm)

Source	Antibiotic diameter of growth inhibition		concentration diameter of growth inhibition				Identified active compound	Type of compound	Tested microorganism
Teimouri et al(۳۰) (۲۰۱۲)	Chloramphenicol ۲۷	Gentamicin ۲۸	۲۵ ۱۰	۵۰ ۱۸	۷۵ ۲۲	۱۰۰ ۲۴	Tannins, Saponin , α-pinene & β-pinene	Methanolic extract	*Staphylococcus aureus* PTCC 1454
Teimouri et al(۳۰) (۲۰۱۲)	Chloramphenicol ۲۸	Gentamicin ۲۹	۲۵ ۸	۵۰ ۱۰	۷۵ ۲۲	۱۰۰ ۲۴	Tannins, Saponin , α-pinene & β-pinene	Methanolic extract	*Bacillus subtilis* PTCC 1447
Teimouri et al(۳۰) (۲۰۱۲)	Chloramphenicol ۲۲	Gentamicin ۲۰	۲۵ -	۵۰ -	۷۵ -*	۱۰۰ ۱۱	Tannins, Saponin , α-pinene & β-pinene	Methanolic extract	*Klebsiella pneumoniae*
Teimouri et al(۳۰) (۲۰۱۲)	Chloramphenicol ۲۳	Gentamicin ۲۴	۲۵ -	۵۰ -	۷۵ -	۱۰۰ -	Tannins, Saponin , α-pinene & β-pinene	Methanolic extract	*Escherichia coli* PTCC 1335
Samak et al (۴۳) (۲۰۱۰)	-				۷۵ ۵۰		Salicylic, gentisic &ferulic	TP leaf oil from Snjezˇnica area	*Bacillus subtilis* NCTC 8236
Samak et al (۴۳) (۲۰۱۰)	-				۷۵ ۲۵		Salicylic, gentisic &ferulic	TP leaf oil from Ucka area	*Bacillus subtilis* NCTC 8236
Balmaki et al (۳۳) (۲۰۱۳)	SXT ۶	CL ۶			۷۵ ۱۵		Germacrene D, β-pinene & Carvacrol	The essence of TP	*Bacillus cereus ATCC* 11778
Balmaki et al (۳۳) (۲۰۱۳)	SXT ۲۰	CL ۳۰			۷۵ ۱۵		Germacrene D, β-pinene & Carvacrol	The essence of TP	*Enterococcus faecalis ATCC 29212*
Balmaki et al (۳۳) (۲۰۱۳)	SXT ۱۷	CL ۴۰			۷۵ ۱۶		Germacrene D, β-pinene & Carvacrol	The essence of TP	*Escherichia coli* ATCC ۲۵۹۲۲
Balmaki et al (۳۳) (۲۰۱۳)	SXT ۶	CL ۶			۷۵ ۶		Germacrene D, β-pinene & Carvacrol	The essence of TP	*Pseudomonas aeruginosa* ATCC 27853
Balmaki et al (۳۳) (۲۰۱۳)	SXT ۱۶	CL ۲۳			۷۵ ۱۶		Germacrene D, β-pinene & Carvacrol	The essence of TP	*Staphylococcus aureus* ATCC 25923
Moghtader et al (۴۷)(۲۰۱۳)	Tetracycline ۱۵				۲۸		α-pinene, β-pinene &Linalool	The essence of TP	*Staphylococcus aureus* PTCC 1431
Moghtader et	Tetracycline				۲۵		α-pinene, β-pinene	The essence of	*Staphylococcus*

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al (۴۷)(۲۰۱۳)	۲۱		&Linalool	TP	*epidermidis* PTCC 1436
Moghtader et al (۴۷)(۲۰۱۳)	Tetracycline ۱۶	۱۲	α-pinene, β-pinene &Linalool	The essence of TP	*Streptococcus faecalis* PTCC 1237
Moghtader (۲۰۱۳) et al(۴۷)	Tetracycline ۲۲	۲۶	α-pinene, β-pinene &Linalool	The essence of TP	*Pseudomonas aeroginosa* PTCC 1430
Moghtader et al (۴۷)(۲۰۱۳)	Tetracycline ۱۹	۲۳	α-pinene, β-pinene &Linalool	The essence of TP	*Shigella Flexneri* 1716
Moghtader et al (۴۷)(۲۰۱۳)	Tetracycline ۱۴	۱۵	α-pinene, β-pinene &Linalool	The essence of TP	*Kellebsiella pnuomonae* PTCC 1053
Moghtader et al (۴۷) (۲۰۱۳)	Tetracycline ۱۷	۲۲	α-pinene, β-pinene &Linalool	The essence of TP	*Salmonella typhi* PTCC 1609
Moghtader et al (۴۷) (۲۰۱۳)	Tetracycline ۱۳	۲۱	α-pinene, β-pinene &Linalool	The essence of TP	*Serratia marcescens* PTCC 1187
Moghtader et al (۴۷)(۲۰۱۳)	Tetracycline ۱۲	۲۷	α-pinene, β-pinene &Linalool	The essence of TP	*Escherichia coli* PTCC 1533

**** Activity did not arise, SXT: sulfamethoxazole-trimethoprime 25 mcg.**

Discussion

According to the results of this study, the main phytochemicals compounds of TP grown in Iran, including alpha-pinene, beta-pinene, Verben, beta-myrcene, beta-pinene, Spathulenol, as well as in the MIC, MBC and the diameter of the inhibition of growth of TP plant grown in Iran against pathogenic bacteria compared to the rest of the world, no significant difference was observed. Of past, human used therapeutic properties of plants as food additives. Today, many plants are examined annually worldwide due to its therapeutic properties. Some part of the research focuses on determining the antimicrobial properties of medicinal plants, cause of special attention are problems, including bacterial resistance and antibiotic side effects that has been created due to the inappropriate application (48).

In a study, the essential oils of TP had proper effect against Salmonella typhimurium bacteria which is an important factor in food poisoning and in another study showed essential oils of TP has a greatest antimicrobial activity against Bacillus cereus (16, 1). Several studies have shown that this herb has antibacterial, anti-inflammatory, antispasmodic and anti-oxidant properties (50, 49).

More than 2000 years, this plant is used in traditional medicine. Diuretic, antipyretic, anti-seizure, anti-diabetic, mosaic, nourishing, anti-obesity and anti-spasmodic, includes the use of the plant. As well as its useful for the treatment of genital-urinary system diseases, delay or absence of menstruation delay and the effect of lowering blood pressure and positive inotropic effect also been reported (51, 29). It's also used in traditional medicine as an analgesic and lipid-lowering drug. In addition, this plant is used as a spice in food and relieve diseases of the stomach and also is used to treat wounds (52, 45).

Another study showed that the plant has the effect of lowering blood sugar, lowering lipids, antipyretics, anti-ulcer and anti-bacteria (53). Keykavusi and colleagues studied the effects of this herb in preventing the growth of Bacillus cereus in soup business model. In this study, the essential oil had inhibitory effect on bacterial growth, but reduced admission of soup flavor because of bitter taste. Therefore, it is recommended to use for industrial several methods such as microencapsulation can be used (31). In addition to the positive things about TP, but the use of herbal medicines containing the extract of TP without any practical guide, caused liver toxicity in many cases by

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increased blood urea (55, 54, 14). According to the results of various studies, it appears that the beneficial effects of herbal medicines in different patients and their beneficial effects on detoxification of xenobiotics toxicity of drugs should no longer possible to ignore their toxicity. In addition, many studies have demonstrated that increasing the dose of TP resulted in increased vulnerability that undermines the positive performance, therefore, it is recommended that the use of high doses of this plant strictly avoided (56-60). TP has a variety of plant essential oil compounds. The main components of this plant are included α-Pinene, β-Pinene, Spathulenol, Bicyclodecene, b-Caryophyllene and Germacrene B. In various studies, the examined plant is prepared from different areas and climates. Therefore, it would be effective on the type of compounds derived from measuring and this explains the impact of this difference. In addition, the most effective factor genetics cannot be ignored (58) but, as was observed, MIC, MBC and zone diameter of growth inhibition of the various components of the Teucrium plant against germs had not significant difference. In addition, these compounds have antimicrobial effect on both gram positive and gram negative, hence it can be harvested that plants from different regions have the same function. Also, it is seems that limited studies regarding the antimicrobial effects of essential oils and plant extracts, is due to toxicity at high doses. This has caused the extensive research on the effects of pharmacological and especially the antimicrobial effect of it has not been done. In order to accurately determine the antimicrobial effects and side effects of TP further studies are needed.

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