

Chemistry, Pharmacology and Medicinal Property of Savory (*Satureja L.*) to Prevent and Cure Illnesses such as Diabetes, Cardiovascular Disease, Alzheimer's Disease, and Cancer

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ABSTRACT

Savory (*Satureja L.*) is known as the Functional Novel Natural Medicine, (*Satureja L.*). Extract are considered important for drug development, because they are reported to have Pharmacological activity in the Asia, Middle East especially China and India. For a long time Savory (*Satureja L.*) plant species have been used for centuries as culinary herbs and spices, as well as traditional remedies for the treatment or relief of various common health symptoms in many parts of the world. Recent studies suggest that the use of some *Satureja* species is effective in protecting the body against oxidative stress, free radical damage, inflammation, microbial infections, etc. A review of many studies suggests that savory species, in addition to treating minor ordinary ailments, can potentially provide a novel natural prevention or treatment for some chronic and serious illnesses such as diabetes, cardiovascular diseases, cancer, and Alzheimer's (Figure 1).

Keywords

Alzheimer's disease and cancer, Cardiovascular disease, Diabetes.

Plants of the genus *Satureja L.* (savory) belong to the Lamiaceae family and contain about 200 species of herbs and shrubs which are grown mostly in the Mediterranean region, Europe, West Asia, North Africa, the Canary Islands, and South America [1]. *Satureja hortensis L.* (summer savory or garden savory) is one of the well-known *Satureja* species that originated in the Mediterranean region and naturalized in parts of North America [2]. On average, this plant grows about 1 or 2 feet producing purplish-pink flowers [3]. Since ancient times, summer savory has been widely used as an, and infectious diseases.[4,5] The volatile oil, oleoresin, tincture, and extract of *Satureja species* have been found to have a variety of properties including antibacterial, antifungal, antioxidant, anti-inflammatory, and many others [4].

The remarkable types in the chemical composition and therapeutic value of savory species provide evidence for the antimicrobial and antioxidant activities of these herbal medicines and also other biological effects [1]. The aim of our study is to determine the

antioxidant properties of the essential oil and various extracts obtained from summer savory by using different types of solvents and chemical composition of hydro-distilled volatile oil from the aerial part of the plant.

Compounds

Among the medicinal plants, *Satureja* species have gained increasing interest because they are composed of different bioactive chemicals such as volatile oils, phenolic compounds, flavonoids, tannins, steroids, acids, gums, mucilage, pyrocatechols, etc. [1,5,6]. Studies have shown that there is an abundance of a variety in chemical composition and therapeutic values of different *Satureja* species [1].

The major constituents of the essential oils from savory species are carvacrol, thymol, phenols, and flavonoids [1]. Many reports show that in *S. hortensis*, carvacrol [7], thymol, γ -terpinene, and p -cymene are the main components of the essential oil and α -terpinene, β -caryophyllene, and β -bisabolene are present in smaller amounts [8,9] (Table 1).

Rosmarinic acid was found to be the major compound in the ethanolic extracts of summer savory and some other Lamiaceae herbs [10]. Rosmarinic acid is known for its antiviral, antioxidant, anti-inflammatory, and immunostimulating activities. The study shows that rosmarinic acid in all the Lamiaceae family members is accompanied with caffeic acid or benzoic derivatives [11].

The high amount of polyphenols and flavonoids, in addition to the simple cultivation and good smelling properties is the reason for using savory species in food preparation and also in cosmetic and pharmaceutical industries [1].

Compound	Retention Time (min)	Amount (%)
α -Thujene	10.61	1.24
α -Pinene	10.99	2.91
Camphene	11.66	0.15
β -Pinene	12.96	0.92
Myrcene	13.42	1.98
α -Phellandrene	14.18	0.74
α -Terpinene	14.97	2.93
ρ -Cymene	15.32	6.30
Limonene	15.94	2.55
γ - Terpinene	16.97	20.72
Cyclopentene	22.20	0.21
Terpinene-4-ol	22.8	0.17
L-Carvone	27.31	0.54
Carvacrol	28.87	24.50
Thymol	29.18	23.12
Carvacryl acetate	31.88	0.75
Aromanderene	34.86	0.34
Ledene	37.12	0.19
β -Bisabolene	37.47	2.20
α -Bisabolene	38.70	0.19
Spathalenol	40.62	0.23
Caryophelene Oxide	40.85	1.70
Benzenemethanol	52.69	0.19

Ref: (Food Control) 2007; 18;1518-23

Table 1: Chemical Composition of summer Savory essential Oil.

Dried summer savory contains approximately 1% of volatile oil composed primarily of carvacrol thymol and monoterpene hydrocarbons such as beta-pinene, *p*-cymene, limonene, and camphene. The leaves contain various minor components including minerals and vitamins.

Winter savory contains about 1.6% of volatile oil. Some authors document the dominant components of the oil as caryophyllene and geraniol or as carvacrol. Twenty-one compounds, which represent 97.4% of the total oil, have been identified. The major compound was phenolic monoterpene thymol followed by monoterpene hydrocarbons *p*-cymene, γ -terpinene, oxygen-containing compounds carvacrol methyl ether, thymol methyl ether, carvacrol, geraniol, and borneol. It also contains triterpenic

acids including ursolic and oleanolic acids.

Medicinal Uses

Savory species have been used in traditional medicine to treat various ailments and their symptoms. They have been used to relieve muscle pain, stomach and intestinal disorders such as nausea, indigestion, and diarrhea, and infectious diseases [1,5,12].

Recently, the other properties of *Satureja* species, including antimicrobial, antioxidant, anti-diabetic, anti-hyperlipidemic, antispasmodic [2], anti-nociceptive [13], anti-inflammatory [13], antiproliferative [5], sedative [2], reproduction stimulatory, and vasodilatory activities have been proven by many studies [1,5].

Antioxidant activity

Oxidative damage plays an important role in the onset and progression of many diseases in the human body and it is caused due to the development of reactive oxygen species (ROS) during regular cell aerobic respiration. Antioxidants have a significant effect in protection of cells against oxidative damages [2] and in the prevention of many degenerative illnesses [14].

Studies of many *Satureja* species have proven their strong antioxidant properties [1]. The essential oil of *S. hortensis* plant is rich in isopropanoids such as carvacrol, thymol, γ -terpinene, flavonoids, and other phenols which are known to possess strong antioxidant effects [1,2]. The leaves of summer savory (*S. hortensis*) are rich in phenolic compounds, particularly rosmarinic acid and flavonoids, which account for the high antioxidant capacity of the leaves [10].

Cancer

Phenolic compounds are naturally present in almost all plant materials and they can delay or inhibit the oxidative damages caused by free radical and non-free radical species [4]. The inhibition of initiation and propagation of oxidative chain reactions can have a protective effect against major illnesses such as cardiovascular disease, neurological disorders, oxidative stress dysfunctions, and cancer [4,14].

Many investigations have proved that phenolic acids and flavonoids can exhibit various pharmacological properties such as antimicrobial, anti-inflammatory, vasoprotective, anti-carcinogenic, anti-allergic, and antiproliferative activities [15].

Some of the savory species such as *Satureja montana* L. have been used in the treatment of different types of cancer [15]. The report shows that among some of the human cancer cells, HeLa (human cervix epidermoid carcinoma), found to be the most sensitive to the extracts of savory also the growth of HT-29 (human colon adenocarcinoma) cells, was inhibited by the extracts at a concentration above 0.7 mg/ml. The result indicates that some *Satureja* species like *S. montana* L. extracts are strong antioxidants which can selectively inhibit the growth of several human tumor cells [15].

Natural products have been shown to be excellent and reliable sources for the development of new drugs. Carvacrol is an aromatic monoterpene found in the essential oils of many aromatic plants [16]. The effect of carvacrol on a human non-small cell lung cancer (NSCLC) cell line known as A549 shows that carvacrol has an inhibitory effect on the cancer cells, but does not have a significant effect on normal lung cells (HFL1) [16]. The study shows that carvacrol may have an anti-carcinogenic effect and it could be used as a drug substance for the treatment of cancer [16].

Antidiabetic and anti-cholesterol effects

Antioxidants play a significant role in the improvement of disorders related to oxidative stress damages, such as diabetes mellitus [17], and the best treatment for preventing and slowing the progression of diabetic complications such as hyperlipidemia and hepatic damage is antioxidant therapy. Recently, researchers are becoming more interested in the extraction of natural antioxidants from medicinal herbs as a replacement for synthetic antioxidants [18]. Polyphenols are well-known natural antioxidants which have proven to function similar to antidiabetic drugs by reducing the blood glucose levels [18].

Satureja khuzestanica (SKE) is a common savory plant of Iran which possesses antioxidant properties and its anti-diabetic activity has been proven in several studies [1,18]. SKE decreases serum glucose and malonaldehyde levels in diabetic patients [18]. The hepatoprotective, hypolipidemic, and antiatherogenic effects of SKE essential oil have been evaluated [18]. These can decrease the risk of cardiovascular death and hepatic damage in diabetic patients [18].

The main components of *Satureja* species are essential oils, such as carvacrol and thymol, which were found to be responsible for lowering the serum cholesterol levels [1,17,18]. Flavonoids, which are also the main ingredients of *Satureja* species, have been reported to have antioxidant and anti-hyperlipidemic properties [17]. In several studies, SKE significantly decreased the fasting blood glucose and triglyceride levels in diabetic and hyperlipidemic rats and also improved lipid peroxidation and ATP levels [17]. This result shows that some *Satureja* species such as SKE, with their lipid lowering and antioxidant properties, could be used as a supplement in diabetic patients with hyperlipidemia [17].

Cardiovascular diseases

Platelet hyperactivity can cause the adhesion of platelet to the vessel wall and can lead to thrombosis (blood clots in the artery or vein) and cardiovascular problems [19].

Studies have reported that *S. hortensis* has blood anticoagulant activity. Carvacrol and other monoterpene hydrocarbons, flavonoids like apigenin, and phenolic acids like labiatic acid could contribute to the anti-platelet property of *S. hortensis* [19]. Studies have proved that the methanol extract of *S. hortensis* L. has inhibitory effect on blood platelet adhesion, aggregation, and secretion, which might be the reason for its traditional use in treating cardiovascular and blood clot problems [9].

Anti-inflammatory and analgesic effects Inflammation is a defense mechanism of body in response to pathophysiological problems, and many studies have been performed to develop more powerful anti-inflammatory drugs with lesser side effects [20].

Lamiaceae family plants are well-known for their significant antispasmodic and pain-relieving properties. Various compounds of *Satureja* species such as some flavonoids have been recognized to be responsible for their analgesic, relaxant, and vasodilatory effects in animal studies [1].

Some species of the genus *Satureja* have been found to have beneficial anti-inflammatory effects in addition to analgesic activity [1]. In traditional folk medicine, *S. hortensis* L. has been used as a muscle and bone pain reliever [13]. Studies have shown that polyphenolic compounds and essential oil of *Satureja* species have potent anti-inflammatory effects. The studies support the traditional usage of *S. hortensis* as a remedy for reducing inflammation and relieving pain [13].

Some studies have shown that some *Satureja* species such as *S. hortensis* and SKE can act as an anti-inflammatory agent and are comparable to prednisolone, indomethacin, and morphine [1]. The anti-inflammatory activity of *S. hortensis* is related to the polyphenolic fraction, especially rosmarinic acid, whose anti-inflammatory and anti allergic properties have been proven in animal and human trials [10].

Alzheimer's disease

Lack of acetylcholine, which is a neurotransmitter, has been accepted as the reason for developing Alzheimer's disease. Acetyl cholinesterase inhibitor drugs have been used for the treatment of Alzheimer's. However, most of these drugs have side effects. The development of natural origin compounds with antioxidant and anticholinesterase activities is highly desirable for controlling this kind of disorder [21].

Antioxidants play an important role as neuroprotective agents in the early stage of Alzheimer's disease [22]. A study shows that in some *Satureja* species, the phenolic compounds, especially flavonoids and flavonoid glycosides, can provide potential source of antioxidants which can slow down the development of the Alzheimer's disease and reduce neuronal degeneration [21].

Satureja species are rich in thymol and carvacrol and their consumption may be useful as moderate cholinesterase inhibitory agents and can protect people against oxidative stress and amnesia without any side effects [21].

Antimicrobial activity

In recent years, there have been tremendous studies focusing on the antimicrobial activity of essential oils of aromatic plants and their potential role in food preservation [23]. There are many reports showing the relationship between the chemical structure of components in the essential oils and their antimicrobial activities. Essential oils act on cell membranes by interfering and

destabilizing the phospholipid bi-layer performance and altering the enzyme activities and genetic resources in bacteria [24].

The essential oil of *S. hortensis* L. contains significant amounts of two phenolic ketones: carvacrol and thymol. They are isomeric compounds containing a phenol group in their structures. Carvacrol and thymol have been generally reported to have a strong inhibitory effect on the growth of wide range of microorganisms including fungi and bacteria [6,8,23].

The high antimicrobial activity of the members of *Satureja* family is due to the presence of phenolic components and their precursors [8,25], which act by disruption of the permeability barrier of cell membrane and inhibition of respiration of the cell [7,8]. Studies have shown that thymol has the best inhibitory effect against *Staphylococcus aureus*. Carvacrol and ρ -cymene are more toxic against *Escherichia coli*. γ -terpinene, the non-oxygenated hydrocarbon, has been reported to be active against *S. aureus* and *Candida albicans* [25].

From ancient times, the antimicrobial activities of some herbs and spices have been recognized and they have been used in food preservation and medicine. Recently, natural food preservatives have received increasing attention due to the growing concern of consumers for microbial resistance in conventional preservatives [26].

The growth of fungi in food can cause spoilage and contamination. Some *Aspergillus species* such as *Aspergillus flavus* and *Aspergillus parasiticus* are able to produce aflatoxin in food and foodstuffs [26]. The presence of toxigenic fungi, mycotoxin, in food and grains stored for a long period can have a potential hazardous effect. Aflatoxins are known to be potent hepatocarcinogens in animals and human beings. Several species of savory have been found to have antifungal activities [26]. In a study, the essential oil of *S. hortensis* has been found to have a strong antifungal activity against *A. flavus* and it can be used as a source of eco-friendly botanical fungicides to protect some stored food products from pathogens and saprophytic fungi [27]. Therefore, summer savory, in addition to its use as a product for flavoring food and other traditional uses, can be considered as an alternative preservative in food products due to its antimicrobial activities [24].

The antiviral activities of essential oil of some savory species also have been documented [5]. It has been proven in studies that *Satureja boliviana* can inhibit the activities of hepatitis B, herpes simplex type 1 virus (HSV-1), and vesicular stomatitis virus (VSV) *in vitro*, and also, the protective effect of *S. montana* against HIV-1 virus has been proved [1,28].

Dosages and Safety

People worldwide traditionally use *Satureja* species as herbal tea, spices, and folk medicine [1]. Savory can be consumed as hot tea, cold infusion, or tablet form. People with high blood pressure take tablets containing 250 mg of dried savory leaves once a day for 60 days [28].

Although the side effects from savory are rare, people who are taking medication for diabetes, hypoglycemia, high blood pressure, bleeding disorders, and other ailments are cautioned about its use [28]. Consultation with a healthcare provider is needed before starting any new therapy or consumption of medicinal plants.

Savory is not recommended for children, pregnant women, and breastfeeding women due to a lack of sufficient evidence for its use in them.

Conclusion

Savory (*Satureja L.*) species have been used as herbal teas and spices for flavoring food and as a traditional remedy for relieving or treating various symptoms. Savory species are composed of high amounts of polyphenols and flavonoids. Studies have shown that the chemical composition of *Satureja* species changes significantly depending on the species, the ecological condition, the geographic location, and stages of development.

In extensive studies done around the world on *Satureja* species, the antimicrobial, anti-inflammatory, antioxidant, antidiabetic, antitumor, and other important medicinal effects of this plant have been demonstrated, in addition to its other traditional uses. With more extensive studies on *Satureja* species in the future, it is possible to find a new complementary or alternative natural medicine for the control, prevention, or treatment of some kinds of serious illnesses such as cardiovascular diseases, cancer, and Alzheimer's. It seems the extracts (aqueous and alcoholic) and essential oil could be considered as a cheap, easily accessible, and potential source of natural antioxidants for food and pharmaceutical purposes.

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