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Essential chemical constituents and medicinal uses of Marjoram (*Origanum majorana* L.) – A comprehensive review

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Abstract

Marjoram (*Origanum majorana* L.) is a perennial herb belonging to family Labiatae that is commonly known as "sweet marjoram". This herbaceous plant is generally found native to Cyprus and Eastern Mediterranean regions of the world and preferably cultivated in Hungry, United States, France and India. Majoram requires relatively warm, dry and well-drained loamy soil along with semi-shaded to sunny environment. Sweet marjoram is also known as "knotted marjoram" that is most commonly used as condiment or spice owing to the presence of number of volatile aromatic compounds. Some major chemical constituents of different parts of various origanum species are known to contain eugenol, citral, geranyl cetate, cadinene, ocimene, linalyl acetate, carvacrol, terpineol, linalool, terpenes, myrcene, α-terpineol, terpinen-4-ol, p-cymene, terpinen-4-ol, (+)-cis-sabinene hydrate, terpinolene, thymol, carvacrol, c-terpinene, linalool, β-caryophyllene, α-terpineol, spathulenol, α-terpinolene, α-terpinene and cis-sabinene hydrat. This plant is commonly used to treat cramps, cough, diarrhea, asthma, indigestion, rheumatism, heart infection, toothache, sneezing, head colds, colic, dyspepsia, flatulence and dysmenorrhea and thus known to have anti-inflammatory, anti-bacterial, anti-oxidant, immune booster, wound healing, anti-viral, anti-microbial, anti-fungal, anti-anxiety, anti-diabetic, anti-mutagenic, anti-gout, anti-ulcer and anti-protozoal potentials.

Key words: Sweet marjoram, knotted marjoram, geranyl cetate, ocimene, carvacrol, linalool, myrcene, β-caryophyllene, anti-inflammatory, anti-oxidant, anti-gout, anti-ulcer

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1. Introduction

Marjoram (*Origanum majorana* L.) is a tender, perennial herb which belongs to family Labiatae and was formally classified as *Majorana hortensis* Moench [1]. It is generally called as "sweet marjoram" and found native to Eastern Mediterranean regions of the world. It is mostly found cultivated in Hungry, United States, France and India. Genus origanum constitutes more than forty four species, six subspecies, three botanical varieties and eighteen naturally occuring hybrids including various types of Oregano such as *Oregano dictamnus* and *Oregano majorana*. The oregano and marjoram continue to be used as steam inhalant in order to relieve laryngitis and to clear sinus. European singers use the preserved marjoram tea by sweetening with honey. The roots of Licorice are an attractive addition in this medicinal formulation. Furthermore, its flowers are hermaphrodite having both sexes on the same plant that are pollinated by honeybees. Some common names of *Origanum majorana* are "knotted majoram", "sweet majoram" and "majoram" in Hindi, "marwa" and "ajanmasurabhi" in Tamil, "sathra" and "murwa" in Kannada, "maruga" in Marathi, "marwa mijirikamy" in Sanskrit, "marwa" and "marzanjosh" in Urdu and "marikozhundu chutanaccu kuvalamayam" in Telugu [2]. It is a bushy half hardy perennial sub shrub that annually grows upto 30-60 cm height. The stems are straight, round and hairy in appearance and green in colour while leaves are greyish green in coloration. Marjoram have tiny white or pale pink flowers that bears oval and dark brown seeds [2]. Origanum herb, reported the presence of large number of constituents in different parts of the plant, especially terpenoids [3-5], phenols [6] and flavonoids as major constituents due to its aromatic nature and others chemical constituents like steroids [3], fatty acids and vitamins [7] as minor component.

2. Historical Perspective

The name oregano is derived from Greek word which means "joy of the mountain" and the Hippocrates used this plant as potential anti-septic agent [8]. Although, oregano is deeply associated with Italy but it was found to be originated in Greece for the very first time. Ancient Greeks used oregano as food for their cattle on fields and this herb is also used as meat flavoring agent [9]. Marjoram

has long history behind as both Romans and Greeks used it to crown their bridal couple with wreaths on marjoram in order to symbolize the happiness, honor and love. This plant has traditionally been used as a remedy for efficient digestion while sweet smell of this plant is associated with a symbol of luck. The garlands made of majoram are intentionally placed on tombstones in order to get rid of haunted spirits. Furthermore, Aristotle has reported that turtle which immediately ate a snake had to eat oregano that acts a strong anti-poison agent. Similarly, Greeks loved to take bath of marjoram oil along with forehead massage. Long time before old Egyptians used oregano as potential remedy owing to its excellent curative effects and food preservative properties [8-10]. This medicinal plant has also been used in traditional and advanced system of medicines along with excessive utilization in food and flavor industry.

3. Demographic Location

Marjoram requires dry, warm, well drained fertile garden loamy soil. Sometimes it can even thrive on chalk. It grows well under wide pH ranges from acidic, neutral to basic soils. It requires nearly full sunshine and can be grown in semi-shade (light good land) or no shade, being drought tolerant. Sweet marjoram dries out rather quickly it requires well-drained soil and frequent watering. Sweet marjoram being a forest-tender herb should be grown out doors as an annual and replanted in the spring. It is propagated by seeds and cutting [11]. It is widely cultivated throughout Europe, North Africa, India and North and South America. Commercial sources of marjoram oil are Morocco, Egypt, Tunisia, Bulgaria, Spain, South Africa, Hungary and Italy. Absolute figures for marjoram oil production are difficult to acquire. World production was estimated to be about 30 metric tons. Marjoram oil is yellow to greenish-yellow oil whose specific gravity is 0.890 to 0.906 and its optical rotation and refractive index at 20°C is +14 to +24 and 1.470 to 1.475 respectively. Its saponification value is 23 to 40 after acetylation is 68 to 86. Marjoram is often used medicinally in form of essential oil, about 400 grams being obtained from 70 kg of fresh herb [11]. The oil is used as an external application for sprains and bruises etc. [12]. Essential oil is used in aromatherapy and it is also called "muscle relaxant" [13].

4. Botanical Description and Morphological Features

Origanum majorana L. is a bushy half hardy perennial sub-shrub that grows as an annual plant. Stem is woody, cylindrical, reddish brown in colour, 40-150 cm long and 0.5 to 1.5 mm in diameter. Stems are reddish, square in shape and having descending, multi-branched branches that spill over to create a mound. Branches are straight having weak, hairy and round shape and green colour with red speckles all over it. The fracture is short, characteristic aromatic in odour and astringent, non-bitter in taste [10]. The leaves of majorana are simple and smooth having petioles with oblong ovate shape and grey coloration. Leaves are arranged in opposite direction to each other on a square shaped stem. Texture of this stem is smooth having large number of hairs. They are 0.2 to 0.8 cm wide and 0.5 to 1.5 cm long with obtuse apex and marginal surface. They are symmetrical in shape having tapered base with reticulate venation. Marjoram has tiny, double lipped, pale pink or white coloured flowers having greyish green bracts which bloom in spike from middle to late summer. They are less than 0.3 cm long and arranged in 1.3 cm long heads. Flowers of this plant are hermaphrodite in nature having both sexes on the same plant. Calyx and corolla are irregular zygomorphic and hypogenous. The bract is prominent, spatulate, 4mm in diameter, hairy along the margin and on the abaxial surface it encloses the calyx. The calyx has five sepals that united to form a single spatulate structure with wide and large (5mm in diameter), bilobed anterior and narrow, small posterior parts. The corolla is 4 mm long and 5 mm in diameter. It is white in colour [14]. Seeds are minute, oval, dark and brown in colour that ripens from August to September. *Origanum majorana* has tap roots. They are 0.2 mm to 0.6 mm in diameter. Roots of the herb are sub-cylindrical in shape and longitudinally wrinkled with transverse fissures. The outer surface of root is dark brown in colour and internal surface is light brown in colour. It has aromatic odour and taste is non-bitter. Fractures are long, irregular and fibrous. Several long, rootlets and root scars are also present [8-10].

Fig 1 Marjoram Flower

Fig 2 Leaves of Marjoram Flower

5. Essential Phytochemicals

The essential oil extracted from various species of marjoram is of high nutritional value and extreme therapeutic potential owing to the presence of volatile

aromatic compounds such as eugenol, citral, geranyl cetate, cadinene, ocimene, linalyl acetate, carvacrol, terpineol, linalool and various other terpenes. Due to anti-bacterial and anti-inflammatory effects, this oil has been used to treat rheumatism, muscular pains and flatulence. Some major chemical constituents of this plant include α-terpineol, terpinen-4-ol, p-cymene and myrcene [15]. The dried and fresh flowers and leaves of origanum are abundantly used as flavoring agent in various food industries. The alcoholic extracts and essential oil obtained from this plant via steam distillation mainly constitutes terpinen-4-ol along with the small amount of (+)-cis-sabinene hydrate [16] which is responsible for specific fragrance and characteristic flavor. In addition to that, α-terpinene, c-terpinene and terpinolene are also found as major components along with carvacrol and thymol [4-17-21]. The anti-oxidant potential of essential oil of majoram [17] and its relevant purified substances [22] has also been reported to found.

Some essential chemical constituents of alcoholic extracts and essential oil of majoram extracted from supercritical fluid extraction are listed in table 1. Results of this scientific study showed that chemical composition of essential oil obtained from supercritical fluid extraction and hydro distillation is almost the same. Few important chemical constituents and characteristic compounds of marjoram are spathulenol, cis-sabinene, β-caryophyllene, α-terpinene, linalool, α-terpinolene, α-terpineol and c-terpinene. Nevertheless, hydrat was only found in supercritical fluid extraction in relatively low concentration. The chemical composition of essential oil of different species of marjoram was found to be similar in both Central Europe and Eastern Europe [4-17-21]. Although supercritical fluid extract and ethanolic extract of marjoram showed almost same chemical composition but the chemical constituents of supercritical fluid extraction such as amount of terpinene-4-ol was almost double in ethanolic extract. Similarly, negligible amount of linalool was found to be present in supercritical fluid extraction nevertheless its amount was doubled in solvent extraction method and even double in essential oil. This bicyclic spathulenol was found in almost same concentration in ethanolic extract and supercritical fluid extraction but was absent in essential oil. It was also stated that characteristic volatile organic compounds were quantified in extracts obtained via supercritical fluid extraction aided by carbon dioxide.

6. Postharvest Management

Marjoram is a soft perennial plant that is usually treated at freezing temperature for long term preservation in order to avoid the serious injuries and death of plants. Upper parts of this plant are generally cut at the start of initiation of flowering and the best product is slowly dried under full shade. During harvesting, shoot must be pluck just before flower for best flavor as fully blossomed flowers are quite bitter in taste. Bundles of marjoram cuttings are mostly hanged upside down in a well-ventilated, dry and dark area [23]. Fresh marjoram leaves are shade dried that changes into deep grayish-green colour from yellow shade while its leaves are harvested just before flowering. Dry seeds and dry leaves of marjoram are preferably marketed in a sealed container and air sealed packs. It is more preferable to store the fresh herb inside the deep freezer or refrigerators for extended usage. However, dried majoram must be stored in properly sealed containers in cool and dry place where it can be stored for upto six months. Freshly washed herbs must be rinsed for few minutes in order to remove pesticides and dirt particles along with some residual impurities. Dried leaves of majoram tend to retain flavor unlike that of various other dry herbs such as thyme and sage. In order to maintain the specific level of flavor and fragrance, it is usually added at the end of cooking recipes [24]. Sometimes, its flavor and smell is also changed due to all nearby plants [25-26]. These plants are found to be very attractive for honey bees as some of its varieties are rich in fragrance just similar to that of thyme and basil [27].

7. Value Added Products

Commercially available essential oil of different origanum species is extensively used as condiment and spice in food and flavor industry owing to the presence of various potential aromatic compounds. Essential oil of this plant is also been used in perfumery and as herb [15] because it constitutes eugenol, terpenes, citral, linalool, geranyl cetate, terpineol, cadinene, carvocrol, ocimene and linalyl acetate. These chemical compounds are known to possess strong anti-bacterial and anti-inflammatory potentials thus abundantly used in number of commercial products and medicinal formulations. Majoram oil is used for treatment of rheumatism, muscular pains and flatulence as it contains eugenol in appreciable amount which is responsible for anti-inflammatory effects when tested against cyclooxygenase enzymes. This enzyme-inhibiting-effect of eugenol makes it an ideal candidate to be used for symptomatic relief in individuals suffering from inflammatory diseases such as bowel conditions, osteoarthritis and rheumatoid arthritis. When this chemical compound is taken in moderate amount, it helps to relieve excess leucorrhea and menstruation pains however it can increase the flow rate during menstruation leading to a condition called menorrhagia. Essential oil of majoram is a potential anti-bacterial and anti-fungal agent that has proved to be effective against *Pseudomonas*, *proteus*, *Shigella*, *Escherichia coli* and *Staphylococcus*.

8. Industrial Applications and Pharmacological Uses

Different parts of majoram plants are used to treat cough, cramps and acute diarrhea [11]. This plant has found to be effective as nerve tonic, expectorant, stimulant, carminative, anti-septic and anti-spasmodic agent [28]. It also works as a curative agent for myocardial infarction, toothache, rheumatism, indigestion, cough and asthma [29] as it contains astringent compounds which help to enhance the appetite and considered to be a remedy for colic pains [30]. Recently it has been found that majoram acts as

sternulatory agent if inhaled and thus prove to be effective against head colds [31]. Prakash [32] has shown that essential oil of this plant is used for colic, dysmenorrhea, flatulence and dyspepsia.

8.1 Pharmacological Uses

Rafsanjani [33] has found that majoram extract constitutes number of active components in addition to pepsin secretions and gastric juice in rats that acts as stimulant for digestion. Some recent investigations have shown that essential functional food components tend to reduce the deterioration and retard the onset of neuropsychiatric diseases such as "Alzheimer Disease" [34]. Roula and coworkers has found that ethanolic extract of majorana has anti-cancer effects on human leukemic cells [35] and anti-proliferative activity along with anti-oxidant effects. Few recent researchers examined that majoram has anti-anxiety potential, pre-anesthetic activities and sedative potentials [34]. Rosa Martha Perez Gutierrez found that methanolic extracts of leaves of majoram acts as inhibitors on the end products of advanced glycation that are the final products of non-enzymatic reactions [36]. They are known to have excellent therapeutic potentials for the diabetes mainly. In another study, it was found that natural marjoram herb and ginger when mixed in equal amount proves to be beneficial for hyper-cholestrolemic patients [37]. Egyptian researchers found that leaf extract and leaf powder of majoram helps in immunosuppression, alleviating genotoxicity and induced complications in tumorous organelles [38].

8.1.1 Anti-Oxidant Activity

Nessrien [39] attempted to find the effects of thyme and marjoram on quality of semifried fish fillets during cold storage. Oxidation of fat is a major problem and a matter of serious concern for food industry and flavor chemistry. Various microbiological assays of essential oil of majoram and thyme are known to have anti-microbial potentials also. Essential oil of thyme and majoram are also rich in phenolic compounds thus exhibit anti-microbial and anti-oxidant assays. Ryszard have recently found that anti-acetyl cholinesterase activities and free radical scavenging effects of essential oil of various majoram species have pronounced effects and high significance due to elevated demand at commercial scale. Phenolic compounds extracted and isolated from thyme, oregano and majoram with 95% extracts of ethanol are therapeutically very important as they are known to have strong anti-oxidant potentials.

8.1.2 Anti-Microbial Effects

Gutierrez [40] found the efficiency of essential oil extracted from majoram in order to check its effects and efficiency as food ingredients. Its essential oil in combination with thyme, sage, rosemary, oregano, majoram, lemon balm and basil has proved to be important medicinal remedy in conventional system of medicine. This concept of combination of essential oil was initially screened against *Pseudomonas aeruginosa*, *Listeria monocytogenes*, *Escherichia coli* and *Bacillus cereus* by using pot on agar test.

8.1.3 Anti-Fungal Potential

Deans and Svoboda [41] attempted to investigate the anti-microbial effects of majoram and found that various fungal strains were significantly affected by this treatment. Anti-fungal potentials of essential oil of majoram were found to be effective against *Aspergillus niger* which is a common spoilage fungus. Furthermore, Alina [42] investigated the anti-fungal effects of eight different essential oils against nine different species of yeasts mainly associated with food spoilage and destruction of microflora. Among thyme, peppermint, majoram, grapefruit, lemon, garlic, onion and basil, majoram and thyme has rather more fungistatic potentials in comparison with essential oil of garlic, onion, grapefruit, lemon, basil and peppermint.

8.1.4 Anti-Anxiety Activity

The extract of leaves has shown anti-anxiety effects on rats in open maze model at intra-peritoneal dose of 200 mg-kg b.w. The effect was dose dependent and comparable to diazepam

8.1.5 Anti-Convulsant Effect

Anti-convulsant effect on rats using the Pentylenetetrazole (PTZ) and maximal electroshock (MES) text at two different doses of 250 and 500 mg/kg i.p. each. The chloroform extract exhibited maximum reduction in the duration of seizures.

8.1.6 Anti-Diabetic Effects

Methanolic extract of the leaves showed anti-diabetic activity in streptozotocin-induced mice through various in vitro and in vivo assays. *Origanum majorana* has shown significant effects on in vitro inhibition of advanced glycation end product formation. The effect was more than the standard anti-glysation agent, amino guanidine [43].

8.1.7 Anti-Gout Potential

The ethanolic extracts of both stems and root showed anti-gout activity in potassium oxonate induced Swiss albino rats at oral dose of stem (200mg/kg b.w.) and root (400mg/kg b.w.) extracts, respectively. The effect was dose dependent and significant in decreasing uric acid, creatinine, ESR, MDA and increasing reduced glutathione level [44].

8.1.8 Anti-Mutagenic Activity

The ethanol extracts of the aerial parts of marjoram has shown anti-mutagenic effect agent cyclophosphamide induced mutation in mice at the minimum effective dose 125mg/kg the effect of marjoram extract was found to protect any changes in RNA, DNA and proteins contents in the liver and testes of treated mice as compared with the control 40.

8.1.9 Anti-Ulcer Effects

The hydro-distilled volatile oil and methanol extract of the leaves showed ulcer healing properties in streptozotocin-nicotinamide induced diabetic rats at three different doses (100, 200 and 400mg/kg, p.o.). The effect

was dose dependent and more effective than glibenclamide and comparable to ronitidine [14].

8.1.10 Anti-Protozoal Potentials

The volatile oil and extracts of the leaves namely, n-hexane, aqueous ethanol, ethanolic ammonia extracts have shown in vitro anti-protozoal effects against single protozoan species *pentatichomonas hominis* by the disc-diffusion method [45].

Table 1 Composition of the marjoram essential oil, ethanolic extract and supercritical fluid extract (% peak area analysed by GC and GC–MS methods)

Compound	^{t}R (min)[a]	TIC$_{tR}$ (min)[b]	Essential Oil	Soxh. Alc.	SFE
α-Pinene	4.14	-	5.9	0.3	-
Camphene	4.58	-	5.8	-	-
β-Myrcene	4.91	-	0.3	-	-
β-Pinene	5.33	-	2.2	0.4	-
α-Terpinene	6.24	10.61	3.2	2.2	2.7
p-Cymol	6.59	-	9.8	0.6	1.8
c-Terpinene	7.18	12.44	14.0	4.1	5.3
Terpenyl-acetate	8.62	-	0.7	-	-
α-Terpinolene	8.77	13.52	1.8	2.5	1.1
Linalool	9.70	-	12.1	6.0	1.1
cis-Sabinene hydrate	9.91	18.86	-	-	1.1
Terpenyl-ester	10.54	21.08	-	1.5	0.9
Terpinen-4-ol	11.25	23.21	30.3	16.6	30.6
α-Terpineol	11.59	25.85	4.4	4.2	4.2
β-Caryophyllene	14.44	23.41	1.8	2.0	2.2
Neophytadiene	18.29	32.21	-	1.2	1.9
Spathulenol	24.28	37.21	-	9.9	9.9
Not identified	27.68	47.61	-	29.4	25.4

[a] t_R is the retention time according to GC method

[b] TIC$_{tR}$ is the retention time from the total ion chromatograms of GC–MS method

9. Summary

Origanum majorana (sweet marjoram) is pleasant smelling herb which belongs to the mint family and grows up to the height of 30 to 60 cm. The well dried leaves of this herb are used in medicinal products. It has fragrant, sharp, bitter and camphor like smell and spicy flavor. Distilled leaves of the flowers yield a volatile oil which is known as the oil of sweet marjoram. The oil is either pale yellow, colorless to yellow green in color with a peculiar odor which is similar to that of nutmeg and mint. The woody perennial majoram has small velvety oval shaped leaves which have pinkish flowers that blossom in summer. This herb is a vital ingredient of Italian dishes. It is majorly cultivated in Spain, North Africa, Hungary and Portugal. The parts that are used to make medicines are the stems, flowers and leaves. The aerial parts are usually collected between the month of July and September. The stems and leaves are used to make infusions, tinctures and powders. Flatulence, nausea, abdominal bloating and minor neural problems can be relieved by consuming an infusion made from this herb. The tincture of the herb is also advised for relieving such problems.

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