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Marjoram (*Origanum majorana*): An essential oil with potential pharmacological properties and health benefits

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Abstract

Origanum majorana, also known as Marjoram, sweet basil, and wild oregano, is a perennial herb grown for its flavor and aroma all over the world. This herb has been used to treat a variety of diseases since ancient times, and it was kept inside homes to repel insects. The essential oils of this herb are stored in oil glands behind the plant cell wall and must be extracted with care to avoid altering the chemical composition. There are several extraction procedures for extracting essential oils from various parts of marjoram, but only a few are used like distillation and supercritical fluid extraction. This plant is high in bioactive chemicals and can be used as a natural preservative and to treat a variety of illnesses by including in food products, health supplements, nutraceuticals and skin care products because it has few negative effects. Essential oils, which contain important bioactive chemicals in concentrated form, are now employed to make medications and flavoring agents. Furthermore, marjoram has various chemical components with pharmacological benefits, including antibacterial, antioxidant, antidiabetic, and antianxiety properties, which are used in the food and pharmaceutical industries to incorporate natural substances into their products.

Keywords: Marjoram, essential oils (E.O), bioactive compounds, health benefits, extraction, food products, nutraceuticals

1. Introduction

Marjoram (*Origanum majorana*) is a medicinal herb that belongs to the family *Lamiaceae* and was earlier known as *Majorana hortensis* Moench (Krishnakumar *et al.*, 2012) [29]. This herb is native to the mountains of the Mediterranean region including Asia Minor, Cyprus, and some European countries and is now widely grown in different parts of the world (Prerna and Vasudeva, 2016) [42]. The word *Origanum* originates from the Greek word *oros* which means mountain and *ganos* meaning joy or light and is sometimes known as "joy of mountains". Marjoram is used synonymously with oregano which is one of the popular herbs used for its strong flavor and aroma. It is known by different names in various parts of India and around the world such as sweet marjoram, pot marjoram, knotted marjoram, wild marjoram (oregano), *Marwa* in Hindi, *ban tulsi* in hilly areas, *marru*, *marwa*, *maruga*, *maruvanu* in Southern parts of India and *murru* in Bengali (Muqaddas *et al.*, 2016) [36].

Some ancient people used this herb as an antiseptic to treat wounds, cuts, colds and coughs and believed that it heals poison, convulsions, insomnia, anxiety, respiratory issues, and digestive problems (Bina and Rahimi, 2017) [11]. This herb is having a very rich history of usage in traditional medicine for curing skin disorders, stomach problems, diabetes, heart-related issues and infections caused by bacteria, viruses, and fungus. Ancient people use to keep this herb with them while working in the field to treat any kind of insect or snake bite (Charles, 2012) [15]. In addition to this, it was also utilized for making herbal tea, for flavor, and for spreading its fragrance in rooms. Nowadays its essential oil is in great demand for utilization in aromatherapy, cosmetics and skincare. Moreover, it is used to treat sore muscles and swollen joints and helps in easing menstrual cramps as well as heavy flow. However, its essential oil must not be used for pregnant and lactating women (Hafez, 2012; Vasudeva, 2015) [22, 53].

Essential oil (E.O) is a liquid mixture of volatile substances that are concentrated forms of chemical compounds present in different plant parts. Most of the components are hydrophobic that consist of phenol and aromatic hydrocarbons in their chemical structure that produces different types of aromas and flavors.

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In the food industry, it is being utilized for giving flavor and aroma to food materials and in packaging materials to protect the food materials from spoilage (Hyldgaard *et al.*, 2012) [24]. These oils contain several pharmacological properties such as antibacterial, antimicrobial, antiviral, anticancer, anti-inflammatory, etc. It is incorporated in various drugs, health

supplements, and nutraceuticals to maintain overall health as well as to treat many diseases (Tongnuanchan and benjakul, 2014) [50]. A clear picture of marjoram flowers and leaves is given after this section to show a small description of the plant.



Fig 1: Marjoram leaves and flowers

2. Morphology and Botanical description

Marjoram is an herbaceous perennial sometimes grown annually according to climatic conditions. It contains small oval-shaped leaves with small pink to purple flowers that grow on top of the leaf foliage. This herb is having a minty and sweet flavor somewhat like oregano but mild in taste having a strong fragrance that is recognizable from a distance. Marjoram is a cross-pollinated plant, and this trait is exploited to develop new varieties to use its chemical compounds in various sectors (Wilson, 2016) [55].

Morphological variations are present in this herb due to cultivation in different regions of the earth. Apart from marjoram subspecies grown and utilized from the genus

Origanum, the first is pot marjoram (*Origanum onites*) used for its leaves for flavoring dishes, and the second is wild marjoram (*Origanum vulgare*) commonly known as oregano and is which is native to Europe and Asia. Sweet marjoram is a bushy herbaceous plant that grows up to a height of 30-60 cm and thrives in mild weather conditions with temperatures ranging from 25-30 °C, sunny and dry. Mostly grown from March to September in loamy-fertile soil with a pH of 6-7. It bears hairy ovate leaves arranged in pairs, and spike-like small pink to purple flowers are present in clusters (Anonymous, 2021) [6]. The taxonomic classification of *Origanum majorana* is described in the given table including some local names of this herb.

Table I: The taxonomic classification of Marjoram (Tripathy *et al.*, 2017) [51]

Taxonomy	
Kingdom	Plantae
Sub-kingdom	Viridi Plantae
Super-kingdom	Embryophyta
Division	Tracheophyte
Sub-division	Spermatophytina
Class	Magnoliopsida
Super-order	Asteridae
Order	Lamiales
Family	Lamiaceae
Sub-family	Nepetoideae
Genus	<i>Origanum</i> L.
Species	<i>Origanum Majorana</i> L.
Local Names	
Pot marjoram, sweet marjoram, knotted marjoram, wild marjoram (oregano), Marwa, ban tulsi, Marru, maruga, maruvanu and murru.	

3. Chemical composition and pharmacological properties

Different parts of the marjoram plant (leaves, stems, flowers) contain almost 2-3% of E.O and are extracted through traditional methods (steam-hydro distillation) and novel

methods (supercritical fluid extraction, microwave-assisted extraction). Mostly hydrocarbons and phenolic compounds are there that form the chemical composition of E.O (Busatta *et al.*, 2017) [13]. Some of the compounds identified in

marjoram E.O are monoterpene, linalool, thymol, geraniol, sabinene carvacrol, carvone, limonene, α - β pinene, vanillic acid, ferulic acid, gallic acid coumaric acid, terpenoids, phellandrene, carvacrol, eugenol. Moreover, marjoram contains flavonoids that predominate in marjoram such as quercetin, catechin, kaempferol, luteolin, and apigenin (Erenler *et al.*, 2016) [19]. Chemical constituents are responsible for the medicinal as well as culinary properties of

marjoram and they are stored in form of E.O. These compounds are having several pharmacological properties like antimicrobial, antibacterial, antispasmodic, antiseptic, anti-depressant, antiviral and many more (Bina and Rahimi, 2017) [11]. Different parts of marjoram contain different types of chemical compounds that consist of several pharmacological properties that are listed in the given table.

Table II: Chemical compounds in Marjoram and their pharmacological properties

Parts Used	Formulations	Chemical Compounds	Pharmacological Benefits	References
Flowers	Essential oils and methanolic extracts	Sabinene, terpenoids, carvacrol, carvone, limonene, camphene, linalool, 1,8-cineole, myrcene	Antimicrobial, antibacterial, antifungal, antiparasitic, nephroprotective, antioxidant	(Ayari <i>et al.</i> , 2013; Jan <i>et al.</i> , 2018; Bouyahya <i>et al.</i> , 2021) [8, 25, 12]
Stems	Essential oils and methanolic extract	Thymol, sabinene, linalool, carvacrol methyl ether, α , β - thujene, α - terpineol, α - pinene, borneol, camphene	Antibacterial, antifungal, antioxidant, antimicrobial, hepatoprotective, antianxiety	(Guerra-bone <i>et al.</i> , 2015; Ayari <i>et al.</i> , 2013; Muqaddas <i>et al.</i> , 2016) [21, 8, 36]
Aerial parts	Essential oils, methanolic extract, petroleum ether extract	Phenolic acids, flavonoids, terpenoids, sabinene, camphene, rosmarinic acid, gallic acid, caffeic acid, phellandrene, vanillic acid, epicatechin, limonene, carvone, thymol	Antimicrobial, antibacterial, antiseptic, antiparasitic, antidiabetic, anticancer, nephroprotective, cardioprotective, anti-inflammatory, antioxidant, antianxiety	Taamalli <i>et al.</i> , 2015; Bouyahya <i>et al.</i> , 2021; Olfa <i>et al.</i> , 2016) [49, 12, 39]
Leaves	Essential oil, ethanolic extract, methanolic extract	Terpenoids, terpineol, sesquiterpene, terpenes, phenolic acids phellandrene, sabinene, flavonoids, tannic acid, coumarins, gallic acid, thujene, pinene, borneol, linalool, carvacrol	Antianxiety, antifungal, antidiabetic, anticancer, antimutagenic, antibacterial, antioxidant, antiparasitic, hepatoprotective, antiprotozoal, relieves menstrual cramps	(Jiang <i>et al.</i> , 2011; Calín-Sánchez <i>et al.</i> , 2015; Ayari <i>et al.</i> , 2016) [26, 14]
Seeds	Essential oils, methanolic and ethanolic extracts	Terpenoids, phenolic acids, gallic acid, catechol, ascorbic acid, cinnamic acid, terpineol, sabinene, phellandrene, myrcene, pinene, thymol, linalool, terpinyl acetate	Antibacterial, antimicrobial, antioxidant, anti-inflammatory, antifungal, antiviral, cardioprotective, stimulates digestive secretions	(Xylia <i>et al.</i> , 2018; Jan <i>et al.</i> , 2018; Baj <i>et al.</i> , 2018; Bouyahya <i>et al.</i> , 2021) [25, 10, 12]

4. Techniques for extraction of essential oil

Marjoram is a rich source of secondary metabolites that form the major bioactive compounds of this plant. There are several methods involved in the extraction of E.O from different parts of this herb. The extraction methods, as well as extraction conditions, can affect the chemical composition of the E.O, resulting in a poor-quality oil. Therefore, methods must be carefully selected and applied (Turek and Stintzing, 2013) [52]. The decision on which method will be used is merely based upon the chemical nature of the substance as well as the time and temperature of the working environment. Before the extraction process, the material is well prepared like cleaning, sorting, grading or cutting and then subjected to the extraction process (Aziz *et al.*, 2018) [9]. Methods involved in the extraction process of marjoram E.O include:

4.1 Conventional extraction methods

Extraction of essential oil from different plant parts has been practiced for a long time and the most common method used was steam or hydro distillation. Both the methods make use of high temperature and pressure to remove oil from plant material. In steam distillation, hot steam is induced in the sample that results in the vaporization of E.O which enter the condenser where the oil and water mixture is separated and collected in different outlets (Gavahian *et al.*, 2018) [20].

In hydro distillation, the plant material is immersed in water or solvent which is boiled until evaporation starts and the vapors are collected in the condenser where oil is separated from the water. The yield of oil extracted from hydro distillation is higher than the oil removed from steam distillation. This method is now improved to microwave-assisted hydro distillation in which distillation is carried out in a microwave oven (Řebíčková *et al.*, 2020) [44].

4.2 Novel extraction methods

Conventional oil extraction techniques provide health and safety for humans as well as the environment due to the utilization of high-temperature, inorganic solvents. To reduce these problems, novel techniques are being developed in which no or very less usage of solvents is there. These techniques are considered green extraction methods because of less carbon emission, use of green solvents, and limited use of other chemicals. Novel extraction techniques are widely utilized in various sectors to extract oils from different plant materials and are very efficient because it consumes less energy (Mwaurah *et al.*, 2020) [38].

The supercritical fluid extraction technique is employed to extract E.O from various parts of marjoram. It yields pure and more concentrated oils as compared to traditional methods that contain residues of water and solvent (Stratakos *et al.*, 2016) [48]. This method is based on the supercritical fluid technique in which gas is directly converted to liquid with help of critical pressure and temperature. It starts with pressurizing the CO₂ until it liquefies, then this gas absorbs the E.O and returns to its original state (Chemat *et al.*, 2020) [16].

Microwave-assisted extraction is an advanced technique that is utilized for the extraction of plant metabolites and E.O with the use of a microwave oven. These waves induce dipole rotation in organic molecules which heats the material and destruction of hydrogen bonding is there. Time taken for extraction affects the quality of volatile compounds and the number of components is increased with increasing the extraction time (Vinatoru *et al.*, 2017; Akhtar *et al.*, 2019) [54, 2].

5. Nutrient profile and Health benefits of marjoram essential oil

Marjoram is one of the traditional herbs utilized for culinary and medicinal purposes since older times. It has a very subtle, sweet, and a little bit of pungent taste which is like oregano but gentle. This herb is used in the preparation of several medicines in Ayurveda to homeopathy for the treatment of a variety of ailments.

5.1 Nutrient profile

Marjoram and its other species are a rich source of vitamins and minerals that help in promoting good health, if consumed in appropriate amounts. Fresh marjoram contains high amounts of vitamin C (51.4 µg of recommended dose per 100g), which helps in boosting immunity, healing wounds and has antiviral effects (Anonymous, 2022) [7]. Additionally, this herb is enriched with several bioactive compounds like carotene, zeaxanthin, and lutein which are termed protective scavengers against free radicals in the human body (Kiczorowska *et al.*, 2015) [28].

5.2 Digestive health

Marjoram is a medicinal herb that consists of various therapeutic properties and was used by Greek ancients as a healing agent in form of a paste, decoction, or aromatherapy (Kumar *et al.*, 2016) [30]. This herb is considered one of the best medicines for gastrointestinal ailments, utilized in different forms like herbal tea or as seasoning. It is believed to enhance the production of the digestive enzyme after a few minutes of consumption, stimulating the appetite and digestion. Its E.O can be massaged on the abdominal area to reduce the flatulence and cramps, hence soothing the digestive tract (Makrane *et al.*, 2019) [34]. Several studies are being conducted on marjoram leaf extracts for the treatment of stomach ulcers. It was found that the daily intake of 250-500 gm of marjoram extract can lower the risk of ulcers in the future. Moreover, it helps in maintaining gut health by promoting the growth of good bacteria (Leyva-Lopez *et al.*, 2016) [31].

5.3 Antianxiety

Stress and anxiety are two main causes that result in several health problems including, depression, insomnia, disturbed mental health, etc. Chemical constituents present in marjoram E.O produce soothing effects that relax the nerves and muscles surrounding the brain (Amaghnouje *et al.*, 2020) [4]. This herb is nervine (strengthens the nervous system) and utilized as an anti-anxiety herb that produces happy hormones and promotes a good mood. It has been used since ancient times for releasing stress and tension by massaging the oil on the affected part or by inhaling the E.O (Tripathy *et al.*, 2017) [51].

5.4 Effective in respiratory ailments

In recent years, the E.O extracted from marjoram is also used to treat respiratory problems through aroma therapy. The oil is diluted and rubbed in the chest area as well as sprayed around the person in form of fragrance. It acts as a natural decongestant and clears the phlegm, resulting in the reduction of chronic cough or sinus (Ali *et al.*, 2015) [3]. Marjoram has been utilized from older times to treat the common cold and viral diseases. The chemical compounds present in this herbal E.O exhibits antiviral properties that act upon the protective coating of the virus, hence killing them (Ma and Yao, 2020)

[32].

5.5 Cardioprotective benefits

The bioactive compounds found in marjoram essential oil contain antioxidant properties and help in eliminating free radicals from blood vessels. High cholesterol diets tend to increase LDL levels which result in the accumulation of lipid layers in blood vessels causing several cardiovascular diseases (Złotek, 2017) [58]. This herb helps in curing such problems if consumed on daily basis in small amounts and maintains heart health. Marjoram can be taken as a supplement to avoid blood clotting and helps in thinning the blood hence protecting against heart attacks (Patrignani *et al.*, 2020) [41]. The Cardioprotective properties of the genus *Origanum* help in avoiding severe heart problems like thrombosis by improving the flow of blood through the circulatory system (Sharangi *et al.*, 2013) [46].

5.6 Hepatoprotective benefits

The chemical components terpenes and terpenoids found in marjoram leaf oil aid in the treatment of liver disorders by removing excess toxins from the body, allowing the liver to operate more efficiently. It was found in some studies that marjoram E.O can cure the damage caused by some chemical compounds to the hepatic cells (Hikal *et al.*, 2018) [23]. Furthermore, marjoram E.O is said to have antioxidant properties. It helps in regenerating liver cells thereby, stabilizing the cell membrane that results in blocking the entry of hepatotoxic substances into the liver. (Madrigal-Santillán *et al.*, 2014) [33].

5.7 Menstrual health

Menstrual health is very important for women to maintain overall health as any kind of change in hormones may result in many ailments. Marjoram extracts and its E.O are very useful in treating painful periods, restoring hormonal balance, and regulating the menstrual cycle (Rababa'h *et al.*, 2020) [43]. Moreover, some of the main compounds present in marjoram help in stimulating the hormonal levels that help in treating polycystic ovary syndrome and the complications linked with it. This herb oil can be used to relieve mood swings and other premenstrual symptoms that cause discomfort before periods (Zambare *et al.*, 2019) [57]. Marjoram E.O is very effective in dysmenorrhea that causes immense pain during periods. This oil is used through aromatherapy to reduce the severe symptoms of dysmenorrhea. Several types of research are conducted on the ethnomedicinal properties of this herb as it contains several compounds that exhibit many health-promoting benefits (Song *et al.*, 2018) [47].

5.8 Aromatherapy

Aromatherapy is a treatment for mental and physical balance by utilization of different E.O extracted from various plants such as marjoram, lavender, eucalyptus, sage, citrus, and rose (Ali *et al.*, 2015) [3]. These oils help in relieving stress and tension by acting upon the limbic system in the brain that revitalizes the nervous system (Agatonovic-kustrin *et al.*, 2020) [1]. Essential oils are either inhaled or massaged over the effective part until it gets absorbed in the skin. Various essential oil blends are used to treat several illnesses, including depression, sleeplessness, anxiety, migraines, muscular discomfort, skin difficulties, and respiratory concerns (Kao *et al.*, 2017) [27].

6. Exploration of marjoram oil in various sectors

Essential oils produced from herbal plants have a variety of health and well-being benefits and are widely utilized in the manufacture of healthcare supplements, nutraceuticals, pharmaceutical goods, Ayurvedic medicine and skin care, among other things (El-sayed *et al.*, 2019) ^[18].

The preservation of fresh lettuce leaves was tested using marjoram oil, ascorbic acid, and chitosan. This mixture was found to boost total phenols and antioxidant levels in fresh-cut lettuce leaves, as well as produce a nice scent. Apart from that, lettuce leaves do not turn brown in storage and retain their fresh flavor for longer periods of time, making marjoram E.O a powerful antioxidant (Xylia *et al.*, 2021) ^[56]. In the food sector, food components must be protected from physical, chemical and biological deterioration, and expanding customer expectations about the partial or complete use of food preservatives are posing a challenge for processors (Angane *et al.*, 2022) ^[5].

Marjoram is used in the food sector because of its antioxidant and antibacterial characteristics, which can be used as a preservative and flavoring agent. It is mostly used in dried form to flavor sausages, preserved meats, soups, herb mixes, sauces, beverages and some other foods (Omara and El-Moez, 2014) ^[40]. The marjoram E.O has recently been used to produce antimicrobial packing film through the nanoencapsulation technique that helps in protecting the food material from microbial spoilage during storage and transportation (Maurya *et al.*, 2021) ^[35].

Essential oils are very volatile in nature, insoluble in water, hydrophobic, and unstable due to which their use is limited to some products. Several studies are conducted to improve the efficiency of E.O by developing new technology. To increase their stability these oils are entrapped in some carrier agents so that they can be used under ambient conditions. Furthermore, marjoram E.O has been used in the manufacturing of mouthwashes, skin ointments, antibiotic medications, herbal shampoos, toothpaste and many other products with exterior applications only (Cimino *et al.*, 2021) ^[17].

Marjoram consists of several bioactive compounds that have many health benefits and pharmacological properties such as antimicrobial, antiviral, hepatoprotective, antidiabetic, anti-inflammatory, etc. therefore, it has a great potential to be used as a nutraceutical or as a health supplement to enhance overall health and wellness (Sachdeva *et al.*, 2020) ^[45]. Moreover, marjoram can be used as a source of vitamins and minerals to boost immunity and can work as a laxative to remove toxins from the body. Marjoram is considered highly effective in protecting against cardiovascular diseases and is incorporated in nutraceutical medicines meant for treating high blood pressure (Murugesan and Orsat, 2012) ^[37].

7. Future perspective

Marjoram has been utilized for its flavor and aroma since ancient times and is also used for therapeutic purposes in the treatment of various diseases. This herb contains distinct types of bioactive compounds that are extracted in form of essential oils through different extraction methods. Several scientific research has been conducted to determine the pharmacological properties of marjoram E.O. The chemical compounds present in marjoram essential oil can be utilized as a potential natural preservative in food industries because plant-based antimicrobial agents are non-toxic and eco-friendly.

In the recent pandemic situation, synthetic drugs were not completely effective against the virus and resulted in various side effects. EOs are rich in chemical compounds that have antiviral and antimicrobial properties. Therefore, these oils can be utilized to treat such infections in the future. Nowadays, various pharmaceutical drugs comprise bioactive compounds that are derived from marjoram and other herbs in place of harmful chemicals as they possess fewer side effects. Herbal E.O are having much more potential in terms of food and medicine which is still not known completely and required to be studied further.

8. Conclusion

Marjoram is a traditional herb utilized since older times in different communities around the world. This herb is a rich source of bioactive compounds such as monoterpenes, terpenoids, flavonoids, phytosterols, tannins, etc. The chemical compounds found in marjoram are beneficial in curing several ailments such as cold, cough, headaches, diabetes, stomach infections, menstrual cramps and joint pains. Moreover, its E.O can be utilized as a natural preservative in food industries to avoid food spoilage. The bioactive compounds present in the E.O extracted from this herb is having different pharmacological properties that can be exploited in the pharmaceutical and nutraceutical industries for health enhancement.

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