International Journal of Chemical and Biochemical Sciences
(ISSN 2226-9614)

Journal Home page: www.iscientific.org/Journal.html

Parsley: A review of habitat, phytochemistry, ethnopharmacology and biological activities

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Abstract

Parsley (*Petroselinum crispum*) is a biennial herb belongs to the carrot family (Apiaceae). It has been cultivated throughout the world and used for thousands of years for food flavoring, essential oil applications and in traditional medicines. Mostly parsley contains apiole, myristicin, α-pinene, β-pinene and elemicin contents. The extent of each of these chemical constituents varies depending on the type of species or cultivars as well as cultivation conditions such as soil type, weather, irrigation, pruning and other horticultural practices. Parsley is an essential component of several industrial applications that range from food to cosmetics to pharmaceutical products. More uses and applications of parsley by-products are continuously added. Further research on maximizing yield per hectare and optimum preservation and oil extraction methods are needed, particularly in the developing world where parsley leaf and flower harvesting and post-harvesting processing methods are much traditional.

Key words: Apiaceae, Vitamin K, Antioxidant, Myristicin, Cosmetics

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1. Introduction

Parsley (*Petroselinum crispum*) belongs to the carrot family (Apiaceae). Parsley is bright green biennial plant in temperate climates and it is an annual herb in tropical and subtropical areas (Figure 1). It has been used for thousands of years and has become an essential ingredient in cooking. Italian or flat leaf parsley, curly leaf parsley and root parsley are three main varieties of parsley and numerous cultivars exist for each variety. These varieties are native to the central Mediterranean region [1]. Variations are present among the varieties and variability is prevalent in morphology, growth habit, flower color, stem, leaves and chemical composition. Pollination occurs in parsley through insects such as butterflies and bees. Parsley can also be pollinated using a small paintbrush with soft bristles. Paintbrush is also used to prevent parsley from cross pollinating with other herbs or flowers. To complicate matters further there are a number of plants outside of the genus *Petroselinum* with the common name parsley, including, "fool's parsley" (*Aethusa cynapium*) which is poisonous.*Petroselinum crispum* is known by different names depending where you are in the world. The most common names of *Petroselinum crispum* are garden parsley, common parsley, curled parsley and moss curled parsley. In the Indian language parsley has different names such as in Hindi it is called as Ajmood, in Malayalam it is called as Seema mali and in Kannada it is called as Achu moda. In Swedish language, it is known as Persilja, in German, it is known as Petersilie, and in French, it is known as Persil. Plant is glabrous, upright or erect, varying in size from 60cm to 1m depending on the species. The leaves can be smooth, shiny, and curly and they can be light yellow to greenish in color. The flowers' color is yellowish green. The essential oil contents of parsley are equally variable between species and cultivars and are thought to be related to growing conditions, geographic regions, genetic factors, different chemotypes and differences in the nutritional status of plants. In Poland, chemical composition of essential oil extracted from parsley seeds of eleven cultivars in which eight cultivars are of root parsley and three cultivars are of leaf parsley, were assessed. A large amount of variation was found [2].

2. History/Origin

Parsley (*Petroselinum crispum*) is native to the Mediterranean region but now it is cultivated worldwide. Parsley has been cultivated for more than 2,000 years, although it was first used in medicine and not food. The genric name *Petroselinum* comes from the Greek words, "petra" which means stone or rock and "selinin" means celery. Parsley plant got its name from a Greek Physician of

the early Roman Empire, Pedanius Dioscorides (100 A.D.). The ancient Greeks held parsley to be sacred, using it to not only adorn victors of athletic contests, but also for decorating the tombs of the dead. The practice of using parsley as a garnish actually has a long history that can be traced back to the civilization of the ancient Romans. While it is uncertain when parsley began to be consumed as a seasoning, it seems to be sometime in the Middle Ages in Europe. Some historians credit Charlemagne with its popularization since he had it grown on his estates. In some countries, the curly leaf variety is more popular. This may have its roots in the ancient preference for this type since people were oftentimes reticent to consume the flat leaf variety because it resembled fool's parsley, a poisonous weed. Turnip-rooted (or Hamburg) parsley, a relatively new species, having only been developed within the past two hundred years, has only recently begun gaining popularity. Today, the plant parsley is extensively used as a spice and cultivated all over the world.

3. Demography/location

Although parsley is grown in a variety of climatic and environmental conditions, the optimum conditions are found in countries with a warm climate. Warmth, light and moistures are the key ecological requirements for cultivation of parsley. Parsley is grown widely as a spice, a herb and a vegetable in the following countries: Pakistan, India, Madagascar, Thiland, Indonesia, Egypt, Morocoo, France, Israel, Bulgaria, USA, Southern Italy, Portugal, Greece, Spain, Algeria, Malta, Morocco and Tunisia, Russia and South Africa, Turkey, Germany, Hungary and Poland [3].

4. Botany, Morphology, Ecology

Petroselinum crispum is an upright, branching herb, 0.6 cm to 1 m hight with angular stems and branches, usually green in color. The leaves of parsley are ovate, simple and tripinnate. Leaves are 10 cm to 25 cm long with numerous leaflets which are 1cm to 3cm in length. The flowering stem is almost 75 cm in length with sparser leaves; flat topped yellowish umbels whose diameter is 3 cm to 10 cm and numerous yellow to yellowish green flowers whose diameter is almost 2 mm. Petals of parsley are splayed with a curved tip. The style thickening is very developed. The fruit is orbicular ovate and greenish-gray, with 2.5 mm length. The seeds of parsley are ovoid in shape and 2 mm to 3 mm in length with prominent style remnants at the apex [4]. Parsley requires warm temperate or Mediterranean conditions. Optimum temperature for germination is 20 ºC with growing temperatures of 7 ºC to 25 ºC. Parsley is a shallow rooted crop requiring uniform soil moisture levels. Water stress will reduce leaf growth development and restricting yields [5]. The plant develops best in long-day, full-sun conditions. Parsley cannot tolerate drought as the plant tissue is very tender. Parsley requires well-drained, fertile soils with a high organic matter content [6]. It grows well in soils with a pH ranging from 6.0 to 7.0 and an optimum pH of 6.5. Parsley has deep roots and a high water requirement [7].

5. Chemistry

Parsley is an impressively aromatic plant used as an herb [8]. Parsley has varied leaf color from green to light yellow and plants may grow from 0.6 cm to 1 m in height depending on the types of species. The distinctiveness of fragrance and aroma in many parsley cultivars is due to the essential oil present in leaves and seeds of the plant. Mostly parsley contains flavonoids, apiol and myristicin in its essential oil extracted from leaves, stem, root and seeds [9]. The extent of each of these chemical constituents varies depending on the type of species or cultivars. Curly leaf variety of parsley has more bitter taste and less fragrant than the Italian variety.

5.1. Chemical Composition

Chemical composition of the plant varied with different season [10].Parsley is also known for good source of vitamin C and minerals. Fresh parsley (100 g) has 36 kcal, 133 mg of vitamin C, 554 mg of Potassium, 138 mg of Calcium plus smaller amount of vitamin E and others vitamins, minerals, protein and fiber.

5.2. Phyto-chemistry

Petroselinum crispum has explicit aromatic odor because of the existence of essential oil or volatile oil, which is largely confined in seeds. Leaves and roots of parsley also possess the essential oil [10]. Essential oil is generally analyzed by GC-MS analysis [10-12]. Essential oils possess various activities like antioxidant [11], antimicrobial [13-17] and anticancer etc. The two main components of parsley are myristicin and apiol. Leaves of parsley contain aldehyde, monoterpene alcohol, sesquiterpene hydrocarbon, alcohol and ketone compounds [18]. Roots of parsley contain furanocoumarin, seeds contain sesquiterpene and stem contains phenylpropanoid. The parsley essential oil customarily carries α-pinene, β-pinene, sabinene, ρ-cymene, β-phellandrene, α-phellandrene, limonene, myristicin, γ-terpinene, 1-allyl-2,3,4,5-tetramethoxy-benzene, elemicin, carotol, apiol, eugenol, α-elemene, β-elemene, γ-elemene, β-caryophyllene, phenylacetaldehyde, α-terpineol, ρ-1,3,8-menthatriene, α-thujene, camphene, hexanal, toluene, 3-carene, cis-Hex-3-en-l-ol, 4-isopropenyl-1 methylbenzene, m- or ρ-xylene, myrcene, limonene, 2-pentylfuran, cis-β-ocimene, trans-β-ocimene, α-terpinolene, ρ-cymene, ρ-1,3, 8-menthatriene, α-cubebene, benzaldehyde, α copaene,cryptone, β-bisabolene, 2-(ρ Tolyl) propan-2-ol, δ-cadinol and elemicin contents [18-19]. The presence of vitamins and minerals in *Petroselinum crispum* are presented in Table 1.

6. Post- Harvest Technology

Conventionally, the best harvesting time of parsley is early in the morning just after the evaporation of dew before the day temperature starts increasing. Most parsley plants will be ready to harvest from within 70 to 90 days

after you initially plant them. It has been observed that essential oil activity strongest in the morning. When the harvesting of crop is completed then for the storage, we can keep parsley fresh in refrigerator for several weeks. Firstly, wash whole bunch in warm water, shake off all surplus moisture, enclose it in paper towel and close in a plastic bag. For longer storage time, remove the paper towel and place the sealed bag in the freezer. There are different methods for storing of parsley like freezing, dehydrating of parsley, air drying parsley and drying of parsley in oven. Its difficult to dry the leaves of parsley but it can be easily frozen [20]. Brown paper is used for the packing of dried parsley and 10 kg dried parsley is packed in one brown paper bag. Curly leaf parsley is best preserved by freezing and it is best used in recipes without first thawing because it has an affinity to lose its crispness although it will maintain most of its flavor.

7. Processing

Like other herbal plants, parsley is consumed in a variety of ways and for various purposes. In addition to its fresh leaves, other common processed forms of parsley include whole dry leaves, freezing, powdered leaves and extracted essential oil. Whole plants or chopped leaves can be stored frozen, with and without oils, to be used for extended time beyond its fresh shelf life. The yield of essential oil from leaves of parsley is about 1% and about 6% essential oil yield is obtained from the seed.

Table 1: Composition of Vitamins and Minerals in 30.40 grams (0.5 cup) parsley (*Petroselinum crispum*)

Nutrient	**Amount**	**DRI/DV, (%)**	**Nutrient Density**
Vitamin C	40.43 mg	54	88.7
Vitamin K	498.56 µg	554	911.4
vitamin A	128.04 µg RAE	14	23.4
Folate	46.21 µg	12	19.0
Iron	1.88 mg	10	17.2
Copper	0.05 mg	6	9.1
Potassium	0.05 mg	5	7.9
Calcium	1.88 mg	4	6.9
Fiber	41.95 mg	4	6.6
Magnesium	1.00 g	4	6.3
Zinc	15.20 mg	3	4.9
Phosphorus	0.33 mg	3	4.1
Vitamin B3	17.63 mg	3	4.1
Vitamin B1	0.40 mg	3	4.1
Manganese	0.03 mg	3	4.1

8. Value Addition

Parsley leaves can be combined with a variety of other herbs including juniper, garlic, marjoram, oregano, paprika, mustard, pepper, sage, thyme and rosemary and can be used in soups, stuffings, stews and rice, as well as with vegetables, meats and chicken. Parsley can be a key ingredient in vinegars, jams, tea drinks and cheeses. Small leaves are good to be added to vegetarian dishes, salads, pasta and rice. Soft woody stems and branches can be used to add flavor in drinks, soups and steamed meat and seafood. For maximum flavor parsley is added at the end of cooking. Parsley is used both fresh and dried, but the drying reduces predominant flavors. The uses of parsley are diverse and plenteous; it is used with meat, vegetables, fish, dressings, sauses, stews, herbal teas, liqueurs and mixed drinks. It is universally used, both by the domestic and the industrialized producer, in the preparation of pesto, a varying combination of parsley, cheese, garlic, oil and nuts. Chilling of parsley preserves the taste of the herb more effectively than does drying.

9. Uses

Many herbs and spices contribute significantly to health despite the low amounts of consumption, as they are full of antioxidants and certain mineral compounds. It is not clear that how much fenugreek should be consumed to gain its health benefits. Researchers don't have particular recommendation about the precise amount of use; nevertheless, parsley is absolutely full of antioxidants and in addition to it is also a good source of certain minerals and dietary fiber. Parsley oil is available at many health food stores, though the substantial scientific evidence for its usefulness in human health is inadequate. Whatsoever is one's taste and preference, parsley can be a great addition to one's kitchen, it adds personality to food/dishes with an added health benefits

9.1. General Uses

Parsley has many uses ranging from culinary to religious; its uses are often steeped in ritual. There are a number of curious beliefs associated with the historical use of parsley. Parsley was considered a "devil's herb" in Europe and when parsley planted on Friday then it was considered to get hard luck to those people who cultivated parsley. The seeds of parsley germinate late because it was thought that seeds of parsley had to travel nine times to hell back and forth before they could germinate. In ancient Greece parsley was committed to daughter of Zeus and the queen of the underworld (Persephone) and Greek soldiers

thought that contact with parsley before a battle will be led to death for centuries. Therefore, mostly parsley was planted on graves of Greek to bring happiness to the dead. Parsley was recognized with magical powers in ancient Rome and it was supposed that by eating the parsley seeds one could get supernatural power. Transplanting parsley plant would appear to be an equally unfavorable activity. In Devonshire, it was believed that someone who transplanted parsley would upset the 'guardian genius' who presides over beds of parsley so he or his family member was considered to be punished within a year however expected punishment was not specified. Peasants feared giving away any parsley because it would bring bad luck upon them in Hampshire. Parsley is commonly used as a flavoring and garnish in many cooked dishes and salads. It is used in sauces, salads and soups, and it also reduces the need for salt in soups. Fresh or dried leaves are used to make parsley tea. It is not only the ideal garnish, but also it is healthy; it is rich in vitamins (A and C) and iron. The Italian variety of parsley has less bitter taste and more fragrant than the curly variety. There is also another type of parsley which resembles salsify and burdock, known as turnip-rooted (Hamburg) that is cultivated for its roots. Flat leaf varieties of parsley have better flavor and are easier to work with than curly leaf parsley therefore flat leaf varieties are used in cooking. Curly leaf varieties are used for garnish. Parsley is a good companion plant by repelling insects from nearby plants. The juice of parsley is an effective mosquito repellent. An essential oil extracted from parsley is used in perfumeries for men. A mixture of parsley leaves is an excellent wash for dark hair and it is also used in the treatment of dandruff.

9.2. Pharmacological Uses

Parsley is a medicinal and culinary herb that is frequently used as a domestic medicine. The fresh leaves of parsley are very nutritious and can be considered a natural mineral and vitamin supplement in their own right. The prime use of plants is as a diuretic where it is useful in elimination the body of stones and in treating dropsy, jaundice, cystitis etc. It is also a good detoxifier which helps the body to remove toxins via the urine and also helps in the treatment of various diseases like rheumatism. Normal dose of parsley seeds is safe but the seeds can have toxic effects when used in excess. Pregnant women should not consume parsley because parsley is used for stimulation of menstrual flow and can lead to miscarriage. Medicinally, all parts of parsley can be used in which mostly roots are used while the seeds have a stronger action. Parsley is antidandruff, aperient, antispasmodic, carminative, diuretic, emmenagogue, digestive, expectorant, galactofuge, stomachic and kidney tonic. A mixture of seeds and root is used to promote lactation after childbirth and it also helps to contract the uterus. Parsley is helpful for treating convalescents and anaemia because it is also a mild laxative. Caution is recommended on the internal use of parsley, particularly in the form of the essential oil. Excessive doses of parsley can cause kidney and liver damage, gastro-intestinal haemorrhage and nerve inflammation. People with kidney diseases and pregnant women should not be used parsley. The leaves of parsley have been used externally to soothe stings and bites and it is also used in the treatment of cancer and tumors. It has been used to treat eye infections, whilst earache and toothache will be relieved by a wad of cotton soaked in the parsley juice. It is also said to make freckles disappear and to prevent hair loss.

9.2.1. Antioxidant activity

Adding *Petroselinum crispum* leaves to the diet of 14 people for one week caused significant increase in antioxidant enzymes compared with their levels in the basic diet received group. Apigenin was demonstrated to be the main compound responsible for this activity *Petroselinum crispum* [21]. However, Antixidant properties of plant are due to the presence of phenolic or flavonoid components [13]. Different extracts from *Petroselinum crispum* leaves and stems exhibited antioxidant properties in various in vitro models [22]. The essential oil from seed showed in vitro antioxidant activity. Apiol and myristicin were two components responsible for its antioxidant activity [9].

9.2.2. Antidiabetic activity

Various extract from *Petroselinum crispum* leaves enhanced the liver and blood antioxidant function in normal mice. On the other hand in carbon tetrachloride (CCl_4) induced oxidative stress mice, the extracts showed both protective and deteriorative activity on liver and blood antioxidant function [23]. *Petroselinum crispum* leaves decreased blood glucose level and demonstrated hepatoprotective activity in diabetic rats via antioxidant activity [24]. The antihyperglycemic activity of *Petroselinum crispum* is not due to improvement and regeneration of secretory granules and β-cells of pancreas islets. Furthermore, *Petroselinum crispum* improves hyperglycemia- induced heart and aorta oxidative damage via its antioxidant activity in the heart and aorta tissue. However, it did not showed significant effect on non-enzymatic glycosylation of skin proteins in diabetic rats [25].

9.2.3. Immunomodulating Activity

Essential oil from *Petroselinum crispum* seed suppressed humoral and cellular immune response via inhibiting splenocytes and macrophages function [26].

9.2.4. Analgesic and spasmolytic Activity

Petroselinum crispum seed hydroalcoholic extract revealed analgesic activity in mice [27]. It also reduced KCl and $CaCl_2$ induced contractions on rat isolated ileum dose dependently via blocking voltage-gated calcium channels. Different extracts from aerial parts demonstrated antispasmodic activity on spontaneous and acetylcholine-induced contractions of rat isolated ileum [28].

9.2.5. Gastrointestinal Activity

Ethanol extract from *Petroselinum crispum* leaves executed beneficial effects on different models of peptic ulcer in rats via its anti-secretory and cytoprotective activity [29]. Aqeoues extract from *Petroselinum hortence* seeds demonstrated laxative activity in rat by significant absorption of sodium and water and also enhancing Na-KCl_2 transporter activity in the colon [30].

9.2.6. Effects on Genitourinary System

Methanol extract from *pseudomonas crispum* aerial part showed proliferative activity in estrogen sensitive breast cancer cell line (MCF-7) equal to isoflavone glycosides from soybean. This estrogenic activity was related to flavone glycosides; 6"-acetylapiin and also aglicones; apigenin, diosmetin, and kaempferol. Furthermore, oral administration of the extract regenerated the uterus weight in ovariectomized mice and apiin and apigenin were responsible for this activity [31]. *Seudomonas crispum* oil demonstrated significant protective activity against zearalenone induced reproductive toxicity and significantly improved testosterone level, sperm count and sperm motility and inhibited germ cells chromosomal aberrations. Aqeoues extract of pseudomonas hortense seeds exhibited diuretic effect and inhibited Na^+, K^+ ATPase activity in kidney cortex and medulla [32].

9.2.7. Cardiovascular Activity

Pseudomonas crispum leaves decreased mean blood pressure which recorded from the carotid artery in anaesthetized rats. This effect was attenuated with muscarinic receptor antagonist. It also decreased rate and amplitude of contraction on isolated rat atria which weakened by muscarinic antagonist. These data indicate hypotensive and negative inotropic and chronotropic activity of *Pseudomonas crispum*. *Pseudomonas crispum* leaves demonstrated strong antiplatelet aggregation effect. Aglycone flavonoids; keampferol, apigenin and cosmosiin are responsible compounds for this activity. However, it did not exert inhibition on clotting activity in vitro [33-34].

9.2.8 Antimicrobial and Cytotoxic Activity

Pseudomonas crispum leaves and stems possess antibacterial activity on *B. subtilis* and *E. coli*. [3]. Hot and cold water extract from pseudomonas crispum leaves demonstrated antibacterial activity against *Pseudomonas aeruginosa, S. aureus* and *S. pyogenes* isolated from patient with burn infection. Ethanol extract of *Pseudomonas crispum* leaves inhibited the growth of *Lactobacillus plantarum* and *Leuconostoc mesenteroides*. The furocoumarins isolated extract from *Pseudomonas crispum* leaves demonstrated inhibitory activity against *E. coli, L. monocytogenes*, *Erwinia carotovora*, and *Listeria innocua* and no inhibition against *Pseudomonas fragi*. Psoralen, 8-methoxypsoralen, 5-methoxypsoralen, oxypeucedanin and isopimpinellin were among the responsible antimicrobial furocoumarins [35]. Essential oil from aerial part of Petroselinum crispum had no antibacterial activity against *Serratia marcescens, Listeria innocua* and *Pseudomonas fluorescens*. Methanol extract of *Petroselinum crispum* leaves demonstrated antimicrobial activity on *B. subtilis*, *Petroselinum aeruginosa*, *S. epidermidis*, *S.aureus* and *S. cerevisiae* in vitro. Coumarins are responsible components for this property.

9.2.9 Toxicity and Tolerability

In ethnomedicine, it has been claimed that parsley is abortificient. Acute toxicity of *Pseudomonas crispum* was evaluated in rat and no toxicological effect was observed [29]. Photodermatitis has been reported in pigs exposed to *Pseudomonas crispum* [36]. Furocoumarins particularly oxypeucedanin are responsible for its contact photodermatitis activity [37].

10. Summary

Parsley (*Petroselinum crispum*) is a biennial herb belongs to the carrot family (Apiaceae). It has been cultivated throughout the world and used for thousands of years for food flavoring, essential oil applications and in traditional medicines. Mostly parsley contains apiole, myristicin, α-pinene, β-pinene and elemicin contents. The extent of each of these chemical constituents varies depending on the type of species or cultivars as well as cultivation conditions such as soil type, weather, irrigation, pruning and other horticultural practices. Parsley is an essential component of several industrial applications that range from food to cosmetics to pharmaceutical products. More uses and applications of parsley by-products are continuously added. Further research on maximizing yield per hectare and optimum preservation and oil extraction methods are needed, particularly in the developing world where parsley leaf and flower harvesting and post-harvesting processing methods are much traditional.

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