



REVIEW ARTICLE

ORIGIN, TAXONOMY, BOTANICAL DESCRIPTION, GENETICS AND CYTOGENETICS, GENETIC DIVERSITY, BREEDING AND CULTIVATION OF PARSLEY

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ABSTRACT

Parsley belongs to the family Apiaceae (Umbelliferae), genus *Petroselinum*, and species *Petroselinum crispum*. Other scientific names are: *P. hortense* Hoffm., *P. sativum* Hoff., *Carum petroselinum* (L.) Benth. and Hook. F. Parsley has the following common names: English–parsley, Chinese–heung choi, Danish–persille, Dutch–peterselie, French–persil, German–petersilie, persil, peterwurz (root), Greek–maintanos, makedonisi, petroselino, Hindi–ajmood, Italian–prezzemolo, Polish–pietruszka zwyczajna, Portuguese–salsa, Russian–petrushka, Spanish–perejil, Swedish–persilja. Parsley is mostly cultivated as an annual culinary herb and is widely grown in Europe and Western Asia. Parsley is to the Western world what *cilantro* (sometimes called Chinese parsley or coriander) is to the Eastern world. Most parts of the plant are used – the leaves, the above-ground herb and the seeds. The essential or volatile oils can be obtained through distillation. The volatile oil obtained from the above-ground herb has the aroma of the fresh herb and is marketed as herb oil. The volatile oil obtained from the seed has a unique distinctive flavour and is marketed as seed oil. It is interesting to note that the name ‘parsley’ originates from the name *Petroselinum* ascribed by Dioscorides. Later on, in the Middle Ages it became *petrocilium* and later expressed in the English language as petersylinge, persele, persley and finally parsley as it is known today. The name *petroselinum* is derived from the Greek word *petros* which means stone, referring to the plant’s habit of growing in rocky places. *Selinon* was the Greek word for parsley in ancient history. Parsley has been known in the Mediterranean region for about 2000 years, where it was cultivated as a medicinal plant. Parsley, a vital culinary and medicinal herb from the Apiaceae family, boasts significant nutritional and therapeutic benefits. Originated from the Mediterranean region, this wonderful herb is a coffer of many phenolic compounds and flavonoids such as apigenin and apiin, essential oils primarily consisting of myristicin and apiol, as well as coumarins. Genetic resources of parsley are considerably represented in ex situ collections worldwide, and the passport data can be retrieved from several database sources. Genetic diversity of this crop needs to be conserved with immediate attention to avoid genetic erosion. Decades of breeding efforts in parsley including selection and interspecific and intervarietal hybridization have led to the development of numerous high-yielding cultivars with biotic stress tolerance and enrichment in essential oil. Despite these achievements, the production potential of parsley of different categories remains significantly low. The growing demand for high and sustainable parsley production drives the scientific communities to increase breeding efficiency, ensuring a continuous supply of improved cultivars. Integration of conventional breeding strategies with cutting-edge molecular breeding tools deploying genomic resources can pave the way for cultivar development in shortest possible time. Pressing need has been felt to enrich the genomic resources vis a vis genetic resources toward development of high-yielding parsley cultivars with key adaptive traits against the climatic vagaries along with nutritional benefit and therapeutic importance. In this review article on Origin, Taxonomy, Botanical Description, Genetic Diversity, Breeding and Cultivation of Parsley are discussed.

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INTRODUCTION

Parsley belongs to the family Apiaceae, genus *Petroselinum*, and species *Petroselinum crispum* (Botanica, 2024; Mindat, 2024; Wikipedia, 2024; wikipedia, 2024a). The word "parsley" is a merger of Old English *petersilie* (which is identical to the contemporary German word for parsley: *Petersilie*) and the Old French *peresil*. Both of these names are derived from Medieval Latin *petrosilium*, from Latin *petroselinum*, which is the latinization of the Greek *πετροσέλινον*, *petroselinon*, 'rock-celery', from *πέτρα*, *petra*, 'rock, stone' and *σέλινον*, *selinon*, 'celery'. Mycenaean Greek *se-ri-no*, in Linear B, is the earliest attested form of the word *selinon* (Wikipedia, 2024). The word "parsley" is a merger of Old English *petersilie* (which is identical to the contemporary German word for parsley: *Petersilie*) and the Old French *peresil*, both derived from Medieval Latin, from Latin *petroselinon*, Charlton T. Lewis, Charles Short, A Latin Dictionary, on Perseus Digital Library which is the latinization of the Greek *πετροσέλινον* (*petroselinon*), "rock-celery", *πετροσέλινον*, Henry George Liddell, Robert Scott, A Greek-English Lexicon, on Perseus Digital Library from *πέτρα* (*petra*), "rock, stone", *πέτρα*, Henry George Liddell, Robert Scott, A Greek-English Lexicon, on Perseus Digital Library + *σέλινον* (*selinon*), "celery". *σέλινον*, Henry George Liddell, Robert Scott, A Greek-English Lexicon. The Euro+Med Plantbase Project: *Petroselinum crispum* Interactive Flora of NW Europe: *Petroselinum crispum* Mycenaean Greek *se-ri-no*, in Linear B, is the earliest attested form of the word *selinon* (GBIF, 2024). Parsley has the following common names: English–parsley, Chinese–heung choi, Danish–persille, Dutch–peterselie, French–persil, German–petersilie, persil, peterwurz (root), Greek–maintanos, makedonisi, petroselino, Hindi–ajmood, Italian–prezzemolo, Polish–pietruszka zwyczajna, Portuguese–salsa, Russian–petrushka, Spanish–perejil, Swedish–persilja (Charles, 2012a). Bladpersilja, Rotpersilja, Persilja, Parsley, Persille, Garden Parsley, Paseri, Ou Qin, Prezzemolo, Common Parsley, Persil, Persil Cultivém (Mindat, 2024). Arabic: baq dunis, maq dunis; Bulgarian: магданос magdanos; Chinese: ou qin; Croatian: peršin; Czech: petržel; Danish: persille; English: common parsley; Finnish: persilja; French: persil commun; German: Blattpetersilie, Petersilie; Greek: maïntano, maïntanos, makedonisi, persemolo; Hebrew: petrosilia; Hungarian: petrezselyem; Italian: prezzemolo; Japanese: paseri; Korean: pa sul li; Khmer: vanns baraing; Polish: pietruszka zwyczajna; Portuguese: salsa; Russian: петрушка petrushka; Serbian: peršun; Slovenian: peteršilj; Slovakian: petržlen záhradný; Spanish: perejil; Swedish: bladpersilja, persilja; Thai: phak chi farang; Turkish: maydanoz; Vietnamese: rau mùi tây (Growables, 2024).

Parsley, *Petroselinum crispum* (Syn. *Apium petroselinum* Linn.; *P. lativum* Hoffm.; *Carum petroselinum* Benth), is a biennial herb belonging to the family Apiaceae (Azeez and Parthasarathy, 2008). It is native to southern Europe and western Asia and in many parts of the world is cultivated commercially as an annual for its attractive and aromatic leaves. In America, parsley is used mostly as a garnish, while in Europe and the Middle East it is used almost as often as salt (Azeez and Parthasarathy, 2008). Chopped parsley leaves are a popular decoration in Central Europe (similar to the use of coriander leaves in China, South-east Asia and parts of India), mostly for soups and vegetables (Azeez and Parthasarathy, 2008). The Latin name, *Petroselinum*, was derived from Greek *pétros*, rock, stone. *Selinum* was the Latin name of celery. The species name was given because of the crispate leaf shape (Azeez and Parthasarathy, 2008). Parsley has been known for over 1000 years in the Mediterranean (Azeez and Parthasarathy, 2008). Parsley is of European (probably Western Mediterranean) origin. The plant was introduced into England from Sardinia in 1548 (Azeez and Parthasarathy, 2008). According to Linnaeus, the wild habitat of parsley is Sardinia, from where it was brought to England and apparently first cultivated there in 1548, while Bentham considered it a native of the Eastern Mediterranean regions and DeCandolle reported Turkey, Algeria and the Lebanon to be its home (Azeez and Parthasarathy, 2008). Since its introduction into the British Isles in the 16th century it has been completely naturalized in various parts of England and Scotland (Azeez and Parthasarathy, 2008). The Greeks held parsley in high esteem, crowning the victors with chaplets of parsley at the Isthmian games and making wreaths with it for adorning the tombs of their dead. Homer relates that warriors fed the leaves to chariot horses (Azeez and Parthasarathy, 2008). European colonists brought parsley to the USA in the 17th century. It is grown throughout Florida as a commercial crop of minor importance in the vegetable-producing areas of central and southern Florida (Azeez and Parthasarathy, 2008). *Petroselinum*, the specific name of parsley, from which the English name is derived, is of classic origin. This last name in the Middle Ages was corrupted into *Petrocilium* – this was anglicized into *petersylinge*, *persele*, *persely* and finally parsley. Linnaeus in 1764 named it *A. petroselinum*, and later to the genus *Carum* (Azeez and Parthasarathy, 2008).

Parsley belongs to the family (Umbelliferae) Apiaceae. Other scientific names are: *P. hortense* Hoffm., *P. sativum* Hoff., *Carum petroselinum* (L.) Benth. and Hook. F. (Charles, 2012a). Parsley is mostly cultivated as an annual culinary herb and is widely grown in Europe and Western Asia. Parsley is to the Western world what *cilantro* (sometimes called Chinese parsley or coriander) is to the Eastern world. Most parts of the plant are used – the leaves, the above-ground herb and the seeds (Charles, 2012a). The essential or volatile oils can be obtained through distillation. The volatile oil obtained from the above-ground herb has the aroma of the fresh herb and is marketed as herb oil. The volatile oil obtained from the seed has a unique distinctive flavour and is marketed as seed oil (Charles, 2012a). It is interesting to note that the name 'parsley' originates from the name *Petroselinum* ascribed by Dioscorides. Later on, in the Middle Ages it became *petrocilium* and later expressed in the English language as *petersylinge*, *persele*, *persely* and finally parsley as it is known today (Charles, 2012a). The name *petroselinum* is derived from the Greek word *petros* which means stone, referring to the plant's habit of growing in rocky places. *Selinon* was the Greek word for parsley in ancient history (Charles, 2012a). Parsley has been known in the Mediterranean region for about 2000 years, where it was cultivated as a medicinal plant (Charles, 2012a). According to Linnaeus, parsley originated in Sardinia and belongs to the family Apiaceae (Umbelliferae). Parsley was known in England around 1548, though some, such as Bentham and De Candolle, believe that the plant was a native of Eastern Mediterranean regions and also of Turkey, Algeria and Lebanon. During the sixteenth century parsley was naturalized in England (Charles, 2012a). The Greeks used parsley for ritual purposes and it is

mentioned in Greek mythology. It was planted near graves and anyone near death was said 'to be in need of parsley'. In Greece, parsley had long been associated with death. According to legend, the fertility king, Archemorus, was the one from whose blood the plant sprouted (Charles, 2012a). For centuries, the association of parsley with death continued and every generation connected parsley with the 'gods' of the day. The Greeks used parsley for funerals and placed wreaths of parsley on tombs. Parsley is also said to have been used as a decorative garland for the head of Hercules, signifying his victory as a pillar of strength (Charles, 2012a). Parsley garlands were given to the winners of athletic competitions. In Roman culture, parsley was often used as a deodorant to mask the smell after consuming garlic. Both the Romans and Greeks fed parsley to their chariot horses for stamina (Charles, 2012a). Parsley, being associated with death, later on became associated with evil or Satan. It was powerful with all its devilish powers and, for those who undermine its powers, there were negative consequences (Charles, 2012a). Virgins could not plant parsley without losing their virginity to the devil. The safest day to plant parsley was Good Friday, and it was usually done by a male head of the household to ward off any evil effects the devil might generate (Charles, 2012a). Since parsley seeds have a slow rate of germination, the popular belief was that the seeds had to travel to hell and back two, three, seven or even nine times, before they could germinate (Charles, 2012a). Parsley is also used in the Hebrew celebration of Passover as a reminder of the grief and sorrow of Hebrews, which came to an end that day (Charles, 2012a). Parsley is also associated with Catherine de Medici and Charlemagne as one of the plants in their garden. It is said that Medici was responsible for the popularity of parsley when she brought it to France from Italy (Charles, 2012a). In ancient times, parsley was used in medicinal concoctions for cure-alls, general tonics, poison antidotes, antirheumatics and formulations to relieve kidney and bladder stones (Charles, 2012a).

Parsley is known since millennia in the Mediterranean; its usage for cultic purposes dates back to old Greece (see celery about the Isthmian Games). Today, chopped parsley leaves are a popular decoration in Central Europe (similar to the use of coriander leaves in China, South East Asia and parts of India), mostly for soups and vegetables (Gernot Katzer, 2015). Parsley is often used for sauces; the famous German *Green Sauce* is an example (see borage). Chopped parsley and garlic in olive oil make for a wonderful Mediterranean sauce, to be served to broiled fish. As parsley aroma suffers from any prolonged heat treatment, parsley leaves should not be cooked if distinct parsley fragrance is desired; quick frying in olive oil, though, is acceptable. There is, however, one important exception: *bouquet garni* (Gernot Katzer, 2015). *Bouquet garni* typically consists of a selection of fresh herbs which are tied to a bundle and cooked in soups, sauces or stews; due to the long cooking time, the herbs' aroma merges with the flavour of the other ingredients, thereby enriching the food without being recognizable in the finished dish (Gernot Katzer, 2015). In the Caucasian region, parsley is also known and popular, although in Azerbaijan, coriander prevails. Georgia, on the other hand, is one of the few countries where both parsley and coriander enjoy equal and high popularity, and both herbs appear (together with others) in large amounts with all the cold foods that make the rich cuisine of that country so unforgettable. Parsley leaves are also often eaten together with cheese. Dried parsley is a component in the famous Georgian spice mixture *khmeli-suneli* (see blue fenugreek). Further East, it is also found, dried or fresh, in the Irani *ghorme*-blend (Gernot Katzer, 2015). The root of parsley is eaten as a vegetable or cooked in soup to improve the soup's taste, as it does not diminish in flavour after a long time of cooking; cf. above for German *Suppengrün*. The fruits, though aromatic, have found little application; their use in vegetable stews or lentil dishes may, however, have surprising effects. Since they are an efficient diuretic drug, large amounts of them may be hazardous, especially for people with kidney weakness; the same holds true, but to a lesser extent, for the root, but not for the leaves (Gernot Katzer, 2015). Parsley is a vegetable, a medicinal herb, and a spice, widely cultivated for more than 2000 years in the southeastern Europe and western Asia. Its name *Petroselinum* derives from the Greek term referring to the plant's habit to grow in rocky places (Kumar *et al.*, 2016). *P. crispum* is native to the central Mediterranean region and is cultivated all over the Europe (Kumar *et al.*, 2016). As a great flavoring to any salad and meat dish, the plant was introduced from Sardinia to England in the sixteenth century (Kumar *et al.*, 2016). There are three different varieties of *P. crispum*: var. *crispum* (curles parsley) with a sharp peppergrass-like taste and cultivated in warmer climate; var. *neapolitanum* (flat leaf parsley) with a sweeter and smoother flavor and grown in a colder conditions characterized by dryness and snow (Italian and eastern European parsley); and the less known var. *tuberosum* (Humburg parsley), primarily grown for its roots (Kumar *et al.*, 2016). *P. crispum* has bright green, fragrant leaves, it adds color and flavor to any food we eat, and it is used to soothe various digestive complaints, such as indigestion, flatulence, and loss of appetite, and may prevent stomach ulcers. Fresh *P. crispum* herb is widely used in Middle Eastern, European, Brazilian, and American cooking. French *persillade* (a sauce made of mixture of chopped garlic and parsley) is well known all over the world, and Italian and Spanish cuisines use the herb in delicious *salsa verde* (Kumar *et al.*, 2016). In addition to its culinary use, *P. crispum* possesses many medicinal properties, first mentioned by the ancient Greeks. *P. crispum* plant is rich in ascorbic acid, carotenoids, flavonoids, apiole, terpenoid compounds, coumarin, phenylpropanoids, phthalides, tocopherol, and furanocoumarins (Kumar *et al.*, 2016). The leaves hold high content of vitamins (A, C, and K), β -carotene, and also lutein, zeaxanthin, folate, choline, niacin, and pantothenic acid. Together with leaves, the plant roots are wonderful source of a range of minerals (Ca, K, Mg, B, P, Fe, Na, Zn, F, Mn, and Se). High concentration of boron and fluoride in parsley leaves might help against bone thinning and osteoporosis, and its great combination of calcium and fluorine supports teeth health (Kumar *et al.*, 2016). *P. crispum* essential oils and extracts demonstrate antioxidant, anti-inflammatory, calcium channel-blocking (in the intestine and uterus muscle), cancer preventive, laxative, and diuretic properties. Due to its essential oil content, *P. crispum* has great insect repellent potential and is always a good companion plant, repelling insects from nearby plants (Kumar *et al.*, 2016). The major constituent of the *P. crispum* leaf oil is *p*-1,3,8-menthatriene, followed by β -phellandrene, myristicin, and β -myrcene, while the major root oil constituent is apiole, followed by myristicin and terpinolene. In addition, the *P. crispum* leaf oil has immunomodulatory effect on mitogen-activated splenocytes and peritoneal macrophages apart that the seed oil is used as a fragrance in soaps, cosmetics, and perfumes and demonstrates strong diuretic activity (Kumar *et al.*, 2016). However, it is important to remember that *P. crispum* essential oils can also be phototoxic and abortifacient and should never be consumed or applied to the skin without caution (Kumar *et al.*, 2016). The methanol extracts of *P. crispum* contain coumarins and express great antimicrobial activity against *B. subtilis*, *P. aeruginosa*, *S. epidermidis*, *S. aureus*, *E. coli*, *Klebsiella pneumoniae*, and *Saccharomyces cerevisiae*, while hydroalcoholic extract of the same plant demonstrates a significant inhibition of the standard *P.*

aeruginosa strain (Kumar *et al.*, 2016). The aqueous extracts of parsley had bactericidal effects against *Helicobacter pylori* and inhibited adhesion of the bacteria to animal stomach section. Daily consumption of *P. crispum* in salad significantly reduces the blood glucose potentially via inhibition of gluconeogenesis and direct stimulation of glycolysis (Kumar *et al.*, 2016). In general, fresh *P. crispum* plant and its oils and extracts are widely used as antiaging, anticarcinogenic, antifungal, anti-inflammatory, digestive aid, laxative, diuretic, and aphrodisiac; help soothe arthritis pain; and are used for bronchitis, bruises, burns, itching, common cold, itching, menstrual cramps, bad breath, goiter, edema, swollen glands, bed-wetting, fluid retention, jaundice, asthma, fever, gas, swollen breasts, snakebites, dropsy, worms, obesity, and expulsion of the gravel and kidney stone (Kumar *et al.*, 2016).

Parsley which belongs to the family Apiaceae is a bright green plant, which is cultivated widely in the tropic, subtropic, and temperate regions (Agyare *et al.*, 2017). It is a biennial plant which is widely cultivated as an annual plant. Traditionally, roots of *P. crispum* has been used as a powerful diuretic, seeds have been used as antimicrobial, antiseptic, antispasmodic, and in the treatment of gastrointestinal disorders, inflammation, halitosis, kidney stones, and amenorrhea (Agyare *et al.*, 2017). Leaves of *P. crispum* have been employed in the treatment of hemorrhoids, gastrointestinal disorders, diuretic, and as a food-flavoring agent in addition to its common usage as vegetable (Agyare *et al.*, 2017). *P. crispum* has been found to possess many pharmacological effects including, antioxidant, antibacterial, antifungal, hepatoprotective, antidiabetic, analgesic, spasmolytic, immunosuppressant, and gastroprotective properties. Hence this section reviews the phytochemical constituents and pharmacological activities of *P. crispum* (Agyare *et al.*, 2017). Leaf parsley (*Petroselinum crispum* (Mill.)) is a biennial plant belonging to the *Apiaceae* (Lindl.) family. It is native to the Mediterranean region and West Asia (Jadczak *et al.*, 2019). As a seasoning vegetable, it is cultivated in Poland on a small scale and its current economic importance remains low (Jadczak *et al.*, 2019). Many cultivars of leaf parsley have not been investigated yet. In Poland, the most valuable cultivars are Festival 68, Gala, Messis, Nataalka, Nutka, and Pesto (Jadczak *et al.*, 2019). The edible parts are leaves that may be dried, frozen or consumed raw. This highly aromatic herb with great biological value is commonly used in China, Mexico, South America, India, North-East Asia (Jadczak *et al.*, 2019). The leaf rosette of leaf parsley has an upright or semi-upright habit and contains 40-100 tripinnate leaves. It is a rich source of many biologically active compounds, including vitamin C, B and K and minerals (Jadczak *et al.*, 2019). Parsley leaves show diuretic and disinfecting properties as their essential oil contains such compounds as apiol, myristicine and α -pinene and they are valued by the food industry for their high content of phenolic compounds (Jadczak *et al.*, 2019). Leaf parsley is a popular herb mostly due to its aromatic flavour. The species is grown, similarly to root parsley, by sowing seeds directly in the field. It is tolerant to low temperatures and may overwinter (Jadczak *et al.*, 2019).

Parsley is grown in temperate and subtropical climate worldwide and predominantly used as aromatic plant for cooking and garnishing (Medicinal, 2020a). Two convarieties are differentiated in parsley, the convar. *Crispum* for usage of the flat or crisped leaves and convar. *Radicosum* with eatable swollen taproots (Medicinal, 2020a). All parts of the plant including leaves, stems and taproots are usable. Products from harvested parsley leaves are marketed dehydrated, frozen or as fresh green bunches (Medicinal, 2020a). Parsley roots are used fresh as vegetable. It is also often used for flavouring and as taste enhancer (Medicinal, 2020a). Parsley is rich in antioxidants, in the flavonoid luteolin, in vitamins C and A and in folic acid. It contains essential oils in roots, leaves and fruits with clear differences in amount and composition. Inside the umbels, a time gradient exists with the oldest partial inflorescences at the external circle (Medicinal, 2020a). Because of protandry, the five anthers start anthesis around 5 days before the two stigmata are receptive to pollen (Medicinal, 2020a). Economically important diseases are Septoria blight caused by *Septoria petroselini*, downy mildew (*Plasmopara petroselini*), powdery mildew (*Erysiphe heraclei*) and Alternaria leaf blight caused by *Alternaria radicina* (Medicinal, 2020a). Breeding objectives for production of leaves are yield, amount of marketable yield, essential oil content, fast regrowth after cutting, colour of leaves, crimping of the leaf blade tissue, relation of leaves to stalk, height and density of plants. For dried products, the colour intensity of the green leaves is important (Medicinal, 2020a). Breeding objectives for turnip-rooted parsley are yield of taproots, length and diameter of the taproot and a smooth taproot. Resistances are also of big interest, especially to Septoria blight and downy mildew (Medicinal, 2020a). Genetic resources of parsley are considerably represented in ex situ collections worldwide. There exist a high number of varieties but also local races or land races are still used and registered (Medicinal, 2020a).

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Parsley belongs to the family Apiaceae (Karmakar *et al.*, 2021). In America parsley is mostly used as a garnish, while in Europe and Middle East it is almost used as often as salt. It is mostly grown outdoors and is seasonally harvested (Karmakar *et al.*, 2021). Parsley is a leafy vegetable, rich in many biologically active compounds, and its name (*Petroselinum*) is derived from the Greek for 'rock celery' or the word *Petroselinum* is derived from the Greek word petros which means "stone," referring to the plant's habit of growing in rocky places. Selinon was the Greek word for parsley in ancient history (Karmakar *et al.*, 2021). It can be distinguished from other leafy green herbs by its unique aroma (Karmakar *et al.*, 2021). Both the crowded, dense-leaved type and the broad open-growing type were described in the 4th century B.C. (Karmakar *et al.*, 2021). Parsley was introduced into England from Sardinia in 1548 (Karmakar *et al.*, 2021). European colonists brought parsley to the United States in the 17th century (Karmakar *et al.*, 2021). It is also popular for container-grown plant for limited-spaces. Chopped parsley leaves are a popular decoration in Central Europe (similar to the use of coriander leaves in China, South East Asia and parts of India), mostly for soups and vegetables. The species name Parsley is known for over a thousand year ago in the Mediterranean (Karmakar *et al.*, 2021). Parsley is a popular culinary herb, commercially cultivated as an annual plant in many parts of the world for its attractive and aromatic leaves. Parsley is the most widely cultivated herb in Europe, and the most used herb in the United States. It is used as a garnish rather than a component of the diet. The oil derived from the leaves can also be used in condiments and seasonings (Karmakar *et al.*, 2021). Dehydrated parsley flakes are produced from parsley grown in commercial fields (Karmakar *et al.*, 2021). Parsley has anti-inflammatory, antimicrobial, diuretic and hypoglycaemic properties due to its content of essential oil and phenolic compounds. Apiol, a phenylpropene is responsible for the abortifacient properties of parsley, and the herb may be used to treat menstrual disorders (Karmakar *et al.*, 2021). Bruised leaves have been used to treat tumours, insect bites, lice, skin parasites, and contusions. At one time, parsley tea was used to treat dysentery and gallstones (Karmakar *et al.*, 2021). Other reported traditional uses include treatment of diseases of the prostate, liver, and spleen. Historically, parsley also has been used in the treatment of anaemia, arthritis, and cancers, as an expectorant, antimicrobial, aphrodisiac, hypotensive, diuretic, and laxative. It also has been used as ascalplotionto stimulate hair growth. However, there have been no clinical trials to confirm these uses (Karmakar *et al.*, 2021). Parsley a member of the *Apiaceae* family is a biennial herb belonging to the carrot family (Spence, 2023). It has been cultivated for more than 2000 years though was first used medicinally (Hippocrates introduced it as a diuretic) rather than as a culinary herb (Spence, 2023). The key aromatic compound in parsley is apiol (which is described as having a herby aroma). In terms of its essential oils, parsley contains apiole, myristicin (also found in nutmeg, and smells spice-like), α -pinene, β -pinene and elemicin (Spence, 2023). Others, meanwhile, have detected the presence of myristicin, apiol, 1-allyl-2,3,4,5-tetramethoxybenzene, β -phellandrene, 1,3,8-p-menthatriene (with an odour described as smelling of turpentine, camphor, herbal, woody), β -pinene, terpinolene, apiin, oxypeucedanin and falcariol (Spence, 2023). 17 compounds contributing to the unique aroma of parsley, with p-1,3,8-menthatriene, myrcene, 2-sec-butyl-3-methoxypyrazine, myristicin, linalool, 6-decenal, and 3-hexenal being the most important flavour compounds (Spence, 2023). Just as for a number of other herbs, the exact proportion of each of the various chemical constituents was found to vary depending on the type of species or cultivars as well as cultivation conditions including soil type, weather, irrigation, pruning and other horticultural practices (Spence, 2023). Chopping parsley leaves led to a rapid change in aroma from a terpeny, parsley-like note and an increase in green, grassy and fruity notes (Spence, 2023). Parsley is widely used now, even in many Indian kitchens, especially in the Metros, and in star hotel restaurants. Parsley is a part of the native flora of the temperate and sub-temperate Europe and West Asia, and the Mediterranean regions (Ravindran, 2023). India, it is cultivated on a small scale. It is found naturalized and also grown widely in most temperate and subtropical countries (Ravindran, 2023). The herb is grown mainly for its leaves and seeds and also for the swollen taproot that is characteristic of the variety, turnip-rooted parsley (Ravindran, 2023). It is also a very famous herbal medicine, well known for its

digestive property (Ravindran, 2023). Various cultivar groups of parsley are known, the commonest one is the common parsley (Ravindran, 2023).

Parsley is a popular medicinal plant widely used in different traditional medicines all over the world (Bahramsoltani *et al.*, 2024). Parsley contains volatile compounds such as terpenes and terpenoids in the essential oil, as well as phenolic compounds in the plant extract (Bahramsoltani *et al.*, 2024). Parsley is traditionally used as a diuretic, liver and stomach tonic, and for urolithiasis and indigestion (Bahramsoltani *et al.*, 2024). Pharmacological investigations also confirm several biological activities of parsley including hepatoprotective, nephroprotective, antiurolithiatic, neuroprotective, cardioprotective, and antineoplastic effects in animal and cell-based studies (Bahramsoltani *et al.*, 2024). Parsley has currently demonstrated several pharmacological activities in preclinical studies; however, there is a big lack in clinical evidence (Bahramsoltani *et al.*, 2024). Considering parsley as a possible valuable medicinal food, future clinical trials are recommended to evaluate the clinical efficacy and safety of the plant in different health conditions (Bahramsoltani *et al.*, 2024). Parsley, or garden parsley is a species of flowering plant in the family Apiaceae that is native to the central and eastern Mediterranean region (Sardinia, Lebanon, Israel, Cyprus, Turkey, southern Italy, Greece, Portugal, Spain, Malta, Morocco, Algeria, and Tunisia), but has been naturalized elsewhere in Europe, and is widely cultivated as a herb, and a vegetable (GBIF, 2024). Parsley is widely used in European, Middle Eastern, and American cuisine. Curly leaf parsley is often used as a garnish. In central Europe, Eastern Europe, and southern Europe, as well as in western Asia, many dishes are served with fresh green chopped parsley sprinkled on top. Flat leaf parsley is similar, but it is easier to cultivate, some say it has a stronger flavour (GBIF, 2024). Root parsley is very common in central, eastern, and southern European cuisines, where it is used as a snack or a vegetable in many soups, stews, and casseroles. It is believed to have been originally grown in Sardinia (Mediterranean area) and was cultivated in around the 3rd century BC (GBIF, 2024). Linnaeus stated its wild habitat to be Sardinia, whence it was brought to England and apparently first cultivated in Britain in 1548, though literary evidence suggests parsley was used in England in the Middle Ages, as early as the Anglo-Saxon period (GBIF, 2024). Parsley or garden parsley is a species of flowering plant in the family Apiaceae that is native to the central and eastern Mediterranean region (Sardinia, Lebanon, Israel, Cyprus, Turkey, southern Italy, Greece, Portugal, Spain, Malta, Morocco, Algeria, and Tunisia), but has been naturalized elsewhere in Europe, and is widely cultivated as an herb, and a vegetable (Mindat, 2024).

Parsley, or garden parsley is a species of flowering plant in the family Apiaceae that is native to Greece, Morocco and the former Yugoslavia (Wikipedia, 2024). It has been introduced and naturalized in Europe and elsewhere in the world with suitable climates, and is widely cultivated as an herb and a vegetable (Wikipedia, 2024). It is believed to have been originally grown in Sardinia, and was cultivated in around the 3rd century BC (Wikipedia, 2024). Linnaeus stated its wild habitat to be Sardinia, whence it was brought to England and apparently first cultivated in Britain in 1548, though literary evidence suggests parsley was used in England in the Middle Ages as early as the Anglo-Saxon period (Wikipedia, 2024). Parsley is widely used in European, Middle Eastern, and American cuisine. Curly-leaf parsley is often used as a garnish (Wikipedia, 2024). In central Europe, eastern Europe, and southern Europe, as well as in western Asia, many dishes are served with fresh green chopped parsley sprinkled on top (Wikipedia, 2024). Flat-leaf parsley is similar, but is often preferred by chefs because it has a stronger flavor. Root parsley is very common in central, eastern, and southern European cuisines, where it is eaten as a snack, or as a vegetable in many soups, stews, and casseroles (Wikipedia, 2024). Parsley is a plant from the parsley family (Apiaceae), which is in the vegetable group, and its origin is considered to be the eastern part of the Mediterranean or West Asia (Abbas mirjalili, 2024). Despite the significant production and consumption of this plant in the country, there are few data about the native populations of this plant (Abbas mirjalili, 2024). Several studies have also been conducted with the aim of cultivating parsley and increasing the seed germination percentage of indigenous populations (Abbas mirjalili, 2024).

Parsley, or garden parsley is a species of flowering plant in the family Apiaceae that is native to Greece, Morocco and the former Yugoslavia (Wikiwand, 2024). It has been introduced and naturalized in Europe and elsewhere in the world with suitable climates, and is widely cultivated as an herb and a vegetable (Wikiwand, 2024). Parsley is widely used in European, Middle Eastern, and American cuisine (Wikiwand, 2024). Parsley can add a touch of color and freshness to any dish, especially soups, stews, casseroles, roasts, fish, and meat. Simply chop some fresh parsley leaves and sprinkle them over your dish before serving. You can also use whole parsley sprigs or curly-leaf parsley to decorate your plate or platter (USAR, 2024). As a salad. Parsley can be used as a salad base or a salad ingredient, adding a burst of flavor and texture to your greens. You can use either curly-leaf or flat-leaf parsley, or a combination of both, and toss them with your favorite dressing and toppings. You can also make a classic Middle Eastern salad called tabbouleh, which consists of chopped parsley, mint, tomatoes, onions, bulgur, lemon juice, and olive oil (USAR, 2024). As a sauce. Parsley can be used to make various sauces that can enhance the taste and appearance of your dishes. You can make a green sauce called chimichurri, which is popular in Argentina and Uruguay, and consists of chopped parsley, garlic, oregano, vinegar, and oil. You can use this sauce to marinate or serve with grilled meat, poultry, or fish. You can also make a lemony sauce called gremolata, which is popular in Italy, and consists of chopped parsley, garlic, and lemon zest. You can use this sauce to serve with braised meat, especially veal or lamb (USAR, 2024). As a pesto. Parsley can be used to make a delicious and nutritious pesto that can be used as a spread, a dip, or a pasta sauce. You can make a parsley pesto by blending parsley leaves, garlic, nuts, cheese, and oil in a food processor or a blender. You can use any nuts you like, such as walnuts, almonds, or pine nuts, and any cheese you like, such as Parmesan, Romano, or feta. You can also add other herbs, such as basil, mint, or cilantro, to your parsley pesto for more flavour (USAR, 2024). As a tea. Parsley can be used to make a refreshing and soothing tea that can have various health benefits. You can make a parsley tea by steeping fresh or dried parsley leaves in hot water for about 10 minutes. You can add honey, lemon, or ginger to your parsley tea for more flavor and sweetness. You can drink parsley tea hot or cold, and enjoy its diuretic, anti-inflammatory, and antioxidant properties (USAR, 2024). Parsley is one of the most widely used herbs in the world, but it is often overlooked or underestimated for its culinary and health benefits (USAR, 2024). Parsley is not only a delicious and colorful garnish, but also a rich source of vitamins, minerals, antioxidants, and phytochemicals that can

enhance the flavor and nutrition of your dishes (USAR, 2024). Parsley has a long and interesting history that dates back to ancient times. According to some sources, parsley originated in the Mediterranean region of southern Europe and western Asia, where it grew wild on rocks and cliffs. The name “parsley” comes from the Greek word “petroselinon”, meaning “rock celery” (USAR, 2024). Parsley was used by the ancient Greeks and Romans for various purposes, such as flavoring food, making wreaths, and honoring the dead. The Greeks associated parsley with death and misfortune, as they believed it sprang from the blood of a mythical hero named Archemorus, who was killed by a serpent. They also used parsley to crown the winners of athletic games and to decorate the tombs of their ancestors (USAR, 2024). The Romans, on the other hand, valued parsley for its medicinal and culinary uses. They used parsley to freshen their breath, to treat digestive disorders, to stimulate menstruation, and to prevent intoxication. They also used parsley to season their food, especially fish and meat dishes (USAR, 2024). Parsley spread to other parts of the world through trade and conquest. It was introduced to Britain by the Romans, to Germany by the Charlemagne, and to the Americas by the Spanish and Portuguese colonists. Parsley became popular in various cuisines and cultures, and was used for both culinary and medicinal purposes (USAR, 2024). Parsley, a vital culinary and medicinal herb from the Apiaceae family, boasts significant nutritional and therapeutic benefits (Roy *et al.*, 2025). Originated from the Mediterranean region, this wonderful herb is a coffer of many phenolic compounds and flavonoids such as apigenin and apiin, essential oils primarily consisting of myristicin and apiol, as well as coumarins (Roy *et al.*, 2025). Genetic resources of parsley are considerably represented in ex situ collections worldwide, and the passport data can be retrieved from several database sources (Roy *et al.*, 2025). Genetic diversity of this crop needs to be conserved with immediate attention to avoid genetic erosion (Roy *et al.*, 2025). Decades of breeding efforts in parsley including selection and interspecific and intervarietal hybridization have led to the development of numerous high-yielding cultivars with biotic stress tolerance and enrichment in essential oil (Roy *et al.*, 2025). Despite these achievements, the production potential of parsley of different categories remains significantly low (Roy *et al.*, 2025). The growing demand for high and sustainable parsley production drives the scientific communities to increase breeding efficiency, ensuring a continuous supply of improved cultivars (Roy *et al.*, 2025). Integration of conventional breeding strategies with cutting-edge molecular breeding tools deploying genomic resources can pave the way for cultivar development in shortest possible time (Roy *et al.*, 2025). Pressing need has been felt to enrich the genomic resources vis a vis genetic resources toward development of high-yielding parsley cultivars with key adaptive traits against the climatic vagaries along with nutritional benefit and therapeutic importance (Roy *et al.*, 2025).

In this review article on Origin, Taxonomy, Botanical Description, Genetic Diversity, Breeding and Cultivation of Parsley are discussed.

ORIGIN AND DISTRIBUTION

Originated in the Mediterranean (possible Sardinia) around 2,000 years ago. It is now of cosmopolitan distribution although found chiefly in north temperate regions (Rademaker, 1999). Originating in the Mediterranean, the vitamin-C rich parsley plant is commonly used in the cuisine of Italy, Greece, and other European and Middle Eastern countries (Class, 2021).

The plant is of European (probably West Mediterranean) origin. Commonly, two different varieties are grown *viz.*, root parsley (var. *tuberosum*) which has a tender, edible root (used as aromatic vegetable), and leaf parsley, solely cultivated for its leaves for use as a garnish. According to Linnaeus, wild habitat of parsley is Sardinia, from where it was brought to England and apparently first cultivated there in 1548 while Bentham considered it a native of the Eastern Mediterranean regions and DeCandolle reported Turkey, Algeria and the Lebanon to be its home. Since its introduction into these islands in the sixteenth century it has been completely naturalized in various parts of England and Scotland. The Greeks held parsley in high esteem, crowning the victors with chaplets of parsley at the Isthmian games, and making with its wreaths for adorning the tombs of their dead. Parsley is believed to be native to southern Europe, but it is now found throughout the world. It has been grown in Britain since at least the 16th century. Parsley has now become naturalized throughout Europe, North America, the West Indies, Algeria and Lebanon. Being a native plant of Mediterranean region and is symbolic of victory and dedicated to Zeus. Parsley also was associated with the goddess Persephone, who was kidnapped by Hades but allowed leave the underworld to return to the earth's surface in spring and summer (Karmakar *et al.*, 2021). Origin of parsley are Southern Europe, eastern Mediterranean (Growables, 2024). Both the crowded, dense-leaved type and the broad open-growing type were described in the 4th century B.C. Parsley was introduced into England from Sardinia in 1548. European colonists brought parsley to the United States in the 17th century, and it continues to be a popular garden vegetable nationwide. Parsley cultivated everywhere for its leaves, seeds and roots. It is grown throughout Florida, both as a commercial crop of minor importance in the vegetable producing areas of central and south Florida, and in gardens from Key West to Pensacola (Growables, 2024).

It is introduced in to Albania, Argentina Northeast, Argentina Northwest, Argentina South, Arkansas, Austria, Azores, Balears, Baltic States, Belarus, Belgium, Bermuda, Brazil South, Bulgaria, California, Canary Is., Cape Provinces, Cape Verde, Central European Russia, Comoros, Connecticut, Corse, Costa Rica, Crozet Is., Czechoslovakia, Denmark, Dominican Republic, East European Russia, Ecuador, Egypt, El Salvador, Finland, Florida, France, Georgia, Germany, Gilbert Is., Great Britain, Guatemala, Gulf of Guinea Is., Haiti, Hawaii, Hungary, Idaho, Inner Mongolia, Iowa, Iran, Ireland, Italy, Kansas, Kazakhstan, Kriti, Krym, Laos, Leeward Is., Libya, Louisiana, Madeira, Marianas, Marshall Is., Maryland, Massachusetts, Mauritius, Mexico Central, Michigan, Mississippi, Mongolia, Montana, Nevada, New Jersey, New York, Newfoundland, North Carolina, Northwest European Russia, Norway, Ohio, Ontario, Pennsylvania, Peru, Poland, Portugal, Puerto Rico, Rhode I., Rodrigues, Romania, Réunion, Sardegna, Sicilia, Sinai, South Carolina, South European Russia, Spain, St.Helena, Sweden, Switzerland, Tadzhikistan, Tasmania, Texas, Trinidad-Tobago, Tristan da Cunha, Tunisia, Turkey, Turkey-in-Europe, Ukraine, Utah, Uzbekistan, Vietnam, Washington (POWO, 2024).

It is believed to have been originally grown in Sardinia, and was cultivated in around the 3rd century BC. Linnaeus stated its wild habitat to be Sardinia, whence it was brought to England and apparently first cultivated in Britain in 1548, though literary evidence suggests parsley was used in England in the Middle Ages as early as the Anglo-Saxon period (Wikiwand, 2024). Although parsley is thought to have originated in the Mediterranean it is one of the most widely grown herbs in the world today. The Romans introduced the herb to Britain during their rule and it was subsequently taken by the early immigrants to the Americas some centuries later (Hillvale, 2024). Parsley is a native of Sardinia and is widely cultivated in the Mediterranean region and the USA. It also grows in Mexico, Dominican Republic, Canada, West Germany, Haiti, France, Hungary, Belgium, Italy, Spain and Yugoslavia. Parsley is a cold weather crop, growing best in rich, moist soil. In India it grows better at higher altitudes (Indianspices, 2025).

TAXONOMY

Umbelliferae or Carrot family. Also known as the Apiaceae, this family is made up of 2850 species in 275 genera (Rademaker, 1999). *Petroselinum* is a genus of two parsley species of flowering plants in the family Apiaceae, native to western and southern Europe and northern Africa. Plants of this genus are bright green, hairless, biennial and herbaceous; they are rarely annual plants. In the first year, they form a rosette of pinnate to tripinnate leaves and a tap root used as a food store over the winter. In the second year they grow a flowering stem up to 1 m tall with sparser leaves and umbels of white or pinkish to yellowish-green flowers. The generic name comes from rendering the Greek word *πετροσέλινον* *petroselinon* "rock-celery" into Latin, from *petra* "rock, stone" and *selinon* "celery". Mycenaean Greek *se-ri-no*, in Linear B, is the earliest attested form of the word *selinon*. The species of this genus are: 1) *Petroselinum crispum* (garden parsley) from southern Europe and northern Africa (southern Italy, Greece, Algeria, Tunisia). It is an important culinary herb, widely used for flavouring and as a vegetable. And 2) *Petroselinum segetum* (corn parsley) from western Europe (Great Britain and the Netherlands south through France to Italy, Spain and Portugal). It is edible with a similar flavour like garden parsley, but it is not widely cultivated. It occurs in grassland, hedgerows, and river banks. In Great Britain, it is confined to lowland regions in southern and central England and southern Wales, and is scarce and declining due to agricultural intensification. It has narrower, more lanceolate leaves than garden parsley, only single pinnate, not tripinnate.

Synonym (Rademaker, 1999).

Petroselinum crispum (syn. *Apium petroselinum*,
Carum petroselinum,
Petroselinum hortense,
Petroselinum sativum,
Petroselinum vulgare)

Synonyms (Plantaedb, 2024).

Ligusticum peregrinum
Petroselinum thermoeri
Petroselinum anatolicum
Peucedanum petroselinum
Peucedanum intermedium
Petroselinum selinoides
Petroselinum sativum
Petroselinum romanum
Petroselinum petroselinum
Petroselinum hortense
Petroselinum peregrinum
Sison peregrinum
Sium oppositifolium
Sium petroselinum
Selinum petroselinum
Siler japonicum
Apium petroselinum var. *angustifolium*
Petroselinum crispum var. *angustifolium*
Ammi petroselinoides
Anisactis segetalis
Apium crispum
Apium laetum
Apium latifolium
Apium latifolium
Apium occidentale
Apium peregrinum
Apium petroselinum
Apium tuberosum
Apium vulgare

Bupleurum petroselinoides
Carum peregrinum
Carum petroselinum
Carum vulgare
Cnidium petroselinum
Petroselinum crispum f. *vulgare*
Petroselinum crispum f. *variegatum*
Petroselinum crispum f. *angustifolium*
Petroselinum sativum var. *variegatum*
Petroselinum crispum var. *vulgare*
Apium petroselinum var. *vulgare*
Apium petroselinum var. *variegatum*
Petroselinum sativum var. *vulgare*
Petroselinum vulgare
Wydleria portoricensis
Petroselinum hortense f. *tenuisectum*
Petroselinum crispum f. *tenuisectum*
Petroselinum crispum f. *radicosum*
Petroselinum crispum f. *breve*
Petroselinum crispum subsp. *tuberosum*
Petroselinum sativum var. *hispanicum*
Petroselinum sativum var. *breve*
Petroselinum sativum var. *longum*
Petroselinum sativum var. *silvestre*
Petroselinum crispum var. *petroselinum*
Petroselinum crispum

Synonyms (wikipedia, 2024a).

<i>Apium</i>	<i>crispum</i>	Mill.
<i>Apium</i>	<i>petroselinum</i>	L.
<i>Petroselinum hortense</i> Hoffm.		

Synonyms (Botanica, 2024).

Apium crispum Mill.
Apium hortulanum Brunfels
Apium laetum Salisb.

Synonyms (Growables, 2024).

Apium crispum Mill.,
A. petroselinum L.,
Carum petroselinum (L.) Benth. & Hook. f.,
P. hortense Hoffm.,
P. sativum Hoffm.,
P. vulgare Lagasca..

Synonyms (Pharm, 2024).

Apium crispum Mill.,
Apium petroselinum L.,
Carum petroselinum (L.) Benth. & Hook. f.,
Petroselinum crispum (Mill.) Mansf.,
Petroselinum crispum (Mill.) Nyman,
Petroselinum hortense Hoffm.,
Petroselinum hortense var. *crispum* L.H. Bailey,
Petroselinum petroselinum (L.) H. Karst.,
Petroselinum sativum Hoffm.,
Petroselinum vulgare Lag.,
Selinum petroselinum (L.) E.H.L. Krause

Homotypic Synonyms (POWO, 2024).

Apium crispum Mill. in Gard. Dict.,
Carum petroselinum var. *crispum* (Mill.) Beck
Petroselinum hortense var. *crispum* (Mill.) L.H.Bailey
Petroselinum sativum var. *crispum* (Mill.) Gaudin
Petroselinum vulgare var. *crispum* (Mill.) Gray

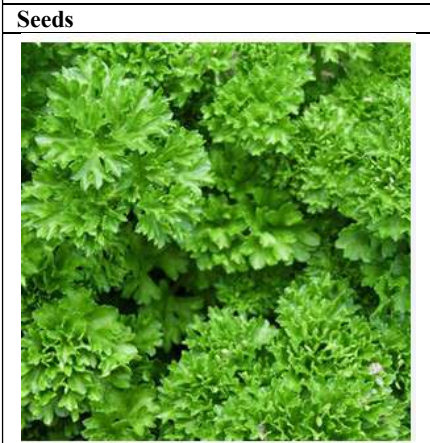
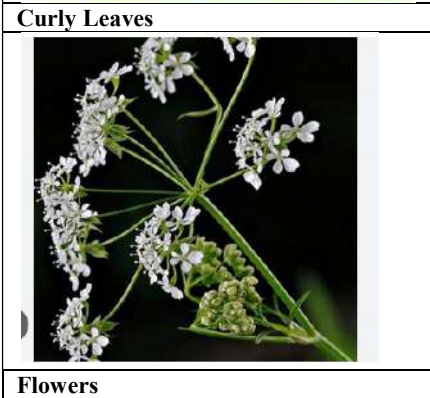
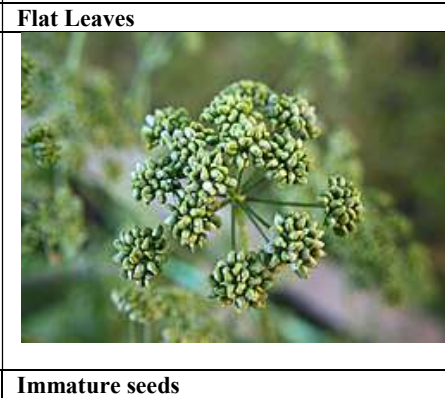
BOTANICAL DESCRIPTION

Parsley is a clump-forming biennial growing to about 30 cm high and twice as wide. It has bright green multi-compound curly or flat leaves. The leaflets are finely divided and held at the end of long stems and the whole plant has a rounded, mound-like shape. In its second summer, parsley sends up stalks with compound umbels of small yellow flowers. There are three types of commonly used parsley: flat leafed or French Parsley (*Petroselinum crispum* French), normal parsley and Hamburg Parsley (*Petroselinum crispum* var. *tuberosum*) (Rademaker, 1999). The erect-growing parsley reaches a height of 0.30–0.46 m and has green leaves and greenish-yellow flowers in compound umbels. The seeds are smooth, ribbed and ovate. Two different varieties are commonly grown, e.g. root parsley (var. *tuberosum*), which has a tender, edible root (used as an aromatic vegetable) and leaf parsley, cultivated solely for its leaves (var. *latifolium* – broad-leaved; var. *crispum* – curly-leaved) for use as a garnish. It is propagated by planting seeds, which are sown about 6 mm deep and covered with a thin mulch layer until germination, which occurs in 7–12 days. The seedlings may be transplanted later. The plants are spaced 5–8 cm apart in rows, 0.30 m apart. Parsley requires a very moist soil and careful weeding is necessary (Azeez and Parthasarathy, 2008). Parsley is an upright, much branched plant, reaching heights of 0.8 m with green leaves and yellow greenish flowers growing in clusters extending from the main stem. Parsley has thin, spindle-shaped roots, with erect, grooved, glabrous, angular stems. The upper leaves are dark green and divided pinnately into featherlike-sections. The lower leaves are bi- or tritenately divided. The small greenish yellow flowers have five petals on compound umbels. The dried leaves mostly consist of leaf fragments with the stem pieces removed. The epidermis on both leaf surfaces is undulate-sinuate, only straight-walled above the nerves, axially stretched with distinctly striated cuticula. The lower epidermis has anomocytic stomata. Trichomes are absent. The fresh roots are yellowish, carrot-shaped, with yellowish-white to reddish-yellow cross-section. The cut and dried root consists of yellowish-white to reddish-yellow pieces with roughly wrinkled surface; in the bark, dark brown and shiny oil cells are present, the xylem is lemon yellow on the outside and white on the inside. In the bark, dark brown, shiny oil ducts are visible and the xylem especially is radially striate with brown medullary rays. The seeds are roundish, ovoid to pear-shaped, strongly laterally compressed, greenish grey to greyish brown double achenes readily split along the commissural surface to give the somewhat sickle-shaped mericarps which are up to 2 mm long and 1–2 mm broad (Charles, 2012a). The leaves are compound, alternately arranged, and are divided into two to three leaflets and the plant can grow to over 1 m tall, and as an annual (in tropical regions) or a biennial crop (in temperate areas). The typical flowering period is in the warmer months and the ideal temperature for pollination and seed production is 29–30°C. The roots are a faint yellow color and carrot shaped. They can grow upto 20 cm in length and 5 cm in width. Hamburg root parsley has larger roots and is commonly used in European cuisine. Parsley is mainly a biennial crop plant. In green house or warmer regions, it can be grown as semi-perennial. There are annual accessions also reported in the gene pool, which need not required vernalization for flowering. Accessions with biennial nature have vegetative growth first with rosette of leaves. The length of the tripinnate leaves with numerous leaflets varies in a wide range inside the species from around 8 to 25 cm. Generally, the leaves of var. *crispum* are shorter while var. *neapolitanum* has longer leaf (Karmakar *et al.*, 2021). After the exposure of first winter, the flowering stalk in biennial parsley will emerged immediately. The leaves of the flower stalk are smaller with simplified pinnation. Flowering plants may reach a height of 60–120 cm. At the end of the stalk umbels of different ranks are formed. Inside the umbels, a time gradient exists with the oldest partial inflorescences at the external circle and the younger unripe flowers in the internal circles. Such a gradient exists also inside the partial inflorescences, which group flowers arising from the same point. Each flower has five petals. The colour of petals varies between accessions from green to white. Protandry is common in the family Apiaceae and occurs in parsley as well. The five anthers start anthesis around 5 days before the two stigmata are receptive to pollen. At the time of receptiveness for pollination, the receptacle nectarines produce a sugar-rich liquid for rewarding pollinating insects. At this time, the flower gets shiny and the stigmatic papillae reach the length of flower radius. In a flower two carpels are fused to a bicarpellate pistil from which the schizocarpic fruits develop. The mature fruits can break into two mericarps of one single fruit (Karmakar *et al.*, 2021).

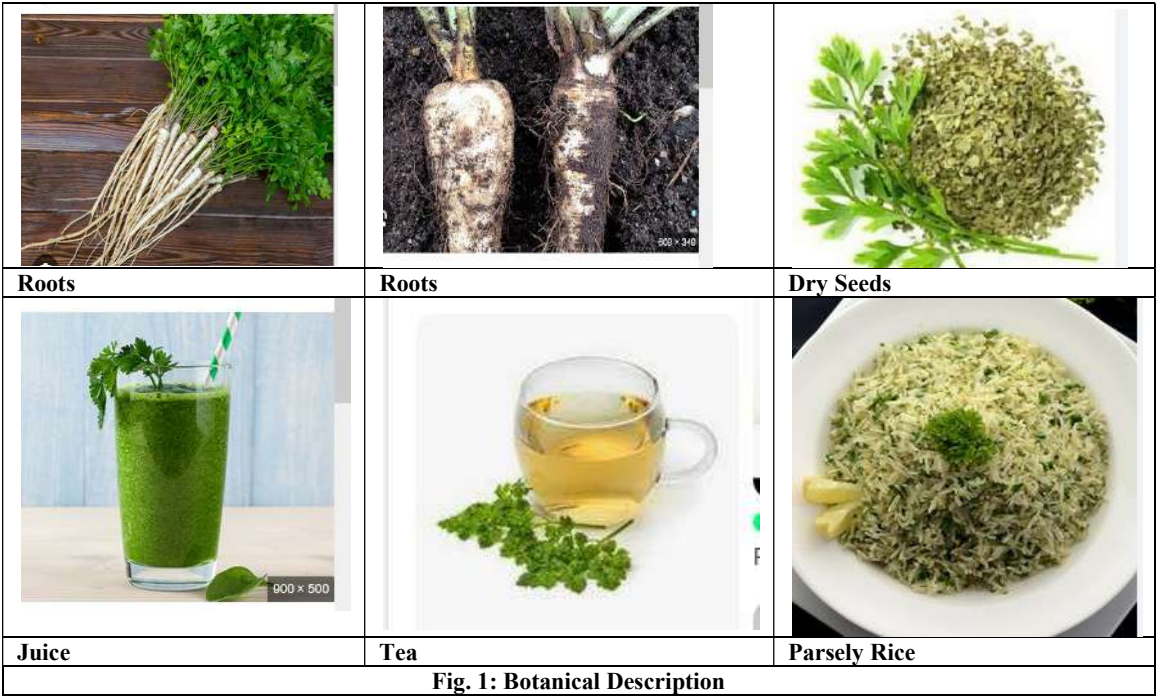
Garden parsley is a bright green, biennial plant in temperate climates, or an annual herb in subtropical and tropical areas. Where it grows as a biennial, in the first year, it forms a rosette of tripinnate leaves 10–25 cm long with numerous 1–3 cm leaflets, and a taproot used as a food store over the winter. In the second year, it grows a flowering stem to 75 cm tall with sparser leaves and flat-topped 3–10 cm diameter umbels with numerous 2 mm diameter yellow to yellowish-green flowers. The seeds are ovoid, 2–3 mm long, with prominent style remnants at the apex. One of the compounds of the essential oil is apiol. The plant normally dies after seed maturation (GBIF, 2024). 40-80 cm biennial plant, glabrous, shiny, aromatic. striated stem, rowing. triangular leaves in their periphery. bi-bi-sternized lowers, with ovalesoval corner segments, incised - toothed, usually upper with 3 whole segments, lanceolate – linear. flowers of a yellowish green, in ombelleslong umbulules, with equal radii. thoughtful styles, longer than the convex stylopode. subglobulous, aromatic fruit (Botanica, 2024). Parsley is a bright green, versatile herb that looks good growing and tastes good too. Parsley contains vitamins A, C, and K as well as several B vitamins, calcium, and iron. The varieties *neapolitanum* (plain, flat, or Italian parsley) and *crispum* (common or curly-leaved) are grown for their leaves, while the lesser-known *tuberosum* ('Hamburg' or turnip-rooted) is grown for its enlarged, edible root as well as for the leaves. During the first year, parsley forms a dense rosette of leaves. In the second year, it develops a 3- to 6-foot stem with small greenish-yellow flowers. Parsley umbels are less dense than those of carrots (Growables, 2024). This common culinary herb grows to 1 m in Europe and China from a taproot. The leaves are spiral and exstipulate. The petiole is of variable length, to 10 cm long and sheathing at the base. The blade is dissected, 5–8 cm×4–10 cm, serrate and aromatic. The inflorescence is an umbel of umbellules, which is 5 cm in diameter. The flowers are minute and white. The fruits are minute and dry achenes (Pharm, 2024). Garden parsley is a bright green, biennial plant in temperate climates, or an annual herb in subtropical and tropical areas. Where it grows as a biennial, in the first year, it forms a rosette of tripinnate leaves 10–25 cm long with numerous 1–3 cm leaflets, and a taproot used as a food store over the winter. In the second year, it grows a flowering stem to 75 cm (30 in) tall with sparser leaves and flat-topped 3–10 cm diameter umbels with numerous 2 mm diameter yellow to yellowish-green flowers. The seeds are ovoid, 2–3 mm long, with

prominent style remnants at the apex. One of the compounds of the essential oil is apiole. The plant normally dies after seed maturation (Wikipedia, 2024). Parsley is a hardy biennial that is usually grown as an annual in the carrot family (Apiaceae). It is native to the Mediterranean area. The genus name comes from the Greek words for rock and celery because it was often found in rocky Greece hillsides. The specific epithet means crinkled or closely curled. Parsley prefers consistently moist, well-drained rich soil in full sun or light shade. They grow better in cool summer areas and can wilt in the hot humid deep South. It is easier to grow from seedlings because the germination period is long. Plant seedlings after the spring frost 8-12” apart. You can start seeds indoors before the spring frost or outdoors after the spring frost or midsummer. Minimize disturbance of the taproot when transplanting the parsley. They grow about a foot tall the first year. They grow 2-3 feet and produce a greenish-yellow flower and seeds the second year. The parsley may reseed itself after the second year. The leaves are not as flavorful when it flowers. You can over winter parsley inside before the temperatures drop to the 20s. When grown indoors, keep it in bright light and water well. Outdoor parsley should be fertilized twice during the growing season and more often if indoors. For continuous growth, snip the outside stalks when harvesting. Parsley can be harvested when they are approximately 8 inches in height (NCSU, 2024). The ancient Greeks used to cover their tombs with wreaths of parsley. Other traditional uses include chewed parsley as a breath freshener, root juice for anti-swelling, tea leaves for digestion, and a poultice for dressing wounds and insect bites. Today, the dark green leaves are widely used as a garnish and flavoring in a variety of foods. The leaves and root can also be dried and used as flavoring. It is high in vitamin A, vitamin C, several of the B complex vitamins and a number of minerals including potassium, iron, copper and manganese. Parsley contains volatile oils like myristicin when could slow down cancer growth. It is also important as a food source for the black swallowtail butterfly larvae. The curly-leaved variety is the most popular and often used as a garnish. The Italian flat-leaf variety has the strongest and sweetest flavor of the varieties. In addition to planting in an edible garden, parsley can be planted with ornamentals. Parsley, especially the curly-leaved variety, can be placed in an ornamental border for architectural interest. If allowed to flower, they look similar to Queen Anne’s Lace and attract butterflies. It can also be planted in containers, hanging baskets, and mass planting (NCSU, 2024).

Botanical description is gikven in Fig. 1.

		
Seeds	12 Day Old Seedlings	Seedlings
		
Curly Leaves	Flat Leaves	Leaves
		
Flowers	Immature seeds	Plants

Continue



Pollination

Cross-Pollination Cross-pollination involves the transfer of pollen between flowers of different plants. This process is vital for increasing genetic diversity, which enhances the resilience of the plants. Supporting cross-pollination is essential for a thriving ecosystem. It leads to better crop yields and healthier plants, making it a key consideration for any gardener looking to maximize their harvest (Rankel, 2024).
Description of Flower Parts Parsley flowers are arranged in an umbelliferous structure, showcasing clusters of small white or yellow blooms. Each flower typically features five petals, which can be either white or yellow, creating a delicate appearance. The sepals are small and green, often going unnoticed. Each flower contains five stamens that produce pollen, while the central pistil houses the ovary, crucial for seed development (Rankel, 2024).
Role in Pollination The nectar-rich flowers of parsley are designed to attract pollinators, making them a vital part of the ecosystem. Their arrangement allows easy access for various pollinator species, ensuring effective pollen transfer. This accessibility not only supports the pollinators but also enhances the overall health of the parsley plants. By fostering a welcoming environment for these creatures, gardeners can significantly improve their crop yields. As we delve deeper into the pollination process, understanding these flower structures will help you appreciate the intricate relationships between plants and their pollinators (Rankel, 2024).
Mechanisms of Self-Pollination Self-pollination occurs when pollen from the anthers falls onto the stigma of the same flower. This process typically happens on warm, sunny days, requiring minimal wind or insect activity. For gardeners, self-pollination offers a reliable method for seed production, especially in isolated conditions. It ensures that even without external pollinators, your parsley plants can thrive (Rankel, 2024).
Role of Pollinators in Cross-Pollination Cross-pollination involves the transfer of pollen between flowers of different plants, and it relies heavily on pollinators. The primary pollinators for parsley are bees and butterflies, both of which play a crucial role in this process. Bees are particularly effective as they forage for nectar, inadvertently transferring pollen from one flower to another. Butterflies, attracted by the nectar, also contribute to this vital exchange. Parsley attracts these pollinators through its nectar-rich flowers and their visibility. This not only enhances genetic diversity but also supports a healthier ecosystem. Understanding both self-pollination and the role of pollinators can significantly boost your gardening success. With this knowledge, you can create a thriving environment for your parsley plants (Rankel, 2024).
Hand Pollination Hand pollination is a valuable technique for gardeners looking to ensure successful seed production in parsley. It's particularly useful when natural pollinators are scarce or when you want to control the pollination process for specific traits (Rankel, 2024).
Step-by-Step Instructions (Rankel, 2024). 1. Identify flowers ready for pollination: Look for open flowers with visible stamens and pistils. These are the indicators that the flower is mature and ready for the process. 2. Collect pollen: Use a small brush or cotton swab to gently collect pollen from the anthers. This step requires a delicate touch to avoid damaging the flower. 3. Transfer pollen: Carefully apply the collected pollen to the stigma of another flower. This ensures that the pollen reaches the female part of the flower for fertilization. 4. Timing: The best time to perform hand pollination is during the morning when flowers are fully open. This maximizes the chances of successful pollination.
Identifying Male and Female Parts (Rankel, 2024). Understanding the flower's anatomy is crucial for effective hand pollination. - Male parts: The anthers are the pollen producers, typically found at the tips of the stamens - Female parts: The stigma is the receptive part that collects pollen. To distinguish between the two, look for the anthers' yellow or orange pollen grains and the sticky surface of the stigma. This knowledge will empower you to pollinate effectively and enhance your parsley's growth. With these steps, you can take charge of your parsley's pollination process, ensuring a bountiful harvest. Next, let's explore how to support pollinators in your garden to create a thriving ecosystem.
Creating a Pollinator-Friendly Environment (Rankel, 2024). Attracting pollinators is essential for a thriving garden. Start by planting a variety of flowering plants that bloom at different times throughout the season. This diversity ensures that there are always flowers available for pollinators. Additionally, providing water sources and shelter can make your garden a haven for these crucial creatures.

GENETICS AND CYTOGENETICS

The somatic chromosome number of parsley is $2n = 2x = 22$ (et al., 2021). Parsley (*Petroselinum crispum*) has 11 pairs of chromosomes, meaning it is a diploid species with a total of 22 chromosomes ($2n = 2x = 22$). These chromosomes include 5 pairs of metacentric, 5 pairs of submetacentric, and 1 pair of acrocentric chromosomes. The chromosomes are primarily medium-sized, ranging from 1.7 μm to 10.2 μm in length. We report the chromosome-level genome sequence of parsley, consisting of 1.85 Gb that mainly arose from the expansion of long terminal repeats. Whole-genome bisulfite sequencing revealed a significantly higher number of hypermethylated differentially expressed genes in leaf blades and petioles than in root tissues. Moreover, we identified and characterized *chalcone isomerase* (*CHI*) genes, encoding key enzymes involved in apigenin biosynthesis in parsley. We also established that the APETALA2 family transcription factor *Pcrispum_6.2855* (*PcAP2*) binds to the (*Pcrispum_11.4764*) *PcCHI* promoter and promotes apigenin accumulation. In conclusion, our work presents a multiomics data resource for understanding apigenin biosynthesis and its transcriptional regulation in parsley, in addition to shedding light on the evolution of parsley within the Apiaceae (Hui Liu et al., 2025).

GENETIC DIVERSITY

The preservation of the genetic variability at the crop plants is an important premise for a long durable agriculture. Romania still has an important genetic diversity at the crop plants. Unfortunately in Romania the risk of this diversity disappearance is very big due to the age of the seeds producers and the big surface of unused land. During 2007-2009, at University of Agricultural Sciences and Veterinary Medicine (USAMV) from Cluj-Napoca a series of actions for collecting vegetable seeds, for description from agronomical, biological and biochemical point of view of authentic local varieties, for producing and preserving seeds in the Gene Bank of Suceava have been undertaken. Investigations were made in 26 counties of the country but the experimental fields were placed at USAMV Cluj-Napoca. In this work paper are briefly presented the main characteristics of the local varieties of parsley. Among the 64 studied cultivars, 54 (85.7%) proved to be local varieties and among these 5.5% are used for leaves, 20.4% for roots and 74.1% have mixt destinations (Maxim et al., 1970). The German parsley (*Petroselinum crispum* [Mill.] Nyman) germplasm collection (220 accessions) was cultivated at two different places in order to study the variability and biodiversity of the collection. With the help of a descriptor a standardized morphological characterisation of the accessions was done. 14 curled, 169 smooth and 25 root parsleys were found. 12 accessions were a mix of smooth and curled parsleys. Differences in the 1000 grain weight and in the flowering time of the morphological types could be detected. However, the measurement of the chlorophyll content was not an appropriate method to distinguish between the morphological types. Different molecular markers were used to explain the relationship between the accessions. All root parsleys form a cluster together with some smooth leaf parsleys, the other smooth and curled parsleys appear in a second cluster. Furthermore, the composition of the essential oil and the volatile compounds were analysed. The content of myrcene and β -phellandrene can be correlated with root parsley and leaf parsley, respectively. For the volatile compounds two groups could be defined which correlate with the molecular clusters. In conclusion, a very well characterised parsley collection will be available for further breeding purposes (Lohwasser et al., 2010).

In order to evaluate the genetic diversity some native populations of parsley Iran, 21 parsley populations which collected from different regions Some of morphological .of Iran and cultured as an augmented design in Shahid Chamran University of Ahvaz and (Chlorophyll content ,Seed weight ,fresh and dry weight ,plant height ,Time of emergence)characteristics including caro)antiPropertiestenoids, vitamin c, catalas and proxidase) of these populations were evaluated. The analysis of variance showed that there was significant differences between genotypes in morphological characteristics and carotenoid. The principal component analysis declared four components which accounted 68.35 percent of total variation. Cluster analysis using the UPGMA classified populations to 3 main groups. The first group with shortest mean of emergence, highest mean fresh and dry weight per plant, and maximum amount of vitamin C and proxidase activity and catalase compared to other groups as compatible the populations are introduced in the Ahwaz conditions. A total can be of the diversity among the native populations of parsley as a valuable genetic resource for the breeding works (Ansari et al., 2014). This study was performed to evaluate the information and efficiency of SRAP marker for estimating genetic diversity in 15 Iranian parsley stands. Amplification of gene loci was performed using four SRAP primer compounds. The highest and lowest number of polymorphic bands formed were Me2-Em5 and Me4-Em1 primers, respectively. The average number of polymorphic bands per primer combination was 8.25. Cluster analysis of molecular traits based on Jaccard similarity coefficient and Neighbor-Joining algorithm divided the studied populations into five groups at a genetic distance of 0.06. Finally, the results of this study showed that there is a great genetic diversity among the populations collected from several geographical regions of Iran and this study showed the usefulness of SRAP marker in determining the genetic diversity among parsley populations (Nasiri et al., 2015). This study was performed to evaluate the information and efficiency of SRAP marker for estimating genetic diversity in 15 Iranian parsley stands. Amplification of gene loci was performed using four SRAP primer compounds. The highest and lowest number of polymorphic bands formed were Me2-Em5 and Me4-Em1 primers, respectively. The average number of polymorphic bands per primer combination was 8.25. Cluster analysis of molecular traits based on Jaccard similarity coefficient and Neighbor-Joining algorithm divided the studied populations into five groups at a genetic distance of 0.06. Finally, the results of this study showed that there is a great genetic diversity among the populations collected from several geographical regions of Iran and this study showed the usefulness of SRAP marker in determining the genetic diversity among parsley populations (Khadijeh Nasiri et al., 2015). Parsley exhibits both phytochemical and genetic variation, with studies using molecular markers like iPBS and ISSR revealing genetic diversity within and between different parsley genotypes, which can be used in breeding programs. Researchers use molecular markers like iPBS (Inter Primary Binding Site) and ISSR (Inter Simple Sequence Repeat) to assess genetic diversity in parsley. Studies have shown that there is variation in the phytochemical parameters and genetic structure of different parsley cultivars. ResearchGate study found that among 64 studied cultivars, 54 (85.7%) were local varieties. Some studies have found that landraces (local varieties) exhibit higher levels of genetic

diversity compared to commercial cultivars. MDPI study found that the polymorphism rate was 31.9%, the mean PIC (Polymorphic Information Content) was 0.17, and the similarity coefficients were between 0.87 and 0.99. Parsley genotypes can differ in their phytochemical properties, which can be revealed through molecular characterization. Studies have identified markers related to phytochemical properties, indicating that certain parsley genotypes are richer in certain compounds. Understanding the genetic diversity of parsley is crucial for breeding programs. Identifying genotypes with desirable traits (e.g., specific phytochemical profiles) can lead to the development of improved parsley varieties. ProQuest study concluded that the Turkish parsley germplasm can serve as an important source of genetic material for plant breeding and selection (Anastasia *et al.*, 2021). Parsley, a vegetable whose leaves are consumed, has many benefits for human health. The first step of parsley breeding is the characterization of existing genotypes. In this study, genetic diversity of 12 different parsley genotypes was determined by ISSR (Inter Simple Sequence Repeat) marker system. In the study, 41 of the 130 bands obtained from 16 ISSR primers were found to be polymorphic. The similarity coefficients ranged from 0.86–0.99 for ISSR. The average polymorphism was 31.5% and the number of bands varied between 4 and 14. While the genotypes that are genetically closest to each other were determined as the 5th and 6th genotypes, the most distant genotypes were the 3rd and 8th genotypes. Findings from the present study showed that there were genetic variations among the parsley genotypes examined. The obtained data will enable more effective utilization of the parsley genotypes, the genetic differences of which have been determined for the future breeding programs (Coşkun *et al.*, 2023a). A molecular genetic diversity study was conducted on 10 Iranian populations of *P. crispum* using start codon targeted (SCoT) molecular markers to investigate infraspecific genetic diversity and population structure. The nuclear genomes extraction were performed using the cetyltrimethylammonium bromide (CTAB) protocol, then amplified using 10 SCoT primers. We found a large amount of population genetic differentiation index (G_{ST}) and total genetic difference in the pooled populations (H_T) among the examined populations, which were supported by H_S , N_M . Additionally, we detected a significant genetic diversity ($\Phi_{IPT} = 0.755$, $P = 0.001$) among the populations and their individuals by the analysis of molecular variance (AMOVA) test, in which its great proportion was assigned to among populations. We detected the largest amounts of genetic polymorphism in populations 1 and 5, while a reverse condition was observed for population 7. We found four genotype groups among the populations that was similar with phylogeographic mapping. The level of genetic divergence between populations (Φ_{IPT}) of each genotype was relatively low. This species produce protandrous florets and cross-pollination plays a significant role in seed production. Therefore, the genetic structure of genotypes must be heterogeneous. In Iran, the genetic structure of all genotypes was nearly homogenous which resulted from a flat rate of gene flow, which agreed with our estimated amount of N_M (0.13). We supposed a range of isolation mechanisms including, isolation by distance, isolation by environment, isolation by ecology, and isolation by resistance act as driving forces to create high genetic differentiation among the parsley populations. These genotypes can be used for future genetic and breeding research to develop new cultivars can survive under biotic and abiotic stresses and yield high biomass (Talebi *et al.*, 2024). Studies using molecular markers like Inter-Simple Sequence Repeat (ISSR) have shown that while there is variation in phytochemical parameters and genetic structure among different parsley cultivars, overall genetic diversity can be low (Anonymous, 2024). The native populations of Jafari have considerable genetic diversity in terms of quantitative traits. Evaluation of morphological traits in plant taxa is a preliminary step in character recognition. The present study showed that there is a diversity of morphological traits in these populations and this diversity is of particular importance in breeding programs, but the confirmation of this diversity requires more detailed studies including molecular and cytological studies (Abbas Mirjalili, 2024).

BREEDING

Genetic Resources: Genetic resources of parsley are considerably represented in ex situ collections worldwide, and the passport data can be retrieved from several database sources. However, the genetic diversity of this crop needs to be conserved with immediate attention to avoid genetic erosion. Decades of breeding efforts in parsley including selection and interspecific and intervarietal hybridization have led to the development of numerous high-yielding cultivars with biotic stress tolerance and enrichment in essential oil. Despite these achievements, the production potential of parsley of different categories remains significantly low. The growing demand for high and sustainable parsley production drives the scientific communities to increase breeding efficiency, ensuring a continuous supply of improved cultivars. Integration of conventional breeding strategies with cutting-edge molecular breeding tools deploying genomic resources can pave the way for cultivar development in shortest possible time. Pressing need has been felt to enrich the genomic resources vis a vis genetic resources toward development of high-yielding parsley cultivars with key adaptive traits against the climatic vagaries along with nutritional benefit and therapeutic importance. The present chapter delves with the current status of genetic and genomic resources, conventional breeding interventions extended for parsley improvement program, and the future applications of omics that enabled breeding approaches and transgenic tools to develop more resilient high-yielding parsley cultivars to meet the future goals (Roy *et al.*, 2025a).

Breeding Objectives: Breeding of parsley is carried out with the objectives of improving the essential oil content and resistance to major pests and diseases besides improved yield. For many crops, yield and its contributing parameters are of main interest. This principle is also useful for parsley. Breeding objectives of this group for leaf production are size of yield, amount of marketable yield, essential oil content, fast re-growth after cutting, color of leaves, crimping of the leaf blade tissue between the secondary veins, relation of leaves to stalk, height and density of plants. Breeding objectives for turnip-rooted Parsley are yield of taproots, length and diameter of the taproot and a smooth taproot (Karmakar *et al.*, 2021).

Methods of Breeding: Two breeding methods are followed viz., Hybridization and Mutation (Karmakar *et al.*, 2021).

Cultivar: The turnip-rooted variety, Halblange [Half-long], had the lowest ratios of myristicin to apiole. Parsley cultivars belonging to the vulgare group had the highest content of sugar, crude protein and carotene, and those of radicosum the highest

content of ascorbic acid. Crossed the celery cvs Pioneer and Prolet with the parsley cvs Listen and Berlinski and with Festival 68 (parsley $\times$ celery). New leaf forms were obtained which had tender leaves, were rich in vitamin C, minerals, protein and sugars, had a celery aroma and could be used like parsley. Certain lines relatively resistant to *Septoria apicola* were selected. The essential oil of the celery $\times$ parsley hybrid, named Festival 68, was similar to that of parsley. The principal constituents in the hybrid essential oil were γ -terpene and heptanol, in parsley myrcene and in celery myrcene and limonene. There were variations in the essential oil content of different varieties. Hamburger Schmitt [Hamburg Cutting] and Enface Schmitt [Plain Cutting] had a relatively high percentage of oil in the fruits, and the fruit oil in the former contained 22% 2,3,4,5-tetramethoxyal -lylbenzene. The turnip-rooted variety Challenge [Half-long] had the lowest ratios of myristicin to apiole. A correlation was noted between the aromatic properties and root shape, cvs with long, thin and evenly tapering roots having the highest aromatic rating (Azeez and Parthasarathy, 2008). There are no fewer than 37 varieties reported and the most valuable is 'Curled Leaf,' a compact type with close, perfectly curled leaves and very finely divided leaf type. 'Italian' (or plain-leaf) is a less decorative but flavour-ful parsley that most closely resembles the original non-curly plants of Europe. It is not cultivated much now, the leaves being less attractive than those of the curled, is of a less brilliant green and coarser in flavour. The 'Hamburg', or turnip-rooted parsley, is grown only for the sake of its enlarged fleshy parsnip-like and turnip-shaped taproot. 'Neapolitan' (or celery leaf) is grown for its leaf stalks, which are blanched and eaten like celery; and 'Dwarf' is suitable both for ornamental and culinary purposes. Both the crowded, dense-leaved type and the broad, open-growing type were described as early as the 4th century BC (Azeez and Parthasarathy, 2008).

A hybrid parsley, cultivars Festival 68, was derived from a parsley $\times$ celery cross, producing 50–80% more foliage than standard parsley cultivars. Festival 68 has the morphological characteristics resembling parsley. The leaves have a high content of ascorbic acid, sugars and essential oils. The leaf yields are 50–80% higher than those of ordinary commercial varieties. New root forms from the same interspecific combination, having intermediate characters in leaf rosette and higher contents of ascorbic acid, carotene, chlorophyll, essential oils and amino acids than either parent, have been obtained, together with others which have larger roots than those of their parents and a long storage period, similar to that of parsley. No differences were observed in total b-carotene levels or in its cis-isomer fractions at the doses of ionizing radiation required for the preservation of foods, nor did it contribute to a decrease of vitamin A. Toxic compounds, such as the photosensitizing furocoumarines including psoralen, bergapten and isoimperatorin, which can induce dermatitis, have been found in parsley roots, though in very low concentrations (Azeez and Parthasarathy, 2008).

There are three common types of parsley – curly leaf parsley, Italian (or flat-leaved parsley) and Hamburg (grown for its celery-type root) (Fig. 2) (Rademaker, 1999):

Curly leaved parsley (*Petroselinum crispum* var. *crispum*) is mostly used as a garnish though it can certainly be eaten. Its dark green color makes curly parsley an attractive decoration and the texture is often more delicate and thus easier to chop. A sprinkle of finely chopped curly parsley is an easy finish for many savory dishes. 'Champion Moss Curled', 'Banquet' and 'Forest Green' are commonly grown standards.

Flat-leaved parsley (*Petroselinum crispum* var. *neapolitanum*) is used mainly in cooked dishes. It is generally considered to be the more flavorful parsley. Flat-leaved parsley is commonly used in salads, stews, soups, sauces and salad dressings. The leaves make a rich tea high in vitamin A and C and the seeds make a tea thought by some to ease asthma; both should be used only in low concentrations. Parsley is the main ingredient of Italian salsa verde. It is also the main ingredient of several Middle Eastern salads, such as tabbouleh. In Britain, parsley is used to flavor a white sauce (roux) commonly served over fish or gammon. While most recipes call for the parsley leaves, the stems are equally if not more flavorful and should be reserved for use, finely chopped, in flavoring broths and stews. There are numerous varieties but 'Plain Italian Dark Green' is a standard and 'Argon' is an improved, disease-tolerant variety with an upright growth habit.

Hamburg parsley (*Petroselinum crispum* var. *tuberosum*) root is grown and used in N. W. Europe but is less frequently found in the US. Its flavor is between that of parsley and celeriac. Parsley is best preserved by freezing, just mince, mix with a little water and freeze in ice-cube trays; store the herbal cubes in a freezer bag to store in the freezer. Use about twice the quantity of dried parsley. Add to stews, soups, stuffings, sauces or stir-fries as needed.

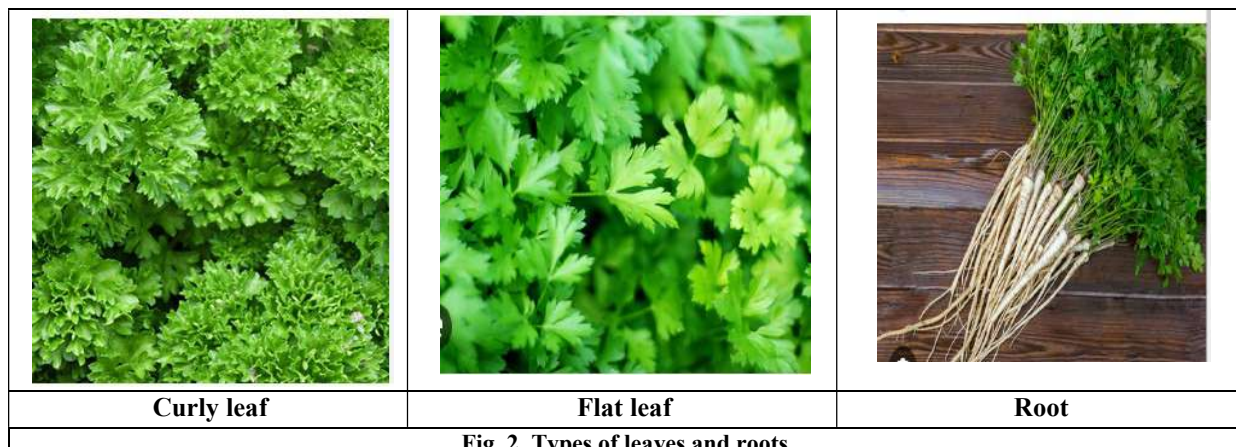


Fig. 2. Types of leaves and roots

There are three cultivated varieties, namely, var. *latifolium* (broad-leaved), var. *crispum* (curly-leaved) both grown for their leaves, and var. *tuberosum* grown for its root. There are three botanical varieties of parsley grown in the United States which are as follows (Karmakar *et al.*, 2021):

***P. crispum* var *crispum* or curly-leaf parsley:** The leaves are bright green and finely cut with toothed-leaf edge. This is the most common variety that is used as a garnish.

***P. crispum* var *tuberosum*:** It is known as hamburger turnip-rooted parsley. This parsley has flat leaves, but is grown for its large, edible root which is prepared as a vegetable.

***P. crispum* var *neapolitanum* or Italian flat-leaved parsley:** The leaves are dark green, flat, and less finely cut. This variety has a stronger flavour than curly-leaf parsley. This type of parsley is commonly used as a flavoring in sauces, soups and stews.

The two most popular types of parsley—flat-leaf and curly parsley—are entirely unique in flavor, and will have notably different effects on any dish. Depending on the flavor and visual effect a cook hopes to achieve, it's important to know the distinction between these two common ingredients and when to let each of them shine (Class, 2021).

Parsley is subdivided into several cultivar groups. Often these are treated as botanical varieties, despite being cultivated selections, not of natural botanical origin.

Leaf parsley: The two main groups of parsley used as herbs are French, or curly leaf (*P. crispum* Crispum Group; syn. *P. crispum* var. *crispum*); and, Italian, or flat leaf (*P. crispum* Neapolitanum Group; syn. *P. crispum* var. *neapolitanum*) (Wikipedia, 2024).

Flat-leaved parsley is preferred by some gardeners as it is easier to cultivate, being more tolerant of both rain and sunshine, and is said to have a stronger flavor—although this is disputed—while curly leaf parsley is preferred by others because of its more decorative appearance in garnishing. A third type, sometimes grown in southern Italy, has thick leaf stems resembling celery (Wikipedia, 2024).

Root parsley: Another type of parsley is grown as a root vegetable, the Hamburg root parsley (*P. crispum* Radicosum Group, syn. *P. crispum* var. *tuberosum*). This type of parsley produces much thicker roots than types cultivated for their leaves. Although seldom used in Britain and the United States, root parsley is common in central and eastern European cuisine, where it is used in soups and stews, or simply eaten raw, as a snack (similar to carrots). Although root parsley looks similar to the parsnip, which is among its closest relatives in the family Apiaceae, its taste is quite different (Wikipedia, 2024).

Each if the three varieties [grown in the USA], have several popular cultivars (Growables, 2024).

- *P. crispum* var. *crispum* Typical curly leaf parsley, with many cultivars including some that look like moss. 'Curled-leaf,' a very finely divided leaf type used more as a garnish; cultivars include: 'Banquet', 'Forest Green', 'Improved Market Gardeners', 'Moss Curled'; hybrid: 'Jade'.
- *P. crispum* var. *neapolitanum* includes the Italian or flat-leaf parsleys which have a slightly stronger flavor than the curly leaf types; less decorative and generally used more in cooking; cultivars include: 'Dark Green Italian', 'Giant of Italy', 'Plain Italian Green'. 'Neapolitan' (or celery leaf) is grown for its leaf stalks, which are eaten like celery.
- *P. crispum* var. *tuberosum* includes the 'Hamburg', turnip-rooted and German parsley cultivars which are grown for their flavorful parsnip-like roots. They have a delicious nutty flavor, reminiscent of a combination of celery and parsley and the tops can be eaten too.

There are two main types of parsley: curly-leaf and flat-leaf. Both types belong to the same species, *Petroselinum crispum*, but have different characteristics and uses (USAR, 2024):

Curly-leaf parsley, also known as common parsley or French parsley, has bright green, crisp, and curly leaves that resemble moss. It has a mild and slightly bitter flavor, and is mainly used as a garnish or a salad ingredient. Curly-leaf parsley is more decorative than flavorful, and is often preferred for its appearance rather than its taste.

Flat-leaf parsley, also known as Italian parsley or neapolitan parsley, has dark green, flat, and smooth leaves that resemble cilantro. It has a stronger and more aromatic flavor, and is mainly used as a herb or a spice. Flat-leaf parsley is more versatile and flavorful than curly-leaf parsley, and is often preferred for its taste rather than its appearance.

Hamburg parsley or turnip-rooted parsley, which belongs to a different variety, *Petroselinum crispum* var. *tuberosum*. This type of parsley has thick, white, and edible roots that resemble parsnips. It has a nutty and earthy flavor, and is mainly used as a vegetable or a soup ingredient. Hamburg parsley is more popular in Europe than in other parts of the world, and is relatively new, having been developed only in the past two hundred years

There are three types of parsley (Wikiwand, 2024)

Curly-leaf parsley is often used as a garnish. In central Europe, eastern Europe, and southern Europe, as well as in western Asia, many dishes are served with fresh green chopped parsley sprinkled on top.

Flat-leaf parsley is similar, but is often preferred by chefs because it has a stronger flavor.

Root parsley is very common in central, eastern, and southern European cuisines, where it is eaten as a snack, or as a vegetable in many soups, stews, and casseroles.

USES

Flavorant, spice flavourings, and herb. In the kitchen, parsley seems to help blend other flavours. It ameliorates strong odours like garlic and fish. It works well with most foods except sweets. It is a principal ingredient in Middle Eastern tabbouleh. The Japanese deep fry parsley in tempura batter. The British make parsley jelly. The Mexicans use it in salsa verde. The French use it in everything. The Germans are especially fond of the root parsleys. Both roots and leaves can be used. Oil, obtained by steam distillation of ripe seeds of the herb, may be used for flavouring. Also produces oleoresin. Because of its high chlorophyll content, parsley makes an excellent breath freshener. Parsley has been used as a medicinal herb since the Middle Ages, but there is little evidence to support its effectiveness other than its value as a natural vitamin supplement (Rademaker, 1999).

Parsley is widely used in Middle Eastern, Mediterranean, Brazilian, and American cuisine. Curly leaf parsley is used often as a garnish. Green parsley is used frequently as a garnish on potato dishes (boiled or mashed potatoes), on rice dishes (risotto or pilaf), on fish, fried chicken, lamb, goose, and steaks, as well as in meat or vegetable stews (including shrimp creole, beef bourguignon, goulash, or chicken paprikash). Parsley seeds are also used in cooking, imparting a stronger parsley flavor than leaves. Parsley, when consumed, is credited with neutralising odours associated with garlic in cooking. In central Europe, eastern Europe, and southern Europe, as well as in western Asia, many dishes are served with fresh green, chopped parsley sprinkled on top. In southern and central Europe, parsley is part of *bouquet garni*, a bundle of fresh herbs used as an ingredient in stocks, soups, and sauces. Freshly chopped green parsley is used as a topping for soups such as chicken soup, green salads, or salads such as *salade Olivier*, and on open sandwiches with cold cuts or *pâtés* (Wikipedia, 2024). *Persillade* is a mixture of chopped garlic and chopped parsley in French cuisine. Parsley is the main ingredient in Italian salsa verde, which is a mixed condiment of parsley, capers, anchovies, garlic, and sometimes bread, soaked in vinegar. It is an Italian custom to serve it with bollito misto or fish. *Gremolata*, a mixture of parsley, garlic, and lemon zest, is a traditional accompaniment to the Italian veal stew, *ossobuco alla milanese*. Root parsley is very common in Central, Eastern, and Southern European cuisines, where it is used as a snack or a vegetable in many soups, stews, and casseroles, and as ingredient for broth. In Brazil, freshly chopped parsley (*salsa*) and freshly chopped scallion (*cebolinha*) are the main ingredients in the herb seasoning called *cheiro-verde* (literally "green aroma"), which is used as key seasoning for major Brazilian dishes, including meat, chicken, fish, rice, beans, stews, soups, vegetables, salads, condiments, sauces, and stocks. *Cheiro-verde* is sold in food markets as a bundle of both types of fresh herbs. In some Brazilian regions, chopped parsley may be replaced by chopped coriander (also called cilantro, *coentro* in Portuguese) in the mixture. Parsley is a key ingredient in several Middle Eastern salads such as Lebanese *tabbouleh*; it is also often mixed in with the chickpeas and/or fava beans while making falafel (that gives the inside of the falafel its green color). It is also a main component of the Iranian stew *ghormeh sabzi*. Parsley is a component of a standard Seder plate arrangement, it is eaten to symbolize the flourishing of the Jews after first arriving in Egypt (Wikipedia, 2024).

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In Brazil, freshly chopped parsley and freshly chopped scallion are the main ingredients in the herb seasoning called (literally "green aroma"), which is used as key seasoning for major Brazilian dishes, including meat, chicken, fish, rice, beans, stews, soups, vegetables, salads, condiments, sauces, and stocks. is sold in food markets as a bundle of both types of fresh herbs. In some Brazilian regions, chopped parsley may be replaced by chopped coriander (also called cilantro, in Portuguese) in the mixture. Parsley is a key ingredient in several Middle Eastern salads such as Lebanese *tabbouleh*; it is also often mixed in with the chickpeas and/or fava beans while making falafel (that gives the inside of the falafel its green color). It is also a main component

of the Iranian stew ghormeh sabzi. Parsley is a component of a standard seder plate arrangement, it is eaten to symbolize the flourishing of the Jews after first arriving in Egypt (GBIF, 2024).

In the kitchen, parsley seems to help blend other flavors. It ameliorates strong odors like garlic and fish. It works well with most all foods except sweets. It's a principal ingredient in Middle Eastern tabbouleh. The Japanese deep fry parsley in tempura batter. The Mexicans use it in salsa verde. The French use it in everything. The Germans are especially fond of the root parsleys. The roots are sliced or grated and used raw in salads. They also are used as seasoning in soups and stews, or roasted, fried, mashed or made into chips like potatoes. Like many root crops, parsley root is sweetened by a good frost. The high chlorophyll content of parsley makes it a natural breath freshener (Growables, 2024).

Culinary: flavoring; breath freshener; garden borders, containers; black swallowtail butterfly larvae host (Growables, 2024).

- The Greeks used parsley in funerals and for wreaths long before it was used as a food.
- The Romans used parsley to disguise the smell of alcohol on their breath. Corpses were once sprinkled with parsley to deodorize them.
- Today parsley oil, extracted from the leaves and stems, is used in commercial shampoos, soaps, perfumes and skin lotions.
- Parsley makes a great house plant, hanging in a sunny kitchen window. A potted parsley house plant will produce pretty garnish for 6-9 months.
- Black swallowtail butterfly. Butterfly lovers often grow a few extra plants to share with caterpillars.

Parsley leaves are ready for use about 3 months after seeding. A few leaves at a time may be removed from each plant, or the entire bunch of leaves may be removed for use. Although parsley leaves are used most commonly in the fresh green condition as a garnish, their characteristic flavour and green colour can be retained if the leaves are dried rapidly. Dehydrated parsley flakes are produced from parsley grown in commercial fields. Green parsley leaves have a mild, agreeable flavour and are an excellent source of vitamin C, iodine, iron and other minerals. Quite often, parsley is left on the plate to become the last bite, as it tends to sweeten the breath (Azeez and Parthasarathy, 2008). The finely chopped leaves are used as flavouring in sauces, soups, stuffing, rissoles, minces, etc., and are also sprinkled over vegetables or salads. The leaves are also dried and powdered as a culinary flavouring when fresh leaves are not available. In addition to the leaves, the stems are also dried and powdered, both as a culinary colouring and as a dye. The roots of the turnip-rooted variety are used as a vegetable and flavouring. The 2-year-old roots are used for medicinal purposes, the leaves are dried, for making parsley tea, and the seeds are used for the extraction of an oil called apiole, which is of considerable curative value. The best seed for medicinal purposes is that obtained from the Triple Moss curled variety, which is grown for producing apiole (Azeez and Parthasarathy, 2008). Parsley leaves, which are strongly diuretic, can jump-start weight loss, and their high vitamin C content makes them useful against colds and flu. Their invigorating, mild flavour is a key ingredient in tabbouleh, a Middle Eastern salad. The powdered seeds of parsley are a folk remedy for hair growth and scalp stimulation, when massaged into the scalp. It also has strong antioxidant properties (Azeez and Parthasarathy, 2008).

Nutritional Value: A rich source of iron and vitamins C and A, parsley also yields fatty acids and an essential or volatile oil. The essential oil of the leaves is considered superior to that from the seeds and is used in condiments and seasonings. Parsley seed oil is used in fragrances for perfumes, soaps and creams. Parsley has a very high content of vitamins (β-carotene, thiamin, riboflavin and vitamins C and E) and is a rich source of calcium, iron and folate. A high proportion of the carotene is 9-cis-β-carotene, which is considered effective against cancer and cardiovascular disease (Azeez and Parthasarathy, 2008). *Petroselinum crispum* (Mill) flat leaves specimens were isolated and identified the flavonoids apigenin (1), apigenin-7-O-glucoside or cosmosiin (2), apigenin-7-O-apiosyl-(1 → 2)-O-glucoside or apiin (3) and the coumarin 2",3"-dihydroxyfuranocoumarin or oxypeucedanin hydrate (4) (Ayurwiki, 2024). Green parsley leaves have a mild, agreeable flavor, and are an excellent source of vitamin C, iodine, iron, and other minerals (Growables, 2024). Parsley is a source of flavonoids and antioxidants, especially luteolin, apigenin, folate, vitamin K, vitamin C, and vitamin A. Half a tablespoon (a gram) of dried parsley contains about 6.0 μg of lycopene and 10.7 μg of alpha carotene as well as 82.9 μg of lutein+zeaxanthin and 80.7 μg of beta carotene. Nutritional Data, Parsley, accessed 2013.08.05 Dried parsley can contain about 45 mg/gram apigenin. The apigenin content of fresh parsley is reportedly 215.5 mg/100 grams, which is much higher than the next highest food source, green celery hearts providing 19.1 mg/100 grams (GBIF, 2024). Parsley is a source of flavonoids and antioxidants, especially luteolin, apigenin, folate, vitamin K, vitamin C, and vitamin A. Half a tablespoon (a gram) of dried parsley contains about 6.0 μg of lycopene and 10.7 μg of alpha carotene as well as 82.9 μg of lutein+zeaxanthin and 80.7 μg of beta carotene. Dried parsley can contain about 45 mg/gram apigenin. The apigenin content of fresh parsley is reportedly 215.5 mg/100 grams, which is much higher than the next highest food source, green celery hearts providing 19.1 mg/100 grams. Parsley essential oil is high in myristicin (Wikipedia, 2024). The plant contains the coumarin oxypeucedanin; the flavonoids apigenin, luteolin, and chrysoeriol; the flavonols kaempferol, quercetin, and isorhamnetin; the polyacetyles falcarinol, falcariindiol—an essential oil sheltering notably 1,3,8-p-menthatriene, myristicin, apiol, myrcene, terpinolene, and 1-methyl-4-isopropenylbenzene—a fixed oil containing petroselinic acid and phylloquinone (Pharm, 2024).

Health Benefits

Here are 8 impressive health benefits and uses of parsley (Healthline, 2024). 1) Contains many important nutrients. 2) Rich in antioxidants. 3) Supports bone health. 4) Contains cancer-fighting substances. 5) Rich in nutrients that protect your eyes. 6) May improve heart health. 7) Parsley extract has antibacterial properties and 8) Easy to add to your diet. As a medicinal plant, parsley

has traditionally been used as an antispasmodic, carminative, diuretic, emmenagogue, and stomachic. The plant has also been used as a remedy for asthma, conjunctivitis, dropsy, fever, and jaundice. The essential oil of parsley seed has been reported to stimulate hepatic regeneration (Growables, 2024).

Health Benefits are as follows (USAR, 2024)

Supporting bone health: Parsley is an excellent source of vitamin K, which is essential for bone formation and maintenance. Vitamin K helps the body use calcium and prevents bone loss and fractures. Parsley also contains calcium, magnesium, and phosphorus, which are important minerals for bone health.

Boosting immune health: Parsley is a good source of vitamin C, which is a potent antioxidant and immune booster. Vitamin C helps the body fight infections, heal wounds, and prevent scurvy. Parsley also contains vitamin A, which is important for vision, skin, and mucous membranes. Vitamin A also helps the body resist infections and inflammation.

Promoting blood health: Parsley is a rich source of iron, which is a vital component of hemoglobin and red blood cells. Iron helps the body transport oxygen and prevent anemia. Parsley also contains folate, which is a B vitamin that helps the body make DNA and prevent birth defects. Folate also helps the body lower homocysteine levels, which are associated with increased risk of cardiovascular diseases.

Protecting kidney health: Parsley is a natural diuretic, which means it helps the body flush out excess fluids and salts. This can help prevent or treat kidney stones, urinary tract infections, edema, and high blood pressure. Parsley also contains oxalates, which can bind to calcium and form kidney stones. However, this can be prevented by drinking enough water and consuming parsley in moderation.

Preventing cancer: Parsley contains various phytochemicals, such as flavonoids, carotenoids, and apiol, which have anti-cancer properties. These phytochemicals can help the body fight free radicals, inhibit tumor growth, and induce apoptosis (cell death) in cancer cells. Parsley may be especially beneficial for preventing or treating cancers of the breast, colon, prostate, skin, and lung

CULTIVATION

Germination/Propagation: Sow seeds at 20°C, expecting germination within 3 months without further temperature treatment. Requires Soaking: These seeds need to be soaked in warm water until they swell, which can take 24-48 hours. Seeds that float are usually not viable and should be discarded, along with the soaking water (Plantaedb, 2024). Propagation of parsley is by Seed (Growables, 2024).

Cultivation: Parsley grows best in moist, well-drained soil, in an area that receives full sun for at least 6 hours a day. It is a biennial but usually grown as an annual in the northeast. Considered tricky to get started, parsley seeds can be sown directly in the ground in late spring, taking 4 - 6 weeks or longer to germinate. Results will be improved if you soak the seeds for up to 24 hours in warm water (around 75° F) before sowing. Plant the seeds ½ to 2 inches apart and ¼ inch deep, in rows 2 feet apart. The germinated plants can later be thinned, if necessary. Parsley can also be started indoors in winter, 8 - 10 weeks before the last frost, and planted out in late spring when the seedlings are 2 - 3 inches high. Batches of seeds may be sowed successively from April to November to provide fresh leaves. Parsley can be harvested continuously throughout the growing season. The outer leaves should be cut 1 - 3 inches above the crown which will in turn encourage new plant growth. Parsley will overwinter in Zones 7 and higher so you may see it pop up on its own in a northeast garden after a mild winter. In their second year the plants will bolt (form flowerheads). These attractive flowerheads be cut off or allowed to set seeds which can be saved for sowing next year (Rademaker, 1999).

The quantity of vitamin C was increased by large temperature changes, especially by low night temperatures; thus, the contents were most frequently highest in the north. However, Moore *et al.* (1997) reported that, when grown at high CO₂, leaf ribulose- 1, 5-bisphosphate carboxylase/oxygenase content was not affected in parsley that produces mannitol (Azeez and Parthasarathy, 2008). Fertilizer application has been reported to influence the quality of parsley. Studies on the application of NPK at 45 g N + 100 g P 2O₅ + 55 kg K₂O/m³, or two or three times this rate of NPK, indicated that N and Potassium, but not the K rate, had a significant effect on the total chlorophyll content, which increased as the rate increased in both cases. There was no change in the total sugar and ascorbic acid contents in response to N, P or K application, but in the case of P only there was a clear increasing trend in both as the application rate increased. Ascorbic acid content increased in response to increasing the K rate. Applying N, P or K increased the activity of peroxidase and catalase, particularly during the early phases of growth (Azeez and Parthasarathy, 2008). Franken and Gnadinger (1994) studied the molecular aspects of the symbiosis between plants and arbuscular endomycorrhizal fungi in parsley cv. Hamburger Schnitt. Phosphate nutrition and low light conditions influenced plant-fungal interactions negatively in different ways. Without chemical fertilizers, legume green manure crops, particularly sunn hemp and hyacinth bean, can increase the yield of culinary herbs like parsley in a crop rotation system (Azeez and Parthasarathy, 2008). Essential oil yield and other chemical parameters are also influenced by the number of cuts. Essential oil was greatest at 0.02% chlorophyll contents, which increased gradually from the first to the third cut (Azeez and Parthasarathy, 2008).

Soak for 24 hours before planting for better germination. Keep the soil moist. 3-5 years but its percentage germination reduces quickly after 1 year. North: Sept.-Mar.; central: Sept.-Mar.; south: all year. Shallow, ¼ in., covered with a thin mulch layer until

the seedlings appear (Growables, 2024). Seedlings may be transplanted later, although do not transplant well due to their taproots which are typical of plants in the Apiaceae family. Most gardeners will find that only a few parsley plants are needed to fulfil their culinary wants. There are four main types of commercial herb production systems (Growables, 2024):

- Broadacre cropping with machine harvesting for manufacturing or seed production
- Intensive in-ground cropping for fresh market
- Hydroponic production for fresh market
- Greenhouse production.

A complete fertilizer at planting time followed by monthly feeding with a nitrogen fertilizer is best on most Florida soils (Growables, 2024). Irrigation during the germination period and the 2-3 weeks following emergence are critical. Too little water at any point will result in diminished leaf yield. Long, warm periods with too little water results in bolting which is undesirable since the plants are grown for their leaves. In addition, bolting reduces the amount, quality, and flavor of the leaves (Growables, 2024). Parsley is a weak competitor with other plants. Weed control is critical throughout the season and will also make harvest more efficient and can best be obtained by using black plastic mulch and cultivation (Growables, 2024). Planted in the fall, parsley will thrive during winter and then flower, produce seeds, and die in late spring. You may be successful in prolonging the life of your parsley by growing it in light shade. It will bolt and flower eventually, but the good news is that bees and other pollinators love the blooms (Growables, 2024). Parsley grows best in moist, well-drained soil, with full sun. It grows best between 22–30 °C (72–86 °F), and usually is grown from seed. Germination is slow, taking four to six weeks, and it often is difficult because of furanocoumarins in its seed coat. Typically, plants grown for the leaf crop are spaced 10 cm apart, while those grown as a root crop are spaced 20 cm apart to allow for the root development. Parsley attracts several species of wildlife. Some swallowtail butterflies use parsley as a host plant for their larvae; their caterpillars are black and green striped with yellow dots, and will feed on parsley for two weeks before turning into butterflies. Bees and other nectar-feeding insects also visit the flowers (Wikipedia, 2024). Parsley grows best in moist, well-drained soil, with full sun. It grows best between 22 –, and usually is grown from seed. Germination is slow, taking four to six weeks, and it often is difficult because of furano coumarins in its seed coat. Typically, plants grown for the leaf crop are spaced 10 cm apart, while those grown as a root crop are spaced 20 cm apart to allow for the root development. Parsley attracts several species of wildlife. Some swallowtail butterflies use parsley as a host plant for their larvae; their caterpillars are black and green striped with yellow dots, and will feed on parsley for two weeks before turning into butterflies. Bees and other nectar-feeding insects also visit the flowers. Birds such as the goldfinch feed on the seeds (GBIF, 2024). In cultivation, parsley is subdivided into several cultivar groups,

Multilingual Multiscript Plant Name Database: Sorting *Petroselinum* names depending on the form of the plant, which is related to its end use. Often these are treated as botanical varieties, but they are cultivated selections, not of natural botanical origin (GBIF, 2024). Leaf parsley: The two main groups of parsley used as herbs are French, or curly leaf (*P. crispum* Crispum Group; syn. *P. crispum* var. *crispum*); and, Italian, or flat leaf (*P. crispum* Neapolitanum Group; syn. *P. crispum* var. *neapolitanum*). Of these, the Neapolitanum Group more closely resembles the natural wild species. Flat-leaved parsley is preferred by some gardeners as it is easier to cultivate, being more tolerant of both rain and sunshine, (Stobart, 1980). The Cook's Encyclopaedia. Macmillan . and is said to have a stronger flavor—although this is disputed—while curly leaf parsley is preferred by others because of its more decorative appearance in garnishing. A third type, sometimes grown in southern Italy, has thick leaf stems resembling celery. Root parsley: Thickened root, Radicosum Group (GBIF, 2024). Another type of parsley is grown as a root vegetable, the Hamburg root parsley (*P. crispum* Radicosum Group, syn. *P. crispum* var. *tuberosum*). This type of parsley produces much thicker roots than types cultivated for their leaves. Although seldom used in Britain and the United States, root parsley is common in central and eastern European cuisine, where it is used in soups and stews, or simply eaten raw, as a snack (similar to carrots). Although root parsley looks similar to the parsnip, which is among its closest relatives in the family Apiaceae, its taste is quite different (GBIF, 2024).

Harvesting: Parsley leaves are ready for use about 3 months after seeding. A few leaves at a time may be removed from each plant, or the entire bunch of leaves may be removed for use. Although parsley leaves are used most commonly in the fresh green condition, their characteristic flavor and green color can be retained if the leaves are dehydrated. Therefore, markets for parsley processed in this manner are growing (Karmakar *et al.*, 2021). The outer leaves can be removed for table use, and the plant continues producing. Cutting entire plants 1.25-3 in. (3.2-8 cm) above the crown may result in secondary growth sufficient to allow for another harvest. Maximum biomass usually occurs at 75-90 days after germination. Rapid removal of field heat without excessive drying helps retain green color and freshness. Parsley can be precooled with ice (package icing or liquid-icing or by vacuum-cooling. Forced-air cooling or hydrocooling are commonly practiced (Growables, 2024).

Yield: The study shows the results of a four-year study on the effects of *Siforga*, a certified organic fertilizer on the yield and market quality of the root of the parsley variety *Berliner medium long*. The researched fertilizer quantities were at the rates of 500, 1.000, 2.000 and 3.500 kg ha⁻¹ and the control treatment was a plot where no organic fertilizer was applied. Field trials were conducted in the spring cycle of parsley growing, from 2005 to 2008, in Starcevo, on anthropogenic soil of subtype chernozem with signs of gley in loess. The results of these study show that the lowest root yield was found in the control treatment (23.22 t ha⁻¹), while the highest yield was found in the treatment with 1.000 kg ha⁻¹ of *Siforga* (37.03 t ha⁻¹). The best market quality of parsley root, that is, the largest portion of 1st class roots had 3.500 kg ha⁻¹ at rate of *Siforga*, whereas the poorest quality was obtained at 500 kg ha⁻¹ rate of *Siforga* (75.11%) (Filipovi *et al.*, 2012). The study evaluated yield, quality parameters and biological value of the yield of selected leaf parsley cultivars. The investigated material included marketable yield (entire leaves),

and chemical analyses of fresh leaves included the determination of dry weight, total acidity, the content of L-ascorbic acid, chlorophyll a and b and total chlorophyll, total carotenoids, total polyphenols and antioxidant activity measured as the inhibition of DPPH radicals. The aim was to investigate a few cultivars of leaf parsley, including ones with curly and with plain leaves. The variety with plain leaves called Plain Leaf produced significantly higher yield of 166.52 t ha⁻¹ in 2015 and 97.31 t ha⁻¹ in 2016. The cultivars Gigante d'Italia, Plain Leaf and Lisette achieved the highest percentage share of leaf blades in their yield. The cultivars Lisette and Neapolitan parsley showed the highest content of pigments. A comprehensive analysis identified cv. Neapolitan as the most valuable cultivar – the richest in polyphenols and L-ascorbic acid and with the highest antioxidant activity measured by the inhibition of DPPH radicals. With the mean content of calcium at 40 007.5 mg kg⁻¹ DM and magnesium at 3208.25 mg kg⁻¹ DM in 2016, the leaves of cv. Titan were the richest in elements building bones, teeth, skin and hair. The leaves of cv. Plain Leaf contained high levels of sodium, magnesium, copper, iron, cadmium and manganese. The growing conditions, including soil type, fertilization, moisture content and insolation, may have had influence on yield and biological value of parsley leaf (Jadczak *et al.*, 2019). Yield of parsley depends on cultivars, season and agro-climate. A yield of 14.4t/ha was obtained at a spacing of 30 cm. Yield was 13.1 t/ha for the classical method of sowing and 23.3 t/ha for the ridge method. Average yield/plant of parsley ranged from 14.9 to 22.1 oz from 4 pickings. Among the curled-leaf cultivars Afro, Forest Green, Sherwood and Unicurl had the highest yields while in plain-leaf type cv. Gigante generally had the highest yields (Karmakar *et al.*, 2021).

Production: The estimated number of hectares of parsley cultivated in North America is 25,091, while worldwide it is 250,905. The yield per acre is reported to be 4238 kg dry herb and 32 kg oil, with oil on a fresh-weight basis being 0.26%. Parsley is a biennial plant but is usually produced as an annual crop. It can be grown from seeds or divisions in fertile soils in full or partial sunlight. Parsley matures in 70–90 days; the harvest begins in October and continues through March, depending on weather and location. Parsley plants form a healthy rosette in the first year, winter mortality being low. Plant growth and seed production are excellent in the second year. Parsley leaves can be hand-harvested three to four times in a season and the plants yield approximately 2.24–6.72 t/ha. Fresh parsley can be stored for up to 2.5 months at 0°C. The roots, leaves and seeds of parsley are used either fresh or as dried oil. The components derived are starch, mucilage, sugar, volatile oil, terpenes, apiin and apiole (Azeez and Parthasarathy, 2008).

Pests: American serpentine leafminer (*Liriomyza trifolii*), beet armyworm [*Spodoptera exigua* (Hubner)], granulate cutworm, (*Feltia subterranea*) and black cutworm (*Agrotis ipsilon*), cabbage looper (*Trichoplusia ni*), wireworms or click beetles (Elateridae), aphids, twospotted spider mite (*Tetranychus urticae*). Swallowtail caterpillars feed on parsley and are present in large numbers in late summer months. Row covers while swallowtail butterflies are present may reduce damage by blocking butterfly access to plants for egg laying (Growables, 2024).

Diseases: Parsley and cilantro are prone to leaf blights, leaf spots, and mildews. Cultural controls include the use of drip irrigation, crop rotation, and limited movement through the fields during wet conditions. Root and crown rot of parsley is best controlled by a two-year crop rotation with non-susceptible plants (Growables, 2024).

Storage: The least decay in storage at room temperature occurs when parsley is harvested at 70 days. Storage at 0°C and 84% RH doubled the shelflife compared with storage at room temperature. For root parsley, irrespective of cultivar, the vitamin C content was highest in roots from the May sowings. The best storage can be obtained with roots of plants sown in April and root contents of vitamin C, dry matter, sugars and nitrates decreased during storage (Azeez and Parthasarathy, 2008). The recommended conditions for commercial storage of parsley are 0 °C (32 °F) with 95 to 100% RH [relative humidity]. Parsley can be stored for 1 to 2 months under these conditions, compared to only 3 days at 18-20 °C (64-68 °F) with 85-90% RH. The endpoint of storage at 0 °C (32 °F) occurs when parsley wilts, at around 20% weight loss. MAP [modified atmosphere packaging] is effective in extending storage life, but temperature changes and condensation must be avoided. Frozen parsley retains more flavor than dried. If you do dry parsley, the Italian varieties are better since they have a stronger flavor to begin with. Dehydrated parsley flakes are produced from parsley grown in commercial fields (Growables, 2024).

Precautions: Excessive consumption of parsley should be avoided by pregnant women. Normal food quantities are safe for pregnant women, but consuming excessively large amounts may have uterotonic effects (GBIF, 2024; Wikipedia, 2024).

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