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A look at the composition, processing, and non-medicinal value of the medicinal plant of Mountain celery

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Abstract

Kelussia odoratissma plant is a valuable plant native to Iran, especially the Zagros region. At present, the natural habitats of this species are limited to areas in Isfahan, Chaharmahal-Bakhtiari, Kohgiluyeh-Boyerahmad, and Lorestan provinces, where It grows in Isfahan province in the mountains of Shahan, Fardan, and also in the area Pashtkoh, Mogoi, Tara, Klose, Kahgan Sofli and Alia and Sebestan Valley area, which are considered as the most important habitats of this species in the country. In addition to being used in traditional medicine, a unique plant has a lot of non-medicinal value, including use in the food industry, fodder, economic income, and ecotourism of the region. Therefore, plant processing in the form of drying, packing, powdering, and extracting its extract and essential oil is common among Iranian people. Of course, considering the high importance of mountain celery and its introduction to the World Food Organization and the World Health Organization, it can play an important role in the lives of people worldwide. Therefore, this review tries to take a look at the composition, processing, and non-medicinal value of the medicinal plant Mountain cele.

Keywords: Dried powder, Economic value, Extracting extracts, *Kelussia odoratissma*, Processing

Introduction

According to the global perspectives of biodiversity, strengthening the role of local communities and the level of stakeholder interaction is essential in the possible actions in implementing strategic plans for biodiversity. Based on this, public participation and addressing social issues are essential for effective protection efforts. In recent years, recognition of the value of traditional knowledge and sustainable customary exploitation has increased and is widely respected, both in global policy-making forums and scientific communities (Singh et al., 2002). Keeping native species in each region is very important to preserve biodiversity (Jabral Ansar et al., 2015), (Mabberley, 2006). Central Zagros is one of the important centers of biodiversity in the country and Southwest Asia. In this region, the region harbors a wealth of medicinal and edible plant species. One of the most important species is mountain celery with the scientific name *Kelussia odoratissima* Mozaff, whose existence has not been reported in other regions of the world (Endemic medicinal plant of Iran) (Naderi Shahab et al, 2013). The use of medicinal plants has caused the production of medicinal plants in developing countries to increase day by day, and on the other hand, the global approach of people in the last few decades to use drugs that are of natural origin has caused the increasing development of medicinal plants, processing and The new formulations of herbal medicines and their trade have become global, so that the import of medicinal plants in different countries such as China, Japan, Germany, Switzerland and Canada is increasing day by day and especially China is the main supplier of medicinal plants due to its diverse climate and plant cover, and European and American countries, of course, some Asian countries are considered major producers of herbal medicines, but herbal raw materials and therapeutic products derived from them contribute It includes an important part of the pharmaceutical market, and therefore it seems necessary to achieve their internationally recognized quality strategies. The World Health Assembly in a number of its resolutions emphasizes the need to supply and control the quality of medicinal plant products by using new techniques and the use of suitable drugs, but Iran has a good potential for entering the market due to its climatic diversity and plant diversity. It has the trade of medicinal plants and herbal medicines, which, in addition to treating diseases, creates employment, self-sufficiency and economic development in the country (Asadabadi, 2010). There is no information about the position of *Kelussia odoratissma* Mozaff in the world based on the statistics of the World Health

Organization, but today, considering the economic and therapeutic importance of medicinal and industrial plants and the development of the herbal treatment attitude in the world, the introduction of medicinal plants to use and optimally manage these God-given resources is necessary (Behmanesh, 2006). Due to the compounds, properties and important therapeutic effects of *Kelussia odoratissma*, agroecological investigation, processing and economic aspects of this medicinal plant can bring it to the attention of the World Health Organization. Therefore, due to the importance of the issue, this plant is investigated.

Material and methods

The author uses the results of the findings obtained from research related to *Kelussia odoratissma* Mozaff and refers to the sites of reliable and relevant scientific publications as well as the books of other researchers to evaluate and compare using related theories, ideas, and research, addressed the topic of the medicinal plant *Kelussia odoratissma* Mozaff.

Results

Places of growth

At present, the natural habitats of this species are limited to areas in Isfahan, Chaharmahal-Bakhtiari, Kohgiluyeh-Boyerahmad, and Lorestan provinces, where It grows in Isfahan province in the mountains of Shahan, Fardan, and also in the area Pashtkoh, Mogoi, Tara, Klose, Kahgan Sofli and Alia and Sebestan Valley area, which are considered as the most important habitats of this species in the country. *Kelussia odoratissma* Mozaff is a valuable edible species exclusive to the central Zagros highlands, which has recently been introduced to botanical knowledge. Although this plant was recently discovered, it has deep roots in the culture of the people of Central Zagros and from the past to the present, an important part of the income of the local inhabitants is provided through it (Zyaei et al, 2015) and it is one of the plant species that, in addition to fodder uses, has non-fodder uses such as medicinal, edible, industrial, etc., which is one of the rare pasture species in the world and native to Iran. *Kelussia odoratissma* Mozaff has diverse and valuable uses. For this reason, it has been named green gold in the Kahkilouye-Boyerahmad region (Jahantab, 2009).

Botanical features, morphology, and plant reproduction

Umbelliferae family or (Apiaceae) with nearly 438 genera and 3500 species is one of the largest

plant families in the world, mostly distributed in the northern hemisphere of the world (Mozaffarian, 2007). This family has 131 genera and 365 species in Iran, among which 118 species are unique to Iran (Mozaffarian, 2003). Mountain celery (Fig. 1) is a rare pasture species in the world and native to Iran with the scientific name *Kelussia odoratissma* Mozaff. Mountain celery is a perennial plant and belongs to the Umbelliferae family (Mozaffarian, 2020). Mountain celery is a perennial plant belonging to the Umbelliferae or (Apiaceae) family, whose height reaches 120 to 200 cm at maturity. The leaves have claw-shaped cuts and umbrella-shaped flowers. The seed of the plant is a yellowish-brown-shaped plate (Naderi Shahab et al., 2013).

Fig 1. Mountain celery (*Kelussia odoratissma*) with the Persian name Keluss

Mountain celery reaches a height of 120 cm and sometimes up to 200 cm. This plant has a cylindrical (round) stem, wide leaves with petioles 35 to 55 cm long, terminal parts 7 to 10 cm long, rectangular-oval, saw-toothed teeth with an oblique or continuous base, pointed tip, close together and more or less overlapping, with reticulated veins, hairless. Umbels 8-12 rays, radii 2-5.4 cm long, glabrous, umbels about 9-flowered, leaves and bracts present, minutely pubescent. Yellow petals, hairless, regular. Fruits are oval-round, 10 to 12 mm long, and 7 to 8 mm wide. Its leaves look like parsley leaves and have deep cuts and are composed of several leaflets. It has a straight and spindle-shaped root, the upper part of which has a large tuber, this tuber is the place to store the nutrients needed by the plant to start the plant's vegetative growth again in the next season. The seed (Fig. 2) of this plant is relatively large, oval, and plate-shaped, and its color also changes in the range of yellow, green, and brown spectrums (Mozaffarian, 2020).

Fig 2. Seeds of *Kelussia odoratissma* Mozaff.

Propagation of this medicinal species is done using seeds. The seed needs a cold period to germinate. *Kelussia odoratissma* Mozaff seed has a type of dormancy that needs cold to break this dormancy, and if it is placed at a high temperature above 8 degrees Celsius, it will never turn green. But if it is cultivated from the beginning at a temperature between +1 and +4, it will germinate and continue to grow. In nature, such a need for cold will be fulfilled by winter cold. The advantage of this sleep is that because this plant must be cultivated in the fall, it does not germinate immediately after absorbing or reaching the seed, and germination is postponed until the next spring (Amu Aghaei & Valivand, 2013). Based on the results of the author's research project (comparison of rainfed and wet cultivation pilots of *Kelussia odoratissma* Mozaff in Kohgiluyeh-Boyerahmed provinces), the growth of mountain celery for one-year and two-year plants continues from early April to early June, but for perennial plants. It continues until September because the plant wants to produce seeds for its survival in nature.

Effective ingredients

Kelussia odoratissma Mozaff has two groups of essential oil and flavonoid compounds. Flavonoids are an important part of the compounds of this plant, which have anti-inflammatory, antiviral, anti-diabetic, and anti-cancer effects. The most important compound in celery essential oil is butylidene dihydrophthalide and butylidene phthalide. Phthalides are mainly found in plant seeds. Also, its important fatty acids are petroselinic acid, linoleic acid, and palmitic acid (Ahmadi et al, 2019) (Fig. 3). The root, leaf, stem, and seeds of mountain celery are among the parts used. This plant has various chemical compounds such as Ostohle, Coumarin, Furanocoumarin, Bergapten, Flavonoid, Apieine, essential oil, Limonene, Phthalide, β-Selinene, vitamins B, C and A, mannitol, inositol, glutamine, choline, asparagine, various minerals, especially phosphorus, silicon, etc., (Varouzi & Sadeghi, 2019). Considering that the phthalides

in this plant are volatile oil compounds, they probably have a good anti-inflammatory effect, and *Kelussia odoratissma* Mozaff has been introduced as a plant with anti-inflammatory properties in Iranian traditional medicine. Also, the presence of flavonoids and essential oils rich in phthalides has been proven in this plant (Asgari et al, 2004). The combination of butylidene phthalide and butylidene dihydrophthalide had the highest proportion of essential oil in the aerial parts of the celery plant at 26.80 minutes with 4.91% and 27.73 minutes with 82.10% respectively. These phthalides make up about 87% of the plant's essential oil (Asgari et al, 2004).

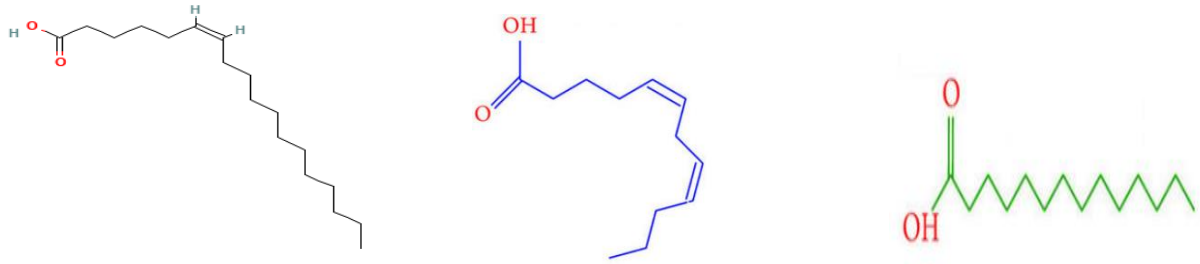

Fig 3. petroselinic acid linoleic acid palmitic acid

Investigations show that the whole extract of mountain celery (*Kelussia odoratissima* Mozaff.) contains substances such as 4, 3, and 7-trihydroxyflavonol and caffeic acid, which can be a suitable antioxidant effect in celery (Salimi et al., 2010). Phytochemical studies conducted on mountain celery showed that the total amount of phenolic compounds extracted from *Kelussia odoratissima* plant was reported to be 1.033 mg per gram of dry weight of the plant and 0.595 mg of these compounds are related to flavonoids (Ahmadi et al, 2007). To check the amount of active ingredients of mountain celery to find out its medicinal properties, firstly, from the three studied ecotypes, including Kohrang, Bazfat, and Doab Samsami ecotypes (Secretariat of the Convention on Biological Diversity, 2020), after examining the obtained spectra and referring to reference books, the main chemical compounds of the essential oil of three ecotypes of mountain celery plant were identified. The number of 24, 21, and 24 compounds representing 90.4, 95.6, and 93.6% of the total essential oil compounds of Kohrang, Bazeft, and Doab Samsami samples were identified, respectively. The comparison of the main essential oil compounds in the studied ecotypes showed that the main compounds in the essential oil of this plant include cis-ligustilide (Z-ligustilide), 3-trans-butylidene phthalide, trans-ligustilide (E-ligustilide), Kesan, spatholnol, 2-octen-1-ol acetate, globolol, butyl phthalide, beta-selinene and pentylbenzene, which

constituted about 88.6% of the essential oil compounds of the studied ecotypes.Two compounds, cis-ligostelide and butylidene phthalide, respectively, in the three investigated ecotypes with 39.5% and 19.1%, make up a total of 58.7% of the essential compounds of the celery plant. Derivatives of phthalides present in the plant make up 86.6% of the compounds of the celery plant. The slight changes in the chemical composition of this plant in different habitats can be considered to some extent due to the effect of various ecological, geographical, climatic, soil, and altitude factors on the composition of the essential oil of different ecotypes of this species. Shakerian et al. (2012) stated that celery seeds contain 25% oil and its most important fatty acids are 71.35% oleic acid, 19.14% linoleic acid, 6.65% palmitic acid, and 1.9% stearic acid and linolenic acid is 0.95%. Table 1, Shows the Percentage composition of the essential oil from K. *odoratissima* leaf analyzed by GC-MS (Rabbani et al., 2011).

Table 1. The percentage composition of the essential oil from K. *odoratissima* leaf was analyzed by GC-MS (Rabbani et al., 2011).

No.	Compound	%	RI (Retention indices)
1	n-propyl benzene	0.2	953
2	Limonene	t	1028
3	A-terpinolene	0.1	1085
4	Unknown	1.7	1157
5	Unknown	6.2	1282
6	2-undecanone	0.1	1291
7	4-vinyl-2-methoxy phenol	0.2	1312
8	A-cubebene	0.1	1347
9	neryl acetate	t	1363
10	A-copaene	1.4	1372
11	B- cubebene	t	1386
12	B-elemene	t	1387
13	B-caryophyllene	0.3	1414
14	A-humulene	0.2	1450
15	trans-β-farnesene	0.1	1453
16	B-acoradiene	0.1	1461
17	germacrene-D	0.3	1475

18	β-himachalene	0.3	1494
19	Cuparene	0.1	1498
20	germacrene-A	0.2	1503
21	β-curcumene	0.3	1511
22	δ-cadinene	0.7	1522
23	cadina 1,4-diene	0.1	1525
24	cis-3-butylidene phthalide	0.4	1667
25	3-butylidene-4,5-dihydrophthalide	85.9	1735
27	3N butyl phthalide	0.3	1815

ligustilide: 3-butylidene-4,5-dihydrophthalide.
Retention indices on an HP-5MS capillary column.
t: trace (≤ 0.05%).
%: Calculated from TIC data.

Extraction of effective substances

The extraction of effective substances is one of the most important steps in the phytochemical research of medicinal plants. Classical methods of extracting the active ingredients of medicinal plants such as distillation with water or steam and extraction with organic solvent by soaking or using Soxhlet have disadvantages such as loss of volatile compounds, destruction of unsaturated and unstable compounds, low efficiency, long extraction time and remaining follows the toxic solvent. The widespread use, high price, and sensitivity of essential oils and other natural compounds to extraction conditions have led to the emergence and expansion of new extraction methods. In addition to maintaining the quality characteristics of natural compounds, these methods are faster and cheaper. Some of these methods include extraction with the help of ultrasound waves, extraction with the help of microwave waves, and extraction with supercritical fluid. In recent years, the use of separation methods or supercritical fluid has become very common. Among the factors affecting this type of extraction, we can mention temperature, pressure, extraction time, and average particle diameter, which is very important. It has been determined that the quality of the essential oils and extracts obtained by the supercritical method is much better in terms of sense (Asghar Doukht, 2020).

Discussion

Studies that refer to the processing and creation of added value that can be extracted from medicinal plants are divided into two categories: A: Studies that refer to the processing of

medicinal plants in the pharmaceutical industry and their economic value. B: Studies that refer to the processing of medicinal plants in other industries or raw consumption, which include various products and by-products that can be extracted from medicinal plants (Jalili & Jamzad, 1999). Considering its application and consumption (Soltani et al., 2005), (Roghani et al., 2007), (Sadeghi, 2007), (Behagh, 2003) and its properties (Salimi et al, 2010), (Soltani, 2008), (Sabziparvar & Byatorkeshi, 2010), (Omidbeigi, 2000), forms and products of mountain celery plant can be found in Iran in the form of dried powder and packaging, essential oil, extract, or even fresh organ. To store and process the product of *Kelussia odoratissma* Mozaff, it is first hand-picked and then dried, because the tender parts of mountain celery, which are sold in the market in May, have great economic value and are considered a source of income. Therefore, the dry product can be packed and marketed (Irvani & Jabral Ansar, 2005). Considering the antimicrobial properties and non-toxicity of *Kelussia odoratissma* Mozaff (Zareatkar et al., 2023), for local consumption of the aerial parts (leaves and stems) of the exclusive celeriac plant (in the form of essential oil, extract and dry powder) in dairy products (properties) Sensory and shelf life, taste and aroma and control of acidity, especially yogurt and buttermilk (Shahrani, 2006) as well as its fodder consumption (dried form is used for livestock) (Irvani & Jabral Ansar, 2005) and preparation of pickles and stews (Faruzandeh Shahraki, 2017), there is a need to processing the *Kelussia odoratissma* plant, including drying, packaging, powdering, extracting essential oils, extracting extracts (Fig. 4).

Extracts Dry powder Dry plant

Fig 4. Types of processing

This plant has fodder value and since it is used in dry form by livestock (mostly sheep), it can provide winter fodder (Irvani & Jabral Ansar, 2005). On the one hand, considering that it is a suitable plant for adding to yogurt, buttermilk, and salad or for flavoring cheese and oil, it is suitable for cooking all kinds of food, including stews, soups, and soups with wonderful aromas and taste, and also because Having natural essential oils has the properties of flavoring and preventing spoilage in dairy products, due to their antimicrobial properties and non-toxicity, they can be used as a suitable alternative to increase the shelf life of this valuable dairy product (Zareatkar et al., 2023), by extracting the extract or essential oil from this plant processed. In addition to the medicinal effects, the essential oil in the seeds and roots of the plant attracts insects and facilitates pollination, repels some animals and plant pests, and protects against damage caused by increased heat (Payam Sabz, 2006), (Soltani et al., 2005), (Asgari et al., 2004). Of course, Fig.5 shows a view of the relationship between animals, insects, and medicinal plants in general.

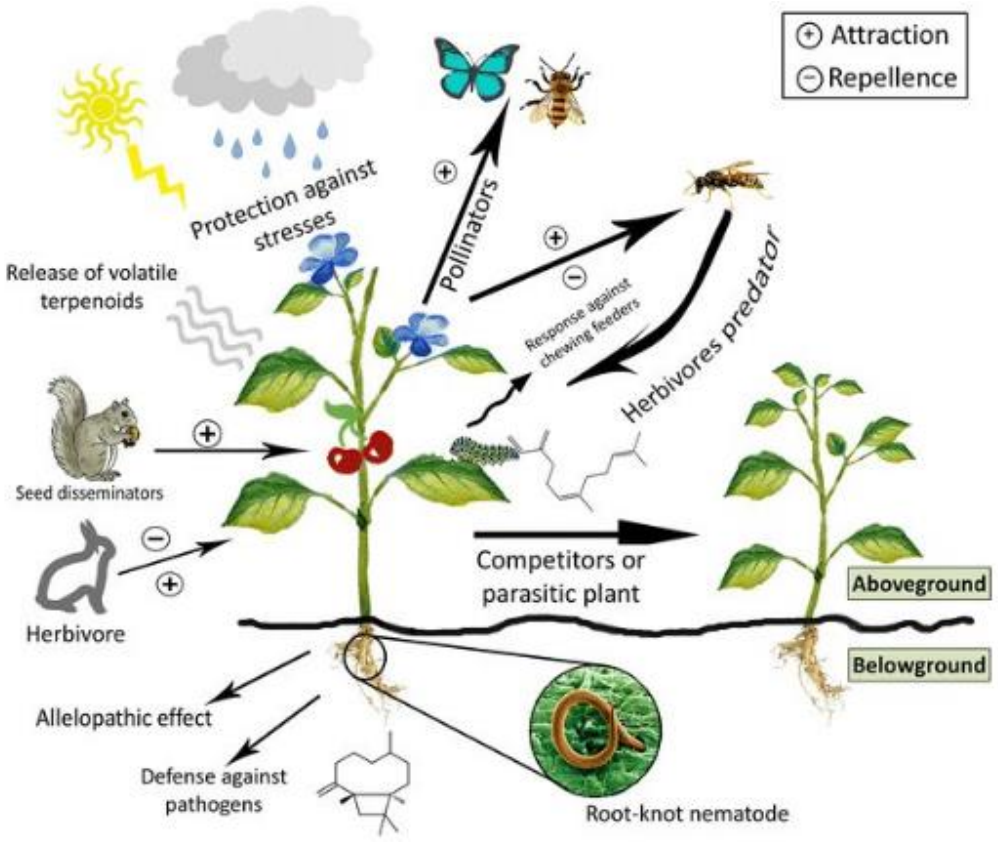

Fig 5. The relationship between animals, insects, and medicinal plants

Essential oils are one of the most important secondary compounds in plants and even some animals, which are of great importance in the food industry due to their cooling aroma and flavoring properties. In this regard, considering the local use of the aerial parts (leaves and stems) of the exclusive mountain celery plant in dairy products, especially yogurt and buttermilk, research was carried out to investigate the effects of the essential oil of the mentioned plant on the sensory properties and shelf life of yogurt. Mountain celery essential was added to industrially produced yogurt in the factory in different concentrations of 20, 40, and 60 parts per million and celery plant powder before packaging, and the yogurt was produced within 30 days and was subjected to physical, chemical, and microbial and sensory evaluation at specific time intervals. The results showed that celery essential oil has an effect on the physical and chemical properties of yogurt and controls the increase in acidity of yogurt, but it reduces the water-holding capacity. It also increases the sensory properties has the greatest effect on the taste and aroma and increases the shelf life of yogurt. Practical/industrial recommendation: The best concentration of essential oil for the production of celery yogurt with sensory quality and proper shelf life in industrial production conditions is 40 parts. It is suggested in millions (Shahrani, 2006). In traditional medicine, properties such as anti-inflammatory, anti-pain, treatment of rheumatism, and blood purification are attributed to the aerial parts of the mountain celery plant, and its seeds and root in boiled form, they are said to have properties to treat colds and severe coughs (Roghani et al., 2007). In the conducted studies and reviews, the analgesic and anti-inflammatory effects (Soltani, 2008) and the anti-anxiety and sleep-inducing effect of the essence and extract of mountain celery have been proven (Saeidi, 2019). Also, in other research, anti-allergic, vascular protective, anti-thrombosis and digestive tract protective, anti-diabetic, lipid anti-peroxidase, and anti-cancer effects have been determined (Behagh, 2003). Of course, Fig 6 shows the biological effects of medicinal plants on human diseases in general.

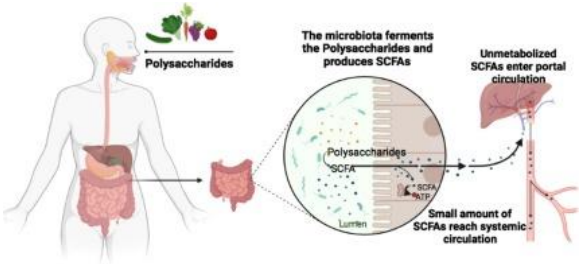

Fig 6. Summarized biological effects from medicinal plant polysaccharides on human health.

Post-harvest physiology is one of the important branches of plant physiology and horticulture, which studies the metabolic and chemical changes in plant tissues and organs, as well as the factors and ways of controlling the quality reduction of products after harvesting and during storage until consumption. Hand-picking and drying the mountain celery plant, then storing and processing the product (extraction of extract or essential oil) for use in the food industry, as well as the use of secondary metabolites in medicinal compounds, including physiological cases after harvesting the mountain celery plant, are considered in the storage and processing of the product. The growth of medicinal plants and the quality and quantity of their effective substances are under the direct influence of two basic factors, environment and genetics. Climatic and environmental changes may have effects on all living organisms, including plants, and interactions between climate and medicinal plants. Medicinal plants are rich reservoirs of secondary metabolites, i.e. reservoirs of the basic active ingredients of many drugs. Secondary metabolites are not common in all plants and their production is significantly influenced by environmental and climate factors. Environmental and climate factors, with their effect on the vegetative and reproductive growth of plants, naturally cause changes in product efficiency, dry weight of the plant, the total amount of the effective substance, and the constituent elements of the effective substance. Considering that the value of medicinal plants depends on the above factors; by choosing and controlling the climate and environmental factors, the maximum amount of product and the maximum number of secondary metabolites can be achieved (Ebadi Esfahani & Moradi, 2014). The mountain celery plant thrives in temperatures between -15\u00b0C and 20\u00b0C (Irvani & Jabral Ansar, 2005) and requires 2,935 to 2,981 hours of sunshine annually (Jabral Ansar, 2015). Its humidity needs are met in snow-bearing areas with approximately 400 mm of annual precipitation, primarily as snow, which is often in the form of snow (Secretariat of the Convention on Biological Diversity, 2020). It also needs shallow to very deep soils with medium to heavy texture that have a high-water holding capacity and are free of salinity and alkalinity (Irvani & Jabral Ansar, 2005), and these soils are rich in organic carbon, likely due to the decomposition of dead leaves and vegetative matter, which is probably caused by the dead leaves and remaining vegetative organs of mountain celery and other related species (Ghasemi Nafchi, 2015). Therefore, for the proper growth, better quality, and quantity of the effective ingredients of this medicinal plant, it is necessary to consider the environmental factors

in the above conditions for this plant to the planted in agricultural conditions or habitats. The climate of all habitats for *Kelussia odoratissma* Mozaff plant is semi-humid, moderately cold with cool and dry summers, and the maximum amount of precipitation is related to the second half of autumn and winter, and it is mostly in the form of snow, and with increasing altitude, the amount of precipitation increases and the amount of temperature decreases (Ghasemi Nafchi, 2015). This plant grows in the heights and snow-covered areas of the central Zagros region, with a minimum altitude of 2500 meters above sea level and an annual rainfall of about 400 mm, which is mostly snow (Secretariat of the Convention on Biological Diversity, 2020). The frost period in mountain celery habitats is at least 130 days a year, and the minimum air temperature is -15 degrees Celsius, the maximum air temperature rarely exceeds 20 degrees Celsius during the vegetative growth of the plant. The growth of this plant is limited to the northern directions of slopes and heights, which have both snow and lower temperatures. However, in high areas and areas with permanent snow, natural habitats of mountain celery can be seen in the directions of different slopes (Irvani & Jabral Ansar, 2005). The number of hours of sunshine in a region is one of the parameters that affect weather indicators water and soil processes and plant growth, including potential evaporation and transpiration (Sabziparvar et al, 2008) and (Sadeghi, 2007). The changing trend of solar hours during the *Kelussia odoratissma* Mozaff habitat did not show any noticeable change. The sunniest hours with 2981 and the lowest with 2935 hours per year have been observed in the northernmost and southernmost points of this plant's habitat, respectively. Therefore, this plant grows in 2935 to 2981 hours of sunshine (Jabral Ansar & Bahreininezad, 2015). The moisture required for the plant *Kelussia odoratissma* Mozaff can be provided in snowy areas with an annual rainfall of about 400 mm, which is often in the form of snow (Secretariat of the Convention on Biological Diversity, 2020). Also (Jahantab et al., 2011) pointed out the importance of precipitation and showed that in the mountain celery habitat in the Kohgiluyeh and Boyer-Ahmad regions, the annual precipitation is about 865 mm and more in the form of snow. Of course, in another study, the highest and lowest amount of rainfall occurred in the winter and summer seasons, respectively, in the habitat of this plant. 52% of the annual precipitation was in winter. After winter, the spring and autumn seasons respectively accounted for the highest amount of annual precipitation in the mountain celery habitat. The distribution of rains started at the end of October and continued until the middle of May. The amount of rainfall

was low in October, which reached its maximum amount in March and its minimum amount in September. Therefore, it can be stated that for the plant *Kelussia odoratissma* Mozaff, the wettest month was March and the driest month was August (Jabral Ansar & Bahreininezad, 2015). The natural habitats of *Kelussia odoratissma* Mozaff can be seen on shallow to very deep soils with medium to heavy textures that have a high-water holding capacity and are free of salinity and alkalinity (Jabral Ansar and Bahreininezad, 2015). Mountain celery generally likes silty clay soils (medium to heavy texture) with acidity between 7.6 and 7.7, which lack salinity (EC) and alkalinity. Also, the soil of the habitats is rich in nutrients such as potassium, calcium phosphorus and some micronutrients. Soil organic carbon also has a high and good amount, which is probably caused by the dead leaves and remaining vegetative organs of mountain celery and other related species. Non-saltiness of soils is also one of the characteristics of high areas where solutes are washed away by precipitation (Ghasemi Nafchi, 2015). The cultivation and establishment of mountain celery *Kelussia odoratissma* Mozaff outside the habitat areas were studied (Jebli & Jafari, 2023). At first, the germination capacity of the seeds was investigated (Oroojalian et al., 2010). Germination of celery seeds was done in two ways in November in field conditions and South Alborz research station (latitude 35 degrees north, longitude 50 degrees east, and altitude 1300 meters above sea level). In the first method, the seeds were planted in two rows in the distance between the two rows of hand-planted spruce trees in heaps at a distance of 1.5 cm from the soil surface. In the second method in the field, the seeds were planted in heaps on the southern stacks of plots with dimensions of 2 x 3 square meters with three repetitions. The cultivated seeds were not irrigated and used only the humidity of the place and spring rains for growth. In the first year, the highest germination percentage of celery seeds between the first was 90%, and in the following years, the plants were established and grew well. The germination of the seeds in the field was 65% in the first year, which decreased in the following years and reached one-third of the first year, finally, in the fourth year, vegetative growth and germination were not observed again. The seeds were planted in Sirachal station (latitude 35 degrees north, longitude 51 degrees east, and altitude 2345 meters above sea level) in two ways. In the first method, in November, a flat and non-sloping area was selected in the shade of trees, and about 100 seeds were poured into the created furrows in a length of one meter. Then the seeds were covered with soil to a depth of 1.5 cm. In the second method, the seeds were

planted in the natural resources' fields on the northern slope of Sirachal up to 2000 meters in the form of heaps in the shade of plants that were sometimes *Astragalus microcephalus*, also near the boulders. In both methods, irrigation was not done and only natural rainfall was used. 85% germination was observed in Sirachal station in a place without a shadow slope and flat area. In the upstream slopes, the amount of greening was about 10% in the first year. Therefore, replanting of seeds was done at Sirachal station in the upstream slopes. Due to the increase in rainfall in 2017, the germination of *Kelussia odoratissma* Mozaff seeds was higher than in 2016, but in the following years, with the decrease in precipitation and especially snow, the germination of seeds reached the lowest value in the sloping area of Sirachal (Jebli and Jafari, 2023). In general, this plant grows in altitudes and areas with annual rainfall of about 400 mm (Secretariat of the Convention on Biological Diversity, 2020). The growth of the plant rarely exceeds 20 degrees Celsius. The growth of this plant is limited to the northern directions of slopes and heights. *Kelussia odoratissma* Mozaff grows on shallow to very deep soils with medium to heavy textures that have high water holding capacity and are free of salinity and alkalinity (Irvani & Jabral Ansar, 2005). The beginning of the growth of the mountain celery species from early to mid-March (along with the increase in temperature), vegetative growth from mid-March to early June, the flowering stage from early June to early July, seeding stage from early to late July and finally the seed fall stage It continues from the beginning to the middle of August, and the distribution pattern of the celery species is random with a tendency to a slight to dense mound (Jahantab et al., 2012). The economic production of mountain celery is driven by its pleasant aroma, essential oil content (4.8%), and its applications in food and health industries. The plant's leaves are used for fragrance and flavoring in products such as yogurt and buttermilk (Shahrani, 2006), while its stems and leaves are also used in pickles and stews (Faruzandeh Shahraki, 2017), it has great economic importance. Therefore, the production of this plant in farms and habitats, due to the use of this plant in transformation industries (food, health, and medicine), can bring employment, economic prosperity, and economic development in villages. At the beginning of the growing season, this plant is in the form of a bud due to the compression of the basal leaves, and it is heavily harvested by the local people and sold at a high price in the market (Kafi and Mahdavi Damghani, 2016). Fresh parts of mountain celery, which are sold in May, have great economic value and are considered as a source of income. It can also

be packaged and marketed as a dry product. This plant has fodder value and because it is used by livestock (mostly sheep) in dry form, it can provide winter fodder. Also, mountain celery habitats have beautiful landscapes that can play an important role in the development of ecotourism (Irvani & Jabral Ansar, 2005). Of course, mountain celery is very important in terms of biodiversity and genetics, and preventing its extinction will preserve the biodiversity of other related species. Since this plant is a type of late-yielding plant and it takes 3-5 years from cultivation to its exploitation, it is necessary to give credit or financial assistance to the farmers who cultivate this crop in the first years. Because this species of *Kelussia odoratissma* Mozaff is endemic and unique to our country, it is possible to plan and act in a targeted manner for marketing, creating export markets, introducing the complete product, essential oil, active ingredients, secondary compounds and its processed export with very significant profitability. The last word is that the provision of economic and technical incentives by the government, entrusting protection matters to the people and encouraging and accompanying them, and promoting the customary system of the village of mountain celery among other rural communities, will be an important factor in preserving and reviving the habitats of this endangered species (Jebli & Jafari, 2023).

Conclusion

The global shift toward natural-origin medicines in recent decades has driven the expansion of medicinal plant cultivation, processing, and the development of herbal medicine formulations. This trend has elevated some Asian countries to become leading producers of herbal medicines. Herbal raw materials and their therapeutic derivatives now constitute a significant share of the pharmaceutical market, underscoring the urgent need for internationally recognized quality standards. Iran, with its diverse climate and rich plant biodiversity, holds significant potential to enter the global trade market for medicinal plants. Among its unique species is mountain celery (*Kelussia odoratissima* Mozaff.), a rare pasture plant endemic to Iran. This plant thrives in semi-humid climates with cool and dry summers, such as those found in provinces like Isfahan, Chaharmahal-Bakhtiari, Kohgiluyeh-Boyerahmad, and Lorestan, where its cultivation is viable. To harness the economic and medicinal potential of mountain celery, it is essential to implement strategic plans that strengthen the role of local communities and foster collaboration among

agricultural stakeholders. Public participation and addressing social issues are vital for successful cultivation efforts. In recent years, the recognition of traditional knowledge and sustainable practices has grown significantly, earning respect in global policy-making and scientific communities. By integrating traditional knowledge with modern agricultural techniques, the cultivation of *Kelussia odoratissima* can contribute not only to disease treatment but also to employment creation, self-sufficiency, and economic development, particularly in rural areas. This approach ensures both the preservation of biodiversity and the sustainable use of this valuable natural resource.

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