Italian Journal of Food Science, 2025; 37 (1): 194–209

Nutraceutical potential of parsley (*Petroselinum crispum* Mill.): Comprehensive overview

Waheeba E. Ahmed[1,2], Albandari A. Almutairi[1], Mona S. Almujaydil[1], Raya Algonaiman[1], Hassan Mirghani Mousa[1], Raghad M. Alhomaid[1*]

[1]Department of Food Science and Human Nutrition, College of Agriculture and Food, Qassim University, Buraydah, Saudi Arabia; [2]Department of Food Science and Technology, Alzaiem Alazhari University, Sudan

***Corresponding Author:** Raghad M. Alhomaid, Department of Food Science and Human Nutrition, College of Agriculture and Food, Qassim University, Buraydah 51452, Saudi Arabia. Email: r.alhomaid@qu.edu.sa

Academic Editor: Prof. Valeria Sileoni, Universitas Mercatorum, Italy

Received: 20 September 2024; Accepted: 25 November 2024; Published: 1 January 2025

REVIEW ARTICLE

Abstract

Leafy vegetables are widely recognized for their significant contribution to human health. Among them, parsley (*Petroselinum crispum* Mill.) is a promising herb with considerable potential to facilitate various favorable effects on health. This review provides a comprehensive overview of the health effects of parsley, highlighting its potential in promoting several health benefits. The available studies suggest that parsley possesses antioxidant and anti-inflammatory properties, exhibits potential for diabetes management, demonstrates hepatoprotective and nephroprotective effects, and shows promise in terms of its potential anticancer properties, among other health-promoting effects. These beneficial effects are attributed to the presence of bioactive compounds in parsley, including phenolic acids and flavonoids, which contribute to its antioxidant capacity. Furthermore, parsley contains key bioactive substances, such as myricetin and apiol, which significantly contribute to its health-promoting properties. In addition, parsley is a rich source of essential vitamins and minerals, making it a valuable herb and a substantial reservoir of nutrients. In conclusion, incorporating parsley into daily diet can enhance overall well-being. Considering the individual variations in potential health benefits, it is crucial to seek guidance from healthcare professionals or nutritionists. This ensures a personalized and evidence-based approach to sustainably integrate parsley into individuals' daily diets.

Keywords: antioxidantes, plants, pasrsley, nutrition, public health, obesity

Introduction

For decades, the significant impact of consuming nutritious food sources has been well documented. Providing a sustainable diet rich in nutritive substances, such as dietary fibers, vitamins, minerals, and other essential components, undoubtedly contributes to the improvement of human well-being. Nutritious foods play a crucial role in supporting optimal physical and mental health, promoting growth and development, and reducing the risk of chronic diseases (Chen *et al.*, 2018; Townsend *et al.*, 2023). Studies have linked the progression and development of chronic diseases to an inadequate diet. Chronic diseases, such as cardiovascular diseases, type 2 diabetes, obesity, certain types of cancers, and neurodegenerative disorders, have complex etiologies influenced by multiple factors, including genetics and lifestyle and dietary choices. An inadequate diet lacking essential nutrients with excessive unhealthy components (such as saturated and trans fats, added sugars, and sodium) or low in dietary fibers, vitamins, minerals, and bioactive compounds can contribute to the development and progression of chronic diseases (Ali *et al.*, 2020; Gropper, 2023; Rappaport, 2016; Steyn and Damasceno, 2006; Teodoro, 2019). Moreover, consumption of specific nutrients, known as nutraceuticals, can have a substantial impact on human health and further improve overall well-being. Nutraceuticals are bioactive compounds or substances derived from food sources that provide health benefits beyond basic nutrition (Al Ali *et al.*, 2021; Nasri *et al.*, 2014).

Green leafy vegetables, such as parsley (*Petroselinum crispum* Mill.), have been acknowledged widely for their significant contribution to human health because of their abundant supply of essential nutrients and bioactive compounds, classified as nutraceuticals. Parsley, a resourceful herb cultivated and consumed for centuries, has a long and fascinating history originating from the Mediterranean and Middle East regions, particularly in Italy, Greece, and Lebanon. It is valued for its distinct flavor and aromatic qualities and is used in both culinary and traditional medicines. Since ancient times, parsley is believed to have diuretic properties and has been used as a traditional remedy for kidney stones. Ancient cultures utilized parsley to address health issues, such as menstrual disorders, gastritis, and prostatitis (Agyare *et al.*, 2017; Charles, 2012; Kumar *et al.*, 2016). Its historical uses have attracted the attention of researchers, leading to investigations of the health claims associated with the herb. Numerous studies have discovered beneficial effects of consuming parsley for various health conditions, such as preventing liver and kidney damage (Ashry *et al.*, 2021; Bastampoor *et al.*, 2021; Goda *et al.*, 2023), enhancing cognitive functions (Ertik *et al.*, 2023; Şener *et al.*, 2022), and alleviating metabolic disorders (Eshak and Mahran, 2018; Soliman *et al.*, 2015). Parsley has a dense nutritional composition with various bioactive components. It is rich in vitamins and minerals, including vitamins A and K, ascorbic acid, potassium, iron, and zinc. Additionally, it contains a wide range of bioactive substances, such as phenylpropenes, phenolics, and pigments (Farouk *et al.*, 2017; US Department of Agriculture, 2019; Zhang *et al.*, 2006). This diverse profile of parsley suggests that it has a strong potential to promote various health benefits. This review aimed to provide a comprehensive overview of the health benefits of parsley, highlighting its potential in promoting various favorable outcomes. By synthesizing the existing studies and research findings, our objective was to reveal the potential health benefits associated with parsley consumption and to present a holistic understanding of its impact on human well-being.

Botanical Description and Longevity Attributes

Parsley (*Petroselinum crispum* Mill.) is a vibrant green herb characterized by distinctive aroma and flavor. It belongs to the Apiaceae family, commonly known as the carrot or parsley family. The scientific name of parsley, *Petroselinum*, has its roots in the Greek words *petros*, meaning 'stone' (indicating its ability to thrive in rocky environments), and *selinon*, referring to 'celery'. Throughout the Middle Ages, the name underwent transformations, evolving from petrocilium to petersylinge, persele, persley, and eventually settling on the familiar term 'parsley', presently recognized in English (Charles, 2004; Daradkeh and Essa, 2016).

Parsley is a biennial herbaceous plant grown in sunny areas with suitable environmental conditions, favorably in humid soil with a pH ranging from 5.3 to 7.3. In such conditions, it could grow up to a height of 60–120 cm but typically reaches 20–30 cm. It is sensitive to water stress, especially if it is planted in the summer and at the end of spring, thereby providing a permanent source of water that can increase its production and improve growth quality. Morphologically, parsley forms a dense, bushy clump with upright, ribbed, and branched stems. Its compound leaves consist of bright green, glossy leaflets with smooth or slightly toothed margins. The leaflets are ovate to triangular in shape and arranged in a pinnate or bipinnate fashion (Figure 1). The seeds are round or pear-like in shape, with a strong lateral compression. They range in color from greenish gray to grayish brown and consist of two connected achenes. These achenes can easily be separated along the commissural surface, revealing mericarps that resemble a sickle shape. The mericarps measure up to 2 mm in length and 1–2 mm in width (Figure 2) (Agyare *et al.*, 2017; Charles, 2012).

Parsley's longevity during storage is influenced by various factors, including temperature, humidity, and proper trimming of stems, all of which contribute to preserving its freshness. Refrigeration is commonly employed and can extend the storage capacity of fresh parsley to approximately 1–2 weeks. However, longer storage durations can be achieved under specific conditions. When stored at a temperature of 0°C, parsley can maintain its quality for up to 1–2 months, while in a cold store at 0–2°C, it can remain fresh for over 12 days. These lower temperatures help to slow down the degradation processes and preserve parsley's vibrant appearance and flavor (Cătunescu *et al.*, 2012; Daradkeh and Essa, 2016). It is worth noting that other factors, such as air circulation, packaging methods, and initial quality of parsley, can impact its shelf life. Exploring alternative preservation techniques, such as drying, can further extend the storage duration of parsley (Dziki *et al.*, 2022).

Nutritional Composition and Bioactive Content

Parsley is a nutrient-rich herb with a distinct nutritional composition, characterized by moderate amounts of

Figure 1. Leaves of parsley (*Petroselinum crispum*).

Figure 2. (A) Seeds, (B) roots, and (C) flowers of parsley (*Petroselinum crispum*).

dietary fiber and rich amounts of vitamins and minerals, along with a diverse array of bioactive phytonutrients, such as phenolic acids and flavonoids; the latter representing its unique nutritional composition. This section discusses both minor and major nutritional characteristics of parsley leaves.

Parsley provides an intense nutrient profile with a low-calorie intake; almost each 100 g of fresh parsley contains 36 calories. In addition to this low-calorie intake, approximately 3 g of dietary fiber can be obtained per 100 g of parsley, which nearly provides 10.7% of the average dietary reference intake (DRI) of fiber (National Institutes of Health [NIH], n.d.; US Department of Agriculture, 2019). Carbohydrates and protein are also present in parsley but in relatively minimal quantity. However, the macronutrient content of parsley is significantly lower compared to its abundance of vitamins and minerals (Table 1). Vitamins and minerals are universally recognized as essential nutrients for various physiological functions of human body, including immune support, energy production, and sustaining optimal bone and muscle health. Diversifying the intake of vitamin- and mineral-rich foods is advisable to meet daily nutritional requirements to enhance the overall well-being (Gharibzahedi and Jafari, 2017; Maqbool *et al.*, 2017). Parsley’s has an excellent diversity of vitamins, including vitamins C, A, E (mainly α-tocopherol), K (phylloquinone), and B-complex. As shown in Table 1, this wide range of vitamins can almost provide per 100 g of fresh parsley leaves an average range of 5–38% of DRI for both adult males and females, with vitamins C and K providing nearly an average of more than 150% DRI. Selected minerals, such as potassium, calcium, and zinc, found in fresh parsley leaves also provide 7−17% of DRI to both adult males and females (NIH, n.d.).

Furthermore, parsley leaves not only provide essential vitamins and minerals but they are also a rich source of a diverse array of phytonutrients, such as phenylpropenes, phenolics, and pigments (Table 2). These constituents potentially function as nutraceuticals by augmenting the nutritional value and health-enhancing properties of parsley. Phenylpropenes, for instance, potentially exhibit biological activities along with their contribution to the distinct flavors and aromas of plants. Phenylpropenes are mainly found in the plant's essential oils, which are responsible for their characteristic fragrances (Burčul *et al.*, 2020). The main phenylpropenes that dominate parsley essential oils are myristicin and apiol, comprising 32.75% and 17.54% of its total chemical composition, respectively (Zhang *et al.*, 2006). Phenolic compounds, on the other hand, contribute to both flavor and color of plants along with playing a key role in plant physiology and defense mechanisms. Phenolic compounds are well demonstrated to exhibit health-promoting properties, such as antimicrobial, anti-inflammatory, and antioxidant effects (Kumar and Goel, 2019; Ullah *et al.*, 2020). Parsley

Table 1. Nutritional composition of parsley leaves (*Petroselinum crispum*).

Component	Dry leaves	Fresh leaves	DRI (%)*
Macronutrients (g 100 g^{-1})			
Fat		0.79[2,6]	
Protein		2.97[4]; 3.10[2]	
Carbohydrates		5.33[2]; 6.33[4]	
Dietary fiber		3.3[4]; 4[2]	12.10
Energy (Kcal 100 g^{-1})		36[4]	
Vitamins			
Vitamin A (µg 100 g^{-1})		400[2]; 421[4]	51
Vitamin C (mg 100 g^{-1})	248.31[1]; 138−163[3]	125[2]; 133[4]	156.4
Vitamin E (mg 100 g^{-1})		0.60[2]	5.6
α-tocopherol		0.75[4]	
γ-tocopherol		0.53[4]	
Vitamin K (µg 100 g^{-1})		164[4]	156
B complex (mg 100 g^{-1})			
Thiamine		0.086[4]	7.49
Riboflavin		0.098[4]	8.22
Niacin		1.31[4]	8.77
Pantothenic acid		0.4[4]	8
Pyridoxine		0.09[4]	6.92
Folate (µg 100 g^{-1})		152[4]	38
Minerals (mg 100 g^{-1})			
Potassium		450[2]; 554[4]	17
Calcium		120[2]; 138[4]	13
Magnesium		50[4]	14
Manganese		0.14[2]; 0.16[4]	
Sodium		53[2]; 56[4]	
Phosphorus		42.65[2]; 58[4]	7.19
Iron		5.55[2]; 6.2[4]	53
Zinc		0.99[2]; 1.07[4]	11
Copper		0.149[4]	16.56

[1]Kuźma *et al.*, 2014; [2]Eshak and Mahran, 2018; [3]Karklelienė et al., 2014; [4]US Department of Agriculture, 2019; [5]Justesen and Knuthsen, 2001.
*Calculated as an average daily reference intake (DRI) for both adult males and females, based on the mean values of estimated components.

Table 2. Main phytonutrients found in parsley (*Petroselinum crispum*).

Component	Dry leaves	Fresh leaves
Phenylpropenes (%)*		
Myristicin		32.75[9]; 26.21[10]
Apiol		17.54[9]
β-Phellandrene		11.61[10]
α-Phellandrene		10.54[10]
p-Cymenene		8.63[10]
Phenolics		
Total (mg GAE 100 g^{-1})	920[4]; 700[6]	985[5]; 1,740[6]
Phenolic acids (mg 100 g^{-1})		
Caffeic acid	85.67[8]	
Ferulic acid	27.07[8]	
Chlorogenic acid	171.30[8]	
Cinnamic acid		
Protocatechuic acid		
Gallic acid	37.49[8]	
Syringic acid	9.49[8]	
Vanillic Acid	26.31[8]	
Flavonoids (mg 100 g^{-1})		
Total (mg QE 100 g^{-1})	1,435[7]	
Catechin	5.36−13.82[1]	
Apigenin	510−630[3]; 1,316[6]	1,375.2[6]
Kaempferol		
Luteolin	24.17[8]	
Cynaroside		
Rutin	22.03[8]	
Chrysoeriol		
Apiin		
Quercetin	19.89[8]	
Pigments		
Carotenoids (mg 100 g^{-1})	31.28[1]; 2−16[2]	
Chlorophyll (mg g^{-1})	0.185[1]; 0.09−0.87[2]	

[1]Kuźma *et al.*, 2014; [2]Dobričević *et al.*, 2019; [3]Justesen and Knuthsen, 2001; [4]Farah *et al.*, 2015; [5]Slimestad *et al.*, 2020; [6]Henning *et al.*, 2011; [7]Chandra *et al.*, 2014; [8]Derouich *et al.*, 2020; [9]Zhang et al., 2006; [10]Farouk et al., 2017.
*Estimated in parsley essential oil.
GAE: gallic acid equivalent; QE: quercetin acid equivalent.

is known to contain rich amounts of phenolic compounds with total content ranging from 700 to 920 mg of gallic acid equivalent (GAE) per 100 g of its dried leaves. Fresh parsley leaves may have a total of 1,740 mg GAE per 100 g of phenolic compounds (Farah *et al.*, 2015; Henning *et al.*, 2011). Parsley's phenolics, phenolic acids, and flavonoids contribute to its distinct flavor while providing additional health-promoting effects. Caffeic acid, ferulic acid, syringic acid, and chlorogenic acid are among the various phenolic acids found in parsley, with amounts ranging from 9 to 171 mg per 100 g of dried parsley leaves. Among parsley's flavonoids are quercetin, rutin, luteolin, and apigenin, with their quantities ranging from 19 to 630 mg per 100 g of dried parsley leaves (Derouich *et al.*, 2020; Justesen and Knuthsen, 2001). Other major constituents that contribute to the color of parsley are its pigments, primarily chlorophyll and carotenoids. Chlorophyll is responsible for the green color of parsley, while carotenoids contribute to its yellow to orange hues. Parsley contains chlorophyll and carotenoids in the range of 0.09–0.87 mg per g and 2–31 mg per 100 g of dried leaves, respectively. These pigments not only provide visual appeal to parsley but also play a vital role in the process of photosynthesis, especially chlorophyll. In addition to offering health benefits to both plants and humans, carotenoids, in particular, play the role of radical scavenger that protects the plant from oxidative damage. It also provides antioxidant activity to the body along with offering other potential health benefits, such as anti-inflammatory and anticancer effects (Chandra *et al.*, 2014; Dobričević *et al.*, 2019; Kuźma *et al.*, 2014).

Traditional Applications and Cultural Significance

Parsley for long has played a significant role in culinary traditions, cultural practices, and traditional medicines around the world. Renowned for its fresh and vibrant flavor profile, this unassuming herb, characterized by delicate leaves and a distinctive aroma, for long has been revered for its ability to impart a burst of freshness to various dishes. Beyond its culinary attributes, parsley holds profound cultural significance, finding a place in diverse traditions and celebrations. This section discusses the versatile uses of parsley in global cuisines, examining its culinary appeal and the intricate cultural symbolism it carries. Furthermore, the lesser-known applications of parsley in traditional medicines across different cultures are discussed, shedding light on its potential health benefits and therapeutic properties.

Culinary applications and cultural significance

Parsley leaves are extensively utilized in culinary practices and have a cultural importance in diverse cuisines globally. It is commonly employed as a decorative element for adding vibrant color and a touch of freshness to numerous dishes, such as soups, stews, salads, and sauces. Parsley is also used as an ingredient in cooked meals to enhance flavors and provide nutritional benefits. The native homeland of parsley is the Mediterranean and Middle East regions, specifically in the eastern Mediterranean and western Asia (Charles, 2004, 2012; Kumar *et al.*, 2016; Odobasic *et al.*, 2017). In western Asian regions, such as Lebanon, Palestine, and Turkey, parsley is commonly used in traditional cuisines, such as *tabbouleh*, a popular Middle Eastern salad that prominently features a high portion of finely chopped parsley along with bulgur wheat, tomatoes, onions, and a dressing of lemon juice and olive oil. Parsley serves as the foundation of this refreshing and nourishing salad, contributing to its vibrant green color and a distinctively fresh and intense flavor. In addition to *tabbouleh*, parsley is widely used as a key ingredient in numerous other Middle Eastern cuisines. For instance, Iraqi cuisine commonly utilizes parsley as a key ingredient in the stuffing mixture of various vegetables, providing a delightful flavor and a refreshing touch to common dishes such as stuffed grape leaves 'dolma', stuffed bell peppers, and stuffed zucchini (Al-Khusaibi, 2019; Nasrallah, 2009). Another notable use of parsley is found in the widely enjoyed dish called *mujaddara*, a native comforting Palestinian cuisine that features a delightful combination of lentils, rice, and caramelized onions. Parsley is often incorporated as a garnish, serving to elevate flavors and introduce a refreshing element to the overall composition of the dish (Khan, 2018). The exploration of parsley's applications in these regions is by no means exhaustive, as its utilization extends to a wide array of dishes. This expansive usage serves to highlight the remarkable versatility and noteworthy significance of parsley within the esteemed gastronomic Mediterranean and Middle Eastern cultures.

Beyond Mediterranean and Middle Eastern regions, the utilization of parsley has expanded since the 16th century, with discovering its route into the culinary traditions of many other countries, including certain European cultures. In French cuisine, parsley is a key ingredient for creating *bouquet garni*, a herb bundle used for enhancing the flavors of stocks, stews, and sauces. Parsley is frequently used as an important component in certain French dishes, such as *moules marinières*, a popular dish featuring cooked mussels prepared with white wine, shallots, butter, and parsley (Julien-David and Marcic, 2020).

Apart from parsley's culinary applications, it is believed to have a cultural and symbolic significance in certain European folklore and traditions. In ancient Greek and Roman cultures, parsley was not commonly cultivated for consumption but rather for other high values. Greek folklore often incorporated parsley as a key feature in festive celebrations, and it was frequently used as a decorative element during Easter festivities. Moreover, parsley seeds are associated with superstitions, with beliefs that they possess extraordinary ability to repel evil spirits. In Roman culture, parsley served as a means to counteract garlic odor. Furthermore, in both Greek and Roman cultures, parsley was considered an exceptional fodder for their chariot horses, with the belief that it provided exceptional nourishment and strength to the animals (Agyare *et al.*, 2017; Charles, 2012).

Parsley as a traditional medicine

Parsley has a long history of being used in various traditional medicinal practices across different cultures. One of the most common medicinal uses of parsley is to manage urinary tract infection and fluid retention. It is often employed as a diuretic agent for treating kidney stones. Additionally, in traditional Turkish and some other cultures, parsley is utilized for managing bleeding, hypertension, hyperlipidemia, hepatic disorders, and diabetes.

In several European countries, such as Spain, Italy, and Serbia, parsley is used to treat a wide range of ailments, such as lumbago, eczema, nosebleeds, menstrual disorders, gastritis, prostatitis, constipation, anemia, toothache, halitosis, baldness, and even for inducing abortion. In regions such as Iraq and Morocco, parsley leaves are applied to treat skin disorders, arterial and cardiac diseases, lumbago, eczema, and nosebleeds (Agyare *et al.*, 2017; Charles, 2012). In traditional Chinese medicine, parsley is significantly employed to tonify and enrich the blood, regulate the body's water balance, and help eliminate toxins. It is believed to have positive effects on digestion and promote a sense of well-being. In India, parsley is utilized for treating cold, cough, fever, stomach issues, and indigestion (Charles, 2012; Punoševac *et al.*, 2021).

Nutraceutical Potential and Health-Promoting Effects

As discussed in the previous section, parsley leaves exhibit a remarkable profile of nutritional and bioactive constituents. The presence of bioactive constituents indicates substantial potential in the management and prevention of various health conditions (Figure 3). This section highlights the predominant health-enhancing effects attributed to the consumption of parsley.

Antioxidant effects

Parsley's abundant contents of phenolic compounds and other bioactive components, such as carotenoids, can boost its radical scavenging activity. Free radicals, or reactive oxygen species (ROS), are highly reactive molecules that if produced in amounts exceeding the body's antioxidant defenses can cause oxidative damage, the phenomenon known as oxidative stress. Oxidative stress is associated with the progression and development of various chronic diseases as well as aging processes (Pizzino *et al.*, 2017; Vona *et al.*, 2021). Phenolic compounds found in parsley, such as flavonoids and phenolic acids, possess strong antioxidant properties by neutralizing free radicals by donating an electron,

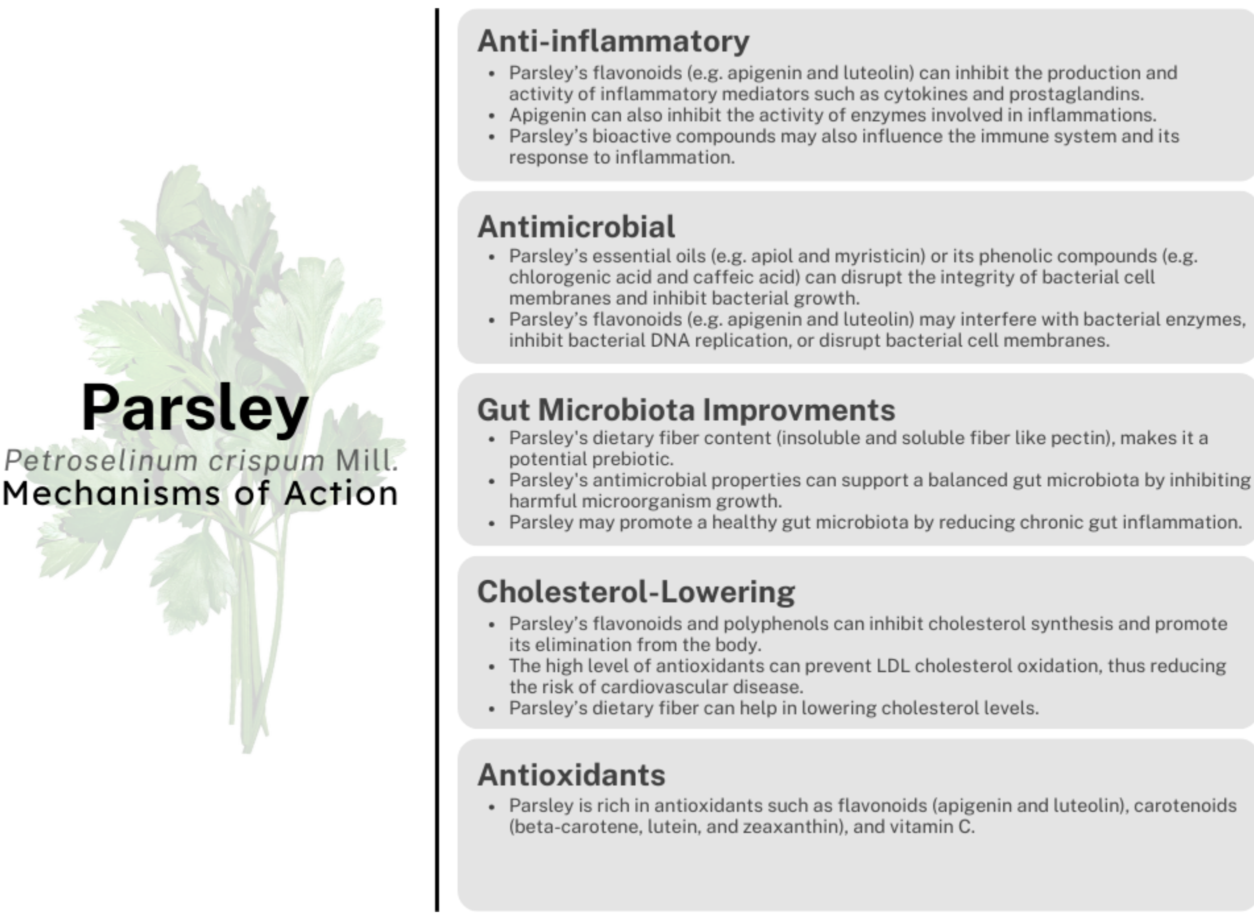

Figure 3. **The possible mechanism of action of parsley (*Petroselinum crispum*) in promoting health benefits.**

thereby alleviating their presence and reducing oxidative stress. Parsley's scavenging activity is found to reach 30–64% against 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical, the widely used indicator of antioxidant capacity (Al-Juhaimi and Ghafoor, 2011; Henning *et al.*, 2011; Hussain *et al.*, 2008). Another study demonstrated that parsley extract showed radical scavenging activity with a half-maximal inhibitory concentration (IC50) value of 3,310 μg mL^{-1}, indicating moderate to excellent antioxidant activity (Tang *et al.*, 2015).

Parsley's strong antioxidant potential is reported in various studies. In male rats exposed to hydrogen peroxide (H_2O_2) to induce oxidative stress, the oral administration of aqueous extract of parsley seeds at a dose of 8 mg 100 g^{-1} body weight (BW) for 4 weeks reversed tissue damage. The results showed a significant elevation in the glutathione levels of plasma and tissues and a reduction in malondialdehyde levels (Khudiar *et al.*, 2001). Consistently, a significant reduction in malondialdehyde levels was observed in hyperuricemic mice orally administrated with parsley juice at a dose of 5 mg 100 g^{-1} BW daily for 2 weeks (Haidari *et al.*, 2011). Similarly, in mice exposed to severe chronic oxidative stress, the daily consumption of 40% parsley for 7 days showed protective effects against oxidative damage by increasing cellular antioxidant enzymes, such as glutathione, catalase, and superoxide dismutase (Akinci *et al.*, 2017). In other animal models, the administration of alcoholic extract of parsley reversed abnormalities observed due to dioxin, a highly toxic environmental pollutant.

Significant reductions in lipid peroxidation, protein carbonyl content, and nitric oxide were observed along with significant increase in antioxidant enzymes (El-Gayar *et al.*, 2016). In the brain tissues of mice exposed to oxidative damage because of extensive doses of D-galactose, protective effects were observed after the administration of ethanolic extract of parsley leaves (Vora *et al.*, 2009). Similar protective effects against oxidative damage were observed in animal models treated with parsley extracts (Guven *et al.*, 2019; Vranješ *et al.*, 2021). In mice models that experienced excessive fatigue, the administration of parsley extract, specifically its flavonoids, demonstrated significant anti-fatigue effects. These effects were potentially linked with the regulation of the Kelch-like ECH-associated protein 1–nuclear factor erythroid 2-related factor 2 (KEAP1/NRF2) and adenosine monophosphate-activated protein kinase–primordial germ cell-1α (AMPK/PGC-1α) pathways. Both these pathways play important roles in cellular homeostasis and adaptation to stress (Wang *et al.*, 2022b). Nevertheless, further research is required to determine whether these findings could be replicated in humans.

Antiobesity effects

Parsley's beneficial effects in promoting weight loss or preventing lipid accumulation were examined in multiple studies. In a study conducted on obese women following a weight loss program, consuming parsley leaves accelerated their weight loss progression. The level of low-density lipoprotein (LDL) cholesterol was effectively reduced among those who consumed parsley in their daily diet. These results were attributed to a significant increase in females' serum antioxidant enzymes (Eshak and Mahran, 2018). In another study conducted with hypercholesteremic-induced mice, supplementation with 20% methanolic extract of parsley seeds significantly reversed increase in the levels of LDL with an increase in high-density lipoprotein (HDL) cholesterol (El Rabey *et al.*, 2017). Similarly, in other hypercholesteremic-induced animal models, 10–20% of parsley was incorporated into animals' diet. The results showed that addition of parsley led to a significant reduction in body weight as well as rate of food efficiency. The histological examination also showed protective effects against liver lipid accumulation (El-Kherbawy *et al.*, 2011). The observed effects were attributed to the dietary fiber content present in parsley, which contributed to the promotion of satiety and enhance food control (Dayib *et al.*, 2020).

In addition, abundant supply of bioactive components in parsley, such as flavonoids and vitamin C, can exhibit antioxidant and anti-inflammatory effects, which have a vital role in supporting metabolic processes and potentially contribute to weight management (Abdali *et al.*, 2015; Taherkhani *et al.*, 2021). Antioxidant compounds are shown to enhance the metabolic system by positively influencing the activity and composition of the gut microbiota, which refers to the diverse community of microorganisms that reside in the gastrointestinal tract. Substances such as flavonoids are shown to stimulate the growth of beneficial bacteria while inhibiting the proliferation of harmful bacteria. Maintaining a balanced gut microbiota is recognized as a targeted strategy against obesity, and studies have shown that obese individuals often have reduced microbial diversity (Davis, 2016; Deledda *et al.*, 2021; Duan *et al.*, 2021; Sarmiento-Andrade *et al.*, 2022; Wang *et al.*, 2022a). On the other hand, some studies suggest that flavonoids may have anti-obesity effects by improving insulin sensitivity and reducing blood glucose fluctuations (Al-Ishaq *et al.*, 2019; Martín and Ramos, 2021). Thereby, parsley might indirectly support weight management by suppressing insulin resistance. Indeed, a couple of studies have reported reduced blood glucose levels in diabetic animal models because of parsley intervention (Bolkent *et al.*, 2004; Sener *et al.*, 2003). Improved insulin sensitivity is generally associated with better blood glucose control and a reduced risk of developing obesity and related metabolic disorders (Clamp *et al.*, 2017).

Antidiabetic effects

Several studies have demonstrated the potential antidiabetic effects of parsley in induced diabetic animal models. In streptozotocin (STZ)-induced diabetic rats, the daily oral administration of parsley aqueous extract at the dosage of 2 g kg^{-1} BW for 28 days showed improvement in blood glucose levels. It also showed protective effects against the progressive alterations observed in rats' aorta and heart tissues caused by STZ injection (Sener *et al.*, 2003). Similar protective effects on the heart tissue of diabetic rats were also observed after oral administration of parsley aqueous extract at a similar dosage (2 g kg^{-1} BW). Administration of parsley also showed a significant reversion in the hyperlipidemia caused by STZ injection (Soliman *et al.*, 2015). Hepatoprotective effects were also observed in diabetic mice treated with parsley extract along with significant attenuation in blood glucose levels. The treatment reversed the progressive alterations observed in the hepatocyte tissue of diabetics along with reversing abnormalities in the levels of alanine aminotransferase (ALT) and alkaline phosphatase (ALP) that occurred due to STZ injection (Bolkent *et al.*, 2004). Consistently, in other diabetic-induced animal models, parsley treatment showed hepatoprotective effects, comparable to glibornuride, a sulfonylureas antidiabetic drug. It was discovered that these effects were attributed to a reduction in nonenzymatic glycosylation process (Ozsoy-Sacan *et al.*, 2006). Nonenzymatic glycosylation, also known as glycation, is a chemical reaction in which excessive glucose molecules bind to proteins or lipids in the absence of enzymatic activity. This process results in the formation of intricate and destructive substances known as advanced glycation end products (AGEs). Attenuating the formation of AGEs and effectively managing their impact has emerged as a therapeutic target in the comprehensive management of diabetes and its associated complications (Singh *et al.*, 2014; Vlassara and Uribarri, 2014).

It was shown in another study that the oral administration of parsley extract promoted significant protective effects on the integrity of pancreatic β-cells (Eltablawy *et al.*, 2012). The observed effects were attributed to the rich composition of bioactive compounds found in parsley, such as polyphenols and phenolic acids. These components possess antioxidant, anti-inflammatory, and antiapoptotic properties, which contributed to preventing the destruction of β-cells (Babu *et al.*, 2013; Silveira *et al.*, 2019). Consequently, Sener *et al.* (2003) reported that the antidiabetic effects observed after the administration of parsley extract were accompanied by a reduction in lipid peroxidation in protected tissues. Ozsoy-Sacan *et al.* (2006) also reported decreased lipid peroxidation and increased levels of lipid glutathione in diabetic rat models following treatment with parsley. Although these studies suggested the potential benefits of parsley in managing diabetes, further research is necessary to validate these findings and determine the precise mechanisms involved.

Hepatoprotective effects

The liver, the main detoxification organ, plays a crucial role in preventing diseases such as fatty liver disease, hepatitis, cirrhosis, and even certain cancers (Kalra *et al.*, 2018). Parsley leaves were shown to promote hepatoprotective effects in multiple animal studies; in alcohol-induced hepatotoxicity in rat models, pretreatment with parsley's oil showed protective effects against the progressive damage caused by alcohol induction, including significant increases in the activities of serum ALT, ALP, and aspartate aminotransferase (AST) (Abou Seif, 2014). In another study, bile obstruction was performed to induce liver damage in rat models followed by oral administration of parsley extract at a dose of 2 g kg^{-1} for 28 days. A similar significant reduction in the levels of AST and ALT suggests the therapeutic potential of parsley leaves against liver fibrosis (Ede *et al.*, 2023). Consistently, in other animal models induced with hepatotoxicity, the oral administration of parsley showed protective effects against liver lipid accumulation as well as inflammatory reactions (Ertaş *et al.*, 2021). Similarly, administration of dietary parsley leaves at the dosage of 4 g kg^{-1} per diet showed protective effects against zinc oxide-induced hepatotoxicity in fish models (Goda *et al.*, 2023).

The hepatoprotective effects of parsley were shown to significantly relate to its properties in stimulating hepatocyte proliferation through up-regulation of hepatic apoptosis-related genes (Bastampoor *et al.*, 2021). The lipid-lowering effects of parsley also have protective effects against lipid-induced liver injury (El-Kherbawy *et al.*, 2011; Eshak and Mahran, 2018). Moreover, the beneficial effects of parsley against liver injury are attributed to its content of intensive nutraceutical agents, such as apigenin and myristicin. Both agents are shown to enhance detoxification ability of the liver by enhancing the activity of its enzymes involved in the process (Salehi *et al.*, 2019; Seneme *et al.*, 2021). In addition, the antioxidant effects of parsley have a role in promoting hepatoprotective effects. Pretreatment with parsley oil conducted by Abou Seif (2014) showed protective effects against hepatocytes' lipid peroxidation as observed by normalizing the levels of hepatic glutathione and catalase. Ede *et al.* (2023) observed similar results after the administration of parsley extract to induce liver damage in mice models.

Nephroprotective effects

The kidneys are other vital organs for efficient detoxification by elimination of waste products, toxins, and excess fluids from the bloodstream. Maintaining healthy kidney function is crucial for sustaining optimal health and overall well-being (Li *et al.*, 2020). Parsley leaves have a role in promoting promising functional effects to combat kidney injuries. In induced renal damages in rat models, administration of parsley extract at a dosage of 250 mg kg^{-1} BW showed significant reduction in the levels of kidney dysfunction serum markers, such as urea, creatinine, and uric acid. Protective effects against degeneration of kidney tissues were also observed (Ashry *et al.*, 2021). Consistently, in ischemia/reperfusion-induced kidney injury in animal models, pretreatment with parsley extract at the doses of 100, 150, and 200 mg kg^{-1} BW showed significant reduction in blood urea nitrogen as well as leukocyte infiltration (Roshankhah *et al.*, 2019). Administration of parsley seed extracts was shown to reduce significantly urine protein content, indicating the kidney's efficiency in filtering and retaining proteins in the bloodstream, rather than allowing them to pass through urine; presence of protein in urine, a state known as proteinuria, is a sign of kidney damage or dysfunction (Gumaih *et al.*, 2017).

The possible role of parsley in promoting nephroprotective effects depend on multiple mechanisms. One of the reported mechanisms is the excellent diuretic property of parsley, which means its ability to promote the production of urine and increase the frequency of urination, leading to eliminating toxins from the body. The diuretic property of parsley is attributed to its rich content of apiol, which is reported to induce vasodilation of renal arteries, thereby improving blood flow to the kidneys. Adequate blood supply is crucial for maintaining renal function and preventing kidney damage (Kreydiyyeh and Usta, 2002). Additionally, parsley leaves inhibit the formation of certain types of kidney stones, such as calcium oxalate stones (Al-Yousofy *et al.*, 2017). Moreover, parsley's nephroprotective effects rely on its anti-inflammatory and antioxidant properties. Ashry *et al.* (2021) reported that the administration of parsley extract lessened abnormalities recorded in the levels of proinflammatory cytokines, including tumor necrosis factor-alpha (TNF-α) and interleukin-1 beta (IL-1β), which occurred as a result of inducing renal damage in mice models. The authors also observed enhancement in oxidative parameters of the kidneys. Similar results were reported by Roshankhah *et al.* (2019), who showed enhancement in the kidney's oxidative parameters, including malondialdehyde and creatinine, after pretreatment to ischemia/reperfusion-induced kidney injury models with parsley extract.

Neuroprotective effects

The beneficial effects of parsley leaves on cognitive functions were investigated in multiple studies. In mice models exposed to cadmium toxicity, the daily administration of parsley juice at doses ranging from 5 to 20 g kg^{-1} BW showed significant lessening of behavioral changes caused by cadmium toxicity (Maodaa *et al.*, 2016). Similarly, in mice dams exposed to cadmium, significant protective effects against developing behavioral changes were observed in their offspring with administration of parsley juice at doses of 20 and 10 mg kg^{-1} BW. Improvement was observed in neurotransmitter levels, compared to positive control offspring (Allam *et al.*, 2016). In mice models induced with Alzheimer's disease-like symptoms because of the treatment with scopolamine, an anticholinergic drug, the administration of parsley extract at a dosage of 2 g kg^{-1} BW for 2 weeks showed protective effects on spatial and recognition memory (Şener *et al.*, 2022). These results were attributed to parsley's beneficial effects in enhancing brain's cholinergic functioning, which is a neurotransmitter working that uses neurotransmitter acetylcholine to transmit signals between neurons in the brain and other parts of the body. Şener *et al.* (2022) found that administration of parsley resulted in a reduced activity of acetylcholinesterase (AChE), an enzyme responsible for breaking down of acetylcholine. By inhibiting or reducing the activity of AChE, the breakdown of acetylcholine is slowed down, leading to increased levels of acetylcholine in the nervous system. Maintaining higher levels of acetylcholine can be considered a therapeutic target for treating certain cognitive conditions, including Alzheimer's disease.

The cholinergic activity of parsley is attributed to its content of apigenin (Salehi *et al.*, 2019). Other nutraceuticals present in parsley, such as myristicin, can promote neuroprotective effects by reducing oxidative stress (Ciftci *et al.*, 2014). It was found in Alzheimer's disease-induced mice that the administration of parsley extract effectively prevented oxidative damage in the lens tissues of the animals (Ertik *et al.*, 2023). Maodaa *et al.* (2016) reported that even at lower doses of 5 g kg^{-1} BW, parsley administration exhibited protective effects against lipid peroxidation in neurons of the brain in mice models.

Anticancer effects

The protective effects of parsley leaves were further examined against proliferation of tumor in a couple of studies. In mice fibroblasts (3T3-L1) cell lines, pretreatment with parsley extract at a dosage of 400 μg mL^{-1} showed inhibition activity against DNA damage caused by induction of H_2O_2. The extract was also shown to inhibit cell migration of breast cancer cells (MCF-7) by nearly 40% (Tang *et al.*, 2015). In a study using similar breast cancer cell lines, the anticarcinogenic properties of parsley were linked to the presence of phytoestrogen and its estrogen-like activity. However, the relationship between phytoestrogens and the incidence of breast cancer is complex and still under investigation (Schröder, 2021; Schroeder *et al.*, 2017). The presence of apigenin and myristicin in parsley leaves could contribute to its anticarcinogenic properties. Both apigenin and myristicin are shown to regulate cell cycle in cancer cells by inhibiting its progression and inducing apoptosis, thereby preventing uncontrolled cell growth (Bao and Muge, 2021; Yan *et al.*, 2017). However, additional studies are required to elucidate precise molecular pathways involved in parsley's anticarcinogenic effects and to thoroughly evaluate its effectiveness in treating or preventing cancer in clinical settings.

Anti-osteoporotic effects

The functional potential of parsley was investigated for its ability to combat bone health issues. In glucocorticoid-induced osteoporosis in mice models, administration of aqueous extract of parsley at a dosage of 2 g kg^{-1} BW for 8 weeks reversed the progressive decrease observed in bone mineral content and density. The results showed an increase in both calcium and phosphorus levels (Hozayen *et al.*, 2016). Although parsley is not a direct source of essential bone-building nutrients, such as calcium and vitamin D, its potential to promote anti-osteoporotic effects might be attributed to its vitamin K content. Vitamin K plays a role in activating osteocalcin, a protein involved in bone mineralization. Maintaining adequate levels of vitamin K can support proper calcium utilization in bones (Akbari and Rasouli-Ghahroudi, 2018; Al-Suhaimi and Al-Jafary, 2020). In addition, magnesium and phosphate present in parsley may also contribute to the regulation of serum parathyroid hormone levels as well as acid phosphatase levels, both of which promote optimum bone health. Parathyroid hormone plays a crucial role in the maintenance of calcium balance, while acid phosphatase is responsible for the degradation of phosphoric acid esters (Alshami and Varon, 2020; Shaker and Deftos, 2023). Hozayen *et al.* (2016) reported that the observed anti-osteoporotic effects in mice were accompanied by normalization in the levels of serum parathyroid hormone and acid phosphatase. On the other hand, parsley's anti-inflammatory and antioxidant potential because of its richness in high-quality phytonutrients can have protective effects against developing osteoporosis. Recent studies have established a connection between the progression of osteoporosis and the presence of chronic inflammation and oxidative stress (Li *et al.*, 2023; Oršolić *et al.*, 2022).

Other effects

Further investigations for using parsley to combat other health conditions were conducted in multiple studies. One study reported antihypertensive effects of parsley's aqueous extract in hypertensive mice. The results indicated that parsley extract promoted vasodilation, which refers to the widening of blood vessels leading to a decrease in blood pressure (Ajebli and Eddouks, 2019). In another study, pretreatment with parsley's aqueous extract through intravenous administration showed antithrombotic effects in rat models subjected to induction of thrombosis. A reduction of 98% was observed in venous thrombus formation (Frattani *et al.*, 2021). Furthermore, it was shown in another study that parsley's essential oil possessed antimicrobial properties against various strains (Linde *et al.*, 2016). Extracts derived from parsley were found to exhibit antibacterial activity against pathogenic bacteria responsible for urinary tract infections (Petrolini *et al.*, 2013) and bacteria associated with burn-related infections (Aljanaby, 2013). Abundance of phenolic compounds in parsley, in addition to their antioxidant properties, has been linked to its antibacterial effects (Wong and Kitts, 2006). The findings of these studies emphasized the potential health benefits of parsley and its extracts and highlighted the need for further exploration of parsley's practical applications in preventing and managing various health conditions. Continued investigations and execution of benefits of parsley could have a positive impact on public health and enhance the well-being of individuals globally.

Potential Toxicity and Safety Considerations

The use of parsley is generally regarded as safe for most individuals if consumed in moderate amounts. However, some studies have identified potential toxicity concerns and safety considerations associated with parsley consumption. An animal study investigating the effects of administration of ethanolic extract of parsley leaves reported mild hepatotoxic and nephrotoxic effects at doses ≥1,000 mg kg^{-1} BW. These findings suggested that the administration of parsley extract should be limited to an optimal dose (Awe and Banjoko, 2013). Additionally, it was indicated that individuals with calcium oxalate kidney stones should apply caution regarding parsley consumption, with an advised limit of not exceeding 1½ cups of parsley because of its high content of calcium oxalate (Ajmera *et al.*, 2019).

Consumption of parsley was found to interfere with certain drug mechanisms. High content of vitamin K in parsley was shown to alter the effectiveness of warfarin (Coumadin) treatment, a commonly used anticoagulant. Additionally, excessive intake of parsley may interfere with diuretic therapy, leading to excessive water loss. Patients on aspirin therapy are also advised to avoid parsley consumption because of potential heightened sensitivity and allergic reactions. Moreover, the presence of myristicin has been associated with central nervous system effects. Ingesting excessive amounts of parsley has been linked to potential interference with opioid therapy, convulsions, and serotonin syndrome (Awe and Banjoko, 2013; Jakovljevic *et al.*, 2002).

Conclusions

The available studies indicated that parsley exhibits considerable potential in facilitating various favorable effects on health. These effects encompass its antioxidant and anti-inflammatory properties, its potential for management of diabetes, hepatoprotective and nephroprotective effects as well as its anticancer properties along with other potential health-promoting effects. These health benefits are largely attributed to the bioactive compounds present in parsley, which include a rich content of antioxidants, such as phenolic acids and flavonoids. Additionally, parsley contains key bioactive substances such as myricetin and apiol, which significantly contribute to its health-promoting properties. Parsley is also a rich source of essential vitamins, minerals, and dietary fiber, making it a substantial reservoir of nutrients and a highly valuable herb. Therefore, incorporating parsley into one's diet may prove to be a commendable addition for individuals seeking to enhance their overall health. However, it should be considered that the potential health benefits associated with parsley consumption could exhibit inter-individual variability. Therefore, it is crucial to avoid perceiving parsley as a remedy for all health issues. Seeking guidance from healthcare professionals or nutritionists is essential to develop a personalized approach, considering individual health requirements, medication interactions, and existing conditions. This promotes evidence-based and well-informed incorporation of parsley into a sustainable daily diet.

Author Contributions

Conceptualization: Albandari A. Almutairi, Hassan Mirghani Mousa, and Waheeba E. Ahmed. Literature research: Albandari A. Almutairi, Raghad M. Alhomaid, and Mona S. Almujaydil. Interpretation of data: Hassan Mirghani Mousa, Raghad M. Alhomaid, and Waheeba E. Ahmed. Visualization: Raya Algonaiman. Writing—original draft preparation: Albandari A. Almutairi and Raya Algonaiman. Writing—review and editing: Raya Algonaiman. All authors had read and agreed to the published version of the manuscript.

Conflict of Interest

The authors declared that there were no conflicts of interest regarding the publication of this paper.

Acknowledgement

The Researchers would like to thank the Deanship of Graduate Studies and Scientific Research at Qassim University for financial support (QU-APC-2024-9/1).

Funding

This research received no external funding.

References

Abdali, D., Samson, S.E. and Grover, A.K. 2015. How effective are antioxidant supplements in obesity and diabetes? Med Principles and Pract. 24(3):201–215. https://doi.org/10.1159/000375305

Abou Seif, H.S. 2014. Ameliorative effect of parsley oil (*Petroselinum crispum*) against alcohol-induced hepatotoxicity and oxidative stress. Med Res J. 13(2):100–107. https://doi.org/10.1097/01.MJX.0000457175.74392.0b

Agyare, C., Appiah, T., Boakye, Y.D. and Apenteng, J.A. 2017. *Petroselinum crispum*: a review. In: Medicinal Spices and Vegetables from Africa. pp. 527–547. https://doi.org/10.1016/B978-0-12-809286-6.00025-X

Ajebli, M. and Eddouks, M. 2019. Antihypertensive activity of Petroselinum crispum through inhibition of vascular calcium channels in rats. J Ethnopharmacol. 242:112039. https://doi.org/10.1016/j.jep.2019.112039

Ajmera, P., Kalani, S. and Sharma, L. 2019. Parsley-benefits & side effects on health. Int J Physiol Nutr Phy Edu. 4(1):1236–1242.

Akbari, S. and Rasouli-Ghahroudi, A.A. 2018. Vitamin K and bone metabolism: a review of the latest evidence in preclinical studies. BioMed Res Int. 2018. https://doi.org/10.1155/2018/4629383

Akinci, A., Eşrefoğlu, M., Taşlidere, E. and Ateş, B. 2017. Petroselinum crispum is effective in reducing stress-induced gastric oxidative damage. Balkan Med J. 34(1):53–59. https://doi.org/10.4274/balkanmedj.2015.1411

Al Ali, M., Alqubaisy, M., Aljaafari, M.N., AlAli, A.O., Baqais, L., Molouki, A., Abushelaibi, A., Lai, K.-S. and Lim, S.-H. E. 2021. Nutraceuticals: transformation of conventional foods into health promoters/disease preventers and safety considerations. Molecules. 26(9):2540. https://doi.org/10.3390/molecules26092540

Al-Ishaq, R.K., Abotaleb, M., Kubatka, P., Kajo, K. and Büsselberg, D. 2019. Flavonoids and their anti-diabetic effects: cellular mechanisms and effects to improve blood sugar levels. Biomolecules. 9(9):430. https://doi.org/10.3390/biom9090430

Al-Juhaimi, F. and Ghafoor, K. 2011. Total phenols and antioxidant activities of leaf and stem extracts from coriander, mint and parsley grown in Saudi Arabia. Pak J. Bot. 43(4):2235–2237.

Al-Khusaibi, M. 2019. Arab traditional foods: preparation, processing and nutrition. In: Traditional Foods: History, Preparation, Processing and Safety. pp. 9–35. https://doi.org/10.1007/978-3-030-24620-4

Al-Suhaimi, E.A. and Al-Jafary, M.A. 2020. Endocrine roles of vitamin K-dependent-osteocalcin in the relation between bone metabolism and metabolic disorders. Rev Endocr Metabolic Disorders. 21:117–125. https://doi.org/10.1007/s11154-019-09517-9

Al-Yousofy, F., Gumaih, H., Ibrahim, H. and Alasbahy, A. 2017. Parsley! Mechanism as antiurolithiasis remedy. Am J Clin Exp Urol. 5(3):55.

Ali, M.Y., Sina, A.A.I., Khandker, S.S., Neesa, L., Tanvir, E., Kabir, A., Khalil, M.I. and Gan, S.H. 2020. Nutritional composition and bioactive compounds in tomatoes and their impact on human health and disease: a review. Foods. 10(1):45. https://doi.org/10.3390/foods10010045

Aljanaby, A.A.J.J. 2013. Antibacterial activity of an aqueous extract of Petroselinum crispum leaves against pathogenic bacteria isolated from patients with burns infections in Al-najaf Governorate, Iraq. Res Chem Intermediates. 39:3709–3714. https://doi.org/10.1007/s11164-012-0874-5

Allam, A.A., Maodaa, S.N., Abo-Eleneen, R. and Ajarem, J. 2016. Protective effect of parsley juice (Petroselinum crispum, Apiaceae) against cadmium deleterious changes in the developed albino mice newborns (Mus musculus) brain. Oxid Med Cell Long. 2016. https://doi.org/10.1155/2016/2646840

Alshami, A. and Varon, J. 2020. Acid phosphatase.

Ashry, M., Atia, I., Morsy, F.A. and Elmashad, W. 2021. Protective efficiency of parsley (Petroselinum crispum) against oxidative stress, DNA damage and nephrotoxicity induced with anti-tuberculosis drugs. Int J Cancer Biomed Res. 5(1):27–36. https://doi.org/10.21608/jcbr.2020.45551.1077

Awe, E.O. and Banjoko, S.O. 2013. Biochemical and haematological assessment of toxic effects of the leaf ethanol extract of Petroselinum crispum (Mill) Nyman ex AW Hill (Parsley) in rats. BMC Comp Altern Med. 13(1):1–6. https://doi.org/10.1186/1472-6882-13-75

Babu, P.V.A., Liu, D. and Gilbert, E.R. 2013. Recent advances in understanding the anti-diabetic actions of dietary flavonoids. J Nutr Biochem. 24(11):1777–1789. https://doi.org/10.1016/j.jnutbio.2013.06.003

Bao, H. and Muge, Q. 2021. Anticancer effect of myristicin on hepatic carcinoma and related molecular mechanism. Pharma Biol. 59(1):1124–1130. https://doi.org/10.1080/13880209.2021.1961825

Bastampoor, F., Hosseini, S.E., Shariati, M. and Mokhtari, M. 2021. Exposure to aqueous-alcoholic extract of parsley leaves (*Petroselinum crispum*) in lead-treated rats alleviate liver damage. Kafkas Üniv Vet Fak Derg. 27(6):717–723.

Bolkent, S., Yanardag, R., Ozsoy-Sacan, O. and Karabulut-Bulan, O. 2004. Effects of parsley (*Petroselinum crispum*) on the liver of diabetic rats: a morphological and biochemical study. Phytother Res. 18(12):996–999. https://doi.org/10.1002/ptr.1598

Burčul, F., Blažević, I., Radan, M. and Politeo, O. 2020. Terpenes, phenylpropanoids, sulfur and other essential oil constituents as inhibitors of cholinesterases. Curr Med Chem. 27(26):4297–4343. https://doi.org/10.2174/0929867325666180330092607

Cătunescu, G.M., Tofanä, M., Mureșan, C., Ranga, F., David, A. and Muntean, M. 2012. The effect of cold storage on some quality characteristics of minimally processed parsley (Petroselinum crispum), dill (Anethum graveolens) and lovage (Levisticum officinale). Bull Univ Agric Sci Veter Med Cluj-Napoca. Agric. 69(2):1843–5386. https://doi.org/10.15835/buasvmcn-agr:8763; https://doi.org/10.15835/buasvmcn-agr:8762

Chandra, S., Khan, S., Avula, B., Lata, H., Yang, M.H., El Sohly, M.A. and Khan, I.A. 2014. Assessment of total phenolic and flavonoid content, antioxidant properties, and yield of aeroponically and conventionally grown leafy vegetables and fruit crops: a comparative study. Evid Compl Alter Med. 2014. https://doi.org/10.1155/2014/253875

Charles, D.J. 2004. Parsley. In: Peter, K.V. (Ed.), Handbook of Herbs and Spices 1st ed., Vol. 2. Woodhead, Cambridge, UK, pp. 230–242. https://doi.org/10.1533/9781855738355.2.230

Charles, D.J. 2012. Parsley. In: Peter, K.V. (Ed.), Handbook of Herbs and Spices 2nd ed. Woodhead, Cambridge, UK, pp. 430–451. https://doi.org/10.1533/9780857095671.430

Chen, Y., Michalak, M. and Agellon, L.B. 2018. Focus: nutrition and food science: importance of nutrients and nutrient metabolism on human health. Yale J Biol Med. 91(2):95.

Ciftci, O., Oztanir, M.N. and Cetin, A. 2014. Neuroprotective effects of β-myrcene following global cerebral ischemia/reperfusion-mediated oxidative and neuronal damage in a C57BL/J6 mouse. Neurochem Res. 39:1717–1723. https://doi.org/10.1007/s11064-014-1365-4

Clamp, L., Hume, D., Lambert, E. and Kroff, J. 2017. Enhanced insulin sensitivity in successful, long-term weight loss maintainers compared with matched controls with no weight loss history. Nutr Diabetes. 7(6):e282. https://doi.org/10.1038/nutd.2017.31

Daradkeh, G. and Essa, M.M. 2016. Parsley. In: Leafy Medicinal Herbs: Botany, Chemistry, Postharvest Technology and Uses. CABI, Wallingford, UK, pp. 189–197. https://doi.org/10.1079/9781780645599.0189

Davis, C.D. 2016. The gut microbiome and its role in obesity. Nutr Today. 51(4):167. https://doi.org/10.1097/NT.0000000000000167

Dayib, M., Larson, J. and Slavin, J. 2020. Dietary fibers reduce obesity-related disorders: mechanisms of action. Curr Opinion Clin Nutr Metab Care. 23(6):445–450. https://doi.org/10.1097/MCO.0000000000000696

Deledda, A., Annunziata, G., Tenore, G.C., Palmas, V., Manzin, A. and Velluzzi, F. 2021. Diet-derived antioxidants and their role in inflammation, obesity and gut microbiota modulation. Antioxidants. 10(5):708. https://doi.org/10.3390/antiox10050708

Derouich, M., Bouhlali, E.D.T., Bammou, M., Hmidani, A., Sellam, K. and Alem, C. 2020. Bioactive compounds and antioxidant, anti-peroxidative, and antihemolytic properties investigation of three apiaceae species grown in the southeast of Morocco. Scientifica. 2020:1–10. https://doi.org/10.1155/2020/3971041

Dobričević, N., Šic Žlabur, J., Voća, S., Pliestić, S., Galić, A., Delić, A. and Fabek Uher, S. 2019. Bioactive compounds content and nutritional potential of different parsley parts (Petroselinum crispum Mill.). J Central Eur Agric. 20(3):900–910. https://doi.org/10.5513/JCEA01/20.3.2417

Duan, M., Wang, Y., Zhang, Q., Zou, R., Guo, M. and Zheng, H. 2021. Characteristics of gut microbiota in people with obesity. Plos One. 16(8):e0255446. https://doi.org/10.1371/journal.pone.0255446

Dziki, D., Hassoon, W.H., Biernacka, B. and Gawlik-Dziki, U. 2022. Dried and powdered leaves of parsley as a functional additive to wheat bread. Appl Sci. 12(15):7930. https://doi.org/10.3390/app12157930

Ede, S., Özbeyli, D., Erdoğan, Ö., Çevik, Ö., Kanpalta, F., Ercan, F., Yanardağ, R., Saçan, Ö., Ertik, O. and Yüksel, M. 2023. Hepatoprotective effects of parsley (Petroselinum Crispum) extract in rats with bile duct ligation. Arab J Gastroenterol. 24(1):45–51. https://doi.org/10.1016/j.ajg.2022.10.006

El-Gayar, H.A., El-Habibi, E., Edrees, G., Salem, E. and Gouida, M. 2016. Role of alcoholic extracts of *Eruca sativa* or *Petroselinum crispum* on dioxin-induced testicular oxidative stress and apoptosis. Int J Sci Res. 5(1):1415–1421. https://doi.org/10.21275/v5i1.NOV152997

El-Kherbawy, G., Ibrahem, E. and Zaki, S. 2011. Effects of parsley and coriander leaves on hypercholesterolemic rats. In: The 6th Arab and 3rd International Annual Scientific Conference on Development of Higher Specific Education Programs in Egypt and the Arab World in the Light of Knowledge Era Requirements, Faculty of Specific Education, Mansoura University, Egypt, April, 2011.

El Rabey, H.A., Al-Seeni, M.N. and Al-Ghamdi, H.B., 2017. Comparison between the hypolipidemic activity of parsley and carob in hypercholesterolemic male rats. BioMed Res Int. 2017. https://doi.org/10.1155/2017/3098745

Eltablawy, N.A., Soliman, H.A. and Hamed, M.S. 2012. Antioxidant and antidiabetic role of petroselinum crispum against stz-induced diabetes in rats. Pathogenesis. 3:4.

Ertaş, B., Turan, F.B., Özbeyli, D., Yanardağ, R., Saçan, Ö. and Şener, G. 2021. Protective effects of Petroselinum crispum (Parsley) extract against methotrexate-induced hepatotoxicity. Eur J Biol. 80(2):173–178. https://doi.org/10.26650/EurJBiol.2021.1023136

Ertik, O., Pazarbaşı, E., Sener, G., Sacan, O. and Yanardag, R. 2023. Petroselinum crispum extract prevents lens damage in scopolamine-induced cognitive dysfunction. Chem Biodiver. 20(11):e202300776. https://doi.org/10.1002/cbdv.202300776

Eshak, N.S. and Mahran, M.Z. 2018. Effect of Parsley on weight reduction and antioxidant enzymes in overweight and obese women subjects. J Home Econ. 28(4):327–341. https://doi.org/10.21608/MKAS.2018.165466

Farah, H., Elbadrawy, E. and Al-Atoom, A.A. 2015. Evaluation of anti-oxidant and antimicrobial activities of ethanolic extracts of parsley (Petroselinum erispum) and coriander (Coriandrum sativum) plants grown in Saudi Arabia. Int J Adv Res. 3:1244–1255.

Farouk, A., Ali, H., Al-Khalifa, A.R., Mohsen, M. and Fikry, R. 2017. Aroma volatile compounds of parsley cultivated in the Kingdom of Saudi Arabia and Egypt extracted by hydrodistillation and headspace solid-phase microextraction. Int J Food Properties. 20(Sup. 3):S2868–S2877. https://doi.org/10.1080/10942912.2017.1381707

Frattani, F.S., Assafim, M., Casanova, L.M., de Souza, J.E., de Almeida Chaves, D.S., Costa, S.S. and Zingali, R.B. 2021. Oral treatment with a chemically characterized parsley (Petroselinum crispum var. neapolitanum Danert) aqueous extract reduces thrombi formation in rats. J Trad Comp Med. 11(3):287–291. https://doi.org/10.1016/j.jtcme.2020.04.003

Gharibzahedi, S.M.T. and Jafari, S.M. 2017. The importance of minerals in human nutrition: bioavailability, food fortification, processing effects and nanoencapsulation. Trends Food Sci Technol. 62:119–132. https://doi.org/10.1016/j.tifs.2017.02.017

Goda, M.N., Shaheen, A.A. and Hamed, H.S. 2023. Potential role of dietary parsley and/or parsley nanoparticles against zinc oxide nanoparticles toxicity induced physiological, and histological alterations in Nile tilapia, Oreochromis Niloticus Aquacul Rep. 28:101425. https://doi.org/10.1016/j.aqrep.2022.101425

Gropper, S.S. 2023. The role of nutrition in chronic disease. Nutrients. 15(3):664. https://doi.org/10.3390/books978-3-0365-7063-1

Gumaih, H., Al-Yousofy, F., Ibrahim, H., Ali, S. and Alasbahy, A. 2017. Evaluation of ethanolic seed extract of parsley on ethylene glycol induced calcium oxalate, experimental model. Int J Sci Res. 6:1683–1688.

Guven, A., Nur, G. and Deveci, H.A. 2019. Effect of green tea (Camellia sinensis L.) and parsley (*Petroselinum crispum*) diets against carbon tetrachloride hepatotoxicity in albino mice. Fresenius Environ Bull. 28(9):6521–6527.

Haidari, F., Keshavarz, S.A., Shahi, M.M., Mahboob, S.-A. and Rashidi, M.-R. 2011. Effects of parsley (*Petroselinum crispum*) and its flavonol constituents, kaempferol and quercetin, on serum uric acid levels, biomarkers of oxidative stress and liver xanthine oxidoreductase activity in oxonate-induced hyperuricemic rats. Iran J Pharm Res (IJPR). 10(4):811.

Henning, S.M., Zhang, Y., Seeram, N.P., Lee, R.-P., Wang, P., Bowerman, S. and Heber, D. 2011. Antioxidant capacity and phytochemical content of herbs and spices in dry, fresh and blended herb paste form. Int J Food Sci Nutr. 62(3):219–225. https://doi.org/10.3109/09637486.2010.530595

Hozayen, W.G., El-Desouky, M.A., Soliman, H.A., Ahmed, R.R. and Khaliefa, A.K. 2016. Antiosteoporotic effect of Petroselinum crispum, Ocimum basilicum and Cichorium intybus L. in glucocorticoid-induced osteoporosis in rats. BMC Complement Altern Med. 16:1–11. https://doi.org/10.1186/s12906-016-1140-y

Hussain, A.I., Anwar, F., Sherazi, S.T.H. and Przybylski, R. 2008. Chemical composition, antioxidant and antimicrobial activities of basil (*Ocimum basilicum*) essential oils depends on seasonal variations. Food Chem. 108(3):986–995. https://doi.org/10.1016/j.foodchem.2007.12.010

Jakovljevic, V., Raskovic, A., Popovic, M. and Sabo, J. 2002. The effect of celery and parsley juices on pharmacodynamic activity of drugs involving cytochrome P450 in their metabolism. Eur J Drug Metab Pharmacokinet. 27:153–156. https://doi.org/10.1007/BF03190450

Julien-David, D. and Marcic, C. 2020. Food, nutrition and health in France. In: Braun, S., Zübert, C., Argyropoulos, D. and Casado Hebrard, F.J. (Eds.), Nutritional and Health Aspects of Food in Western Europe. Academic Press, *Cambridge, MA,* pp. 109–131. https://doi.org/10.1016/B978-0-12-813171-8.00007-X

Justesen, U. and Knuthsen, P. 2001. Composition of flavonoids in fresh herbs and calculation of flavonoid intake by use of herbs in traditional Danish dishes. Food Chem. 73(2):245–250. https://doi.org/10.1016/S0308-8146(01)00114-5

Kalra, A., Yetiskul, E., Wehrle, C.J. and Tuma, F. 2018. Physiology, liver.

Karklelienė, R., Dambrauskienė, E., Juškevičienė, D., Radzevičius, A., Rubinskienė, M. and Viškelis, P. 2014. Productivity and nutritional value of dill and parsley. Hortic Sci. 41(3):131–137. https://doi.org/10.17221/240/2013-HORTSCI

Khan, Y. 2018. Zaitoun: Recipes and Stories from the Palestinian Kitchen. Bloomsbury, London.

Khudiar, K., Abdullah, B. and Al-Mzaien, K. 2001. The protective effect of the aqueous extract of parsley (Petroselinum sativum) seeds on experimentally induced oxidative stress in rats. Iraqi J Vet Med. 25(1):154–172. https://doi.org/10.30539/ijvm.v25i1.1157

Kreydiyyeh, S.I. and Usta, J. 2002. Diuretic effect and mechanism of action of parsley. J Ethnopharmacol. 79(3):353–357. https://doi.org/10.1016/S0378-8741(01)00408-1

Kumar, N. and Goel, N. 2019. Phenolic acids: natural versatile molecules with promising therapeutic applications. Biotechnol Rep. 24:e00370. https://doi.org/10.1016/j.btre.2019.e00370

Kumar, V., Marković, T., Emerald, M. and Dey, A. 2016. Herbs: composition and dietary importance.

Kuźma, P., Drużyńska, B. and Obiedziński, M. 2014. Optimization of extraction conditions of some polyphenolic compounds from parsley leaves (*Petroselinum crispum*). Acta Sci Pol Technol Aliment. 13(2):145–154. https://doi.org/10.17306/J.AFS.2014.2.4

Li, P., Garcia-Garcia, G., Lui, S.-F., Andreoli, S., Fung, W., Hradsky, A., Kumaraswami, L., Liakopoulos, V., Rakhimova, Z. and Saadi, G. 2020. Kidney health for everyone everywhere—from prevention to detection and equitable access to care. Braz J Med Biological Res. 53(3):e9614. https://doi.org/10.1590/1414-431x20209614

Li, Q., Tian, C., Liu, X., Li, D. and Liu, H. 2023. Anti-inflammatory and antioxidant traditional Chinese medicine in treatment and prevention of osteoporosis. Front Pharmacol. 14:1203767. https://doi.org/10.3389/fphar.2023.1203767

Linde, G., Gazim, Z., Cardoso, B., Jorge, L., Tešević, V., Glamočlija, J., Soković, M. and Colauto, N. 2016. Antifungal and antibacterial activities of Petroselinum crispum essential oil. Genet Mol Res. 15(3). https://doi.org/10.4238/gmr.15038538

Maodaa, S.N., Allam, A.A., Ajarem, J., Abdel-Maksoud, M.A., Al-Basher, G.I. and Wang, Z.Y. 2016. Effect of parsley (Petroselinum crispum, Apiaceae) juice against cadmium neurotoxicity in albino mice (Mus musculus). Behav Brain Funct. 12(1):1–16. https://doi.org/10.1186/s12993-016-0090-3

Maqbool, M.A., Aslam, M., Akbar, W. and Iqbal, Z. 2017. Biological importance of vitamins for human health: a review. J Agric Basic Sci. 2(3):50–58.

Martín, M.Á. and Ramos, S. 2021. Dietary flavonoids and insulin signaling in diabetes and obesity. Cells. 10(6):1474. https://doi.org/10.3390/cells10061474

Nasrallah, N. 2009. Delights from the Garden of Eden, 2nd edn. Equinox Publishing, Sheffield, UK.

Nasri, H., Baradaran, A., Shirzad, H. and Rafieian-Kopaei, M. 2014. New concepts in nutraceuticals as alternative for pharmaceuticals. Int J Prev Med. 5(12):1487.

National Institutes of Health (NIH). n.d. Nutrient recommendations and databases. Office of Dietary Supplements, NIH. https://ods.od.nih.gov/HealthInformation/nutrientrecommendations.aspx#dri (Accessed on 11 August 2024)

Obasic, A., Sestan, I. and Bratovcic, A. 2017. The extraction of heavy metals from vegetable samples. In: Ingredients Extraction by Physicochemical Methods in Food. Elsevier, New York, NY, pp. 253–273. https://doi.org/10.1016/B978-0-12-811521-3.00006-5

Oršolić, N., Nemrava, J., Jeleč, Ž., Kukolj, M., Odeh, D., Jakopović, B., Jazvinšćak Jembrek, M., Bagatin, T., Fureš, R. and Bagatin, D. 2022. Antioxidative and anti-inflammatory activities of chrysin and naringenin in a drug-induced bone loss model in rats. Int J Mol Sci. 23(5):2872. https://doi.org/10.3390/ijms23052872

Ozsoy-Sacan, O., Yanardag, R., Orak, H., Ozgey, Y., Yarat, A. and Tunali, T. 2006. Effects of parsley (*Petroselinum crispum*) extract versus glibornuride on the liver of streptozotocin-induced diabetic rats. J Ethnopharmacol. 104(1–2):175–181. https://doi.org/10.1016/j.jep.2005.08.069

Petrolini, F.V.B., Lucarini, R., Souza, M.G.M.d., Pires, R.H., Cunha, W.R. and Martins, C.H.G. 2013. Evaluation of the antibacterial potential of *Petroselinum crispum* and *Rosmarinus officinalis* against bacteria that cause urinary tract infections. Brazil J Microbiol. 44:829–834. https://doi.org/10.1590/S1517-83822013005000061

Pizzino, G., Irrera, N., Cucinotta, M., Pallio, G., Mannino, F., Arcoraci, V., Squadrito, F., Altavilla, D. and Bitto, A. 2017. Oxidative stress: harms and benefits for human health. Oxid Med Cell Long. 2017. https://doi.org/10.1155/2017/8416763

Punoševac, M., Radović, J., Leković, A. and Kundaković-Vasović, T. 2021. A review of botanical characteristics, chemical composition, pharmacological activity and use of parsley. Arch Pharm. 71(Notebook 3):177–196. https://doi.org/10.5937/arhfarm71-30800

Rappaport, S.M. 2016. Genetic factors are not the major causes of chronic diseases. Plos One. 11(4):e0154387. https://doi.org/10.1371/journal.pone.0154387

Roshankhah, S., Jalili, C. and Salahshoor, M.R. 2019. Protective effects of *Petroselinum crispum* on ischemia/reperfusion-induced acute kidney injury in rats. Physiol Pharmacol. 23(2):129–139.

Salehi, B., Venditti, A., Sharifi-Rad, M., Kręgiel, D., Sharifi-Rad, J., Durazzo, A., Lucarini, M., Santini, A., Souto, E.B. and Novellino, E. 2019. The therapeutic potential of apigenin. Int J Mol Sci. 20(6):1305. https://doi.org/10.3390/ijms20061305

Sarmiento-Andrade, Y., Suárez, R., Quintero, B., Garrochamba, K. and Chapela, S.P. 2022. Gut microbiota and obesity: new insights. Front Nutr. 9:1018212. https://doi.org/10.3389/fnut.2022.1018212

Schröder, L. 2021. Influence of the phytoestrogens of *Sambuccus nigra* and *Petroselinum crispum* on the proliferation and receptor expression in breast cancer cell lines lmu].

Schroeder, L., Koch, J., Mahner, S., Kost, B.P., Hofmann, S., Jeschke, U., Haumann, J., Schmedt, J. and Richter, D.U. 2017. The effects of *Petroselinum crispum* on estrogen receptor-positive benign and malignant mammary cells (MCF12A/MCF7). Anticancer Res. 37(1):95–102. https://doi.org/10.21873/anticanres.11294

Seneme, E.F., Dos Santos, D.C., Silva, E.M.R., Franco, Y.E.M. and Longato, G.B. 2021. Pharmacological and therapeutic potential of myristicin: a literature review. Molecules. 26(19):5914. https://doi.org/10.3390/molecules26195914

Şener, G., Karakadıoglu, G., Ozbeyli, D., Ede, S., Yanardag, R., Sacan, O. and Aykac, A. 2022. Petroselinum crispum extract ameliorates scopolamine-induced cognitive dysfunction: role on apoptosis, inflammation and oxidative stress. Food Sci Human Wellness. 11(5):1290–1298. https://doi.org/10.1016/j.fshw.2022.04.009

Sener, G., Saçan, Ö., Yanardag, R. and Ayanoglu-Dülger, G. 2003. Effects of parsley (Petroselinum crispum) on the aorta and heart of STZ induced diabetic rats. Plant Foods Human Nutr. 58:1–7. https://doi.org/10.1023/B:QUAL.0000041152.24423.bb

Shaker, J.L. and Deftos, L. 2023. Calcium and phosphate homeostasis. Endotext [Internet].

Silveira, A.C., Dias, J.P., Santos, V.M., Oliveira, P.F., Alves, M.G., Rato, L. and Silva, B.M. 2019. The action of polyphenols in diabetes mellitus and Alzheimer's disease: a common agent for overlapping pathologies. Curr Neuropharmacol. 17(7):590–613. https://doi.org/10.2174/1570159X16666180803162059

Singh, V.P., Bali, A., Singh, N. and Jaggi, A.S. 2014. Advanced glycation end products and diabetic complications. Korean J Physiol Pharmacol (KJPP). 18(1):1. https://doi.org/10.4196/kjpp.2014.18.1.1

Slimestad, R., Fossen, T. and Brede, C. 2020. Flavonoids and other phenolics in herbs commonly used in Norwegian commercial kitchens. Food Chem. 309:125678. https://doi.org/10.1016/j.foodchem.2019.125678

Soliman, H.A., Eltablawy, N.A. and Hamed, M.S. 2015. The ameliorative effect of *Petroselinum crispum* (parsley) on some diabetes complications. J Med Plants Stud. 3(4):92–100.

Steyn, K. and Damasceno, A. 2006. Lifestyle and related risk factors for chronic diseases. Dis Mortality SSA (DMSSA-1). 2:247–265.

Taherkhani, S., Suzuki, K. and Ruhee, R.T. 2021. A brief overview of oxidative stress in adipose tissue with a therapeutic approach to taking antioxidant supplements. Antioxidants. 10(4):594. https://doi.org/10.3390/antiox10040594

Tang, E.L.H., Rajarajeswaran, J., Fung, S. and Kanthimathi, M. 2015. Petroselinum crispum has antioxidant properties, protects against DNA damage and inhibits proliferation and migration of cancer cells. J Sci Food Agric. 95(13):2763–2771. https://doi.org/10.1002/jsfa.7078

Teodoro, A.J. 2019. Bioactive compounds of food: their role in the prevention and treatment of diseases. Oxid Med Cell Longev. 2019:3765986. https://doi.org/10.1155/2019/3765986

Townsend, J.R., Kirby, T.O., Marshall, T.M., Church, D.D., Jajtner, A.R. and Esposito, R. 2023. Foundational nutrition: implications for human health. Nutrients. 15(13):2837. https://doi.org/10.3390/nu15132837

Ullah, A., Munir, S., Badshah, S.L., Khan, N., Ghani, L., Poulson, B.G., Emwas, A.-H. and Jaremko, M. 2020. Important flavonoids and their role as a therapeutic agent. Molecules. 25(22):5243. https://doi.org/10.3390/molecules25225243

US Department of Agriculture. 2019. FoodData Central. https://fdc.nal.usda.gov/

Vlassara, H. and Uribarri, J. 2014. Advanced glycation end products (AGE) and diabetes: cause, effect, or both? Curr Diabetes Rep. 14:1–10. https://doi.org/10.1007/s11892-013-0453-1

Vona, R., Pallotta, L., Cappelletti, M., Severi, C. and Matarrese, P. 2021. The impact of oxidative stress in human pathology: focus on gastrointestinal disorders. Antioxidants. 10(2):201. https://doi.org/10.3390/antiox10020201

Vora, S.R., Patil, R.B. and Pillai, M.M. 2009. Protective effects of *Petroselinum crispum* (Mill) Nyman ex AW Hill leaf extract on D-galactose-induced oxidative stress in mouse brain.

Vranješ, M., Štajner, D., Vranješ, D., Blagojevič, B., Pavlovič, K., Milanov, D. and Popovič, B.M. 2021. Medicinal plants extracts impact on oxidative stress in mice brain under the physiological conditions: the effects of corn silk, parsley, and bearberry. Acta Chimica Slovenica. 68(4):896. https://doi.org/10.17344/acsi.2021.6885

Wang, X., Qi, Y. and Zheng, H. 2022a. Dietary polyphenol, gut microbiota, and health benefits. Antioxidants. 11(6):1212. https://doi.org/10.3390/antiox11061212

Wang, Y., Zhang, Y., Hou, M. and Han, W. 2022b. Anti-fatigue activity of parsley (*Petroselinum crispum*) flavonoids via regulation of oxidative stress and gut microbiota in mice. J Funct Food. 89:104963. https://doi.org/10.1016/j.jff.2022.104963

Wong, P.Y. and Kitts, D.D. 2006. Studies on the dual antioxidant and antibacterial properties of parsley (*Petroselinum crispum*) and cilantro (*Coriandrum sativum*) extracts. Food Chem. 97(3):505–515. https://doi.org/10.1016/j.foodchem.2005.05.031

Yan, X., Qi, M., Li, P., Zhan, Y. and Shao, H. 2017. Apigenin in cancer therapy: anti-cancer effects and mechanisms of action. Cell Biosci. 7(1):1–16. https://doi.org/10.1186/s13578-017-0179-x

Zhang, H., Chen, F., Wang, X. and Yao, H.-Y. 2006. Evaluation of antioxidant activity of parsley (*Petroselinum crispum*) essential oil and identification of its antioxidant constituents. Food Res Int. 39(8):833–839. https://doi.org/10.1016/j.foodres.2006.03.007