

Review

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[Mohamad Hesam Shahrajabian](#) * and [Wenli Sun](#) *

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Review

Five Important Seeds in Traditional Medicine, Pharmacological Benefits and Seed Biology

Mohamad Hesam Shahrajabian [#] and Wenli Sun ^{*,#}

Biotechnology Research Institute, Chinese Academy of Agricultural Sciences, Beijing 100081, China;

sunwenli@caas.com; hesamshahrajabian@gmail.com

* Correspondence: sunwenli@caas.com; Tel.: +86-13-4260-83836

[#] These authors contributed equally to this work.

Abstract: Knowledge about pharmacological benefits of different seeds is an important factor for cultivation and application of medicinal herbs and plants. The seeds of medicinal plants are stores of valuable and active secondary metabolites that have been commercially and economically beneficial and helpful for medicine and pharmacy. The major parameter of reproduction and preservation of plants are also seeds which have a functional role in the distribution and establishment of plant in different regions. Five important seeds which have tremendous medicinal and pharmacological benefits are anise, basil, borage, cilantro and chamomile. Anise seed is used as a spice, either whole or ground, and its essential oil and extract are also obtained from the seeds. Basil seeds have a long history of usage in Chinese and Ayurvedic medicine, which are the good source of minerals, high in fiber including pectin, rich in flavonoids and other polyphenols. Borage seed oil is used for skin disorders such as seborrheic dermatitis, atopic dermatitis, and neurodermatitis. Cilantro is an annual herb that is part of the Apiaceae family. The seeds are rich in iron, zinc, copper and essential minerals which can decrease bad cholesterol and improves good cholesterol in the body. Chamomile can be considered for treatment of insomnia, hemorrhoids, anxiety, diarrhea and may help with wound healing and skin irritation. The keyword searches for Anise, Seed, Basil, Borage, Cilantro, Chamomile, Seed biology, Traditional medicinal science and seed anatomy were performed by using Scopus, Web of Science, PubMed and Google scholar. The aim of this article review is to survey the pharmacological and health benefits of seeds of five important medicinal plants.

Keywords: anise; basil; borage; cilantro; chamomile; seed biology; seed production; seed germination; seed dormancy; seed priming; seedling establishment; anatomy and germination

1. Introduction

Aromatic and medicinal plants are gaining more importance because of their potential application in food, pharmaceutical and fragrance industry [1–5]. Medicinal and aromatic plants have been used in cosmetics, perfumery, pharmaceuticals and food flavoring since ancient times, because of the presence of essential oils and different components [6,7]. Anise or aniseed is an aromatic medicinal plants of the Apiaceae family [8], and its ethanol extract and essential oil are responsible for its efficacy [9]. It mainly contains trans-anethole, anethole, followed by estragole, sterols, scopoletin, coumarins, limonene, and pinens [10–12]. Its seeds are cultivated commercially and used for flavoring [13], and its aromatic seeds have been used in medicine as a mild expectorant [14,15].

Basil is cultivated for its essential oil, because it is used as odorizer and flavorant in perfumery and the food industry, as well as pharmaceutical industries [16–18]. In traditional medicine, it has been used in folk medicine to treat coughs, headaches, diarrhea, warts, constipation and kidney dysfunction, as well as to promote digestion and to stimulate appetite [19,20], because of presence of secondary metabolites like tannins, anthocyanins, phenols, flavonoids and steroids [21,22]. Its oil, linalool, and estragole indicated nematocidal activities and acaricidal activities [23]. It has marvelous biological characteristics such as anti-angiogenic, anti-inflammatory, anti-tumor, anti-allergic, anti-depressant and anti-microbial [24–29].

Borage is an annual herb which is cultivated for culinary uses and medicinal application, even though, it is commercially planted for borage seed oil [30,31]. Borage seed oil is the plant rich in the gamma-linolenic acid which is utilized as food or dietary supplement [32,33]. Other than seed oil it contains a lot of fatty acids like linoleic acid, oleic acid, stearic acid, palmitic acid, erucic acid and eicosenoic acid [34,35]. It is consumed for the treatment of different diseases such as eczema, multiple sclerosis, heart diseases, diabetes and arthritis [36–38].

One of the most important and popular herbs in the Apiaceae family is Coriander [39,40], which is well-known for its antioxidant activity due to its natural phenolic-rich components [41,42]. The plants are utilized as pain reliever and sedative and the principle ingredient of coriander essential oil in linalool [43]. The coriander plants have different pharmacological effects like anti-cancerous, hypoglycemic, stomachic, carminative, spasmolytic, anti-mutagenic, antimicrobial, antioxidant and antifungal activity making it an important medicinal plant in pharmaceutical industries [44–49].

Chamomile is widely cultivated for its flowers and essential oils, and it has been considered as one of the oldest and most extensively used in traditional herbal medicine in different parts of the world [50–52]. It has been used to treat different kinds of complaints such as rheumatic pain, muscle spasms, influenza, convulsions, anxiety, hemorrhoids, mucosal ulceration, skin inflammation, and gastrointestinal disorders [53–58]. A systematic review was conducted by searching electronic databases, including 550 articles. Relevant articles were selected on the basis of the nutritional, chemical, agronomical, and functional properties of anise, basil, borage, cilantro and chamomile seeds. The databases used were the Web of Science (<https://clarivate.com/webofsciencegroup/solutions/web-of-science/>), EBSCO (www.ebsco.com), and Scopus (www.scopus.com), among others. The keywords which have been used in this study were anise, basil, borage, cilantro, chamomile, seed production, seed biology, anatomy and germination, seed extract and pharmaceutical benefits. This work aims to provide an overview of medicinal effects and pharmacological benefits of the seeds of five important medicinal plants from recently published articles and studies.

2. Anise (*Pimpinella anisum* L.)

Pimpinella anisum L. belongs to the Apiaceae (Umbelliferae) family is an annual herb and a grassy plant with small green to yellow seeds and white flowers, which grows in Iran, Turkey, Egypt, India and many other warm parts of the world [59,60]. The major constituents of anise are anethole, eugenol, estragole, pseudoisoeugenol, anisaldehyde, methylchavicol, terpene hydrocarbons, coumarins, estrols, scopoletin, umbelliferon, polyacetylenes and polyenes [61–65]. Anise methanolic extract are molecular formula are Anethole ($C_{10}H_{12}O$), Eicosane ($C_{20}H_{42}$), Varidiflorene ($C_{15}H_{24}$), Docosane ($C_{22}H_{46}$), Pentadecane ($C_{15}H_{32}$), Nonadecane ($C_{19}H_{40}$), Butanoic acid ($C_{15}H_{20}O_3$), Octacosane ($C_{28}H_{58}$), Heneicosane ($C_{21}H_{44}$), Hexadecane ($C_{20}H_{42}$) and Cyclohexane ($C_{26}H_{50}$) [66]. It has various therapeutic impacts on several conditions such as gynaecologic, digestive, neurologic, and respiratory disorders and against stored-product insects [67–69]. It is predominately grown for its fruits, commercially called “seeds” that are presently used for flavouring [70,71]. It has been reported that hot water extracts of the seeds have been consumed in folk medicine for their laxative and diuretic effect, expectorant and anti-spasmodic action, and their capability to ease intestinal colic and flatulence [72]. The methods of hydrodistillation (HD), solvent extraction, steam distillation, press, Ohmic-assisted hydrodistillation (OH), ohmic heating, ultrasound, microwave extraction and supercritical fluid can be considered as advanced and usual extraction methods [73]. Balbino et al. [74] showed that pressurized liquid extraction can be a useful tool for modulating the content and composition of bioactive molecules in lipid extracts from Apiaceae seeds. The water extracts of anise seeds showed greater antioxidant capacity than that of ethanol [13]. Lee [75] reported that anisaldehyde, estragole, anethole, and myrcene derived from anise seeds are appropriate as a lead compound to development new factors for selective control of the stored food mite (*Tyrophagus putrescentiae*). Yazdi et al. [76] found that dietary inclusion of 10 g anise/kg can be used as alternatives to in-feed antibiotics for broiler diets. Foliar applications of aniseed essential oil at concentrations of 0.2% and 0.4% (0.1 and 0.2 mL, respectively) to lettuce plants infested with homogeneous populations

of *Nasonovia ribisnigri* decreased the number of insects in comparison with the control in the greenhouse and laboratory trials [77]. In traditional medicine, its seeds recommended for its central tranquilizing action, but on the basis of experiment, it failed to support and have significant roles in anxiety-related central action [78]. Iannarelli et al. [63] reported that aniseed essential oil indicated a significant anti-inflammatory impacts on both HTEpC and HBEPc cells together with mucus hypersecretion. The main points about anise seeds are presented in Table 1. The most important health benefits of anise seeds are shown in Figure 1.

Table 1. Key points about anise seeds.

*Anise seed consists of fixed oil, volatile oil, mucilage, proteins and starch.
*Essential oil of Anise seeds consists of eugenol trans-anethole, coumarins, anisaldehyde, estragole, scopoletin, umbelliferon, polyacetylenes, estrolterpene, and methyl chavicol anisaldehyde.
*Aniseeds contain 1.5-5% essential oil and utilized as flavouring, carminative, digestive, and relief of gastrointestinal spasms.
*Aniseeds have different characteristics like as antimicrobial, antiviral, antifungal, antioxidant, and insecticidal effects.
*Aniseeds can cause muscle relaxant, gastric protection, and influence digestive system.
*In diabetic patients, it has hypolipidemic and hypoglycemic impacts and decreases lipid peroxidation.
*Aniseed also has significant impacts on dysmenorrhea and menopausal hot flashes in women.
*The most notable compounds of aniseeds essential oil were trans-anethole, γ -hymachalen, estragole, <i>p</i> -anisaldehyde, and methyl chavicol.

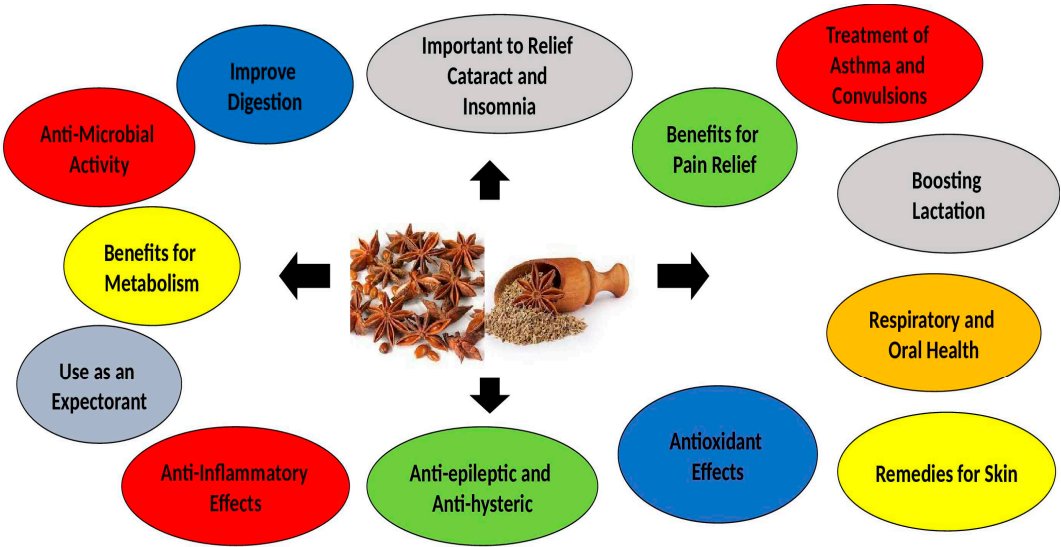


Figure 1. The most important health benefits of anise seeds.

3. Basil (*Ocimum basilicum* L.)

Basil seed is rich in fiber, nutrients and health benefits [79–83]. The seeds are high in dietary fiber and, thus, have significant potential as a functional ingredients, the mucilage obtained from basil seeds has been extensively studies, and has notable emulsifying, thickening, foaming, viscosity, stabilizing, and gelling properties [84–88]. Basil seeds are not normally utilized as a food, despite the literature indicating that its consumption stands for both its nutritious value and for its significant health advantages, such as antimicrobial, antidiabetic, antioxidant, and anticancer characteristics [89,90]. Basil has also been extensively applied in traditional medicine in the treatment of headaches, constipation, coughs, warts, diarrhea, kidney problems and worms [91]. Carbohydrate (hemicellulose, cellulose, and ligning) (60.8%), lipid (13.8%) and crude protein (13.7%) are the

principle constituents of basil seed and the residue is mainly ash and moisture. Its black seeds are oval, the length, width and thickness are 3.22 ± 0.33 mm, 1.84 ± 0.24 mm and 1.37 ± 0.15 mm, respectively, and the main composition of the basil seed includes carbohydrate, protein and lipid [92–94]. The physical characteristics of basil seeds in Iran are 1.82 mm width, 3.11 mm length, 1.34 mm thickness [95], 1.84 mm width, 3.22 mm length, 1.37 mm thickness [96], the seeds from Serbia have 1.30–1.54 mm width, 2.31–2.64 mm length, and 0.99–1.14 mm thickness, and the seeds from India have 1.06 mm width and 1.97 mm length [84]. The basil plant seeds are small (2–3 mm), egg-shaped, elongated and black-colored and are generally applied in most desserts, and the seed also contain several traditional medicinal importance as it is useful in the treatment of various medical ailments such as ulcer, diarrhea, piles, dyspepsia, etc [97]. It can be categorized into different types such as the large leaf robust type, tall slender type, compact types, dwarf types which are small and short leafed, purple types, *purpurascens*, and *citriodorum* types.

Iranian basil seed is oval in shape and black in color with mean dimensions of 3.11 ± 0.29 mm (length), 1.34 ± 0.19 mm (height) and 1.82 ± 0.26 mm (width) [98]. The mineral components of basil seeds are Fe (2.27 mg/100 g), Mn (1.01 mg/100g), Zn (1.58 mg/100 g), Mg (31.55 mg/100 g), Na, K and Ca [99]. Basil seed gum is the mucopolysaccharide obtained from basil seed and it shows a fibrillar structure connected with many globules and suggests different practical use as emulsifier, stabilizer, fat replacer, and thickener [100–102]. Basil seed gum is a plant-derived hydrocolloid which its high molecular weight (Mw) (2320 kDa) imparts high pseudoplastic and viscous behaviour [100]. It is identified as an anionic heteropolysaccharide including glucomannan, which is composed of two main fractions with different molecular weights and monosaccharides units: PERBSG fraction (6000 kDa) and SUPER-BSG (1045 kDa) [103,104]. Basil seed gum demonstrated high flexible chain which makes it liable to change structure by adding sugar solutions, and it indicated random coil to rod conformation and no molecular entanglement at the various conditions [105,106]. Basil seed mucilage demonstrates significant chemical and physical properties like high water absorbing capacity, stabilizing and emulsifying properties [107–109]. The *Ocimum basilicum* mucilage (OBM) contains carbohydrates like D-Galactose, D-Glucose, D-Mannose, glucomannan, L-Rhamnose, pectins, hemicellulose materials, and little amount of non-polysaccharides like fat, minerals and protein [110–112].

The amino acid components of basil seeds are aspartic acid, glutamic acid, serine, glycine, arginine, alanine, histidine, threonine, tyrosine, proline, valine, leucine, cysteic acid, isoleucine, lysine, phenylalanine, methionine sulfone and tryptophan [113]. Basil seeds have a specific content of gum (generally ranging from 10% to 20% on the basis of the treating methods) with surprising functional characteristics which is comparable with some other commercial gums like xanthan [114]. Calcined basil seed indicated the adsorption capability of herbicides [115]. Rectal administration of combination of basil seeds plus gum arabic after induction of colitis, showed anti-inflammatory and antioxidant impacts, and accelerates the healing of the colon in experimental colitis increased by acetic acid [116]. Peptides from its seeds revealing anti-oxidant, α -amylase and α -glucosidase inhibitory activity using *in-vitro* models [117]. The hydrocolloids from seeds can be utilized in food formulations because of their availability, affordable price, and functionality [118,119]. Generally, the basil seeds have appropriate antioxidant potential, which is higher than other seeds, such as red seeds or sesame, and could be utilized to develop new natural antioxidants or be included as ingredients to prevent oxidative deterioration in foods [120,121]. Basil seeds are traditionally applied as a natural treatment for indigestion, ulcers, sore throats, diarrhea, and kidney disorders [121,122], and they have been used as a diuretic, aphrodisiac, antipyretic, and anti-dysenteric [121]. Key points about basil seeds are presented in Table 2. Fascinating health benefits of basil seeds are shown in Figure 2.

Table 2. Key points about basil seeds.

*It is commonly called sweet basil or basil, which belongs to the Lamiaceae family.
*Its name comes from the Greek word Basileus meaning Royal or king, and it is usually known as king of the herbs because of its different applications in cosmetic, medicine, food and pharmaceutical industries.
*Its seeds are utilized to enrich fruit-based beverages for functional and visual goals.
*Basil seeds are high in dietary fiber which has made it unique as a functional ingredient.
*Basil seeds has not only high nutritious value, but also they have used due to their high and notable health benefits such as anticancer, antioxidant, antidiabetic and antimicrobial activities.
*The important of physical and morphological characterization of seeds are because of the relationship between size and the shape of seeds, and the design of tools for agricultural activities such as production, storage and its potency for food application.
*The area in which they are planted and their origin are important factors which influence of seeds changes.
*The correlation with moisture may influence size of seeds.
*The seeds can vary bioactive components and nutritional composition on the basis of environmental conditions, agronomic management, altitude, geographical location, origin of the seeds, soil properties and the degree of water absorption.
*The basil seeds are important source of carbohydrate which vary between 43.9 and 63.8 g/100 g of seed.
*The seeds contain non-starchy polysaccharides in the form of lignin, hemicellulose and cellulose.
*The basil seeds contain mucilage and the content is about 17-20%.
*The basil seed gum is also applied for different purposes like a disintegrant, good source of fiber, a suspending agent, a pharmaceutical excipient, an anti-diabetic agent and a notable biodegradable edible film.
*The main non-essential amino acids of basil seeds are aspartic and glutamic acid.
*All essential amino acids except tryptophan and S-containing types can be found in basil seeds.
*The amino acid composition of basil seeds are aspartic acid, serine, glutamic acid, glycine, histidine, arginine, threonine, tyrosine, valine, lysine, alanine, proline, isoleucine, leucine, phenylalanine, cysteic acid, methionine sulfone and tryptophan.
*Basil seeds have a fat content vary between 9.7% and 33.0%.
*The most important fatty acid composition of basil seeds are palmitic acid, stearic acid, oleic acid, linoleic acid, and linolenic acid.
*The main macronutrients minerals that are needed in higher amounts include phosphorus, calcium, sulfur, potassium, magnesium, sodium and chloride.
*The major micronutrients are iron, zinc, copper, manganese, silicon, iodine, fluoride and chromium.
*Basil seeds contain high antioxidant potential, and the total phenolic content and antioxidant capacity of basil seeds are determined by DPPH (2,2-diphenyl-1-picryl-hydrazyl-hydrate) and Folin-Ciocalteu methods.
*The antimicrobial activity of basil seed oil against both Gram-negative and Gram-positive bacteria is reported.
*In traditional medicine, basil seeds applied as natural remedy for the treatment of ulcers, indigestion, kidney disorders, sore throats and diarrhea.
*The basil extracts also demonstrated antioxidant, anti-inflammatory, antidiarrheal, antiulcer and chemo-preventive impacts.

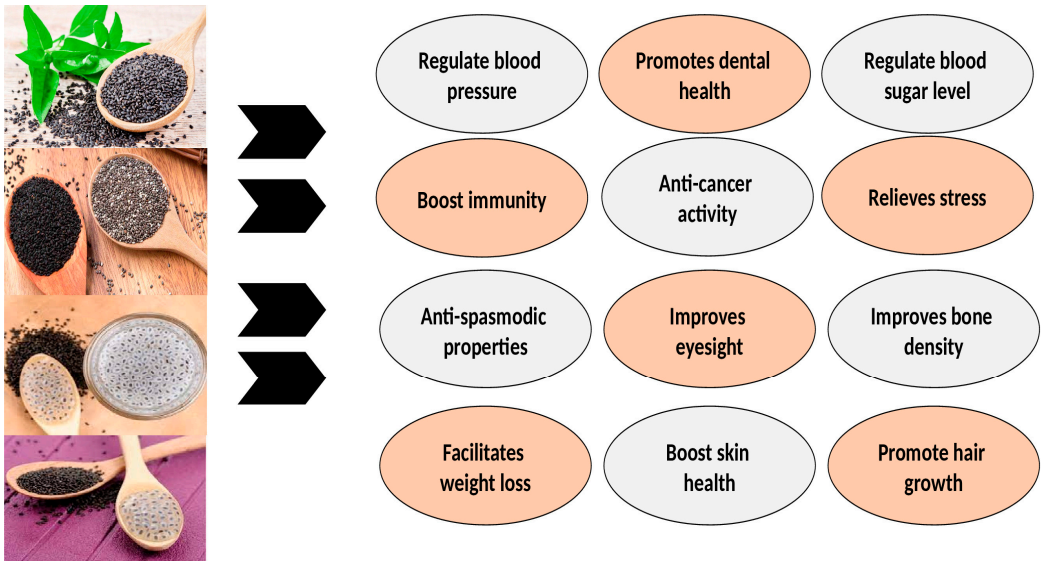


Figure 2. The most important health benefits of basil seeds.

4. Borage (*Borago officinalis* L.)

Borage is on of the most important medicinal and nutritional plant because of the occurrence of high levels of γ -linolenic acid (GLA) in its seed oil [123–126]. It is a notable garden herb of the plant family Boraginaceae, and it is freshly consumed in salads [127,128]. In addition, this oil consists of more than 60% of polyunsaturated fatty acids (PUFA), and the high PUFA amount of borage oil makes it susceptible to oxidation [126]. Its seed oil is a highly emollient oil that hydrates, protects and nourishes the skin. The plant is a culinary and traditional medicinal herb native to the Mediterranean area, which is self-incompatible, and therefore pollinating insects are needed to transfer pollen between different plants with at least two honey bee hives per hectare [129]. Due to its potential market for gamma linolenic acid (GLA), it has been the subject of increasing agricultural interest and different fatty acid obtained from the seeds [130]. In addition to GLA, borage seeds contain stearic, erucic, linoleic, palmitic, oleic, α -linolenic, and erucic acids [131–134]. GLA is an omega-6 essential fatty acid which has been considered as having many positive therapeutic impacts such as treatment of diabetes, arthritis, heart disease, atopic eczema, cyclic mastalgia, and multiple sclerosis [135,136]. Oil from plant seeds includes mostly of triglycerides consisting of C16-C20 fatty acids, triglycerides are sufficiently soluble in SC-CO₂, but much more so in *n*-alkane, like propane [137]. Borage seed oil is mostly obtained by organic solvent extraction (mainly hexane), extrusion procedure such as cold pressing and hot expelling or a mixture of extrusion processes and solvent extraction [138]. Borage extracts showed remarkable antioxidant properties and these impacts were related to their phenolic components [139]. HPLC analysis allowed to recognize nine phenolic acids during seed maturation with the performance of rosmarinic, sinapic and syringic acids [140]. Key points about borage seeds are presented in Table 3. The most impressive health benefits of borage are presented in Figure 3.

Table 3. Key points about borage seeds.

*Borage is an oilseed with a high gamma-linolenic acid content.
*The major producers of borage seeds are the USA, Canada, England and Chile.
*Borage seed is one of the most notable sensitive agronomic seeds as significant deterioration happens after only one year of storage.
*The main reasons of membrane disruption are both increased free fatty acid levels and free radical productivity by lipid per oxidation.
*The seeds also contain palmitic, linoleic, stearic, α -linolenic, oleic, erucic, and erucic acids
*Gamma-linolenic acid showed the potential to relieve the symptoms and signs of various chronic inflammatory diseases such as atopic dermatitis and rheumatoid arthritis.

*Gamma-linolenic acid can also be appropriate in respiratory, gastrointestinal and cardiovascular disorders.

*Borage seeds also have different volatile compounds with antimicrobial activities.

*Methods and units of measurement of antioxidant activity of borage seeds are Folin-Ciocalteu (mg polyphenols.g⁻¹ seeds d.w.), FRAP (μmol Fe II.g⁻¹ seeds d.w.), DPPH (DPPH rem, %), and AE (dm³.[μmol s⁻¹]).

*The average oil content of the borage seed is 30-40% by weight.

*Borage seed oil is used to treat various skin disorders such as seborrheic dermatitis, atopic dermatitis, and neurodermatitis.



Figure 3. The most important health benefits of borage seeds.

5. Cilantro (Coriander) (*Coriandrum sativum* L.)

Cilantro is an annual herb which belongs to family Apiaceae, the cilantro plant yields two primary products that are applied for flavoring purposes, mature seeds as the spice coriander and immature fresh green herb [141–143]. All parts of the plant are edible with dried seeds and fresh leaves most usually used as culinary ingredients [144,145]. It is probably one of the first species used by humanity [146–148]. Principle constituents in cilantro are aldehydes (82.6%) followed by alcohols (16.6%). Cilantro is also an appropriate source of essential fatty acids [149,150]. α -linolenic acid and Linoleic acid are found in high concentration, are essential fatty acids and are precursors of omega-6 fatty acids and omega-3 fatty acids, respectively [151]. The major monoterpenes of coriander are linalool followed by camphor, geraniol, and limonene [152]. The essential oils found in cilantro leaves and seeds have become increasingly popular as functional foods and substitute sources of natural preservative factors. Its essential oil has been utilized in the food industry for its flavor and aroma, or to mask displeasing odors of certain foods, because of its distinctive pungent, aldehydic and fatty aroma [153]. The major aromatic compounds are aliphatic aldehydes (mainly C₁₀-C₁₆ aldehydes) with a fetid-like aroma in the fresh herb oil [154]. The oil composition of seeds can be influenced by several parameters like genetic structure, plant and soil macro and micro nutrient contents, climatic conditions, and agronomical practices [155–157].

The seeds of coriander are ovate globular, the length of the seed is 3-5 mm and color and there are many longitudinal ridges on the surface, when dried, is generally brown, but may be green, straw-colored or off white; usually, the seed if sell sun dried and made accessible for both whole and ground, and coriander seeds have a sweet, mild, slight pungent, like citrus flavor with a hint of sage [158]. There are three main extraction processes used to obtain vegetal oil (VO) and essential oil (EO) from coriander seeds, which are organic solvent extraction (Soxhlet), steam distillation, and supercritical fluid extraction [159]. The most cited compounds are (*E*)-2-decenal, decanal, (*E*)-2-dodecenal, (*E*)-2-tridecenal, dodecanal and tetradecenal [160,161]. Lasram et al. [162] reported that

seed essential oils of coriander proved to be a potential natural source of aflatoxin and antifungal inhibition agent against *Aspergillus flavus*. Seeds also have antimicrobial potential against various pathogen bacteria and yeasts, and both lipophilic and hydrophilic extracts of coriander have indicated significant antioxidant activities in in vivo and in vitro studies [163]. Mixing of fractions of eucalyptus, coriander, dill and cilantro resulted in synergistic, additive or antagonistic impacts against individual test microorganisms [164]. Chemical characterization of cilantro essential oil can be considered as a potential antifungal, methylglyoxal suppressor and antiaflatoxigenic [165]. The seeds are major accountable for the medical application of coriander and have been utilized as a drug for indigestion, rheumatism, against worms and pain in the joints [166].

The coriander seeds have a satisfying flavour owing to the specific composition of the essential oil [166]. The high content of hydroxycinnamic acids was observed in ethanolic extracts achieved from exhausted coriander seeds with lowest mean particle size, consequently, coriander seeds, which have been identified for its rich essential oil content, could be applied for sequential production of polyphenolic-rich extracts with high antioxidant activity [167,168]. Coriander seeds antioxidant activity is primarily related to high levels of phospholipids, carotenoids and tocopherols. Coriander seed essential oil had a significant inhibitory impacts on *Candida albicans* [169]. Coriander seeds and leaves are nearly good sources of essential oil [170], and the content of essential oils is usually influenced by coriander cultivar, weather conditions, geographical location of the growth area and stage of maturity [171]. Coriander seeds essential oil had a very notable impacts on *Candida albicans*; Gram-positive bacteria were more sensitive to the essential oil of coriander seeds than Gram-negative bacteria [172]. Coriander seeds aqueous extract treatment increased exploratory activity in the animal models of anxiety, and restored monoamines and GABA levels to the respective baseline levels and it declined excitotoxic levels of glutamate in the hippocampus region [173]. Key points about cilantro seeds are presented in Table 4. The surprising health benefits of cilantro has presented in Figure 4.

Table 4. Key points about cilantro seeds.

*Cilantro is the seed of an annual small plant, which is commonly refers to the spice and belongs to the Apiaceae family (Umbelliferae).
*Cilantro also known as coriander, Mexican parsley and Chinese parsley.
*The largest producer of cilantro is India.
*The seeds of cilantro are nearly ovate globular and there are several longitudinal ridges on the surface.
*The length of the seed is 3-5 mm, color.
*Cilantro seeds have a sweet, mild, slight pungent like citrus flavor with a hint of sage.
*Fatty oil and essential oil are two major components of coriander seeds.
*Cilantro can be grown from transplanted or seed.
*The fatty oil content changes between 9.9% and 27.7%, and the essential oil content of dried cilantro seeds changes between 0.03% and 2.6%.
*Linalool is the most important essential oil in seeds of coriander.
* Linalool, which a terpene alcohol identified in cilantro has important function in many therapeutic benefits and possesses anxiolytic, analgesic, anticonvulsant and neuroprotective effects.
*Its essential oil is an important component of detergents, emulsifiers, creams, surfactants, perfumes and lotions.
*Moisture content is one of principle factor which influences the physical properties of seeds.
*The seeds showed the presence of different compounds such as glucosides, monoterpenoid, monoterpenoid glycosides and aromatic constituent glycosides like norcarotenoid glucoside.
*Different methods such as solvent extraction such as water, methanol and n-hexane, hydrodistillation, sonication and microwave-assisted extraction use to extract the chemical components of cilantro.
*The extracts and essential oil of coriander seeds contains sedative-hypnotic activity.

- *In traditional medicine, its seeds were consumed to relieve pain, inflammation and rheumatoid arthritis.
- *In traditional Iranian medicine, cilantro seeds has been used for relief of insomnia.
- *The seeds have been consumed to relieve different gastrointestinal disorders like diarrhea, flatulence, nausea and indigestion.
- *In Morocco, Saudi Arabia and Jordan, they are used to lower blood glucose levels.
- *The most important health benefits of cilantro are hypolipidemic activity, anti-atherogenic and antioxidant properties, antihypertensive potential, and antiarrhythmic activity.

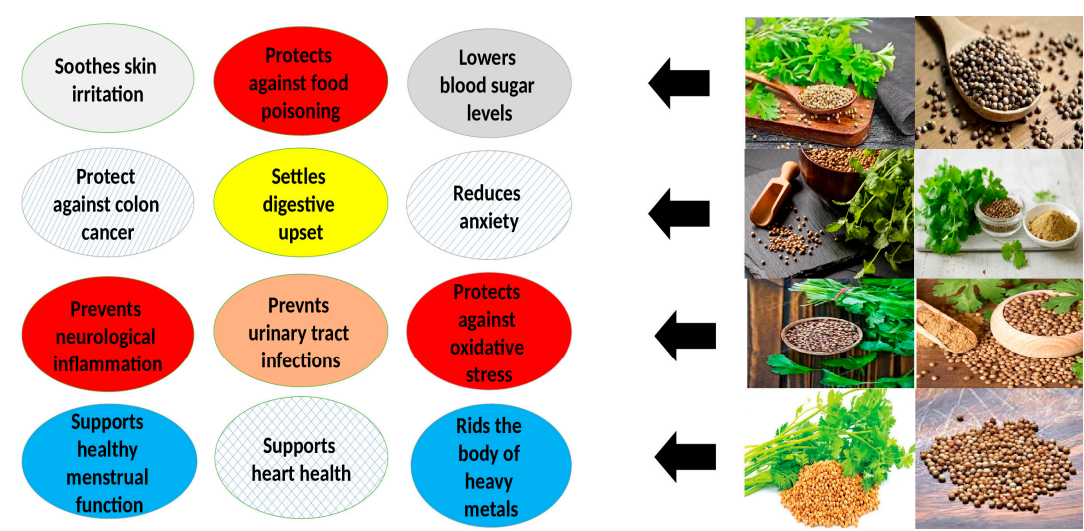


Figure 4. The most important health benefits of cilantro seeds.

6. Chamomile (*Matricaria chamomilla* L.)

Chamomile belonging to the Asteraceae family and also called as German chamomile, is a medicinal plant of high economic importance in the world [174–176]. It is applied in perfumery, pharmaceutical, cosmetics, aromatherapy, food and flavor industries [177–180]. It is an aromatic annual herbaceous plant with capitulum inflorescence, and it is native to Western Asia and Eastern Europe [181]. Its seeds are one of the few seeds that need light to germinate, so establishing them by seed in a delicate process. Chamomile is classified mostly into five chemotypes, according to its content, of α -bisabolol, bisabolol oxide A and B, chamazulene, and bisabolone oxide in its essential oil [182]. The essential oil of chamomile has showed significant antioxidant, antibiotic, sedative, antifungal, anti-inflammatory and anti-allergic activities [183–186]. Chamomile could show potent antioxidant activity because of its content of flavanols, isoflavones, flavonoids, anthocyanin, flavones, isocatechins, tannins acid, and coumarin [187–190]. Chamomile is mainly used as infusion for anxiolytic and sedative purposes [191,192]. Utilizing chamomile in combination with Silver nanoparticles (AgNPs) may be an effective technique for efficacious treatment of lung cancer [193]. It has been reported that extracts of three essential oils of marjoram, chamomile, and *Eucalyptus* contain acaricidal activity against *Tetranychus urticae* [194]. Angelic, methacrylic acid esters, isobutyric and pinene were the main hydro-distilled essential oil volatiles [195–197]. It has been reported that chamomile seed based salvia substitute was effectual in relieving xerostomia signs [198]. Cicco et al. [199] showed that chamomile essential oils exerted their antioxidant and anti-inflammatory activity by regulating macrophages and CD4⁺ T cells-mediate immune response. Madadi et al. [200] concluded that 150 mg/L of chamomile shoot extract could be effective as a bioherbicide to sustainably control flixweed in wheat production. Chamomile extract is recommended in further decreasing the clinical traits and ameliorating the quality of life of Chronic Rhinosinusitis (CRS) patients [201]. Temperature, relative humidity, seed moisture content, and nature of the seeds impact the seed longevity during storage, and increment in temperature as well

as moisture can lead to fungal growth which decreases seed viability [202–207]. Key points about chamomile seeds are presented in Table 5. Top health benefits of chamomile are shown in Figure 5.

Table 5. Key points about chamomile seeds.

*Two main and popular kinds of chamomile are German chamomile and Roman chamomile which belongs to Asteraceae (Compositae) family.
*Chamomile contains terpenes, volatile oils, organic acids, coumarins, flavonoids, sterols and polysaccharides.
*Chamomile is mainly cultivated by seeds, but keeping seed viability for long time is very important factor as well as seed germination.
*Chamomile has anti-inflammatory, antioxidant, anticancer, neuroprotective, anti-diarrheal, antibacterial and anti-allergic activities.
*Chamomile is widely utilized herb in traditional medicine of China, Rome, Greece, Germany and West of Asia.
*In traditional medicine, it is used to treat ulcers, wounds, gout, eczema, bruises, skin irritations, canker sores, burns, sciatica, neuralgia, hemorrhoids, rheumatic pain, mastitis and hemorrhoids.
*It has been used to treat croup, colic and fevers in children, and also applied as an emmenagogue and an uterine tonic in women.

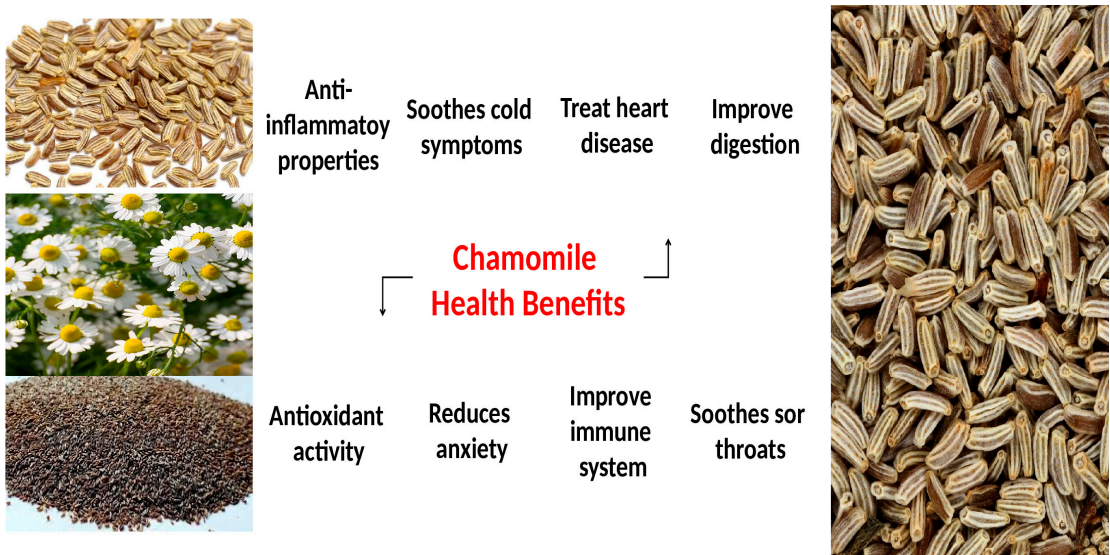


Figure 5. The most important health benefits of chamomile seeds.

7. Conclusion

Medicinal plant and herb seeds are seeds which have been standing in a special connection to humankind since the beginning of history. In these days, there is worldwide identification to the importance of medicinal and aromatic plants due to their uses in feed, food, pesticide and cosmetics industries as well as their preventive and curative characteristics, which is indicated by a growing demand for medicinal and aromatic products in the markets. Anise seeds are rich in nutrients, particularly its seeds are rich in iron, anise seed may help treat depression and reduce symptoms of it. Its seeds may help to prevent stomach ulcers and decrease unfavorable symptoms. Anethole which is an active component in anise seed, inhibits bacterial growth and other compounds possess potent antimicrobial properties. Anise seeds can help relieve menopause signs, balance blood sugar levels and decrease inflammation. The basil seeds are black colored and with oval shape, which has been used in traditional medicine such as antipyretic, antispasmodic, treatment of ulcer, stomachic, diarrhea and rich in plant compounds including flavonoids. In traditional medicine, borage used in herbal medicinal science, while commercially it is harvested as an oil seed. The seeds can decrease

arthritis, relief from respiratory issues, having tremendous benefits to improve skin condition and cardiovascular health, important for treatment of allergies and diseases, recommended to relieve fever with anti-cancer activities. Chamomile plants are a member of the Asteraceae family, and two important common types of it are German chamomile and Roman chamomile. Terpenoid group like derivatives of acetylene and chamazulene are the main sources of antioxidants. It may help with depression and stress, improves digestion, appropriate to decrease pain and reduce inflammation. It has also strong anti-inflammatory and pain-reducing capabilities, anti-cancer activities, relieves congestion and promotes skin health. All these mentioned seeds of medicinal and aromatic plants which are also rich in many nutrients can boast a wide array of health benefits.

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