



Antioxidant potential and phytochemistry of Cumin (*Cuminum cyminum* L.)

Neha Sahrawat, Manshi and Neelam Chaturvedi

Department of Food Science and Nutrition,
Banasthali Vidyapith, Rajasthan-304022, India

ABSTRACT

Introduction: Cumin (*Cuminum cyminum* L.) is an annual herbaceous plant that is in addition to being one of the most popular seed species, it is also among the ancient and therefore most cultivated aromatic and herbaceous natural products with a wide range of medicinal, nutraceutical, and pharmaceutical properties. It is widely used in the beverage, food, and liquor industries, as well as in medicine, perfume, and cosmetics. The goal of this research was to provide an accurate and contemporary review of cumin's antioxidant potential, phytochemistry, and biological activities.

Methods: Data was collected by reviewing pertinent material that was retrieved from several databases, such as Google Scholar, Springer, PubMed and Science Direct.

Results: Cumin has been found to possess various pharmacological activities such as anti-diabetic, anti-infertility, anti-microbial, immunomodulator, anti-fungal, analgesic, hepatoprotective, anti-osteoporotic, immunomodulator, anti-inflammatory, anti-asthmatic, antioxidant, dietary fibre, anti-cancer, blood platelet aggregation, anti-stress and also has ophthalmologic effects because of the existence of numerous chemical components.

Conclusion: Cumin contains essential elements such as cymene, thymol, terpinene, cumin aldehyde, pinene, oleoresin and others that have been shown to be effective against a variety of diseases. It is an important source of energy, improves immunity, and it protects against several ailments. More studies are, however, required to unravel novel components and applications of cumin.

Key words: Cuminum cyminum, Cumin, Antioxidant potential, Phytochemistry, Medicinal properties

INTRODUCTION

For centuries, herbal and other natural products have been used for disease management, whether for prevention or treatment (Ahmed et al., 2019). Because of their accessibility, safety, and usefulness, some edible herbal plant species, such as cumin (*Cuminum cyminum* L.), are also popularly used as food additives (Rebey et al., 2017). Cumin is an annual plant with numerous medicinal, nutraceutical, and pharmaceutical properties. It is also one of the oldest and most cultivated aromatic and herbaceous natural products. Cumin is also widely used in the beverage, food, alcoholic beverage, medicine, perfume, and toiletry industries (Bhatt et al., 2017). It is native to and widely cultivated in a variety of locations, primarily in arid and semi-arid climates such as Egypt, Saudi Arabia, China and the Mediterranean, in addition to India and Iran. However, India is the world's major consumer of cumin seed (Table 3), while China is the world's largest exporter and producer (Mikail et al., 2020). Cumin is rich in antioxidants and has long been used as a coagulant, carminative, astringent and stimulant, in addition to treatment for diarrhoea, dyspepsia,

diarrhoea, epilepsy, whooping cough, toothache, flatulence jaundice and indigestion (Piri et al., 2019). Cumin is widely used as a culinary spice and in folklore therapy due to the presence of aromatic substances in the herb. Cumin is a traditional spice dating back to the Middle Ages. Because of its peppery taste and aroma, it was extremely popular. Cumin became an epitome of love and fidelity in Europe during the Middle Ages, and some people still carry cumin in their pockets to give in wedding ceremonies. Cumin is a small hairy, brownish-colored seed plant with a spicy sweet aroma and a powerful slightly bitter and pungent flavour (Rebey et al., 2012).

Table 1: Taxonomical classification of *Cuminum cyminum*

Kingdom	Plantae
Super division	Spermatophyta
Genus	<i>Cuminum</i> L.
Species	<i>Cuminum cyminum</i> L.
Order	Apiales
Class	Magnolipsida
Subclass	Rosidae
Division	Magnoliophyta
Family	Apiaceae
Subkingdom	Tracheobionta

Source: (Rai et al., 2012)

Table 2: Botanical description of *Cuminum cyminum*

Microscopic Characteristics	
Endosperm	Polygonal cells and containing micro spheroidal crystals of calcium oxalate
Vittae	Yellowish brown consisting of small, thin-walled, polygonal, tubular, cutinized cells
Epicarp	Colorless cell, Single layer, having stomata
Testa	Present
Endosperm	Thin walled, large elongated cell
Fibro vascular tissue	Present
Mesocarp	Other type sclereids are small groups made up of significantly elongated cells, while one type of sclereids are single layer longitudinal cells with walls that are mildly thickened
Macroscopic Characteristics	
Flower	The small flowers are radially symmetrical with 5-small sepals, 5-petals, and 5-stamens
Leaves	The leaves are 5 to 10 cm long, pinnate or bipinnate, with thread-like leaflets.
Stem	It has an erect stem, with little slender branched, not very tall, from 20 to 50 cm

Fruit	The cumin fruits (seeds) are elliptical, flat on one side, convex, furrowed, and rough on the other, from 5 to 6 mm. in length and about 1.5 mm. in thickness, and of a light brown color. Each has seven longitudinal ridges.
Organoleptic Characteristics	
Taste	Aromatic, warm, bitter and disagreeable
Odor	Strong and Heavy aromatic and peculiar
Color	Leaves- yellowish green Flower- White or Pink Seed- Yellowish-brown Stem- Inner core White and Outer core Grey or dark

Source: (Singh et al., 2017)

Table 3: Features of *Cuminum cyminum* varieties

Variety name	Organization/Institution name	Features
Ac-01- 167	Ajmer Rajasthan	This variety is suitable for limited available water conditions. Its bold seeds are resistant to Fusarium wilt
RZ-209	RAU, SKN College of Agriculture, Jobner, Rajasthan	A local collection from Ahore was used to develop it through repeated single plant progeny selection (Jalore). The plants grow erectly and have bright pink flowers and strong grey pubescent grains. It is resistant to the diseases wilt and blight
RZ-19	RAU, SKN College of Agriculture, Jobner, Rajasthan	It was produced by continually selecting single plant descendants from the Kekri local collection (Ajmer). The plants have an upright growth habit, pink blooms, and striking grains that are pubescent in grey. It is good for late sowing season and resistant to wilt and blight
RZ-341	RAU, SKN College of Agriculture, Jobner, Rajasthan	High volatile oil content and low volatile oil content have been polycrossed to create the variety. The plants are bushy and semi-erect, with long, bold seeds that are less likely to be affected by wilt, blight, or powdery mildew. They also contain a lot of volatile oils
GC-2	SDAU, Jagudan, Gujara	The variety has been created through polycrossing between plants with high volatile oil content and those with low volatile oil content. The plants are bushy and semi-erect, with long, bold seeds that are less likely to be affected by wilt, blight, or powdery mildew. They also contain a lot of volatile oils
GC-1	SDAU, Jagudan, Gujarat	The cultivar has been created using regional germplasm. The plants are bushy and spreading, and the pink blossoms have prominent, rectangular grains that can endure breaking and lodging. It can withstand wilt, powdery mildew, and blight to a certain extent. Gujarat and Rajasthan are good places for it
GC-4	SDAU,	This variety has been developed through selection from GC-3. This is very popular
Mc.43	SDAU, Jagudan, Gujarat	The Mc.43 plant has semi-spreading leaves, bold, lustrous grains, and the ability to endure lodging and breaking. Fusarium wilt, Alternaria blight, and powdery mildew can all be tolerated by it to a certain extent

Source: (Parashar et al. 2014; Verma et al. 2018; Dar et al. 2019)

Cumin belongs to Magnoliophyta division and Apiaceae family as mentioned in Table 1. Cumin can attain heights of 30-60 cm and has a glabrous, branched, and slender stem. It has thread-like leaflets on compound leaves. It blooms in terminal umbels and each cumin branch has 3-9 umbels with 5-7 umbellets that contain small hermaphrodite flowers in white or pink. It has schizocarps or fruits with two mericarps, and seeds about 6 mm long that are oblong but thicker in the middle. It is typically planted in the winter or autumn, with seedlings emerging after 14 to 50 days. Cumin seedling growth is normally initiated at low temperatures (<20 °C) and is halted at high temperatures (Soltani et al., 2019). Cumin has a low vigour due to its increased sensitivity to environmental stresses and the presence of 10% oil in its seeds (Piri et al., 2019). Cumin seeds have antispasmodic, abortifacient, carminative, and emmenagogic, stomachic properties and diuretic. The seeds' distinguishable and potent aroma is responsible for their use as spices as well as other medicinal purposes. As mentioned in Table 2 the organoleptic characteristics i.e., aroma is primarily due to cuminal, which accounts for 2.5 to 4.0% of the seed. Cumin seed essential oils are predominantly composed of hydrocarbons and aldehydes (Kanani et al., 2019). The purpose of this investigation is to provide a concise and onward review of cumin's antioxidant potential, phytochemistry, and biological activities. The information was gathered from the review of relevant literature obtained from various databases, such as Google Scholar, Springer, PubMed and ScienceDirect.

Reported studies on C. cyminum

The quality and quantity of the chemicals frequently found in cumin varies in different portions of the plant, including the leaves, shoots, roots, and flowers, according to the literature. Although the terpene composition of the shoots and flowers is comparatively equivalent, the flowers have higher terpene concentrations. Moreover, neither α -pinene nor β -pinene were discovered in the roots, while α -phellandrene was notably the only terpenoid component found in the leaves and α -pinene was most abundant in the flowers (Ghannadnia et al., 2014). In addition to significant amounts of phenolic compounds, cumin fruits also primarily comprise cellulose, fixed oil content (approximately 10%), mineral elements, protein, sugar, and volatile oils (1.5%) (Moghaddam et al., 2015). Oil-in-water nanoemulsions of *C. cyminum* essential oil have successfully proven the inclusion of lipophilic bioactive ingredients into functional food gels (Rostami et al., 2018). Natural deep eutectic solvents have also been utilised to substantially improve the quantity and quality of cumin essential oil extraction, providing it an economical and environmentally beneficial extraction method (Zhao et al., 2019). Utilizing saline and hot aqueous cumin extracts, as well as its oleoresin and essential oil, researchers were able to increase enzymatic (amylase, lipase, protease, and phytase) activities and antioxidant activity (Milan et al., 2008).

Phytochemistry of Cumin

Cumin seeds enclose amino acids, aldehyde (60%) fats, glycosides (22%), flavonoids, volatile oil (2-5%), and the yellow coloured fresh oil is mainly comprised of cuminaldehyde (Iacobellis et al., 2005). Cuminaldehyde, 1, 8-cineole, limonene, α - and β -pinene, o- and p-cymene, α - and β -safranal, terpinene, and linalool are the major compounds found in cumin. The cumin fruit contains lignin, fatty matter, resin, gum, salts, and protein bodies the significant proportion of which are extractives, malates and volatile oil. The cumin seeds' proximate composition demonstrates that they possess fixed oil (about 10%), mineral elements, cellulose, protein, sugar, and volatile oil (El-Kani et al., 2007). Cumin seeds contain volatile oil (1-5%), which provides the seeds their distinctive aroma. Following separation, a large number of phenolic compounds, including flavonoids, phenolic acids, and phenolic diterpenes, are identified in cumin fruits, which are strongly associated with their antioxidant activity and have a significant function in inhibiting lipid peroxidation and various types of oxidising enzymes (Gallo et al., 2010). Cumin essential oils (Table 4) outlined include limonene, vanillin, octanol, anisyl alcohol, thymol, cuminaldehyde, benzoic acid and anethole. Citric, malic, aspartic, propionic, ascorbic, tartaric, oxalic, fumaric and maleic acids are present in cumin, as are gallic acid, salicylic acid, cinnamic acid, resorcinol, p-hydroxybenzoic acid, hydroquinone, rutin quercetin and coumarin (Li et al., 2004).

Table 4: Essential oil composition of *Cuminum cyminum*

Component	Percentage (%)
Cumin Aldehyde	27.6
Terpinene	17.25
p-Mentha-1,3-diene-7-al	15.18
β -Pinene	10.22
p-Mentha-1,4-diene-7-al	9.48
p-Cymene	5.51
p-Mentha-3-en-7-al	2.91
Myrcene	0.83
α -Pinene	0.63
Sabinene	0.58
β -Phellandrene+1.8-cineole	0.49
β -Caryophyllene	0.45
Limonene	0.39
Cumin alcohol	0.36
p-Mentha-1,3-diene-7-ol	0.31

Source: (Mehdizadeh et al., 2017)

Biological potency

Table 5 gives a brief description of the most significant biological functions of cumin as reported in the literature. These include immunomodulatory, antidiabetic, anti-inflammatory, insecticide, antifungal, antioxidant and antibacterial activities.

Table 5: Biological potency of *Cuminum cyminum*

Component	Medicinal Properties	Benefits	Source
Cumin essential oil	Anti-inflammatory	By substantially inhibiting the mRNA expression of the inflammatory proteins' interleukin-1 (IL-1) and IL-6, cyclooxygenase (COX-2), and inducible nitric oxide synthase (iNOS), respectively.	(Wei et al., 2015)
Phytoestrogens	Anti-fertility	By anti-implantation effects	(Bhatt et al., 2014)
Cuminaldehyde and flavonoids	Gastrointestinal Disorders	By activating, our salivary glands in our mouth (the mouth-watering flavor), facilitating the primary digestion of the food Antiulcer by enhancing gastric mucin protection and regeneration. Provide protection against hepatotoxicity	(Pratyusha et al., 2013)

Iron, essential oils, vitamin-C, vitamin-A	ImmunoModulator	Cumin strengthens our immune system since it contains large amounts of iron, essential oils, vitamin C, and vitamin A.	(Chauhan et al., 2010)
Phytoestrogens	Anti-osteoporotic	By reducing the excretion of calcium in the urine and increasing calcium levels.	(Morshedi et al., 2014)
Cuminaldehyde	Anti-diabetic	Improves serum insulin and glycogen levels, lowers blood sugar, and inhibits glycosylated haemoglobin, creatinine, and blood urea nitrogen.	(Patil et al., 2013)
vitamin-E	Skin Disorders and boils	Vitamin-E nourishes skin and keeps it healthy, radiant, and youthful.	(Khosravi et al., 2015)
Cuminaldehyde, carvone, linalool	Anti-microbial	It inhibits toxin production and mycelium growth	(Deletre et al., 2015)
Cuminaldehyde	Insecticidal effects	Shows toxicity against <i>Anopheles gambiae</i> strain	(Kedia et al., 2014)
Eugenol, limonene	Anti-cancer	By regulating the metabolism of carcinogens and xenobiotics using phase I and phase II enzymes	(Rai et al., 2012) (Tavakoli et al., 2015)

Antioxidant properties

With maturation, the phenolic content and excellent antioxidant properties of cumin essential oils rise (Moghaddam et al., 2015). Cumin, black cumin, and bitter cumin were all extracted using methanol, and the total phenolic concentration ranged from 4.1 to 53.6mg/g dry weight. The total phenolic content of the *Cumin cyminum* methanol extract was reported to be 9mg/g on dry weight. Also, it has been demonstrated that the methanolic extracts of cumin have greater antioxidant activity than the aqueous extract (Ghasemi et al., 2018). Another study evaluated the phenolic components and antioxidant activity of 26 spice extracts, including cumin. The measure of antioxidant activity (TEAC) is trolox mmol/100 g dry weight. According to Mohamed et al., (2018), cumin extract has a total phenolic content of 23.02 ± 0.045 mg GAE/g extract and a total flavonoid content of 19 ± 0.132 mg QE/g extract, respectively. Total phenolic and flavonoid contents of cumin types were established as between 7.02 and 77.10 mgGAE/100g to 20.24 and 132.14 mgQE/100g, respectively. Moreover, the antioxidant activity values of cumin samples varied between 0.04 and 2.78 mmolTE/kg (Ozcan, 2022). Researchers have examined the antioxidant potential of cumin (*Cuminum cyminum*) using three different assays: 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging, soybean lipoxygenase dependent lipid peroxidation, and Fe²⁺ ascorbate induced rat liver microsomal lipid peroxidation. Cumin's methanolic extract had a 9mg/g dry weight total phenol concentration. On the lipoxygenase dependent lipid peroxidation system, the DPPH radical scavenging system, and the rat liver microsomal lipid peroxidation system, the methanolic extract of cumin seeds had IC⁵⁰ values of 1.72 ± 0.02 , 0.52 ± 0.01 , and 0.16 ± 0.30 , respectively. The research also demonstrated that cumin is an effective antioxidant that can neutralise hydroxy, peroxy, and DPPH free radicals, which prevents lipid peroxidation caused by these radicals (Thippeswamy and Naidu, 2005).

Antimicrobial activity

It has been investigated that ethanolic extracts of *C. cyminum* have antibacterial properties against *Staphylococcus aureus* (Mostafa et al., 2018). Moreover, the *C. cyminum* essential oils have antibacterial qualities (Khalil et al., 2018). According to reports, cortisol elicitation increased the cumin essential oil's yield and chemical content as well as its antibacterial, antifungal, antioxidant, and in vitro cytotoxic effects (Taghizadeh et al., 2019). Moreover, it has been documented that *C. cyminum* essential oils have antifungal properties against *Candida albicans* (Minooeianhaghighi et al., 2017). Cumin has reportedly shown a broad-spectrum antifungal action against a number of pathogenic *Candida* and other fungus species in the literature (Naeini et al., 2014); (Petretto et al., 2018).

Antidiabetic, Immunomodulatory and Anti-inflammatory activity

C. cyminum supplementation has significantly improved assessments of fasting blood glucose and glycosylated haemoglobin (Jafari et al., 2017). Also, it has been noted that *C. cyminum* essential oil has the strongest antidiabetic - amylase inhibitory properties (Tahir et al., 2016). The administration of cumin, an efficient immunomodulatory drug, significantly and dose-dependently raised the CD4⁺ and CD8⁺ T cell count and regulated T lymphocyte expression. Also described in the literature are *C. cyminum*'s favourable immunomodulatory and other traits (Srinivasan, 2018); (Tabarsa et al., 2020). According to published research by Srinivasan (2018), *C. cyminum*-supplemented therapies had a significant impact on a number of inflammatory biomarkers, including high-sensitivity C-reactive protein (hsCRP), adiponectin and TNF 1,26.

CONCLUSION

This review's overarching point is that cumin has a high antioxidant potential. This spice's essential oils have high antioxidant activity, and its nonvolatile extracts have good free radical inhibition properties. Many research investigations done in recent decades have validated its health benefits, particularly in dyslipidemia, diabetes, hypertension, inflammatory diseases, cancer and respiratory disorders. These seeds are also gastroprotective, immunostimulant, hepatoprotective, neuroprotective and nephroprotective. As a result, this study concludes that, in addition to its use as a flavouring agent, cumin has high antioxidant potential and numerous health benefits.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the technical assistance of the Food Science and Nutrition Division, Banasthali Vidyapith, 304022, Rajasthan.

FUNDING

Not applicable.

COMPETING INTERESTS

The authors state that they do not have any competing interests.

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