

Cumin (*Cuminum cyminum* L.): A review of its ethnopharmacology, phytochemistry

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ABSTRACT

Introduction: Cumin (*Cuminum cyminum* L.) is an annual plant that is not only one of the most popular seed species but also one of the oldest and most cultivated aromatic and herbaceous natural products with numerous medicinal, nutraceutical, and pharmaceutical properties. It is widely used in the beverage, food, liquor, medicine, perfume, and toiletry industries. The objective of this work was to provide a precise and up-to-date review of the ethnopharmacology, phytochemistry, and biological activities of cumin. **Methods:** Information was gathered from the review of relevant literature obtained from various databases, such as Science Direct, Springer, PubMed, Google, and Google Scholar. **Results:** The various parts of the cumin plant (leaves, shoot, root, and flowers) contain similar and different chemical compounds. **Conclusion:** The medicinal and health potential of cumin is mainly attributed to its antioxidant, antibacterial, antifungal, anti-inflammatory, antidiabetic, insecticide, and immunomodulatory properties. More studies are, however, required to unravel novel components and applications of cumin.

Key words: Cuminum cyminum, Cumin, Ethnopharmacology, Phytochemistry, Biological Activities

INTRODUCTION

The usage of herbal and other natural products for disease management, whether for prevention or treatment, has been known for ages¹⁻⁵. Some edible herbal plant species, such as cumin (*Cuminum cyminum* L.), are also commonly used as food additives owing to their accessibility, safety, and usefulness⁶. Cumin belongs to the *Apiaceae* family, tribe *Ammineae*, and subtribe *Carinae*, and has $2n = 14$ chromosomes^{1,6,7}.

Cumin is the second most popular seed species after black pepper⁸. It is an annual plant and is also one of the oldest and most cultivated aromatic and herbaceous natural products with numerous medicinal, nutraceutical, and pharmaceutical properties. Cumin also has wide usage in the beverage, food, liquor, medicine, perfume, and toiletry industries⁷. It is native to and cultivated extensively in several places, mainly in arid and semi-arid climates, such as China, Egypt, Saudi Arabia, and the Mediterranean, as well as India and Iran. However, the largest consumer of cumin seed in the world is India while China is the largest exporter and producer. Cumin has remarkable antioxidant properties and is traditionally used as an astringent, carminative, coagulant and stimulant, as well as remedy against diarrhea, dyspepsia, epilepsy, toothache, whooping cough, flatulence, indigestion, and jaundice^{6,7,9-11}.

Cumin grows to about 30–60 cm tall, with a glabrous, branched, and slender stem. It has compound leaves with thread-like leaflets.

It has terminal umbel inflorescence. Each cumin branch has 3-9 umbels with 5-7 umbellets, consisting of small hermaphrodite flowers which are either white or pink. It has schizocarps, *i.e.* fruits containing two mericarps, and about 6 mm long seeds which are oblong but thicker in the middle. It is mostly planted in the winter or autumn with the emergence of seedlings occurring after about 14 – 50 days. Cumin seed germination usually occurs at low temperatures (< 20 °C) and is arrested at high temperatures¹². Cumin has a weak vigor owing to its increased sensitivity to environmental stresses and because its seeds contain 10% oil¹¹.

The seeds of cumin are characterized by abortifacient, antispasmodic, diuretic, emmenagogic, carminative, and stomachic properties. Oleoresin from the seeds is commonly applied in crackers, sauces, meat, and sausages. The distinct and strong aroma of the seeds are responsible for its use as spices as well as other medicinal uses. The aroma is mainly due to cuminal which makes up 2.5 – 4.0% of the seed. The essential oils of cumin seeds primarily contain hydrocarbons and aldehydes⁸.

The objective of this work is to provide a precise and up-to-date review of the ethnopharmacology, phyto-

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chemistry, and biological activities of cumin. The information was gathered from the review of relevant literature obtained from various databases, such as Science Direct, Springer, PubMed, Google, and Google Scholar.

Previous studies on *C. cyminum*

According to literature, the quality and quantity of the compounds commonly identified in cumin vary in the various parts of the plant, such as the leaves, shoots, roots, and flowers. Though both the shoots and flowers have relatively similar terpene compounds, their concentrations are higher in the flowers. Furthermore, α -pinene and β -pinene were not found in the roots, α -phellandrene was notably the only detected terpenoid compound in the leaves while the flowers had the highest concentration of α -pinene¹³. Cumin fruits mainly contain cellulose, fixed oil content (about 10%), mineral elements, protein, sugar, and volatile oils (1.5%), as well as appreciable amounts of phenolic compounds¹⁴. Formulated *C. cyminum* essential oil in oil-in-water nanoemulsions have demonstrated successful incorporation of lipophilic bioactive agents into functional food gels¹⁵. Natural deep eutectic solvents have also been used to significantly enhance cumin essential oil extraction with a higher yield and premium quality, as an eco-friendly and economical extraction technique¹⁶.

An increase in enzymatic (amylase, lipase, protease, and phytase) activities and antioxidant activity were achieved with saline and hot aqueous cumin extracts, as well as its oleoresin and essential oil¹⁷. Water-soluble *C. cyminum* polysaccharides possess lower molecular weight and effectively stimulate RAW264.7 and NK-92 cells to express interleukin (IL)-1 β , IL-6, IL-12, and tumor necrosis factor (TNF)- α inflammatory cytokine, and release nitric oxide¹⁸. Kedia and colleagues have also reported the fumigant, larvicidal, oviposition deterrent, ovicidal, repellent, and pupaecidal activities of *C. cyminum* seed essential oil, as well as its 4 main components (cymene, cumin aldehyde, γ -terpinene, and (-)- β -pinene) against *Callosobruchus chinensis* and *Sitophilus oryzae*¹⁹. Cumin is considered a very useful eco-friendly alternative for the management of insect infestation in food commodities. *C. cyminum* also has a remarkable antibiofilm and quorum sensing inhibitory potential against Gram-negative bacterial pathogens²⁰. The essential oils of cumin have also demonstrated strong fumigant effects and toxicity against *Anopheles gambiae*²¹.

Ethnopharmacology of Cumin

The common ethnomedicinal uses of cumin are summarized in **Table 1**. Traditionally, cumin is commonly used as a remedy against gastrointestinal, inflammatory and neurological disorders, as well as toothaches²¹. In Iranian traditional medicine, cumin fruits are also used as a medication for colic, diarrhea, dyspepsia and flatulence, and for stimulation of breast milk production¹⁴. It is used in Morocco for the flavoring of foods and soft dates¹⁰. It is also commonly used in Tunisia as aromatic herbs and culinary spices⁶, as well as in Italy for various gastrointestinal and neurological diseases²¹.

Phytochemistry of Cumin

The various parts of the cumin plant (leaves, shoot, root, and flowers) contain similar and different chemical compounds¹³. The most important chemicals which have been identified from cumin essential oils are shown in **Table 2**.

Biological activities of Cumin

The most important biological activities of cumin found in literature are summarized in **Table 3**. They include antioxidant, antibacterial, antifungal, anti-inflammatory, antidiabetic, insecticide, and immunomodulatory properties.

Antioxidant activity

Cumin essential oils have remarkable antioxidant activities and phenolic contents which increase with maturity¹⁴. Both the pure extracts and active agents of the European cumin have also been evaluated and found to be highly effective²⁹. Mohamed, Hamed and Fouda (2018)²⁴ have reported that cumin extract contains 23.02 ± 0.045 mg GAE/g extract and 19 ± 0.132 mg QE/g extract for total phenolic and total flavonoids, respectively.

Antimicrobial activity

The antibacterial activity of ethanolic extracts of *C. cyminum* against *Staphylococcus aureus* has been reported²⁵. The essential oils of *C. cyminum* also possess antimicrobial properties³⁰. Coronatine elicitation reportedly enhanced the yield and level of chemical components, as well as antibacterial, antifungal, antioxidant and *in vitro* cytotoxic activities of the cumin essential oil³¹. The antifungal effects of *C. cyminum* essential oils against *Candida albicans* have also been reported²². According to literature, cumin has demonstrated a broad-spectrum antifungal effect against several pathogenic *Candida* and other fungal species^{10,23}.

Table 1: Ethnomedicinal uses of cumin

Region	Plant part used	Traditional uses and ethnobotanical reports	References
Iran	Spice	Antispasmodic, lactogage and carminative ingredient.	Tabarsa, <i>et al.</i> (2020) ¹⁸
Iran	Cumin seed (zire in Iran)	Treatment of mild digestive disorders as a carminative, eupeptic, astringent in bronchopulmonary disorders, cough remedy, as well as an analgesic.	Minooeianhaghighi, Sepehrian and Shokri (2017) ²²
Iran		stimulant, carminative, coagulant, and anti-diabetic properties.	Jafari, Sattari and Ghavamzadeh (2017) ¹
Tunisia	Seed	Aromatic herbs and culinary spices, stimulant, carminative, astringent, and as a remedy against indigestion, flatulence, and diarrhea.	Rebey <i>et al.</i> (2017) ⁶
Italy	Seeds	Aromatic herbs for toothaches, gastrointestinal, and neurological diseases.	Benelli <i>et al.</i> (2018) ²¹ .
Morocco	Seeds	Flavoring of foods especially soft dates.	Petretto <i>et al.</i> (2018) ¹⁰ .

Antidiabetic activity

The supplementation of *C. cyminum* has reportedly improved fasting blood glucose level and glycosylated hemoglobin readings¹. *C. cyminum* essential oil was also reported to exhibit maximum antidiabetic inhibition activity of α -amylase³².

Anti-inflammatory activity

According to literature, treatments supplemented with *C. cyminum* have a profound effect on several inflammatory biomarkers, such as adiponectin, high-sensitivity C-reactive protein (hsCRP), and TNF- α ^{1,26}. Srinivasan (2018)²⁷ has also reported a detailed anti-inflammatory activity of *C. cyminum*.

Insecticide activity

Cumin essential oils possess effective insecticide activity against adult *Myzus persicae* and *Musca domestica*²¹.

Immunomodulatory activity

Cumin is an effective immunomodulatory agent whose administration significantly and dose-dependently increased the CD4⁺ and CD8⁺ T cell count and modulated T lymphocyte expression²⁸. The detailed immunomodulatory and other beneficial properties of *C. cyminum* have also been reported in literature^{18,27}.

CONCLUSION

Cumin is mostly cultivated for its numerous medicinal, nutraceutical, and pharmaceutical properties. It also has a wide use in beverage, food, liquor,

medicine, perfume, and toiletry. The medicinal and health potentials of cumin are mainly attributed to its antioxidant, antibacterial, antifungal, anti-inflammatory, antidiabetic, insecticide, and immunomodulatory properties. The various parts of the cumin plant (leaves, shoot, root, and flowers) also contain similar and different chemical compounds. More studies are, however, required to unravel novel components and applications of cumin.

ABBREVIATIONS

eNOS: Endothelial nitric oxide synthase,
hsCRP: high-sensitivity C-reactive protein
IL-6: Interleukin-6
TNF- α : Tumor necrosis factor-alpha
TRX1: Thioredoxin 1
TRXR1: Thioredoxin reductase 1

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AUTHOR'S CONTRIBUTIONS

Abdulmutalib Alabeed Allaq, Norrizah Jaafar Sidik, Aziyah Abdul-Aziz, and Idris Adewale Ahmed were all involved in the review conceptualization and first draft of the manuscript. Then All authors were involved in the first review and subsequent completion of the review. And all the authors were then involved in the critical review of the manuscript, final review, and editing. All authors read and approved the final

Table 2: Common important chemicals in cumini essential oils

Compound	Chemical category	Part/Extract	References
Cumin aldehyde	Essential oil	Seed and fruit	Kedia <i>et al.</i> (2015) ¹⁹ ; Moghaddam <i>et al.</i> (2015) ¹⁴ ; Jafari, Sattari and Ghavamzadeh (2017) ¹ ; Petretto <i>et al.</i> (2018) ¹⁰ .
γ -Terpinine	Essential oil	Seed and fruit	Naeini, Naderi, and Shokri, (2014) ²³ ; Kedia <i>et al.</i> (2015) ¹⁹ ; Moghaddam <i>et al.</i> (2015) ¹⁴ ; Jafari, Sattari and Ghavamzadeh (2017) ¹ .
α -Sabinin	Essential oil	Seed	Jafari, Sattari and Ghavamzadeh (2017) ¹ .
α -Flandren	Essential oil	Seed	Jafari, Sattari and Ghavamzadeh (2017) ¹ .
α -Kadinin	Essential oil	Seed	Jafari, Sattari and Ghavamzadeh (2017) ¹ .
p-Cymene	Essential oil	Seed	Naeini, Naderi, and Shokri, (2014) ²³ ; Kedia <i>et al.</i> (2015) ¹⁹ ; Moghaddam <i>et al.</i> (2015) ¹⁴ ; Petretto <i>et al.</i> (2018) ¹⁰
α -Pinene	Essential oil	Fruit	Naeini, Naderi, and Shokri, (2014) ²³ ; Moghaddam <i>et al.</i> (2015) ¹⁴ ; Petretto <i>et al.</i> (2018) ¹⁰
(-)- β -Pinene	Essential oil	Seed	Kedia <i>et al.</i> (2015) ¹⁹ ; Petretto <i>et al.</i> (2018) ¹⁰
α -Phellandrene,	Essential oil	Fruit	Moghaddam <i>et al.</i> (2015) ¹⁴ ; Petretto <i>et al.</i> (2018) ¹⁰ ;
α -Terpinene	Essential oil	Fruit	Moghaddam <i>et al.</i> (2015) ¹⁴ ; Petretto <i>et al.</i> (2018) ¹⁰
α -Terpineol	Essential oil	Fruit	Naeini, Naderi, and Shokri, (2014) ²³ ; Moghaddam <i>et al.</i> (2015) ¹⁴ ; Petretto <i>et al.</i> (2018) ¹⁰
Safranal	Essential oil	Fruit	Moghaddam <i>et al.</i> (2015) ¹⁴ ;
Limonene	Essential oil	Seed	Naeini, Naderi, and Shokri, (2014) ²³ ; Petretto <i>et al.</i> (2018) ¹⁰ .
1,8-Cineole	Essential oil	Seed	Naeini, Naderi, and Shokri, (2014) ²³ ; Petretto <i>et al.</i> (2018) ¹⁰ .
Linalool	Essential oil	Seed	Naeini, Naderi, and Shokri, (2014) ²³ ;
Linalyl acetate	Essential oil	Seed	Naeini, Naderi, and Shokri, (2014) ²³ ;
α -Terpineol acetate	Essential oil	Seed	Naeini, Naderi, and Shokri, (2014) ²³ ;
Geraniol	Essential oil	Seed	Naeini, Naderi, and Shokri, (2014) ²³ ;
Methyl eugenol	Essential oil	Seed	Naeini, Naderi, and Shokri, (2014) ²³ ;
Sabinene	Essential oil	Seed	Naeini, Naderi, and Shokri, (2014) ²³ ; Petretto <i>et al.</i> (2018) ¹⁰ .
Terpinolene	Essential oil	Seed	Naeini, Naderi, and Shokri, (2014) ²³ ; Petretto <i>et al.</i> (2018) ¹⁰ .
α -Thujene	Essential oil	Seed	Naeini, Naderi, and Shokri, (2014) ²³ ; Petretto <i>et al.</i> (2018) ¹⁰ .
Myrcene	Essential oil	Seed	Naeini, Naderi, and Shokri, (2014) ²³ ; Petretto <i>et al.</i> (2018) ¹⁰ .
γ -Terpineol	Essential oil	Seed	Naeini, Naderi, and Shokri, (2014) ²³ ; Petretto <i>et al.</i> (2018) ¹⁰ .
Daucene	Essential oil	Seed	Petretto <i>et al.</i> (2018) ¹⁰
d3-Carene	Essential oil	Seed	Petretto <i>et al.</i> (2018) ¹⁰
Pinocarvone	Essential oil	Seed	Petretto <i>et al.</i> (2018) ¹⁰
Cariophyllene	Essential oil	Seed	Petretto <i>et al.</i> (2018) ¹⁰
Farnesene-(Z)- β	Essential oil	Seed	Petretto <i>et al.</i> (2018) ¹⁰
Germacrene D	Essential oil	Seed	Petretto <i>et al.</i> (2018) ¹⁰
α -Acoradiene	Essential oil	Seed	Petretto <i>et al.</i> (2018) ¹⁰
Carotol	Essential oil	Seed	Petretto <i>et al.</i> (2018) ¹⁰

Table 3: Most important biological activities of cummin

Properties	Model	Findings	References
Antioxidant	<i>In vitro</i>	The antioxidant activities of cummin essential oils are positively correlated with their phenolic contents which increase at stages of intermediate and premature.	Moghaddam <i>et al.</i> (2015) ¹⁴ ; Mohamed, Hamed and Fouda (2018) ²⁴ .
Antibacterial	<i>In vitro</i>	Ethanol extracts of <i>C. cyminum</i> antibacterial effect have against <i>Staphylococcus aureus</i> .	Mostafa <i>et al.</i> (2018) ²⁵ .
Antifungal	<i>In vitro</i>	<i>C. cyminum</i> essential oils have a broad-spectrum antifungal effect against several pathogenic <i>Candida</i> species	Naeini, Naderi, and Shokri (2014) ²³ ; Minooeian-haghighi, Sepehrian and Shokri, (2017) ²² ; Petretto <i>et al.</i> (2018) ¹⁰ .
Anti-inflammatory	Animal model (rat)	Nine weeks of intervention improved plasma nitric oxide, decreased the systolic blood pressure up-regulated the gene expression of eNOS, Bcl-2, TRX1, and TRXR1; and down-regulated Bax, TNF- α , and IL-6.	Kalaivani, Saranya and Ramakrishnan (2013) ²⁶ ; Srinivasan (2018) ²⁷ .
Antidiabetic and anti-inflammatory	Human	Eight weeks of intervention improved fasting blood glucose, glycosylated hemoglobin as well as serum levels of insulin, TNF- α , C-reactive protein, and adiponectin.	Jafari, Sattari and Ghavamzadeh, (2017) ¹
Insecticide	Insect vectors	Cumin essential oils were very active against adults of <i>Musca persicae</i> (LC50=3.2 ml/L) and <i>M. domestica</i> (LD50=31.8 μ g/adult).	Benelli <i>et al.</i> (2018) ²¹ .
Immunomodulatory	Animal (Swiss albino mice)	Cumin administration significantly increased CD4 and CD8 (T cells) count through the modulation of T lymphocytes expression and dose-dependently.	Chauhan <i>et al.</i> (2010) ²⁸ ; Srinivasan (2018) ²⁷ ; Tabarsa <i>et al.</i> (2020) ¹⁸ .

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COMPETING INTERESTS

The authors declare that they have no competing interests.

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