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MYCOFLORA OF SPICES : A REVIEW

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ABSTRACT

Spices are important for human being and have a long history of use in therapy throughout the world and still make an important role as traditional medicine. This review addresses the worldwide Mycoflora contamination which secretes secondary metabolites which known as mycotoxin. Mycoflora as major common contaminants of spices and that causes adverse effect on animal, crops and human that result in economic losses and illnesses. To prevent and screen for contamination and ensure safety and conformity to quality standard of spices and their products should be included in appropriate regulatory framework.
***Keywords*:** Cumin, Coriander, Fennel, Black cumin, Seed Mycoflora

INTRODUCTION

Spices are defined as plant substances from indigenous or exotic origin, aromatic or with strong taste, used to enhance the taste of foods (Germano and Germano, 1998). Spices are important to human being since the beginning of history. They have been mentioned in the Bagavad Gita, Epic of Gilgamaesh and the Old Testament. Archeologists discovered spices in Egyptian tombs as early as 3000 BC. The strong preservative quality of many spices made them ideal for embalming. Many of the spices had strong connections or affiliations with different Gods (The spice house, 1957). Each spice has a unique aroma and flavour, which derive from compounds known as phytochemicals or secondary compounds. Spices are cultivated in different parts of world; however, India is largest spice producing country. The spices are cultivated in various places of India like Tamil Nadu, Kerala, Andhra Pradesh, Karnataka, Rajasthan, Gujarat, Madhya Pradesh, Uttar Pradesh, Punjab and Kashmir etc. based on different agro climatic conditions. In Uttar Pradesh, various spices are cultivated such as cumin, coriander, fennel and Black seed at commercial level. After harvesting seeds are stored in different storage conditions. Furthermore they are usually dried on the ground in the open air in poor hygienic conditions that even more promote growth of various microbes like viruses, bacteria fungi and nematodes among these micro organisms, fungi play a dominated role in decreasing quality and longevity of the seeds .Fungi causes seed borne diseases like discoloured seeds, damaged seeds and undersized seeds, which decrease seeds germinability. Seed borne fungi are divided into 2 groups-field fungi and storage fungi. Seeds are liable to be infected with storage fungi like *Aspergillus, Pencillium, Fusarim* and *Alternaria* which elaborate toxic metabolites, called “mycotoxins” which cause health hazards in animals and human beings (Bilgrami *et al*., 1984). Some seeds do not suitable for human consumption and refused at commercial level. Fundamentally this possess on the production which affect the economy of the country.

Cumin (*Curminum cyminum* L)

Cumin is an important seed spices in India at commercial level. In the world India is the largest producer as well as largest consumer of cumin seed. It is most important spice in the world after pepper. The spice has been mostly cultivated in India (large producer about 90% of the world production). During Ravi season, cumin is mainly cultivated in Gujarat and Rajasthan. Rajasthan (56%) is a largest producer of cumin followed by Gujarat (44%) cumin is one of the most important spice crops of these states (Gujarat and Rajasthan). At state level, Cumin was cultivated in 295400 hectares leading to a production of 300940 tonnes in Gujarat and 511080 hectares with production 200850 tonnes in Rajasthan (during 2015-16). But in both current years 2016-17 and 2017-18 possess same production of cumin were grown in 278750 hectares with 291490 tonnes production in Gujarat and 500140 hectares with 206940 tonnes production in Rajasthan. At national level, cumin was cultivated in 780950 hectares with 500380 tonnes production during 2017-18. A part from India, cumin also cultivated in other countries in the world such as Syria, Morocco, Turkey, Greece, Egypt, Iran etc. The total production at world level is around 300000 tons. Today production of Cumin is specially centred in South and central Asia. In cumin seeds commonly known as jeera (in hindi) which obtained from an annual herbaceous flowering plant belong to family *Umbellifereae* (*Apiaceae*), native from the east Mediterranean to South Asia. It play a major role as flavouring agent. It is a tropical plant and grown in cool climate, sandy-loamy soil with PH 6.8-8.3 range, require less water with 25-30˚C temperature.

Cumin seeds are oblong and yellowish-brown in colour. Its seeds have good nutrient composition (2.5 to 45% volatile oil, 10% fixed oil, protein, dietary fibre and mono-saturated fat in high amount), vitamins A, C, E, K and good source of various mineral such as iron, calcium, manganese, magnesium, copper. Volatile oil of dry cumin seeds have mainly cuminaldehyde (used in perfumery). Cuminaldehyde is a major bioactive compound. Cuminaldehyde and Cuminic Alcohol are main constituent of aroma compound. Other important components of volatile oil of cumin are terpinene, P-mentha-1, 3-diene-7-al, β-pinene,P-mentha-1,4-diene-7al, a-phellandrene, p-cymene, P-mentha.3-en-7al whereas a-pinene sabinene, B-phellandrene, Hydrocuminine also found in small quantities (Li and Jiang, 2004). In India, cumin seeds have been used for thousands of years as a traditional ingredient of several dishes as well as traditional medicine. It is used as preservative and stimulant, antispasmodic, carminative and antimicrobial agent. It is also used in traditional medicine to treat flatulence and digestive disorders. It is used as astringent, anti-inflammatory, constipating, revulsive, diarrhea, diuretic, uterine, galactogogue and nerve stimulant. Mainly used in seasoning soups, chutney, meats, curry powder, pickles. Cumin seeds and distilled cumin are used as a stimulant, carminative, antimicrobial agent and antispasmodic (Romeilah *et al*., 2010). a-pinene and b-pinene (component of volatile oil) are reported to possess anti-inflammatory activity

Seed mycoflora

Cumin seed is being attacked by several fungal pathogens. Many of them are detected as seed borne mycoflora. Seed borne mycofloralike *Alternaria tenuis, Fusarium oxysporum, Fusarium equesti, Cladosporium,* and *Drechslera spicifer*, were found predominating (Chohan *et al*., 2001). *Alternaria burnsii* also found from 150 samples of Cumin seed samples of Rajasthan (Rastogi, 1993). *Alternaria alternate* and *Aspergillus flavus* are observed as dominant fungal spcies (Sumanth *et al*., 2010). Similarly, in Cumin *Aspergillus flavus, A. niger* and *Penicillium spp.* have been recorded in samples from Erbil city markets (Toma and Abdulla, 2013). *Aspergillus niger* was observed as higher fungal incidence followed by *Syncephalastrum recemosum. Rhizopus nigricans, Mucor variance, Aspergillus fumigates, A. flavus, Cladosporium cladosporioides* and *Helminthosporium tetramera* had least incidence in cumin samples of Amravati District (Hedawoo *et al*., 2014). *Aspergillus flavus* and *A. niger* had higher percent incidence of isolated fungi followed by *A.parasiticus, Rhizopus oryzae, A. ochraceus, A. terrus, Penicillium citrinum, Rhizopus nigricans* and *Fusarium oxysporum* were recorded in cumin samples of Bihar (Jeswal and Kumar, 2016). *A. alternata, Aspergillus niger, Aspergillus flavus, Curvularia lunata, Fusarium pallidoroseum, Aspergillus ochraceus, Rhizopus* sp. and *Drechslera rostrata (Setosphaeriarostrata).* In the *Alternaria* sp. pathogenicity test, including some symptoms like tip burning, brown to black spots on leaves, stems and inflorescences, and blighting of most of the plant were founded (Chand and Jain, 2000). The pathogenicity of *Fusarium oxysporum, F. solani, F. moniliforme* and *Verticillium* sp. was studied on black cumin seeds and seedlings, using both seed and soil inoculation. A higher percentage of pre and post-emergence damping off developed from seed inoculation with each of the four fungi than from soil infestation (Christensen and Kaufman, 1965). The transmission of *Fusarium oxysporum, F. solani, F. moniliforme* and *Verticillium* sp. from seed to mature plants of black cumin was also studied (Elwakil and Ghoneen, 1999).

Coriander (*Coriandrum sativum*)

Coriander is cultivated as commercial spice crops and plays an important role in Indian economy. It is cultivated all over the world. Coriander is grown in South America, Europ, Turkey, China, Pakistan, Malasiya, India, Spain, North America, Thailand, Morocco, Italy, Maxico, Central America, France, Russia. India is a largest producer in the world. In India, coriander is mostly grown in Andhra Pradesh, Maharashtra, Tamil nadu, Rajasthan, Uttar Pradesh, Haryana and Madhya Pradesh during Rabi season. In current year 2017-18, Coriander was cultivated in 665190 hectare with 866800 tonnes production at country level. In India, coriander seeds are known as dhania in hindi. Linalool, a-pinene, graniol, camphor, geranyl acetate, oleic acid, linoleic acid and palmitic acid are present in their seeds as phytochemical constituents and flavonoids, aminoacid, tannins, saponins, steroids, carbohydrates, cardiac glycosides sterols are also present as major nutritional components. Coriander has been used in medicine for thousands of years (Mathias, 1994). It is also used externally to treat ulcers and rheumatism. The seeds have significant amounts of calcium, iron, magnesium, and manganese. Coriander contains antioxidants, which can delay or prevent the spoilage of food seasoned with this spice. A study found both the leaves and seed to contain antioxidants, but the leaves were found to have a stronger effect (Wangensteen *et al*., 2004). Its seeds are used in traditional Indian medicine as adiuretic by boiling equal amounts of coriander seeds and cumin seeds, then cooling and consuming the resulting liquid. It is used also to flavour several alcoholic beverages (gin). Mostly coriander seeds are consumed as curry powder. The young plant is used for flavouring and garnishing curries and soups. The fruits (seeds) are widely used as condiments with or without roasting in the preparation of curry powders, sausages and seasonings. It is an important ingredient in the manufacture of food flavourings, in bakery products, meat products, soda and syrups, puddings, candy preserves and liquors. It is one of the five spices that make up curry powder. In medicines it is used as a carminative, refrigerant, diuretic, and aphrodisiac. In household medicines, it is used against seasonal fever, stomach disorders, and nausea. Coriander oil and oleoresins are primarily used in seasonings for sausages and other meat products, Carminative, diuretic, tonic, stimulant, stomachic, refrigerant, aphrodisiac, analgesic, anti-inflammatory. Coriander fruits contain: volatile oil, fatty acids, the aromatic coriandrol and other mineral substances (Christensen and Kaufman, 1969). Its pharmacological activities are anti-ulcer, anti-oxident, anti-pyretic, anti-diarrheal, anti-convulsant, anti-cancer and anti-microbial.

Seed Mycroflora

Seed mycoflora of coriander was investigated and observed by several workers. Seed borne mycoflora such as *Alternaria alternata, Fusarium moniliforme*, *Phoma species*, *Fusarium semitectum*, *Fusarium solani*, *Fusarium equiseti* were founded associated with coriander seed samples (Hashmi and Ghaffar, 1991). Some other seed born fungi such as *Aspergillus flavus, A. niger, A. ochraceus, Penicillium* sp., *Rhizopus arrhizus, R. stolonifer* and

Syncephalastrum racemosum were recorded in Indian samples (Shrivastava and Jain, 1992). The seed-borne pathogens are one of the major causes of serious diseases in growing crops because of poor health and quality of seeds. To realize this aspect, the study has been undertaken and it was observed that total Eleven fungal species viz. *Alternaria alternate, Aspergillus flavus, A. fumigatus, A. niger, A. ochraceus, Cladosporium cladosporioidis, Curvularialunata, Fusarium moniliforme, Mucor variance, Penicillium chrysogenum* and *Rhizopus nigricans* were reported on Coriander seeds. Maximum percent of incidence was recorded of *Aspergillus niger* and minimum of *Curvularia lunata* (Hedaoo and Chakranarayan, 2011). *Memnoniella echinulata, Fusarium moniliforme* and *Aspergillus flavus* were recorded in the fresh and stored seeds of coriander (Singh *et al*., 2013). *Aspergillus flavus* and *A. Niger* had higher percent incidence of isolated fungi *while A. fumigates* and *A. ochraceus* had least incidence (Jeswal and Kumar, 2016). Similarly, *Aspergillus niger, Aspergillus spp*. UFLADC 01 and *Aspergillus sclerotion niger* were isolated from coriander seeds (Mahmood *et al*., 2017). *Aspergillus flavus, Aspergillus niger, Alternaria alternate, Penicillium spp*. And *Botrytis spp.* were also recorded (Khan *et al*., 2019).

Fennel (*Foeniculum vulgare mill*.)

Fennel as also another important spice crop of India at commercial level which play a major role in Indian economy. Fennel is grown in Russia, Romania, Italy, France, Argentina, USA and India at large scale and also cultivated in China, Egypt, Syria, Morocco, Denmark, Bulgaria and Japan. In India, its production was 148640 tonnes in 89580 hectares during 2017-18 at country level. Funnel is cultivated extensively in Gujarat, Rajasthan and Uttar Pradesh (Northern India as a cold weather crop) and also grown in Tamil nadu, Bihar, Maharashtra, Karnataka, Jammu - Kashmir, Panjab at small scale. Fennel seeds are obtained from the herb *Foeniculum vulgare*, native of southern Europe and the Mediterranean region (Clevelya *et al*., 1997) belonging to the family *Apiaceae*. Fennel seeds are oblong, small, cylindrical and greenish-yellow. The leaves of fennel are used for garnishing. Leaves and stalks are used in salads. It is an essential ingredient in Italian sausages, widely used to sprinkle on pizza. Dried fruits have fragrant odour and pleasant aromatic taste and therefore used as a masticatory. They are also used for flavoring soups, meat dishes, sauces, pastries, confectionaries and liquors. The fruits are aromatic, stimulant and carminative, stomachic, emmenagogue, refrigerant, cardiac stimulant, antiemetic, aphrodisiac, anthelmintic (Spices board of India, Kerala). Fennel contains anethole, which can explain some of its medical effects: It, or its polymers, acts as phytoestrogens (Albert, 1980). The essence of fennel can be used as a safe and effective herbal drug for primary dysmenorrhea.

Seed Mycroflora

Fennel cultivars was screened from seed mycoflora where *Aspergillus flavus, A. niger, Rhizopus stolonifer,Cladosporium cladosporioides* and *Curvularia lunata* (*C. lunatus*) isolated. These caused seed infection and subsequently reduced the seed viability. Seed viability reduction was recorded with *A. flavus* due to maximum seed infection whereas *R. stolonifer* caused minimum seed infection resulting in the lowest seed viability reduction (Kumar and Kumar, 2001). Similar result was founded in 127 seeds samples of *Foeniculum vulgare* from Rajasthan. *Aspergillus* sp., *Curvularia* sp., *Drechslera tetramera* and *Fusarium* sp. were dominant and pathogenic. These caused loss in seed germination, seedling symptoms and mortality of seedling (Dwivedi *et al*., 2008). *Aspergillus spp.* viz *A. niger, A. flavus, A. ochraceus* and *A. flavus var. colum-naris* from samples of *Foeniculum vulgare* were recorded (Moharram *et al*., 1989). Fennel seeds samples of Amravati District were contaminated with seed born fungi viz. *Aspergillus flavus* exhibited higher incidence followed by *Rhizopus nigricans* while *Fusdarium moniliforme, Penicillium chrysogenum and curvularia lunata had least incidence* (Hedawoo *et al*., 2014). *A. parasiticus, A. flavus, A. niger, A. ochraceus* and *P. verrucosum* were detected in Bihar seed samples of *Foeniculum vulgare* Mill. (Jeswal and Kumar, 2015). Similarly, *Aspergillus niger, Aspergillus fumigatus, Chrysonilia sitophila, Mucor sp., Rhizopus sp., Cercospora sp.* and *Cylindrocarpon sp. Ewre* isolated from fennel seeds (Abraham and Thomas, 2018).

Black cumin (*Nigella sativa* L.)

Black cumin is a spice plant, a member of Ranunculaceae family, commonly known as kalonji in Hindi, native to Arab countries and many other parts of the Mediterranean region. *Nigella sativa* is an annual herb native to North Africa, Southern Europe and Southwest Asia and it is cultivated in many countries in the world like Mediterranean region, Syria, South Europe, Middle Eastern, India, Pakistan, Turkey, Saudi Arabia, Bangladesh, Israel, Lebanon, Nepal, Sri Lanka, Egypt and Iraq. In India it is cultivated commercially in Madhya Pradesh, Bihar, Punjab and Assam. It is also cultivated in other states like Uttar Pradesh, Rajasthan, Tamil Nadu, West Bengal, Himachal Pradesh, Gangtic Plains and Maharashtra. it has been recorded that *Nigella sativa* seeds were prescribed by ancient Egyptian and Greek physicians to treat headache, nasal congestion, toothache and intestinal worms. It was used to promote menstruation, to increase milk production and as a diuretic. *Nigella sativa* seeds have been used as folk medicine in the Middle and far East as a traditional medicine for a wide range of illnesses, including bronchial asthma, headache, dysentery, infections, obesity, back pain, hypertension and gastrointestinal problems. It is use in some skin conditions such as eczema has also been recognized worldwide (Goreja, 2003). The seeds can be ground to a powder, mixed with a little flour as a binder and applied directly to abscesses, nasal ulcers and rheumatic joints. *Nigella sativa* seeds have ability to reduce toxicity due to their antioxidant activities (Salem, 2005).

Seed mycoflora

Seeds of Nigella Sativa L were collected During Pre Harvest, Post Harvest and Storage Conditions. *Alternaria alternata, A. tenuissima, Aspergillus flavus, A. fumigates, Cheatomium globusum, Cladosporium herbarum, Curvularia lunata, Fusarium solani, Memnoniella echinata, Mucor spp* were found to be almost common occurrences in pre harvest, post harvest and stored seeds. Some fungi were specially isolated only from by specific stages for viz. *A. longissima*at pre harvest, *Fusarium moniliforme, Cladosporium herbarum, at post harvest stage, A. luchuensi, A, nidulens, A. niger, A. ochracius, A. restictus, A.vercicolor, Cheatomium spp. Emercella nidulance, Epicoccum purpurenscens, Penicillium*

*citrinum, P. restrictumm, Phoma spp, Rhizoctonia solani, Verticillium terrestre*at storage stage of *N. sativa* L. (Anwar and Ansari, 2016). Similarly, *Alternaria alternate, A. aculeatus and penicillium spp*. Were isolated on unsterilized surface of *Nigella sativa* L. Seeds and *A. aculeatus* also isolated on sterilized surface (Toma and Abdulla, 2013). This literature survey clear that, lot of work have been done on isolation of seed spices mycoflora.

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