

# **Handbook of herbs and spices**

**Edited by**

**K. V. Peter**



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# **Handbook of herbs and spices**

Volume 2

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# Handbook of herbs and spices

Volume 3

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K. V. Peter



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# Introduction

Herbs and spices play a pivotal role in the day-to-day life of mankind as important flavouring agents in foods, beverages and pharmaceuticals and also as ingredients in perfumes and cosmetics. The manufacturers of foods, beverages, cosmetics and pharmaceuticals are responding to the growing wave of consumer resistance and legislative limitations set for products containing chemical additives. Spices as sources of natural colours and flavours present welcome opportunities in the international market. The nutritional, antioxidant, antimicrobial and medicinal properties of spices also have widespread applications.

## I.1 Production of quality spices

Production of quality clean spices without any pesticide/chemical residues is important in this era of free international trade resulting from globalisation. Organic spices which fetch 20 to 50% higher prices than spices from conventional farms are devoid of pesticides and chemical residues and are superior in quality. Adoption of good agricultural practices helps to reduce the above contaminants. Quality assurance systems such as HACCP is of great relevance in the production of quality spices. Decontamination techniques and proper packaging and storage techniques play a major role in maintaining quality of spices.

### I.1.1 Rational uses of pesticides and controlling the pesticide/chemicals residues in herbs and spices

All over the world, people are becoming more and more conscious of health problems due to consumption of foods contaminated with pesticide residues. It is estimated that a large number of people suffer from pesticide poisoning and suffer every year due to the toxic effects of chemicals. Promotion of a farming technique adopting ecologically sound plant protection measures, organic recycling and bio-waste management would go a long way in bringing back the health of soil and reducing the pesticide residues of farm produce. The role played by various beneficial microorganisms including mycorrhizae, biocontrol agents and plant-growth-promoting rhizobacteria are enormous in enhancing crop growth and disease control without leaving any chemical residues on plants. The effective bioagents for the control of major diseases of spice crops are listed in Table I.1.

**Table I.1** Effective bio agents for the control of major diseases in spice crops

Crops	Major diseases	Causal organisms	Bio control agents
Cardamom (small)	Azhukal	<i>Phytophthora meadii</i> , <i>P. nicotianae</i> var. <i>nicotianae</i>	<i>Trichoderma viride</i> <i>T. harzianum</i> <i>Laetisaria arvalis</i>
	Rhizome rot	<i>Rhizoctonia solani</i> , <i>Pythium vexans</i>	<i>Gliocladium virens</i> Arbiscular Mycorrhizal Fungi (AMF)
	Seed rot	<i>Fusarium oxysporum</i>	<i>Trichoderma</i> sp.
	Seedling rot	<i>R. solani</i> , <i>P. vexans</i>	<i>Pseudomonas fluorescens</i>
	Root rot	<i>F. oxysporum</i>	<i>Bacillus subtilis</i>
Black pepper	Foot rot (quick wilt)	<i>Phytophthora capsici</i>	AMF <i>T. viride</i> , <i>T. harzianum</i> , <i>Gliocladium virens</i> <i>Paecilomyces lilacinus</i>
	Slow decline (slow wilt)	<i>Rodophilus similies</i> , <i>Meloidogyne incognita</i>	<i>G. virens</i> , <i>T. viride</i> <i>T. harzianum</i> , AMF <i>Verticillium</i> , <i>Chlamydosporium</i> sp. <i>Pasteuria penetrans</i>
Vanilla	Root rot	<i>Fusarium oxysporum</i> , <i>Sclerotium rolfsii</i>	<i>T. viride</i> , <i>T. harzianum</i>
	Stem rot, stem blight, beans rot, beans yellowing and rotting shoot tip rot	<i>P. meadii</i> , <i>F. oxysporum</i> <i>Sclerotium rolfsii</i> <i>F. oxysporum</i> , <i>Colletotrichum gloeosporioides</i>	<i>B. subtilis</i> <i>P. fluorescens</i> <i>T. viride</i> <i>T. harzianum</i> <i>P. fluorescens</i>
Ginger	Soft rot (rhizome rot)	<i>Pythium aphanidermatum</i> , <i>P. myriotylum</i> , <i>Fusarium</i> sp.	<i>T. viride</i> <i>T. harzianum</i>
	Ginger yellows		<i>Trichoderma</i> sp.
Turmeric	Rhizome rot	<i>Rhizoctonia solani</i> , <i>Sclerotium rolfsii</i>	<i>Trichoderma</i> sp.
	Storage rots		
Chillies, Paprikas	Damping off in seedlings	<i>Pythium</i> sp., <i>Phytophthora</i> sp.	<i>T. viride</i> <i>T. harzianum</i> <i>P. fluorescens</i>
	Anthracnose (fruit rot)	<i>Colletotrichum lindemuthianum</i>	<i>B. subtilis</i> <i>P. fluorescens</i> <i>B. subtilis</i> <i>Trichoderma</i> sp.
Thyme	Wilt disease	<i>F. oxysporum</i>	<i>T. viride</i>
	Leaf rot	<i>F. oxysporum</i>	<i>T. harzianum</i>
Rosemary	Thread blight	<i>Rhizoctonia solani</i>	<i>T. harzianum</i>
Sage	Wilt	<i>R. solani</i>	<i>T. harzianum</i>
Mint	Wilt	<i>F. oxysporum</i>	<i>T. harzianum</i>
Horse-radish	Leaf blight	<i>Colletotrichum</i> sp.	<i>T. harzianum</i>
	Root rot, wilt	<i>Verticillium</i> sp.	<i>T. harzianum</i>
Burmese-coriander	Wilt	<i>Fusarium</i> sp.	<i>T. harzianum</i>
Marjoram	Leaf blight	<i>Colletotrichum</i> sp.	<i>T. harzianum</i>
	Leaf spot	<i>Phoma</i> sp.	<i>T. harzianum</i>
Oregano	Leaf spot	<i>Curvularia lunata</i>	<i>T. harzianum</i>

Guidelines for production of organic spices are developed for various producing countries. The Spices Board of India (2001) published the guidelines for production of organic spices in India. The nutrient composition of selected organic cakes and recommended quantity of organic manure for various spice crops are presented in Table I.2.

### I.1.2 Radiation processing to decontaminate spices

Radiation processing offers good scope for increasing shelf life, enhancing quality and microbial safety without changing the natural flavour attributes of spices. This technique is widely practised in North America and Europe to decontaminate imported

**Table I.2** (a) Nutrient composition of selected organic cakes and (b) recommended quantity of organic manure for various spice crops

(a)			
Oil cakes	Nutrient contents (%)		
	Nitrogen	Phosphorus	Potash
Edible cakes			
Coconut cake	3.0	1.9	1.8
Niger cake	4.7	1.8	1.2
Sesamum cake	6.2	2.0	1.2
Sunflower cake	7.9	2.2	1.9
Groundnut cake	7.3	1.5	1.3
Non-edible cake			
Cotton seed cake (with shells)	6.4	2.9	2.2
Mahua cake	2.51	0.80	1.85
Neem cake	5.22	1.08	1.48
(b)			
Spice crops	Organic manure	Quantity	
Black pepper	Farmyard manure	4–10 kg/plant	
Small cardamom	Neem cake/FYM/Vermicompost/Poultry manure	4–5 kg/plant	
Large cardamom	Cattle manures/organic cakes	2 kg/plant	
Vanilla	Farmyard manure/Vermicompost	4–5 kg/plant	
Chilli	Farmyard manure/	4–5 t/ha	
	Sheep manure/	3–5 q/ha	
	Neem cake	3–4 q/ha	
Ginger	Farmyard manure/	5–6 t/ha	
	Neem cake	2 t/ha	
Turmeric	Farmyard manure/	5–6 t/ha	
	Neem cake	2 t/ha	
Fennel	Farmyard manure	10–12 t/ha	
Coriander	Farmyard manure	4 t/ha	
Cumin	Farmyard manure	4–5 t/ha	
Fenugreek	Farmyard manure	4–5 t/ha	
Celery	Farmyard manure	10–12 t/ha	
Clove	Farmyard manure	15–40 kg/plant	
Nutmeg	Farmyard manure	15–40 kg/plant	

Source: Spices Board of India (2001).



spices. The various producing countries also started installing facilities for radiation processing of spices. Radiation sterilisation along with good agricultural and manufacturing practices help to produce clean, high quality spices free from pesticide and chemical residues. Being a cold process, it does not affect the delicate aroma and flavour compounds in spices. The risk of post-treatment contamination can be eliminated by subjecting the pre-packed spices to irradiation. Table I.3 gives the list of countries that have approved irradiation processing of food products and spices items permitted for irradiation under the Indian Prevention of Food Adulteration Act (PFA) rules.

Low doses of irradiation (< 1 K.Gy) help to inhibit sprouting in onion, garlic, ginger, etc. A medium dose application (1–10 K.Gy) eliminates spoilage microbes and food pathogens and high dose application (>10 K.Gy) sterilises food for special requirements and for shelf-stable foods without refrigeration.

### I.1.3 Packaging in spices for maintenance of quality

Spice products are hygroscopic in nature and being highly sensitive to moisture,

**Table I.3** (a) Countries which have approved radiation processing of food products and (b) spice items permitted for irradiation under Indian Prevention of Food Adulteration Act (PFA) rules

(a)

S. no.	Country	S. no.	Country	S. no.	Country
1	Argentina	19	Ghana	37	Philippines
2	Australia	20	Greece	38	Poland
3	Austria	21	Hungary	39	Portugal
4	Bangladesh	22	India	40	Russian Federation
5	Belgium	23	Indonesia	41	South Africa
6	Brazil	24	Iran	42	Spain
7	Canada	25	Ireland	43	Sweden
8	Chile	26	Israel	44	Syria
9	China	27	Italy	45	Thailand
10	Costa Rica	28	Japan	46	Turkey
11	Croatia	29	Republic of Korea	47	Ukraine
12	Cuba	30	Libya	48	UK
13	Czech Republic	31	Luxemburg	49	Uruguay
14	Denmark	32	Mexico	50	USA
15	Egypt	33	Netherlands	51	Vietnam
16	Finland	34	New Zealand	52	Yugoslavia
17	France	35	Norway		
18	Germany	36	Pakistan		

(b)

Name of spice	Dose of irradiation		Purpose
	Minimum	Maximum	
Onion	0.03	0.09	Sprout inhibition
Shallots (small onion)	0.03	0.15	Sprout inhibition
Garlic	0.03	0.15	Sprout inhibition
Ginger	0.03	0.15	Sprout inhibition
Spices	6.0	14.0	Microbial decontamination

Source: Sharma *et al.* (2003).

absorption of moisture may result in caking, discolouration, hydrolytic rancidity, mould growth and insect infestation. As spices contain volatile aromatic principles, loss of these principles and the absorption of foreign odours as a result of inefficient packaging may pose serious problems. In addition, heat and light accelerate deterioration of aroma and flavour components.

Spices containing natural colouring pigments need protection from light (capsicum, cardamom, turmeric and saffron). Spice powders like onion and garlic contain highly volatile sulphur compounds and need rigorous protection from loss/absorption of flavour. The essential oil components naturally present in most of the spices are subject to oxidation by atmospheric oxygen, particularly at high storage temperature resulting in the development of off-flavours. Packing of spice oils and oleoresins is done in epoxy lined steel drums and high-density polythene containers. For certain oils and oleoresins, aluminium and stainless steel containers are used. Polyethylene terephthalate (PET) bottles, which possess very good odour barrier properties and food-grade high-molecular-weight high-density polyethylene (HMHDPE) containers are also used for storing essential oils and oleoresins. Most of the whole spices are protected by pericarp and the natural antioxidants present therein, and need less rigorous protection than ground spices. The packaging materials suitable for different spice products are listed in Table I.4.

**Table I.4** Packaging in spices

Spice	Product	Type of packaging	Packing material
Black pepper	Whole pepper	Bulk	Gunny bags (burlap bags) polyethylene-lined double burlap bags.
	Whole pepper	Retail	HDPE pouches 200 gauge
	Ground pepper	Retail	Laminated heat stable aluminium foil (polyethylene coated) Moisture-proof cellulose film Double-lined polyethylene bags
Cardamom	Green cardamom	Bulk	Wooden boxes or tins lined with heavy gauge black polyethylene, metal foil or waterproof paper.
	Cardamom seed	Retail	Air-tight tin. Wooden chests lined with aluminium foil laminate
	Cardamom powder	Retail	Lacquered cans, PVDC and HDPE pouches
Ginger Turmeric	Dry ginger	Bulk	Single/double gunny bags
	Dry turmeric	Bulk	Double gunny bags
	Turmeric powder	Retail	Aluminium foil laminate
	Turmeric powder	Bulk	Fibreboard drums, multiwall bags and tin containers
Chilli	Dry chilli	Bulk	Wooden crate dunnage with a layer of matting
	Chilli powder	Retail	Plastic laminate and aluminium combination pouches with nitrogen gas. 3000 gauge low-density polyethylene pouches

## I.2 Herbs and spices as sources of natural colours and flavours

The food sector is now experiencing a trend back towards natural colourants due to changes in legislation and consumer preference as synthetic food colourants pose health hazards like cancer, asthma, allergy, hyperacidity and thyroidism. But low tinctorial power, poor stability (to changes in pH, oxygen, heat and light), low solubility, off-flavour and high cost limit the use of natural colours. These problems can be overcome by improving the traditional extraction methods using enzymes, microorganisms, super-critical CO<sub>2</sub>, membrane processing and encapsulation techniques.

Before synthetic colours came into existence, spices like chilli, saffron, turmeric, etc., were used in Indian cuisines to add colour. The Central Food Technological Research Institute of India (CFTRI) has developed technology for the manufacture of certain natural food colours such as kokum (red) and chillies (red). Kokum contains 2–3% anthocyanin and is regarded as a natural colour source for acidic foods. Garcinol is the fat soluble yellow pigment isolated from rind of kokum fruit. Garcinol is added at 0.3% level to impart an acceptable yellow colour to butter. Colour components present in spices and natural shades available with spices are presented in Table I.5.

### I.2.1 Sources of natural colours in spices

#### *Paprika*

The colour in paprika is due to carotenoids, namely capsanthin and capsorubin, comprising 60% of total carotenoids. Other pigments are cryptoxanthin, zeaxanthin, violaxanthin, neoxanthin and lutein. The outer pericarp of paprika is the main source of capsanthin and capsorubin. Indian paprika oleoresin is orange in colour which is less preferred in the international market. Oleoresin contains up to 50% capsorubin. Paprika oleoresin is insoluble in water whilst being readily soluble in vegetable oil and is made dispersible in water by the addition of polysorbate.

Applications are in sausages, cheese sauces, gravies, salad dressings, baked goods, snacks, icings, cereals and meat products.

**Table I.5** Colour components in spices

Colour component	Tint	Spice
Carotenoid		
β-carotene	Reddish orange	Red pepper, mustard, paprika, saffron
Cryptoxanthin	Red	Paprika, red pepper
Lutein	Dark red	Paprika, parsley
Zeaxanthin	Yellow	Paprika
Capsanthin	Dark red	Paprika, red pepper
Capsorubin	Purple red	Paprika, red pepper
Crocetin	Dark red	Saffron
Neoxanthin	Orange yellow	Parsley
Violaxanthin	Orange	Parsley, Sweet pepper
Crocin	Yellowish orange	Saffron
Flavonoids	Yellow	Ginger
Curcumin	Orange yellow	Turmeric
Chlorophylls	Green	Herbs

Source: Ravindran *et al.* (2002).

The ingredients of paprika colour are paprika oleoresin and refined vegetable oil. Stability is as follows:

Heat	good
pH (colour range)	pale pinkish
Light	good
Concentration	40000 IU

### *Turmeric*

Curcumin is the golden-yellow pigment present in turmeric, regarded as the pure colouring principle with very little of flavour components. It is produced by crystallisation from the oleoresin and has a purity level of 95%. Pure curcumin is insoluble in water and hence is dissolved in food grade solvent and permitted emulsifier (Polysorbate 80). Curcumin gives a lemon-yellow colour in acidic pH. It is used at levels of 5–20 ppm. Curcumin is available in two basic forms, oleoresin and curcumin powder, both are used as food colourants.

The ingredients of turmeric colour (oil soluble) are curcumin and turmeric oleoresin. Stability is as follows:

Heat	very good
pH (colour range)	greenish yellow to reddish yellow
Light	poor
Application	butter, margarine, cream desserts, fruit wine, bread, biscuit and cakes.

It is blended with other natural colours such as annatto and beetroot red for use in confectionary, ice cream, dairy products such as yoghurts.

### *Saffron*

Saffron gives a wonderful golden colour to food but due to its powerful and distinctive flavour, it is prized in soups, stews, bread and rice dishes in many global cuisines. Saffron is perceived as luxurious and expensive and hence its use is restricted in foods. The intensive colour of saffron is caused by carotenoids, especially crocetine esters with gentobiose. Other carotenoids present are alpha and  $\beta$  carotene, lycopene and zeaxanthin.

## **I.2.2 Spices as sources of natural flavours**

The increasing demand in developed countries for natural flavour offers tremendous potential for spice crops as sources of natural flavours. The main flavour compounds present in herbs and spices are presented in Table I.6. The recovery of essential oil and oleoresin from various spices and the major aromatic principles present in spices are illustrated in Table I.7. Extraction of oils and oleoresins is accomplished using a range of methods, including steam distillation, hydrocarbon extraction, chlorinated solvent extraction, enzymatic treatment and fermentation, and super-critical carbon dioxide extraction.

Carbon dioxide extraction from solid botanicals is now adopted on a commercial scale. The resulting essential oils have no solvent residue, fewer terpenes and enhanced black notes. Enzymatic treatment and fermentation of raw botanicals also result in greater yields and quality of essential oil. More recently, the use of genetic engineering

**Table I.6** Important flavour compounds in spices

Spice	Important flavour compounds
Allspice	Eugenol, $\beta$ -caryophyllene
Anise	(E)-anethole, methyl chavicol
Black pepper	Piperine, S-3 Carene, $\beta$ -caryophyllene
Caraway	d-carvone, crone derivatives
Cardamom	$\alpha$ -terpinyl acetate, 1-80-cineole, linalool
Cinnamon, cassia	Cinnamaldehyde, eugenol
Chilli	Capsaicin, dihydro capsaicin
Clove	Eugenol, eugenyl acetate
Coriander	d-linalool, C10-C14-2-alkenals
Cumin	Cuminaldehyde, p-1,3-mentha-dienal
Dill	d-carvone
Fennel	(E)-anethole, fenchone
Gingerol	Gingerol, Shogaol, neral, geranial
Mace	$\alpha$ -pinene, sabinene, 1-terpenin-4-ol.
Mustard	Allyl isothiocyanate
Nutmeg	Sabinene, $\alpha$ -pinene, myristicin
Parsley	Apiol
Saffron	Safranol
Turmeric	Turmerone, Zingiberene, 1,8-cineole
Vanilla	Vanillin, p-OH-benzyl-methyl ether
Basil, sweet	Methylchavicol, linalool, methyl eugenol
Bay laurel	1,8-cineole
Marjoram	e- and t-sabinene hydrates, terpinen-4-ol
Oregano	Carvacrol, thymol
Origanum	Thymol, carvacrol
Rosemary	Verbenone, 1-8-cineole, camphor, linanool
Sage, Clary	Salvial-4 (14)-en-1-one, linalool
Sage, Dalmation	Thujone, 1,8-cineole, camphor
Sage, Spanish	e- and t-sabinylacetate, 1,8-cineole, camphor
Savory	Carvacrol
Tarragon	Methyl chavicol, anethole
Thyme	Thymol, carvacrol
Peppermint	1-menthol, menthone, menthufuran
Spearmint	1-carvone, carvone derivatives

and recombinant DNA technology have resulted in *in vitro* production of natural esters, ketones and other flavouring materials. Cloning and single cell culture techniques are also of benefit to the flavourist.

### I.2.3 Herbs and spices as medicinal plants

The medicinal properties of spices have been known to mankind from time immemorial. Spices were used extensively in the traditional systems of medicines such as Ayurveda, Sidha and Unani. In the recent past, there has been increasing interest in the biological effects of spices as they are safe and cause no side effects to humans. Extensive studies are going on in developed countries for the separation of medicinal components from spices and evaluation of their biological properties. A classic example for such study is the Piperine alkaloid separated from black pepper and marketed as Bioperine (98% pure piperine). This alkaloid could increase bioavailability of certain drugs and nutrients like beta carotene. The medicinal properties of spices are summarised in Table I.8.

**Table I.7** Recovery of essential oil and oleoresin from spices and the major aromatic principle

Spice	Essential oil (%)	Aromatic principle	Oleoresin (%)
Black pepper	1–4.0	Terpin hydrate	10–13
Cardamom (small)	6–10	$\alpha$ -terpinyl acetate 1,8-cineole	10–12
Cardamom (large)	1–3	1,8-cineole	–
Ginger	1–2.5	Zingiberine	5–10
Turmeric	2–6	Turmerone	8–10
Nutmeg	7–16	Myristicine Elemicin	10–12
Clove	16–18	Eugenol	20–30
Cinnamon	1–3	Cinnamaldehyde (bark oil) Eugenol (leaf oil) Camphor (root bark oil)	10–12
Allspice	1–3 (leaf oil) 3–4.5 (berry oil)	Eugenol	–

**Table I.8** Medicinal properties of spices

Spice	Medicinal property
Black pepper	Carminative, antipyretic, diuretic, anthelmintic, anti-inflammatory and antiepileptic
Cardamom	Antidepressive, carminative, appetizer, diuretic
Ginger	Carminative, anti-nauseant, diuretic, antifatulence, antihistaminic, aphrodisiac and cholesterol lowering
Turmeric	Carminative, antibiotic, antifatulence, antiseptic and anti-inflammatory
Garlic	Antimicrobial, diuretic, diaphoretic, antifatulence, cholesterol lowering and anti-inflammatory
Clove	Antiflatulence, analgesic, stimulant, carminative and anti-nauseant
Nutmeg	Stimulant, carminative, astringent, aphrodisiac, anti-inflammatory
Cinnamon	Stimulant, Carminative, astringent, aphrodisiac, anti-inflammatory
Chilli	Carminative and antirheumatic
Saffron	Stimulant, stomachic and anticarcinogenic
Allspice	Stimulant, digestive and carminative
Basil, sweet	Stomachic, anthelmintic, diaphoretic, expectorant, antipyretic carminative, stimulant, diuretic, demulcent
Bayleaves (laurel)	Stimulant, narcotic
Caraway	Stomachic, carminative, anthelmintic, lactagogue
Celery	Stimulant, tonic, diuretic, carminative, emmenagogue, anti-inflammatory
Chive	Stimulant, diuretic, expectorant, aphrodisiac, emmenagogue, anti-inflammatory
Coirander	Carminative, diuretic, tonic, stimulant, stomachic, refrigerent, aphrodisiac, analgesic, anti-inflammatory
Cumin	Stimulant, carminative, stomachic, astringent and antiseptic
Dill	Carminative, stomachic, antipyretic
Fennel	Stimulant, carminative, stomachic, emmenagogue
Fenugreek	Carminative, tonic, aphrodisiac
Leek	Stimulant, expectorant
Marjoram	Carminative, expectorant, tonic, astringent
Mint (peppermint)	Stimulant, stomachic, carminative, antiseptic
Mint (spearmint)	Stimulant, carminative and antispasmodic
Oregano	Stimulant, carminative, stomachic, diuretic, diaphoretic and emmenagogue
Parsley	Stimulant, diuretic, carminative, emmenagogue, antipyretic, anti-inflammatory
Rosemary	Mild irritant, carminative, stimulant, diaphoretic
Sage	Mild tonic, astringent, carminative
Tarragon	Aperient, stomachic, stimulant, febrifuge
Thyme	Antispasmodic, carminative, emmenagogue, anthelmintic, spasmodic, laxative, stomachic, tonic, vermifuge

This volume is the third in the series *Handbook of herbs and spices* and has two parts. The first part deals with general aspects referred to the industry such as quality spice production, quality assurance systems, decontamination techniques, packaging, spices as sources of natural colours and flavours, effect of Agreement on Agriculture on spice production and export, etc. The second part deals with detailed information on individual spices. It is hoped that this book will form a good reference source for those who are involved in the study, cultivation, trade and use of spices and herbs.

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