

Introduction to herbs and spices: medicinal uses and sustainable production

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Abstract: This introductory chapter contains a brief history of herbs and spices, including cultivation, trade and uses. The cultivation requirements of important herbal spices are discussed, as well as uses of herbs and spices in food and beverages, perfumes and cosmetics, and medicinal and nutraceutical uses. The important flavour compounds in major culinary and herbal spices are considered. Other topics discussed in this chapter are antioxidants isolated from herbs and spices, active plant constituents and the molecular phytopharmacology of a few herbs and spices. It also deals with biosafety and efficacy issues from a phytochemical perspective.

Key words: acids, alcoholic beverages, alkaloids, anthraquinones, antioxidant and antimicrobial properties, biosafety, bitters, colouring agents, cosmetics, coumarines, flavones, glycosides, gums, herbal remedies, herbs, medicinal and nutraceutical uses, perfumery, pharmaceuticals, resins, saponins, spices, tannins, volatile oils.

1.1 Introduction

The history of herbs and spices is as long as the history of mankind. People have used these plants for medicinal purposes since the earliest times, and the knowledge of herbs has been handed down from generation to generation for thousands of years (Brown, 1995). The terms 'herb' and 'spice' have more than one definition. According to a common one, herbs are plants, some parts of which contain essential oils useful in food, medicine and/or cosmetics and which usually grow in temperate regions, both in the wild and under cultivation. They do not develop persistent woody tissue. Spices are generally derived from woody plants that grow in tropical areas. They have to be imported to other parts of the world, making them expensive. The earliest gardens were herb gardens and the present-day concept of a herb garden has developed largely from ancient Egyptian, Christian and Islamic traditions. Herbs gardens were planted about 4000 years ago in Egypt. Herb growing was often associated with temples, which required herbs and sacred flowers for daily worship and rituals. Both horticulture and botany began with the study of herbs. In most parts of the world, herbs are grown mainly as field crops or on a small

scale as a catch-crop among vegetables and ornamentals as they were thousands of years ago.

Ancient cultures of the Middle East, Greece, China and India revered the power of nature and developed herbal remedies based on the plants found in their home environments. The first known herbal compilation of herbal remedies was ordered by the King of Sumeria around 2000 BC and included 250 medicinal substances including garlic (Fetrow and Avila, 1999). In earlier times, medicinal plants were chosen for their colour or shape of leaves, for example, heart-shaped leaves were used for heart problems, while plants with red flowers were used for treating bleeding disorders. This primitive approach is called the Doctrine of Signatures. The lives of people and plants are more entwined than is often realized. About 80 % of the world population is dependent upon medicinal plants for primary healthcare, particularly in the developing economies where local communities are offered immediate access to safe and effective products so as to treat ill health through self-medication (Akerle, 1992). Currently there is great commercial interest in reinvestigating and developing new pharmaceuticals from natural sources, including herbs and spices. Lastly, it should also not be forgotten that many medicinal herbs are also food, oil and fibre plants and have always been grown for a range of purposes (Parry, 1969; Rosengarten, 1973; Andi *et al.*, 1997). The popularization of traditional healthcare in most parts of the world has led to a tremendous demand for medicinal plants, which are often still collected from their natural habitats. This practice has the potential to lead to their depletion and, ultimately, their extinction. This chapter reviews the uses of herbs and spices, with a focus on medicinal uses, as well as the requirement for sustainable production methods.

1.1.1 Sustainable production of herbs and spices

People all over the world have picked and uprooted herbs from the wild since ancient times.

Medicinal herbs, in particular, have always been mainly collected from the wild, and the knowledge of where they grow and the best time to gather them has formed an important oral tradition among healers from many different countries and cultures. These ancient traditions aimed at successfully balancing supply and demand, allowing plant stock to regenerate seasonally. However, some of the most commonly used culinary herbs, such as chilli peppers (*Capsicum annuum* var. *annuum*) and basil (*Ocimum basilicum*), have such a long history of use and cultivation that truly wild plants have never been recorded. They presumably became extinct because of over-collection. Owing to the strong commercial pressures of food and pharmaceutical industries of today, unregulated gathering has led to severe genetic erosion of a range of herbs and spices. Wild populations frequently contain genes of value in plant-breeding – for instance to increase the levels of active principles, or to confer resistance to disease, so their conservation is important.

Out of about 2000 medicinal and aromatic plants traded in Europe, 1200–1300 are native to the continent with only 130–140 species predominantly derived from cultivated stock. Large-scale cultivation is one practice that can take the pressure off wild stocks. Countries with large-scale cultivation include Argentina, Chile, China, India and Poland (Kuipers, 1997). By enhancing cultivation, food and

pharmaceutical companies can have greater control over quality and supply while reducing pressure on populations of wild plants. Increased exchange of information and self-regulation between stakeholders and by manufacturers of herbal products is also desirable. *In situ* conservation measures and demonstration gardens can be incorporated into management systems for wild populations, and can raise awareness of conservation issues. Substitution by a different species with the same constituents can in addition take pressure off a vulnerable species (e.g. *Calendula officinalis* or *Sambucus nigra* as a substitute for Goldenseal, *Hydrastis canadensis*). Lastly, changing the method of harvest may make practices more sustainable. A Swiss-based herbal remedies and cosmetics company has found that arnica (*Arnica montana*) can be harvested sustainably if only sections of the above-ground parts of the plants are harvested. Sustainable cultivation can be an effective means of providing income for the poorest sectors of the society and can contribute social stability while supporting conservation. Exhaustive details of general herb and spice cultivation practices in India have been compiled by Parthasarathy and Rajeev (2010). Cultivation requirements for some herbs are summarized in Table 1.1.

1.2 Main uses of herbs and spices

1.2.1 Uses in the foods and beverage industry, perfume and cosmetics industries

Herbs and spices have tremendous importance in the way we live, as ingredients in food, alcoholic beverages, medicine, perfumery, cosmetics, colouring and also as garden plants. Spices and herbs are used in foods to impart flavour, pungency and colour. They also have antioxidant, antimicrobial, pharmaceutical and nutritional properties. In the USA, as well as other western countries, there is a trend towards the use of culinary herbs and spices to produce more appealing foods with reduced levels of fat, sugar and salt, and a more general increase in the popularity of ethnic foods from Asia and Latin America. Between 1970 and 2005, the overall per capita consumption of spices doubled, increasing from 1.6 pounds per year to 3.3 pounds per year; however, in the case of garlic, usage has increased more than six-fold (USDA-ERS, 2011).

The basic effects of spices when used in cooking and confectionery can be for flavouring, deodorizing/masking, pungency and colouring (Table 1.2). They are also used to make food and confectionery more appetizing and palatable. Some spices, such as turmeric and paprika, are used more for imparting an attractive colour than for enhancing taste. Because of their antioxidant and antimicrobial properties, spices have dual function – in addition to imparting flavour and taste, they play a major role in food preservation by delaying the spoilage of food. Spices also form an important component in quite a few alcoholic beverages and beers (Table 1.3).

Many herbs and spices have been used in cosmetics, perfumery and beauty and body care since ancient times. The toiletries and allied industries use spices and herbs and their fragrant oils for the manufacture of soaps, toothpastes, face packs, lotions, freshness sachets, toilet waters and hair oils. They are essential ingredients in beauty care as cleansing agents, infusions, skin toners, moisturizers, eye lotions, bathing oils, shampoos and hair conditioners, cosmetic creams, antiseptic

Table 1.1 Cultivation requirements of some herbal spices and their uses

Plant	Propagation	Common uses
Anise	Annual. Seeds are sown in a dry, light soil in early summer. Seedlings should be thinned to 15–18 inches apart. Anise needs 120 frost-free days to produce fully ripened seed heads.	The aromatic seeds are used in cooking, in pot-pourris and in some simple home remedies.
Basil	Perennial. Grows easily from seed. It is frost sensitive. Basil needs medium-well-drained soil and full sun. Pinch tips and flower buds to promote bushiness.	The leaves are a classic complement to enrich the flavour of tomatoes; they are also used to enhance the flavour of salads, sauces and vegetables.
Chervil	Annual and resembles parsley. Seeds are sown in spring. Thin to 15 cm (6 inches) apart. Likes moist, well-drained soil and partial shade. Will self-sow.	The leaves, with their delicate anise-like flavour, are often used in soups and salads.
Lavender	Perennial, with many varieties. English lavender is the hardiest. Mulch it over the winter. Propagation is easiest by root division. Likes full sun and alkaline, gravelly soil.	Grown for its fragrance in the garden and to be used in pot-pourris and sachets.
Oregano	Perennial. Prefers well-drained slightly alkaline soil and full sun. Propagate by seed, root division or cuttings.	The leaves are a favourite seasoning for pizza and other Italian dishes.
Parsley	Biennial, usually grown as an annual. Both the curly and the flat-leaved types like a rich, well-drained soil and full sun or partial shade. Parsley seeds germinate slowly. Be patient; keep the soil moist. Thin to 20 cm (8 inches) apart.	Curly leaved parsley is popular as garnish, but flat leaved (Italian) parsley is more flavourful and is used as addition to salads and sauces. Parsley tea makes a healthful tonic.
Rosemary	Perennial, grown indoors in cold climates. Propagate by layering or cuttings. Rosemary needs full sun, and a sandy well-limed soil. Cut it back after flowering to prevent it from becoming leggy.	This is an aromatic flavouring for meat and poultry dishes. Also used for making wreaths.
Savory	Winter savory, a perennial, has a peppery, pungent flavour. Summer savory, an annual, is similar but more delicate. Plant seeds of summer savory in a rich, light, moist soil; thin to 20 cm (8 inches) apart. Winter savory thrives in poorer soil and with less water. It can be propagated by seed, division or cuttings.	Savory is used to flavour sausages and other meats and is sometimes included in a bouquet garni.
Thyme	Perennial. There are many species and varieties including lemon, English, golden and garden. The garden variety is the most popular for cooking. Thyme grows well on dry slopes; pruning after flowering will keep it from getting woody. Propagated by cuttings.	The leaves add pungent taste to meats and vegetables; thyme sprigs are a main ingredient in bouquet garni for soups and stews.

Source: Reader's Digest (1990).

Table 1.2 Basic uses of herbs and spices

Basic function	Major function	Subfunction
Flavouring	Parsley, cinnamon, allspice, dill, mint, tarragon, cumin, marjoram, star anise, basil, anise, mace, nutmeg, fennel, sesame, vanilla, fenugreek, cardamom, celery	Garlic, onion, bay leaves, clove, thyme, rosemary, caraway, sage, horseradish, Japanese pepper, saffron,
Deodorizing/ masking	Garlic, savory, bay leaves, clove, leek, thyme, rosemary, caraway, sage, oregano, onion, coriander	
Pungency	Garlic, savory, bay leaves, clove, leek, thyme, rosemary, caraway, sage, oregano, onion, coriander, Japanese pepper, mustard, ginger, horseradish, red pepper, pepper	Parsley, pepper, allspice, mint, tarragon, cumin, star anise, mace, fennel, sesame, cardamom, mustard, cinnamon, vanilla, horseradish, Japanese pepper, nutmeg, ginger
Colouring	Paprika, turmeric, saffron	

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

Table 1.3 Spices and herbs used in alcoholic beverages

Alcoholic beverages	Spices and herbs used
Vermouth	Marjoram, sage, coriander, ginger, cardamom, clove, mace, peppermint, thyme, anise, juniper berry
Gin	Coriander, juniper berry
Aquavit	Anise, fennel, dill, caraway
Curaçao	Cinnamon, clove, nutmeg, coriander
Kummel	Caraway, fennel, coriander
Anisette	Anise, fennel, nutmeg
Ganica	Cinnamon, cardamom, coriander, mint, fennel, clove, pepper
Geme de cumin	Cumin
Geme de cacao	Clove, mace, vanilla
Geme de menthe	Peppermint
Peppermint schnapps	Peppermint

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

and antitanning lotions and creams, and for improvement of complexion and purifying blood (Pamela, 1987; Ravindran *et al.*, 2002). A few important chemical flavour constituents in herbs and spices are summarized in Table 1.4.

1.2.2 Medicinal and nutraceutical uses

Herbs and spices have been an essential factor in health care through the ages in all cultures. There are a number of different systems of herbal medicine, the most important of which are Chinese and Indian (*Ayurvedic*) systems of medicine. The use of major medicinal spices in Ayurveda has been reviewed by Mahindru (1982). Herbs and spices are prepared in a number of ways to extract their active

Table 1.4 Antioxidants isolated from herbs and spices

Spice and herbs	Systematic names	Substances and type of substances
Rosemary	<i>Rosemarinus officinalis</i>	Carnosic acid, carnosol, rosmarinic acid, rosmanol
Sage	<i>Salvia officinalis</i>	Carnosol, carnosic acid, rosmanol, rosmarinic acid
Oregano	<i>Origanum vulgare</i>	Derivatives of phenolic acids, flavonoids, tocopherols
Thyme	<i>Thymus vulgaris</i>	Thymol, carvacrol, <i>p</i> -cunene-2, 3-diol, biphehyls, flavonoids
Ginger	<i>Zingiber officinale</i>	Gingerol-related compounds, diarylheptanoids
Turmeric	<i>Curcuma domestica</i>	Curcumins
Summer savory	<i>Satureja hortensis</i>	Rosemarinic acid, carnosol, carvacrol, thymbol
Black pepper	<i>Piper nigrum</i>	Phenolic amides, flavonides
Red pepper	<i>Capsicum annuum</i>	Capsaicin
Chilli pepper	<i>Capsicum frutescence</i>	Capsicin, capsaicinol
Clove	<i>Eugenia caryophyllata</i>	Eugenol, gallates
Marjoram	<i>Marjorana hortensis</i>	Flavonoids
Common balm	<i>Melissa officinalis</i>	Flavonoids
Licorice	<i>Glycyrrhiza glabra</i>	Flavonoids, licorice phenolics

ingredients for internal and external use, including infusions, decoctions, macerations, tinctures, fluid extracts, teas, juices, syrups, poultices, compresses, oils, ointments and powders. Important spices, their botanical names and their medicinal properties are given in Table 1.5.

Active plant constituents

Herbs and spices are rich in volatile oils, which give pleasurable aromas. In addition, herbs may contain alkaloids and glycosides, which are of greater interest to pharmacologists. Some of the main active constituents in herbs are as follows (Brown, 1995; De Guzman and Sienonsma, 1999):

- **Acids:** These are sour, often antiseptic and cleansing.
- **Alkaloids:** These are bitter, often based on alkaline nitrogenous compounds. They affect the central nervous system and many are very toxic and addictive.
- **Anthraquinones:** These are bitter, irritant and laxative, acting also as dyes.
- **Bitters:** Various compounds, mainly iridoides and sesquiterpenes with a bitter taste that increases and improves digestion.
- **Coumarines:** These are antibacterial, anticoagulant, with a smell of new-mown hay.
- **Flavones:** These are bitter or sweet, often diuretic, antiseptic, antispasmodic and anti-inflammatory. Typically yellow, and present in most plants.
- **Glycosides:** There are four main kinds of glycosides:
 - *cardiac:* affecting heart contractions;
 - *synogenic:* bitter, antispasmodic sedative, affecting heart rate and respiration;
 - *mustard oil:* acrid, extremely irritant;
 - *sulphur:* acrid, stimulant, antibiotic.
- **Gums and mucilages:** These are bland, sticky or slimy, soothing and softening.

Table 1.5 Important spices and their medicinal properties

Serial number	Common name	Botanical name	Medicinal uses
1	Ajowan	<i>Trachyspermum ammi</i> L. Sprague ex. Tussil	Antispasmodic, stimulant, tonic and carminative. Administered in flatulence, dyspepsia, diarrhoea and cholera. Effective in relaxing sore throat and in bronchitis. External application of fruit paste recommended in asthma. Used in preparation of ointment for checking chronic discharge. It is diuretic and carminative.
2	Allspice	<i>Pimenta dioica</i> (L.) Merr	Used to treat flatulence, dyspepsia and diarrhoea, rheumatism and arthritis. Remedy for depression, nervous exhaustion and stress. Has antioxidant properties.
3	Angelica	<i>Angelica archangelica</i> L.	Has antispasmodic, aphrodisiac, anticoagulant, bactericidal, carminative, diuretic, expectorant, nervine, stimulant and tonic properties. Used in stomach complaints, vomiting and leucoderma. Reduces accumulation of toxins.
4	Anise	<i>Pimpinella anisum</i> L	Carminative with good flavour and fragrance.
5	Asafoetida	<i>Ferula asafetida</i> L.	Stimulant of mucous membrane, carminative, antispasmodic, expectorant, laxative and digestive. Also used in asthma, bronchitis and whooping cough.
6	Basil	<i>Ocimum basilicum</i> L	Carminative and antimicrobial used against gas, nausea and dysentery.
7	Black caraway	<i>Bunium persicum</i> (Bosis) B Fedtsh	Stimulant and carminative. Used in treating diarrhoea, dyspepsia, fever, flatulence, stomachic, haemorrhoids and hiccups.
8	Black cumin	<i>Nigella sativa</i> L.	Seeds are carminative, stimulant, diuretic, emenagogue and galactagogue. They are used in mild cases of puerperal fever and skin eruptions. Alcoholic extract shows antibacterial activity. Also used as preservative.
9	Black mustard	<i>Brassica nigra</i> (L)Koch	Used against lung congestion, bronchial problems and inflammation.
10	Black Pepper	<i>Piper nigrum</i> L.	Used as an aromatic stimulant in cholera, vertigo and coma and as a stomachic in dyspepsia and flatulence. Externally valued for its rubefacient properties. Used to protect against filariasis.
11	Capers	<i>Capparis spinosa</i> L.	Reduce flatulence and have antirheumatic and antioxidant properties. Used as hepatic stimulants, diuretics, kidney disinfectants, vermifuges and tonics.
12	Caraway	<i>Carum carvi</i> L.	Antispasmodic and used against gas pains.

Table 1.5 Continued

Serial number	Common name	Botanical name	Medicinal uses
13	Cardamom	<i>Elettaria cardamomum</i> Maton	Used as adjuvant to carminative drugs, as stomachic and in dyspepsia. Home remedy for indigestion, nausea, halitosis, bronchial infections, skin diseases, inflammations, itching and poisons.
14	Capsicum	<i>Capsicum annum</i> L.	Source of capsaicin, capsorubin and vitamins C, A and E, it has health-enhancing effects in clearing lungs, increasing flow of digestive juices, triggering brain to release endorphins (pain killers) and anti-oxidant and as a muscle relaxant. Used in flavouring and colouring food products.
15	Celery	<i>Apium graveolens</i> L.	Carminative and sedative used against gas pains and as a tonic.
16	Cinnamon	<i>Cinnamomum verum</i>	Carminative, antispasmodic, aromatic stimulant, diuretic, haemostatic, astringent, stomachic and germicide. Used in pain balms, cold, cough and gastric troubles. It also has antimicrobial and anti-oxidant properties.
17	Clove	<i>Syzygium aromaticum</i> Merr & Perry	Aromatic, stimulant and carminative, used in gastric irritation and dyspepsia. Administered in powdered form to relieve nausea and vomiting, to correct flatulence. Oil used as local analgesic for hypersensitive dentine and carious cavities. Has antiseptic and pain-relieving qualities.
18	Coriander	<i>Coriandrum sativum</i> L.	Fruits carminative, diuretic, tonic, stomachic, antibilious, laxative, refrigerant and aphrodisiac. Fruits and leaves used against colic, dizziness, kidney stones, indigestion and sore throat.
19	Cumin	<i>Cuminum cyminum</i> L.	Seeds are stimulant, carminative, stomachic, astringent and useful in diarrhoea and dyspepsia and in veterinary medicine. Is an appetite stimulant and good digestive. Used for common gastrointestinal upsets.
20	Dill	<i>Anethum graveolens</i> L.	Folk remedy for infant cholic and digestive disorders.
21	Fennel	<i>Foeniculum vulgare</i> Mill	Antispasmodic and used in indigestion and stomach cramps.
22	Fenugreek	<i>Trigonella foenum-graceum</i> L.	Seeds are carminative, tonic, anti-arthritis and galactagogue. Used externally in poultices as emollient for intestinal inflammations. Aqueous extract shows antibiotic activity. Used in treatment of chronic bronchitis, diabetes, hepato- and splenomegaly.

Table 1.5 Continued

Serial number	Common name	Botanical name	Medicinal uses
23	Galangal	<i>Kaempferia galanga</i>	Stimulant, expectorant, carminative and diuretic. Also used for dyspepsia, headache and malaria.
24	Garlic	<i>Allium sativum</i> L.	Has a significant carminative effect with a release or nausea. It brings about a decrease in triglycerides and cholesterol. Oil drops used in earache. Preparations given in pulmonary phthisis, bronchiectasis, gangrene of the lung and whooping cough. Used in laryngeal tuberculosis, lupus and duodenal ulcers and pulmonary tuberculosis. Used in dyspepsia, flatulence and colic. Antiseptic, antispasmodic and used in lowering cholesterol and reducing hypertension.
25	Ginger	<i>Zingiber officinale</i> Rosc	Carminative, stimulant, remedy for flatulence and colic, adjunct to stimulant remedies. Contains antihistaminic factor, remedy for diarrhoea and constipation, anorexia and indigestion. Ginger tea is used for colds, coughs, flu and hangovers. Ginger compresses are used to relieve sinus congestion, kidney problems, menstrual cramps and various aches and pains. Its is also rubefacient.
26	Greater galangal	<i>Alpinia galangal</i> L. Willd.	Rhizomes are bitter, acrid, thermogenic, nerve tonic, stimulant, carminative, stomachic, disinfectant, aphrodisiac, bronchodilator and have tonic properties. Also known for antimicrobial, antifungal, antiprotozoal and expectorant activities. Used in skin diseases, indigestion, colic, dysentery, enlarged spleen, respiratory diseases, cholera, mouth and stomach cancer.
27	Horse radish	<i>Armoracia rusticana</i> Gart.	Antimicrobial, diuretic, stimulant and diaphoretic. Used in treatment of arthritis, respiratory and urinary infections and fevers.
28	Juniper	<i>Juniperous communis</i> L.	Diuretic and carminative.
29	Kokkam and cambodje	<i>Garcinia indica</i> Chiocy <i>Garcinia cambogia</i> Desr.	Source of natural red pigment and hydroxycitric acid which reduces cholesterol and used as anti-obesity agent. It is used against bilious infections, dysentery, mucous diarrhoea, etc.
30	Lavender	<i>Lavendula officinalis</i> Chaix	Carminative, spasmolytic, tonic and antidepressant. Used in headache, neuralgia, rheumatism, depression, etc.

Table 1.5 Continued

Serial number	Common name	Botanical name	Medicinal uses
31	Long pepper	<i>Piper longum</i> L.	As a stimulant, anticolic, antitussive and inducing resistance to infections. Fruits and roots used in respiratory tract diseases, as counter-irritant and analgesic, as a snuff in coma and drowsiness, sedative in insomnia and epilepsy, as a cholagogue, emmenagogue and abortifacient and as ingredient in rejuvenating medicine.
32	Lovage	<i>Levisticum officinale</i> W.D.J.Koch	Used against gas pains and breath deodorizer.
33	Marjoram	<i>Marjorana hortensis</i> M	Source of sweet marjoram oil. Antioxidant antispasmodic, antimicrobial, carminative, stimulant and nerve tonic. Used in asthma, coughs, indigestion, rheumatism, tooth ache and heart conditions.
34	Mints	<i>Mentha piperita</i> L (pepper mint), <i>M. spicata</i> (spear mint)	Menthol from peppermint is added in many medicines for its therapeutic effects. They have carminative and emmenagogue effects. They make refreshing herbal teas.
35	Nutmeg	<i>Myristica fragrans</i> Houtt.	Used as stimulant, carminative, astringent, aphrodisiac, tonic, electuaries and forms constituent of preparations prescribed for dysentery, stomach ache, flatulence, nausea, vomiting, malaria, rheumatism, sciatica and early stages of leprosy. Mace has been recommended for treatment of inflammations of bladder and urinary tract. Butter is a mild external stimulant in ointments and hair lotions. Used in helminthiasis, cough, asthma, amenorrhoea, dysmenorrhoea, etc.
36	Onion	<i>Allium cepa</i> L	External antiseptic has many medicinal properties. Also used in reducing intestinal disorders, hypertension, diabetes, cholesterol, fat in the blood and inflammation.
37	Oregano	<i>Origanum vulgare</i>	Rich in vitamins E and B6, riboflavin, niacin, pantothenate and biotin. Is an antioxidant, carminative, stomachic, diaphoretic and expectorant. Used in colic, coughs, headaches and irregular menstrual cycles.
38	Parsley	<i>Petroselinum crispum</i> Mill	Used as liver tonic, laxative, carminative and against kidney stones. Relieves flatulence and colic. Rich in minerals and vitamins A, C.
39	Pomegranate	<i>Prunica granata</i> L.	Astringent, anthelmintic and used against tapeworm. Cooling and refrigerant and used against dysentery and diarrhoea.

Table 1.5 Continued

Serial number	Common name	Botanical name	Medicinal uses
40	Rosemary	<i>Rosemarinum officinalis</i> L.	Carminative, antidepressant, anticarcinogenic, antispasmodic, rubefacient, antimicrobial and anti-inflammatory. Used in pulmonary diseases and as an antidiarrhoeic, antidiabetic, antispasmodic and antidepressant.
41	Sage	<i>Salvia officinalis</i> L.	Used for excessive sweating, fever and nervous disorders. Carminative and antiseptic.
42	Saffron	<i>Crocus sativus</i>	
43	Star anise	<i>Illicium verum</i> Hooker	Antimicrobial, carminative, diuretic and stomachic. Used in digestive disturbances, cough mixtures and colic pain.
44	Summer savory	<i>Satureja hortensis</i> L.	Aromatic, carminative and has expectorant properties.
45	Sweet flag	<i>Acorus calamus</i> L.	Constituent of tonics. Also has antacid, purgative, anti-oxidant, antimicrobial and anti-insecticidal properties. Used in skin and hair care and also as stimulant.
46	Tarragon	<i>Artemisia dracunculus</i> L.	Diuretic, stimulant and emmenagogue.
47	Thyme	<i>Thymus vulgaris</i> L.	Used in bronchitis and whooping cough. Has antimicrobial, antifungal, anti-oxidant, spasmolytic and anti-inflammatory activities.
48	Turmeric	<i>Curcuma longa</i> L.,	As an ingredient of curry powders, improves flavour and functions as antiseptic, antipoison factor. Aromatic stimulant tonic, carminative and anthelmintic. Paste of turmeric and neem leaves is applied to facilitate the process of scabbing. Used in treating eosinophilia. Ingredient of recipes intended for promotion of health and intelligence of children. As stomachic, tonic, blood purifier, antiperiodic, alterative, etc. Anti-oxidant and has anticarcinogenic and anti-AIDS properties.

Sources: Ravindran *et al.* (2002); Peter (2004); Reader's Digest (1990).

- **Resins:** Often found as oleoresins or oleogum resins – they are acrid, astringent, antiseptic, healing.
- **Saponins:** These are sweet, stimulant hormonal, often anti-inflammatory, or diuretic, soapy in water.
- **Tannins:** These are astringent, often antiseptic, checking bleeding and discharges.
- **Volatile oils:** These are aromatic, antiseptic, fungicidal, irritant and stimulant.

Table 1.6 Molecular phytopharmacology of a few herbs and spices

Plant	Active principle	Molecular action	Uses
<i>Piper longum</i>	Piperine	RNA synthesis	Antiviral
<i>Curcuma longa</i>	Curcumin	Protein synthesis	Against Alzheimer's
<i>Mangifera indica</i>	Mangiferin	Macrophage activation	Immunostimulant
<i>Coleus forskohlii</i>	Forshlin	cAMP increase	Against glaucoma

Source: Vaidya (2002).

Selected modern research into the medicinal properties of herbs and spices

The lower incidence of adverse reactions to herbal medicines and decreased cost as compared to conventional pharmaceuticals are driving national healthcare institutions to consider plant medicine as an alternative to synthetic drugs. Pharmaceutical firms recognize the potential of natural products to provide novel drugs as well as templates for the development of improved versions of the existing treatments for human illnesses. The 'natural' movement towards increased use of herbs and spices has also slowly begun to reduce the demand for synthetically derived drugs. 'Bio-prospecting' of natural resources has impetus around the world; the search for new and novel molecules as therapeutic agents is extensive. Studies indicate that around 60% of the antitumour and anti-infective agents in the later stages of clinical trials have plant origin (Singh *et al.*, 2000). Many medicinal herbs used in Ayurveda have multiple bioactive principles. It is not always easy to isolate compounds and demonstrate that the efficacy can be attributed to any one of the active principles. However, the active principles and their molecular mechanism of action of some of the medicinal plants are being studied (Table 1.6). Further examples of research into medicinal plants are given below.

Researchers have found a positive linear correlation between phenolic compounds, primarily phenolic acids and flavonoids, and the antioxidant capacity of herbs and spices. As several metabolic diseases and age-related degenerative disorders are closely associated with oxidative processes in the body, the use of herbs and spices as a source of antioxidants to combat oxidation warrants further attention. Immediate studies should focus on validating the antioxidant capacity of herbs and spices after harvest, as well as testing their effects on markers of oxidation. Table 1.7 lists some antioxidants identified in herbs and spices and their extracts. Plant phenols may scavenge free radicals involved in lipid peroxidation as has been documented (Madsen *et al.*, 1996). Miguel (2009) has reviewed the antioxidant activity of medicinal and aromatic plants.

In terms of the prevention of cancer, turmeric has been identified as a spice that decreases expression of receptor tyrosine kinases (RTKs) such as epidermal growth factor receptor (EGFR) and HER2 (Aggarwal and Shishodia, 2006). (RTKs are key regulators of normal cellular processes and also play a crucial role in the development and progression of many types of cancer). As described by Aggarwal and Shishodia, 'The activator protein-1 (AP-1) pathway is linked to growth through regulation, cell transformation, apoptosis, cellular proliferation, repression of tumour-suppressor genes, as well as being involved in the stages of tumour

Table 1.7 Important flavour compounds in major culinary and herbal spices

Spices	Important flavour compounds
Culinary spices	
Allspice	Eugenol, β -caryophyllene
Anise	(E)-anethole, methyl chavicol
Black pepper	Piperine, S-3-carene, β -caryophyllene
Caraway	<i>d</i> -carvone, carone derivatives
Cardamom	α -Terpinyl acetate, 1-8-cineole, linalool
Cinnamon, cassia	Cinnamaldehyde, eugenol
Chilli	Capsaicin, dihydrocapsaicin
Clove	Eugenol, eugenyl acetate
Coriander	<i>d</i> -Linalool, C10-C14-2-alkenals
Cumin	Cuminaldehyde, <i>p</i> -1, 3-mentha-dienal
Dill	<i>d</i> -Carvone
Fennel	(E)-anethole, fenchone
Ginger	Gingerol, shogaol, neral, geranial
Mace	α -Pinene, sabinene, 1-terpenin-4-ol
Mustard	Allyl isothiocyanate
Nutmeg	Sabinine, α -pinene, myristicin
Parsley	Apiol
Saffron	Safranol
Turmeric	Turmerone, zingiberene, 1,8-cineole
Vanilla	Vanillin, <i>p</i> -OH-benzyl-methyl ether
Herbal spices	
Basil, sweet	Methylchavicol, linalool, methyl eugenol
Bay laurel	1, 8-cineole
Marjoram	<i>e</i> - and <i>t</i> -Sabinene hydrates, terpinen-4-ol
Oregano	Carvacrol, thymol
Origanum	Thymol, carvacrol
Rosemary	Verbenone, 1-8-cineole, camphor, linanool
Sage, clary	Salvia-4 (14)-en-1-one, linalool
Sage, Dalmatian	Thujone, 1,8-cineole, camphor
Sage, Spanish	<i>e</i> - and <i>t</i> -Sabinylacetate, 1,8-cineole, camphor
Savory	Carvacrol
Tarragon	Methyl chavicol, anethole
Thyme	Thymol, carvacrol
Peppermint	<i>l</i> -Menthol, menthone, menthufuran
Spear mint	<i>l</i> -Carvone, carvone derivatives

metastasis...Quercetin, which is an active component in basil, coriander, cumin, and fennel, as well as curcumin, and capsaicin have been shown to suppress AP-1 activation...Coriander and fennel have been found to decrease expression of both mitogen-activated protein kinase (MAPK) pathway and c-Jun N-terminal kinase (JNK), which is another component of MAPK pathways' (Aggarwal and Shishodia, 2006), so may have a role to play in cancer prevention.

The role of curcumin as an antioxidant, anticarcinogenic and anti-HIV agent is fast changing our acceptance of herbal components in pharmaceuticals (Farooqi *et al.*, 2000). The antidiabetic and hypocholesterolaemic effect of fenugreek ensures its use in various antidiabetic preparations. Ginger is used as an anti-emetic for cancer chemotherapy. The hypoglycemic and hypocholesterolaemic properties of

black caraway (*Carum carvi*) oil have been reported. Rosemary oil improves chronic circulatory weakness on external application. Extracts of *Ginseng biloba*, hawthorn, ginseng and garlic are good for cardiovascular disorders, such as hyperlipidaemia, cerebral and cardiac insufficiency. Peppermint oil, spearmint oil and extracts have been reported to be effective as inhibitors of helicobacteria. *Andrographis paniculata* is used as an astringent anodyne tonic and is useful in treatment of jaundice due to the andrographolide lactones present in it. *Aloe vera* gel is used for preparing health drinks due to presence of anthrone and polysaccharides (Farooqi *et al.*, 2000).

1.3 Safety and efficacy issues: a phytochemical perspective

The potential for a herbal product to cause adverse reactions can be assessed from the perspective of the phytochemical content of the plant. Reports of phytochemicals with adverse reaction profiles are available. Tannin-containing herbs can inhibit trace element and B vitamin absorption. They should therefore not be used in high doses for long periods. Saponins are gastric irritants. Hence, doses of herbs which contain saponins can cause reflux and/or vomiting in sensitive individuals. The alternative is to give them in enteric-coated tablets or with meals. Pungent herbs such as capsicum and ginger (*Zingiber officinale*) may lead to gastroesophageal reflux. In the case of herbs that contain mustard oils such as horseradish (*Armoracia rusticana*), the burning sensation is real and can cause considerable gastric discomfort. High doses of ginger can cause heartburn.

Controlled trials of herbal products are necessary to establish safety and efficacy; manufacturing standards are required to ensure product quality. Ideally, quality control and assurance methods should be defined for each product on the market. Without adhering to standards for purity, potency, disintegration and dissolution, a consistent, high-quality product cannot be produced. Powdered herbs and extracts in oral dosage forms are the most popular with consumers. Specific compounds from a bulk herb may be extracted and prepared for delivery. Extracts concentrate the active components. They may be taken as such or made into a fluid extract or tincture including a solvent. Tinctures are made when the active component is not water soluble. Tinctures and freeze-dried herbs are preferred to those that are dried or encapsulated because there is less loss of potency by oxidation. The chemical stability of these products is complex, making it a challenge to determine expiration or shelf-life dating. Botanicals packaged in dosage forms for medicinal purposes may behave as drugs, even if they are not regulated as such. Pharmacokinetic data remain quite limited (Desmet and Brouwers, 1997).

The American Spice Trade Association (ASTA) Safety Guidelines for Spices Sold in the United States insists that steps need to be taken at every step throughout the process of growing, harvesting, drying, and processing spices to ensure that clean, safe spice is ultimately delivered to the consumer. ASTA advise the following of good agricultural practices (GAP) (to minimize the potential for contamination of spices by heavy metals, mycotoxins, pesticide residues, etc). ASTA also provide guidelines on handling and storage of materials to minimize the contamination risks. The society encourages using the following techniques: good manufacturing

practices (GMP) (processing of spices, facility construction and design, maintenance of the grounds, equipment design pest control, etc.); a hazard analysis critical control point (HACCP) plan (a key analytical tool to allow for the identification of physical, chemical and microbiological risks and the steps to prevent the resulting risks to food safety); microbial reduction techniques (to ensure spices are free of pathogens); and supply chain management (to ensure clean, safe spice).

Future research into the medicinal properties of herbs and spices should focus on identifying the key molecules in the cell signalling network which are affected by components of herbs and spices and elucidation of their mechanisms of action. A range of bioactive compounds in herbs and spices have been studied in animals for their anti-carcinogenic properties (among many others), but the challenge lies in integrating this knowledge to ascertain whether any effects can be observed in humans, and within defined cuisines.

1.4 The structure of this book

This book is the second volume of the series *Handbook of herbs and spices (Second edition)*. A group of introductory chapters address general issues of importance to those using herbs and spices in consumer products, such as antimicrobial and antioxidant properties. The following chapters contain detailed information on particular herbs and spices. The crops are organized alphabetically and range from ajowan to tamarind. Two chapters on a selection of less-commonly encountered herbs and spices complete the volume. It is hoped that the two volumes of the second edition of *Handbook of herbs and spices* will form a useful reference work for all those involved in the study, cultivation, trade and use of herbs and spices.

1.5 References

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