

Understanding Spices for Processing

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ABSTRACT

Spices are unique because they add both flavor and color to the food and effective in small quantities. Spices when added to foods contribute flavor, pungency and color, and contribute antioxidant, antimicrobial, pharmaceutical and nutritional properties. The indirect effects are salt reduction, sugar reduction and control the cooking or processing of food. The complex effects that the spices give to food are - increased appetite, masking effect, improvement of texture and preservation. Since the flavor compounds of spices are thermo-labile, proper packaging is essential to maintain the flavor. The bitterness of some spices is decomposed during cooking. Spices enhance the flavor of some foods and may also increase the palatability of other foods. In spice processing, their end use is important. This is more of individual judgment although some patterns are common. Spice blends have a more delicate flavour than individual spices in a mixture. Cultural preferences and country's food habits determine the composition of a spice blends. With the world moving towards processed food, specific chemical component of a spice is becoming more important than the whole spice.

INTRODUCTION

Food is the basic requirement of all living things. Human beings differ from other animals in their ability to use various items in their food. In fact we human beings have a wider range of food items in comparison to any other zootic species. One more thing that separates us from other animals is the ability to process food and the most important way of processing food is cooking. Wrngham (2009) is of the opinion that evolution of man is related

to the ability to control fire and the advent of cooked meals. Cooking increased the value of our food. it changed our bodies, our brains, our use of time and our social lives. In short it changed our life and us. Agricultural revolution which changed the human society is also linked to the ability of human beings to cooking. Origin of agriculture is supposed to have happened in three stages, which changed the human beings from hunter gathers to farmers and house builders. Human beings must have learned the

utility of cooking of food, along with taming of plants and animals and must have developed taste. For long it was thought that advent of spices in food began out of necessity. Large animals when killed need to be consumed soon, else it will rot. Perhaps the use of spices started to slower the process or even to mask the foul flavors and to increase their palatability. This however is debatable, because spices were always considered a luxury. So people who can afford spices can also afford fresh food/meat. Most of the spices that are used today have medicinal properties. Therefore their use must have started as medicines slowly finding way into regular cooking because of their ability to impart special quality to food and this hypothesis has credence.

What are spices?

Spices are "any dried, fragrant, aromatic, or pungent vegetable or plant substance, in the whole, broken, or ground form, that contributes flavor, whose primary function is seasoning rather than nutrition, and that may contribute relish or piquancy to foods or beverages" (Farrell, 1990). Two other words commonly synonymously used with spices are herbs and condiments. Spices are used as an ingredient during the preparation of food while condiments are added after the food is prepared as per individual preferences (<http://wiki.answers.com/Q/>

What is the difference between spices and condiments? Thus spices are also used as condiments, examples are coriander, pepper which are added during the food preparation or after the food is prepared. Generally many a condiments (particularly the western condiments like ketchup, sauces, mustard), has some preparation of their own before being used.

Herbs and spices are the two words which are often interchangeably

used with thin line of difference between them. In common parlance, herbs or herbal spices refer to the plants in which the leaves either fresh or dry are used for flavoring the foods and beverages. While spice refers to any of the plant part used – stem, bark, tuber, seed and even leaf to impart flavor to food or to improve the quality of the food. Most of the herbal spices have medicinal properties and therefore are used to use this particular property. In many a spices, their leaves as well as other parts are used as spices. Cinnamon, fennel and fenugreek are examples in which both leaves and other parts are used as spices. Spices, in contrast to herbs have strong flavor, zesty, are pungent and are fiery and fragrant giving the food an exotic and exiting taste

(<http://www.helpwithcooking.com/spice-guide/introduction-spices.html>).

Basic uses of spices

Spices are mainly used for their direct and indirect or complex effects. The direct effects of spices are imparting flavor to food, making food tastier (it can be pungency, bitterness or sweetness), give color to food (normally spices given three colors- red, yellow and green), or the exploitation of the antifungal effect, or antibacterial effect or antioxidant effect when added to food. The complex effects include masking effect (masking of bad odours of food, such as in meats), improvement of texture of the food or help in preservation of food. The basic effects of spices when used in cooking and confectionary can be for flavoring, deodorizing/ masking, pungency and coloring which are listed in Table 1.

Besides giving aroma and flavor either on their own or when added to food, spices also contain alkaloids and glycosides which are of greater interest to pharmacologists. Lists of common active constituents are given

in Table 2. As such most of the traditional medicine systems use spices and herbs as medicines. *Ayurveda* the Indian system of medicine and *Unani* systems use spices as ingredients in several of their preparations. The medicines basically are concoctions and extracts made from raw spices. Some of the ethnomedical uses of spices are given in Table 3. Although not valued for the nutritional properties, spices contain important nutrients. Azeez and Leela (2011) provide a good account of exploiting the nutraceutical properties in spices.

Flavor

Spices contain various types of flavoring compounds imparting them mild to very strong flavors. The flavor in spices is because of the volatile essential oil content. Essential oil in spices is made up of a number of compounds which

differ according to spice. The flavor characteristics of spices vary according to where it is grown, harvest times and other factors. The spices lose the flavor components upon storage although the rate of loss of components is dependent on storage time and method. The loss is directly proportional to temperature of storage. The essential oil components of a sample of spices are given in Table 4.

Essential oils are terpenes having 10, 15 or 20 carbon atoms. Compounds with 10 carbon atoms are called monoterpenes, 15 carbon atoms are called Sesquiterpenes while the ones with 20 carbon atoms are called Diterpenes. Monoterpenes have strong aroma and are volatile, hence are utilized in perfumes or essences. Flavor is thermolabile hence has to be handled with care during cooking or even processing so that the flavor is retained.

Table 1. Basic uses of spices (From Peter, 2004)

Basic function	Major function	Sub function
Flavoring	Parsley, cinnamon, allspice, dill, mint, tarragon, cumin, marjoram, star anise, basil, anise, nutmeg, fennel, cardamom, celery	Garlic, onion, bay leaves, clove, thyme, rosemary, caraway, sage, savory, coriander, pepper, saffron, ginger, leek, mustard
Deodorizing, Masking	Garlic, savory, bay leaves, cloves, leek, thyme, rosemary, caraway, sage, oregano, onion, coriander	Parsley, pepper, allspice, mint, tarragon, cumin, star anise, mace, fennel, sesame, cardamom, mustard, cinnamon, vanilla, horse radish, Japanese pepper, nutmeg, ginger
Pungency	Japanese pepper, mustard, ginger, horseradish, red pepper, pepper	Red pepper
Coloring	Paprika, turmeric, saffron	

Table 2. Active constituents in spices and their medicinal properties (From Peter, 2004)

Constituent	Property
Acids	Often antiseptic and cleansing
Alkaloids	They affect the central nervous system and many are very toxic and addictive
Anthraquinones	Irritant, and laxative, also used dyes
Bitters	Mainly iridoides and Sesquiterpenes with a bitter taste that increase and improves the digestion
Coumarins	Anti bacterial and anticoagulants
Flavones	Diuretic, antiseptic, antispasmodic and anti inflammatory.
Glycosides	Affect heart contractions, sedatives, stimulant and antibiotics. Specific properties vary with species
Tannins	Astringent, often antiseptic, checks bleedings and discharges
Volatile oils	Aromatic, antiseptic, fungicidal, irritant and stimulant

Table 3. Ethno-medical uses of some spices (From Parthasarathy 2010)

Spice	Ethnomedical use
Allspice	To cure toothache, carminative and stimulant
Alpinia	Used in infusion to heal stomach cramps and dysentery
Anise	Used as carminative, for stomachache and gastric pain and as vermifuge
Black pepper	Dried powder used for curing urinogenital complaints and berries with onion are used to extract guinea worms.
Clove	Bark infusion used for diarrhea, dysentery and leaf infusion of rdiabetes. Fruits as remedy against diarrhea, as beverage and tonic. Seeds are used to treat blood pressure and sugar in urine.
Fennel	Leaf infusions for stomach ailments, remedy to vomiting
Ginger	Rhizomes used for treating hemorrhage, malaria, headache, as a digestive, carminative and anti asthmatic
Nutmeg	Fruit is chewed to alleviate stomachache
Turmeric	Treating sprains, bruises, as analgesic to treat stomach pain etc
Vanilla	Used against poor blood circulation and skin ailments.

Table 4. Chemical compounds in essential oil of a sample of spices

Spice	Chemical compounds in essential oil
Coriander	Linallol, α , β -pinine, ρ -cymene
Cumin	Cuminaldehyde, eugenol, caryophyllene, pinene
Fennel	Anethole, limonene, fenchone, α -pinene, camphene
Pepper	Piperine, caryophyllene, α -oubebe, phellandrene, camphene, myrcene

Pungency

Pungency is the result of stimulation of taste buds by essential oils. Stronger pungency is the result of concentration of essential oils in a spice. However, some of the spice compounds can be perceived as pungent even at low concentrations. The pungent components are either acid-amide compounds, carbonyl compounds, thioether compounds or isothiocyanate compounds (Hirasa and Takemasa, 1998). The pungent compound in some of the species is given in Table 5. Hot sensation spreads in the mouth while, sharp sensation stimulates the mucous membrane of both the nose and oral cavity. Hot sensation is perceived with mostly non volatile compounds while

sharp sensation is perceived with mostly volatile compounds.

Color

Some of the spices are exclusively used to impart color to the food. Turmeric, pepper and saffron belong to this category. The coloring compound in some of the spices is listed in Table 6. The component is either water soluble (saffron) or oil soluble (paprika or turmeric), hence the choice of the spice for color depends on the medium of extraction of color in the food. The color tones change due to pH of the solution, or because of the heating. Hence care should be taken while using the heating.

Table 5. Pungent compounds in spices (From Hirasa and Takemasa, 1998)

Spice	Pungent compound	Basic structure	Sensation
Red pepper	Capsaicin Hihydrocapsaicin	Acid amide group	Hot  Sharp
Ginger	Zingerol, Shogaol	Carbonyl group	
Onion	Diallyl sulfide	Thioether group	
Garlic	Diallyl sulfide		
Mustard	Allyl isothiocyanate, P-hydroxybenzyl isothiocyanate	Isothiocyanate group	
Horseradish	Allyl-isothiocyanate	Isothiocyanate group	

Table 6. Color components of spices (From Peter 2004)

Color component	Tint	Spice
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
Capsorbin	Purple red	Paprika, red pepper
Crocetin	Dark red	Saffron
Neoxanthin	Orange yellow	Parsley
Violaxanthin	Orange	Parsley, sweet pepper
Crocin	yellow orange	Saffron
Flavonoid	yellow	Ginger
Curcumin	Orange yellow	Turmeric
Chlorophylls	Green	herb

Deodorizing/ masking effect of spices

It is common practice to use garlic and onion while cooking the meats. These have the ability to deodorize or mask the bad smells of meats. Generally three types of deodorizing effects by spices are observed. Chemical deodorizing where the smelled compounds change into non smelling compounds due to non volatile or other odourless substances by chemical reaction. Masking effect where strong flavor covers bad smell, sometimes when two different smells become odourless when mixed. Physical deodorizing where smelled compounds absorbed by porous substances. The last is uncommon with spices. Whether a particular spice can deodorize or not depends on when and how a spice is added to the food. Garlic when added at the end of food preparation has little use, however when the same is added right at the beginning of food preparation has the desired effect.

Anti microbial properties of spices

Throughout the history, food borne bacteria or the toxins produced by them

have been health hazard which still are even today. Spices restrict or reduce the growth of harmful bacteria in the food and perhaps this is the reason that the spices are so much valued. The antimicrobial properties of spices have been verified through several *in vitro* studies. De, De and Benerjee (1999) tested 35 spices and found that 20 spices had antimicrobial properties while six of the spices tested had both antibacterial and antimycotic properties. A good review of the antimicrobial activities of the spices is given by Tassou (2004) and Hirasa and Takemasa (1998). The food spoilage is more common in tropical environments than in temperate environments. Hence the use of spices is more in the tropical environs. In a study conducted by Billing and Sherman (1998), a liner increase in the number of spices used to the mean temperature of the country was found. Similarly Sherman and Flaxman (2001) found that the use of spices is more in meat preparations than in non meat preparations as the meat is more liable to be spoiled by the microbes and the spices's antimicrobial

properties help in preventing this spoilage. They have found that the spices with antimicrobial properties more commonly appeared in food preparations than those which have less of this property. For example they reported that the onion, garlic, cumin, allspice and mustard appear more commonly in the spices used in food as these have higher antimicrobial properties. Besides having antimicrobial properties, spices also have insecticidal properties. Details of their insecticidal properties have been reviewed by Tassou (2004) and Hirasa and Takemasa (1998). It is a common practice to use cloves in grain bins to prevent the attack of stored grain pests in India. Similarly, a little mustard oil is used in the granary to prevent the attack of insects. Mustard also has nematicidal properties. In the organic control of pests of diseases on crops, concoctions made of cloves, asafetida, mustard and other spices are common.

Antioxidant properties

Fat is an important component present in all types of foods. Oxidation of fat present in the food is one of the reasons of food deterioration. Fats in the food react with oxygen present in the air to generate peroxides which further are oxidized and decomposed into low molecular alcohol and aldehyde compounds resulting in rancidity. In order to reduce this synthetic antioxidants are commonly added. Butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), propyl gallate (PG) are some of the synthetic antioxidants used. Many of the herbal spices are known as excellent sources of natural antioxidants and consumption of fresh herbs in the diet therefore contributes to the daily intake of antioxidant intake. Phenolic compounds present in spices are the primary antioxidants and a linear relationship between total phenolic content and the

antioxidant properties of spices has been found. Essential oils, oleoresins, and even aqueous extract of spices possess antioxidant properties.

Cooking with spices

The way spices are used for cooking is more of individual preferences, and also culture dependent. Both pepper and black pepper have pungency and hotness. But the use of pepper is more common in oriental cooking while use of pepper is more common in western cultures. Spice blends are more common in Indian cooking, while few chosen spices are frequently used in Japanese cooking. Similarly how a spice is used in cooking depends on its individual property. Further, spices have either synergistic or suppressive properties when used in combinations. Vanilla is used in ice creams and cakes, as it increases the sweetness of the products. In other words with the same amount of sugar added, addition of few drops of vanilla essence greatly increases the feel of sweetness. Similarly addition of cinnamon to cakes has similar effects. Imagine the taste of ice-cream with pepper. A single spice may be used in different ways in different parts of the world. Generally locally available spices are more frequently used in Asia and Africa while exotic spices are more frequently used in Europe and Americas.

Cooking with spices depends on whether spices are used in fresh or dry. In what form they are used- spices can be used in either whole, ground, extract or in blends. At what time the spice is added in cooking- before, during or after the cooking. Which property to be used- the flavor, the deodorizing or masking property to be exploited or to exploit its coloring property is to be exploited. Also the age of spice- whether it is a fresh stock or old also matters in cooking. Generally the older stocks of spices have no use,

unless properly packed and stored. Cooking process can be divided into three stages- preparation before cooking, cooking using heat and the final preparation after the food is removed from heat. Garnishing is generally done at the third step as it helps exploit the flavor of the spices added. Similarly cooking with onion and garlic is best done when they are added in the second step, as the heat helps in exploiting the deodorizing properties.

The amount of spice added is also an important factor in cooking. Spices are never added in large quantities. However it is difficult to quantify the amount of spice to be added as again it depends on the individual's preference and many times is ingrained in the culture of the society. The Asian and African cooking requires higher amount of spices in comparison to western cooking. Pleasant flavored spices can have a medicinal like smell or taste if added in excess. Normally several spices are added together, hence the "strength" of a particular spice can be controlled by adjusting the amount of spice added.

Spice processing

Spice processing involves post harvest handling of spices. These include cleaning, grading, processing for specific purposes and packing. Clean food ingredients are everyone's requirement. The demand for clean spices is even more. All the countries have their own set of standards for the quality of spices. The Agmark standards of India and ASTA standards are the internationally accepted standards for quality assurances of spices. An account of the standards is provided in Agrawal, Sastry and Sharma (2001).

Spices are used either whole, ground or their extracts are used. Raw spices have the flavor components locked in their cells which are released

during the process of cooking. However, since large volume of inert matter is associated with the flavor principles, it increases the transport cost and demands extensive storage facilities, besides deterioration of quality on long storage. Ground spices are the whole spices milled to a specific fineness. Compared to the whole spices they can be incorporated more uniformly in food products, although like whole spices, ground spices also have a limited shelf life. Spice extracts serve as a alternative to whole and ground spices and provide stability and consistency required in food formulations. They can be customized to meet specific product needs for solubility/ dispensability, aroma, taste and color and are microbiologically stable. Whole and ground spices are the commonly used form. However, ground spices are more common as they can be used to prepare spice blends.

If a spice is grouped with other spices, the total spice combination will have a more delicate flavor than when each is used individually. This is called the "spice-blending" effect. For the preparation of spice blends, cultural preferences and country's food habits are taken into consideration. Many a times even within a country because of common choices and variation in the food habits, specialized regional blends are prepared for marketing. While it is difficult to give an account of such variations and blends which are internationally traded, a good account is given by Hirasa and Takemasa (1998). With the world moving more towards to processed food, use of specific chemical component of spices in food preparation is becoming the order of the day. Therefore the use of spices extracts either in the form of essential oil or oleoresins rather than whole spices is more preferred.

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