# 1

# Introduction

Food is the first and foremost requirement of life. Man has utilized his innovative ideas to reduce the monotony of consuming regular diet by adding spices to it. Spices can transform an ordinary meal into an adventure. Once considered a luxury, spices today have become an integral part of our daily diet. Since their role is to offer a pleasant flavour and aroma to the food and add greatly to the pleasure of eating, spices are thus often referred to as food additives or adjuncts. Spices stimulate appetite, and initiate and augment salivary and gastric secretions. Digestion of food would have been incomplete in their absence, as digestion of carbohydrate, the frequent source of energy in our diet, begins with admixture of food and saliva (De 1999).

The story of spices is one of the most remarkable chapters in the history of vegetable products. Use and cultivation of spices dates back to the prehistoric era. The earliest literary record on spices found in India was around 6000 BC in *Rig Véda*. Centuries ago, Greek and Roman ships carried Indian spices, perfumes and textiles to Mesopotamia, Arabia and Egypt. Captain Vasco da Gama was the first voyager to succeed in establishing Calicut Port as the gateway to the spice land of Asia. He could return to his homeland only with two ships, both fully loaded with a cargo of Indian spices, and the cost of these spices was estimated to be sixty times more than their expenditure incurred on the voyage. The value of spices from the East was realized in the West during da Gama's time. In the middle age, a pound of ginger was priced equivalent to the value of three sheep. Pepper was considered as the most valuable spice, and a sack of it was said to be as worth as a man's life. Da Gama's successful voyage intensified an international power struggle for control over the spice trade. For many years Venice was the leader. In the sixteenth century, the Portuguese snatched the control of the spice trade, and held monopoly for the next 200 years. Then Dutch supplanted Venice and remained supreme for many years. Later, the British Empire took over and shared with Holland most of the spice trade of the world. Indeed, the fascinating history of spices is a story of adventure, exploration, conquest and fierce naval rivalry (Pruthi 1979).

Within the last one decade the international trade in spices has grown by leaps and bounds. An estimated 500,000 tonnes of spices and herbs valued at 1500 million US dollars are now imported globally every year. An impressive 46% of this supply comes from India. The Indian export of spices has reached the 468 million US dollar marks during 1999-2000. Pepper is the most important spice exported from India. However, now-a-days, chilli has taken the major share. Small cardamom, ginger, turmeric, seed spices, curry powder, and spice oils and oleoresins are the other items of spice exported from India. The largest markets for Indian spices are Kuwait, UAE, Iraq, Saudi Arabia and the United States. A huge market also exists in other countries like Germany, Japan, Canada, UK, Australia and the Middle East (Singh and Singh 1996).

Spices are mostly used as flavouring agent in a number of food products, such as curries, bakery products, pickles, processed meat and beverages. They not only serve to season insipid foods and give zest to an otherwise monotonous diet, but also act as flavour disguisers. They help to mask the off-flavour of food, which if unspiced may have to be thrown away. Certain spices match well with particular food, but there are no hard and fast rules that a spice can not be added to make a nonconventional match. A keen cook experiments to create original and tasty combinations.

Allspice, named as due to the fact that its flavour resembles a combination of cinnamon, clove and nutmeg, goes well in barbecue sauce and pickling. Black pepper contributes an important component of culinary seasoning. A dash of pepper can be used

effectively to adjust the flavour, just before the end of cooking. It is an essential ingredient of poultry dressings, sausages, hamburger and frankfurter seasoning. Caraway is used in rye bread, cabbage dishes and pork. Cardamom is mostly used as a dessert spice in the West and as a curry spice in the East. Use of cinnamon in puddings, sweet sauces and ice-cream is quiet common, however it is indispensable in some of the fish and meat dishes. Cloves are good in baking, ham and in flavouring curries, gravies, pickles, ketchup, sauces and beef dishes. Coriander accompanies sausages, pickles, pudding, but best with slow cooking dishes such as roast. It is also used in meat, fish and salad and specially in flavouring liquor, particularly gin. Cumin is used in soups, breads and to flavour meat and fish dishes.

Majority of the people living in the Indian Subcontinent prefer dishes those are hot. So chillies, either fresh or dry, are essentially used in almost all vegetable and meat preparations in the region. No Indian diet is complete without a serving of hot pickle, prepared with a variety of chillies. Fenugreek is used mainly in curries and Indian dishes. In the States of Maharashtra and Gujarat in India, ground fenugreek is mixed with wheat flower to prepare chapati, a delicious home-made bread. In Egypt and Ethiopia, fenugreek is a popular ingredient of bread. Garlic is a staple of Italian cooking as well as Chinese, French and American cuisine. In India, it is used in several food preparations, notably in chutney, pickles, curry powder, curried vegetables and meat preparations. Ginger is mainly used in a number of food products like ginger bread, confectionary, curry powder, certain curried meats and fishes, table sauces, pickles and in soft drinks. Mustard seeds are used in barbecue sauces, marinades and rubs, and in India in preparing different vegetable and fish preparations. Poppy seed is a staple in Indian cooking, specially preferred in potato curry by the Bengali. Turmeric is mainly used for colouring purposes (Singh and Singh 1996).

Examples cited here are just a glimpse of culinary treasure that spice kingdom possesses. Credit of a class cook is there, where he or she can win the heart of people by timely adding appropriate spices in optimum quantity to the meal.

Uses of spices are not restricted to mere seasoning. Their usage as flavoring agent of food and beverages, as food preservative, in medicinal preparations, in cosmetics, perfumery and bakery goods is equally important (Singh and Singh 1996). Nutritive value of spices can not be ignored. Spices are well-known appetizers and considered essential in the culinary art of the world. Though consumed in small amounts, spices are considered good sources of minerals and appreciable amounts of vitamins. Spices like cumin, coriander, fenugreek, asafoetida, turmeric, black pepper, mace and tamarind are the rich sources of iron. Cumin, asafoetida, coriander, clove, turmeric, mace, pepper and omum are known to supply an abundant amount of calcium. Cumin, coriander, fenugreek, chilli, garlic, nutmeg, turmeric, tamarind, mace, small cardamom and clove are considered good sources of phosphorus. Potassium is found in turmeric, coriander, cumin and fenugreek. Cumin, turmeric, fenugreek, coriander and omum are the good sources of sodium. Mace, pepper, coriander, turmeric, cumin,

chilli and clove are the sources of carotene (vitamin A). Chilli, garlic, cumin, fenugreek, coriander and omum can supply abundant riboflavin (vitamin $B_2$). Good sources of thiamine (vitamin $B_1$) are chilli, cumin, nutmeg, fenugreek, mace and coriander. Vitamin C is present in chillies and garlic (Singh and Singh 1996).

Although food is indispensable for the maintenance of life, it can also be responsible for ill health. In recent years, the consumers' awareness has played a predominant role in emphasizing the need for microbiologically safe foods for human consumption. Foodborne disease is perhaps the most widespread health problem in the contemporary world and an important cause of reduced economic productivity (WHO 1992). The available evidence clearly indicates that biological contaminants are the major cause (Adams and Moss 1995). In most of the cases of foodborne illness, the pathogenic effect occurs in the alimentary tract giving rise to symptoms of diarrhoea and vomiting. Toxins frequently play a pivotal role in this process.

Contamination of spice is not an exception. However, spices are mostly grown and harvested in warm and humid areas of the world where the growth of a wide variety of micro-organisms is readily supported. The load of total heterotrophs or of Enterobacteriaceae in particular, often acts as an indicator of the hygienic situation of a region where the spices are produced and processed. As many other agricultural commodities, spices are exposed to a wide range of environmental microbial contamination during collection, processing, and in the retail markets by dust, waste water, and animal and even human excreta (De Boer *et al.* 1985; Silliker *et al.* 1985). Contaminated spices may cause a microbiological problem, depending on the end use. Cuisines that incorporate spices may pose a risk to public health because they are often added to foods that undergo no further processing or are eaten raw. Spices are the principal source of sporeforming bacteria in large volumes of foods, such as soups, stews and gravies produced by catering establishments. Under favourable conditions, they germinate and multiply to infective and toxic levels (Pafumi 1986). Cleanliness and flavour properties are considered as the two important factors when evaluating the quality of spices. According to modern hygiene standards, condiments should contain neither pathogenic micro-organisms nor insects, and must be reasonably free from extraneous matter and defective material (Lewis 1984). Presence of microbes in spices could shorten shelf-life and reduce overall quality of commercially prepared food (Ayres *et al.* 1980). According to Leistner (1984), 1% increase in the amount of untreated spices added to food resulted in addition of up to $10^6$ organisms per gram food.

Previous studies on the microbiology of spices have demonstrated profiles of micro-organisms, including total heterotrophs (Powers *et al.* 1975, 1976; Baxter and Holzapfel 1982; Schwab *et al.* 1982), *Bacillus cereus* (Powers *et al.* 1976; Antai 1988), *Clostridium perfringens* (Kneifel and Berger 1994), *Escherichia coli* (Patel *et al.* 1976; Kaul and Taneja 1989) and *Salmonella* (Patel *et al.* 1976; Bruchmann 1995). The cause of heavy contamination of spices resulting in food spoilage and health hazards is due to the low

standards of hygiene associated with production, harvesting, cleaning, processing and packaging. In many of the spice-growing countries, including India, spices after harvesting are often sun-dried by spreading them on an open field or tarfelt road, and then sold without any treatment in order to reduce the microbial load. Thus, it is expected that spices sold in these areas contain a more or less "original" microflora. It was found in studies with samples of spices from limited parts of India that those were highly contaminated with any or all of mesophilic sporeformers and coliforms and so were of poor quality when compared with international standards (Krishnaswamy *et al.* 1974; Geeta and Kulkarni 1987; Kaul and Taneja 1989; Shah *et al.* 1996).

Importers of spices have become highly quality-conscious and are stipulating rigid microbial standards. The need for quality standards in spices is as acute as in other foods. Standards lay the foundation for development of production and export along sound lines and thus serve the interest of both producers and purchasers. Due to inferior quality, we are gradually loosing the export market for pepper. Indian spices are facing a stiff competition from other producing countries. Absence of recognized standards of quality constitutes a serious disability to India's competitive marketing of spices in the world. Thus, it is imperative to maintain rigid microbiological quality control of these valuable commodities meant for external as well as internal trade (Krishnaswamy *et al.* 1971, 1974).

More data should be made available to have an objective for evaluating their quality as well as for the decision whether treatment of these food additives that may be used in the preparation of shelf-stable products, is needed or not. The purpose of this study was, therefore, to determine the occurrence and load of important foodborne bacterial pathogens in spices offered for sale to consumers in retail stores all over India, and to study their behaviour such as antimicrobial resistance pattern, thermal inactivation of the sporeformers, enterotoxin production, and effects of different hurdles in order to understand the safety aspects and tackle the potential health hazards caused by them.

Hence, the protocol adopted to attain these objectives was as follows:

1. observing hygienic status of the retailed outlets of spices in India, and sampling a variety of spices through a cross-section of the retailers;

2. isolating major foodborne bacterial pathogens from the collected samples using their respective selective media;

3. characterizing the isolates in order to determine their taxonomic status;

4. elucidating the identified isolates from spices to reveal microbiological quality of the spices;

5. determining antibiograms of the representative isolates against antimicrobials to find out their resistance patterns;

6. studying thermal inactivation of the sporeformers in order to minimize potential health hazards;

7. evaluating capability of the sporeformers to produce enterotoxins to ascertain their possible dreadfulness;

8. determining survivability, growth and toxigenicity following intentional inoculation of foods with enterotoxigenic strains as well as with spices containing them; and

9. examining the influence of different hurdles such as pH, sodium chloride, benzoic acid, sorbic acid, nisin and garlic extract on the growth of spice isolates with a view to control a possible menace that may be caused by them.