CHAPTER 7

Functional foods in Indian tradition and their significance for health

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Contents

7.1 Introduction

India is known for its rich heritage and cultural diversity. Apart from the latter, India also has vast biodiversity, with a wide variety of cereals, pulses, fruits, vegetables, and spices being grown in different regions of the country. The association of food with health is known since ancient times, with the famous quote of the father of medicine, Hippocrates, "Let thy food be thy medicine and thy medicine be thy food." Many of the traditional foods commonly used in India can be termed as "functional foods," owing to their health beneficial attributes. A variety of spices, herbs, barks, fruits, flowers, and roots from different plants have been used in ancient and traditional medicine (Nadkarni and Nadkarni, 1976).

The daily diet of India contains a wide range of foods drawn from different food categories in various combinations. There are vast regional differences in the type of ingredients used and the dishes prepared and this diversity confers the status of "functional foods" as they are abundant in dietary fiber, antioxidants, and probiotics contributed from whole grains, fruits, vegetables, and fermented foods (Srinivasan, 2010). Thus they are wholesome not only in nutrition but also for their health benefits that range from improving the gastrointestinal health and boosting the immune system to maintaining ideal body weight; attributes that help in the prevention of lifestyle

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disorders such as hyperlipidemia, cardiovascular diseases, diabetes, and possibly certain types of cancer (Srinivasan, 2010).

7.2 Traditional Indian food patterns

Traditional dietary patterns in India have evolved basically from available locally grown crops to suit the different climatic conditions. Every region has its own unique choice of foods and combinations. A typical North Indian meal consists of unleavened bread (*chapati*, *paratha*, *nan*, *phulka*, *roti*) as the main course, consumed with accompaniments such as vegetable curries, cooked and seasoned pulse preparations, pickles, chutneys, and curd. South Indian meal consists of rice, served with pulse preparations such as *sambar and rasam* and fried and curried vegetables, accompanied by crispy fried *pappads*, pickles, and curd. These are the daily basic meal patterns. Meals during festivals and other religious functions are much more elaborate, including a wide range of cereal and pulse preparations, vegetables, sweets, and salads, all in one meal.

Chapathi is unleavened bread prepared from a dough of whole wheat flour that is rolled flat on a board and shallow fried with a small amount of oil.

Paratha, roti, and *phulka* are variations of chapathi: paratha being rolled in layers, while roti and phulka are fried without oil.

Nan is prepared from refined wheat flour (maida), and baked in a special kiln called "tandoor."

Chutney is a spicy side dish prepared by frying and grinding together a mixture of spices, tamarind, certain pulses, and vegetables such as onion, cucumber, ridge gourd, and fresh coconut.

Sambar and *rasam* are soups prepared from cooked red gram or masur dhal. The former is a thick soup in which a variety of vegetables are used. Both *sambar* and *rasam* contain tamarind extract and spice powders. *Rasam* is thinner in consistency, usually prepared by adding tomato and pepper powder in addition to the spice powder.

Pappads are round, crispy snacks, usually made from seasoned black gram dough that is flattened and sun dried. The sun-dried *pappads* are stored and deep fried in oil just before use. There are several variations in *pappads*, using ingredients such as potato, tapioca (sabudana), sweet potato, jackfruit, and onion.

Apart from the basic meals, there are a number of dishes prepared from combinations of cereals, pulses, vegetables, and spices, some examples being *biriyani, pulao, bisibele bhath*, khichdi, etc. These are appetizing whole meals by themselves, containing multiingredients in the right proportions to impart desired flavor and texture.

Common South Indian breakfast items include *idli*, *dosa*, *vada*, *pongal*, and *upma*, while North Indians prefer *paratha* or *dhokla* for breakfast.

Biriyani is a main course dish prepared from rice and meat/chicken/vegetables and is heavily spiced.

Pulao is prepared from the aromatic basmati rice and vegetables and is mildly spiced.

Bisibele bhath is a typical south Indian dish prepared from rice, red gram dhal, vegetables, spices, and condiments including tamarind.

Khichidi is a north Indian main course dish prepared from rice, red gram/green gram dhal, vegetables, and seasoned with spices and *ghee*.

Idli is prepared by steaming the fermented batter of rice and black gram dhal. Idli is typically consumed along with *sambar* and coconut *chutney*

Dosa is also prepared from the fermented batter of rice and black gram dhal. In the preparation of dosa, the batter is poured onto a frying pan, flattened, and fried crisp with a small quantity of oil. *Dosa* as well is consumed along with coconut *chutney*, or with cooked and seasoned potato. The proportions of rice and pulse differ between *idli* and *dosa*.

Vada is a deep-fried snack, prepared from the dough of black gram or Bengal gram dhal.

Pongal is prepared by cooking rice and green gram dhal together and seasoning with black pepper, cumin, and *ghee*

Upma is a south Indian breakfast dish prepared by cooking wheat semolina (rava) and seasoning it with onion, curry leaves, tomato, mustard, cumin, etc. Vegetables such as carrot, beans, and potatoes are added to upma.

Dhokla is a north Indian dish prepared using a fermented batter of rice and Bengal gram dhal.

This chapter presents some of the functional components and attributes of foods that are traditionally used in Indian diets.

7.3 Cereals and millets

Cereals and millets form the staple foods of Indian dietary and are the major sources of macronutrients. During the Aryan civilization, around 3000 years ago, barley was the major grain consumed, whereas rice came to prominence a little later (Achaya, 1994). At present, the major cereals and millets commonly consumed are rice, wheat, finger millet (*Eleucine coracana*), and sorghum (*Sorghum bicolor*). Other minor millets such as

pearl millet (*Pennisatum glaucum*) are also consumed in various parts of the country, either as a staple or used in addition to the staples.

Apart from being important sources of macronutrients in the Indian context, cereals and millets also contribute micronutrients such as vitamins and minerals (Gopalan et al., 1999), several phytochemicals, as well as dietary fiber (Goufo and Trindade, 2014; Bhaskarachary et al., 2016, Dykes, 2019). The health benefits of whole grains are also attributed to their nondigestible carbohydrate content (Bhaskarachary et al., 2016). Thus cereals and millets are functional foods that are beneficial to health. The bioactive compounds of cereals and millets are presented in Table 7.1.

Rice is a good source of several antioxidant molecules, and colored rice varieties (black, red, purple, and brown) are known to exhibit good antioxidant properties (Goufo and Trindade, 2014). Wheat, which was extensively consumed by the Harappans (Achaya, 1994), is a major staple even today. It is a rich source of fructooligosaccharides, fructans, and other bioactive components that are attributed to several health beneficial properties (Shewry and Hey, 2015). Sorghum also contains a wide array of phytochemicals, most of which are concentrated in the bran layer. These are responsible for a number of health benefits exerted by sorghum (Dykes, 2019). Millets such as finger, pearl, and kodo millet (*Paspalum scrobiculatum*), besides being good sources of micronutrients, are also very rich in several phytochemicals with high antioxidant activity (Palanisamy et al., 2014). This beneficial activity is attributed to their phytate, polyphenol, and dietary fiber contents (Sreeramulu et al., 2009; Vali et al., 2018; Bhaskarachary et al., 2016; Saxena et al., 2007).

Table 7.1 Bioactive components of cereals and millets.

Food	Bioactive components	Health benefits
Rice—white, black, brown, purple, red	γ-Oryzanol, phenolic acids, flavonoids, anthocyanins, tocopherols, tocotrienols, phytic acid	Antioxidant activity
Wheat	Fructooligosaccharides, fructans, dietary fiber, nonstarch polysaccharides—arabinoxylans, cellulose, resistant starch, lignin, chitin, pectins, β-glucans, etc., phenolics, terpenoids	Antidiabetic, cholesterol-lowering, anticancer, antiinflammatory
Sorghum	Phenolic acids, flavonoids, condensed tannins, polycosanols, phytosterols, stilbenes, and phenolamides	
Finger millet; other millets	Benzoic acid, cinnamic acid, other polyphenols	Antidiabetic, antitumerogenic, antiatherosclerogenic, antioxidant, antimicrobial

In India, cereals and millets are consumed in various forms. Rice used to be hand-pounded decades ago in most of the households. Although changing times have seen increased consumption of milled and polished rice, other types of rice, such as par-boiled rice, brown rice, and black rice are also consumed in different regions. Other traditional rice products include flaked rice, puffed rice, and puffed paddy. Whole wheat flour is preferred over the refined wheat flour in the preparation of *chapathi* or *paratha*. Other wheat products such as semolina, vermicelli, and broken wheat are also used almost on a daily basis. Finger millet, sorghum, pearl millet, and other millets are milled into flour before use.

7.4 Pulses and legumes

Pulses and legumes are an integral part of traditional Indian diets and have been so since ancient times; black gram (*Vigna mungo*), green gram (*Vigna radiata*), and lentil (*Lens culinaris*) find a mention in *Vedic* text (Achaya, 1994). At present, along with these, there are many others that are used in whole or dehusked form. These include red gram (*Cajanus cajan*), Bengal gram (*Cicer arietinum*), cowpea (*Vigna unguiculate*), horse gram (*Dolichos biflorus*), and kidney bean (*Phaseolus vulgaris*). These foods are the single most important source of protein in vegetarian diets, especially for the lower economic segments of the population. They also provide significant amounts of micronutrients. Pulses and legumes are rich in dietary fiber, especially when consumed whole. Several studies have documented the antioxidant activity of pulses and legumes (Sreeramlu et al., 2009; Saxena et al., 2007; Kumar and Xu, 2017a, 2017b; Prasad and Singh, 2015). Horse gram was used in traditional medicine to treat ailments such as kidney stones, urinary diseases, piles, common cold, throat infection, and fever (Prasad and Singh, 2015). The antioxidant activity of pulses and legumes is attributed to their rich polyphenol content.

7.5 Milk and milk products

Milk is the only source of complete protein for vegetarians, who form a significant chunk of the Indian population. Indian diets not only include milk, but also its products, the most important being fermented milk, or curd (*dahi*). Curd is consumed on a daily basis in almost all Indian households, particularly in South India. Milk has been reported to be rich in biologically active molecules with demonstrated clinical benefits. Numerous milk-derived compounds have potential applications as clinical therapies in infectious and inflammatory disease, cancer, and other conditions (Hill and Newburg, 2015; Verardo et al., 2017). Curd functions as probiotic on account of lactic acid bacteria with multiple health benefits (Srinivasan, 2010). *Paneer*, or cottage cheese, is another highly nutritious popular milk product used in cooking. Milk and its products find various uses in Indian cuisine. Milk, apart from being consumed as a beverage, is

Table 7.2 Bioactive components of milk and its products.

Food	Bioactive components	Health benefits
Milk	Lactoferrin, transforming growth factor β, cytokine, milk glycans, including human milk oligosaccharides, ω-3 and ω-6 PUFA, short-chain fatty acids, gangliosides, phospholipids	Antiinflammatory, antimicrobial, anticancer
Curd	Probiotics	Cholesterol-lowering, improved lactose intolerance, stimulation of the immune system, cancer prevention
Colostrum	Immune, growth and tissue repair factors, transforming growth factors α and β, insulin-like growth factors 1 and 2	Boosting the immune system, prevention of gastrointestinal infections, muscular and skeletal repair

extensively used in the preparation of a wide variety of traditional sweets. Curd is consumed along with rice and also used in the preparation of various sweets and curries. The bioactive factors of milk and its products are listed in Table 7.2.

The use of bovine colostrum for preparing a sweet dish is a unique feature of Indian cuisine. Colostrum is very rich in immune, growth and tissue repair factors. Bovine colostrum has possible use in the treatment or prevention of gastrointestinal tract infections. It is said to be the only natural source of transforming and insulin-like growth factors. Colostral growth factors have multiple regenerative effects that extend to all structural body cells, such as the gut (Uruakpa et al., 2002).

7.6 Other foods of animal origin

Meat, poultry, and fish are consumed by a large segment of the Indian population. These foods are important sources of complete protein, as well as several micronutrients. Besides this, meat and fish proteins are sources of novel bioactive peptides known to possess several beneficial physiological functions including antihypertensive, antioxidant, immunomodulatory, antimicrobial, prebiotic, antithrombotic, and hypocholesterolemic effects (Ryan et al., 2011). Fish is also an important source of the biologically active fatty acids, docosahexaenoic acid (DHA), and eicosapentaenoic acid (EPA). DHA plays an important role in fetal brain development and the development of motor skills and visual acuity in infants. The other beneficial functions of DHA and EPA include the prevention of atherosclerosis, dementia, rheumatoid arthritis, and Alzheimer's disease (Mohanty et al., 2016). India, being a land of numerous rivers, has

abundant biodiversity in fish. Fish is an important food of the population living in coastal regions. A wide variety of freshwater and marine fish is available. The foods of animal origin are consumed in combination with cereals, vegetables, and spices. A wide variety of curries, gravies, and rice dishes are prepared fusing meat and fish. The extensive use of spices adds value to these foods and probably helps in reducing the ill effects of cholesterol, of which these foods are rich sources.

7.7 Vegetables and fruits

India has vast biodiversity of vegetables and fruits that are extensively consumed. Vegetables form a very important part of the daily diet and are consumed in almost all the meals. India is probably the only country where a large variety of vegetables are consumed daily.

Green leafy vegetables (GLV) need a special mention in the Indian context. GLV is extensively and easily grown and is available all through the year. A large variety of GLV, namely amaranth (*Amaranthus gangeticus*), fenugreek (*Trigonella foenum graecum*), spinach (*Spinica oleracea*), drumstick (*Moringa oleifera*), mint (*Mentha spicata*), and coriander (*Coriandrum sativum*), and several local varieties such as mustard leaves (*Brassica campestris var. sarason)*, basale (*Basella rubra*), chakotha (*Rumex vesicarius*), keerai, and kilkeerai (*Amaranthus tricolor*) are a part of the daily diet. There are several hundreds of varieties of GLV, apart from those mentioned here. These greens are prepared as curries, sautéed, shallow fried, boiled, or steamed with other ingredients. GLV is the storehouse of micronutrients, being very rich sources of β-carotene, vitamin C, folic acid, dietary fiber, and several minerals (Krishnaswamy and Rajagopal, 2018). Apart from nutrients, GLV are abundant in several phytochemicals. The consumption of drumstick leaves and mustard leaves is unique to India. Drumstick leaves have been attributed to several medicinal properties (Table 7.3), including stabilizing blood pressure (Motohashi et al., 2017). Mustard leaves as well are a rich source of phytochemicals, which were found to be responsible for the antioxidant and other health beneficial properties (Frazie et al., 2017).

A number of roots and tubers, such as potato, sweet potato, yam, tapioca (cassava), and carrot, are commonly consumed in India. Nutritionally, these vegetables provide energy, while some of them contain protein, vitamin C, and β-carotene. Roots and tubers also contain good amounts of dietary fiber (Chandrasekara and Thamilini Josheph, 2016). In addition to nutrients, roots and tubers are significant sources of a number of bioactive compounds that are responsible for several health beneficial attributes of roots and tubers (Chandrasekara and Thamilini Josheph, 2016).

Several other vegetables such as brinjal, pumpkin, ladies finger (okra), cucumber, *tendli* (coccinia), ridge gourd, snake gourd, bitter gourd, drumstick, and the *brassica* vegetables such as cabbage, cauliflower, knol khol, turnip, and kale are all widely consumed in India. All these vegetables, apart from being good sources of micronutrients,

Table 7.3 Bioactive components of vegetables.

Food	Bioactive components	Health benefits
Green leafy vegetables	Polyphenols, flavonoids, carotenoids, sinigrin and its hydrolysis products (mustard leaves), thiocarbamate glycosides (DSL)	Antimicrobial, antioxidant, antifungal, antihypertensive, antiinflammatory, antihyperglycemic, anticancer
Roots and tubers	Saponins, phenolic compounds, glycoalkaloids, phytic acids, carotenoids, ascorbic acid	Antioxidant, immunomodulatory, antimicrobial, antidiabetic, antiobesity, and hypocholesterolemic
Other vegetables	Gallic acid, protocatechuic acid, catechin, caffeic acid, ferulic acid, sinapic acid, quercetin, resveratrol, and kaempferol	Antioxidant

are also very good providers of phytochemicals with high antioxidant activity (Singh et al., 2016).

India, with its varied agroclimatic conditions, is ideal for growing a wide variety of fruits such as banana, mango, papaya, bael (*Aegle marmelos*), orange, pineapple, guava, custard apple, sapodilla (sapota), jambolan (jamun), pomegranate, and jackfruit. These fruits are rich sources of flavonoids, carotenoids, electrolytes, and other bioactive compounds (Bhaskarachary et al., 2016). They are also very rich sources of minerals and vitamins, especially vitamin C, since they are consumed fresh, without cooking.

Indian cuisine also includes the use of the peels of several vegetables and fruits in preparations such as pickles, chutneys, and preserves, common examples being lime, bitter orange, and mango, being pickled along with the peel. This is an added advantage, as the bioactive components that are localized in the peels would also be included.

Liberal consumption of fruits and vegetables is very well known to promote health and helps in the prevention of diet-related chronic diseases such as cardiovascular disease including stroke, cancer, diabetes mellitus, cataract, age-related maculopathy, gastrointestinal problems, chronic obstructive pulmonary disease, and bone health (Krishnaswamy and Rajagopal, 2018).

7.8 Oilseeds, oils, and fats

Oilseeds are an important part of Indian dietary, being used in the preparation of several powders, sweets, seasoning, etc. The most common oilseeds consumed are peanut, sesame, coconut, and mustard. Peanut (or groundnut, as it is known in India) occupies

Table 7.4 Bioactive components of oilseeds.

Food	Bioactive components	Health benefits
Peanuts	Chlorogenic acid, caffeic acid, coumaric acid, ferulic acid, flavonoids, resveratrol	Antioxidant
Sesame seeds and oil	Sesamin, asarinin, sesamolin	Antioxidant, antiproliferative, antihypertensive, neuroprotective, hypocholesterolemic
Mustard seeds	Sinapic acid, sinapine, sinapoyl glucose, dithiolthiones	Protect against liver toxicity, antimutagenic

a prominent place on the shelf of almost every Indian kitchen. Besides being rich sources of protein, energy, and micronutrients, peanuts have been reported to be rich in phytochemicals (Arya et al., 2016). Apart from containing good amounts of vital minerals, peanuts also contain antioxidant minerals such as selenium, manganese, and copper. Peanuts have a desirable lipid profile, with high unsaturated fatty acid content. The high oleic acid content in peanuts is responsible for their beneficial biological effects (Arya et al., 2016). Sesame seeds and mustard seeds have several health beneficial components (Table 7.4) (Monteiro et al., 2016; Mayengbam et al., 2014; Srinivasan, 2010).

Vegetable oils are most commonly used for cooking in India. Sesame, mustard, groundnut, and coconut oils have been used since ancient times, and continue to dominate even today. Although sesame, groundnut, and coconut oil are used in South India, mustard oil is the most used in the northern parts. In ancient times, cooking oils were not refined, but freshly extracted crude oils were used. It was a common practice for people to go to the traditional oil extracting units to collect oil, which was used for cooking. This practice, however, is no longer common, and refined cooking oils are commercially available. In recent years, sunflower, safflower, and rice bran oils as well have become popular.

Apart from cooking, oils are also used in the preparation of various types of pickles. For this, unrefined oils are preferred, sesame and mustard oils being most commonly used. Sesame seeds were one of the first crops processed for oil. Sesame oil is considered to be more stable than most vegetable oils due to the presence of antioxidants in it; it is also least prone to turn rancid, as it retains its natural structure and does not break down even at very high temperatures (Srinivasan, 2010). Similar to the seeds, sesame oil also has bioactive components with health beneficial effects (Monteiro et al., 2014).

Clarified butter, known as *ghee*, is an important part of the Indian cuisine. Ghee is used as a cooking medium and also added to dishes just before consumption. *Ghee* has been shown to lower blood cholesterol levels by increasing the biliary excretion of cholesterol, bile acids, uronic acid, and phospholipids (Kumar et al., 2000).

7.9 Spices and condiments

Spices, which are used to enhance the flavor of food, form a very important part of traditional Indian cookery. A correct blend of various spices is crucial to every dish. The variety and amount of spices that are used regularly in Indian cuisine is probably the highest, as compared to any country. Spices are used individually as well as in mixes known as *garam masala*, *rasam* powder, *sambar* powder, *chutney* powder, etc. Spices are known to contain several bioactive components such as curcumin, capsaicin, eugenol, gingerone, flavonoids, and essential oils. Exhaustive studies have documented various health beneficial effects of spices (Srinivasan, 2005a; 2005b) (Table 7.5). Spices are known to contain several bioactive components

Condiments used to add a desirable sour taste to many traditional Indian preparations include acidulants such as tamarind (*Tamarindus indica*), kokum (*Garcinia indica*), lime, *amchur* (dried raw mango powder), and *amla* fruit (*Phyllanthus emblica*). The acidulants lime and amchur, by virtue of their organic acid content, have been shown to enhance the in vitro availability of iron and zinc from cereals and pulses (Srinivasan, 2010). These acidulants are known to be good sources of polyphenols. *Amla* fruits are valued highly in the traditional medicinal systems and form the major ingredients in popular Ayurvedic preparations (Srinivasan, 2010). *Kokum*, valued for its nutritive value and medicinal properties, is widely used as an acidulant in the coastal regions of

Table 7.5 Health effects of spices and condiments.

Spices	Health benefits
Garlic, onion, turmeric, fenugreek, red pepper	Hypocholesterolemic
Turmeric, red pepper	Antilithogenic
Fenugreek, onion, garlic, turmeric, cumin	Hypoglycemic
Turmeric, red pepper, clove	Antioxidant, antiarthritic, antiinflammatory
Turmeric, garlic, ginger, mustard	Cancer preventive
Ginger, cumin, ajowan, fennel, coriander, onion, mint, black pepper	Digestive stimulant
Turmeric, garlic, asafetida	Antimicrobial
Amla fruits	Hypolipidemic, antidiabetic, and antiinflammatory, inhibit HIV-1, tumor development, and gastric ulcer
Kokum	Anticarcinogenic, antioxidant, antiinflammatory, antineurodegenerative, antianxiety, antimicrobial, DNA repair activities Reduces obesity and regulates blood cholesterol levels

South India and is a rich source of polyphenols and other bioactive components (Motohashi et al., 2017; Srinivasan, 2010).

Thus almost all the foods that form an integral part of the Indian cuisine are loaded with health beneficial bioactive components, besides being rich in nutritive value. The fact that these ingredients are consumed in ideal combinations enhances their beneficial potency all the more. The variety and ideal combinations of foods in traditional Indian dietary make these diets unique and popular all over the world.

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