

Study material on

Course 5.4 Health and functional foods

(For three years Diploma in food technology)

Government Polytechnic Mandi Adampur

## Syllabus of course health and functional foods

1. Introduction- definition, status and scope of health and functional foods in India. (02hrs)
2. Definition, types and importance of nutraceuticals (05hrs)
3. Types of health and functional foods and their properties (05hrs)
4. Various food constituents responsible for functional effects (20hrs)
  - Anti-carcinogenic, hypocholesterolemic and hypoglycemic foods
  - Anti-oxidants
  - Fortified and enriched foods
  - Biofedic, probiotic foods prebiotics and symbiotic
  - High protein and high and low energy foods
  - Artificial sweeteners
  - Geriatric foods
5. Importance of fibre in health and prevention of diseases (06hrs)
6. Fortification and enrichment, definition and importance, fortified foods-salts atta, oil, enriched juices and health drinks (5hrs)
7. Organic and genetically modified foods (GM) in relation to health (5hrs)

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# Chapter 1

## Introduction

### DEFINITION

A functional food as the name suggest is a food providing an additional function (often one related to health-promotion or disease prevention) by adding new ingredients or more of existing ingredients.

The term was first used in Japan in the 1980s where there is a government approval process for functional foods called Foods for Specified Health Use (FOSHU).

The general category of functional foods includes processed food or foods fortified with health-promoting additives, like "vitamin-enriched" products. Products considered functional generally do not include products where fortification has been done to meet government regulations and the change is not recorded on the label as a significant addition ("invisible fortification"). An example of this type of fortification would be the historic addition of iodine to table salt, or Vitamin D to milk, done to resolve public health problems such as goiter or rickets. Fermented foods with live cultures are considered functional foods with probiotic benefits. Uptil now there is no standard globally accepted definition of functional foods and functional food are defined in a number of ways by different agencies.

Health Canada define functional food as: A functional food is similar in appearance to, or may be, a conventional food, is consumed as part of a usual diet, and is demonstrated to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions.

In Britain, the Ministry of Agriculture, Fisheries and Food has developed a definition of a functional food as "a food that has a component incorporated into it to give it a specific medical or physiological benefit, other than purely nutritional benefit.

At 9th International Conference on "Functional Foods and Chronic Diseases: Science and Practice" at the University of Nevada, Las Vegas on March 15-17, 2011 an attempt was made to

evolve a general definition of functional foods as "Functional Food is a Natural or processed food that contains known biologically-active compounds which when in defined quantitative and qualitative amounts provides a clinically proven and documented health benefit, and thus, an important source in the prevention, management and treatment of chronic diseases of the modern age".

FSSAI 2006 define functional foods as: Broadly "Functional food" may be defined *as* a food which influences specific functions in the body that may provide added health benefits or remedy from some diseased condition following the addition/concentration of a beneficial ingredient, or removal/substitution of an ineffective or harmful ingredient. Foods might inherently possess these supposedly beneficial qualities, or they may be fortified/modified and/or genetically altered. The concept of functional is elaborated in some detail under following paragraph.

Foods for special dietary uses or functional foods or nutraceuticals or health supplements means: (a) foods which are specially processed or formulated to satisfy particular dietary requirements which exist because of a particular physical or physiological condition or specific diseases and disorders and which are presented as such, wherein the composition of these foodstuffs must differ significantly from the composition of ordinary foods of comparable nature, if such ordinary foods exist, and may contain one or more of the following ingredients, namely (i) plants or botanicals or their parts in the form of powder, concentrate or extract in water, ethyl alcohol or hydro alcoholic extract, single or in combination; (ii) minerals or vitamins or proteins or metals or their compounds or amino acids (in amounts not exceeding the Recommended Daily Allowance for Indians) or enzymes (within permissible limits); (iii) substances from animal origin; and (iv) a dietary substance for use by human beings to supplement the diet by increasing the total dietary intake.

The functional food also need to satisfy following conditions: (i) a product that is labelled as a "Food for special dietary uses or functional foods or nutraceuticals or health supplements or similar such foods" which is not represented for use as a conventional food and whereby such products may be formulated in the form of powders, granules, tablets, capsules, liquids, jelly and other dosage forms but not parenterals, and are meant for oral administration; (ii) such product does not include a drug as defined in clause (b) and ayurvedic, sidha and unani drugs as defined

in clauses (a) and (h) of section 3 of the Drugs and Cosmetics Act, 1940 and rules made there under; (iii) does not claim to cure or mitigate any specific disease, disorder or condition (except for certain health benefit or such promotion claims) as may be permitted by the regulations made under this Act; (iv) does not include a narcotic drug or a psychotropic substance as defined in the Schedule of the Narcotic Drugs and Psychotropic Substances Act, 1985 and rules made there under and substances listed in Schedules E and EI of the Drugs and Cosmetics Rules, 1945.

#### STATUS AND SCOPE OF HEALTH AND FUNCTIONAL FOODS IN INDIA

India is the 10th biggest buyer of functional foods globally and there is a huge opportunity for the dairy industry in this segment. India's fast growing middle class and changing lifestyle are the key drivers of the growing market for functional foods especially dairy products like probiotic yogurt but it is still behind the global trends. According to a Ernst&Young-FICCI report published in 2009, the total market for nutraceuticals in India is growing at 21 percent per annum and is valued at Rs 4,400 crore. Functional foods which are already available in the Indian market include those with removal of an allergic protein (gluten free atta), those containing live bacteria (probiotics, prebiotics) such as Yakult health drink and Amul's butter milk or those containing some health nutrients such as energy bars, juices and soy based products.

Due to exceptional growth of the Indian economy and higher purchasing power parity (PPP) of the consumers in the last decade, consumers are moving towards specific functional foods. Urbanization, changing population demographics and a strong desire among Indian consumers to maintain a healthy lifestyle are additional factors driving this market. Although this is a new concept in our country and the market is still in infancy but the demand for functional foods would continue to increase due to their specific health benefits and Government's plan to invest \$ 21.5 billion in food processing industry in next five years.

Industry analysts such as Frost & Sullivan and Netscribes (India) Pvt. Ltd. also predict a continued growth of the sector in the future. With young Indian consumers earning and spending more, India is expected to become the fifth largest consumer market in the world by 2025 from being the 10th largest currently. This presents huge opportunities for the functional foods sector at various stages of the supply chain in both new and niche segments. Beverages and dairy will drive this growth of functional foods in India.

Presently only a few functional food players are present in the market. However, due to higher profitability margins, there is a huge scope for the new entrants in this industry. But the entry of such players and their success would depend upon their capability to develop a specific idea (particular functional food), the patent or licensing if any, the complexity of the process involved in synthesis (fortification, plant extraction, chemical synthesis, strain development and isolation, issues of strain stability etc.), the extent of benefit achieved by the consumers, its relative cost as compared to the traditional form of that food and also the economies of scale involved in the production.

The economic returns from functional foods could be so high that these can offer improved opportunities for all the links of the supply chain starting from producers and up to retailers. Apart from this, functional foods can be an opportunity for economic growth of our country as India is endowed with rich biodiversity and traditional knowledge of the health effects of certain indigenous plant species.

## GLOBAL SCENARIO

Functional foods are an emerging field in food science due to their increasing popularity with health-conscious consumers and the ability of marketers to create new interest in existing products. The functional food industry, consisting of food, beverage and supplement sectors, is one of the several areas of the food industry that is experiencing fast growth in recent years. This kind of growth is fueled not only by industrial innovation and development of new products that satisfy the demand of health conscious consumers but also by health claims covering a wide range of health issues.

The global market size has been estimated between US\$30 and US\$60 billion with Japan, United States, and Europe being the leading markets and is growing at 14 percent annually. . Developing countries have started to emerge as exporters to cater to the increasing demand in the developed countries. Moreover, demand for functional foods within the developing countries is growing, presenting a lucrative opportunity to develop domestic markets.

# Chapter 2

## Importance of nutraceuticals

### DEFINITION

The term nutraceutical was originally defined by Dr. Stephen L. DeFelice, founder and chairman of the Foundation of Innovation Medicine (FIM), Crawford, New Jersey. According to DeFelice, nutraceutical can be defined as, “a food (or part of a food) that provides medical or health benefits, including the prevention and/or treatment of a disease” Dr Stephen DeFelice coined the term "Nutraceutical" from "Nutrition" and "Pharmaceutical" Since the term was coined by Dr. DeFelice, in 1989 its meaning has been modified by Food Directorate of Health Canada which defines nutraceutical as: a product isolated or purified from foods, and generally sold in medicinal forms not usually associated with food and demonstrated to have a physiological benefit or provide protection against chronic disease. Examples are betacarotene and lycopene.

According to The Ministry of Agriculture, Fisheries and Food, Britain there is a slight difference between the functional foods and nutraceuticals. When food is being cooked or prepared using "scientific intelligence" with or without knowledge of how or why it is being used, the food is called "functional food". Thus, functional food provides the body with the required amount of vitamins, fats, proteins, carbohydrates, etc. needed for its healthy survival. When functional food aids in the prevention and/or treatment of disease(s) and/or disorder(s) other than anemia, it is called a nutraceutical. Examples of nutraceuticals include fortified dairy products (e.g. milk) and citrus fruits (e.g. orange juice).

Within European Union (EU) law the legal categorization of a nutraceutical is, in general, made on the basis of its accepted effects on the body. Thus, if the substance contributes only to the maintenance of healthy tissues and organs it may be considered to be a food ingredient. If,

however, it can be shown to have a modifying effect on one or more of the body's physiological processes, it is likely to be considered to be a medicinal substance

Within European Medicines law a nutraceutical can be defined as a medicine for two reasons:

- 1) It can be used for the prevention, treatment or cure of a condition or disease or
- 2) It can be administered with a view to restoring, correcting or modifying physiological functions in human beings

## TYPES OF NUTRACEUTICAL

Regarding the promise of nutraceuticals, they are categorised in two ways:

- Potential nutraceuticals
- Established nutraceuticals

A potential nutraceutical is one that holds a promise of a particular health or medical benefit; such a potential nutraceutical only becomes an established one after there are sufficient clinical data to demonstrate such a benefit. It is disappointing to note that the overwhelming majority of nutraceutical products are in the 'potential' category, waiting to become established.

Presently over 470 functional foods and nutraceutical products are available with documented health benefits. Some authors propose another classification of nutraceuticals as given below:

- Probiotic
- Prebiotic
- Dietary fiber
- Omega 3 fatty acid
- Antioxidant

## IMPORTANCE OF NUTRACEUTICALS

Nutraceuticals are currently receiving recognition as being beneficial in coronary heart disease, obesity, diabetes, cancer, osteoporosis and other chronic and degenerative diseases such as Parkinson's and Alzheimer's diseases. Evidences indicate that the mechanistic actions of natural

compounds involve a wide array of biological processes, including activation of antioxidant defenses, signal transduction pathways, cell survival-associated gene expression, cell proliferation and differentiation and preservation of mitochondrial integrity. It appears that these properties play a crucial role in the protection against the pathologies of numerous age-related or chronic disease. It is very imperative that the nutrients found in many foods, fruits and vegetables are responsible for the well documented health benefits. For example, lutein and zeaxanthin prevent cataracts and macular degeneration; beta-carotene and lycopene protect the skin from ultraviolet radiation damage; lutein and lycopene may benefit cardiovascular health, and lycopene may help prevent prostate cancer.

Nutraceuticals are available in the form of isolated nutrients, dietary supplements and specific diets to genetically engineered foods, herbal products and processed foods such as cereals, soups and beverages. Nutraceuticals provide all the essential substances that should be present in a healthy diet for the human. Nutraceuticals provides energy and nutrient supplements to body, which are required for maintaining optimal health. Nutraceuticals are widely used in the food and pharmaceutical industries. Some Nutraceuticals are useful in maintaining healthy prostate function, remedy for restlessness and insomnia. Nutraceuticals, such as glucosamine and chondroitin sulfate, offer possible chondroprotective effects against joint injury.

### **Benefits of nutraceuticals**

From the consumers' point of view, functional foods and nutraceuticals may offer many benefits:

- May increase the health value of our diet.
- May help us live longer.
- May help us to avoid particular medical conditions.
- May have a psychological benefit from doing something for oneself.
- May be perceived to be more "natural" than traditional medicine and less likely to produce unpleasant side-effects.
- May present food for populations with special needs (e.g. nutrient-dense foods for the elderly)

# Chapter 3

## Types of functional foods

Consumers judge the food products not only in terms of taste and nutritional needs, but also in terms of their ability to improve the health and well-being. Functional foods exert a beneficial effect health .They could have an added health component or reduced harmful component.

Functional foods may be whole, fortified, enriched, or enhanced foods.

### TYPES OF FUNCTIONAL FOODS

A large number of fruits, vegetables, dairy products and some sea foods have shown functional effects. About 470 individual foods are reported to be functional. For convenience these individual foods are classified in following categories:

- Beans
- Berries
- Cruciferous vegetables
- Chocolate
- Citrus fruits
- Fish
- Tea
- Nuts
- Whole grains
- Yogurt

### **Beans**

Dry beans or legumes are an inexpensive (as compared to meat) and healthy way to include additional servings of vegetables into your diet. Cooked beans are low in calories, loaded with complex carbohydrates, and contain little fat. In addition, beans are good sources of B vitamins, potassium, and fiber, which promotes digestive health and relieves constipation.

The demand for bean products is growing because of the presence of several health-promoting compounds in edible bean products known as saponins. Clinical studies have suggested that saponins have the ability to:

- Help protect the human body against cancers
- Lower cholesterol
- Lower blood glucose responses

In epidemiological studies, saponins have been shown to have an inverse relationship with the incidence of kidney stones. Soybean is emerging as a very promising functional food. There is a growing recognition of the health effects of soy on cholesterol levels. A recent U.S. survey revealed that 76 percent of consumers considered soy products to be healthy. In 1999, the Food and Drug Administration (FDA) approved a health claim for the cholesterol-lowering properties of soy protein. One year later, the American Heart Association (AHA) recommended that patients with elevated cholesterol should include soy protein foods in their diets. A daily intake 25 grams of soy protein per day is considered beneficial.

Soy has phytoestrogens called isoflavones. Two of the most common ones are daidzein and genistein. Soy isoflavones are believed to play a role in prostate cancer, where supplementation with isoflavones has shown a reduction in prostate cancer risk in studies. Soy iso-flavones, and possibly soy proteins as well, are believed to play a role in bone health. There is also the biologically active non-isoflavone component of soy that has received much attention in past years— soy protein. The protein part is believed to be responsible for the additional benefits seen from soy consumption, which are:

- Cholesterol-lowering effects
- Blood pressure-lowering effects
- Reduction of cancer risks
- Favorable effects on kidney function

## **Berries**

Traditionally, when we think of berries, we think of things like blueberries, strawberries, raspberries, and blackberries, but there are also other varieties such as cranberries, boysenberries and gooseberries.

Many berries are suitable to eat raw after rinsing and most types of berries vary from 50 to 100 calories per serving when eaten raw berries are loaded with vitamin C, potassium, and fiber. All berries with strong red and blue colors have phytochemicals that can potentially reduce cancer rates and other chronic diseases. Oxygen radical absorptive capacity (ORAC), is a way to measure the antioxidant capacity of fruits and vegetables. Berries have some of the highest antioxidant levels of any fresh fruits.

Because of the antioxidant power found in strawberries, regular consumption of this fruit has been shown to have the potential to lower one's risk of heart disease. In addition, studies have shown that strawberries are involved in inhibiting inflammatory enzymes. This reduces the inflammatory response that is involved in the etiology of many diseases. Studies on two antioxidant compounds in strawberries (ellagic acid and quercetin) have demonstrated that these substances:

- Have anticancer activity
- Work to block the initiation of carcinogenesis
- Suppress progression and proliferation of tumors

### **Cruciferous vegetables**

Cabbage, broccoli and Brussels sprouts are in the family of cruciferous vegetables.

The health benefits associated with cruciferous vegetables has been attributed to their high concentration of glucosinolates. Cabbage is one of the oldest vegetables around. It continues to be a dietary staple for many and is an inexpensive source of vitamins A and C, and fiber. Broccoli is a good source of vitamins A and C, potassium, folacin, iron, and fiber. It has as much calcium per ounce as milk.

Brussels sprouts contain significant amounts of the antioxidants vitamins A and C and is a good source of fiber. This vegetable is also a good source of vegetable protein. However, this protein is not complete protein, and should be combined with whole grain and other protein foods.

The consumption of cruciferous vegetables has been associated with a reduced risk of cancer of the lung, stomach, colon, and rectum.

### **Chocolate**

Cocoa and chocolate are food products made from cacao beans.

Although consumed by the Olmecs, Mayans, and Aztecs long ago, cacao beans were first introduced to the Old World in 1502 by Christopher Columbus when he brought them back to Spain. Over the past three decades, chocolate has been viewed more as a confectionary rather than as a medicine. In 2001-2002, the average world cocoa consumption was 1.17 pounds per person, with approximately \$73.2 billion dollars going to the confectionery market globally.

Cocoa powder and cocoa extracts have been shown to exhibit a high antioxidant capacity.

When compared to several other flavanol-rich foods and food extracts, cocoa powder and cocoa extracts were found to exhibit a higher antioxidant capacity than:

- Green and black tea
- Red wine
- Blueberries
- Garlic
- Strawberries

The antioxidants found in cocoa enhance vascular function and decrease platelet stickiness and therefore influence the cardiovascular system beneficially. Several studies support the suggestion that the consumption of flavanol-rich foods, such cocoa powders and dark chocolates, may be associated with a reduced risk for vascular disease.

### **Citrus fruits**

Oranges belong to a class known as “citrus fruits.” They are highly valued for their vitamin C content. They are the primary source of vitamin C for most Americans. However, oranges are also a good source of: folacin, calcium, potassium, thiamin, niacin, and magnesium. The juice contains more vitamin C per serving than does the whole fruit.

Citrus fruits contain phytochemicals called flavonoids. The flavonoid hesperidin was first described about two centuries ago. Research throughout past years has confirmed that hesperidin is an anti-inflammatory agent used to treat many conditions. Hesperidin blocks an enzyme

involved in an inflammatory reaction such as the release of histamine. Research has shown that citrus flavonoids and their metabolites are potent antioxidants. It is believed that they are able to suppress many of the events of cancer and inflammation which involve reactive oxygen species. Some of the flavonoids in citrus fruits such as tangerine and orange are the most potent cancer fighting compounds, particularly against lung and prostate cancer cells.

## **Fish**

Over 30 years ago, Danish researchers found that the lower rates of heart disease found in Greenland Eskimos were associated with their higher intake of seafood, particularly cold water fish. There are two classes of essential fatty acids: omega-3 and omega-6.

Fish oil is the most significant source of dietary omega-3 fatty acid, and it consists of both: eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Fish is a good source of protein and low in saturated fat. The following types of fish are especially good sources of omega-3 fatty acids:

- Mackerel
- Lake trout
- Herring
- Sardines
- Albacore tuna
- Salmon

The American Heart Association recommends eating fish (particularly fatty fish) at least two times per week. Numerous observational studies have shown that omega-3 FA enriched diets are associated with a reduction of:

- Cardiovascular mortality
- Heart attack
- Sudden death

In several studies, a higher fish intake was associated with a decreased incidence of coronary artery disease (CAD) and cardiovascular mortality. Overall, it has been shown that a minimum of one fish meal per week translates to a 52% reduction in sudden cardiac death.

Over 15 clinical trials and 2 meta-analyses favor the use of fish oil in patients with rheumatoid arthritis (RA). A double-blind placebo controlled trial showed that fish oil supplementation of 130 mg/kg of body weight each day decreased the following in the control group:

- Number of stiff joints
- Duration of morning stiffness
- Pain

Global arthritis activity. Increased fish oil intake allows some with RA to reduce or even eliminate the use of non-steroidal anti-inflammatory drug (NSAID)

## **Tea**

Tea, in the form of green or black tea, is one of the most widely consumed beverages in the world. Although its consumption does varies from place to place, it is believed to be second only to water. Black tea is consumed predominantly in Western countries, along with some Asian countries, whereas green tea is consumed predominantly in China, Japan, India, and a number of countries in north Africa and the Middle East.

Green tea comes from the mature leaves of the plant and is sold as either fresh or dried unfermented leaves. The very early shoots are highly sought after and from these, white tea is made. Total polyphenols in these early shoots comprise about 20-30% by weight, 60 to 80 percent of which are catechins. Mature leaves naturally contain lesser amounts of catechins than do the early leaves, and with the processing of green tea, the concentration is further decreased (~15%). The catechins found in green tea have been shown to possess biological activity which may be beneficial in the prevention and treatment of various forms of cancer. Green tea is also believed to exhibit beneficial effects on the following:

- Arthritis
- Bone Density
- Stress

In addition, it has also found to exhibit:

- Antiviral properties
- Anti cariogenic effects
- Ultraviolet skin protection

Unlike green tea, the preparation of black tea requires fermentation. During this process, catechins in black tea are partially converted to theaflavins. A less extensive fermentation leads to a lighter flavored tea, called oolong tea. Therefore, of the teas mentioned, white tea has the highest concentration of catechins, followed by green tea, oolong tea and, lastly, black tea.

## **Nuts**

In 2003, the U.S. FDA approved this package label:

“Scientific evidence suggests but does not prove that eating 1.5 ounces per day of most nuts, as part of a diet low in saturated fat and cholesterol, may reduce the risk of heart disease.”

According to FDA, "Types of nuts eligible for this claim are restricted to almonds, hazelnuts, peanuts, pecans, some pine nuts, pistachio nuts and walnuts..”

Nuts are important for what they don't offer:

1. Nuts do not contain cholesterol.
2. Nuts only contain trace amounts of sodium. (Unless it has been added to the nuts during processing)
3. Nuts are usually thought of as a high fat food. Although, this is true that nuts are high in fat, but it is not the same as animal fat. Nuts are mostly high in heart-healthy unsaturated fats, the fats that lower your bad cholesterol. Health benefits of some individual nut are given below:

### *Walnuts*

One ounce of walnuts (about 14 shelled walnut halves) is all that is needed to meet the 2002 dietary recommendations for omega-3 FA. The type of omega-3 FA found in walnuts is alpha-linolenic acid, which can be transformed into either EPA or DHA in humans and animals.

### *Almonds*

One ounce of almonds (about 20-24 shelled whole almonds) provides 35% of the daily value for vitamin E.

### *Peanuts*

Although it is often discussed with nuts, peanuts are actually a legume, along with dry beans, peas and lentils. One ounce of roasted peanuts provides about 10% of the daily value for folate.

## **Whole grains**

As defined by the 2005 Dietary Guidelines for Americans, a whole grain is a grain that contains the entire grain kernel:

- Outer bran layer
- Endosperm
- Inner germ layer

The *outer bran layer* is rich in B vitamins and phytonutrients such as flavonoids and indoles, along with a small amount of protein. The *endosperm* is predominantly carbohydrate, and the *germ layer* is concentrated with minerals such as iron and zinc, along with the antioxidant vitamin E.

The milling process, which removes both the bran and the germ, determines how much of the whole grain is retained. It impacts the nutritional value of the end product.

A *refined grain* is a grain that has been milled. Milling has negative effects in that it takes dietary fiber, iron, and many B vitamins from the grain.

To make up for this loss of nutrients during the milling process, most refined grains are *enriched* after processing, where certain B vitamins (such as thiamin, riboflavin, niacin, and folic acid) and iron are added back. However, the fiber content of the original grain is not restored.

Benefits associated with whole wheat foods can be achieved at relatively low levels of intake (between 2 and 3 servings/d).

However, the consumption of whole wheat foods in some Western countries has been noted to be *less than one serving per day*, which is equivalent to less than one slice of whole wheat bread per day.

## **Yogurt**

In recent years, many studies have been published on the health effects of yogurt and the bacterial cultures used in the production of yogurt.

The lactic acid-producing bacteria (LAB) used in the U.S. include *Lactobacillus* and *Streptococcus* species

Dairy products are generally considered an excellent source of high-quality protein, calcium, potassium, phosphorus, magnesium, zinc, and the B vitamins riboflavin, niacin, vitamin B-6, and vitamin B-12. However, the final nutritional value of yogurt depends on several factors.

In 2002, a definition was proposed by the Joint Food and Agriculture Organization/World Health Organization Working Group. They state that a probiotic is a: “Live microorganism which when administered in adequate amounts confer a health benefit to the host.”

Current scientific concepts agree that yogurt cultures *are probiotics* if two criteria are met:

1. A beneficial physiological effect can be obtained by consumption of the live cultures
2. The benefit has been sustained appropriately in human studies.

The benefits of yogurt and LAB on gastrointestinal health have been explored mainly in animal models and, occasionally in human subjects as well.

In some studies using yogurt, individual LAB species, or both, promising health benefits were found for individuals with:

- Lactose Intolerance
- Constipation
- Diarrheal diseases
- Colon Cancer
- Inflammatory Bowel Disease (IBD)
- *Helicobacter pylori* infection
- Allergies

## PROPERTIES OF FUNCTIONAL FOODS

Functional foods have been either enriched or fortified, a process called nitrification. This practice restores the nutrient content in a food back to similar levels from before the food was processed. Sometimes. Additional complementary nutrients are added, such as vitamin D to milk.

Health Canada defines functional foods as “ordinary foods that has components or ingredients added to give it a specific medicinal or physiological benefits, other than a purely nutritional effect. In Japan. All functional foods must have three properties:

1. Such foods should Prevent in their naturally occurring form, rather than a capsule, tablet, or powder.
2. Functional foods should be consumed in the diet as often as daily.
3. Should regulate a biological process in hopes of preventing or controlling diseases.

# Chapter 4

## Food constituents and their functional effects

### ANTI-CARCINOGENIC FOODS

#### **Soyabean**

Soy may lower the risk for breast and prostate cancers. Whole soy is more beneficial than foods with processed soy protein (energy bars).

#### **Berries**

Contain antioxidants that reduce and repair the kind of damage to cells that can lead to cancer. When they're not in season, frozen berries can be consumed since they're typically just as healthy as fresh.

#### **Tea**

It has antioxidants called catechins that may block certain enzymes that lead to cancer. In animal research, stomach, liver and skin tumors shrank in mice fed green or black tea. Steeping tea for at least five minutes releases the most antioxidants.

#### **Fatty Fish**

Several studies have indicated that the mega-healthy components of fish – like omega-3 fatty acids – guard against cancer (just as they do against cardiovascular disease), but experts stress that more trials are necessary. Fatty fish like salmon, mackerel, herring, lake trout, sardines and albacore tuna are high in omega-3s.

#### **Garlic**

According to the American Institute for Cancer Research, garlic may lower your risk for colon cancer with compounds that block tumor formation and cancer cell growth in the colon.

#### **Nuts**

All nuts may prevent cancer. Peanuts in particular have been linked to a lower rate of endometrial and colorectal cancers in women. The protective benefits of nuts most likely come from antioxidant compounds like folic acid and magnesium, according to a research review in the *American Journal of Clinical Nutrition*.

### **Flaxseeds**

Researchers say the lignans, compounds that act like antioxidants, in this high-fiber seed may help reduce the growth and spread of breast cancer. Grind flaxseed before eating (or buy ground instead of whole) to better absorb the nutrients.

### **Cruciferous vegetables**

Brussels sprouts, cauliflower, cabbage and broccoli contain sulfur-containing compounds that may inhibit the growth of cancer cells. Studies have linked them to lower rates of lung, liver, colon, breast and endometrial cancers.

### **Sweet Potatoes**

Beta-carotene, the antioxidant that gives sweet potatoes (as well as carrots, cantaloupe and mangoes) their orange color, may help prevent the damage to cell membranes that leads to cancer.

### **Low-Fat Dairy**

In recent research, premenopausal women who had at least one serving a day of low-fat yogurt or milk reduced their breast cancer risk. Most dairy products also contain vitamin D, which has been associated with lower risk for pancreatic and colorectal cancers.

### **Grapes**

Red and purple grapes contain the same disease-fighting compound found in wine – resveratrol – which has been shown to slow the growth of cancer cells and block tumor formation in the liver,

stomach and breast. Lycopene, the pigment that gives grapes their color, also boasts cancer-fighting properties.

### **Leafy Green vegetables**

Dark green leafy vegetables are loaded with folate, a B vitamin that helps repair damaged DNA that's vulnerable to cancer. Some studies suggest it may guard against gastrointestinal tract cancers in particular – and possibly breast cancer too.

### **Beans**

Having meatless meals can slash your risk for cancer, so consider eating more beans (such as black, pinto, lima and kidney) as well as other legumes (like lentils and black-eyed peas). Postmenopausal women whose diets contain lots of beans have lower rates of invasive breast cancer.

### **Whole Grains**

Compared with refined grains (like white bread and regular pasta), whole grains have much more fiber, which may protect against colorectal cancers because it helps move food through your digestive system faster. At least half of your daily grain servings should be whole grains.

## **HYPOCHOLESTROLEMIC FOODS**

A high level of LDL or 'bad' cholesterol is well-recognized as a risk factor for heart disease; if one wants to keep a heart attack or a stroke at bay, attention must be paid to keep it at lower side. Along with this, we also ought to do what we can to increase our store of HDL or 'good' cholesterol. Here are some foods that have been a part of Indian cuisine for ages, and are now being found to have valuable cholesterol-reducing action.

### **Fenugreek**

Fenugreek seeds are a rich source of constituents known as steroidal saponins that help to reduce the body's absorption of cholesterol coming in through the fat-rich foods we eat.

Besides, researchers also speculate that these saponins may have a role to play in reducing the body's production of cholesterol. This, along with the fibre present in the fenugreek seed coat makes methi a valuable weapon in the fight against high levels of cholesterol and triglycerides.

### **Flaxseed or Alsi**

Also called linseed, flaxseed is a rich source of omega-3 fatty acids that have a protective action on heart health. Like fenugreek, these seeds also contain a lot of fiber and this binds with cholesterol, preventing its absorption. The regular use of flaxseed is said to prevent the arteries from hardening due to the deposition of cholesterol; it also helps reduce the risk of coronary artery disease and hypertension. Flaxseeds also have the effect of increasing the concentrations of a polipoprotein A1 which goes to form HDL cholesterol.

### **Garlic**

Garlic has long been used in Indian kitchens to pep up spicy dishes; our ancestors appear to have known a lot about its medicinal value. Research now shows that garlic reduces LDL cholesterol, prevents a rise of blood pressure and also avoids the deposition of plaque on the walls of arteries, reducing chances of heart attack and stroke. Garlic contains sulphurous compounds that act as antioxidants and also help with expansion of the blood vessels, keeping blood pressure at a normal level.

### **Onions**

Onion contains a constituent called quercetin that is known to be a strong antioxidant; this means it can prevent the damaging effects of free radicals on human tissues. Researchers have linked quercetin of onions with increased levels of HDL cholesterol as well as low levels of LDL cholesterol.

### **Nuts**

Nuts such as almonds, pistachios, hazelnuts and walnuts are rich in polyunsaturated fatty acids that help to keep the arteries healthy. However, eat them in raw form without adding salt or sugar or you will add to the calorie content.

## **Fish**

Certain species of fish are a storehouse of the healthy omega-3 fatty acids that reduce LDL cholesterol and protect the heart. Herring, salmon, mackerel, sardines, halibut and lake trout are good sources of these fatty acids that also help increase HDL cholesterol.

## **Oats and Beans**

Oats are a rich source of fiber and a compound called beta glucan; these act together to bring about a reduction in the levels of LDL cholesterol. Beans also contain a large amount of fiber and can help to reduce the quantity as well as the rate of cholesterol absorption from the diet.

## **Olive oil**

Olive oil contains a potent mix of antioxidants that can lower your "bad" (LDL) cholesterol but leave your "good" (HDL) cholesterol untouched.

Try using about 2 tablespoons (23 grams) of olive oil a day in place of other fats in your diet to get its heart-healthy benefits. To add olive oil to your diet, you can saute vegetables in it, add it to a marinade or mix it with vinegar as a salad dressing. You can also use olive oil as a substitute for butter when basting meat or as a dip for bread. Olive oil is high in calories, so don't eat more than the recommended amount.

The cholesterol-lowering effects of olive oil are even greater if you choose extra-virgin olive oil, meaning the oil is less processed and contains more heart-healthy antioxidants. But keep in mind that "light" olive oils are usually more processed than extra-virgin or virgin olive oils and are lighter in color, not fat or calories.

## **HYPOGLYCEMIC FOODS**

It is no exaggeration—balancing y the blood sugar could be a matter of life or death. Chronic high blood sugar levels are toxic to the body, destroying organs and blood vessels and paving the way to a heart attack, type 2 diabetes, stroke, dialysis, nerve damage, erectile dysfunction, or even blindness. Following are some foods which help reduce blood glucose level or in other words have a hypoglycemic effects.

### **Blueberries**

A groundbreaking study published in the *Journal of Nutrition* in 2010 found a daily dose of the bioactive ingredients from blueberries increases sensitivity to insulin and may reduce the risk of developing diabetes in at-risk individuals. That's important because too many carbs produces too much insulin, which could lead to insulin resistance and type 2 diabetes.

### **Avacados**

In spite of high fat content avocados have beneficial effects on blood sugar metabolism. They're still good. Avocados are full of monounsaturated fat, the kind that helps slow the release of sugars into the bloodstream, prompting less insulin release.

### **Chia seeds**

This ancient gluten-free grain stabilizes blood sugar, manages the effects of diabetes, improves insulin sensitivity, and aids symptoms related to metabolic syndrome, including imbalances in cholesterol, higher blood pressure, and extreme rises in blood sugar levels after meals.

### **Cinnamon**

A 2003 study in the journal *Diabetes Care* showed that cinnamon may cause muscle and liver cells to respond more readily to insulin, thereby improving weight loss. Better response to insulin means better blood sugar balance and, therefore, less insulin released into your body.

### **Mango**

Mangos may taste sugary sweet, but this delicious fruit may actually lower blood sugar according to research published in the journal *Nutrition and Metabolic Insights*. "Our results indicate that daily consumption of 10 grams of freeze-dried mango, which is equivalent to about one-half of a fresh mango (about 100 grams), may help lower blood sugar in obese individuals,"

### **Olive oil**

Olive oil rich in the same monounsaturated fat found in avocados, prevents not only belly fat accumulation, but also insulin resistance.

### **Eggs**

A study published in 2008 in the *International Journal of Obesity* found overweight and obese people given two eggs a day for breakfast lost 65 percent more weight than those eating a similar breakfast without eggs. The researchers said eating eggs may control hunger by reducing the

post-meal insulin response and control appetite by preventing large fluctuations in both glucose and insulin levels.

### **Vinegar**

Vinegar has been found to blunt blood sugar and insulin increases, as well as heighten the sensation of fullness after a higher-carbohydrate meal. An Arizona State University study found people who started a meal with a vinegar drink enjoyed better blood sugar and insulin profiles following meals.

### **Cherries**

Cherries contain naturally occurring chemicals called anthocyanins, which could help lower blood sugar levels in people with diabetes. A study published in the *Journal of Agricultural and Food Chemistry* found anthocyanins could reduce insulin production by 50 percent.

## ANTIOXIDANT PROVIDING FOODS

### **Antioxidants**

Antioxidants are substances, which retard or prevent deterioration, damage or destruction caused by oxidation. During the last few years researches has confirmed that many have the common disease (CVS, diabetes, cataracts, high blood pressure, infertility, respiratory infection and rheumatoid arthritis) are associated with tissue deficiency and/or low dietary levels of compounds called antioxidants which make them an essential part of the nutraceutical market.

Some researchers also believe that free-radical damage may be involved in promoting chronic diseases like heart disease and cancer.

During oxidation free radicals are generated, these free radicals at a molecular level burn everything they touch. Antioxidants are quite large in number and diverse in nature which opposes the process of oxidation largely by neutralizing free radicals at relatively small concentrations and have the potential to inhibit the oxidants chain reactions and ultimately reconstitute the damaged membranes. Dietary antioxidants and some accessory molecules, such as zinc and certain vitamins are important in maintaining free radical scavenging systems, biosynthetic capacity, membranes, enzymes and DNA. Antioxidants are found in the vegetable

oils e.g., Soybean oil, canola oil, corn oil, oat oil, wheat germ oil, palm oil, evening prime rose oil. Here are some foods which constitute rich source of anti-oxidants.

### **Tomatoes**

Tomatoes are brimming with the antioxidant lycopene which is more potent in cooked tomatoes.

*Antioxidants:* Vitamin A, vitamin C, lycopene

### **Berries**

Berries like strawberries, blueberries and raspberries are overflowing with antioxidants called anthocyanins.

*Antioxidants:* Vitamin C, anthocyanin, quercetin

### **Peaches**

The antioxidant lutein gives this stone fruit its gorgeous hue. Lutein helps keep your heart, skin and eyes healthy.

*Antioxidants:* Vitamin A, vitamin C, lutein, zeaxanthin

### **Kale**

One cup (chopped) of this powerhouse veggie has 206% of your daily recommended dose of vitamin A and 134% of your daily recommended dose of vitamin C.

*Antioxidants:* Vitamin A, vitamin C, lutein

### **Plums**

Stone fruit like plums are bursting with all types of good-for-you phytochemical antioxidants.

*Antioxidants:* Beta-carotene, vitamin C, neochlorogenic acid, chlorogenic acid

### **Bellpepper**

A bell pepper has more vitamin C than an orange. Red peppers have even more vitamin C than the green ones.

*Antioxidants:* Vitamin A, vitamin C, vitamin E

### **Cantaloupe**

The bright orange color of this melon comes from the antioxidant beta-carotene.

*Antioxidants:* Beta carotene, vitamin C, zeaxanthin

### **Corn**

Corn has a handful of antioxidants including zeaxanthin, which helps protect your eyes.

*Antioxidants:* Vitamin C, lutein, zeaxanthin

### **Spinach**

This green leafy bunch of goodness is one of the top sources of the antioxidant lutein, which helps protect your eyes.

*Antioxidants:* Beta-carotene, lutein, zeaxanthin

### **Cherries**

These are high in two inflammation-fighting phytochemicals: anthocyanin and quercetin.

*Antioxidants:* Vitamin A, vitamin C, anthocyanin, quercetin

## FOOD FORTIFICATION

Fortification involves the addition of nutrients to foods irrespective of whether or not the nutrients were originally present in the food. The aim of fortification is to help the population achieve the recommended amounts of nutrients. Fortification is often undertaken to address low intakes of a nutrient. Dietary surveys can suggest which groups of the population might benefit from having higher intakes of some nutrients.

### **Restoration and substitution**

Nutrients or food components may be added for a variety of reasons:

**Restoration** – This is where nutrients lost during food processing are replaced. For example, by law in the UK, iron, thiamine and niacin must be added to brown and white flour, as they are removed with the bran during the milling of wheat to make white and brown flour.

**Substitution** – Nutrients are sometimes added to produce a substitute product with similar nutritive value. For example, some soya based drinks sold as a substitute for cow's milk may have calcium voluntarily added.

Adding nutrients to foods, particularly staple foods such as cereals, milk products, sugar, oil and salt, can increase intakes among most of the population. In countries where intakes of certain nutrients are very low, fortification can help to reduce nutrient deficiency diseases. For example, the addition of iodine to salt to decrease iodine deficiency disorders such as goiter.

Fortification of some foods may also be seen as providing a marketing advantage, especially where the purchasers have some awareness of the 'benefits' of the nutrient being added. This may include adding nutrients to products that would not normally be a natural source, such as adding omega-3 fatty acids to breads and fibre to yogurts. The addition of a nutrient may also offer some technical benefit (for example, vitamin C is an antioxidant and can reduce the rate of spoilage in some products), or a direct health benefit for a

subgroup of the population (for example fortification of flour with folic acid to prevent neural-tube defects in babies).

It is a public health measure to prevent or control some nutritional disorders. For getting maximum benefits the vehicle must be a part of the regular daily diet by relevant section of the population. During fortification amount of nutrient added must provide an effective supplement for low consumers of the vehicle. The component to be fortified should not be harmful to high consumers and at same time it must not cause noticeable change in the taste, smell, appearance or consistency. Cost of the process should be economical.

Some common examples of food fortification in India are as follows.

- Fluoridation of drinking water in endemic areas to prevent dental caries.
- Iodisation of salt to prevent iodine deficiency diseases (IDD).
- Vitamin A fortification of Vanaspathi.
- Iron to salt or Flour.
- Milk with Vitamin D
- Salt with Iodine
- Fruit juice with Calcium
- Toothpaste with fluoride
- Flour with Folic Acid
- Bread with Niacin

### **Fortification in some other countries**

The legislation regarding food fortification in the EU is Regulation (EC) No 1925/2006 on the addition of vitamins and mineral and of certain other substances to food. It applies only to the voluntary fortification of foods, not to foods that are subject to mandatory fortification, and specifies upper safety limits and minimum levels for each nutrient.

Vitamins and minerals may not be added to:

- unprocessed foods e.g. fruit, vegetables, meat, poultry and fish;
- beverages containing more than 1.2% by volume of alcohol.
- **UK – Flour fortification**
- Nutrients can be lost during the milling process (e.g. in the production of white and brown flour), the amount being dependent on the quantity of bran and germ removed. However, the UK food industry is required by law to fortify the wheat flour. This regulation stipulates the amount of iron, calcium, thiamine and niacin that must be added to all white and brown flour, to levels present in unrefined, wholemeal flours. This ensures that white flour and brown flour contain similar levels of these nutrients to wholegrain flour (which contains the endosperm, germ and bran).
- Flour fortification means that products made with the fortified flour e.g. bread, will also therefore be fortified.
- **Certain EU countries – Margarine fortification**
- Margarines have the same amount of total fat as butter, but with less saturated fat. Margarine is defined by law and must contain a minimum of 80%, but less than 90% fat and a maximum of 3% milk fat. It is mandatory to fortify margarine with vitamin A at levels of 800-1000µg per 100g and vitamin D at 7.05-8.82µg per 100g, under UK law. Belgium, Poland and Sweden also have legislation requiring the mandatory fortification of margarine with vitamin A and D in various amounts.
- **Certain EU Countries - Salt fortification**
- Since the 1920s, some countries have iodized their salt to help prevent against iodine deficiency diseases. The World Health Organisation (WHO) recommends universal salt iodization – the fortification with iodine of all salt used for human and animal consumption – as the main strategy for eliminating iodine deficiency. EU countries which require the mandatory fortification of salt with iodine include Austria, Denmark, Lithuania, Poland and Slovenia.
- **EU - Fortification of breakfast cereals**
- Breakfast cereals are fortified in many countries across the EU, with micronutrients including B vitamins, iron, calcium and vitamin D. This can provide a valuable contribution to the diet of breakfast cereal consumers.

## ENRICHMENT OF FOODS

- When foods are processed, they often lose some of the important nutrients such as vitamins and minerals in the process. If the food is labeled “enriched” then the vitamins and/or minerals which were lost have simply been added back to restore it to its original nutritional value. Many consumers think that “enriched” means that the food has extra nutrients added to it which will make it more nutritious. That is not true. It has simply been restored to its original state.
- “Enriched” is most often seen in relation to flour. The refining process necessary to produce white flour is so rigorous that it removes a large amount of nutrients. Most companies who market white flour now “enrich” it by adding back the nutrients which were lost during this process.

## BIOFEDIC FOODS

## PROBIOTIC FOODS

Probiotics are organisms such as bacteria or yeast that are believed to improve health. They are available in supplements and foods. The idea of taking live bacteria or yeast may seem strange at first. After all, we take antibiotics to fight bacteria. But our bodies naturally teem with such organisms. The digestive system is home to more than 500 different types of bacteria. They help keep the intestines healthy and assist in digesting food. They are also believed to help the immune system.

### **Probiotic bacterial species**

The various types of bacteria that are having the probiotics characteristics are:-Lactobacilli, Lactobacillus rhamnosus, Lactobacillus reuteri, Lactobacillus case, Bifidobacterium, Bifidobacterium lactis, Bifidobacterium longum, Bifidobacterium breve, Bifidobacterium infantis, Streptococcus, Lactococcus, Lactococcus platinum, Lactococcus reuteri, Lactococcus agilis, Enterococcus, Saccharomyces, Bacillus, Pediococcus.

## **Characteristics of probiotic bacteria**

Probiotic bacteria should have the following features:

1. GRAS (generally recognized as safe).
2. In vitro resistance to hydrochloric acid and pancreatic juice.
3. Produce antimicrobial substances.
4. Compete with bad bacteria to adhere on the gut wall.
5. Compete for the nutrients and stimulate immunity.
6. Alter the intestinal micro flora balance, inhibit growth of harmful bacteria, promote good digestion, boost immune function and increase resistance to infection.

## **Benefits of probiotics**

Researchers believe that some digestive disorders happen when the balance of friendly bacteria in the intestines becomes disturbed. This can happen after an infection or after taking antibiotics. Intestinal problems can also arise when the lining of the intestines is damaged. Taking probiotics may help.

“Probiotics can improve intestinal function and maintain the integrity of the lining of the intestines,” These friendly organisms may also help fight bacteria that cause diarrhea.

### *Boosting Immune System*

There’s also evidence that probiotics help maintain a strong immune system. In societies with very good hygiene there is a sharp increase in autoimmune and allergic diseases. That may be because the immune system isn’t being properly challenged by pathogenic organisms. Introducing friendly bacteria in the form of probiotics is believed to challenge the immune system in healthy ways.”

### *Probiotics may help lots of ailments*

Although they are still being studied, probiotics may help several specific illnesses, studies show. In 2011, experts at Yale University reviewed the research. They concluded that probiotics are most effective for:

- Treating childhood diarrhea
- Treating ulcerative colitis
- Treating necrotizing enterocolitis, a type of infection and inflammation of the intestines mostly seen in infants

- Preventing antibiotic-associated diarrhea and infectious diarrhea
- Preventing pouchitis, an inflammation of the intestines that can follow intestinal surgery
- Treating and preventing eczema associated with cow's milk allergy
- Helping the immune system

The Yale University panel of experts concluded that probiotics may be helpful in other ways, although the evidence is less convincing. These include:

- Treating symptoms of irritable bowel syndrome
- Treating vaginitis
- Treating diarrhea caused by *C. difficile* bacteria
- Treating Crohn's disease

Probiotics may also be useful in unexpected ways. A study published in 2010 suggests that probiotics may lower the risk of common childhood illnesses such as ear infections, strep throat, and colds.

### **Cautions about probiotics**

For the most part, taking probiotics is safe and causes few side effects. People in cultures around the world have been eating yogurt, cheeses, and other foods containing live cultures for centuries.

Still, probiotics may be dangerous for people with weakened immune systems or serious illnesses. One study found that patients with severe pancreatitis who were given probiotics had a higher risk of death.

### **Some probiotic foods**

#### **Yogurt**

The yogurts that have natural ingredients and claiming to contain “live and active cultures” have maximum health and probiotics benefits. Not all yogurts are the same, some are filled with sugars and syrups.

#### **Kombucha tea (fermented tea)**

Found in Asian grocery stores and health food stores, Kombucha tea is a dark tea that has been found to increase energy and help with the stomach's natural digestion. It can be taken hot or iced.

#### **Miso soup**

Popular in Japanese restaurants, miso soup is a tofu and vegetable broth soup that's low in calories and high in probiotics and protein. It is a healthy and delicious break from the normal canned soup.

### **Soy milk**

Soy naturally contains some probiotic benefits, but new soy milk products on the market have added extra live cultures. Look for labels that say “live and active cultures” to be sure.

### **Kefir**

A cross between yogurt and milk, kefir is a delicious way to get probiotics and vitamins into your system.

### **Sauerkraut**

This delicious pickled cabbage dish also contained probiotics. Add a scoop on your favorite hot dog or eat as a side dish.

### **Milk**

Though it’s relatively new to the market, there are a few types of milk that contain added probiotics. Some research has concluded that probiotic milk may cause gas and bloating in kids and the elderly so such people should use this with caution.

### **Dark chocolate**

Dark chocolate contains probiotics and antioxidants to keep your stomach healthy and at the same time your sweet tooth satisfied.

### **Pickles**

Whether you like them sweet or dill, pickles contain a good amount of probiotics for your system.

### **Tempeh**

Made from soy protein, tempeh is a delicious meat substitute that’s full of vitamin B12 and probiotics. Try it baked, grilled, or sautéed for a tasty meatless meal.

### **Kimchi**

A popular Korean side dish, kimchi is fermented and pickled cabbage that can be very spicy. Filled with vitamins, calcium, and probiotics; it’s an excellent and hot way to stay healthy.

### **Olives**

Olives in brine have large amounts of probiotics because the brine allows the probiotic cultures to thrive. Snack on your favorite type of olive or add to a salad or pizza.

## **PREBIOTICS**

Making up the prebiotic family are several fibrous elements that occur naturally in the foods you eat. The two most common subtypes of prebiotics are the closely related inulins and fructo-oligosaccharides, or FOS, both of which pass through the small intestine without being digested or absorbed, making them excellent prebiotics. Once these prebiotics reach the colon, they stimulate the growth of bifidobacteria (probiotics that occur naturally in the human gastrointestinal tract) and other beneficial microorganisms. Another subtype within the prebiotic family is that of the galacto-oligosaccharides, or GOS, which are synthesized from lactose (a complex sugar present in cow's milk) by enzymatic activity within the body. GOS are also present in several nondairy foods.

### **Symbiosis of prebioti and probiotic**

Research has established strong evidence of a symbiotic relationship between prebiotics and probiotics, An animal study that showed that the combination of the prebiotics inulin and oligofructose and the probiotics *Lactobacillus rhamnosus* and *Bifidobacterium lactis* significantly reduced the number of colon tumors found in test animals. The prebiotics and probiotics work hand in hand to promote better health.

### **Foods rich in prebiotic**

Foods that contain high levels of inulin and FOS include asparagus, burdock, chicory, dandelion root, Jerusalem artichoke, leeks and onions, according to Enzymes can convert the lactose from milk into GOS in the human body, these prebiotics also occur naturally in several plant-based foods. These foods include grains, legumes and cruciferous vegetables such as broccoli, Brussels sprouts, cabbage, cauliflower, collard greens, kale, radish and rutabaga.

### **Criteria for food components or ingredients as prebiotics**

A prebiotic nature has been attributed to many foods and their components those fulfill the following properties-

1. Resists host digestion and absorption processes.
2. Fermented by the micro flora colonizing the gastrointestinal system.
3. Selectively stimulates the growth and/or the activity of one or a limited number of bacteria with the gastrointestinal system.

## **Prebiotic containing foods**

Raw Chicory root: 64.6% prebiotic fiber by weight

Raw Jerusalem artichoke: 31.5% prebiotics by weight

- Raw Dandelion greens: 24.3% prebiotic fiber by weight
- Raw Garlic: 17.5% prebiotics by weight
- Raw Leek: 11.7% prebiotic fiber by weight
- Raw Onion: 8.6% prebiotics by weight
- Cooked Onion: 5% prebiotic fiber by weight
- Raw Asparagus: 5% prebiotics by weight
- Raw Wheat bran: 5% prebiotic fiber by weight
- Wheat flour, baked: 4.8% prebiotics by weight
- Raw Banana: 1% prebiotic fiber by weight
- However, as the need for functional foods rises, prebiotics are being added to many every day food choices such as cereals, biscuits, breads, table spreads, drinks, and yoghurts.
- If all consumers met their dietary requirements, and ate 5-8 servings of fruits and vegetables per day, then their dietary fibre needs would be met. However, the vast majority of the population do not meet these requirements by consuming fruits and vegetables alone. Functional food sincrease consumer choice by adding prebiotics to every day food items. By continuing to eat and drink common foods, but choosing functional alternatives (i.e. Bread containing prebiotics) dietary requirements can be met, without significant changes to food preferences

## **Benefits of prebiotics**

A prebiotic effect occurs when there is an increase in the activity of healthy bacteria in the human intestine. The prebiotics stimulate the growth of healthy bacteria such as bifidobacteria and lactobacilli in the gut and increase resistance to invading pathogens. This effect is induced by consuming functional foods that contain prebiotics. These foods induces metabolic activity, leading to health improvements. Healthy bacteria in the intestine can combat unwanted bacteria, providing a number of health benefits.

## Difference Between Prebiotics and Probiotics

Prebiotics are a dietary fibre that trigger the growth of bacteria having favourable effects on the intestinal flora. Probiotics, however, are live micro-organisms contained in the food we eat. They remain intact throughout the digestive process, and deliver healthy bacteria directly to the large intestine. Since probiotics do not stimulate metabolic activity they provide a different set of benefits than prebiotics. Both sets of benefits are valuable for our health wellness, and can act symbiotically to provide numerous health benefits. In fact, the benefits of consuming both prebiotics and probiotics are so strong that synbiotic products (products in which both a probiotic and a prebiotic are combined) are being developed as functional foods.

## HIGH PROTEIN FOODS

### 1Meat

Meat contains a significant amount of proteins. White or poultry meats are healthier than red meats because of its high content of lean proteins. Chicken is one of the most nutritious and versatile meats. Four ounces of chicken contains 32 grams of protein with very low fat and cholesterol. Chicken is best nutritionally when boiled, roasted and baked.

Dark meat though good in proteins, contains a high amount of fats and can also raise cholesterol levels. 58 grams of Chicken breasts contains 17 grams protein and 37 gram chicken thigh contains 9 grams of protein. For a high amount of protein, pick the lean meats or go for poultry or fish. Try and avoid frying meats like bacon, hot dog or deep fried chicken as frying removes the protein content. Meat from organs like liver or kidney contains too much sodium and fats which outweigh the benefit of the high protein foods.

| Food Source of Protein    | Amount of Protein in 100 grams | Protein to Calorie Ratio |
|---------------------------|--------------------------------|--------------------------|
| Lean beef                 | 36 g                           | 5.3                      |
| Turkey and Chicken Breast | 32 g                           | 4.5                      |
| Beef cooked               | 16.91 g to 40.6 g              | 9.6                      |

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|             |                   |     |
|-------------|-------------------|-----|
| Lamb cooked | 20.91 g to 50.9 g | 6.8 |
|-------------|-------------------|-----|

**2Beans/ Legumes:**

Beans and legumes are one of the best options when it comes to protein rich foods and are considered the best protein source for vegetarians. Legumes include peas, lentils and beans like Pinto, garbanzo, white, kidney and soy beans, are all packed with protein. Beans are also loaded with dietary fibre and 8 essential amino acids. Beans contain an approximate 9 mg of protein per gram, and some varieties also contain 12g per 100 grams.

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| Food Source of Protein | Amount of Protein in 100 grams | Protein to Calorie Ratio |
|------------------------|--------------------------------|--------------------------|
| Soy bean               | 36 g                           | 12.5                     |
| Kidney beans           | 24 g                           | 2.5                      |
| Black beans            | 21 g                           | 16.1                     |
| Chickpeas              | 19 g                           | 19.1                     |
| baked beans            | 6 g                            | 25.5                     |

**3. Nuts:**

Nuts like cashew, almonds, and peanuts are again high protein food. Highest amount proteins are available in Brazil nuts. One ounce of Brazil nut is sufficient to fulfil the protein requirement for the day. Brazil nuts are rich in amino acids and omega 3 fatty acids which help in muscle development and prevent skin dryness. Almonds are nuts with a number of health benefits including a high level of protein. ¼ cup of almonds contains 8 grams of protein.

Almonds have low fat content and are a great source of protein rich food for vegetarians. Peanuts are a high source of protein as well with 8 grams of protein. Peanut butter is also a good source of proteins and provides us with 8 grams of protein per 30 grams. The only downside with protein is that it is high in fats, so add to your diet in moderation.

| Food Source of Protein | Amount of Protein in 100 grams | Protein to Calorie Ratio |
|------------------------|--------------------------------|--------------------------|
| Nuts and seeds         | 33 g                           | 15.8                     |
| Almonds                | 21 g                           | 27                       |
| Peanut butter          | 8 g                            | 23.2                     |
| Pistachios             | 8 g                            | 28.1                     |
| Sunflower Seeds        | 6 g                            | 27.1                     |
| Flaxseed               | 5 g                            | 29.6                     |

#### 4. Dairy Products:

Dairy products such as milk, yoghurt, cream and cheese are important sources of protein. They also provide with essential minerals and vitamins. Calcium in milk keeps the teeth and bones in a healthy condition and help to prevent osteoporosis and arthritis. Skimmed milk and low fat dairy products are an even healthier option especially for people who want to lose weight.

A half cup of low fat cottage cheese or paneer contains 90 calories with 16 grams of protein. Low fat Swiss cheese contains 8 grams of proteins, parmesan cheese provides us with 10 grams protein and Romano cheese contains 9 grams protein per 100 grams.

| Food Source of Protein | Amount of Protein in 100 grams | Protein to Calorie Ratio |
|------------------------|--------------------------------|--------------------------|
| cheese or paneer       | 16 g                           | 20                       |
| parmesan cheese        | 10 g                           | 15.3                     |
| Romano cheese          | 9 g                            | 12.2                     |

|                      |     |      |
|----------------------|-----|------|
| Low fat Swiss cheese | 8 g | 14.7 |
| yo ghurt and milk    | 6 g | 18   |

### 5. Sea Food:

Sea foods are a very good source of protein and are low in fats. A three ounce serving of salmon contains 20 grams of protein and 5 grams of fat. Salmon is also packed with omega 3 and 6 essential fatty acids which are needed for healthy living. Tuna provides 24 grams of protein per 100 grams and cod fish provides 20 grams of protein per 100 grams.

| Food Source of Protein | Amount of Protein in 100 grams | Protein to Calorie Ratio |
|------------------------|--------------------------------|--------------------------|
| halibut                | 46 g                           | 4.8                      |
| Fish                   | 26 g                           | 4.5                      |
| Tuna                   | 24 g                           | 4.1                      |
| salmon                 | 20 g                           | 10.4                     |
| cod fish               | 18 g                           | 4.5                      |

### 6. Guavas:

Guavas are packed with 3 grams of proteins. Apart from protein, also contains calcium and a high amount of Vitamin C.

| Food Source of Protein | Amount of Protein in 100 grams | Protein to Calorie Ratio |
|------------------------|--------------------------------|--------------------------|
| guavas                 | 3 g                            | 26.6                     |

### 7. Avocados:

Avocados are one of the most nutritious foods and contain a high amount of protein. This fruit provides 5 grams of protein per 8 ounces. This is a great protein food for vegetarians.

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| Food Source of Protein | 8Ounce(224 g) | Protein to Calorie Ratio |
|------------------------|---------------|--------------------------|
| Avocados               | 5 g           | 17.5                     |

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### 8. Cauliflower:

Cauliflower contains a good 3gms of proteins per serving. Cauliflower is also a good source of Vitamin K and provides us with anti-inflammatory benefit which serves a number of bodily functions. Cauliflower is rich in fibre and is beneficial for digestive tract. Cauliflower can be made to a tasty curry or soup and can be eaten mashed or steamed dish.

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| Food Source of Protein | Amount of Protein in 100 grams | Protein to Calorie Ratio |
|------------------------|--------------------------------|--------------------------|
| cauliflower            | 3 g                            | 11.5                     |

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### 9. Dates:

Date is a sweet and delicious fruit which is grown on date palm tree. Dates are a very good source of protein and a single date contains 0.220 grams of protein. 100 grams of dates will provide you with 2.50 grams of protein. Dates contain a number of health benefits and are eaten both as soft and dried fruits.

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| Food Source of Protein | Amount of Protein in 100 grams | Protein to Calorie Ratio |
|------------------------|--------------------------------|--------------------------|
| Dates                  | 2.5 g                          | 11.5                     |

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### 10. Broccoli:

Broccoli is low in fat, high in protein and contains essential nutrients like Vitamin A, Vitamin B, Vitamin C iron and dietary fibre. ½ cup of broccoli provides 2 grams of proteins. Broccoli can

be prepared in a number of ways which include roasting and grilling of broccoli, adding them to salads and preparing a curry out of it.

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| Food Source of Protein | Amount of Protein in 100 grams | Protein to Calorie Ratio |
|------------------------|--------------------------------|--------------------------|
| Broccoli               | 2.8 g                          | 13.5                     |

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### **11. Spinach:**

Our diet is incomplete without spinach. 1 cup of cooked and boiled spinach contains 5 grams of proteins. Spinach is also abundant in Vitamin A, Vitamin B, iron, dietary fiber and all of B complex vitamins.

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| Food Source of Protein | Amount of Protein in 100 grams | Protein to Calorie Ratio |
|------------------------|--------------------------------|--------------------------|
| Spinach                | 2.9 g                          | 7.5                      |

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### **12. Brussels Sprouts:**

Brussels sprouts come packed with vitamins, minerals, fibre and proteins. 1 cup cooked and boiled Brussels sprouts comes with 4 grams of proteins. These sprouts also contain some essential organic compounds which have potent anti-cancer properties.

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| Food Source of Protein | Amount of Protein in 100 grams | Protein to Calorie Ratio |
|------------------------|--------------------------------|--------------------------|
| Brussels Sprouts       | 4 g                            | 8.5                      |

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### **13. Sweet Corn:**

Sweet corn is an excellent addition to pizza, pasta, soups and various other dishes. But sweet corn kernels are sweet and juicy and are best prepared simply with just a little butter with a dash of lime. Sweet corn is also a good source of antioxidants and contains ample amounts of Vitamin B complex like thiamine, niacin, Folate, and pantothenic acids.

| Food Source of Protein | Amount of Protein in 100 grams | Protein to Calorie Ratio |
|------------------------|--------------------------------|--------------------------|
| Sweet Corn             | 4 g                            | 21.5                     |

#### 14. Egg Whites:

Eggs are an excellent source of proteins particularly egg whites. Egg whites are low in cholesterol and high in protein. Egg whites are also low in fat which makes it a perfect food for healthy and nutritious breakfast. One cup of egg whites contains 26 grams of protein. This will also provide you with energy and essential amino acids. Adults are advised to eat one egg daily.

| Food Source of Protein | Amount of Protein in 100 grams | Protein to Calorie Ratio |
|------------------------|--------------------------------|--------------------------|
| Egg Whites             | 26 g                           | 5.2                      |

#### 15. Coconut:

Both coconut water and coconut pulp contains very high level of nutrition. Coconut water contains an array of health benefits and is highly recommended especially during summer season. Do not throw away the shell after drinking the water as the soft pulp of tender coconut is equally rich in proteins. The pulp tastes extremely delicious. You can either have it raw or add in salads. Coconut milk is also rich in proteins and healthy fats.

| Food Source of Protein | Amount of Protein in 100 grams | Protein to Calorie Ratio |
|------------------------|--------------------------------|--------------------------|
| Coconut                | 3.3 g                          | 97.5                     |

#### 16. Bananas:

Bananas are one of the healthiest fruits and contain 4 grams of protein per 100 grams. Bananas are must have for breakfasts. You can eat it as a whole or make a milk shake out of it. You can also prepare curry or sabzi with raw banana and it tastes amazing. Bananas are also good for people who suffer from constipation problems. They are also rich in amino acids which can be used as a face pack to treat dry skin.

| Food Source of Protein | Amount of Protein in 100 grams | Protein to Calorie Ratio |
|------------------------|--------------------------------|--------------------------|
| Bananas                | 4 g                            | 14.5                     |

### 17. Soy milk:

Soy milk is another great option for vegetarians to get their good dose of proteins. 8 ounces of soy milk contains 7 grams of proteins. Adding this super drink to your diet will provide you with recommended daily allowance of protein needed by an individual.

| Food Source of Protein | Amount of Protein in 100 grams | Protein to Calorie Ratio |
|------------------------|--------------------------------|--------------------------|
| Soy milk               | 4 g                            | 13.5                     |

## HIGH ENERGY FOODS

**Sweet Potato:** High in carbohydrates and loaded with beta-carotene (vitamin A) and vitamin C, these will help fight off midday fatigue.

**Honey:** A spoonful of honey is nature's equivalent of an energy drink. Low on the glycemic index, this natural sweetener acts as a time-released muscle fuel during exercise and helps replenish muscles post-workout.

**Bananas:** Because they are composed mostly of sugars (glucose, fructose and sucrose) and fiber, bananas are a foolproof energy food.

### Jam and Jelly

They are full of energy with about 65-68% sugar.

### Bread

Whole grain bread has around 20 grams of carbohydrates in one slice. The number is even higher for white bread.

## 7. Pasta

White flour or semolina pasta is a high-glycemic food.

Some more examples of energy rich foods include following:

- Sugary beverages, which includes everything from soft drinks to flavored coffee drinks to bottled iced tea.
- Desserts, candy, and other foods sweet foods.
- Food with added sugar, molasses, honey, and any of these ingredients.
- Fruits that are naturally high in sugar, such as ripe bananas and figs, or dried fruit, which often has sugar added or is so concentrated that it contains a lot of sugar

Starch is basically long strands of glucose, so they break down to sugars in the body. High-starch foods include:

- Starchy vegetables: Potatoes, sweet potatoes, and corn are examples of high carb, starchy vegetables.
- Flour - Any food made with flour (bread, crackers, donuts, cakes, cookies, pastries, etc.)
- Whole Grains - Rice, barley, oats, quinoa, etc, are high in starch
- Most legumes (beans and peas) are high in starch, but it is more slowly-digested.

Granular sugar

This is an example of a nearly 100% carbohydrates that has almost no fat, protein, minerals or vitamins.

Pizza

The amount of carbohydrate varies greatly depending on the thickness of the crust, whether it's whole wheat or white crust and on all the toppings used to create the pizza. The carb content tends to be 22-30%.

#### Potato

Everybody loves a potato but even the "healthy baked potato" is loaded with carbohydrates. Hash browns are 35% carbohydrate and French fries are 27%. A baked potato is 21% carbs, which translates into 36 g of carbohydrate in a medium-size potato. Many people fail to realize just how high in carbs potatoes really are.

#### Cakes and cookies

Cookies and cakes are always high in carbohydrates. The flour used in baking is nearly 80% carbohydrate that pushes the carbohydrate content in cookies and cakes well into the 80% range or higher for carbohydrate content.

#### Jam and preserve

The majority of these are fruit-based and contain a substantial proportion of carbohydrates. 64-68% is an average for carbs and the thicker jams contain less water and are higher in carbohydrate content.

#### **Sauces, sweet pickles, and salad dressings**

The average for this group is around 35% carbs. Sauces, low-fat dressings and salad dressings are sweetened and that increases the carbohydrate content.

#### Sugary cereals

Breakfast cereals are notorious for their extremely high carbohydrate content. Many of these are packed with extra sugar even though their claim to be "healthy". The carbohydrate content frequently reaches 90 to 93%. A healthy alternative is oatmeal or rye cereal. These have only about 10% carbohydrates that are rich in vitamins and slow burning.

## Crackers

Even low-fat crackers are easily 80% carbohydrate. The majority of these snacks are high in carbohydrate content that makes them tasty and hard to resist

## Apple and banana

Bananas contain the highest amount of sugar of all the fruits. A single Apple contains 21 g of carbohydrates. Bananas are nearly 24 g of carbohydrates but are high in fiber and potassium.

## Hard candies

Hard candies are nearly 100% carbohydrates and have little nutritional value. The manufacturing process simply takes refined carbohydrates and sugars and packs them into a pretty shiny candy.

## Soda

Soda contains no nutritional value. One can contains at least 36 grams of carbohydrates and causes your blood sugar to spike rapidly. Avoid drinking soda due to the carbonic acid that is damaging to the teeth and can irritate the stomach.

## Bread and pasta

Quinoa or buckwheat are the best choices for pasta. Even whole-grain pastas and breads contain carbohydrate. A single slice of whole-grain bread contains 20 g of carbohydrates.

### **Carbohydrate content in common High Carb Foods**

| <b>Breads</b> | <b>Serving</b>    | <b>Carb content (g)</b> |
|---------------|-------------------|-------------------------|
| Bagel         | One single; plain | 60                      |
| Peter bread   | One large pita    | 30-45                   |
| Croissant     | 1 medium size     | 25                      |

|                                |                  |                         |
|--------------------------------|------------------|-------------------------|
| Pancake                        | Average size 6"  | 30                      |
| Muffin                         | 1 whole          | 30                      |
| <b>Cereals and grains</b>      | <b>Serving</b>   | <b>Carb content (g)</b> |
| Cooked pasta                   | One cup          | 45                      |
| Cooked rice                    | One cup          | 45                      |
| <b>Vegetables</b>              | <b>Serving</b>   | <b>Carb content (g)</b> |
| Cooked sweet potatoes          | 10 ounces; baked | 60                      |
| Corn on the cob                | 6 inch piece     | 30                      |
| <b>Fruits and dried fruits</b> | <b>Serving</b>   | <b>Carb content (g)</b> |
| Raisins                        | ½ cup            | 45                      |
| Dried apricots                 | ¼ cup            | 28                      |
| Pears                          | 6 ounces         | 20                      |
| Pineapples                     | 1 diced cup      | 20                      |
| <b>Dairy products</b>          | <b>Serving</b>   | <b>Carb content (g)</b> |
| Food flavored yogurt           | One serving      | 28                      |
| Plain rice milk                | One cup          | 20                      |

| <b>Beans</b>   | <b>Serving</b> | <b>Carb content (g)</b> |
|----------------|----------------|-------------------------|
| Garbanzo beans | ½ cup          | 30                      |
| Lentils        | ½ cup          | 20                      |
| <b>Snacks</b>  | <b>Serving</b> | <b>Carb content (g)</b> |
| French fries   | One large      | 60                      |
| Granola        | ½ cup          | 45                      |
| Pizza          | Large slice    | 75                      |

## LOW ENERGY FOODS

Low energy density foods are those that are low in calories. In many cases, low energy density or low-calorie foods are whole, unprocessed foods, such as fruits, vegetables, very lean proteins and low-fat dairy products without added sugars. Filling your plate with low energy density foods is beneficial for weight loss.

### **Fruits**

Fruits and vegetables are among the most nutritious and filling low energy density foods. Choose fruits that are fresh or frozen versus dried or canned in syrup or juice. Fruits contain fructose, which is fruit sugar, so they are, in general, higher in calories than vegetables. One serving of fruit is about 1 cup, or one medium-sized piece, and provides, on average, 60 to 80 calories. Examples of fruits that provide the most volume for the least amount of energy in the form of calories include peaches, nectarines, kiwi fruit, melon and berries -- such as raspberries, strawberries or blueberries.

## **Vegetables**

Like fruits, choose fresh or frozen vegetables, without breading or sauce. Most vegetables are lower in calories than fruits because they do not contain fructose. According to the U.S. Department of Agriculture one serving is 1 cup, raw or cooked, for all vegetables except leafy greens. For leafy greens, the serving size is 2 cups. One serving provides, on average, less than 50 calories per cup. Examples of low energy density vegetables include asparagus, cucumber, green beans, spinach, lettuce, sweet bell peppers, radishes, onions, broccoli, cauliflower and mushrooms.

## **ARTIFICIAL SWEETENERS**

Five artificial sweeteners – acesulfame K, aspartame, neotame, saccharin, sucralose – are approved for use in the U.S. All are chemically manufactured molecules – molecules that do not exist in nature.

Artificial sweeteners are used in one of two ways. They may be used directly in commercially processed foods, or they are mixed with one or more starch-based sweeteners before sale to consumers. Artificial sweeteners are so intensely sweet that dextrose or maltodextrin, or both, must be added to dilute their intense sweetness in order to imitate the sweetness of a sugar. Artificial sweeteners can not be sold directly to consumers since only infinitesimally small amounts are required to mimic sugar's sweet taste.

Food and Drug Administration regulations permit any food product that has 5 or fewer calories per serving to be labeled as containing "0" calories. Additionally, diabetics must count these starch-based sweeteners as part of their carbohydrate limits since insulin is required for their metabolism.

So, not only do the artificial sweeteners packaged for sale to consumers have calories, these products do not have the same clean sweet taste of pure, natural sugar.

### **Acesulfame K**

Acesulfame K, also known as acesulfame potassium or ace K, is approximately 200 times sweeter than sugar. Acesulfame K has no calories because it's not metabolized by the body. Acesulfame K is sold under the brand names of Sunett, Sweet One, and Sweet & Safe.

In addition to tabletop products, ace K can be found in thousands of a wide variety of oral hygiene and pharmaceutical products, as well as foods and beverages. Ace K is approved as a general-purpose sweetener in the U.S., and is used in such diverse products as dry beverage and dessert mixes, hard and soft candies, chocolate confections, chewing gum, baked goods, dairy products, carbonated drinks and alcoholic beverages. Acesulfame K has the advantage that it is stable at temperatures below 400°F.

Acesulfame K is commonly blended with other nutritive and artificial sweeteners. It will be listed in the ingredient statement of a packaged food or beverage as “acesulfame potassium.”

### **Aspartame**

Aspartame is approximately 200 times sweeter than sugar. Aspartame is marketed under the NutraSweet, Equal and Sugar Twin brands.

Aspartame is completely broken down by the body into its two component amino acids – aspartic acid and phenylalanine – and a small amount of methanol (wood alcohol). Although aspartame therefore has four calories per gram, its intense sweetness means so little of aspartame is used that essentially no calories are provided.

Like ace K, aspartame is approved as a general-purpose sweetener in the U.S., and is used in the same type of foods and beverages. However, since aspartame is not stable at cooking and baking temperatures, its use is limited in baked goods and some dry dessert mixes.

Products containing aspartame must carry a label advising those with phenylketonuria, a rare genetic disorder, that phenylalanine is present. It is listed in the ingredient statement on a food or beverage package as “aspartame.” The ingredient listing for a tabletop product like Equal reads “dextrose with maltodextrin, aspartame.”

## **Neotame**

Neotame is the newest of the artificial sweeteners approved for general use in the U.S. Like aspartame, it is composed of aspartic acid and phenylalanine. However, neotame is structurally different which makes it about 40 times sweeter than aspartame, or approximately 8,000 times sweeter than sugar.

While structurally different, neotame is still metabolized like aspartame. It is completely broken down into aspartic acid and phenylalanine. Because only trace amounts of neotame are required to mimic the sweetness of sugar, it contributes no calories.

Use as a tabletop product and packaged food ingredient is anticipated. Neotame can be used in the same foods and beverages as both aspartame and acesulfame K.

## **Saccharin**

Saccharin was discovered more than 100 years ago, which makes it the oldest of the artificial sweeteners. Its sweetness depends on how it is used, and ranges from 200 to 700 times sweeter than sugar.

In the U.S., saccharin is approved as a special dietary sweetener which limits its use to beverages and tabletop products. Also, approval for its use stipulates that specific maximum amounts are not to be exceeded.

Saccharin is available commercially as “sodium saccharin” (most common), “calcium saccharin” or “acid saccharin.” Saccharin is sold under such brands as Sweet ‘N Low, Sweet Twin and Necta Sweet. A one-gram packet of a popular tabletop brand has an ingredient statement that reads “dextrose, 3.6% sodium saccharin (36 mg per packet), calcium silicate (an anti-caking agent).”

## **Sucralose**

Sucralose is made from sucrose by a multi-step patented manufacturing process that selectively replaces three hydroxyl (molecularly bonded hydrogen and oxygen atoms) with chlorine atoms. This molecular change makes sucralose 600 times sweeter than sugar.

In 1999, sucralose was approved as a general-purpose sweetener in the U.S. Sucralose is sold under the brand name Splenda. The ingredients of the tabletop product are listed as “dextrose, maltodextrin and sucralose” on the packet.

Food manufacturers value sucralose because it is the most heat stable of the artificial sweeteners. This property has increased the introduction of sucralose into a broad range of foods and beverages previously sweetened with the other approved general-purpose artificial sweeteners.

## GERIATRIC FOODS

Geriatric nutrition applies nutrition principles to delay effects of aging and disease, to aid in the management of the physical, psychological, and psychosocial changes commonly associated with growing old. The foods meeting out such needs are called geriatric foods.

Calorie requirements decrease with age, although individuals vary greatly depending on their activity level and health status. Diets that fall below 1,800 calories a day may be low in protein, calcium, iron, and vitamins, so should feature nutrient-dense foods.

The cornerstone of geriatric nutrition is a well-balanced diet. This provides optimal nutrition to help delay the leading causes of death: heart disease, cancer, and stroke. In addition, ongoing research indicates that dietary habits, such as restricting one’s calorie intake and consuming antioxidants, may increase longevity.

As we age, our lifestyle may be less active; we may sit more and perform less vigorous exercises or physical labor. Also, our body’s metabolism may be less efficient or slower. These lifestyle and metabolism changes may cause weight gain and less efficient absorption of nutrients. We should select more nutrient-dense foods with lower amounts of fat and sugar (empty calories). If we have problems losing weight, then we should limit our fat or sugar intake. We should eat a variety of foods that are good sources of protein, vitamins, minerals, and fiber.

Some general dietary recommendations

1. Eat a variety of foods that are good sources of protein, vitamins, minerals, and fiber. It is important to eat nutrient dense foods with calories. Eating fewer foods or calories may be due to poor appetite, less activity, or medical conditions, which may result in weight loss.
2. Eat at least three servings of calcium-rich foods. Calcium and vitamin D are important to maintain bone health.

3. Drink eight cups of water. This is needed because of higher intake of medications and to prevent dehydration and constipation.
4. Eat fiber-rich foods from grains, fruits, vegetables, dried beans, and nuts.
5. Eat fortified foods with vitamin B12, calcium, and vitamin D. Consult a doctor or dietitian, if you need a dietary supplement.

### **Fiber-Rich Diet**

Fiber or roughage is important to have a healthy digestive system and proper bowel function. Constipation is a problem for many aging adults. Choose a variety of high-fiber foods - vegetables, fruits, beans, nuts, and whole-grain products - drink plenty of water and be physically active to stay regular. Eat at least one high fiber food (pears, dried beans and peas, corn, dates, 100% bran cereals, or potatoes with skins) every day to help you get 20-35 grams of fiber each day.

### **Intake of Enough Fluids.**

Water or other liquids are needed to avoid and prevent constipation and dehydration. Drink six to eight (8-ounce) glasses of fluid every day - water or other liquids (100% juices, milk, beverages, or soup). Limit the amount of caffeinated drinks (coffee, tea, and soda) and be sure to drink at least 2 glasses of water per day. If you are taking medications, you need more water.

### **Calcium-Rich Foods**

Calcium and Vitamin D are essential to maintain strong bones and teeth. After age 50, more calcium or 1,200 milligrams are needed to prevent a disease called osteoporosis. As you age, minerals in your bones are lost and bones may get thinner. Protect your bones by choosing calcium-rich foods, such as milk, cheese, yogurt, greens, broccoli, sardines, canned salmon with bones, dried beans and peas, tofu, and calcium-fortified foods. If you have problems digesting milk,

- Drink lactose reduced milk.
- Eat yogurt or cheese, where the lactose has been broken down, 3
- Drink a smaller amount of milk or buttermilk at a time,
- Eat other calcium-rich foods that are not milk-based.

### **Vitamin D**

Helps the absorption of calcium. It is found in fluid milk, dried milk products, and fortified cereals. Your body can make its own Vitamin D when your skin is exposed to the sunshine. Several times a week try to take a walk or sit in the sun for 20-30 minutes. This is especially important in the winter when there is less sunlight.

### **Protein-Rich Foods**

Body proteins are constantly being made and used during your lifetime to maintain cell and organ functions. Adequate protein intake and protein reserves are important for older adults, especially during periods of emotional and physical stresses. Protein helps to prevent muscle loss. Eat protein-rich foods such as meats, fish, dried beans and peas, or tofu. Also, these foods are good sources of iron and zinc.

As you age, blood levels of vitamin B-12 usually decrease. Vitamin B-12 is needed to make red blood cells and maintain the central nervous system. Animal foods are good sources of vitamin B-12.

### **Plant-Based Diet**

Research reveals that a variety of nutrient-dense fruits, vegetables, and whole-grain foods may protect cells against free radicals (unstable compounds). They also may help protect you against the adverse effects of everyday cancer causing agents such as pollution, dietary factors, tobacco smoke, and viruses. Antioxidants are compounds, such as vitamins A, C, and E, which are found in foods. They protect us from cell damage and may reduce the risk of cancer and heart disease, and may slow down the aging process. Phytochemicals are chemicals or ingredients naturally found in all plant foods. Some phytochemicals help to protect a healthy, normal cell from turning into a cancerous cell. Also, phytochemicals may slow down the growth of tumor cells. Eat colorful meals and snacks by choosing lots of fruits, vegetables, dried beans, nuts and whole-grain foods. It is the easiest way to get all of these important nutrients.

- Vitamins - A, C, E, D, & niacin, riboflavin, thiamin, folate, B-6 & B-12.
- Minerals - calcium, iron, & zinc.
- Fiber - soluble & insoluble.
- Proteins, Carbohydrates, & Fats.
- Antioxidants & Phytochemicals.

### **Requirement of Supplements**

Every day in the media we see ads for dietary supplements that promise to prevent aging changes or improve physical, mental, and nutritional health. Although we know that vitamins, minerals, antioxidants, and possibly particular herbs are beneficial to health, it is important that we don't use supplements in place of food or in extremely high amounts. Some herbal remedies or high potency vitamin or mineral supplements can interfere with the action of certain prescription and over the counter medications. Be sure to check with your doctor before starting any dietary supplements.

# Chapter 5

## Fibers for health and prevention of diseases

### DEFINITION

Fiber is also known as roughage. It is the indigestible part of plant foods that pushes through our digestive system, absorbing water along the way and easing bowel movements.

The word fiber (North American) can also be spelled fibre (British). It comes from the Latin word *fibra*, meaning fiber, thread, string, filament, entrails. Dietary fiber refers to nutrients in the diet that are not digested by gastrointestinal enzymes.

### TYPES OF FIBERS

Fiber is made up of non-starch polysaccharides, such as cellulose, dextrans, inulin, lignin, chitins, pectins, beta-glucans, waxes and oligosaccharides. The word fiber is misleading, because many types of dietary fibers are not fibers at all.

There are two broad types of fiber, soluble and insoluble.

#### **Soluble fiber**

These dissolves in water. It changes as it goes through the digestive tract, where it is fermented by bacteria. As it absorbs water it becomes gelatinous.

#### **Benefits of soluble fiber:**

- It reduces **cholesterol**, especially levels of LDL (bad cholesterol)
- It regulates sugar intake, this is especially useful for people with **diabetes** and metabolic syndrome

Soluble fiber binds with fatty acids, slows down the time it takes to empty the stomach and the rate of sugar absorption by the body.

Food sources of soluble fiber include: kidney beans, pinto beans, brussels sprouts, broccoli, spinach, zucchini, apples, oranges, grapefruit, grapes, prunes, oatmeal, and whole-wheat bread.

### **Insoluble fiber**

They does not dissolve in water. As it goes through the digestive tract it does not change its form.

#### **Benefits of insoluble fiber:**

- Promotes regular bowel movements and prevents **constipation**
- Speeds up the elimination of toxic waste through the colon
- By keeping an optimal pH in the intestines, insoluble fiber helps prevent microbes from producing substances which can lead to **colorectal cancer**

Food sources of insoluble fiber include: vegetables - especially dark green leafy ones, root vegetable skins, fruit skins, whole wheat products, wheat bran, corn bran, nuts, and seeds.

### **Role of fibers in prevention of some diseases**

There's no shortage of research showing how fiber may boost your health and prevent some diseases.

- **Blood sugar control:** Soluble fiber may help to slow your body's breakdown of carbohydrates and the absorption of sugar, helping with blood sugar control.
- **Heart health:** An inverse association has been found between fiber intake and heart attack, and research shows that those eating a high-fiber diet have a 40 percent lower risk of heart disease.<sup>1</sup>
- **Stroke:** Researchers have found that for every seven-grams more fiber you consume on a daily basis, your stroke risk is decreased by 7 percent.<sup>2</sup>
- **Weight loss and management:** Fiber supplements have been shown to enhance weight loss among obese people, likely because fiber increases feelings of fullness.
- **Skin health:** Fiber, particularly psyllium husk, may help move yeast and fungus out of your body, preventing them from being excreted through your skin where they could trigger acne or rashes.

- **Diverticulitis:** Dietary fiber (especially insoluble) may reduce your risk of diverticulitis – an inflammation of polyps in your intestine – by 40 percent.
- **Hemorrhoids:** A high-fiber diet may lower your risk of hemorrhoids.
- **Irritable bowel syndrome (IBS):** Fiber may provide some relief from IBS.
- **Gallstones and kidney stones:** A high-fiber diet may reduce the risk of gallstones and kidney stones, likely because of its ability to help regulate blood sugar.

### Daily requirement of fibers

According to the Academy of Nutrition and Dietetics, the recommended daily amount of fiber for women is 25 grams and for men its 38 grams. However, after the age of 50 it is recommended that women drop their intake to 21 grams and men to 30 grams.

Most dietitians say your ratio of insoluble vs. soluble fiber should be 75% to 25%, or 3 parts insoluble to every 1 part soluble. As most high-fiber containing foods usually have both types, it should not be necessary to be too careful about dividing them up.

Oat, oat brans, psyllium husk and flax seed are rich in both types of fibers. In other words, your focus should be on fiber intake in general, rather than what type of fiber.

If you consume 25g of fiber each day you should meet your daily requirements. Ideally, you should consume 5 servings of fruit and vegetables, as well as some servings of whole grain products, each day.

### Fibre content of some cereals grains, seeds and fruits and vegetables.

| Cereal grains - ½ cup cooked | Soluble | Insoluble |
|------------------------------|---------|-----------|
| Barley                       | 1g      | 4g        |

|                                   |                |                  |
|-----------------------------------|----------------|------------------|
| Oatmeal                           | 1g             | 2g               |
| Oatbran                           | 1g             | 3g               |
| <b>Seeds</b>                      | <b>Soluble</b> | <b>Insoluble</b> |
| Psyllium seeds ground (1 Tbsp)    | 5g             | 6g               |
| <b>Fruit (1 medium fruit)</b>     | <b>Soluble</b> | <b>Insoluble</b> |
| Apple                             | 1g             | 4g               |
| Banana                            | 1g             | 3g               |
| Blackberries (½ cup)              | 1g             | 4g               |
| Citrus Fruit (orange, grapefruit) | 2g             | 2-3g             |
| Nectarine                         | 1g             | 2g               |
| Peach                             | 1g             | 2g               |
| Pear                              | 2g             | 4g               |
| Plum                              | 1g             | 1.5g             |

|                                  |                |                  |
|----------------------------------|----------------|------------------|
| Prunes (¼ cup)                   | 1.5g           | 3g               |
| <b>Legumes (½ cup cooked)</b>    | <b>Soluble</b> | <b>Insoluble</b> |
| Black Beans                      | 2g             | 5.5g             |
| Kidney Beans                     | 3g             | 6g               |
| Lima Beans                       | 3.5g           | 6.5g             |
| Navy Beans                       | 2g             | 6g               |
| Northern Beans                   | 1.5g           | 5.5g             |
| Pinto Beans                      | 2g             | 7g               |
| Lentils (yellow, green, orange)  | 1g             | 8g               |
| Chick Peas                       | 1g             | 6g               |
| Black eyed Peas                  | 1g             | 5.5g             |
| <b>Vegetables (½ cup cooked)</b> | <b>Soluble</b> | <b>Insoluble</b> |
| Broccoli                         | 1g             | 1.5g             |

|                  |    |      |
|------------------|----|------|
| Brussels Sprouts | 3g | 4.5g |
| Carrots          | 1g | 2.5g |

# Chapter 6

## Food fortification and enrichment

### DEFINITION

**Food fortification** or **enrichment** is the process of adding micronutrients (essential trace elements and vitamins) to food. It may be a purely commercial choice to provide extra nutrients in a food, while other times it is a public health policy which aims to reduce the number of people with dietary deficiencies within a population.

While it is true that both **fortification** and **enrichment** refer to the addition of nutrients to food, the true definitions do slightly vary. As defined by the World Health Organization (WHO) and the Food and Agricultural Organization of the United Nations (FAO), **fortification** refers to "the practice of deliberately increasing the content of an essential micronutrient, ie. vitamins and minerals (including trace elements) in a food irrespective of whether the nutrients were originally in the food before processing or not, so as to improve the nutritional quality of the food supply and to provide a public health benefit with minimal risk to health," whereas **enrichment** is defined as "synonymous with fortification and refers to the addition of micronutrients to a food which are lost during processing."

Food fortification was identified as the second strategy of four by the WHO and FAO to begin decreasing the incidence of nutrient deficiencies at the global level.

As outlined by the FAO, the most common fortified foods are:

- Cereals and cereal based products
- Milk and Milk products
- Fats and oils
- Accessory food items
- Tea and other beverages
- Infant formulas

### Types of Food Fortification

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The four main methods of food fortification (named as to indicate the procedure that is used in order to fortify the food):

1. Biofortification (i.e. breeding crops to increase their nutritional value, which can include both conventional selective breeding, and modern genetic modification)
2. Synthetic biology (i.e. addition of probiotic bacteria to foods)
3. Commercial and industrial fortification (i.e. flour, rice, oils (common cooking foods))
4. Home fortification (e.g. vitamin D drops)

## **Criticism**

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Several organizations such as the WHO, FAO, Health Canada, and the Nestlé Research Center acknowledge that there are limitations to food fortification. Within the discussion of nutrient deficiencies the topic of nutrient toxicities can also be immediately questioned. Fortification of nutrients in foods may deliver toxic amounts of nutrients to an individual and also cause its associated side effects. As seen with the case of fluoride toxicity below, the result can be irreversible staining to the teeth. Although this may be a minor toxic effect to health, there are several that are more severe.

The WHO states that limitations to food fortification may include: human rights issues indicating that consumers have the right to choose if they want fortified products or not, the potential for insufficient demand of the fortified product, increased production costs leading to increased retail costs, the potential that the fortified products will still not be a solution to nutrient deficiencies amongst low income populations who may not be able to afford the new product, and children who may not be able to consume adequate amounts thereof.

Food safety worries led to legislation in Denmark in 2004 restricting foods fortified with extra vitamins or minerals. Products banned include: Rice Crispies, Shreddies, Horlicks, Ovaltine and Marmite.

Danes said [Kelloggs] Corn Flakes, Rice Krispies and Special K wanted to include "toxic" doses which, if eaten regularly, could damage children's livers and kidneys and harm fetuses in pregnant women.

### **Limited absorption**

One factor that limits the benefits of food fortification is that isolated nutrients added back into a processed food that has had many of its nutrients removed, does not always result in the added nutrients being as bioavailable as they would be in the original, whole food. An example is skim milk that has had the fat removed, and then had vitamin A and vitamin D added back. Vitamins A and D are both fat soluble and not water soluble, so a person consuming skim milk in the absence of fats may not be able to absorb enough of these vitamins as one would be able to absorb from drinking whole milk.

Phytochemicals such as polyphenols can also impact nutrient absorption.

### **Importance**

The WHO and FAO, among many other nationally recognized organizations, have recognized that there are over 2 billion people worldwide who suffer from a variety of micronutrient deficiencies. In 1992, 159 countries pledged at the FAO/WHO International Conference on Nutrition to make efforts to help combat these issues of micronutrient deficiencies, highlighting the importance of decreasing the number of those with iodine, vitamin A, and iron deficiencies. A significant statistic that led to these efforts was the discovery that approximately 1 in 3 people worldwide were at risk for either an iodine, vitamin A, or iron deficiency. Although it is recognized that food fortification alone will not combat this deficiency, it is a step towards reducing the prevalence of these deficiencies and their associated health conditions.

There are also several advantages to approaching nutrient deficiencies among populations via food fortification as opposed to other methods. These may include, but are not limited to: treating a population without specific dietary interventions therefore not requiring a change in dietary patterns, continuous delivery of the nutrient, does not require individual compliance, and potential to maintain nutrient stores more efficiently if consumed on a regular basis.

Diets that lack variety can be deficient in certain nutrients. Sometimes the staple foods of a region can lack particular nutrients, due to the soil of the region or because of the inherent inadequacy of the normal diet. Addition of micronutrients to staples and condiments can prevent large-scale deficiency diseases in these cases.

### **Examples of fortification in foods**

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Many foods and beverages worldwide have been fortified, whether a voluntary action by the product developers or by law. Although some may view these additions as strategic marketing schemes to sell their product, there is a lot of work that must go into a product before simply fortifying it. In order to fortify a product, it must first be proven that the addition of this vitamin or mineral is beneficial to health, safe, and an effective method of delivery. The addition must also abide by all food and labeling regulations and support nutritional rationale. From a food developer's point of view, they also need to consider the costs associated with this new product and whether or not there will be a market to support the change.

Examples of foods that have been fortified and shown to have positive health effects:

### **Fortified salt**

"Iodine deficiency disorder (IDD) is the single greatest cause of preventable mental retardation. Severe deficiencies cause cretinism, stillbirth and miscarriage. But even mild deficiency can significantly affect the learning ability of populations..... Today over 1 billion people in the world suffer from iodine deficiency, and 38 million babies born every year are not protected from brain damage due to IDD."—Kul Gautam, Deputy Executive Director, UNICEF, October 2007

Iodised salt has been used in the United States since before World War II. It was discovered in 1821 that goiters could be treated by the use of iodized salts. However, it was not until 1916 that the use of iodized salts could be tested in a research trial as a preventative measure against goiters. By 1924, it became readily available in the US.

Currently in Canada and the US, the RDA for iodine is as low as 90 µg/day for children (4–8 years) and as high as 290 µg/day for breast-feeding mothers.

Diseases that are associated with an iodine deficiency include: mental retardation, hypothyroidism, and goiter. There is also a risk of various other growth and developmental abnormalities.

### **Fortified atta**

The consumption of fortified and enriched flour as part of a staple diet by most people makes it an ideal source of essential nutrients that may otherwise be lacking in the diet. Consuming

whole-wheat flour products has the added advantage of providing fiber, antioxidants and phytonutrients in addition to the vitamins and trace minerals that are naturally present in wheat. Whole-grain products are a healthier option, as they may reduce risk of heart disease, diabetes and even some forms of cancer.

Wheat flour fortification is a preventive food-based approach to improve the micronutrient status of populations. In 2009, the World Health Organization (WHO) released recommendations for such fortification, with guidelines on the addition levels for iron, folic acid, vitamin B12, vitamin A, and zinc at various levels of average daily consumption. Iron is the micronutrient of greatest concern to the food industry, as some believe there may be some adverse interaction(s) in some or all of the finished products produced from wheat flour.

### **Benefit of Enriching and Fortifying Flours**

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Flour enriched with iron, thiamin, riboflavin and niacin have been part of the American diet since 1941 and have helped to eradicate beriberi and pellegra from the United States. Although folic acid fortification started only in 1998, its presence in flour is responsible for the decline in the incidence of neural tube defects in babies by 23 percent in the U.S. and by 54 percent in Nova Scotia, Canada.

### **Fortified oil**

Combating malnutrition in low-income countries is a critical part of realizing many of the UN Millennium Development Goals including reducing child mortality, improving maternal health, achieving universal education, and eradicating extreme hunger and poverty. One way of addressing the nutritional gap in vitamin A may be through the fortification of vegetable oils used for cooking.

Leafy greens, proteins, squashes and some fruits contain the most amounts of dietary vitamin A. Unfortunately the absence of these foodstuffs from the diets of many people in low-income countries causes vitamin A deficiency—a leading worldwide cause of blindness and night blindness in children. A lack of dietary vitamin A also contributes to serious health concerns including diarrhea, measles and weakened immune systems.

Vitamin A—as well as vitamins D and E—are fat soluble meaning that the human body can only absorb the vitamin when fats are present during digestion. Fat soluble vitamins do not lose

potency when heated or cooked and the addition of vitamins to vegetable oil does not increase costs for oil packaging or storage. Furthermore, vitamins can be added to different vegetable oils without a change in technology. This means enhancing the locally-preferred cooking oil—canola, palm, soybean, coconut or sunflower—instead of imposing an unfamiliar alternative which households might not use regardless of health benefits.

Agriculture giant Cargill began an oil fortification program in India in 2008. Cargill estimates that on average each Indian consumes approximately 12 kilograms per year of vegetable oil. Through their Oil Fortification Initiative which adds vitamins A, D, and E to domestically-manufactured cooking oils, Cargill has provided increased nutrition to 99 percent of the Indian population.

Cooking oil is a very suitable food for fortification with vitamin A since it is widespread in private and commercial use. In addition, the fortification process requires no special equipment, as vitamin A itself is an oil in its natural state shows good heat stability in frying and storage, and is readily miscible with other oils and fats.

Fat soluble micronutrients can be added to oil, i.e. vitamins A, D, E, and K. WFP recommends to add 30,000 IU vitamin A/kg and 3,000 IU vitamin D/kg.

### **Adding the fortificant in the vegetable oil**

Mixing liquids with liquids is relatively easy, a container (e.g. a big tank) can be used to put oil (e.g. by pump) and to mix the correct quantity of vitamin mix in it by rotary stainless mixer or the tank can be equipped with a screw or blade adapted to liquid mixing.

### **Fortificant losses during storage:**

Studies demonstrated that after 18 months of storage in dark sealed containers losses of more than half of the vitamin content were experienced.

When storage was not carried out in the dark, most of the vitamin content was lost after 6 months. **Packaging of the fortified oil in opaque containers** was therefore demonstrated to be a critical consideration.

Vitamin A fortified oil showed good vitamin retention after 5 months of storage in sealed metal containers at high temperature and humidity

### **Enriched juices and health drinks**

# Chapter 7

## Organic and GM foods

### ORGANIC FOOD

Organic foods are produced using methods of organic farming. Currently, the European Union, the United States, Canada, Mexico, Japan and many other countries require producers to obtain special certification in order to market food as organic within their borders.

In general organic farming responds to site-specific farming and crop conditions by integrating cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity. Synthetic pesticides and chemical fertilizers are not allowed, although certain organically approved pesticides may be used under limited conditions. In general, organic foods are also not processed using irradiation, industrial solvents, or chemical food additives.

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While there may be some differences in the amounts of nutrients and anti-nutrients when organically produced food and conventionally produced food are compared, the variable nature of food production and handling makes it difficult to generalize results, and there is insufficient evidence to make claims that organic food is safer or healthier than conventional food. Claims that organic food tastes better are generally not supported by evidence.

### **Meaning and origin of the term**

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For the vast majority of its history, agriculture can be described as having been organic; only during the 20th century was a large supply of new chemicals introduced to the food supply. The organic farming movement arose in the 1940s in response to the industrialization of agriculture known as the Green Revolution.

In 1939, Lord Northbourne coined the term *organic farming* in his book *Look to the Land* (1940), out of his conception of "the farm as organism," to describe a holistic, ecologically

balanced approach to farming—in contrast to what he called *chemical farming*, which relied on "imported fertility" and "cannot be self-sufficient nor an organic whole." Early soil scientists also described the differences in soil composition when animal manures were used as "organic", because they contain carbon compounds where superphosphates and haber process nitrogen do not. Their respective use effects humus content of soil. Properly used in this agricultural science context, "organic" refers to the methods grown and processed, not necessarily the chemical composition of the food.

Ideas that organic food could be healthier and better for the environment originated in the early days of the organic movement as a result of publications like the 1943 book, *The Living Soil. Gardening and Farming for Health or Disease*,

Early consumers interested in organic food would look for non-chemically treated, non-use of unapproved pesticides, fresh or minimally processed food. They mostly had to buy directly from growers. Later, "Know your farmer, know your food" became the motto of a new initiative instituted by the USDA in September 2009. Personal definitions of what constituted "organic" were developed through firsthand experience: by talking to farmers, seeing farm conditions, and farming activities. Small farms grew vegetables (and raised livestock) using organic farming practices, with or without certification, and the individual consumer monitored.

Small specialty health food stores and co-operatives were instrumental to bringing organic food to a wider audience. As demand for organic foods continued to increase, high volume sales through mass outlets such as supermarkets rapidly replaced the direct farmer connection. Today there is no limit to organic farm sizes and many large corporate farms currently have an organic division. However, for supermarket consumers, food production is not easily observable, and product labeling, like "certified organic", is relied on. Government regulations and third-party inspectors are looked to for assurance.

In the 1970s, interest in organic food grew with the publication of *Silent spring* and the rise of the environmental movement, and was also spurred by food-related health scares like the concerns about Alar that arose in the mid-1980s.

### **Public perception of organic foods**

There is widespread public belief, promoted by the organic food industry, that organic food is safer, more nutritious, and tastes better than conventional food. These beliefs have fueled increased demand for organic food despite higher prices and difficulty in confirming these claimed benefits scientifically.

Psychological effects such as the “halo” effect, which are related to the choice and consumption of organic food, are also important motivating factors in the purchase of organic food. In China the increasing demand for organic products of all kinds, and in particular milk, baby food and infant formula, has been "spurred by a series of food scares, the worst being the death of six children who had consumed baby formula laced with melamine" in 2009 and the 2008 Chinese milk scandal, making the Chinese market for organic milk the largest in the world as of 2014. A Research Centre survey in 2012 indicated that 41% of Chinese consumers thought of food safety as a very big problem, up by three times from 12% in 2008.

### **Taste**

A 2002 review concluded that in the scientific literature examined, “While there are reports indicating that organic and conventional fruits and vegetables may differ on a variety of sensory qualities, the findings are inconsistent.” There is evidence that some organic fruit is drier than conventionally grown fruit; a slightly drier fruit may also have a more intense flavor due to the higher concentration of flavoring substances.

Some foods, such as bananas, are picked when unripe, are cooled to prevent ripening while they are shipped to market, and then are induced to ripen quickly by exposing them to propylene or ethylene, chemicals produced by plants to induce their own ripening; as flavor and texture changes during ripening, this process may affect those qualities of the treated fruit. The issue of ethylene use to ripen fruit in organic food production is contentious because ripeness when picked often does affect taste; opponents claim that its use benefits only large companies and that it opens the door to weaker organic standards.

### **Chemical composition**

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With respect to chemical differences in the composition of organically grown food compared with conventionally grown food, studies have examined differences in nutrients, antinutrients, and pesticide residues. These studies generally suffer from confounding variables, and are

difficult to generalize due to differences in the tests that were done, the methods of testing, and because the vagaries of agriculture affect the chemical composition of food; these variables include variations in weather (season to season as well as place to place); crop treatments (fertilizer, pesticide, etc.); soil composition; the cultivar used, and in the case of meat and dairy products, the parallel variables in animal production. Treatment of the foodstuffs after initial gathering (whether milk is pasteurized or raw), the length of time between harvest and analysis, as well as conditions of transport and storage, also affect the chemical composition of a given item of food. Additionally, there is evidence that organic produce is drier than conventionally grown produce; a higher content in any chemical category may be explained by higher concentration rather than in absolute amounts.

### **Nutrients**

A 2014 meta-analysis of 343 studies, found that organically grown crops had 17% higher concentrations of polyphenols than conventionally grown crops. Concentrations of phenolic acids, flavanones, stilbenes, flavones, flavonols, and anthocyanins were elevated, with flavanones being 69% higher.

A 2012 survey of the scientific literature did not find significant differences in the vitamin content of organic and conventional plant or animal products, and found that results varied from study to study.<sup>[5]</sup> Produce studies reported on ascorbic acid (Vitamin C) (31 studies), beta-carotene (a precursor for Vitamin A) (12 studies), and alpha-tocopherol (a form of Vitamin E) (5 studies) content; milk studies reported on beta-carotene (4 studies) and alpha-tocopherol levels (4 studies). Few studies examined vitamin content in meats, but these found no difference in beta-carotene in beef, alpha-tocopherol in pork or beef, or vitamin A (retinol) in beef. The authors analyzed 11 other nutrients reported in studies of produce. Only 2 nutrients were significantly higher in organic than conventional produce: phosphorus and total polyphenols).

Similarly, organic chicken contained higher levels of omega-3 fatty acids than conventional chicken. The authors found no difference in the protein or fat content of organic and conventional raw milk.

### **Anti-nutrients**

The amount of nitrogen content in certain vegetables, especially green leafy vegetables and tubers, has been found to be lower when grown organically as compared to conventionally. When evaluating environmental toxins such as heavy metals, the USDA has noted that organically raised chicken may have lower arsenic levels, while early literature reviews found no significant evidence that levels of arsenic, cadmium or other heavy metals differed significantly between organic and conventional food products. However, a 2014 review found lower concentrations of cadmium, particularly in organically grown grains.

### **Pesticide residues**

The 2012 meta-analysis determined that detectable pesticide residues were found in 7% of organic produce samples and 38% of conventional produce samples. This result was statistically heterogeneous, potentially because of the variable level of detection used among these studies. Only three studies reported the prevalence of contamination exceeding maximum allowed limits; all were from the European Union. A 2014 meta-analysis found that conventionally grown produce was four times more likely to have pesticide residue than organically grown crops.

The American Cancer Society has stated that no evidence exists that the small amount of pesticide residue found on conventional foods will increase the risk of cancer, though it recommends thoroughly washing fruits and vegetables. They have also stated that there is no research to show that organic food reduces cancer risk compared to foods grown with conventional farming methods.

The Environmental Protection Agency has strict guidelines on the regulation of pesticides by setting a tolerance on the amount of pesticide residue allowed to be in or on any particular food.

### **Bacterial contamination**

The 2012 meta-analysis determined that prevalence of *E. coli* contamination was not statistically significant (7% in organic produce and 6% in conventional produce). Four of the five studies found higher risk for contamination among organic produce. When the authors removed the one study (of lettuce) that found higher contamination among conventional produce, organic produce had a 5% greater risk for contamination than conventional alternatives. While bacterial contamination is common among both organic and conventional animal products, differences in

the prevalence of bacterial contamination between organic and conventional animal products were statistically insignificant.

### **Health and safety**

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There is no scientific evidence of benefit or harm to human health from a diet high in organic food, and conducting any sort of rigorous experiment on the subject is very difficult; a 2012 meta-analysis noted that "there have been no long-term studies of health outcomes of populations consuming predominantly organic versus conventionally produced food controlling for socioeconomic factors; such studies would be expensive to conduct." A 2009 meta-analysis noted that "Most of the included articles did not study direct human health outcomes. In ten of the included studies (83%), a primary outcome was the change in antioxidant activity. Antioxidant status and activity are useful biomarkers but do not directly equate to a health outcome. Of the remaining two articles, one recorded proxy-reported measures of atopic manifestations as its primary health outcome, whereas the other article examined the fatty acid composition of breast milk and implied possible health benefits for infants from the consumption of different amounts of conjugated linoleic acids from breast milk." In addition, as discussed above, difficulties in accurately and meaningfully measuring chemical differences between organic and conventional food make it difficult to extrapolate health recommendations based solely on chemical analysis.

With regard to the possibility that some organic food may have higher levels of certain antioxidants, evidence regarding whether increased anti-oxidant consumption improves health is conflicting.

As of 2012, the scientific consensus is that while "consumers may choose to buy organic fruit, vegetables and meat because they believe them to be more nutritious than other food.... the balance of current scientific evidence does not support this view." A 12-month systematic review commissioned by the FSA in 2009 and conducted at the London School of Hygiene & Tropical Medicine based on 50 years' worth of collected evidence concluded that "there is no good evidence that consumption of organic food is beneficial to health in relation to nutrient content." There is no support in the scientific literature that the lower levels of nitrogen in certain organic vegetables translates to improved health risk.

## **Economics**

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1. Demand for organic foods is primarily driven by concerns for personal health and for the environment. Global sales for organic foods climbed by more than 170 percent since 2002 reaching more than \$63 billion in 2011 while certified organic farmland remained relatively small at less than 2 percent of total farmland under production, increasing in OECD and EU countries (which account for the majority of organic production) by 35 percent for the same time period. Organic products typically cost 10 to 40% more than similar conventionally produced products, to several times the price. Processed organic foods vary in price when compared to their conventional counterparts.

While organic food accounts for 1–2% of total food production worldwide, the organic food sales market is growing rapidly with between 5 and 10 percent of the food market share in the United States according to the Organic Trade Association, significantly outpacing sales growth volume in dollars of conventional food products.

## **GM FOODS**

Genetically-modified foods (GM foods) are in news now a days for various reasons. European environmental organizations and public interest groups have been actively protesting against GM foods for months, and recent controversial studies about the effects of genetically-modified corn pollen on monarch butterfly caterpillars have brought the issue of genetic engineering to the forefront of the public consciousness in the U.S.

### **Definition**

The term GM foods or GMOs (genetically-modified organisms) is most commonly used to refer to crop plants created for human or animal consumption using the latest molecular biology techniques. These plants have been modified in the laboratory to enhance desired traits such as increased resistance to herbicides or improved nutritional content. The enhancement of desired traits has traditionally been undertaken through breeding, but conventional plant breeding methods can be very time consuming and are often not very accurate. Genetic engineering, on the other hand, can create plants with the exact desired trait very rapidly and with great accuracy. For example, plant geneticists can isolate a gene responsible for drought tolerance and insert that

gene into a different plant. The new genetically-modified plant will gain drought tolerance as well. Not only can genes be transferred from one plant to another, but genes from non-plant organisms also can be used. The best known example of this is the use of B.t. genes in corn and other crops. B.t., or *Bacillus thuringiensis*, is a naturally occurring bacterium that produces crystal proteins that are lethal to insect larvae. B.t. crystal protein genes have been transferred into corn, enabling the corn to produce its own pesticides against insects such as the European corn borer.

### **Advantages of GM foods**

The world population has topped 6 billion people and is predicted to double in the next 50 years. Ensuring an adequate food supply for this booming population is going to be a major challenge in the years to come. GM foods promise to meet this need in a number of ways:

- **Pest resistance** Crop losses from insect pests can be staggering, resulting in devastating financial loss for farmers and starvation in developing countries. Farmers typically use many tons of chemical pesticides annually. Consumers do not wish to eat food that has been treated with pesticides because of potential health hazards, and run-off of agricultural wastes from excessive use of pesticides and fertilizers can poison the water supply and cause harm to the environment. Growing GM foods such as B.t. corn can help eliminate the application of chemical pesticides and reduce the cost of bringing a crop to market.

- **Herbicide tolerance** For some crops, it is not cost-effective to remove weeds by physical means such as tilling, so farmers will often spray large quantities of different herbicides (weed-killer) to destroy weeds, a time-consuming and expensive process, that requires care so that the herbicide doesn't harm the crop plant or the environment. Crop plants genetically-engineered to be resistant to one very powerful herbicide could help prevent environmental damage by reducing the amount of herbicides needed. For example, Monsanto has created a strain of soybeans genetically modified to be not affected by their herbicide product Roundup ®. A farmer grows these soybeans which then only require one application of weed-killer instead of multiple applications, reducing production cost and limiting the dangers of agricultural waste run-off.

- **Disease resistance** There are many viruses, fungi and bacteria that cause plant diseases. Plant biologists are working to create plants with genetically-engineered resistance to these diseases.

- **Cold tolerance** Unexpected frost can destroy sensitive seedlings. An antifreeze gene from cold water fish has been introduced into plants such as tobacco and potato. With this antifreeze gene, these plants are able to tolerate cold temperatures that normally would kill unmodified seedlings.

- **Drought tolerance/salinity tolerance** As the world population grows and more land is utilized for housing instead of food production, farmers will need to grow crops in locations previously unsuited for plant cultivation. Creating plants that can withstand long periods of drought or high salt content in soil and groundwater will help people to grow crops in formerly inhospitable places

- **Nutrition** Malnutrition is common in third world countries where impoverished peoples rely on a single crop such as rice for the main staple of their diet. However, rice does not contain adequate amounts of all necessary nutrients to prevent malnutrition. If rice could be genetically engineered to contain additional vitamins and minerals, nutrient deficiencies could be alleviated. For example, blindness due to vitamin A deficiency is a common problem in third world countries. Researchers at the Swiss Federal Institute of Technology Institute for Plant Sciences have created a strain of "golden" rice containing an unusually high content of beta-carotene (vitamin A). Since this rice was funded by the Rockefeller Foundation<sup>14</sup>, a non-profit organization, the Institute hopes to offer the golden rice seed free to any third world country that requests it. Plans were underway to develop a golden rice that also has increased iron content.

- **Pharmaceuticals** Medicines and vaccines often are costly to produce and sometimes require special storage conditions not readily available in third world countries. Researchers are working to develop edible vaccines in tomatoes and potatoes. These vaccines will be much easier to ship, store and administer than traditional injectable vaccines.

- **Phytoremediation** Not all GM plants are grown as crops. Soil and groundwater pollution continues to be a problem in all parts of the world. Plants such as poplar trees have been genetically engineered to clean up heavy metal pollution from contaminated soil.

## **Human health risks**

### *Allergenicity*

Many children in the US and Europe have developed life-threatening allergies to peanuts and other foods. There is a possibility that introducing a gene into a plant may create a new allergen or cause an allergic reaction in susceptible individuals. A proposal to incorporate a gene from Brazil nuts into soybeans was abandoned because of the fear of causing unexpected allergic reactions. Extensive testing of GM foods may be required to avoid the possibility of harm to consumers with food allergies. Labeling of GM foods and food products will acquire new importance, which I shall discuss later.

### *Unknown effects on human health*

There is a growing concern that introducing foreign genes into food plants may have an unexpected and negative impact on human health. A recent article published in *Lancet* examined the effects of GM potatoes on the digestive tract in rats. This study claimed that there were appreciable differences in the intestines of rats fed GM potatoes and rats fed unmodified potatoes. Yet critics say that this paper, like the monarch butterfly data, is flawed and does not hold up to scientific scrutiny. Moreover, the gene introduced into the potatoes was a snowdrop flower lectin, a substance known to be toxic to mammals. The scientists who created this variety of potato chose to use the lectin gene simply to test the methodology, and these potatoes were never intended for human or animal consumption.

On the whole, with the exception of possible allergenicity, scientists believe that GM foods do not present a risk to human health.