

A Manual On

Functional FOODS



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INTRODUCTION



The primary role of diet is to provide sufficient nutrients to meet the nutritional requirements of an individual. There is now increasing scientific evidence to support the hypothesis that some foods and food components have beneficial physiological and psychological effects over and above the provision of the basic nutrients. Today, nutrition science has moved on from the classical concepts of avoiding nutrient deficiencies and basic nutritional adequacy to the concept of "positive" or "optimal" nutrition.

The research focus has shifted more to the identification of biologically active components in foods that have the potential to optimize physical and mental well being and which may also reduce the risk of disease. Many traditional food products including fruits, vegetables, soya, whole grains and milk have been found to contain components with potential health benefits. In addition to these foods, new foods are being developed to enhance or incorporate these beneficial components for their health benefits or desirable physiological effects.

The concept of functional foods was born in Japan. Generally, they are considered as those foods which are intended to be consumed as part of the normal diet and that contain biologically active components which offer the potential of enhanced health or reduced risk of disease. Examples of functional foods include foods that contain specific minerals, vitamins, fatty acids or dietary fiber, foods with added biologically active substances such as phytochemicals or other antioxidants and probiotics that have live beneficial cultures.

As interest in this category of foods has grown, new products have appeared and interest has turned to the development of standards and guidelines for the development and promotion of such foods. There is already a wide range of foods available to today's consumer but now the

impetus is to identify those functional foods that have the potential to improve health and well-being, reduce the risk from, or delay the onset of, major diseases such as cardiovascular disease (CVD), cancer and osteoporosis. Combined with a healthy lifestyle, functional foods can make a positive contribution to health and well being.

Functional foods offer great potential to improve health and/or help prevent certain diseases when taken as part of a balanced diet and healthy lifestyle. The research opportunities in nutrition to explore the relationship between a food or a food component and an improved state of health and well-being, or reduction of disease, present the greatest challenge to scientists now and in the future. The communication of health benefits to consumers is also of critical importance so that they have the knowledge to make informed choices about the foods they eat and enjoy.

CHAPTER 1

CEREALS



Cereal-based food products have been the basis of the human diet since ancient times. Dietary guidelines all over the world are recommending the inclusion of whole grains because of the increasing evidence that whole grains and whole-grain-based products have the ability to enhance health beyond the simple provision of energy and nutrients. In this review we will examine the main chemical components present in whole grains that may have health enhancing properties (dietary fiber, inulin, beta-glucan, resistant starch, carotenoids, phenolics, tocotrienols, and tocopherols) and the role that whole grains may play in disease prevention (cardiovascular diseases and strokes, hypertension, metabolic syndrome, type 2 diabetes mellitus, obesity, as well as different forms of cancer). The knowledge derived from the functional properties of the different chemical components present in whole grains will aid in the formulation and development of new food products with health enhancing characteristics.

OATS

Oats (*Avena sativa* L.) have received considerable attention for their high content of dietary fibres, phytochemicals and nutritional value. It is believed that consumption of oats possesses various health benefits such as hypocholesterolaemic and anticancerous properties. Oats have also recently been considered suitable in the diet of celiac patients. Owing to their high nutritional value, oat-based food products like breads, biscuits, cookies, probiotic drinks, breakfast cereals, flakes and infant food are gaining increasing consideration. Oat consumption in human diet has been increased because of health benefits associated with dietary fibres such as β -glucan, functional protein, lipid and starch components and phytochemicals present in the oat grain. Oats also contain a varied range of phenolic compounds including ester linked glycerol conjugates, ester linked alkyl conjugates, ether and ester linked glycerides, anthranilic acids and avenanthramides (AVAs). These compounds possess high level of antioxidant activity. Oat is a good source of phenolic compounds. These phenolic compounds may contribute to the functional and nutritional properties of the grain. The major phenolic acids in oats are ferulic, p-coumaric, caffeic, vanillic, hydroxybenzoic acid and their derivatives. Oat fibre has been associated with reduced risk of heart diseases. The hypocholesterolemic effect of oats is attributed to β -glucan; two hypotheses for possible mechanisms are suggested; first, the intestinal viscosity effect of β -glucan which is believed to increase the thickness of the unstirred layer of the small intestine, slowing and inhibiting the absorption of lipids and cholesterol. The second mechanism of action hypothesized is that β -glucan causes binding of bile acids in the intestine causing them to be excreted in faecal waste. Oat bran is a dietary fiber and β -glucan enriched oat fraction that can be used in products aiming towards improved nutritional status

Whole wheat

The health promoting effects of whole wheat or whole wheat based products are mainly due to the presence of phytochemicals in wheat, including phenolic, carotenoids, lignans and vitamin E. Each of these phytochemicals in combination or alone accelerates health promoting events. Several past studies have shown the effectiveness of polyphenols against oxidative stress and dietary fibre against cancer. The phytosterols are mainly located in the wheat kernel. Phytosterols have been shown to reduce low-density lipoprotein cholesterol and may have a promising effect against cancer. Wheat phenolics include the phenolic acids, flavonoids, and alkylresorcinols. Ferulic acid (main phenolic acid in wheat), caffeic acid, sinapic acid,

protocatechuic acid, vanillic acid, p-hydroxybenzoic acids, p-coumaric acid, and syringic acid are some phenolic acids present in wheat bran and whole wheat flour. Phenolic acids are mainly known for their antioxidative properties.

Whole wheat is a rich source of dietary fibres that include a non-starch polysaccharide, resistant starches, sugar alcohols, and oligosaccharides. It has been shown that oligosaccharide alone or in combination with probiotics significantly reduced colonic aberrant crypt foci and tumors induced azoxymethane. Phytosterols, phenolics, and selenium shown in whole wheat have anticancer effects. Some compounds act as antioxidants, locking up minerals and trace element capable of producing free radicals from fats. Phenolics present in the whole wheat can act as antibiotics or antioxidants. The presence of the orthophenolics in wheat was correlated significantly with tumour inhibition .The metabolism of lignans (di-phenolics found in whole wheat) has been also been correlated with a reduced risk of breast cancer. Dimethyl benzoquinone (found in wheat germ) was shown to be effective as an anticancer agent in the rodent colon cancer model at low concentration.

Ferulic acid has a high anti-oxidative activity and is also actively involved in the production of insoluble dietary fibre. The inhibitory activities of the ferulic acid against carcinogenic diseases has been attributed to the prevention of the formation of carcinogen compound from precursor compound and the blockage of the reaction of carcinogen with cellular macromolecules. Serum low density lipoprotein (LDL) cholesterol (major risk factor for CHD) was reported to decrease with increased intake of soluble fibre, plant sterols and higher intake of whole wheat .Whole wheat flour has been able to improve glycaemic control and insulin sensitivity, decrease blood pressure and produce a healthy body mass index (BMI) . The mechanism for the above response was due to the presence of bran, which decreased glucose absorption and produced SCFA from the fermentation of resistant carbohydrates, which in turn improved insulin sensitivity.

BARLEY

Barley (*Hordeum vulgare* L.) has been commonly cultivated for centuries due to its versatility, ability to adapt to unfavorable climate and soil conditions, and superior properties for the malting and brewing industries. The increased interest in barley as a human food ingredient

results from studies that have shown barley to be an excellent source of dietary fibre and, in particular, β -glucan. The health effects of barley have been primarily attributed to the dietary fibre fraction, particularly β -glucan. Water-soluble dietary fibre can form viscous solutions, thus reducing the intestinal transit at the intestine level, delaying gastric emptying and slowing glucose and sterol absorption by the intestine, thus lowering the serum cholesterol, postprandial blood glucose and insulin levels. Insoluble dietary fibres usually have a high water holding capacity, which contributes to increased fecal bulk.

Barley is rich in functional ingredients, such as gamma-aminobutyric acid (GABA), flavonoids, saponarin, lutanarin, superoxide dismutase (SOD), K, Ca, Se, tryptophan, chlorophyll, vitamins (A,B1,C,E), dietary fibre, polysaccharide, alkaloid, metallothioneins, polyphenols and others. Barley grass promotes sleep, anti-diabetes, regulating blood pressure, enhancing immunity, protective liver, beauty anti-acne/detox, antidepressant, improving gastrointestinal function, anti-cancer, anti-inflammation, antioxidants, hypolipidemic, anti-gout, reduce hyperuricemia, preventive antihypoxia, cardiovascular diseases, antifatigue, preventive constipation, alleviated atopic dermatitis, preventive heart disease, calcium supplement, improving cognition and so on. Barley may be one of the best functional foods for preventive chronic diseases and the best raw material of modern diet structure for promoting the development of large health industry, further reveals GABA, flavonoids, SOD, K-Ca, vitamins and tryptophan mechanism in preventive and therapeutic role of barley for chronic diseases

RAGI

Ragi is a staple food for majority of the population in some parts of India and in other developing countries. Finger millet has gained importance because of its functional components such as slowly digestible starch and resistant starch. The composite flour of ragi and wheat appears not only improve the nutritional quality but promote the health benefits. Finger millet stands unique among the cereals such as barley, rye and oats with higher nutritional contents and has outstanding properties as a subsistence food crop. It is rich in calcium (0.34%), dietary fiber (18%), phytates (0.48%), protein (6%–13%) minerals (2.5%–3.5%), and phenolics (0.3%–3%). Moreover, it is also a rich source of thiamine, riboflavin, iron, methionine, isoleucine, leucine, phenylalanine and other essential amino acids. The abundance of these phytochemicals enhances the nutraceutical potential of finger millet, making it a powerhouse of health benefiting nutrients.

It has distinguished health beneficial properties, such as anti-diabetic (type 2 diabetes mellitus), anti-diarrheal, antiulcer, anti-inflammatory, antitumorogenic (K562 chronic myeloid leukemia), atherosclerogenic effects, antimicrobial and antioxidant properties.

The tiny millet grain has a dark brown seed coat, richer in polyphenols compared to other continental cereals such as barley, rice, maize and wheat. In recent years, finger millet has gained importance, because of its nutritional strength in terms of dietary and functional fiber, starch pattern, as well as high calcium and iron contents. The calcium and iron contents in finger millet varieties have been reported to be 220–450 and 3–20%, respectively

MAIZE

Maize (*Zea mays* L.) is an important cereal grain in the world, providing nutrients for humans and animals. Corn provides many health benefits due to the presence of quality nutrients within. Besides being a delicious addition to any meal, it is rich in phytochemicals and provides protection against a number of chronic diseases. Fiber in maize aids in alleviating digestive problems such as constipation and hemorrhoids, Corn is rich in vitamin B constituents, especially thiamin and niacin. Thiamin is essential for maintaining nerve health and cognitive function as well as lowering the risk of colon cancer due to corn being a whole-grain. Corn is also a good source of pantothenic acid, which is an essential vitamin for carbohydrate, protein, and lipid metabolism in the body. Corn provides a large percentage of the daily folate requirement. The kernels of corn are rich in vitamin E, a natural antioxidant that is essential for growth and protection of the body from illness and diseases. Corn contains abundant minerals which positively benefit the body in a number of ways. Phosphorous, along with magnesium, manganese, zinc, iron, and copper are found in all varieties of corn. It also contains trace minerals like selenium, which are difficult to find in most normal diets. Phosphorous is essential for regulating normal growth, bone health, and optimal kidney functioning. Magnesium is necessary for maintaining a normal heart rate and for increasing bone mineral density.

Corn is a rich source of antioxidants which fight cancer-causing free radicals. It is a rich source of a phenolic compound called ferulic acid, an anti-carcinogenic agent that has been shown to be effective in fighting tumors that lead to breast and liver cancer. Anthocyanins, found in purple corn, also act as scavengers and eliminators of cancer-causing free radicals.

Antioxidants have been shown to reduce many of the dangerous forms of cancer because of their ability to induce apoptosis in cancerous cells while leaving healthy cells unaffected. Corn helps to prevent anemia caused by a deficiency of these vitamins. It also has a significant level of iron, which is one of the essential minerals needed to form new red blood cells; a deficiency of iron is one of the main causes of anemia as well. Yellow corn is a rich source of beta-carotene, which forms vitamin A in the body and is essential for the maintenance of good vision and skin. Beta-carotene is a great source of vitamin A because it is converted within the body according to the amount required by the body. Vitamin A can be toxic if too much is consumed, so deriving it through beta-carotene transformation is ideal. It will also benefit the health of skin and mucus membranes, as well as boost the immune system.

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CHAPTER 2

PULSES AND LEGUMES



Pulses constitute an important source of several substances needed for good health, as photochemical and natural bioactive compounds. These grains are very high in nutrients; rich with protein, complex carbohydrates, soluble dietary fiber, and can be stored for months without losing their high nutritional value. Pulses are incorporated into a healthy, balanced diet, to fight against obesity but also to prevent and treat chronic diseases such as diabetes, cardiovascular diseases and cancer. The functional properties of some commonly used pulses and legumes are discussed below:

Bengal gram

Bengal Gram, also better known as dark brown peas or chana, is widely regarded as an important pulse, owing to its nutritional properties. It contains a good amount of iron, sodium and selenium in addition to small doses of manganese, copper and zinc. A handful of Bengal gram is a very good source of fibre and folic acid.

Serves as an energy booster

Bengal gram helps increase the total energy in the body, which is why it is fed to horses too. Chana is the richest source of proteins in legumes and hence helps fuel the body. Methionine, a type of amino acid present in chana is beneficial in the proper functioning of the cells.

Restricts diabetes

Bengal gram has beneficial properties that help increase body strength and gives it the added power to absorb more glucose, which helps diabetic patients. Additionally, a handful of this gram will help you build tolerance while also reducing glucose, blood sugar levels as well as other general conditions.

Helps the digestive system

If your digestive system is not functioning properly, it can usually lead to a heap of problems including indigestion, vomiting, dyspepsia and diarrhea, among other ailments. The resistant starch in Bengal gram aids faecal bulking or in other words, prevents constipation. Another benefit of these dark brown chickpeas is that they contain phytochemicals called saponins, which serve as potent antioxidants, thereby helping to keep your system clean.

Treats anemia

Anemia results from iron deficiency. This variety of gram contains rich iron proteins and folate which help in boosting the haemoglobin count.

Controls blood pressure

While intake of low sodium diet is vital for a healthy blood pressure, increasing the potassium intake is important to maintain blood pressure at a balanced level. Chickpeas being high in potassium and low in sodium can actually be helpful to control a proper blood pressure level compared to many other foods. 100 grams of chickpeas contain 875 mg of potassium, all of which can be absorbed into the body.

Maintain heart health

The constituents of chickpeas are highly supportive for a better heart health. High fiber content coupled with Vitamin C, Vitamin B6 and potassium makes it a perfect food for a strong heart. Chickpeas are completely devoid of cholesterol and studies have shown that consuming sufficient amount of chickpeas on a daily basis can effectively reduce the risk of heart diseases.

Chickpeas can help in better brain functioning

Chickpeas have also been related with better learning and memory. The choline content of chickpeas nourishes the nerve cells and it can also be helpful in relieving stress. The all-round ability of chickpeas to promote better bone and brain health makes it an ideal food for growing children.

Chickpeas and cancer prevention

Chickpeas have been found to have extensive cancer fighting properties due to some of its unique constituents. The selenium present in chickpeas promotes proper functioning of the liver, which can be helpful for detoxifying compounds that might cause cancer. In addition to that selenium being anti-inflammatory also controls the growth of cancerous tumors. The folate content of chickpeas helps in synthesis and repairing of DNA, providing protection from cancer formation due to DNA mutation. The phytochemical, saponins present in chickpeas can also prevent multiplication and spread of cancer cells in the body.

Black gram

Black gram is a type of bean grown in the Indian subcontinent, which has a surprising number of health benefits, including its ability to boost energy, protect cardiovascular health, reduce pain and inflammation, improve immunity, aid in maintaining skin health, prevent diabetes, build strong bones, strengthen the nervous system, and optimize digestion. Seeds have high content of carbohydrates, protein, minerals, fat, vitamins, potassium, niacin, calcium, iron, riboflavin and thiamine and amino acids

Digestive health

Consumption of Black gram helps to treat health conditions such as constipation, bloating and indigestion. Black gram has high content of fiber. Fiber is essential to maintain digestive health. It adds bulk to stools which assist passage of waste through intestinal tract.

Heart health

Consume black gram and foods rich in fiber to ensure heart health. Evidence shows that foods rich in fiber such as black gram lower the level of blood cholesterol. High level of cholesterol is the major risk factor in heart attack, stroke and atherosclerosis. It contains folate which is associated with lower risk of heart disease. It contains adequate amounts of magnesium and iron which promotes blood circulation in the body.

Treatment for diabetes

Black gram is rich in fiber which is beneficial to maintain blood sugar. Fiber helps to regulate the absorption of nutrients which maintains balance in glucose and sugar amount in blood.

Relieve inflammation

Black gram is used in Ayurvedic medicine as it is able to soothe inflammation and provides relief from pain. Black gram contains wide range of nutrients which eases internal inflammation and also lowers oxidative stress in body. Black gram assist internal inflammatory conditions and extract prepared with black gram is applied topically for dealing painful muscles and joints. Apply it to aching joints to get faster relief.

Skin health

Black gram in powdered form is used in India to keep the skin look fresh and make it supple. It has nourishing properties which assist to rejuvenate tired and sallow looking skin. It is useful for treating skin problems such as age spots, sun damage, acne and wrinkles. It is used for exfoliating skin and when combined with lemon juice, it makes natural bleach which could lighten skin.

Nervous problems

Black gram is helpful for dealing nervous associated problems such as hysteria, nervous weakness memory weakness and schizophrenia. Though the consumption of black gram could not treat these conditions completely, it could provide relief from these problems. Being a great source of minerals and vitamins, it is helpful to maintain good health and also refresh the mind.

Build muscles

Black gram is helpful for those who want to improve muscle health. Being a rich source of protein, it is an ideal choice for developing and strengthening whole body by stimulating muscle tissue build. Both men and women are advised to consume black gram daily for improving muscles and keep it stronger and attractive.

Cowpea

Cowpeas are not only versatile and delicious, but also important for human health, offering a number of benefits, such as their ability to improve digestion, aid sleep disorders, manage diabetes, protect the heart, detoxify the body, promote healthy skin, aid in weight loss, and strengthen circulation.

Good for pregnant ladies

Cowpea possesses folate (Vitamin B9) which assists in lowering the chances of neural tube defects like anencephaly or spina bifida. The deficiency of folate leads to the birth defects such as malformations of limb and heart. Folate is also essential for the replication of DNA because the fetus cells could not grow without the presence of folate. This is an essential vitamin that is necessary for having a healthy pregnancy. The pregnant women should consume the prenatal vitamin so that they would consume the adequate amount of folate.

Prevents Anemia

Cowpeas possess the mineral (Iron) in high amount which eliminates the anemia. Iron assists in the protein metabolism which is essential for the RBCs and hemoglobin production and also inhibits anemia.

Supports a Healthy Metabolism

Potassium, copper, various antioxidants and folate assist to maintain the metabolism health in the people who intake the cowpeas daily. Copper acts as an essential part in functioning 50 different reactions of metabolic enzymes in the body. The reactions of enzymes are vital to maintain the smooth functioning of metabolism.

Helps Maintain Strong Bones

Cowpeas possess the calcium and phosphorus which is a vital mineral to maintain the strength and structure of bones. Manganese assists in the formation of bones by regulating the enzymes and hormones which is involved in the process of bone metabolism. Phosphorus assists in the mineral density of bones that forbids the bone break, fracture and osteoporosis. Cowpeas contain 4% calcium, 38% phosphorus and 35% manganese.

Encourages Mental Well-being

Cowpea possesses tryptophan which is effective for treating disorders of social anxiety, insomnia and provides a sound sleep. It assists the neurotransmitters which maintain the level of energy, control mood and appetite.

Helps heal and repair muscle tissue

Cowpeas contain isoleucine which assist to raise the endurance and also fixes the tissue in the muscles and promotes the clotting of the injury. The presences of amino acids enhance the energy. Valine, isoleucine and leucine are three chain of amino acid which enhances the recovery of muscles. It also stabilizes the blood sugar. 0.53 grams Isoleucine, 1.01 grams leucine and 0.63 grams Valine is obtained in one cup of cooked cowpeas.

Helps maintain bowel health

The cowpeas possess dietary fibers which promote and soften the stool. It reduces the constipation with the easy flow of bulky stool.

Supports a Healthy Cardiovascular System

The recent studies summarize that thiamine counteracts with the heart diseases and maintains the healthy function of ventricles which cures the heart failure. Adding vitamin B1 rich food Cowpeas to your diet may help to prevent cardiovascular diseases.

Supports Immune system

Cowpeas possess threonine which may assist the immune system by promoting the antibodies production. The threonine produces the serine and glycine which is essential for the collagen, muscle tissue and elastin production. It maintains the healthy and strong connective muscles and tissues. Cowpeas which are rich in threonine may help to boost your Immune system

Green gram

Green gram is also known as the mung bean. Mung beans possess enzymes, nutrients and antioxidants which are essential for maintaining good health. The presence of medicinal properties in the Mung beans assists to enhance the health. It is good for the health of eyes, hair, nails and liver. It also enhances the blood circulation. It is loaded with high amount of fiber and low in calories. Mung beans are used in traditional Chinese medicine for the therapeutic uses such as to detoxify body and eliminate heat.

Prevents heart ailments

Mung beans have the ability to reduce bad cholesterol levels. It assists to regulate the level of cholesterol as its antioxidants eliminates free radicals, repairs the damage of blood vessels and reduce inflammation. Strokes and heart attacks are the cause of oxidized LDL cholesterol. Mung beans help to clear arteries and enhance circulation.

Prevents cancer

Mung beans possess high amount of polyphenols and oligosaccharides that assist to eliminate the development of cancer. The clinical studies show that it possesses anti-tumor properties which prevent DNA damage and mutation of dangerous cells.

Prevents Type 2 diabetes

The Mung beans possess an anti-diabetic effect which helps to treat the type 2 diabetes. The study conducted by The Institute of Crop Sciences shows that when the Mung bean supplement was provided to the rats, their blood glucose, glucagon, plasma C-peptide, triglyceride level and total cholesterol was decreased but at the same time their glucose tolerance was improved with the rise in insulin responsiveness.

Enhance immunity

The phytonutrients found in Mung beans acts as an anti-inflammatory and anti-microbia which assists to enhance immunity and counteract the harmful bacteria, colds, viruses, irritation, rashes etc. Mung beans enhance the absorption of nutrients as well as immune defense.

Enhance foetal development

Folate is essential for the DNA synthesis, tissue and cell growth, cognitive function, balance hormones and reproduction. The adequate consumption of folate is vital during pregnancy which helps to prevent neural tube defects, prevent early births and termination.

Helps to lose weight

Mung beans possess high amount of protein and fiber. The researcher reports that the beans which are high in fiber increase the cholecystokinin which is a satiety hormone. The other studies show that the consumption of beans increases the satiety. The daily intake of Mung beans lowers the food intake which enhances weight loss.

Reduce PMS(Pre Menstrual Syndrome)

Mung beans are loaded with Vitamin B6, Vitamin B and folate which helps to control the fluctuations of hormone that leads to PMS symptoms. These assist to reduce the severity and pain related to the PMS cramps, mood swings, headaches, muscle pains and fatigue.

Assist digestion

Mung beans are easy to digest and also help to detoxify the body. As they are rich in fiber, it assists in digestion and prevents the IBS symptoms such as constipation. In India, Mung beans

are cooked with turmeric, coriander, cumin and ginger which help to add taste as well as eliminate the stomach pains.

Horse gram

Horse gram is a miracle super food and the food is widely consumed as a staple diet in the southern parts of India. Horse gram is regarded as the protein-rich lentil found on the planet. It can benefit with a number of health issues since it is a grain that contains a good as well as rich quantity of vitamins, proteins, as well as iron. Along with weight loss, it will help in lowering of excess fat through the body. Horse gram is full of B-complex vitamin and proteins. It will help in purifying menstruation as well as cures and helps prevent arthritis. The existence of adequate dietary fiber within the gram will help balance sugar glucose as well as blood pressure levels. Listed here are some functional properties of horse gram.

Helps relieve menstrual problems

It really is considered that horse gram includes a number of healing qualities that really help cope with menstruation problems. Ladies who are experiencing abnormal periods in addition to extreme bleeding can consume horse gram water regularly or have the option of including horse gram soup or even sprouts on their everyday diet.

Eliminates kidney stones

Kidney stones could be painful and therefore are brought on because of the deposit of oxalates. As a result, it is suggested that an individual struggling with kidney stones need to consume low doses of calcium as well as phosphorus. The reason horse gram is so effective is really because it includes diuretic properties which will help break down kidney stones.

Common Cold and fever

The soup of horse gram is good to prevent common cold, fever, bronchitis as well as asthma. It reduces congestion as well as makes breathing easy. It provides needed nutrition to enhance body immunity in fever and common cold.

Protects against diabetes

Unprocessed raw horse gram seeds consist of useful anti-hyperglycemic qualities which help in the decrease in insulin resistance. As a result, horse gram has become a suggested food for diabetics.

Increase Sperm Counts

Horse gram consists of calcium, phosphorus, iron and amino acid that boosts sperm count. Horse gram sucked out of the dirt from your body.

Antioxidant activity

It is a super food which is rich in protein and antioxidants. Horse gram has high content of protein than other vegetables. As it is a slowly digestible starch, this food is helpful for diabetic patients as well as obese individuals. Horse gram helps to suppress appetite and also stabilize the level of blood sugar. Studies show that antioxidants help to prevent oxidative stress which is occurred when free radical damage destroys healthy cells. Horse gram is also an excellent source of phenolic acids and polyphenols. The plant based chemicals prevent from chronic diseases and cancer.

Prevent constipation

Constipation is the problem in releasing bowels. Constipation is caused due to lack of intake of water lack of fiber in diet, lack of minerals, due to unhealthy lifestyle and stress. Besides powerful nutrients, it contains abundant amounts of fiber which helps to counteract the problems of constipation.

Lentils

Lentils are edible pulses or seeds that belong to the legume family. The health benefits of lentils include a high protein content, improved digestion, a healthy heart, diabetes control, control of cancer, weight loss, a solution for anemia, and better electrolytic activity due to potassium. It is good for pregnant women, the prevention of atherosclerosis, and it helps in maintaining a healthy nervous system.

Good for Muscle Generation

Our organs and muscles need a constant supply of protein for repair and growth of the body. Lentils, especially sprouted lentils, contain all the essential amino acids that are needed by our body for good muscle building and smooth functioning of the body.

Control Diabetes

Dietary fiber filled food such as lentils helps in controlling blood sugar levels. Dietary fiber slows down the rate at which food is absorbed by the blood and thus maintains the sugar level constantly.

Improve Digestion

As lentils contain high levels of dietary fiber, it improves digestion if consumed regularly. It also helps in easy bowel movement, resulting in decreased constipation.

Heart Health

Lentils, with their negligible amounts of fat, are an ideal source of protein without adding any extra fat to the body, thereby promoting a healthy heart. Lentils contain magnesium, which helps in relaxing cardiovascular muscles and help lower blood pressure.

Prevent Atherosclerosis

The consumption of lentils provides a supply of antioxidants that decreased the chances of developing atherosclerosis. Also, these antioxidants play a role in neutralizing free radicals and thereby preventing cell and gene damage (aging).

Good Source of Folic Acid

Lentils are a good source of Vitamin B-complex, such as folate or folic acid. The consumption of folic acid by pregnant woman helps in preventing birth defects. Folate found in lentils helps in the formation of red blood cells, is good for pregnant women, and plays a key role in maintaining homocysteine levels. It is also known to be effective against hypertension and DNA damage, which may result in cancer.

High Iron Content

Lentils contain high amount of iron, which is needed by the body for optimum hemoglobin production. About 36% of the iron of the Daily Recommended value can come from eating 1 cup (200 grams) of lentils every day.

PEAS GREEN

Green Peas are actually tiny powerhouses of nourishment which are a benefit for your health and also the entire planet. Peas are great to have along with dinner if you have an inflammation related illness that ought to be treated from inflammation since the nutrition in peas has got anti-inflammatory qualities. Peas are even far better to consume on a regular basis because of all of the fiber within them that can help drive harmful toxins as well as waste through the digestive system, which will help avoid digestive diseases as well as stomach and colon cancers. Listed are some popular health benefits of consuming sweet peas

Improves your bone health

Vitamin K, present in green peas helps in absorbing calcium making it a wonderful food item for enhancing your bone health. Nearly 50% of your daily Vitamin K1 requirement is fulfilled by a cup of boiled peas. Apart from that nutrients like Vitamin B1 and folic acid are also found abundantly in peas which in turn help to prevent osteoporosis.

Fights and Damages Diabetes

Manganese found in green peas is essential to help with proper production of digestive enzymes responsible for a process called gluconeogenesis. Gluconeogenesis involves the transformation of protein's amino acids into sugar and the balance of sugar within the bloodstream. Including green peas is the best option for fighting diabetes.

Prevents signs of ageing

The presence of antioxidants in green peas help to reduces free radical damage and also removes harmful toxins from the body. Therefore, consume more peas to slow down this process and prevent signs of ageing.

Helps reduce depression

People suffering from depression are recommended to consume foods rich in antioxidants. Since peas are loaded with antioxidants and are easily available, snacking on boiled peas is an outstanding idea to deal with mood swings.

Improves your immunity

Strong immune system is essential for fighting infections and protects you from a wide range of diseases. Since green peas are a good source of Vitamin C in addition to being packed with various nutrients, eating them improves your immunity as well as prevents from several other immune systems related illnesses as well.

Heart health

Vitamin K present in green peas may help keep lower blood pressure by removing the build-up of several minerals in the arteries (mineralization), allowing the heart to freely push blood through the body. Mineralization occurs naturally with age and is a major risk factor for heart disease. Sufficient intake of vitamin K rich food like green peas has also been shown to lower the risk of stroke.

Pregnancy and Birth Defects

Green peas consist of Vitamin B9 which is a reliable resource for limiting defects during pregnancy and the birth of a child. It is a common situation that pregnant women maintaining a diet deficient of this vitamin are far less likely to deliver a healthy child. The birth defects caused by its deficiency include neural tube defects. Therefore, Vitamin B9 efficiently improves the chances of giving birth to a healthy, happy child.

Prevents stomach cancer

Green Peas consists of considerable amount of antioxidants and anti-inflammatory agents which helps to keep body healthy and lower your chances of suffering from cancer. It is mostly achieved because of the presence of coumestrol, a polyphenolic compound, which has been related with decreased risk of stomach cancer.

Curing Cataracts (Eye Disorder)

Cataracts are the most common conditions of visual problems which are caused due to the deficiencies of vitamin C. A decrease in the level of vitamin C in the lens of the human eye has been seen more commonly when cataracts are present. Green peas consist of 58 mg of Vitamin C which is 64.44% of the daily recommended value. So people suffering from eye disorders must consume more green peas regularly to cure cataract. An increase of vitamin C intake increases the blood supply to the ocular areas of the body and cures all eye related disorders.

RAJMA

Kidney beans are loaded with important nutrients, vitamins and minerals which are essential to live a healthy and prosperous life. Including kidney beans on a regular diet helps us to fight with Rheumatoid Arthritis, Relieves Fatigue, good for digestive health, cures acne and many other diseases.

Beneficial for digestive health

Kidney beans are a good source of dietary fiber. Fiber is normally of two types insoluble and soluble, kidney beans include both. Soluble fiber is helpful in reducing the amount of cholesterol you absorb from food and insoluble fiber provides required bulk for good digestive health as well as bowel movements.

Cardiovascular Benefits

Kidney beans include higher fiber content which is essential to reduce cholesterol level. Folate content in kidney beans also helps to lower homocysteine which further decreases the chance of heart attacks, vascular disease and many other heart related diseases. Apart from that magnesium contained in kidney beans helps to maintain healthy functioning of the cardiovascular system.

Relieves Fatigue

Fatigue, also mentioned as lethargy, tiredness, listlessness and exhaustion describes a physical and mental state of being tired and weak. Magnesium content of Kidney beans can significantly provide relief from fatigue. It also relaxes nerves, blood vessels and muscles. Regular kidney

beans consumption also helps to reduce muscle soreness, headache, migraine and different effects of Asthma.

Rheumatoid Arthritis

Rheumatoid Arthritis is a serious long-lasting progressive illness resulting in inflammation of joints and leads to throbbing deformity as well as immovability, particularly in the ankles, feet, fingers and wrists. Frequent Kidney beans intake is best options for decreasing such inflammatory conditions since kidney beans contain reasonable quantity of Copper content. Copper is essential to encourage certain enzymatic activity as well as sustain elastic properties of joints, blood vessels and ligaments.

Alzheimer's disease

Alzheimer's disease is actually a progressive mental weakening which takes place in middle or old age, because of general deterioration of the brain. It is the main reason of premature senility. Vitamin B is essential nutrients for proper brain function which is found in significant amounts in Kidney beans. It nourishes your brain nerves and cells which can avoid age linked disease such as Alzheimer's.

Bone Strength

Calcium and manganese present in Kidney beans are essential nutrients for maintain strong bones and other trace minerals help to prevent osteoporosis. Different research have proven that low quantities of folic acid in the diet result in growth of homocysteine levels and considerably increases risk of osteoporosis related bone fractures, mainly hip fracture in women and in men. Vitamin K content is also an acute nutrient for bone health. Vitamin K deficient people are at high risk of suffering from bone fractures problems. Vitamin K has shown to stop fractures in women who have passed through menopause and have previously started to experience bone loss.

Antioxidants & Anti-aging Properties

Kidney Beans are loaded with antioxidants that are considered to have strong anti-aging properties and to encourage longevity by limiting the damage caused by free radicals. It will help

protect the skin and the rest of the body from long-term problems caused by environmental factors as well as unhealthy foods.

Curing Cataracts (Eye Disorder)

Cataract is most common conditions of visual problems. Kidney beans consist of considerable amount of vitamin C. An Insufficient quantity vitamin C within lens of the human eye has been discovered mostly when cataracts are present. An increase of vitamin C intake increases the blood supply to the ocular areas of the body.

RED GRAM

Pigeon peas are an excellent source of magnesium, phosphorus, calcium and potassium. Besides, it contains fewer amounts of copper, zinc and magnesium. It provides an adequate amount of iron and selenium. The flattened shape pods hold a substantial place among pulses in India. The seeds vary in shape, size and color. It is round or oval in white, brown, red, grayish or purplish with a white hylum. A few well-known advantages of Pigeon Peas are listed below:

Maintains blood pressure

Potassium is the key mineral which is found in pigeon peas that acts as a vasodilator, reduces the blood constriction and also reduces blood pressure. Those who suffer from hypertension should add pigeon peas to the daily diet because they are highly prone to the cardiovascular disease.

Assist in growth

Pigeon peas are also loaded with high protein content which is required for the growth and development. It is essential for the formation of cells, tissues, muscles and bones. It also assists in the healing process and cell regeneration in the body. One cup of cooked pigeon peas possesses 11 grams of protein.

Prevent anemia

Folate is found in adequate amount in pigeon peas which helps to prevent anemia and neural tube defects in unborn which is caused due to the deficiency of folate.

Anti-inflammatory properties

The seeds, leaves and peas of pigeon peas are used to treat inflammation due to the presence of organic compounds. The mashed pigeon peas paste is used as a treatment for piles which is known as hemorrhoids.

Helps in losing weight

Pigeon peas possess low amount of calories, cholesterol and saturated fats which makes it healthy. The presence of dietary fiber keeps full for a long period of time, increase metabolism rate and reduces the possibilities of weight gain. The nutrients found in pigeon peas converts into the usable energy than to store as a fat.

Boost energy

Vitamin B is also present in pigeon peas. Riboflavin and Niacin enhance the carbohydrate metabolism, prevent in fat storage and boost energy levels. It is suitable for the people living in arid climates, physical work that reduces the energy quickly.

Aids immunity

To maintain the nutrients, raw is better because 25% of nutrients are lost when cooked. The uncooked peas help to enhance the immune system. Vitamin C promotes the white blood cells production and acts as an antioxidant that promotes in overall wellness as well as strong immunity.

Healthy heart

Pigeon peas contain dietary fiber, potassium and low cholesterol which help to maintain the healthy heart. Potassium lowers the strain on heart by reducing the blood pressure. Dietary fiber maintains cholesterol balance and prevents atherosclerosis.

Digestive health

Pigeon peas are rich in dietary fiber which is essential for maintaining the digestive health. Fiber adds bulk to the stool and enhances the bowel movements by reducing the strain as well as inflammation. It reduces the constipation, cramping, bloating and diarrhea. Fiber enhances the efficiency of nutrient absorption.

SOYBEAN

Soybeans or soya beans scientifically known as *Glycine max* are a type of legume that belongs to family Leguminosae (pulse family) and is native to eastern Asia. Soybeans have a wealth of health benefits, including prevention of Breast and Prostate Cancer, heart health, sleep disorders, metabolic activity, circulation and oxygenation, alleviation of menopausal symptoms, birth defects, bone health, healthy weight gain, diabetes and digestive Health.

Heart Health

Soybeans supply minimal amount of fat, but it is not supplying you with a saturated fat diet. Soybeans are actually a good source of healthier, unsaturated fat, which help to lower your total cholesterol. This allows you to avoid conditions like atherosclerosis, which can easily result in heart attacks and strokes. Apart from that, there are some specific fatty acids that are essential for a healthy system. Linoleic acid and linolenic acid are two fatty acids, found significantly in soybeans helps to regulate smooth muscle function in the body, and helps to maintain suitable blood pressure levels. Finally, the fiber in soybeans helps to reduce cholesterol levels in the body by scraping that excess off of the walls of blood vessels and arteries.

Sleep Disorders

Soybeans help to control a number of aspects of the metabolism that help in decreasing sleep disorders and the occurrence of insomnia. However, soybeans have a high content of magnesium, which is a mineral that is directly associated to increasing the quality, duration, and restfulness of your sleep.

Metabolic Activity

As previously mentioned, soybeans are an extremely important source of protein. When the body contains sufficient amount of proteins then the metabolic functioning and overall system will get

a major boost. Proteins are actually the building blocks of cells and blood vessels and basically every important part of the human body. Proteins from soybeans ensure the proper health and regrowth of cells if they need to be repaired or replaced. It will be hard to get sufficient protein when you follow a vegetarian or vegan lifestyle; therefore soybeans provide an excellent replacement for the proteins normally acquired in red meat, chicken, eggs, dairy products, and fish.

Circulation and Oxygenation

Soybeans consist of abundance amount of copper and iron, both of these is important for the formation of red blood cells. With an appropriate amount of red blood cells in the body, extremities of the body and essential organ systems can get the blood flow and oxygen that they need to function proficiently.

Alleviation of Menopausal Symptoms

Menopause is the period in a woman's life when menstruation stops. It is often related with unpleasant symptoms, like sweating, mood swings and hot flashes that are brought about due to reduction in estrogen levels. Studies indicate that isoflavones, found in soybeans, help to alleviate the symptoms of menopause. Traditionally, hormonal therapies have been used as a treatment for menopausal symptoms. Today, isoflavone supplements are widely used as an alternative treatment.

Birth Defects

Soybeans consist of impressive amount of Vitamin B complex levels and the high levels of folic acid are very important for pregnant women. Folic acid guarantees the prevention of neural tube defects in infants, which confirms a happy and healthy baby.

Bone Health

Osteoporosis is a disorder described by reduced bone density and increased risk of fractures, particularly in senior women. Frequent consumption of soy products help to reduce the risk of osteoporosis in women that have undergone menopause. These beneficial effects seem to be caused by isoflavones.

Diabetes

Diabetes is one of the dreaded diseases spreading in the global population for more than a decade. Soybeans are definitely effective method of prevention and management of this disease, mainly because soybeans have shown an ability to increase insulin receptors within the body, thus helping to manage the disease efficiently or prevent it from occurring in the first place. Earlier research focusing on this particular relationship of soy products to a decrease in Type 2 diabetes are very promising, primarily in Asian populations.

Including pulses, beans, and lentils in your daily diet is a crucial method to stay healthy as it provides essential vitamins and minerals to the body. It also helps the body to grow and recover, apart from boosting its immunity. Pulses are even more beneficial for growing children, pregnant women and senior citizens.

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CHAPTER 3

VEGETABLES AND FRUITS



Vegetables and fruits provide excellent sources of nutrients, such as protein, vitamins, minerals, and fiber, as well as non nutrient phytochemicals such as sulfur-containing compounds. The non nutrient phytochemicals may contribute to the normal functioning of the human body . The consumption of a variety of vegetables and fruits is important, since nutrients act together as functional ingredients. The antioxidant composition and capacity of vegetables and fruits relative to intake data are important to understand the health implications of various dietary patterns. It has been reported that vegetables ranked in the top ten in an antioxidant assay.

It would appear that major public health benefits could be achieved by substantially increasing consumption of vegetables and fruits. Numerous studies indicated that increased vegetable and fruit consumption by humans significantly reduced the risk of cancer. Some of the commonly used vegetables and fruits are given below:-

Beans (*Phaseolus vulgaris* L.)

Beans have been characterized as a nearly perfect food because of their high protein, fiber, prebiotic, vitamin B, and chemically diverse micronutrient composition. As a result, dry beans

are used throughout the world representing 50% of the grain legumes consumed as a human food source. Considering their high phenol content, the pinto bean as well as other dry beans, probably promotes health in part via anti oxidative mechanisms. Resistant starch is a component of beans that have protective property against CVD . Additionally, beans contain high polyphenols that have shown to protect LDL against oxidation and decrease the uptake and degradation of cell-modified LDL by macrophages . Accordingly, beans may protect against Metabolic Syndrome symptoms due to the high levels of unabsorbed carbohydrates .it also delay delivery of glucose by prolonging tissue absorption, modulating fat utilization, and controlling appetite through increased satiety . Beans starches were able to modulate blood glucose levels.

The beans and other type of legumes exhibited a dose-dependent anti-proliferation effect on all the cancer cell lines tested. Importantly, beans presented the second strongest anti-proliferative activity of all analyzed legumes. The anticancer activity of beans has been mainly attributed to their polyphenolic compounds. Resistant starch in beans acts as substrates for bacterial fermentation that also results in the generation SCFAs. It is the production of these SCFAs that provide the anti-cancer protection, particularly butyrate. This SCFA has been associated with growth arrest, apoptosis, and differentiation in several colon cancer cell lines. Starch, dietary fiber, and the nonstarch polysaccharides (soluble and insoluble, pectins, gums, hemicelluloses, inulin, fructans, stachyose and raffinose) present in pinto beans act on the GI tract, influencing the microbiome and its fermentable products.

Cruciferous vegetables

Cruciferous vegetables contain little fat, are low in energy, and are sources of micronutrients (vitamins A, C and E, folic acid, selenium), fiber and other phytochemicals (carotenoids, coumarins, flavonoids and other phenolic compounds, and glucosinolates). The indolyl glucosinolate, glucobrassicin, found in high levels especially in Brussels sprouts, is hydrolyzed by myrosinase to give indole-3- carbinol (I3C). This indole has chemopreventive property, especially toward the mammary gland. It may reduce estrogenic activity and may be protective against estrogen-related cancers. Diet-derived indole derivatives as major activators of aryl hydrocarbon receptors (AhR). Tryptophan is another nutrient also found in cruciferous vegetables which shows anti-inflammatory activities. Sulforaphane (SFN), an isothiocyanate

compound of cruciferous vegetables, protects from oxidative stress, inflammation and radiation injury. Berteroin (5-methylthiopentyl isothiocyanate) is another compound of cruciferous vegetables which is mainly present in cabbage, rucola salad leaves and mustard oil act as local anti-inflammatory agent.

Tomato and tomato products

The carotenoid lycopene is the main phytochemical in tomatoes, and it gives ripe tomatoes their red color. In addition, other carotenoids, such as α - and β -carotene, lutein and zeaxanthin, are found in tomatoes, although in minor quantities. The health benefits of lycopene range from hypocholesterolemic, cardioprotective and osteoporotic effects to anti-mutagenic activity and anti-cancer potential. Tomatoes have a pronounced potential to attenuate carcinogenesis. The chemopreventive properties of tomatoes are rendered by the interaction between its bioactive compounds lycopene, phytoene and β -carotene. Clinical data have postulated that tomatoes have a beneficial effect to bone health. Tomatoes contain B-vitamins and vitamin K, and relative large quantities of the vitamins e (mainly α -tocopherol) and c (i.e. ascorbic acid). Both vitamins e and c are generally known for their potent antioxidant activity, whereas these compounds are also involved in other physiological processes. Vitamin c modulates apoptosis, cell signalling, inhibits cytokine production and promotes proliferation of endothelial cells. The roles for the vitamin α -tocopherol include the prevention of platelet aggregation and adhesion which in turn contributes to an improved endothelial function. α -Tocopherol also controls cellular processes such as differentiation, proliferation and apoptosis and plays a central role in the cholesterol metabolism and alters the gene transcription of activator protein-1 (aP-1) which is responsible for the regulation of gene expression of cytokines and growth factor.

Citrus fruits

Citrus fruits are principal sources of vitamin C, folate, fiber, flavonoids and phenolic acids, monoterpenes, carotenoids and limonoids. The various health benefits of citrus fruits have been attributed to the antioxidant activity of their constituent flavonoids (flavanones, flavones, flavonols and anthocyanins) .In biological studies, citrus flavonoids demonstrated anticarcinogenic (antimutagenic and antiproliferative effects, inhibition of carcinogenic cell invasion) and cardiovascular (effects on capillary fragility, platelet aggregation, coronary heart disease) properties. Citrus flavonoids have also been found to have antiinflammatory,

antiallergic, and antiviral activities. The monoterpene D-limonene, which is the major component of the oil from citrus peel, has also been shown to protect against cancer; it induces glutathione transferases, a family of phase II detoxification enzymes.

Berries

Berries are not only delicious, low energy food, but also rich sources of fiber, antioxidant vitamins and various phenolic compounds (flavonoids and phenolic acids). The main classes of flavonoids in berries are anthocyanins, proanthocyanidins, flavonols and catechins. Phenolic acids present in berries are hydroxylated derivatives of benzoic acid and cinnamic acid. Various potential health benefits from berries have been attributed to flavonoids and phenolic acids. Berries of *Vaccinium* sp. have been reported to possess a wide range of biological activities. Blueberry (*Vaccinium* sp.) helps maintaining the health and acts as a barrier to the effects of aging, particularly with respect to neurodegeneration and cognitive defects. There is also evidence of its action in the prevention of cardiovascular diseases and some types of cancer. Many beneficial effects seem to be related to the antioxidant properties of phenols present in the fruit .

Strawberries

Amongst the fruits, fresh strawberries are considered to be one with the highest content of ascorbic acid. Among the berry species, strawberries have similar content to raspberries, but about four-times more ascorbate than blueberries. Strawberries have been referred in many sources of folk medicine and official pharmacopoeia as a potential remedy, i.e., due to their astringent and diuretic properties. In the form of fruit paste they are used in folk medicine to heal skin diseases and wounds, and the juice for inflammation of the nerves and lungs . The leaf extract of strawberries has anti-diabetic, antioxidant, anti-inflammatory, and anti-apoptosis effects. Antioxidants in strawberries also help to lessen the risk of cardiovascular incidents by inhibition of LDL-cholesterol oxidation, or improved vascular endothelial function. This could reduce the risk of incidence of thrombosis . It is known that some compounds present in strawberries, such as ellagic acid and quercetin , have demonstrated anti-cancer activity in their purified forms or fractions, sometimes enriched with specific components. Crude extracts of strawberries and pure compounds of anthocyanins (cyanidin-3-glucoside, pelargonidin, and

pelargonidin-3-rutinoside) show antioxidant and human tumor cell anti-proliferative activities in vitro. Thus, they could suppress the growth of human oral, colon, and prostate cancer cells. The preventative effect of berry fruits for human esophageal cancer is because of their potential to modify exposure of several genes relating to the progress of oral cancer .

Blackberries

Blackberries are known for curing and preventing a wide variety of ailments, such as colitis, in folk medicine. Blackberries are considered to be promising sources of active compounds with neuroprotection qualities against age-related diseases, such as neurodegeneration. Digested metabolites from wild blackberries, in quantities that could be found in human plasma, could protect neuronal cells against oxidative damage that is an influential attribute of neurodegeneration. Polyphenol extracts from blackberry also possess anti-inflammatory properties.

Blueberries

Blueberries have been reported to have a pharmacological impact against ophthalmologic disorders. They improve blood and oxygen delivery to the eye and scavenge free radicals, which contribute to cataract and macular degeneration. Blueberries containing proanthocyanidins, anthocyanins, and flavonols are beneficial in bone protection, too. Blueberries also exhibit anti-diabetic properties and protection of pancreatic β -cells from glucose-induced oxidative stress. Blueberries could also be used for decreasing blood pressure, decreasing of blood cholesterol and, therefore, lowering of cardiovascular risk and atherosclerosis prevention. Blueberry phytochemicals could inhibit growth and metastatic potential of breast and colon cancer cells. The synergistic effect of polyphenol compounds and ascorbic acid correlate with inhibition of cancer cell proliferation, inhibit the growth of tumor cells, and induce apoptosis . It was assessed that pure anthocyanins, such as cyanidin 3-glucoside, delphinidin, as well as peonidin 3-glucoside, suppressed growth of human tumor cells and apoptosis of colon and breast cell lines.

Cranberries

Cranberries contain a lot of biologically active substances; which came to be thought of as one of the novel functional foods and nutraceuticals. They are known as a good source of vitamins, such

as ascorbic acid. Cranberries (juice, concentrated powders, capsule formulations, and tablets) are known that could prevent and treat an occurrence of urinary tract infections. This effect is achieved by proanthocyanidins contained in cranberries that can prevent adhering of *Escherichia coli* to uroepithelial cells in the urinary tract. Due to this fact, cranberries could also be used for stomach ulcer. Another potential health effect of cranberries is the finding that extracted compounds from cranberry have shown the prevention and reduction of the cardiovascular disease risks and protection against lipoprotein oxidation. It has been demonstrated that the hydroxycinnamic acid derivatives and flavonoids from cranberry juice can reduce not only the oxidation of LDL but also its mobility and, thus, reduce one of the significant critical steps in the atherosclerotic process, which is oxidation of LDL-cholesterol. In addition, cranberry extract could significantly elevate synthesis of hepatic LDL receptors. Antioxidant Capacity of Cranberries due to phytochemicals, such as benzoic and cinnamic acid derivatives, and flavonols.

Grapes

Grapes and wine Grapes and wines contain large amounts of phenolic compounds including flavonoids (catechins, epicatechin, quercetin, anthocyanidins), phenolic acids (hydroxycinnamates) and tannins . The phenolic substances in wine mainly originate from grapes, but the phenolic profile of wine is not the same as that of fresh grapes or grape juice due to significant changes taking place during wine making.

Garlic

Garlic is one of the earliest of cultivated spices and foods and the most widely quoted in the literature for medicinal properties and health benefits. A number of epidemiological studies have shown that garlic consumption is correlated to reduced cancer risk. These studies have suggested that allyl sulfur compounds in garlic act primarily on the initiation phase of carcinogenesis, inhibiting development of chemically-induced tumors in various sites through the induction of phase II detoxification enzymes and inhibition of P 450 E1, the enzyme responsible for the metabolic activation of carcinogens. The garlic have ability to inhibit the synthesis of N-nitroso compounds and its antibacterial activity against *Helicobacter pylori*. Garlic protects against

CVD by bringing about lipid normalization, enhanced fibrinolytic activity, inhibited platelet aggregation and reduced blood pressure .

Banana

Creamy, rich, and sweet, bananas are a favorite food for everyone from infants to elders. Banana is characterized for its functional properties. They are a good source of potassium, an essential mineral for maintaining normal blood pressure and heart function. While bananas are a very low-fat food (less than 4% of their calories come from fat), one type of fat that they do contain in small amounts are sterols like sitosterol, campesterol, and stigmasterol. As these sterols look structurally similar to cholesterol, they can block the absorption of dietary cholesterol. Bananas are good source of fiber.

Bananas are a fascinating fruit in terms of their carbohydrate and sugar content. Even though bananas are a fruit that tastes quite sweet when ripe, they are low in glycemic index (GI) value. Within their total fiber content, bananas also contain pectin. This water-soluble pectins and higher proportional fructose content helps to normalize the rate of carbohydrate digestion and moderates the impact of banana consumption on our blood sugar. Similarly, fructooligosaccharides (FOS) in bananas helps to maintain the balance of *Bifidobacteria* in our lower intestine, and helps in overall digestive health.

Amla

The functional property of Indian Gooseberry, also known as Amla, can be partially attributed to its high vitamin C content. Amla enhances food absorption, balances stomach acids, fortifies the liver, nourishes the brain and mental functioning, and supports the heart. It also strengthens the lungs, regulates elimination of free radicals, enhances fertility, helps the urinary system, improves skin quality, and promotes healthier hair. This fruit acts as a body coolant, flushes out toxins, increases vitality, aids in vision care, improves muscle tone, and acts as an antioxidant.

Besides being a fruit amla is also slightly diuretic in nature. Drinking Gooseberry juice with honey is good for improving eyesight and improve near-sightedness and cataracts while reducing intra-ocular tension. This is mainly due to its impressive carotene content, which has

long been known for its powerful effect on vision-related conditions, including those that stem from the free radical activity. Vitamin A and carotenes reduce macular degeneration and night blindness while strengthening your vision before the age-related degeneration from free radicals can occur. It helps the body to absorb calcium in a positive way. It is better to consume amla on a regular basis so that its nutrients are always in the system and menstrual cramps can be prevented. Gooseberry contains chromium, which has a therapeutic value for diabetic patients. Chromium also enhances the effect of beta-blockers, which are used for heart health, by reducing the levels of LDL cholesterol in the body. It stimulates the isolated group of cells that secrete the hormone insulin, thereby reducing blood sugar in diabetic patients and keeping their body balanced and healthy. Amla is very high in fiber and stimulates the secretion of gastric and digestive juices. It strengthens the heart muscles, so the blood circulation is done throughout the body. The iron content in it promotes the creation of new red blood cells, thereby increasing circulation, and the oxygenation of organs and cells to maximize growth and regeneration of tissue while keeping the blood vessels and arteries clean.

It protects against infection and improves the body's immune response. They are also a very good source of vitamin C, which is famous for its impressive antioxidant abilities. It increases the white blood cells in the body, which are the main line of defense for the immune system since these cells attack and eliminate foreign toxins and substances in the bloodstream throughout the body. Due to its strong cooling and laxative properties, Gooseberry is a useful component in remedies for diarrhea and dysentery. It provides great relief for the gastric syndrome and hyperchlorhydria (burning sensation in the abdomen). As a laxative, it helps flush out toxins or harmful substances that cause discomfort or illness, so the healing process can begin. It then cools the burning sensation and reduces the discomfort often felt during diarrhea. Consuming Gooseberry powder with butter and honey before a meal improves appetite. It also helps balance nitrogen levels, thereby increasing weight in a healthy way. Amla prevents health-related hyperlipidemia by reducing the number of free radicals in the body through its antioxidant qualities. Free radicals are associated with signs of aging like wrinkles and age spots.

The fresh fruit of gooseberries contains more than 80% water, protein, minerals, carbohydrates, and fiber. It is also used as a remedy for fever, liver disorder, indigestion, anemia, urinary

problems, respiratory problems, cerebral, gastric and cardiovascular illness. Gooseberry lowers cholesterol levels, increases red blood cell production, and strengthens teeth and nails.

Spinach

Spinach is storehouse for many phytonutrients that have health promotional and disease prevention properties. It is very low in calories and fats (100 g of raw leaves provide just 23 calories). Fresh 100 g of spinach contains about 25% of daily intake of iron, one of the highest for any green leafy vegetables. Fresh leaves are a rich source of several vital antioxidant vitamins like vitamin-A, vitamin-C, and flavonoid polyphenolic antioxidants such as *lutein*, *zeaxanthin*, and *β-carotene*. Together, these compounds help act as protective scavengers against oxygen-derived free radicals and reactive oxygen species (ROS) that play a healing role in aging and various disease processes. *Zeaxanthin*, an important dietary carotenoid, is selectively absorbed into the retinal macula lutea in the eyes where it thought to provide antioxidant and protective UV light-filtering functions. It thus helps protect from "age-related macular related macular disease" (ARMD), especially in the older adults. Spinach leaves are an excellent source of vitamin-K. 100 g of fresh greens provides 402% of daily vitamin-K requirements. Additionally, it also has an established role in patients with *Alzheimer's disease* by limiting neuronal damage in the brain. This green leafy vegetable also contains good amounts of many B-complex vitamins such as vitamin-B6 (pyridoxine), thiamin (vitamin B-1), riboflavin, folates, and niacin. 100 g of farm fresh spinach has 47% of daily recommended levels of vitamin-C. Its leaves also contain a good amount of minerals like *potassium*, manganese, magnesium, copper and zinc. Regular consumption of spinach in the diet helps prevent osteoporosis, iron-deficiency anemia. Moreover, its soft leaves are believed to protect the human body from cardiovascular diseases and cancers of colon and prostate.

Sweet potatoes

Sweet potato contains such functional components as polyphenols, anthocyanins and dietary fiber, which are important for human health. Sweet potato roots are a good source of carbohydrates, while sweet potato tops (leaves and stems) contain additional nutritional components in much higher concentrations than in many other commercial vegetables. Sweet potato leaves are cooked as a

vegetable in many parts of the world. They are rich in vitamin B, carotene, iron, calcium, zinc and protein, and the crop is more tolerant of diseases, pests and high moisture than many other leafy vegetables grown in the tropics. Sweet potatoes are starchy, nutrient-rich root vegetables that are low in sodium and low in cholesterol. They are rich in complex carbohydrates, which mean they digest slowly, providing sustained energy. Fiber comes in insoluble and soluble varieties, each of which benefits your intestinal health when consumed on a regular basis. Insoluble fiber creates bulky stool that is easy to pass, which prevents constipation and reduces the risk of intestinal diseases. A medium-sized sweet potato has nearly 1,100 micrograms of vitamin A, 542 milligrams of potassium and 22 milligrams of vitamin C.

Carrot

Carrot is one of the important root vegetables rich in bioactive compounds like carotenoids and dietary fiber. Due to appreciable level of variety of different compounds present, carrots are considered as a functional food with significant health promoting properties. The consumption of carrot and its products is increasing steadily due to its recognition as an important source of natural antioxidants having anticancer activity. Carrot is a significant source of phytonutrients including phenolics, polyacetylenes and carotenoids. Carrot is rich in β -carotene, ascorbic acid and tocopherol and is classified as vitaminized food. Phenolics or polyphenols have received considerable attention because of their physiological functions, including antioxidant, antimutagenic and antitumor activities. Phenolics in carrots are present throughout the roots but are highly concentrated in the periderm tissue. The carrot cell wall is composed of pectin (galacturonans, rhamnogalacturonans, arabinans, galactans and arabinogalactans-1), cellulose (β -4, D-glucan), lignin (trans-coniferyl alcohol, trans-sinapyl alcohol and trans-p-coumaryl alcohol) and hemi-cellulose (xylans, glucuronoxylans β -D-glucans and xyloglucans). Carrots are high in dietary fibers and these fibers play an important role in human health and diets rich in dietary fibers are associated with the prevention, reduction and treatment of some diseases such as diverticular and coronary heart diseases.

Onions

Onions are considered to be functional food as it is very low in calories and fats. 100 grams carry just 40 calories. It is also rich in soluble dietary fiber. The phytochemical compounds allium and Allyl disulfide in the onions convert into *allicin* by the enzymatic reaction when its bulb (modified leaves) are distorted (crushing, cutting, etc.). These compounds have anti-mutagenic, anti-diabetic properties and reduce cholesterol production by inhibiting *HMG-CoA reductase* enzyme in the liver cells. Further, it also found to have antibacterial, antiviral, and anti-fungal activities. Additionally, *Allicin* also decreases blood vessel stiffness by facilitating the release of nitric oxide (NO) and thereby bring a reduction in the total blood pressure. Further, it blocks platelet clot formation and has fibrinolytic action (clot breakdown) in the blood vessels and thereby prevents blood clots from growing and becoming problematic. Altogether, it helps decrease in overall risk of coronary artery disease (CAD), peripheral vascular diseases (PVD), and stroke. Onions are a rich source of chromium, a trace mineral that helps tissue cells respond appropriately to insulin levels in the blood. It thus helps facilitate insulin action and control sugar levels in diabetes. They are also a good source of antioxidant flavonoid quercetin, which is found to have anti-carcinogenic, anti-inflammatory, and antidiabetic functions. They are also good in antioxidant vitamin, vitamin-C and mineral manganese. Manganese is essential as a co-factor for the anti-oxidant enzyme, superoxide dismutase. Also, isothiocyanate antioxidants in them help provide relief from cold and flu by exerting anti-inflammatory actions. Onions are also good in the B-complex group of vitamins like pantothenic acid, pyridoxine, folates, and thiamin.

Bitter gourd

Bitter gourd has functional and endorsing benefits in vegetables. It is very low in calories, carrying just 17 calories per 100 g. Nevertheless, its pods are rich sources of phytonutrients like dietary fiber, minerals, vitamins, and anti-oxidants. It contains phytonutrient, polypeptide-P, and plant *insulin* known to lower blood sugar levels. Also, it composes hypoglycemic agent called Charantin. *Charantin* increases glucose uptake and glycogen synthesis inside the cells of the liver, muscle, and fatty (adipose) tissue. Together, these compounds may have been thought to be responsible for blood sugar levels reduction in the treatment of type-2 diabetes. Fresh pods

are an excellent source of folates, carrying about 72 µg/100g (18% of RDA). Vitamin folate when taken by mothers during their early pregnancy time would help reduce the incidence of neural tube defects in the newborn babies. Fresh bitter melon is an excellent source of vitamin-C. Further, it is an excellent source of health benefiting flavonoids such as β-carotene, α-carotene, lutein, and zeaxanthin. It also contains a good amount of vitamin-A. Together, these compounds help act as protective scavengers against oxygen-derived free radicals and reactive oxygen species (ROS) that play a role in aging, cancers and various disease processes. It also stimulates smooth digestion and peristalsis of food through the bowel until it is excreted from the body. Thus, it helps in relieving indigestion and constipation problems. Further, it has small amounts of B-complex vitamins such as niacin (vitamin B-3), pantothenic acid (vitamin B-5), pyridoxine (vitamin B-6) and minerals such as iron, zinc, potassium, manganese and magnesium. Early laboratory tests suggest that certain phytochemical compounds in bitter melon might be effective in the treatment of HIV infection.

Various culinary fruits provide significant amounts of fiber and water, and many are generally high in vitamin C. An overview of numerous studies showed that fruits (e.g., whole apples or whole oranges) are satisfying (filling) by simply eating and chewing them.^[41] The dietary fiber consumed in eating fruit promotes satiety, and may help to control body weight and aid reduction of blood cholesterol, a risk factor for cardiovascular diseases. Regular consumption of fruit is generally associated with reduced risks of several diseases and functional declines associated with aging.

Vegetables play an important role in human nutrition. Most are low in fat and calories but are bulky and filling. They supply dietary fiber and are important sources of essential vitamins, minerals, and trace elements. Particularly important are the antioxidant vitamins A, C, and E. When vegetables are included in the diet, there is found to be a reduction in the incidence of cancer, stroke, cardiovascular disease, and other chronic ailments. Research has shown that, compared with individuals who eat less than three servings of fruits and vegetables each day, those that eat more than five servings have an approximately twenty percent lower risk of developing coronary heart disease or stroke. The nutritional content of vegetables varies considerably; some contain useful amounts of protein though generally they contain little fat, and

varying proportions of vitamins such as vitamin A, vitamin K, and vitamin B₆; provitamins; dietary minerals; and carbohydrates. Subjects

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CHAPTER 4

PROBIOTICS, PREBIOTICS AND SYNBIOTICS



The most important function of alimentation is represented by the assurance of human metabolic needs as well as wellbeing and satisfaction induced by sensorial characteristics of food. In the same time, by modulating some target functions of the body, the food components might have benefic psychological and physiological effects, beside the nutritional ones, already accepted.

In fact, food must contribute to health improving/protection and sustain systems of defense against different aggressions. We are situated at a new frontier of nutrition, in which the foods are evaluated by their biological potential and by their ability to reduce the risk of developing certain diseases.

In essence, probiotic functional food are products that, by their biological active compounds and consumed in current diets, contribute to optimal human physical and psychical health.

The appearance and development of functional probiotic food are the response of production field to the results of cellular and molecular biology field research, which demonstrates the implication of food components in proper functioning cellules and subcelular structures. The importance of these studies is essential in contemporaneous context in which the environment assaults by many ways the human body, fully stressing it's protection, adaption and equilibrium maintenance systems. By their specific action, the food components might contribute to the maintain the normal parameters of cellular edificium and of the human body equilibrium.

Nowadays we are assisting to an intensification of research in food – alimentation – health relationship field. The idea that food might increase/defend health due to active biological components from its composition conquers more and more acceptability in the scientific community and there are many publication in this field. Unlike the last years, the customers from many countries become more and more interested in health beneficial determined by alimentation, including probiotic functional food. In Romania, even before the adherence to UE, there were registered studies concerning manufacturing of probiotic functional foods, especially in dairy industry and explaining the induced benefits for health.

In this trend of food science are included some of the studies developed over the years by researchers from Galati Food Science and Engineering Faculty.

PROBIOTICS

The name probiotic comes from the Greek pro bios which means ‘for life’. The history of probiotics began with the history of man; cheese and fermented milk were well known to the Greeks and Romans, who recommended their consumption, especially for children and convalescents. Probiotics are defined as the living microorganisms administered in a sufficient number to survive in the intestinal ecosystem. They must have a positive effect on the host.

The term probiotic was first used in 1965 to describe the substances secreted by one microorganism that stimulate the growth of another. A powerful evolution of this definition was coined by in 1974, who proposed that probiotics are organisms and substances which contribute to intestinal microbial balance. In more modern definitions, the concept of an action on the gut micro flora, and even that of live microorganisms disappeared in 1998 defined probiotics as the food which contains live bacteria beneficial to health, whereas in 2001 defined them as microbial cell preparations or components of microbial cells that have a beneficial effect on the health and well-being.

Some strict criteria have been proposed in 1992, for example, proposed the following parameters to select a probiotic: total safety for the host, resistance to gastric acidity and pancreatic secretions, adhesion to epithelial cells, antimicrobial activity, inhibition of adhesion of pathogenic bacteria, evaluation of resistance to antibiotics, tolerance to food additives and stability in the food matrix.

The probiotics in use today have not been selected on the basis of all these criteria, but the most commonly used probiotics are the strains of lactic acid bacteria such as *Lactobacillus*, *Bifidobacterium* and *Streptococcus* (*S. thermophilus*); the first two are known to resist gastric acid, bile salts and pancreatic enzymes, to adhere to colonic mucosa and readily colonize the intestinal tract.

Probiotic microorganisms are isolated from human gastrointestinal system. *Lactobacillus* and *Bifidobacterium* species are widely known. *E. faecium*, *E. faecalis*, *S. thermophilus*, *Lc. lactis* subsp. *lactis*, *Leuconostoc mesenteroides*, *Propionibacterium freudenreichii*, *Pediococcus acidilactici*, *Sporolactobacillus inulinus*, *E. coli*, bacteria such as some *Bacillus* species, other lactic acid bacteria species, yeast such as *Saccharomyces cerevisiae* and *Saccharomyces boulardii* are commonly used as probiotics.

PROPERTIES OF LACTIC ACID BACTERIA

The lactic acid bacteria are generally defined as a cluster of lactic acid-producing non-spore-forming, Gram-positive rods and cocci that share many biochemical, physiological, and genetic properties. They are distinguished from other Gram positive bacteria that also produce lactic acid (e.g., *Bacillus*, *Listeria*, and *Bifidobacterium*) by virtue of numerous phenotypic and genotypic differences. Five sub-clusters are evident from this tree, including:

- (1) *Streptococcus-Lactococcus* branch (Family *Streptococcaceae*)
- (2) *Lactobacillus* branch (Family *Lactobacillaceae*)
- (3) *Lactobacillus-Pediococcus* branch (Family *Lactobacillaceae*)
- (4) *Oenococcus-Leuconostoc-Weissella* branch (Family *Leuconostocaceae*)
- (5) *Carnobacterium-Aerococcus-Enterococcus-Tetragenococcus-Vagococcus* branch
(Families *Carnobacteriaceae*, *Aerococcaceae*, and *Enterococcaceae*).

Seven of the twelve genera of lactic acid bacteria, *Lactobacillus*, *Lactococcus*, *Leuconostoc*, *Oenococcus*, *Pediococcus*, *Streptococcus*, and *Tetragenococcus*, are used directly in food fermentations. Although *Enterococcus* sp. are often found in fermented foods (e.g., cheese, sausage, fermented vegetables), except for a few occasions, they are not added directly. In fact, their presence is often undesirable, in part, because they are sometimes used as indicators of fecal contamination and also because some strains may harbor mobile antibiotic resistance genes.

Importantly, some strains of *Enterococcus* are capable of causing infections in humans. Likewise, *Carnobacterium* are also undesirable, mainly because they are considered as spoilage organisms in fermented meat products. Finally, species of *Aerococcus*, *Vagococcus*, and *Weisella* are not widely found in foods, and their overall significance in food is unclear.

LACTIC ACID BACTERIA (LAB) AND FERMENTED MILK

Characteristics of Lactic and Probiotic Bacteria

After the first discovery of LAB by Louis Pasteur in 1857 during the alcohol fermentation, Tissier at the Pasteur Institute in 1899 isolated *Bacillus bifidus* (*Bifidobacterium*), a type of anaerobic lactic acid bacteria from the stools of breast - fed infants. *Lactobacillus casei* was isolated from cheese by Orla - Jensen in 1916 and from indigenous micro flora in the human GI tract by Shirota in 1929. LAB strains are the major representatives of probiotics, both in dairy food, such as fermented milk, and the pharmaceutical market. LAB is associated with various habitats, particularly those rich in nutrients such as various food substrates and plant materials, which they are able to ferment or spoil. Other habitats include soil, water, manure, sewage, and silage. Some LAB strains inhabit the human oral cavity, the intestinal tract, and the vagina and may beneficially influence these human ecosystems. LAB produces lactic or acetic acid and some carbon dioxide from carbohydrates during fermentation. General characteristics are Gram - positive, non motile, non - spore - forming, coccus - and rod - shaped with less than 50% of G+C content. *Bifidobacterium* species currently belongs to *Actinomyces* with higher than 60% of G+C content. The genera include *Lactobacillus*, *Lactococcus*, *Leuconostoc*, *Pediococcus*, *Streptococcus*, and *Bifidobacterium*, etc.

LACTOBACILLUS ACIDOPHILUS

Lb. acidophilus is a Gram - positive, catalase - negative, rod - shaped bacterium with no gas from glucose or gluconate; thiamine is not required with aldolase activity. It is facultative with best growth obtained in the absence of excess oxygen. Energy is obtained through homofermentative metabolism of a variety of carbohydrates to mainly D - lactic acid. The optimum growth is between 35 – 38 ° C but grows at 45 ° C, with no growth at below 15 ° C. This becomes an advantage when this organism is added to non fermented milk, because little or no acid development will occur during refrigerated storage of the product. *Lb. acidophilus*, being a normal inhabitant of the small intestine, is resistant to bile. Growth occurs at initial pH values of

5 – 7 with an optimum of 5.5 – 6.0. As acidity varies from 0.3 to 1.9% lactic acid, some of the characteristics enable it to provide potential health and nutritional benefits for human and animal hosts. Therefore, *Lb. acidophilus* is the most commonly suggested organism for dietary use.

LACTOBACILLUS CASEI

This species possesses many of the same characteristics as *Lb. acidophilus*, which have potential for health and nutritional benefits. Although its optimum growth temperature is 37 ° C, unlike *Lb. acidophilus*, it grows at 15 ° C with no growth at 45 ° C. There is no gas from glucose, but gas from gluconate and ribose. Four subspecies are currently recognized. It also ferments a number of carbohydrates homofermentatively to L (+) - lactic acid. It is a normal inhabitant of the small intestine and is resistant to bile.

BIFIDOBACTERIUM sp.

Bifidobacteria are obligate anaerobes in the Actinomycetales branch of the high Gram - positive bacteria with distinct fructose - 6 - phosphate “shunt” metabolic pathway. However, *Bifidobacterium* spp. has similar characteristics to LAB: Gram - positive; non – spore - forming; non motile bacilli; catalase - negative; and irregularly shaped rods with club - shaped or spatulate extremities, many of which form branched cells. They are sensitive to oxygen and have more strict growth requirements. As the obligate anaerobes, they are considered normal inhabitants of the small intestine and are bile resistant. The major fermentation products are acetic acid and lactic acid in the molar ratio (3: 2). This becomes an important factor to provide antagonisms toward undesirable microorganisms in the intestinal tract, because acetic acid is more toxic to microorganisms than lactic acid. Since *Bifidobacterium* are sensitive to oxygen, difficulty may be encountered in maintaining high levels of viability in products during storage unless anaerobic conditions are used. This makes it technologically more difficult for them to maintain the viability, and thus they are commonly not used as often as *Lactobacillus*.

ENTEROCOCCUS FAECIUM/ENTEROCOCCUS FAECALIS

Enterococci are singular, double or short chained gram positive cocci. These bacteria can be found with high amounts in dairy products and other foods and although having extensive biotechnological properties such as; capability to produce bacteriocin, having probiotic traits and usage in dairy industry, there isn't a consensus on to consider them food borne pathogens.

However recent studies have shown that *E. faecalis* and some lactic acid bacteria species can cause clinical infections, especially infective endocarditis. *E. faecalis* can be found not only in human and animal faeces but also on plants and this largely reduces its usage as a sanitation indicator.

STREPTOCOCCUS THERMOPHILUS

S. thermophilus is a gram positive, circular or elliptical bacteria which has a diameter of 0,7 - 0,9 micron. Morphology of bacteria depends on the genus, environment and growth temperatures. For instance, they have short chains at 45°C, are diplococcus at 30°C but have long chains in cultures that have high acidity. Bacteria show symbiotic relationship with *L. bulgaricus* at yoghurt production. At first *S. thermophilus* shows activity in the milk fermented to produce yoghurt, and slightly increases the acidity of the media and consumes oxygen. *L. bulgaricus* starts to grow rapidly in this medium and forms valine which is a necessity for *S. thermophilus*'s growth. Besides yoghurt production, they are present in various starter cultures that are used to produce fermented dairy products and cheese.

SACCHAROMYCES CEREVISIAE BOULARDII

Saccharomyces boulardii was discovered by French researcher Boulard in 1923 and is Gram positive yeast which is a member of *Saccharomycetaceae* family. It is elliptical or spherical shaped and has a size of 4-8 µm. It forms ascospore and grows in standard yeast mediums with and optimal growth temperature of 37°C and has the capability to assimilate and ferment carbohydrates and can prevent microbial pathogen growth. *Saccharomyces boulardii* shows no pathogenic properties and was isolated from a tropical fruit (lychee fruit) which grows in Southeast Asia and was used for the treatment of diarrhea. In 1962, lyophilized commercial preparation of *S. boulardii* was introduced and notably in France, used as a cure for diarrhea ever since. Lyophilized *S. boulardii* is being used clinically in Europe, Asia, Africa and South America. Preclinical and experimental studies have shown that *Saccharomyces boulardii* has anti inflammatory, antimicrobial, enzymatic, metabolic and antitoxic activities.

PROBIOTICS AS FUNCTIONAL FOODS

The term “functional food” itself was first used in Japan, in the 1980s, for food products fortified with special constituents that possess advantageous physiological effects. Functional

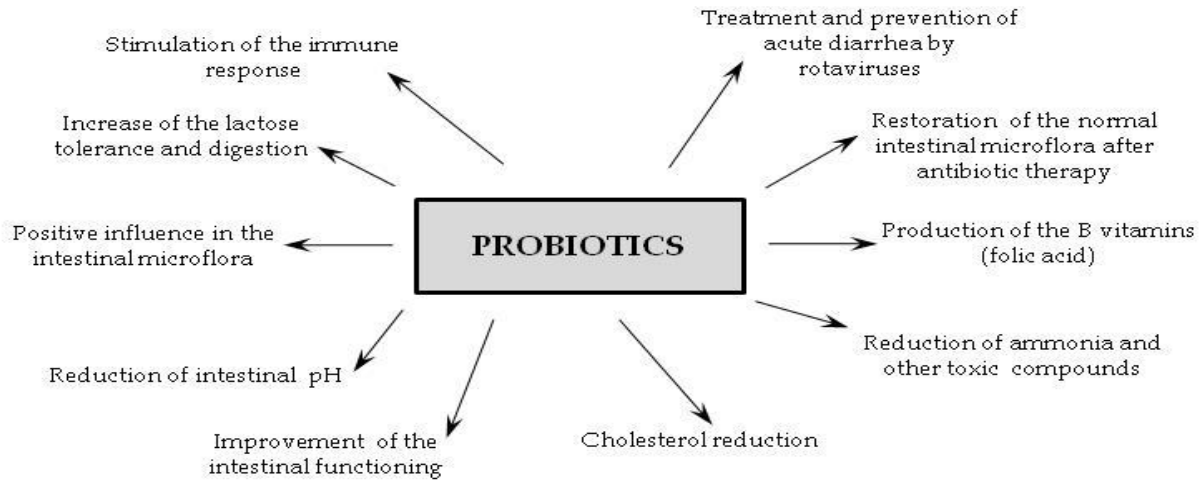
foods may improve the general conditions of the body (e.g. pre- and probiotics), decrease the risk of some diseases (e.g. cholesterol-lowering products), and could even be used for curing some illnesses.

In the last decades consumer demands in the field of food production has changed considerably. Consumers more and more believe that foods contribute directly to their health. Today foods are not intended to only satisfy hunger and to provide necessary nutrients for humans but also to prevent nutrition-related diseases and improve physical and mental well-being of the consumers. In this regard, functional foods play an outstanding role. The increasing demand on such foods can be explained by the increasing cost of healthcare, the steady increase in life expectancy, and the desire of older people for improved quality of their later years.

The European Commission's Concerted Action on Functional Food Science in Europe (FuFoSE), coordinated by International Life Science Institute (ILSI) Europe defined functional food as follows: "a food product can only be considered functional if together with the basic nutritional impact it has beneficial effects on one or more functions of the human organism thus either improving the general and physical conditions or/and decreasing the risk of the evolution of diseases. The amount of intake and form of the functional food should be as it is normally expected for dietary purposes. Therefore, it could not be in the form of pill or capsule just as normal food form".

BENEFICIAL EFFECTS OF PROBIOTICS

A number of health benefits have been contributed to products containing probiotic organisms. While some of these benefits have been well documented and established, others have shown a promising potential in animal models, with human studies required to substantiate these claims. More importantly, health benefits imparted by probiotic bacteria are very strain specific; therefore, there is no universal strain that would provide all proposed benefits, not even strains of the same species. Moreover, not all the strains of the same species are effective against defined health conditions.



It is important to note that health benefits imparted by probiotic bacteria appear to be strain specific, and not species - or genus - specific. None of the strains will provide all proposed benefits, not even strains of the same species, and not all strains of the same species will be effective against defined health conditions.

Gastrointestinal Health

During the first days of life, the gut is enriched with bacteria, and the development of the micro flora is rapid and depends on the following: genetic factors, delivery mode, mother's flora, type of feeding, and environmental surroundings. Due to the instability of the baby's micro flora, the resistance against pathogen colonization is weak; thus, the manipulation of the growing gut flora by probiotic intake may help development of various intestinal infections. Elevated numbers of *Bifidobacterium* spp. in a breast - fed infant 's gut over formula - fed infants may be the cause of probiotic health benefits. Probiotics stimulate the developing immune system, which has lifelong positive effects to the host. Probiotics are now being used as a supplement in some infant formulas.

Disease/Disorder Prevention and Treatment

Common gastrointestinal diseases and disorders such as diarrhea (including travelers' and antibiotic - associated diarrhea), constipation, and inflammatory bowel disease (IBD) have all shown indications of improvement when treated with probiotics. Millions of people, especially children in developing countries, die every year due to diarrhea, an intestinal disturbance often

caused by an imbalance of the gut ' s flora with rotavirus infection and *Clostridium difficile* overgrowth. Antibiotic - associated diarrhea is a major clinical problem occurring in up to 25% of patients, with diarrhea owing to *Clostridium difficile*. The clinical and economic costs of antibiotic - associated diarrhea are significant and better treatments are needed. Probiotics may offer potential effective therapy for antibiotic - associated diarrhea by restoring intestinal microbial balance. A number of different probiotics have been evaluated in the prevention and treatment of antibiotic - associated diarrhea in adults and children, including the nonpathogenic yeast, *Saccharomyces boulardii*, and multiple lactic - acid fermenting bacteria such as *Lb. rhamnosus* GG (LGG). A careful review of the literature supports the efficacy of *S. boulardii* in the prevention of antibiotic - associated diarrhea recurrent *C. difficile* infection in adults, whereas LGG is useful in the treatment of antibiotic - associated diarrhea in children.

Oral Health

A certain strain of *Streptococcus salivarius* called K12 in lozenge form has been shown to be an effective treatment for halitosis. Treatment with probiotics reduced counts of oral *Candida* in the elderly and may be a new strategy for controlling oral yeast infections. A significant reduction of the oral carriage of *Streptococcus mutans* by ingesting yogurt containing *Lb. fermentum*, compared with the placebo yogurt. Probiotics on halitosis and definite inhibition on the production of volatile sulfur compounds. In addition, a reduction of gingivitis and gum bleeding was observed with the application of *Lb. reuteri*. The oral health applications of probiotics or replacement therapy with *Str. mutans* strains of attenuated virulence and increased competitiveness were more than 700 bacterial taxa in the oral cavity.

Urogenital and Vaginal Health

Infections that involve urogenital microbial flora imbalance such as yeast vaginitis, bacterial vaginosis, and urinary tract infection can be recurrent. Lactobacilli have been shown to inhibit the growth of *Candida albicans* and/or its adherence on the vaginal epithelium.

Immunomodulation and Skin Health

Probiotics may influence the immune mechanisms of the host by effects on mucosal barrier mechanisms and on the functional maturation of the immune system. Cell - wall components, such as lipoteichoic acid and peptidoglycan from Gram - positive bacteria, are potent immune

modulators. The number of people afflicted with atopic diseases such as eczema (dermatitis), allergic rhinitis, or asthma is increasing in western societies. These diseases are caused by a hereditary predisposition to developing certain hypersensitivities upon exposure to specific antigens and might be in part attributed to reduced microbial exposure in early life. Reduced symptoms of the atopic syndrome in infants have been observed when treated with probiotics. A randomized placebo - controlled trial was performed with Lactobacillus GG, prenatally with pregnant women and postnatal for 6 months with their infants. Reduced symptoms of the atopic eczema and dermatitis syndrome in food allergic infants have also been observed when treated with probiotics.

Lactose Intolerance

Two major types of lactose intolerance are encountered in the population worldwide. Primary or adult type maldigestion is due to a decrease in β - galactosidase (also called lactase) in childhood or teenage years. Secondary type lactose maldigestion is thought to be caused by a loss of small intestinal mucosa (which results in severe diarrhea, bowel resection, etc.). Symptoms associated with lactose intolerance include abdominal pain, bloating, flatulence, and diarrhea. People suffering from lactose intolerance can often tolerate certain fermented milk products like viable yogurt. Microbial β - galactosidase present in yogurt survives gastric passage and supports cleavage of lactose. Moreover, the high viscosity of yogurt compared to milk increases the time for microbial or human β - galactosidase to hydrolyze lactose. One of the health benefits of probiotic organisms is probably generally accepted relief of the symptoms of lactose intolerance. However, reduced levels of lactose in fermented products due to partial hydrolysis of lactose during fermentation are only partly responsible for this greater tolerance for yogurt.

Cholesterol - Lowering and Antihypertensive Effects

Cholesterol plays a vital role in many functions of the body, but too much cholesterol in the blood will cause arterial clogging and increase the risk of heart disease and/or stroke. Many studies have proposed a hypocholesterolemic effect when fermented products and probiotics are consumed, especially with selected strains of lactic acid bacteria. Fermented milk containing Lb. acidophilus L1 was found to lower serum cholesterol. This would translate to 6 – 10% reduction in risk for coronary heart disease. The mechanisms of action proposed for the reduction of cholesterol include the inhibition of exogenous cholesterol absorption in the small intestine by

assimilation by the bacteria, as well as suppressing bile acid resorption by bacterial hydrolase activity.

PROBIOTIC DAIRY PRODUCTS

Foods that affect specific functions or systems in the human body, providing health benefits beyond energy and nutrients—functional foods—have experienced rapid market growth in recent years. This growth is fueled by technological innovations, development of new products, and the increasing number of health-conscious consumers interested in products that improve life quality. Since the global market of functional foods is increasing annually, food product development is a key research priority and a challenge for both the industry and science sectors. Probiotics show considerable promise for the expansion of the dairy industry, especially in such specific sectors as yogurts, cheeses, beverages, ice creams, and other desserts. This book chapter presents an overview of functional foods and strategies for their development, with particular attention to probiotic dairy products.

TYPES OF PROBIOTIC DAIRY PRODUCT

The most common probiotic dairy products worldwide are various types of yogurt, other fermented dairy product, various lactic acid bacteria drinks and mixture of probiotic (fermented) milks and fruit juice. Probiotic cheese, both fresh and ripened, has also been launched recently.

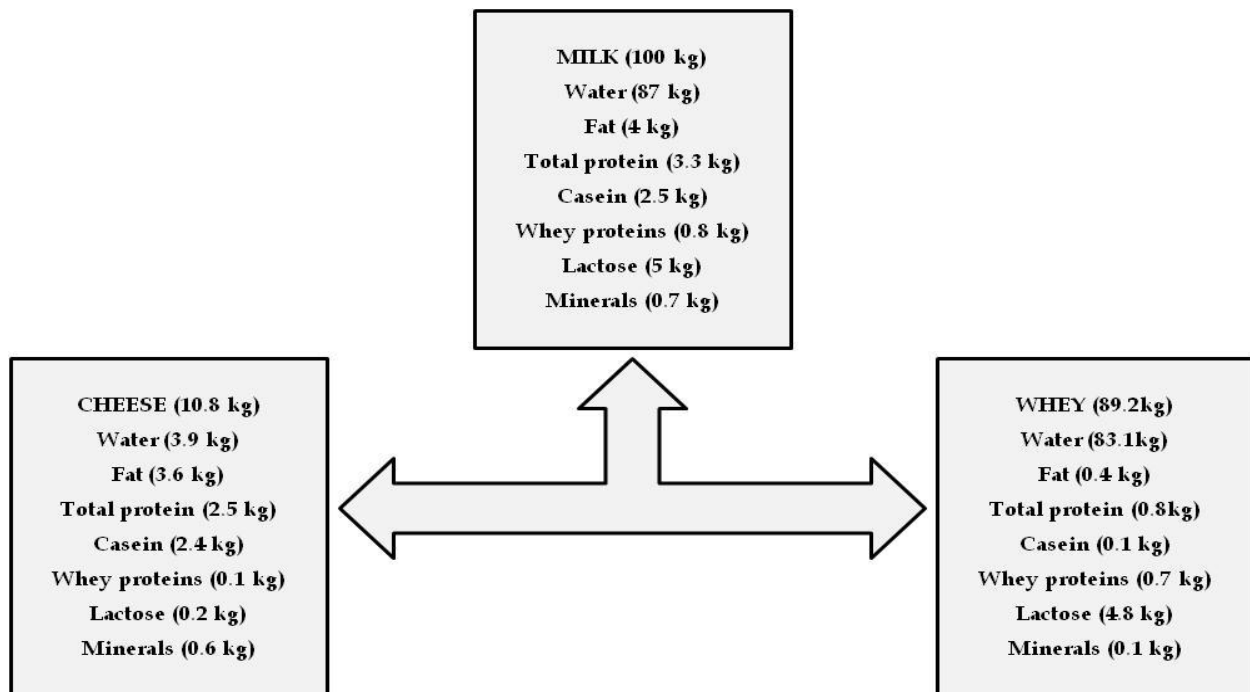
FERMENTED MILKS AND BEVERAGES

Fermented milks and beverages make up an important contribution to the human diet in many countries because fermentation is an inexpensive technology, which preserves the food, improves its nutritional value and enhances its sensory properties.

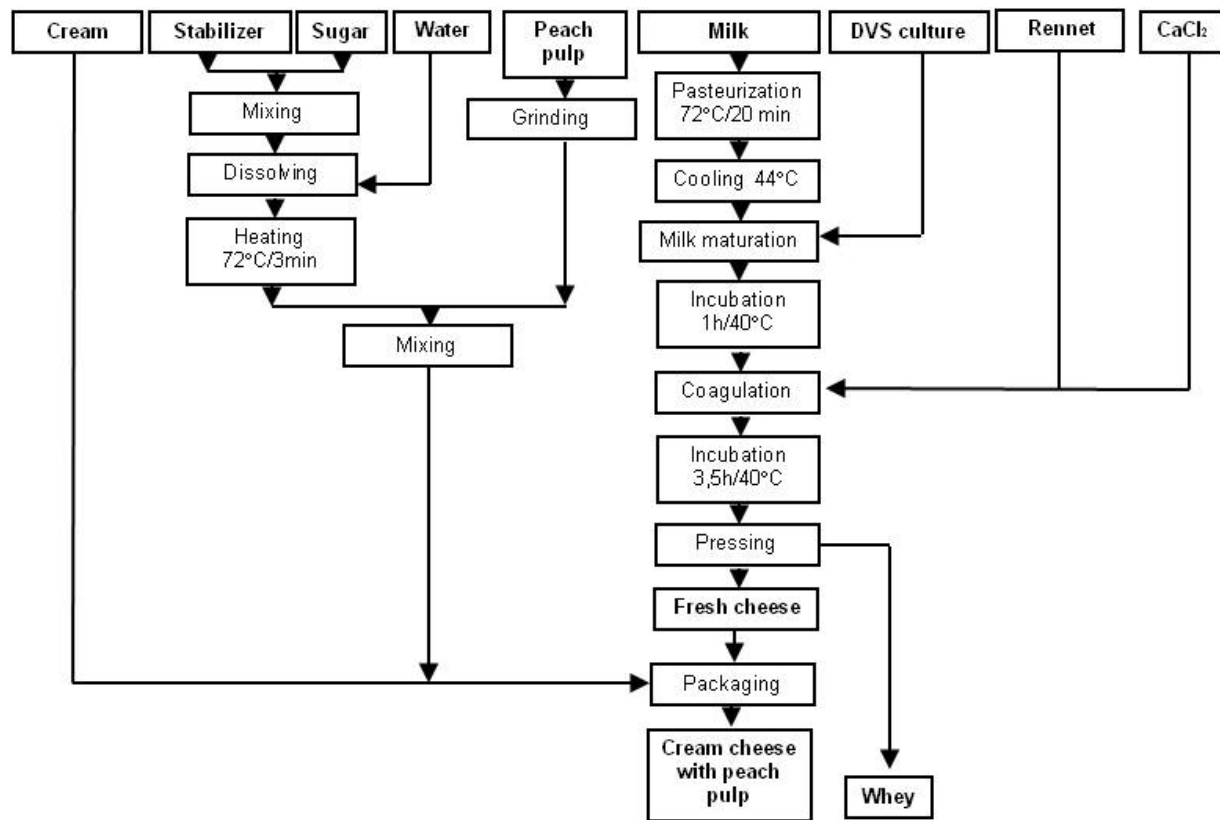
CHEESES

Perhaps no other fermented food starts with such a simple raw material and ends up with products having such an incredible diversity of color, flavor, texture, and appearance as does cheese. It is even more remarkable that milk, pale in color and bland in flavor, can be

transformed into literally hundreds of different types of flavorful, colorful cheeses by manipulating just a few critical steps. In an attempt to diversify the range of probiotic dairy products, there has been made a series of research on the introduction of probiotic bacteria in cheese. Cheese is an interesting way of supplying probiotic bacteria due to the chemical composition of the raw milk that encourages their growth, metabolism and viability and also due to their relatively low acidity compared to other food products.



Fresh cheese is the most suitable cheese to carry probiotic bacteria, due to the high composition of nutrients, low acidity and low salt content used probiotic fresh cheese and peach pulp in order to obtain a dessert, Probiotic bacteria, *Lactobacillus acidophilus* La 5, was introduced in the fresh cheese as an agent of milk maturation, during coagulation stage. The product was rich in nutritive components (proteins: 10.9...11.3%; fat: 9.1...10.4% and minerals: 2...2.3%) and has a pseudoplastic rheological behaviour. This influenced the sensorial properties of the product, which achieved a creamy texture including in its structure the minced peach pulp and fat globules from the cream.



Telemea is a cheese variety originated in Romania, from where its manufacture spread to other Balkan countries and Turkey. The specific of this variety of cheese is ripening in brine.

Beneficial Effects of Cheese on Health

Among dairy products, cheese has been a part of dietary culture since the dawn of history and is produced using unique food processing procedures, such as fermentation and ripening. A wide variety of cheeses has been produced around the world to satisfy different taste and health requirements, depending on differences in the lactic acid bacteria used as the starter and manufacturing process. In recent years, cheese has been suggested to have a variety of health promotive effects. Comparison of the effects of consumption of butter and cheese, prepared using an identical amount of milk fat, revealed that consumption of cheese was associated with lower serum cholesterol levels than the consumption of butter with an identical amount of fat. Regarding homeostasis, it was shown that women with the highest cheese consumption had beneficially lower concentration of plasminogen activator inhibitor 1. Because *Lactobacillus helveticus* has higher protease activity than other starter microorganisms, they focused on some

peptides from the cheese and also investigated the effects of the peptides on the production of adiponectin from primary cultures of rat abdominal adipose cells.

YOGURT

Yogurt is defined as fermented milk obtained by lactic acid fermentation due to the presence of *Lactobacillus delbrueckii* ssp. *bulgaricus* and *Streptococcus salvarius* ssp. *thermophilus* in milk. Other lactic acid bacteria (LAB) species are now frequently added to give the final product unique characteristics. Strictly speaking, the microorganisms in the final product must be abundant and viable. Yogurt products come in a wide variety of flavors, forms, and textures and include low fat, nonfat, light, Swiss or custard, and frozen yogurts. Yogurt might contain active cultures, be heat - treated, be in liquid or drinkable form, and have fruit at the bottom. Yogurt has been considered as a functional food. Functional foods are generally considered processed foods containing ingredients that aid specific body functions, in addition to being nutritious. The functionality of such foods is derived from their bioactive components. Bioactivity refers to the application of bioactive ingredients or nutraceuticals in foods like prebiotics, probiotics, flavonoids, phytosterols, phytostanols, bioactive peptides, and bioactive carbohydrates. In fact, yogurt contains properties or components that can benefit human health.

The Beneficial Effects of Yogurt

The four major beneficial effects of fermented milk are as follows:

- 1) Substances in milk that are useful to our body, such as proteins, fats, lactose, vitamins, and minerals are provided in fermented milk, in much the same way as in natural milk.
- 2) The lactic acid produced is said to reduce gastric acid secretion, stimulate peristalsis, and prevent putrefaction in the intestine. A part of the lactic acid combines chemically with calcium to form lactic acid - calcium complex, which is a more easily absorbable form. Part of the milk proteins digested to peptones and peptides are more easily utilized, consequently improving liver function and stimulating intestinal secretion. Trace amounts of active substances produced also may promote or maintain a healthy balance of the intestinal flora or may improve intestinal metabolism.

3) In the case wherein the lactic acid bacteria are killed by gastric juice or bile, or when pasteurized fermented milk drinks are taken, the cellular components released are absorbed. They have a stimulatory effect on the immune system, augment the anticancer immunity, promote liver function, and may be associated with detoxication of harmful substances in the intestine.

4) If the viable lactic acid bacteria reach the intestine and succeed to multiply there, the substances produced during growth may improve the balance of the intestinal flora and play a role in the detoxication of harmful substances produced by other bacteria.

Yogurt and the Immune System

The immune system functions to eliminate invading microorganisms and viruses, rid the host system of damaged tissue, and destroy neoplasm. Yogurt is known to have immune stimulatory effects, which are thought to be through its components but the exact mechanisms are not yet fully understood. The major microorganisms in yogurt are Gram - positive bacteria and have cell wall components such as peptidoglycan, polysaccharide, teichoic acid, and lipoproteins. All these components have been shown to have immunostimulatory properties. Other nonbacterial milk components (whey protein, calcium, vitamins, and trace elements) and components produced during the fermentation process (free amino acids and peptides) may also contribute to the immunostimulatory attributes of yogurt.

Yogurt and Gut Diseases

Gastrointestinal diseases result from a change in the gut micro flora caused by invading pathogens. Before the appearance of symptoms, the invading pathogen must first establish itself in sufficient numbers in the gut. Yogurt consumption is known to modulate conditions such as acute viral and bacterial diarrhea, inflammatory bowel disease, traveler ' s diarrhea as well as antibiotic associated diarrhea, necrotizing enterocolitis, irritable bowel syndrome, and constipation through actions of containing probiotics and other compounds. Treatment of diarrhea by administering living lactic acid bacteria to restore disturbed intestinal microfl ora has a long tradition. Antibiotic - associated diarrhea is most common among patients receiving antibiotic treatment induced by a disturbance of the intestinal microbial balance. Yogurt supplementation could effectively decrease the incidence and duration of antibiotic - associated

diarrhea. *L. acidophilus* – and *L. casei* – fermented milk were shown to have a preventive effect against antibiotic - associated diarrhea and to reduce *C. difficile* – associated incidence.

Inflammatory bowel disease is an umbrella term used for Crohn's disease and ulcerative colitis. One characteristic common to both is diarrhea. This symptom can be particularly distressing to an individual with inflammatory bowel disease and is often manifested by fear, anxiety, and embarrassment. The intestinal micro flora plays an important role in the pathogenesis of inflammatory bowel disease. A number of microbial agents are implicated as initiating factors in the pathogenesis of inflammatory bowel disease. These include *Mycobacterium para tuberculosis*, measles virus, *Listeria monocytogenes*, and adherent *E. coli*. Therefore, alteration of the gut micro flora through introduction of probiotic lactic acid bacteria could theoretically result in some clinical improvement. Furthermore, modulation of cytokine expression and stabilization of the mucosal barrier by probiotic lactic acid bacteria could promote disease resolution. Probiotics offer an alternative by altering the intestinal micro flora and modulating the immune response without the risk of side effects associated with conventional therapy

Yogurt and Cancer

Cancer is generally caused by genetic mutations in cells. These mutations may be due to the effects of carcinogens, such as tobacco smoke, radiation, chemicals, or infectious agents, may be randomly acquired through errors in DNA replication, or are inherited. Since some carcinogens or cancer - causing chemicals can be ingested or generated by metabolic activities of gut microorganisms, yogurt and other probiotic cultures or preparations may modulate cancer development through detoxification of ingested carcinogens, cellular uptake of mutagenic compounds, alteration of intestinal micro flora, and production of compounds (e.g., butyrate) that will participate in the process of apoptosis, have anticarcinogenic properties, and enhance immune response.

The presence of large numbers of probiotic bacteria in the gut serves to decrease the populations and metabolic activities of harmful bacteria that may generate carcinogenic compounds. Some pathogenic bacteria may convert procarcinogens to carcinogens, and limiting their growth means a reduction in the amount of carcinogens in the intestine. Reducing the enzymes that promote the

conversion of procarcinogenes to carcinogenes in the gut may be another possible mechanism responsible for the antitumor activity of yogurt.

Yogurt and Cardiovascular Diseases

Cardiovascular disease, defined as a range of diseases of the heart and circulatory system, is the most important cause of death in Western countries. A high level of serum total cholesterol is generally considered to be a risk factor for cardiovascular disease. Therefore, it is very important to decrease elevated serum cholesterol levels in order to prevent cardiovascular disease.

The mechanisms responsible for the hypocholesterolemic effects of yogurt are still under investigation. It has been proposed that the lactic acid bacteria incorporated in yogurt products may be responsible for the hypocholesterolemic effects. One proposed mechanism of the hypocholesterolemic activity of lactic acid bacteria is assimilation of cholesterol by the bacterial cells. Removal or assimilation of cholesterol by intestinal organisms in the small intestine could reduce the amount of cholesterol available for absorption from the intestine, thus exerting some control on serum cholesterol levels. Alternatively, the hypocholesterolemic activity of lactic acid bacteria could be due to the suppression of bile acid resorption by deconjugation as a function of the bacterial bile salt hydrolase activity

BIOACTIVE COMPONENTS IN YOGURT

Almost all milk components may contribute potential health benefits — including proteins, peptides, lipids, minor carbohydrates, minerals, and vitamins. In the manufacture of yogurt, live bacteria are added. Others such as bioactive peptides are generated during the fermentation process while others such as minerals are added to increase the nutritional quality or flavor of yogurt products. Probiotic microorganisms can exert their beneficial properties through two mechanisms: direct effects of the live microbial cells (probiotics) or indirect effects via metabolites of these cells. The most important metabolites in fermented milk may be peptides that are not present prior to fermentation.

KEFIR

Kefir is a naturally carbonated, slightly acidic fermented dairy product which is produced with kefir grains and contains complex and specific mixture of yeast and bacteria in a polysaccharide

matrix. Kefir is a North Caucasia originated fermented dairy product which is considered to be important for human diet in many regions such as Southwest Asia, East and North Europe, North America, Japan, Middle East and Russia. Kefir is recommended for six months old and older infants and due to its Bifidobacterium bifidum content, Bifidokefir has been found more effective on the treatment of infantile intestinal diseases than regular kefir. Kefir is produced using kefir grains and full or non fat milk and is a fermented dairy product consists of gel like colonies of casein and microorganism (bacteria and yeast) in a synbiotic relationship. There are several ways to produce kefir. Traditional and industrial processes are commonly used and food scientists are trying to develop new methods to obtain similar kefir produced with traditional ways. Consumers prefer kefir produced with kefir grains to kefir produced with starter culture. In comparison with the traditional kefir, cultured kefir is lower in acidity and shows less syneresis. Kefir can be produced using cow, sheep, goat, soy, rice and coconut milk. Pastorized, raw, semi skimmed, skimmed, non fat or full fat milk can be used in production. In the production of kefir with the use of cow, sheep and goat milk, lactic acid and alcohol fermentations take place simultaneously. It is stated that as a result of this simultaneity,

PREBIOTICS

Prebiotics are defined as “nondigestible food ingredients that beneficially affect the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon”. They are recognized for their ability to increase levels of health - promoting bacteria in the intestinal tract of humans or animals. Prebiotics target the activities of Bifidobacteria and/or lactobacilli. Many criteria have to be met for a food ingredient to be considered a prebiotic. First, it should not be hydrolyzed or absorbed in the stomach or small intestine of the host. Otherwise, the bacteria would no longer have access to the compound and therefore no benefits would be encountered. Secondly, the prebiotic must be selective for beneficial commensal bacteria in the colon. It must be verified that the food ingredient does not also stimulate pathogenic strains in the gut. Finally, its fermentation by commensal bacteria should induce beneficial effects to the host. At the present time, the only prebiotics known are carbohydrates, disaccharides, and polysaccharides.

Different prebiotics will stimulate the growth of different indigenous gut bacteria. Prebiotics have enormous potential for modifying the gut microbiota, but these modifications occur at the level of individual strains and species and are not easily predicted a priori. Furthermore, the gut environment, especially pH, plays a key role in determining the outcome of interspecies competition. Both for reasons of efficacy and of safety, the development of prebiotics intended to benefit human health has to take account of the highly individual species profiles that may result. Fruit, vegetables, cereals, and other edible plants are sources of carbohydrates constituting potential prebiotics. The following may be mentioned as such potential sources: tomatoes, artichokes, bananas, asparagus, berries, garlic, onions, chicory, green vegetables, legumes, as well as oats, linseed, barley, and wheat. Some artificially produced prebiotics are, among others: lactulose, galactooligosaccharides, fructooligosaccharides, maltooligosaccharides, cyclodextrins, and lactosaccharose. Lactulose constitutes a significant part of produced oligosaccharides (as much as 40%). Fructans, such as inulin and oligofructose, are believed to be the most used and effective in relation to many species of probiotics.

Production of Prebiotics

A wide range of prebiotics have been isolated from plant materials, including β - glucans from oats; inulin from chicory root; and oligosaccharides from beans, onions, and leeks. The use of inulin, a natural oligosaccharide found in some plants, significantly changed the composition of the mucosa - associated flora. Industrial production processes have been established to extract the nondigestible oligosaccharides from natural sources, by hydrolyzing polysaccharides or by enzymatic and chemical synthesis from disaccharide substrates. These processes usually produce a range of oligosaccharides differing in their degree of polymerization and sometimes in the position of the glycosidic linkages. Residual substrates and monosaccharides are usually present after oligosaccharide formation, but such sugars can be removed by membrane or chromatographic procedures to form higher - grade products that contain pure oligosaccharides. Worldwide, there are 13 classes of food - grade oligosaccharides currently produced commercially.

Prebiotic Selection Criteria

There are five basic criteria for the classification of food components such as prebiotics. The first criterion assumes that prebiotics are not digested (or just partially digested) in the upper segments of the alimentary tract. As a consequence, they reach the colon, where they are selectively fermented by potentially beneficial bacteria. The fermentation may lead to the increased production or a change in the relative abundance of different short-chain fatty acids (SCFAs), increased stool mass, a moderate reduction of colonic pH, reduction of nitrous end products and faecal enzymes, and an improvement of the immunological system, which is beneficial for the host. Selective stimulation of growth and/or activity of the intestinal bacteria potentially associated with health protection and wellbeing is considered another criterion. A prebiotic must be able to withstand food processing conditions and remained unchanged, non-degraded, or chemically unaltered and available for bacterial metabolism in the intestine.

Prebiotic Substances

The majority of identified prebiotics are carbohydrates of various molecular structures, naturally occurring in human and animal diets. The physiological properties of potential prebiotics determine their beneficial effect on the host's health. Prebiotics may be classified according to those properties as:

- not digested (or only partially digested);
- not absorbed in the small intestine
- poorly fermented by bacteria in the oral cavity
- well fermented by seemingly beneficial intestinal bacteria
- Poorly fermented by potential pathogens in the bowel.

Carbohydrates, such as dietary fibre, are potential prebiotics. Prebiotic and dietary fibres are terms used alternatively for food components that are not digested in the gastrointestinal tract. A significant difference between those two terms is that prebiotics are fermented by strictly defined groups of microorganisms, and dietary fibre is used by the majority of colonic microorganisms. Prebiotics may be a dietary fibre, but dietary fibre is not always a prebiotic. The following non-starch polysaccharides are considered to be dietary fibre: cellulose, hemicellulose, pectins, gums, substances obtained from marine algae, as well as lactulose, soy oligosaccharides, inulins,

fructooligosaccharides, galactooligosaccharides, xylooligosaccharides, and isomaltooligosaccharides. Based on the number of monomers bound together, prebiotics may be classified as: disaccharides, oligosaccharides (3–10 monomers), and polysaccharides. The most promising and fulfilling criteria for the classification of prebiotic substances, as evidenced by in vitro and in vivo studies, are oligosaccharides, fructooligosaccharides (FOS), galactooligosaccharides (GOS), isomaltooligosaccharides (IMO), xylooligosaccharides (XOS), transgalactooligosaccharides (TOS), and soybean oligosaccharides (SBOS). Also, polysaccharides such as inulin, reflux starch, cellulose, hemicellulose, or pectin may potentially be prebiotics.

SYNBIOTICS

Synbiotics are used not only for the improved survival of beneficial microorganisms added to food or feed, but also for the stimulation of the proliferation of specific native bacterial strains present in the gastrointestinal tract. The effect of synbiotics on metabolic health remains unclear. It should be mentioned that the health effect of synbiotics is probably associated with the individual combination of a probiotic and prebiotic. Considering a huge number of possible combinations, the application of synbiotics for the modulation of intestinal microbiota in humans seems promising.

Synbiotic Selection Criteria

The first aspect to be taken into account when composing a synbiotic formula should be a selection of an appropriate probiotic and prebiotic, exerting a positive effect on the host's health when used separately. The determination of specific properties to be possessed by a prebiotic to have a favourable effect on the probiotic seems to be the most appropriate approach. A prebiotic should selectively stimulate the growth of microorganisms, having a beneficial effect on health, with simultaneous absent (or limited) stimulation of other microorganisms.

Beneficial Effects of Prebiotics and Synbiotic Because of the survivability and colonization difficulties that abound with probiotics, the prebiotic approach offers an attractive alternative. Prebiotics exploit selective enzymes production by those gut microorganisms that may impart health benefits to the host. While some peptides, proteins, and certain lipids are potential prebiotics, nondigestible carbohydrates have received the most attention. Certain carbohydrates, oligo - and polysaccharides, occur naturally and meet the criteria of prebiotics. Some

nondigestible carbohydrates have a number of functional effects on the GI tract, which have been used to validate emptying, modulation of GI tract transit times, improved glucose tolerance, reduced fat and cholesterol absorption via binding of bile acids, increased volume and water - carrying capacity of intestinal contents, modulation of microbial fermentation with increased short - chain fatty acid (SCFA) production, and decreased pH and ammonia production. The combination of these effects could potentially result in improved host health by reducing intestinal disturbances (constipation and diarrhea), cardiovascular disease, and intestinal cancer. The combination of probiotics and natural stimulating agents consists as a practical means to increase the effectiveness of probiotic preparations for therapeutic use. Stimulating agents include substrates named prebiotic and potentiated probiotics.

It is important to consider that many bacteria inhabiting the large bowel have not yet been identified and are difficult to culture routinely. One consequence of this is that we do not know what the global effects of prebiotics are on the structure of the microbiota. Another important factor to bear in mind when using prebiotics selectively to modify the microbiota composition is that prebiotics on their own can only enhance the growth of bacteria that are already present in the gut. However, different people harbor different bacterial species, and the composition of the microbiota can be affected by a variety of other factors, such as diet, disease, drugs, antibiotics, age, etc. There are also preparations, referred to as synbiotics, on the market that combine probiotics and prebiotics to enhance health benefits. Synbiotics are defined as “ a preparation containing microorganism strains and synergistically acting compounds of natural origin that increase the probiotic effects on the small intestine and the colon ”.

The health benefits imparted by probiotics and prebiotics as well as synbiotics have been the subject of extensive research in the past few decades. These food supplements termed as functional foods have been demonstrated to alter, modify and reinstate the pre-existing intestinal flora. They also facilitate smooth functions of the intestinal environment. Most commonly used probiotic strains are: *Bifidobacterium*, *Lactobacilli*, *S. boulardii*, *B. coagulans*. Prebiotics like FOS, GOS, XOS, Inulin; fructans are the most commonly used fibers which when used together with probiotics are termed synbiotics and are able to improve the viability of the probiotics.

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CHAPTER 5

MEAT AND MEAT PRODUCTS



Meat and meat products show highly satiating characteristics and in this respect, functional foods could be a food-related solution because these types of products could be designed to be less calorifically dense and while remaining more highly satiating and tasty. In this way, the food industry, the meat and related products industry in particular, could contribute to making lives easier and more active.

Meat and meat products have many disease-preventing, health-promoting benefits, which makes them a viable option to be used as functional foods. The research highlighted that enriching meats with fibre, probiotics and omega-3 fatty acids may help consumers to link meat with a healthy lifestyle. Meat contains many important nutrients, including bioactive compounds such as taurine, L-carnitine, creatine, conjugated linoleic acid (CLA) and endogenous antioxidants. Meat also contains unique endogenous antioxidants including carosine, anserine and others, along with iron and zinc, nutrients often lacking in the average diet. It also contains a significant source of vitamin B-12. Fibre-enriched meat products may also offer health advantages, although they can elicit a grainy texture and have a restrictive digestive tolerance.

Various approaches are being followed for the development of functional meat products including production practices, post harvest techniques and reformulation techniques. Among these this reformulation is most commonly used method to develop functional meat products as it can help to avoid undesirable component and obtain most desirable composition with optimum palatability. It is possible to develop enormous range of functional meat products with the help of functional ingredients through reformulation technique. Such functional meat products may be obtained by following various approaches.

Fat reduction and alteration in meat products

Consumer acceptability of meat products is determined by various factors. These include nutritional value, price of protein and quantity as well as quality of the final product. Now-a-days, health conscious consumer is also concerned about fat content of meat and meat products. The lipid content of lean meat is very less but the percentage of fat content reaches much higher in processed meat products. Saturated fatty acids and monounsaturated fatty acids are dominant in meat fat. Different methods of fat reduction in meat products include trimming of external and intermuscular fat, genetic and dietary modification and fat replacements or substitutes.

Addition of vegetable oils to meat products

Vegetable oils have also been used as partial substitutes of pork backfat in low-fat frankfurters and other types of cooked product giving rise to products with more adequate fatty acid profiles and cholesterol levels than traditional one. Other studies on fermented sausages found that the replacement of 20% pork backfat with olive oil does not affect the weight losses and makes the sausages lighter in color and more yellow. The product has an acceptable odor and taste but unacceptable appearance because of the intensively wrinkled surfaces and the development of casing hardening. In their studies into “salami” products, found that the partial substitution of pork backfat by extra virgin olive oil did not substantially affect the chemical, physical, and sensory characteristics of the products, with the exception of water activity and firmness. Linseed oil is another source of fat, substitute of pork backfat with linseed oil in the manufacture of dry-fermented sausages decreased the n6:n-3 ratio (from 14.1 to 2.1) as a consequence of the increase in - linolenic acid.

Addition of soy

Soy proteins (flours, concentrates, and isolates) are more commonly used in processed meat products for their functional properties and relatively low cost compared with lean meat. Soy proteins have been incorporated in these products for their water-binding and fat-binding ability, enhancement of emulsion stability, and increased yields.

Substitution of nitrite in meat products

The curing of meat generally involves the use of a mixture of sodium chloride, sugar, nitrate and/or nitrite and often a reductant such as sodium ascorbate or sodium erythorbate. Nitrites play an important role in preservation, flavour development and possibly for texture. The main contribution of nitrite to the preservation of meat products is its ability to inhibit C. It has been found that a reduction in pH drastically lowered residual nitrite.

Other novel ingredients for functional meat products

There are various health promoting ingredients, that when incorporated at appropriate levels can make meat products healthier or functional. Certain bioactive components like, polyunsaturated fatty acids, use of lecithin, various pre and probiotics, isoflavones, saponins, phytosterols, phytates, proteinase inhibitors, oligosaccharides and powdered brewers yeast can be added in the meat products to make them healthier. Whey protein can be used to develop functional food or meat products. Aloe Vera leaf gel can also be added in meat products to make them functional due to its possible health related action. Supplementing meat products with omega-3 fatty acids can have beneficial effects on the health.

Microbial contamination of meat and meat products is unavoidable as microorganisms are present on animals and in their environment. Thus, raw and not fully heated (commercially processed) or otherwise processed/preserved (e.g. frozen, fermented/dried, high hydrostatic pressure processed, irradiated) meat and meat products are prone to spoilage and compromised safety due to microbial presence and growth. Raw meat products (although few consumers eat certain meat products raw or undercooked, intentionally or accidentally; a practice not recommended) need further processing and/or cooking before consumption. This makes them shelf-stable or semi-perishable, and safe for consumption or ready-to-eat. In general, the shelf-life, quality and safety of meat and meat products are extended and improved through adequate processing, appropriate marketing, storage and preparation for consumption, under properly clean, sanitary and hygienic conditions, following an integrated approach throughout all sectors

of the food supply web, including producers, processors, distributors, retailers, as well as consumers.

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CHAPTER 6

SPICES AND OTHER FUNCTIONAL FOODS



A spice is a seed, fruit, root, bark, or other plant substance primarily used for flavoring, coloring or preserving food. A spice may be available in several forms: fresh, whole dried, or pre-ground dried. The most common spices being used black pepper, cinnamon cumin, garlic, red chilli, turmeric, nutmeg, ginger and cloves.

Turmeric:

The turmeric (*Curcuma longa*) plant, a perennial herb belonging to the ginger family, is cultivated extensively in south and southeast tropical Asia. The rhizome of this plant is also referred to as the “root” and is the most useful part of the plant for culinary and medicinal purposes. The most active component of turmeric is curcumin, which makes up 2 to 5% of the spice. Curcumin exhibited antioxidant properties. It can increase serum activities of antioxidants such as superoxide dismutase (SOD). It can scavenge different forms of free radicals, such as reactive oxygen and nitrogen species (ROS and RNS, respectively) it can modulate the activity of GSH, catalase, and SOD enzymes active in the neutralization of free radicals.

Inflammation has been identified in the development of many chronic diseases and conditions. These diseases include Alzheimer’s disease(AD), Parkinson’s disease, multiple sclerosis, epilepsy, cerebral injury, cardiovascular disease, , cancer, allergy, asthma, bronchitis, colitis,

arthritis, renal ischemia, psoriasis, diabetes, obesity. Curcumin has also been shown to suppress inflammation through many different mechanisms, hence curcumin acts as potential anti-inflammatory agent.

Cardiovascular Effects:

Curcumin's protective effects on the cardiovascular system include lowering cholesterol and triglyceride levels, decreasing susceptibility of low density lipoprotein (LDL) to lipid peroxidation, and inhibiting platelet aggregation.

Gastrointestinal Effects:

Curcumin exert several protective effects on the gastrointestinal tract. curcumin inhibited intestinal spasm and p-tolymethylcarbinol, a turmeric component, increased gastrin, secretin, bicarbonate, and pancreatic enzyme secretion. Turmeric has also been shown to inhibit ulcer formation caused by stress, alcohol, indomethacin, pyloric ligation, and reserpine, significantly increasing gastric wall mucus.

Black pepper

The black pepper (*Piper nigrum*) is a flowering vine in the family Piperaceae, cultivated for its fruit which is usually dried and used as a spice and seasoning, known as a peppercorn. The most active component in black pepper is piperine. Piperine inhibited free radicals and reactive oxygen species, therefore known to possess protective effects against oxidative damage. Piperine was found to prevent the oxidative stress by inhibiting lipid peroxidation, human lipoxygenase and arresting hydroxyl and superoxide free radicals, decrease lung carcinogenesis. Hence piperine possess antioxidant activity. Piperine reduces the risk of lung cancer by altering lipid peroxidation and by antioxidative protection enzymes activation. thereby piperine possess anti cancer activity.

Dietary piperine enhances digestion by stimulation of the pancreatic enzymes and considerably decreases the food transit time of gastrointestinal tract. Piperine increases the saliva production and gastric secretions, and increases the production and activation of salivary amylase. The

orally administration of piperine or *P. nigrum* stimulate the liver to the secrete bile acids which in turn play key role in the absorption and digestion of fats.

Piperine has shown bioavailability enhancing effects on many therapeutically important drugs and nutrients. Piperine increases the absorption of many drugs and nutrients from the gastrointestinal tract by various mechanisms. It alters the membrane dynamics and increases permeability at site of absorption. these enzymatic inhibition by piperine resulted in increased bioavailability of many drugs and nutrients e.g. amoxicillin, ampicillin, resveratrol, beta-carotene, curcumin, gallic acid, Therefore, piperine is known as bioavailability enhancer and a potent drug's metabolism inhibitor.

Cumin seeds

Cumin (*Cuminum cyminum*) is a flowering plant in the family Apiaceae, native from the east Mediterranean to South Asia. Its seeds (each one contained within a fruit, which is dried) are used in the cuisines of many different cultures, in both whole and ground form. The active constituents in cumin are b-pinene, p-cymene, g-terpinene, and cuminaldehyde. They provide carminative, eupeptic, astringent, antibacterial, cough remedy and analgesic effects.

Dietary supplementation of both cumin and was found to prevent the occurrence of colon cancer induced by a colon-specific carcinogen, 1,2-dimethylhydrazine (DMH). the excretion of fecal bile acids and neutral sterols was significantly increased, and cumin was shown to protect the colon and to decrease the activity of β -glucuronidase and mucinase enzymes.

Black cumin

Black cumin can refer to the seeds of either of two quite different plants, both of which are used as spices: *Bunium bulbocastanum*, black cumin is considered similar to caraway, but they are two distinctly different plants. The seeds differ dramatically in shape, color and size. *Nigella sativa*, black cumun is also called kalonji or nigella, and more common in the Far East, Mideast, India and Africa. Black cumin seed have two different forms of alkaloids: isoquinoline alkaloid that includes: nigellicimine, nigellicimine n-oxide and pyrazol alkaloid that includes: nigellidine and nigellicine. Cholesterol lowering property of black cumin may be owing to reduction in hepatocytic synthesis of serum cholesterol or by lowering reabsorption in small

intestine. Hypoglycemic activity of black cumin may be due to stimulation of release of insulin and partial proliferation of pancreatic beta-cells, mediated by extra pancreatic actions.

Cloves

Cloves are the aromatic flower buds of a tree in the family Myrtaceae, *Syzygium aromaticum*. The active component eugenol is present in clove. Eugenol has antimicrobial effects such as disrupt cellular membranes, inhibit biofilm formation, suppress quorum sensing, decrease virulence factors, and arrest cell cycle. Hypoglycemic activity of eugenol may be stimulated by glucose uptake, increase glycogenesis and repress hepatic gluconeogenesis. The neurobehavioral benefits of eugenol are alter nerve transmission, improve nerve function, reduce oxidative stress, decrease stress-induced hormones/growth factors, and modulate brain neurotransmitters and neuropeptides. Thereby it has neuroprotective effect which helps in the prevention of neurological disorders such as epilepsy.

Bay leaves

They are dried aromatic leaves of laurel tree. The leaves are often used to flavor soups, stews, and in briyani preparation. The phytonutrient present in bay leaves is parthenolide. Parthenolide induced inhibition of nitric oxide synthesis has been implicated to be an effective treatment of certain inflammatory and autoimmune diseases including migraine and multiple sclerosis. Parthenolide inhibits growth of tumor cells, thereby it exhibits anti-tumorigenic effect.

Fenugreek

Fenugreek (*Trigonella foenum-graecum*) is an annual plant in the family Fabaceae, with leaves consisting of three small obovate to oblong leaflets. It is cultivated worldwide as a semiarid crop. Its seeds and its leaves are common ingredients in dishes from South Asia. Fenugreek seeds and leaves are used as spices.

Fenugreek seeds are rich sources of protein, dietary fibre, B vitamins, iron and several other dietary minerals. Fenugreek seeds are high in soluble fibers, saponins, trigonelline, diosgenin, and 4-hydroxy leucine. Soluble fibers like galactomannan help in lowering blood sugar by slowing down digestion and absorption of carbohydrates thereby fenugreek seeds are used in the treatment of type 2 diabetes mellitus.

Saponins present in fenugreek seeds form large mixed micelles with bile salts and significantly reduce serum cholesterol by increasing fecal excretion of bile salts, thereby inhibiting cholesterol absorption. Thus fenugreek seeds are used to manage hypercholesterolemia. Fenugreek seeds and leaves contain phenolic and flavonoid compounds which help to enhance its antioxidant capacity. A substance saponin present in fenugreek seeds shows anticancer property.

Ginger

Ginger (*Zingiber officinale*) is a flowering plant whose rhizome, ginger root or simply ginger, is widely used as a spice. Gingerols are the bioactive compound present in ginger. Shogaol an active compound present in ginger exhibited the most potent antioxidant property, because it lowered induced lipid peroxidation and raised the levels of antioxidant enzymes, together with serum glutathione. Gingerols and shogaol these compounds inhibit synthesis of pro-inflammatory cytokines and act as anti-inflammatory agents. Gingerols Inhibits the process of angiogenesis thereby act as anticancer agents. Therefore ginger is used in the treatment of skin cancer. Ginger provides carminative effect.

Chilipepper

The chili pepper (also chile pepper, chilli pepper, or simply chilli) is the fruit of plants from the genus *Capsicum*, members of the nightshade family, Solanaceae. They are widely used in many cuisines to add spiciness to dishes. The active constituents in chili pepper are capsaicin. Low amounts of capsaicin inhibits acid secretion, stimulates alkali, mucus secretions and particularly gastric mucosal blood flow which help in prevention and healing of gastric ulcers. Capsaicin detoxifies carcinogens induced by benzoapyrene to prevent lung cancer. Capsaicin reduces body weight mainly through activation of transient receptor potential vanilloid 1 (TRPV1) cation channel. and the anti-obesity effect of capsaicin is associated with a modest modulation of the gut microbiota.

Cinnamon

It is a spice obtained from the inner bark of several tree species from the genus *Cinnamomum*. It is used mainly as an aromatic condiment and flavoring additive in a wide variety of cuisines, sweet and savoury dishes, breakfast cereals, snack foods, and traditional foods. The bioactive

compounds present in cinnamon are cinnamaldehyde, cinnamic acid, and cinnamate. These compounds exhibit anti-inflammatory, antioxidant properties. Cinnamon can also improve the health of the colon, thereby reducing the risk of colon cancer it act as coagulant and prevents bleeding. It also increases the blood circulation in the uterus and advances tissue regeneration.

Nutmeg

It refers to the seed or ground spice of several species of the *Myristica* genus. *Myristica fragrans* (fragrant nutmeg or true nutmeg). In Kerala Malabar region, grated nutmeg is used in meat preparations and also sparingly added to desserts for the flavour. It has antioxidant property thereby reducing oxidative stress and neutralizing free radicals.

Green tea

Increasing interest in its health benefits has led to the inclusion of green tea in the group of beverages with functional properties. Green tea has been consumed everyday by millions of people around the world since ancient times in order to maintain and improve health. Nowadays, green tea is considered one of the most promising dietary agents for the prevention and treatment of many diseases. Available data suggests that aqueous extract of the green tea designed as catechins (EGCG, EGC, ECG and EC) possess antioxidant, antimutagenic, antidiabetic, anti-inflammatory, antibacterial and antiviral, and above all, cancer-preventive properties. Epidemiological studies suggest that consumption of green tea may have a protective effect against the development of several cancers. The polyphenols present in tea can also decrease the risk factor of specific type of cancers by inducing phase I and phase II metabolic enzymes that increase the formation and excretion of detoxified metabolites of carcinogens. In addition, several epidemiological studies with humans have demonstrated that regular green tea consumption has beneficial effects and it shows a significant rate of protection against the development of some oral diseases and against solar radiations. It also contributes to body weight control and to the rise of bone density as well as being able to stimulate the immune system. Most modern medicines used to treat cancer have serious side effects, high costs, and other associated risks. Green tea, on the other hand, is safe and widely available as a beverage and a nutritional supplement. While no single food item can be expected to provide a significant

effect on public health, it is important to note that a modest effect between a dietary component and a disease having a major impact on the most prevalent causes of morbidity and mortality, i.e., cancer and heart disease, should merit substantial attention. Furthermore, growing scientific evidence suggests that green tea is effective in preventing many diseases associated with aging, including prostate and other cancers. It is yet promising area of research for future human studies.

Summary listing of various bioactive food components, common food sources, and biological functions

<i>Bioactive component</i>	<i>Food source</i>	<i>Functions</i>
Glucosinolates, diallyl sulfides, isothiocyanates	Broccoli, cauliflower, brussels sprouts, garlic, onions	Induction of detoxifying enzyme systems, antimicrobial, immunomodulator, anticancer
Tocopherols and tocotrienols	Vegetable oil, nuts, seeds	Antioxidant, immunomodulator
Isoflavonoids and polyphenols	Grapes, red wine, tea, fresh fruit, and vegetables	Antioxidant, lipid- lowering, immunomodulator, antiosteoporotic, anticancer
Phytoestrogens (genistein, daidzein)	Soybean and other soy-based products, flaxseed, cabbage, legumes, tea	Anti-estrogen, anti- osteoporotic, antiproliferative
Phytosterols	Vegetable oils, nuts	Lipid-lowering
Dietary fiber	Whole grains, oats, fresh fruit with skin	Lipid-lowering
γ -linolenic acid, α -linolenic acid, and omega-3 fatty acids	Evening primrose or borage oil, walnuts, rapeseed, flaxseed, fish, microalgae	Anti-inflammatory, lipid- lowering
Lutein	Green leafy vegetables	Reduction in age- related macular degeneration
Carotenoids	Carrots, corn, squash, green leafy vegetables, oranges, papaya, red palm oil	Antioxidant immunomodulators
Lycopene	Tomatoes	Antiproliferative, anticancer
Bioactive peptides:	Milk and fermented milk	Immune system enhancing,

<i>Bioactive component</i>	<i>Food source</i>	<i>Functions</i>
lactoferrin, glycomacropeptide	products	antiproliferative, antimicrobial
Probiotics	Fermented milk products	Immunomodulators, anticancer , gastrointestinal health modulators

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CONCLUSION

Mounting evidence supports the observation that functional foods containing physiologically-active components, either from plant or animal sources, may enhance health. It should be stressed, however, that functional foods are not a magic bullet or universal panacea for poor health habits. There are no “good” or “bad” foods, but there are good or bad diets. Health-conscious consumers are increasingly seeking functional foods in an effort to control their own health and well-being. These factors include the complexity of the food substance, effects on the food, compensatory metabolic changes that may occur with dietary changes, and, lack of surrogate markers of disease development. Additional research is necessary to substantiate the potential health benefits of those foods for which the diet-health relationships are not sufficiently scientifically validated.

Research into functional foods will not advance public health unless the benefits of the foods are effectively communicated to the consumer. Finally, those foods whose health benefits are supported by sufficient scientific substantiation have the potential to be an increasingly important component of a healthy lifestyle and to be beneficial to the public and the food industry.



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