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A review of Role of nutraceuticals in human health

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ABSTRACT

Nutraceuticals combine "nutrition" and "pharmaceutical," meaning they are foods or parts of foods that play an important role in keeping the body healthy. The nutraceutical market is growing worldwide because of changes in health trends and population growth. These foods include things like dietarydietry fiber, prebiotics, probiotics, healthy fats, antioxidants, and natural or herbal foods. Nutraceuticals help fight common health problems like obesity, heart disease, cancer, osteoporosis, arthritis, diabetes, and high cholesterol. Overall, nutraceuticals have brought a new way of thinking about medicine and health, where the food industry focuses more on research to improve health.

Key Words: *Dietary fiber. Probiotics. Prebiotics. Polyphenols. Spices. Human diet.*

Introduction

Over the past two decades, with heightened interest in the good impacts of nutrition through diet, lifestyle modifications over the recent years have changed simple eating habits. Junk food has become extremely more popular now than ever before, and consequently, there are many more health issues arising from bad nutrition. Today, one in three people suffers from obesity. Heart disease is still a killer, according to statistics, in most countries classified as developing. Next follows cancer, osteoporosis, arthritis, and so on.

Thus, most people feel frustrated about these expensive, high-tech treatments in modern medicine. Other health options that are found to be helpful are then sought by such people, and the complexity of the health care system makes nutraceutical, or foods that have health benefits, an attractive option. In fact, this ancient saying of Hippocrates is very true today: "Let food be thy medicine and medicine be thy food.".

Nutraceutical is one of the newest forms of a natural product and can be classified somewhere on that gray line between food and medicine..[1]

Although mankind has been using nutraceutical for ages, it was only recently that science began to prove them as effective tools for health. Nutraceutical come in plant and animal origins, and they are a really exciting venture for the food industry in terms of creating new, healthy products..[2]

Today, researches in nutrition are not merely on the foods that guard health and prevent diseases but more towards those that fight harmful bacteria, chemicals, or unhealthy fats. The general idea and benefits of nutraceutical on the health of the foods we consume form the focal point of this review.

Nutraceutical

The concept of "nutraceutical" was first proposed in studies from the U.K., Germany and France, which showed that people considered diet more important for good health than exercise or genetic factors. The word "nutraceutical" is a portmanteau of "nutrition" and "pharmaceutical," and was coined by Stephen De Felice as founder of the Foundation for

Innovation in Medicine in 1989. De Felice defined nutraceutical as "a food (or part of a food) that provides health benefits, including the prevention or treatment of disease."[3]

Health Canada has a similar definition but determines that these are formed from foods, sold in forms like pills, powders, or other medicinal forms rather than usual food.[4]

Nutraceutical originated in the food industry, herbal and dietary supplements, the pharmaceutical industry, and large companies combining medicine, farming, and nutrition.[5]
They involve a range of products from specific nutrients or herbal supplements to special "designer" foods genetically engineered and also processed foods like cereals, soups, and drinks.[6]

Nutraceutical may help support health in various areas, including preventing and treating arthritis, colds and coughs, sleeping disorders, digestion, or even certain cancers. They might also help with osteoporosis, blood pressure, cholesterol, pain management, depression, and even diabetes[7]

According to Rishi (2006) and Hathcock (2001), the nutraceutical industry has three main areas, including herbal/natural products, dietary supplements, and functional foods. Herbal/natural products and dietary supplements are growing the fastest out of the three areas.The global nutraceutical market had attained $74.7 billion at 2007. $46.7 billion was that at 2002. The main areas or markets for nutraceuticals are found in the USA, UK, and Japan..[8]

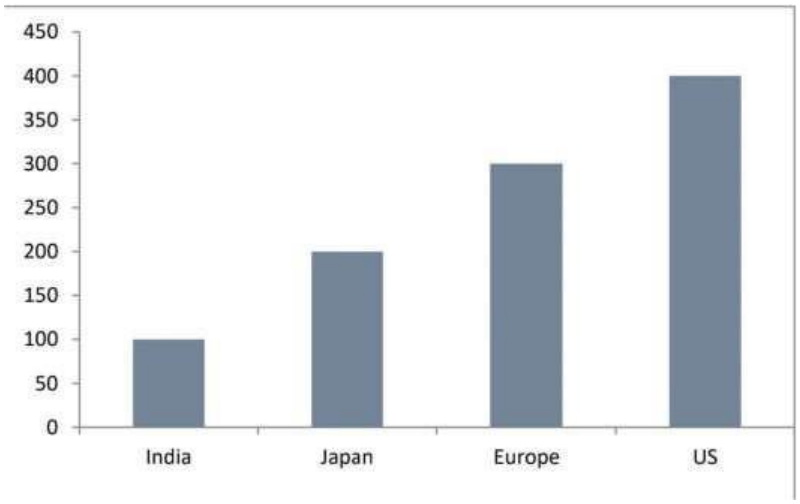

Fig. 1 Nutraceutical Market in different Countries

Research and development are booming in this burgeoning nutraceutical field. Indeed, one of the huge scientific needs is the standardization of nutraceutical compounds or products. This includes carefully conducting clinical studies to support health claims, which will help build trust with consumers and benefit the nutraceutical companies.

CLASSIFICATION OF NUTRACEUTICALS ;
Classification based on food sources
Nutraceutical are classified as traditional/conventional or no traditional nutraceutical based on natural food sources (Ruchi, 2017). [9]

Traditional nutraceutical:
These organic compounds are called photochemical, which plants produce to protect themselves. Thus, their presence in our diet may benefit our health. Photochemical support the body's needed processes, such as acting as helpers in biochemical reactions.Traditional nutraceutical are natural, uncomplicated foods. They contain natural nutrients in them that provide health benefits. Penelope is present in tomatoes, omega-3 fatty acids in salmon, and sapiens in soy. Such nutrients are present in a variety of fruits, vegetables, grains, fish, dairy, and meat products. Research further proved that apart from just nutrition, tomatoes benefit the body through their lycopene content, and salmon benefits the body through its omega-3s.These types of nutraceuticals are directly taken from nature and are consumed straight, thereby providing so much health benefit. (Chanda et al., 2019) [10].
Chemical components, pro biotic microbes, and nutraceutical enzymes are all examples of classic nutraceuticals.

Chemical constituents include the following classifications:

Nutrients: Nutrients can be used to manage and prevent a number of conditions such as strokes, cataracts, osteoporosis, diabetes, heart disease, and cancer. Mineral ingredients derived from plants and animals, plus dairy, are useful in the

management of osteoporosis and anemia. Omega-3 fatty acids in flambeed and salmon play key roles in reducing inflammatory conditions, supporting brain functioning, and reducing cholesterol buildup.

Herbals: Botanical foods or herbs are some of the oldest known foods with several remedies for short-term as well as long-term illnesses. Many medicinal herbs have nutraceuticals, therefore, they are a good source of natural medicine meant for the treatment of severe and chronic health problems**.** [11].

Phytochemicals are plant chemicals that have protection or anticancer activities but are not nutritional. Non-essential nutrients help out by inhibiting harmful substances, with provision of aiding in digestion and enhancing absorption or stability of nutrients that are important. Phytochemicals, also known as nutritionists, are compounds found in a wide variety of foods; they include whole grains, beans, fruits, vegetables, and herbs. These compounds, when alone or in combination, hold great promise for the treatment of a host of health problems. [12].

Pro biotic microorganisms :

Pro biotic are living bacteria provided in adequate amounts to have a health benefit. They appear in many different forms, ranging from powder, liquid, gel, and paste to granules or capsules, and are often used for the treatment of conditions like lactose intolerance, diarrhea, and antibiotic-associated problems.The two most commonly known pro biotic are Lactobacillus and Cyanobacteria, but yeast like S. eviscerate and some species of E. coli and Bacillus can be used as well. Lactic acid bacteria, including Lactobacillus, were already used centuries ago in the fermentation of food to enhance health.Pro biotic are beneficial because they enhance the gut health and immune system, improve nutritional uptake, alleviate symptoms of lactose intolerance, and reduce certain infections. [13].

Nutraceutical enzymes :

Enzymes are of life; without them, our bodies cannot work. People with diseases like low blood sugar or blood sugar and obesity can, somehow, improve their symptoms by taking enzyme supplements from microbes, plants, or animals.Non-conventional nutraceuticals are additives produced through nutrient enrichment bestowed on food products as a result of agricultural breeding. Some examples include calcium-enriched orange juice, vitamin- and mineral-enriched breakfast cereals, and folic acid-enriched flour. Agricultural scientists have devised techniques to enrich the nutritional properties of crops.Non-traditional nutraceuticals are divided into recombination and fortified categories. Recombine nutraceuticals are such nutraceuticals that are prepared by employing biotechnology. Here, enzymes containing nutrients are extracted from fermentation processes and make cheese and bread very nutritious. Biotechnology also enables energy-rich foods like bread, wine, yogurt, cheese, and vinegar to be developed. It permits creating probiotics and extracting healthy compounds by either enzyme or fermentation technologies and genetic engineering. [14].

Classification by chemical nature :

Figure 2 represents the classification of nutraceuticals based on whether they are derived from primary and secondary metabolites, which ranges from isoprenoid derivatives, phenols, amino acids, carbohydrates, fatty acids, structural lipids, and minerals.

Classification on Basis of Mechanism of Action

Nutraceuticals have further classification on mode of action. For health properties, nutraceuticals may be assorted especially by its function. These classifications range from antibacterial and anti-fungal to antioxidant, anti-inflammatory, and anti-obesity nutraceuticals.

[15]

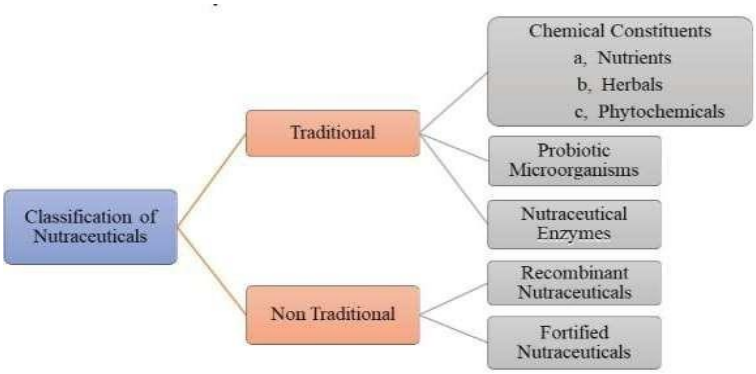

Fig . 2 Classification of nutraceuticals based on their source

Categorizing nutraceuticals

Nutraceuticals may be categorized in many ways, which will facilitate easy and convenient learning about them for use in clinical trials, food development, or diet plans. Common classifications include their food sources, how they work in the human body, and what chemical makeup they contain. The food sources applied in nutraceuticals are all natural, and their categories may differ.[16]

1.Dietary Fibre

2.Probiotics
3.Prebiotics
4.Polyunsaturated fatty acids
5.Antioxidant vitamins
6.Polyphenols
7.Spices

Dietary fibre

Dietary fiber are plant substances that are not broken down by digestive tract enzymes but are instead upon them by gut micro-flora. The diet fibers mainly include non-starch monosaccharide (NSP) such as cellulose's, nitrocellulose, gums, pectin, lignin, resistant starches, and dextrins. Soluble foods include fruits, oats, barley, and beans. Chemically, dietary fiber consists of carbohydrate polymers with a degree of polymerization of three or higher and is not digested and absorbed in the small intestine.[17]

Dietary fibers can be further divided, based upon water solubility, into two types:

Insoluble Dietary Fiber (IDF): This includes cellulose's, some nitrocellulose, and aligns, which is fermented to a limited extent in the colon.

Soluble Dietary Fiber (SDF): It includes Beta-glucagon, pectin's, gums, mucilage's, and nitrocellulose. These are fermented in the colon.

The soluble fiber components delay gastric emptying and therefore reduce the digestion pace. It increases nutrient uptake while inducing satiety. Soluble fiber has been shown to lower LDL cholesterol and improve glucose tolerance by increased binding of insulin receptors. It also enhances bulk in the feces by retaining water, allowing for an improvement in gut transit time and stimulation of beneficial bacteria like Cyanobacteria. High fiber intake is linked with lower risks of chronic conditions, including coronary heart disease, stroke, hypertension, diabetes, obesity, and gastrointestinal disorders.[18]

Other benefits of dietary fiber include serum lipoprotein changes, enhanced control of blood glucose levels, weight control, and facilitation for gut regularity. Some evidence also exists for an enhancement of immune response by some fibers. In contrast, the intake of an excessive amount of fiber results in reduced absorption of vitamins and minerals and accompanied by diarrhea and other gastrointestinal problems.

Generally, the dietary intake of fiber falls within the range of 20-35 g/day in adults and approximately 14 g per 1,000 k cal in children.

Polyunsaturated fatty acids (PUFA)

The PUFAs are termed as "essential fatty acids" since they are essential to the body's functioning, which means that they need to be supplied through diet. There are two kinds of PUFAs: namely the omega-3 (n-3) and the omega-6 (n-6).Omega-3 Fatty Acids: The primary ones are α-linolenic acid (ALA), eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA). ALA is the precursor of both EPA and DHA. These have primarily been found in fatty fish, like mackerel, salmon, and tuna, as well as in fish oils. In contrast, ALA is obtained in flaxseed, soybeans, canola, walnuts, and red/black currant seeds.[19]

Omega-6 Fatty Acids: These also comprise linoleic acid (LA), γ-linolenic acid (GLA), and arachidonic acid (ARA). LA is contained in vegetable oils such as corn oil, safflower, soybean oil, while ARA is mostly contained in meat, poultry, and eggs.Advantages of Omega-3 Fatty Acids: Omega-3 fatty acids have beneficial effects on cardiovascular health in that they help prevent irregular heartbeats, decreased lipid levels, and reduced blood clotting. New studies are emerging to show that omega-3s also promote healthy premature infants, manage asthma, and reduce the symptoms of bipolar disorder, depression, and other conditions.The FDA recommends a daily intake of no more than 3 g of EPA + DHA, with no more than 2 g from a supplement.

Probiotics

Probiotics are live microorganisms that, when administered in adequate amounts, may confer health benefits through improvement of the balance of intestinal macrobiotic. They are used to treat such common conditions as lactose intolerance, diarrhea, and antibiotic-associated side effects.

Some common probiotics are:

Lactobacillus, such as L. acidophilus
Gram-positive cocci, such as Lactobacillus lactis
Cyanobacteria, like B. bifidum

Probiotics: They maintain health of the gut due to the presence of antibacterial substances produced and resisting the acidity of the stomach, adhesion with the tissues of the gut. They also play a role in reducing the chance of systemic diseases, such as allergy, asthma, infections, cancer.[20]

Prebiotics

Prebiotics are those components of diet which selectively nourish the beneficial gut bacteria so as to enable their proliferation, such as Lactobacillus and Bifido bacteria. These include typically short chain oligo saccharides, which cannot be hydrolized by human body, like for example fructo-oligosaccharides, extractable from food products, bananas, chicory roots, or beans.These health benefits include improved lactose tolerance, antitumorigenic effects, better gut

immunity, and reduced cholesterol levels. An average daily intake of prebiotic is 5-20 g though higher amounts of consumption may contribute to diarrheal diseases and bloating.
[21]

Selenium

Selenium is a trace mineral that supports the body's antioxidant defense system and regulates thyroid hormone metabolism. It is plentiful in Brazil nuts. The human body produces selenoenzymes such as glutathione peroxidase to protect cells from oxidation.It has a reduced risk of certain cancers and cardiovascular diseases, although the evidence for its direct effect on heart disease is not well defined. It also enhances the immune function and guards the thyroid.Recommended intakes range from 20 μg in children to 55 μg in adults. Too much selenium will lead to selenosis through extreme loss of hair and gastrointestinal issues and fatigue.[22]

Antioxidant Properties of Vitamins

Vitamins C, E, and carotenoids (like β-carotene) are highly protective antioxidants. They exert antioxidative effects, which prevent oxidative stress that leads to degenerative diseases, cancer, and heart disease.Vitamin E, including tocopherols and tocotrienols, protect cell membranes and LDL cholesterol from oxidation.Vitamin C is an antioxidant that neutralizes free radicals and has a synergistic effect with Vitamin E.Carotenoids such as β-carotene, lutein, and lycopene quench free radicals and protect tissues against oxidative processes' damage.

These are some of the common vitamins found in fruits and vegetables, and an important role in preventing diseases.[23]

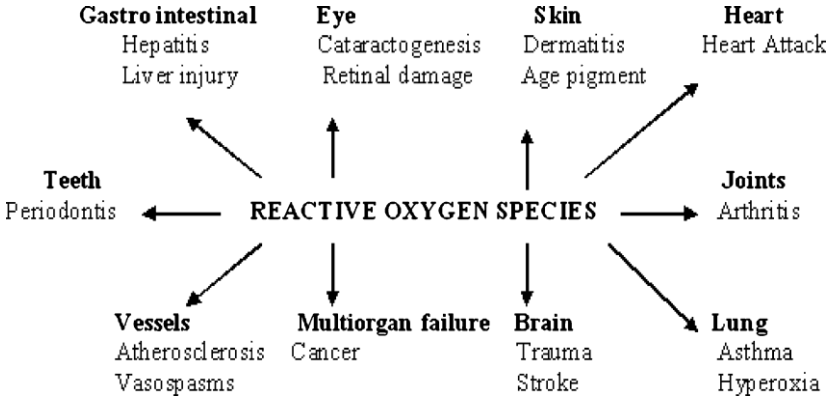

Fig. 3 Clinical conditions involving reactive oxygen species

Polyphenols

More than 8,000 types of poly-phenols are accounted for by a vast number of phytochemicals, mostly produced by plants as secondary metabolites, primarily to protect themselves against environmental stress like photosynthetic stress and ROS. Flavonols, flavones, flavan-3-ols, flavanones, and anthocyanins are some of the most important ones. These compounds are mainly synthesized through an extremely branched phenylpropanoid pathway.[24]

Flavonoid s and phenolic acids are among the most ubiquitous food polyphenols. New emerging research on these compounds has generated much interest based on their potential health benefits. In vitro studies have demonstrated that these polyphenol compounds may influence cellular processes-for example, gene expression, apoptosis or programmed cell death, platelet aggregation, and intercellular signaling. All these imply them to be compounds with anti-carcinogenic and potentially anti-atherogenic effects[25].With such properties, polyphenols are regarded as extremely important dietary components that foster health and avert various chronic diseases.0as illustrated in Fig. 4.

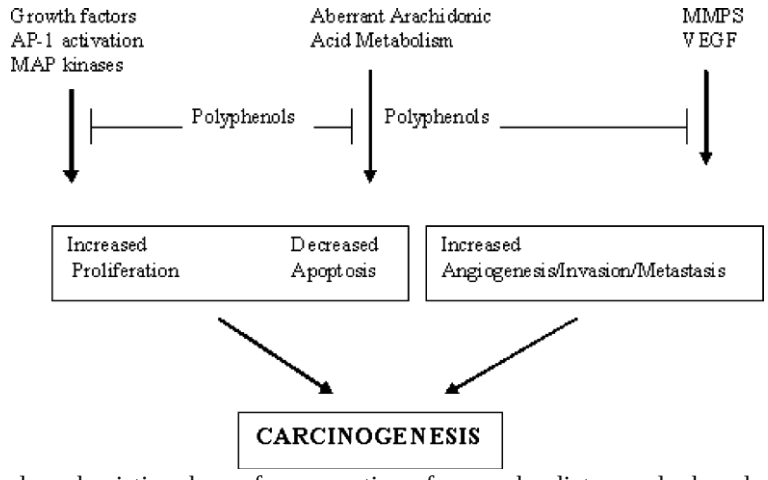

Fig. 4 Proposed mechanistic scheme for prevention of cancer by dietary polyphenols

Polyphenols are plant kingdom compounds that have many health benefits like antioxidant, anti-inflammatory, anti-microbial, and protecting the heart. They are also believed to be able to stop Alzheimer's and diabetes diseases. However although most famous for their antioxidant activities, polyphenols proved to be far more potent than vitamins C and E when tested in a lab-assay comparing the same molar quantities of the two nutrient-compounds. However, the degree to which polyphenols are effective in the body will largely depend on the rate at which they absorb and metabolize within the body system, that is, how well they are digested and broken down.Flavonoid s have been reported to raise the level of glutathione in the body, which is a compound that plays an essential role in protecting cells from damage and thus facilitates detoxification in the body.Another well-known example is the French Paradox, in which the French have fewer cases of heart disease despite a diet rich in fats. It is partly accredited that a polyphenol contained in red wine, resveratrol, which the French drink regularly. Resveratrol is found to have antioxidant and anti-inflammatory properties that protect the heart and may have a cancer-preventing effect .[26]

Tea and Its Health Benefits

Tea, specifically green tea, is another good source of polyphenols such as catechins that have been proven to help in the prevention of cancers, mainly in the lungs and other organs. Some research also indicates that consumption of green tea regularly may reduce the risk of cancer, especially among nonsmokers and non-users of alcohol. In addition, green tea reduces the risk of heart disease because it can decrease cholesterol and prevent damage to lipids in the body.[27]

Legumes and Soybeans

Legumes, such as soybeans, are very rich in protein and polyphenols-isoflavones. These compounds act as phytoestrogens. That is, these types of compounds can mimic the action of estrogen within the body. Isolation of compounds from soybean has been revealed to have a protective effect against hormone-dependent cancers like breast and prostate cancer. However, soybeans have yet to be established as a method for preventing colon cancer. Other legumes include hyacinth beans and winged beans containing other added compounds that may fight cancer and microbes. Among the lesser-known legumes, there are cowpeas and Cajanus cajan, rich in antioxidants that would prevent the body from contracting various diseases and help with nutrition.[28]

Polyphenols are thought to help prevent cancer by virtue of their antioxidant activity, but evidence remains very sketchy and much more research is required. Better methods for determining the amounts of specific polyphenols in our diets would help us understand their role in cancer prevention-as it would biomarkers, or biological markers of exposure, and better dietary surveys. We cannot yet say, for now, that the intake of specific polyphenols (or foodstuffs) on a regular basis reduces the risk of cancer in humans.[29]Too much exposure to polyphenols-even from the diet-can also be harmful. Flavonoid, one family of polyphenols, can cause DNA damage and have been linked to infant leukemia, among other things. Although the radicals formed by flavonoid s are not as damaging as some of the other not so nice stuff circulating in the body, cell damage is cell damage and can contribute to disease.

There is, however, concern that supplementing with flavonoid s to increase the levels of glutathione-protective molecules may not be safe-or even useful-because these compounds are very poorly understood and the actions of these molecules within the body are very complex. We don't really know whether polyphenols have a role in regulating glutathione levels in humans, or whether they have direct effects on critical processes in cells that protect us from disease. It is for this reason that it remains a mystery why fruits and vegetables that contain polyphenols help to prevent illness.(Moskaug et al. 2005).[30]

Table 2 Antioxidant phytochemicals of some tropical legumes Values represent means of triplicate. Values with the same alphabet along the same column are not significantly different ($p>0.05$) Source: Oboh (2006)

Sample	Vitamin C (mg/100 g)	Phytate (%)	Total phenol (mg/g)
V.unigulata (white)	0.5 ± 0.1^{b}	2.5 ± 0.4^{ab}	0.3 ± 0.0^{b}
V.unigulata (IT8pD 997 white)	0.9 ± 0.1^{a}	1.4 ± 0.1^{c}	0.3 ± 0.1^{b}
V.unigulata (brown drum)	0.9 ± 0.1^{a}	1.9 ± 0.3^{a}	0.4 ± 0.1^{b}
V.unigulataI (brown)	0.9 ± 0.2^{a}	2.3 ± 0.1^{ab}	1.0 ± 0.3^{a}
V.unigulata(Ife brown)	0.9 ± 0.1^{a}	2.0 ± 0.4^{b}	0.9 ± 0.1^{a}
C.cajan (brown)	0.9 ± 0.0^{a}	2.4 ± 0.2^{ab}	1.2 ± 0.2^{a}
C.cajan (white)	0.9 ± 0.1^{a}	2.0 ± 0.1^{b}	0.4 ± 0.1^{b}
S.sternocarpa	0.8 ± 0.2^{a}	2.4 ± 0.3^{ab}	0.7 ± 0.1^{ab}

Spices

For thousands of years, spices have been added to enhance taste, aroma, and visual appeal of food. In tropical countries, there is a readily available assortment of spices that seem to make the food more flavorful and delectable. Trace amounts of spices have been proven to carry huge health benefits. They have antioxidant, anti-inflammatory, and protectiveness properties. Another area where spices have protective effects is on the digestive, heart, lung, metabolic, reproductive, and nervous systems. They could therefore contribute to overall health improvements. Some of these functional aspects of the spices are mentioned in the Fig. 6.

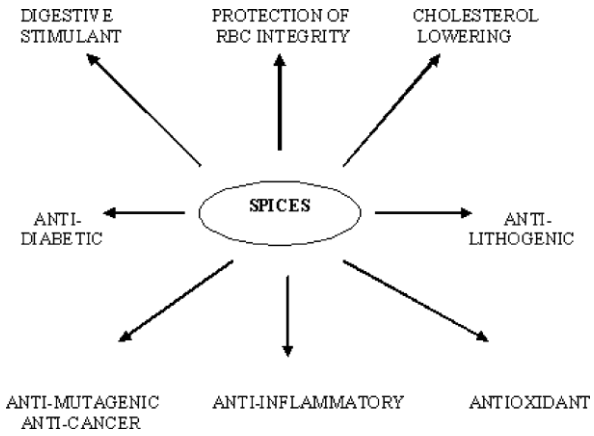

Fig. 5 Summary of potential health benefits of spices

Most spice ingredients are terpenes and other parts of essential oils, which have been found to be effective in various ways. For example, taking about 50 grams of onion and 5–6 cloves of garlic raw would reduce cholesterol. Recent studies prove that aged garlic extract actually works better than fresh garlic in improving cholesterol levels as well as lowering blood pressure. Administering it with fish oil lowers cholesterol and triglycerides further.Most spices and herbs are not toxic if used in food but can be lethal if applied in huge quantities as medication and especially accompanied by concomitant medications. Excessive garlic, for example, at a dosage of 4 ml/kg bwt of raw garlic juice, may lead to health problems such as anemia, loss of weight, problems with the heart, liver, and kidneys, among others. Massive onion ingestion affects tissues in rats[31].

Some spices, including fenugreek seeds, garlic, onion, and turmeric, contain substances that can manage diabetes and all the subsequent complications. The chronic use of curcumin lowers blood lipid peroxide by an average of 33% because of its antioxidant activity. Spices and herbs are classified as "generally recognized as safe" (GRAS) for human consumption in the United States..[32]

THERAPEUTIC POTENTIAL OF NUTRACEUTICALS IN HUMAN HEALTH:

Prevention and treatment approaches through nutraceuticals have been one of the most important strategies in the management of cardiovascular diseases such as hypertension, coronary heart disease, or more commonly known as heart attack, and cerebrovascular diseases, otherwise called stroke. Cardiovascular diseases associated with an unhealthy diet that consists of calorie-dense foods, nutrient-poor foods, and heavily processed foods causes systemic inflammation, poor insulin sensitivity, obesity, hypertension, high cholesterol, and glucose intolerance.[33]Some foods and its fractions have been identified to reduce the risk of CVD. Its potential to improve cardiovascular health includes polyphenols found in grapes, cocoa, and tea. Other nutrients include vitamin D, coenzyme Q10, folic acid, omega-3 fatty acids, and polyphenols, which contribute to artery health and avoiding harm to the cardiovascular system.The best sources of flavonoids include onions, grapes, apples, and cherries. They tend to lower blood pressure level because they inhibit the Angiotensin Converting Enzyme, which leads to hypertension and coronary artery disease. Flavonoids also inhibit the enzyme cyclooxygenase since it breaks prostaglandin that causes platelets to stick together as clots. By this mechanism, the vasculature is preserved so that smaller capillaries remain open and provide oxygen and nutrients to the cells.These nutraceuticals added to the diet can significantly lower the heart disease risk factor and improve overall cardiovascular health.

Nutraceuticals in cancer:

Cancer is a condition where, in any part of the body, cells do not divide normally; these malignant cells may invade normal ones. Cancer arises through many complicated factors which occur sequentially leading up to the uncontrolled spread of these malignant cells, termed as metastasis. It is one of the major global health threats with rising incidence and mortality rates.Oxidative stress and redox signaling, along with environmental aspects, contribute to the development and spread of cancer. ROS can make cancer cells more resistant to therapy. Chronic inflammation is also closely related to increased risk of cancer due to its potential to suppress the immune system and induce genetic mutations as well as alteration of cancer-related proteins through free radicals and aldehydes produced during chronic inflammation.[34]Therefore, many natural products and antioxidants such as plant and microbial secondary metabolites

have been incorporated into chemotherapy to make the treatment more effective. Foods and herbs, such as ginger, garlic, flaxseed, cabbage, soybeans, fenugreek, green tea, and umbelliferous vegetables, possess tremendous anticancer properties.

Nutraceuticals, especially phytochemicals play a very important role in recovery from cancer. Most of the drugs used against cancers of today are evolved from nature. Low-carb, moderate protein, fiber, and healthy fat diets are also suggested for cancer patients to be eaten that may enhance the recovery of the disease by medical treatments.

Nutraceuticals in Diabetes Mellitus: Diabetes mellitus is a chronic metabolic disorder wherein the body is unable to convert carbohydrates into energy because of an absolute or relative lack of insulin-the hormone secreted by the islets of Langerhans of the pancreas. It is diagnosed by elevated, abnormal blood glucose levels-the consequence either of little production of insufficient insulin or the body's inability to properly utilize it. Various nutraceuticals and bioactive compounds, which include phenolic compounds, sulfur compounds, herbs, and natural antioxidants, play a significant role in glucose metabolism and may contribute to the prevention of diabetes and its complications. Among dietary supplements such as L-carnitine, lipoic acid, omega-3 fatty acids, berberine, chromium, soy, and phytoestrogens, these are all commonly accessible and thus can be used as a management in diabetes as suggested by the clinicians.[35]

Nutraceuticals in Obesity: Obesity is caused due to over-consumption of high-fat and energy-dense foods. Due to these deposits of fat plaques inside the arteries, it leads to narrowing up of the arteries and blocks the blood flow to various organs, which causes angina pectoris, heart attack, cardiac arrest, transient ischemic attacks, and stroke. Obesity has been defined as an excess amount of body fat, though there is no clear threshold to define what is "unhealthy." Body Mass Index is also used most commonly for classifying weight status: "normal weight" (18.5-24.9 kg/m²), "overweight" (25-29.9 kg/m²), or "obese" (30 kg/m²). Functional foods includes fortified margarine (plant sterol and stanol esters), oolong tea (catechins), green tea (organosulfur compounds), garlic (organosulfur compounds), psyllium (soluble fiber), and soybean (protein). These foods can help treat obesity and prevent it from occurring. The mechanisms of action of these foods include removing excess fat through the inhibition of pancreatic lipase, induction of thermogenesis, prevention of adipocyte differentiation, enhanced lipid metabolism, and decreased appetite.) [36].

Nutraceuticals in Alzheimer's disease:

Alzheimer's disease refers to the most common form of dementia, a progressive and degenerative neurological disorder. This disease has no known cure, and it leads to death in old age. In Alzheimer's, necrobiosis occurs because some portions of the beta-amyloid proteins fragment accumulate to form plaques, thereby interfering with acetylcholine communication between neurons. It causes inflammation, reshaping proteins, and neuron damage that leads to the development of neurofibrillary tangles, which break micro tubules and allow progression of disease. Nutraceuticals compounds beta-carotene, curcumin, lutein, glycogen, and turmeric alone would have been capable of inhibiting the activity of the Alzheimer's disease as they counteract oxidative stress, mitochondrial dysfunction, and neuronal degeneration to offer protective roles for the brain.[37]

Nutraceuticals in Osteoporosis: Osteoporosis is defined by low bone mass with reduction in bone tissue and loss of bone micro structure, thus drastically increasing the chances of experiencing fractures. It comprises two major classes of risk factors: non-modifiable factors that include gender, age, body size, and race and modifiable factors like hormonal levels, lifestyle, diet, alcohol use, smoking, and physical activity. More and more, nutraceuticals-herbs and minerals-dietary items such as dairy products are used to help manage osteoporosis. Calcirol D-3 is yet another nutraceutical that has been promoted hugely. Its several ingredients include calcium and vitamins. All these support the health of bones, thereby helping in the treatment of osteoporosis. Macrobiotics also possesses the potential in lowering the symptoms of osteoporosis and the risk associated with developing this medical condition.[38]

Nutraceutical in osteoarthritis:

This is a condition that is marked by the loss of cartilage in joints, inflammation of the synovial membrane, and resorption of the subchondral bone. It is termed as the most common type of arthritis affecting millions of people worldwide. The protective cartilages at the end of the bones break down over the time, which causes the pain and limits the mobility in the affected joints. Common sites that get affected are the hands, knees, hips, and the spine. Osteoarthritis cannot be cured; however, there is provided treatment to reduce the pain and increase joint mobility. Nutraceuticals like CS (Chondroitin Sulfate) and GLN (Glucosamine) are mostly used to increase symptoms management of osteoarthritis. Combination Glucosamine and Chondroitin is also used in the form of MSM for treating osteoarthritis or joint disorders. Glucosamine is one of the amino sugars found in crustaceans and mushrooms and is the substance that makes up a majority part of GAGs, which are involved in the proper function of joints.[39]

Nutraceuticals in Parkinson's Disease:

Parkinson's disease is a neurodegenerative disorder characterized by the loss of dopaminergic neurons in the substantia nigra due to the subsequent degradation in the amount of dopamine within the brain. There is no cure for this disease, and with L-Dopa, side effects are severe. A number of nutraceuticals have been shown to possess neuroprotective effects and may replace the conventional drugs. These works through multiple mechanisms by chelating iron, modulating cell

signaling, ROS scavenging and free radical scavenging, antiinflammatory, antiapoptotic cell death inhibiting, and augmenting mitochondrial functions. Some phytochemicals such as plant polyphenols, stilbenes, and soybeans can inhibit the further progression of Parkinson's disease. They seem to be promising adjuvant therapy candidates along with pharmacological treatments.[40].

Nutraceutical in COVID-19:
SARS-CoV-2 and Its Impact on Global Health SARS-CoV-2 is a corona virus responsible for COVID-19, which has been ravaging global health and the economy since its emergence in early 2020. WHO first reported the infection in Wuhan, China, on December 31, 2019, and declared it a pandemic on March 11, 2020. COVID-19 is caused by a corona virus: single-stranded positive sense RNA virus; therefore, the RNA can be directly translated into viral proteins in the infected cells. It has been found that this virus also actually causes various symptoms, such as fever, gastrointestinal problems, and lost memory.

Role of Nutraceuticals and Functional Foods in COVID-19: The pandemic has also peaked interest in immune-enhancing foods, vitamins, and nutraceuticals in managing or even preventing COVID-19. Bioactive compounds in food and nutraceuticals may also provide novel potential therapies against COVID-19 because of its anti-inflammatory property and suppression of the virus. These bioactive compounds, among st many others- vitamins A, B, C, D; minerals like selenium, zinc, iron, and polyphenols: quercetin, catechins, anthocyanins have been known to interfere with the proteins of viral envelopes of viruses such as SARS-CoV, MERS-CoV, and SARS-CoV-2. Such functional foods and supplements may hence become natural therapeutic agents that boost the immunity in the body and more importantly, may offer a preventive tool for COVID-19 patients.[41].

Conclusion
With the advancement of lifestyles, at times their bodies experience more oxidative stress. Oxidative stress is when there are too many free radicals in the body. Free radicals are harmful molecules. These free radicals affect the body in various ways. Furthermore, with age, our body's defense mechanism against these free radicals becomes weak. Thus, in the last several years, research has been on how to prevent this through nutraceuticals, which are healthy-promoting products found in nature.The mechanisms of action for most antioxidants, like vitamins and healthy fats (PUFAs), are twofold: some of them directly scavenge harmful free radicals, while the others enhance the self-defense mechanism of the body. Indeed, the review discusses the potential benefits and risks of nutraceuticals for presumably healthy individuals, though efficiency of a specific nutraceutical would be determined by genetic predisposition as well as lifestyle habits of the individual, such as smoking or heavy drinking.
Nutraceuticals can be used in the prevention of diseases and promotion of good health when taken within the amounts required.

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