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REVIEW ARTICLE

Health Benefits in a New Era of Medicine: Probiotics as Nutraceutical

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ABSTRACT

We are aware of the function and needs of the six major nutrients found in food: water, vitamins, minerals, fats, proteins, and carbs. In addition to these elements, foods also include other vital nutrients that are required for good health and are increasingly popular. The idea of "functionality" was inspired by this comprehensive view of nutrition. Due to its potential for having beneficial nutritional, safe, therapeutic, and effective impacts, nutraceuticals have recently gained a lot of attention. They might be involved in biological activities like gene expression, antioxidant defenses, cell division, and upkeep of the mitochondria's integrity. Nutritional supplements are used to boost immunity, prevent chronic diseases, slow down the aging process, and ultimately raise.

Keywords: Curcumin, Intestinal microbiota, Lactobacillus, Nutrition, Pharmaceutical, Probiotics.

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INTRODUCTION

Hippocrates accurately highlighted "Let food be your medicine and medicine be your diet" almost 2000 years ago. Due to the growing understanding that "nutraceuticals" have a significant role in improving health, there is currently a greater interest on a global scale. Dr. Stephen L. De Felice, Chairman of the Foundation for Innovation in Medicine, combined the terms "nutrition" and "pharmaceutical" to create the term "nutraceutical" in 1989. Nutraceuticals, as described by Dr. Stephen Defelice, are any substances that can be used as food or as a component of food and offer medicinal or health benefits, such as the ability to prevent or treat disease. These goods might include everything from isolated minerals, dietary supplements, and diets to GE foods, herbal remedies and these goods can include everything from isolated nutrients, dietary supplements, and diets to GE foods, herbal products, and processed foods including cereals, soups, and drinks. Foods and nutrients are essential to the body's normal operation.[1] Contrarily, nutraceuticals, according to Health Canada, are products made from food but sold in the form of pills, powders, or other therapeutic forms not often associated with food. Development of genetically modified probiotic bacterial strains that can produce and release immunomodulators, such as interleukin-10, trefoil factors (compact proteins co-expressed with mucins in the GIT), or lipoteichoic acid (a significant component of the cell wall of bacteria), is currently the main focus of the field's progressof Gram-positive bacteria) that may have an effect on the host immune system and restore the quantity of beneficial commensal bacterial species.[2] A nutraceutical has been shown to have physiological advantages or to offer defence against chronic diseases. People are more conscious of their lifestyle choices and immunity. As a result, they favoured nutraceutical supplements the most.[3]

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Classification of Nutraceuticals

Functional foods can be categorised in a number of ways and can be recognised or chosen based on their characteristics, therapeutic relevance, or composition. Among the essential standards for categorising functional foods are.

- Food Supply
- Sources of Nutrients and Non-Nutrients
- Organ and Organ System
- Food Modifications
- Particular Foods
- Mechanism of Action
- Chemical Nature

Diet's Perceived Impact on Disease Prevention

Globally, chronic diseases pose a serious threat to public health. According to estimates from the World Health Organization, chronic diseases account for 61 percent of all fatalities worldwide. The percentage of

Table 1: Benefits of functional food through bioactive components

Beta carotene	Carotenoids are among the most common and significant bioactive compounds particularly due to their diverse functions.
Dietary fibers	Dietary fibers include cellulose, hemicellulose, poly fructose, galactooligosaccharides, gums, mucilages, pectins and lignins.
Phytoestrogens	Phytoestrogens are plant compounds parallel to estrogenic (or estrogens), which have roles in the metabolism of carbohydrates, proteins, lipids.
Plant sterols	Sterols and stanols are present in fruits, vegetables, nuts, seeds, cereals, legumes and vegetable oils.
Probiotic	Probiotics are living microbes that include Lactobacillus species, Bifidobacterium species and yeasts
Fatty acids	Essential fatty acids (EFAs) are long-chain polyunsaturated fatty acids, which play an important role in human health promotion, and since the human body cannot synthesize them they must be obtained through diet.
Isothiocyanates	Isothiocyanates are a cluster of phytochemicals containing sulphur that occurs naturally as glucosinolate conjugates in cruciferous vegetables.
Organosulfur compounds	found in garlic and other allium species such as onions and leaks. These flavor compounds also have anti-carcinogenic properties.
Inulin-fructooligosaccharides (FOS)	FOS has its place in the group of carbohydrates known as non-digestible oligosaccharides (NDO) and has been associated with human consumption.
Resveratrol	A polyphenol present in the skins of grapes, berries, and peanuts, has been stated to have anti-inflammatory, antioxidant, and anticancer properties
Quercetin	This is a classic flavonoid universally present in fruits and vegetables, and its antioxidant effect is understood to be helpful for human health
Curcumin	Turmeric/curcumin is one of the important and strongest members of the polyphenol category. Curcumin's basic function is as an anti-inflammatory and an antioxidant, exhibiting functional health benefits.
Gingerol	This is an active ingredient in ginger, a compound that is perceived to relax blood vessels, stimulate blood flow and relieve pain.

chronic disease-related deaths in the total number of deaths worldwide is predicted to rise to 70% and reach a global burden of disease of 56% by 2030. The inverse link between whole grain consumption and CHD[5,6] demonstrates that whole grains have also been proved to be cardioprotective. One of the most important methods for lowering the risk of chronic lifestyle-related disorders including diabetes, dyslipidemia, hypertension, obesity, etc. that are brought on by poor metabolic regulation is through food. The latest trend is to reevaluate foods and their nutritional value.The new trend is to think again about foods and getting enough of them as the first line of defence against these aberrant modes. For the formulation of firm selection criteria for particular strains or combinations of strains for particular clinical diseases, understanding the diverse mechanisms of probiotic action is essential.[4]

Functional Food and Diabetes Management

Hyperglycemia, developing insulin resistance, beta cell dysfunction, impaired insulin secretion, impaired lipid and lipoprotein metabolism, increased oxidative stress, and subclinical inflammation are all characteristics of type 2 diabetes, which may contribute to micro and macrovascular complications. Diet therapy is a cornerstone of diabetes management, and numerous meta-analyses have demonstrated the beneficial effects of functional foods in managing diabetes. In addition to a diabetes diet, functional food consumption, as recommended by epidemiological studies, may provide additional health advantages for patients.

Functional Food and Cancer Management

The leading cause of death is cancer. It has a complex origin, and the rate of cell reproduction and the course of carcinogenesis differ depending on the type of cancer and the cell or tissue involved. According to numerous studies, dietary variables are considered to be responsible for roughly 30% of cancer cases worldwide, which is preventable. One of the key management and therapy approaches for cancer is a balanced diet that includes functional foods.

Coronary Artery Disease and Role of Fiber

Fiber has been proposed to be helpful in the diabetic diet since it has been noted to modulate glycemicresponse.[6] A increasing health concern, cardiovascular disease (CHD) is currently the world's leading cause of mortality.

High total cholesterol and lowdensity lipoprotein (LDL) cholesterol levels have been shown in numerous studies to be mortality and CHD risk factors. Based on its water solubility characteristics, fibre is often subclassified.[7] Fiber has been proven to be useful in enhancing glycemic control and may be crucial in a diabetic diet.[8] Fiber helps treat diabetes, hypercholesterolemia, and the metabolic syndrome by reducing weight and controlling the absorption of glucose and cholesterol. Coronary artery disease will eventually progress significantly its management is significantly influenced by soluble fibre. The benefits of various functional food through their respective bioactive component are illustrated in brief in the (Table 1).

Probiotic

The word "probiotic" means "for life" and is derived from the Greek words "pro" and "biotos." Havenaar and Huisint Veld[9] proposed the contemporary definition of probiotic. Probiotics are defined as live microbial cultures of a single strain or combination of different strains that benefit the host animal, either directly or indirectly, by enhancing its intestinal microbial balance, by the Food and Agriculture Organization of the United Nations and the World Health Organization. Some antibiotics are resistant to probiotic cultures. There are worries that pathogenic bacteria in the gut may pick up antibiotic resistance from probiotic strains.[11] Bifidobacterium and Lactobacillus, two genera of lactic acid bacteria, are the most frequently used and have probiotic properties. Additionally, the role of probiotics in the prevention and treatment of disorders linked to harmful bacteria, such as cancer, diabetes, and obesity, is an intriguing and quickly developing study field. Probiotics have shown tremendous promise as treatments for a number of illnesses, but the exact processes underlying these benefits are still not entirely understood. The removal of the intestine's harmful flora and maintenance of a friendly environment are made possible by probiotics, such as the beneficial ingestion of Bacillus bulgaricus.[10] Probiotics are defined as "live microorganisms that when administered in suitable proportions bestow a health benefit on the host" by FAO/WHO, which is the definition currently in use.

Role of Probiotic Bacteria in Dairy Fermentation

Probiotic bacteria play one or more roles in dairy fermentations, including;

- Preserving milk by producing lactic acid and perhaps antibacterial substances.
- The creation of flavouring substances (such as the acetaldehyde found in cheese and yoghurt) and other metabolites (such as extracellular polysaccharides) that will give a product the desired organoleptic qualities.
- Increasing the nutritional value of food, such as by releasing free amino acids or synthesising vitamins and minerals.
- Providing unique medicinal or preventative qualities, such as cancer prevention and serum cholesterol level regulation.

Role of Milk and Milk Fat

By decreasing their direct exposure to severe conditions, the buffering action of milk and milk fat may preserve probiotics in such conditions when added to dairy foods, helping them to tolerate harsh gastrointestinal conditions better than when added to non-dairy carrier foods. A product that is consumed orally and contains a "dietary ingredient" meant to supplement food is referred to as a dietary supplement. The survival and bile acid tolerance of probiotics were found to be improved by dairy products high in milk fat, such as ice cream.

Role of Probiotics in Non-Dairy Foods

Dairy products have significant negatives such as allergy, lactose intolerance, and cholesterol content; therefore, non-dairy probiotic diets are advantageous for those who suffer from such medical conditions. The main non-dairy probiotic foods on the market right now include soy products, cereal-based goods, fruit and vegetable juices, and fermented meat and fish products. However, fermentation is often avoided when making non-dairy probiotic carriers like fruit and vegetable juices because it can lead to unfavourable sensory characteristics in these products due to a variety of variables such the development of acidity and changes in viscosity, texture, and colour. With just one additional step of fermentation, the production of fermented and non-fermented fruit and vegetable juices can be quite similarin the production of fermented juices.

Probiotics Selection

The safety considerations for production/manufacturing relating to technological factors, application, survival and colonisation in the host, and their health advantages must be kept in mind while choosing the probiotics strain. For the purposes of identification, classification, and typing, it is advised to combine phenotypic and genetic approaches. After research in vitro, focus shifts to studies in animal models, then clinical trials (phase 1), individual patient studies (phase 2), and eventually large-scale human studies (phase 3). Most importantly, they work to crowd out pathogens like yeasts and other bacteria and viruses that could cause disease and form a mutually beneficial relationship with the human digestive system.[11]

The following factors are important quality-control qualities that must be continuously monitored and improved: General, functional, health, production, and quality control aspects are among the aspects. The primary distinction between this group and pharmaceuticals is that the former are single-targeted pure substances used at high doses, whilst the latter are multi-targeted combinations present at low concentration.[12]

General Aspects

Origin: A selected animal microbiota should have been the source of probiotics. The source can come from an animal origin, a food source like raw milk or fermented food, or a human origin like the big or small intestines of humans or breast milk.

Genus, Species, and Strain Identification: In accordance with WHO/FAO recommendations, probiotics are strain-specific, hence it is necessary to identify them at the genus, species, and strain levels. For the purposes of identification, classification, and typing, it is advised to combine phenotypic and genetic approaches.

In terms of biosafety: chosen strains must not be poisonous or pathogenic. The safety record of lactic acid bacteria is generally good. The microorganism strains should be GRAS (Generally Recognized as Safe) (GRAS).

Functional Aspects

- Gastric condition resistance: Probiotic bacteria must be able to live in the digestive system. The strain affects how long ingested probiotics survive in various regions of the digestive system. While certain strains, like those of Bifidobacteria or L. acidophilus, can transit through the entire intestine at high concentrations, others, like those of these bacteria, are quickly destroyed in the stomach.
- Bile acid resistance: Organisms used as probiotics must be bile acid resistant. The conjugated form of bile acids (500–700 ml/d) is released into the duodenum from the gall bladder after being produced in the liver from cholesterol. It is capable of hydrolyzing bile salts.[13]
- Probiotics adhere to and colonise the tissues and epithelium of the intestine. Probiotic bacteria have historically been selected for based on their ability to adhere to intestinal mucus and epithelial cells. The probiotic cells may be prevented from being washed out by adhering to the intestinal mucosa, allowing for temporary colonisation, immunological regulation, and pathogen competitive exclusions.The ability of the probiotic strain to produce antimicrobial compounds is crucial in the development of probiotic supplements and probiotic-rich foods.
- Antimicrobial activity against potentially harmful bacteria. Organic acids, fatty acids, hydrogen peroxide, and diacetyl are only a few of the metabolic substances that lactic acid bacteria create that have antibacterial properties.
- Immune system modification: Probiotic strains should be able to stimulate and control a number of components of the innate and acquired immune response. The ability of a Bifidobacterium and a Lactobacillus strain to affect how the immune system functions differs significantly.

Health Aspects

A high concentration of probiotic bacteria, approximately 105 to 107 CFU/g of product, must be present and viable. They should protect against diarrhoea, cancer, depressed immune function, insufficient lactase digestion, infant allergies, failure-to-thrive, hyperlipidaemia, hepatic diseases, helicobacter pylori infections, and AIDS, as well as gastroenteritis, irritable bowel syndrome, and Inflammatory Bowel Disease (IBD; Crohn's disease and ulcerative colitis).

Production Aspects

Acid production: One important factor in choosing the probiotics for milk-fermented products is the pace of acid development. In addition to preventing the growth of undesirable microorganisms, a quick acid production in the raw material is necessary for the aroma, texture, and flavour of the finished product, all of which have a positive impact on the product's overall acceptability in terms of pH, texture, flavour, and aroma.

Proteolysis: Proteolysis (Casein hydrolysis) plays a role in the creation of the texture, flavour, and body of the final product, such as various types of yoghurt and cheeseAn extremely significant characteristic of LAB in the hydrolysis of milk proteins (casein) that feed amino acids to the cells that are needed for LAB growth is the ability to manufacture cell wall bound ExtraCellular Proteases (CEP). Streptococcus Thermophilus and Lactobacillus Bulgaricus are mostly linked to protein breakdown.Probiotics must have the ability to survive in food, feed, and nutritional supplements.

Probiotic stability and vitality: Probiotic stability has received a lot of attention from manufacturers. The probiotic strain should, more crucially, be resilient enough to resist a typical industrial production process. Stability varies depending on the strain.

Storage: To ensure the vitality of the microorganisms, probiotic supplements should be stored at 4 to 5 degrees Fahrenheit, and they should be consumed before the product's expiration date. Probiotic supplements must be stored in a refrigerator in order to be viable.

Aspects of Quality Control

Regarding the probiotic's clearance over specific health claims, the quality control standards are crucial. Therefore, strain qualities and their stability during industrial processing and usage should be considered in functional food laws. Quality control processes for the production of probiotics should take into account things like:

- Quality control criteria and procedures should be established and put into place.
- Confirming the genetic purity of a chosen species.
- Verifying the probiotics' effectiveness.
- Ensuring the probiotics are pure.
- Validating the completed item through unbiased testing.

Probiotic Labelling

As an illustration, the research and marketing of probiotic products are still in their infancy in India. Therefore, strict labelling regulations should be put in place to avoid deceiving customers. Only if a physiological (health) benefit in humans has been proven, the term "probiotic" should be used on product labels. Probiotic-related regulatory framework designed to better address concerns like efficacy, safety, labelling, fraud, and claims.

Probiotics's Benefits for Health

Probiotics' anti-diabetic properties: It is possible to think of probiotics as a biotherapeutic treatment for diabetes. Several nutraceuticals and probiotic formulations have undergone anti-diabetic testing in various labs. According to research, Lactobacillus has antihyperglycemic, insulin-releasing, insulin-mimicking, and immunomodulatory effects. Additionally, it reduces the hereditary risk of type 1 diabetes in children by stopping the autoimmune from destroying -cells. Lactobacillus and other probiotics are much less prevalent in type 2 diabetic patients, and this positively correlates with plasma glucose concentration. Diabetes may have altered gut flora due to the lack of readily available fermentable sugars and carbohydrates, which are typical substrates; therefore, regular replenishment can be beneficial.

Probiotics' anti-inflammatory properties: SCFA production is being linked to Inflammatory Bowel Disease (IBD), especially acetate, butyrate, and propionate. Furthermore, it has been established that these SCFAs are essential for preserving colonic homeostasis. Additionally, probiotics have anti-inflammatory properties and enhance intestinal motility. Therefore, it is reasonable to assume that increasing the production of SCFAs by supplementing with indigestible carbohydrates and fibre (prebiotic) alone or in combination with probiotics could be beneficial therapeutic treatments.

Probiotics' anti-cancer properties: In vitro research has shown that the probiotic strains Lactobacillus fermentum NCIMB-5221 and -8829 are particularly effective at inhibiting colorectal cancer cells and encouraging healthy epithelial colon cell proliferation by producing SCFAs (ferulic acid). Angiogenesis and the formation of cancer cells are two processes that curcumin has been proven to influence in order to prevent carcinogenesis.[13] Genomic, proteomic, and molecular pathology-based research on cancer has increased public awareness of the disease and our understanding of it over the past ten years.[14]

Probiotics' anti-allergic properties: In vitro investigations of some probiotics, such as Lactobacillus plantarumL 67, have demonstrated the potential to prevent illnesses linked to allergies by causing their host to produce interleukin-12 and interferon-gamma.

Probiotics' angiogenic activity: Angiogenesis is a significant phenomena and a requirement for the healing of wounds. In the angiogenic process, inflammatory cells are recruited and cytokines, matrix-degrading enzymes, and chemokines are produced. As a result, new vessels develop from pre-existing ones. Major human diseases like cancer, diabetic retinopathy, and IBD including CD and UC all suffer from deregulated angiogenesis.

Probiotics' effects on the brain and central nervous system: Both gastrointestinal and GIT disorders are strongly linked to the colonisation of the microbiota in the GIT. An interactive, bi-directional communication known as the "microbiota-gut-brain axis" is created when the GIT and CNS exchange regulatory signals.

Probiotics' ability to combat obesity: An increase in calorie availability, increased sedentarism, and better control of ambient temperature are all associated with abnormal or excessive fat (obesity) buildup that directly harms health. This mismatch between energy intake and expenditure causes obesity. Probiotic strains, such as *Lactobacillus gasseri* BNR17, have demonstrated the ability to reduce leptin release by preventing the growth of adipocyte tissue, which is the major source of leptin and adiponectin. It has also been observed that other probiotic microorganisms, including Lactobacillus acidophilus, Bifidobacterium longum, and L. casei, have hypocholesterolemic properties.[29]

Probiotics and Helicobacter pylori Infection: Helicobacter pylori is a tiny, curved to spiral-shaped rod-shaped bacteria that is the primary etiologic agent of chronic gastritis, gastric cancer, and other gastric malignancies. It is strongly linked to duodenal peptic ulceration. Proton pump inhibitors and antibiotics are currently used in conjunction to treat this bacterium. Probiotics appear to directly combat microbes. Probiotics considerably reduced symptoms including diarrhoea and taste disturbance.

Probiotics and Acute Pancreatitis: By lowering bacterial translocation, probiotics have been demonstrated to be useful in preventing complications in experimental acute pancreatitis.

Probiotics and Multi-Organ Dysfunction Syndrome (MODS): In patients with decreased gut perfusion after major surgery, trauma, or shock, impaired intestinal barrier function has been theorised to have a role in the development of sepsis and multiple organ failure (MOF). Probiotics can lessen this disease's symptoms and indications.

Illustration on the Basis of Curcumin

Demethoxycurcumin and bisdemethox-ycurcumin are further curcuminoids that can be found in turmeric. Due to its antioxidant, antimutagenic, antibacterial, and anticancer qualities, curcuma longa is utilised as a medical herb in Asian nations. Turmeric is derived from the rhizomes of the plant Curcuma longa, which belongs to the Zingiberaceae family refer to the (Fig 1.) for the chemical structure. Feeding wheat bran and cellulose to humans has been shown to reduce faecal mutagens, rectal cell proliferation, and harmful secondary bile acids such lithocholic and deoxycholic acids.[24] Curcumin, the principal curcuminoid found in turmeric, is generally considered its most active constituent.Curcumin is traditionally an Eastern spice, and is consumed in great quantities in certain regions.[14] Curcumin (1,7-bis(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione), also called diferuloylmethane, is the main natural polyphenol found in the rhizome of Curcuma longa (turmeric) and in others Curcuma spp.[18]

Metabolism of Curcumin

Numerous studies evaluated that curcumin undergoes metabolism in different components after oral administration in animals.The mechanisms by which curcumin exerts its anti-cancer effects are comprehensive and diverse, targeting many levels of regulation in the processes of cellular growth and apoptosis.[16] Because of its metabolism, curcumin has demonstrated poor bioavailability after oral dosing in animals which may be related to its inadequate absorption. Curcumin bioavailability may also be poor in humans, as indicated by a pilotstudy of a standardized curcuma extract in colorectal cancer patients.Curcumin has been shown to improve systemic markers of oxidative stress.[15] Following oral administration, curcumin undergoes bioreduction to tetrahydrocurcumin, hexahydrocurcumin, octahydrocurcumin, and hexahydrocurcuminol in rat and mouse in vivo as well as in suspensions of human and rat hepatocytes. Additionally, reduced curcumin is converted into

Fig 1: Rhizome and powder form of Curcumin

curcuminglucuronide, dihydro-curcumin-glucuronide, tetrahydrocurcumin-glucuronide, and curcuminsulfate through the process of glucuronidation. According to research, rats' glucuronides of tetrahydrocurcumin and hexahydrocurcumin are the main biliary metabolites of curcumin. Dihydroferulic acid and traces of ferulic acid were minor biliary metabolites (Dias B.L., 2022).

Bioavailability of Curcumin

The systemic bioavailability of curcumin taken orally is not very high. The effectiveness of curcumin in preventing type 2 diabetes in the general human population has been studied.[17] Following oral intake, curcumin metabolites rather than the active ingredient are found in plasma or serum. Notably, Turmacin, a polysaccharide fraction derived from turmeric free of curcuminoids, dramatically reduced arthritic symptom scores when compared to placebo.[21] When tetrahydrocurcumin and hexahydrocurcumin derivatives are absorbed from the gut, curcumin undergoes a biotransformation.According to research investigations, reductases first convert curcumin to dihydrocurcumin and tetrahydrocurcumin, which are then converted by -glucuronidase into monoglucuronide conjugates known as dihydrocurcumin-glucuronide and tetrahydrocurcumin-glucuronide. Micelles, microemulsions, liposomes, nanoparticles, and other lipid and biopolymer particles can all contain curcumin.[25] Significant improvements in either pain management or physical function were seen in the trials that enabled statistical comparisons of curcuminoid results with those of placebo controls.[20,21]

As a result of the change in the stomach and liver, reduced compounds like hexahydrocurcumin or curcuminsulphates may be produced. According to various animal studies,[18] the majority of oral curcumin is eliminated in the faeces (90%). Finally, the mode and route of administration used affect the excretion of curcumin metabolites. Curcuminoid dosage effects on bioavailability. Other ingested dietary components' bioactivities haven't gotten much attention. For instance, there is conflicting information regarding mineral absorption and curcumin intake.[23]

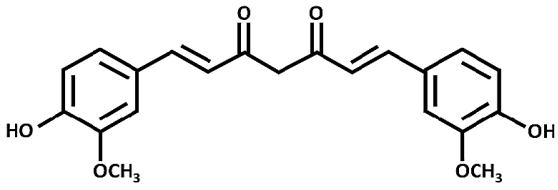

Fig 2: Chemical structure of Curcumin

Health Benefits of Curcumin

Antioxidant Effect: The two main mechanisms by which curcumin affects a variety of ailments are its antioxidant and anti-inflammatory qualities.[30] It has been demonstrated that curcumin improves oxidative stress systemic indicators. There is proof that it can boost antioxidants' serum activity, like superoxide dismutase (SOD). Purified curcuminoids have been shown to have a significant impact on all of the oxidative stress parameters that have been studied, including plasma SOD and catalase activities, glutathione peroxidase (GSH) and lipid peroxide concentrations in the blood, according to a recent systematic review and meta-analysis of randomised control data

Anti-Inflammatory: Oxidative stress has been linked to a number of chronic diseases, and both inflammation and its harmful processes can be easily induced by one another. Nuclear factor (NF)-B is a transcription factor that is activated by tumour necrosis factor (TNF-), which is a significant mediator of inflammation in most illnesses.[24]

Metabolic Syndrome: The term "metabolic syndrome" refers to a group of symptoms that include obesity, particularly visceral obesity, low HDL cholesterol, raised LDL cholesterol, low triglyceride levels, insulin resistance, hyperglycemia, and hypertension[26]

Cancer: In normal cells, growth-promoting and growth-restraining signals are delicately balanced so that proliferation only takes place when necessary, such as during wound healing and normal tissue turnover. Cells undergo orderly division and proliferation during these processes, which stop when they are no longer necessary. In other words, a healthy cell turns cancerous when its proliferation is no longer regulated by healthy growth. The inhibition of cell proliferation, decrease in tumour load, and induction of apoptosis in numerous cancer models both in vitro and in vivo have also been linked to curcumin's anti-tumor effects.

Curcumin's wound-healing properties: Inflammation, granulation, and tissue remodelling are all part of the intricate processes that go into tissue repair and wound healing. In order for a wound to heal, various cells, extracellular matrix proteins, and their receptors must interact.[27] Cytokines and growth factors mediate this interaction. According to research conducted on animals like rats, curcumin speeds up the production of tissue granulation, which promotes the healing of cutaneous wounds. Additionally, curcumin has demonstrated encouraging outcomes in the management of infection, arthritic pain, and liver function.

CONCLUSION

Functional foods are typically associated with the enhancement of health. Functional foods and bioactive substances may have a variety of physiological effects, but they can improve organ or system function, physical performance, cognitive, behavioural, and psychological function, as well as fight against chronic diseases. When consumed in small doses, nutraceuticals exhibit qualities like good bioavailability and bio-efficacy and have a favourable impact on health that is characterised by the prevention and treatment of disease. Human health and wellbeing are largely dependent on general lifestyle choices and the eating of wholesome meals. It has been proven that include and consuming biologically active components in fruits and vegetables can aid in the fight against conditions including cancer, cardiovascular disease, obesity, and gastrointestinal tract illnesses.

A sophisticated microbiome has colonised the human gastrointestinal tract. Beneficial intestinal bacteria perform a wide range of crucial tasks, such as producing different nutrients for their host, preventing infections brought on by intestinal pathogens, and regulating a healthy immune response. Therefore, altering the intestinal microbiota to attain, restore, and maintain a favourable ecosystem balance as well as the activity of microorganisms found in the gastrointestinal tract are required for the host's enhanced health. The intestinal microbiota benefits from the addition of probiotics to the human diet.

REFERENCES

1. Verma Garima, Mishra Manoj, "A review on nutraceutical: classification and its role in various diseases", International journal of pharmacy and therapeutics, Issue 2018, Page no: 152.
2. Jha Kumar Sajal et-al, "Nutraceuticals and Pharmaceutics: Its important and their Application", International Journal of Drug Development and Research, Vol.13, Page no: 1-2.
3. Shahidi Fereidoon, "Nutraceuticals, Functional Food and Dietary Supplements in Health and Disease, Vol. 20, Page no: 226-230. Available from:doi.org/10.38212/2224-6614.2144
4. Nwosu Kingsley Onyeka et-al, "Nutraceuticals: History, Classification and Market Demand", Research Gate Publication,Chapter:2020, Page no:13-14. Available from:doi.org/10.1007/978-3-030-42319-3
5. Das Gitishree et-al, "Benefaction of Probiotics for Human Health: A Review", Journal of Food and Drug Analysis,Vol.26, Page no.927-939.Available from:doi.org/10.1016/j.jfda.2018.01.002

6. Kechagia Maria et-al, "Health Benefits of Probiotics: A Review", ISRN Nutrition Publication, Vol.2013, Page no:1-2. Available from: doi: 10.5402/2013/481651
7. Thantsha M.S.et-al, "Probiotics What They Are, Their Benefits And Challenges", Research Gate Publication,Chapter:12, Page no.21-22.
8. Srivatsan S Eri et-al, "Curcumin: A review of anti-cancer properties and therapeutic activity in head and neck squamous cell carcinoma", Molecular Cancer Publication, Vol.2011, Page no.1-2. Available from: doi.org/10.1186/1476-4598-10-12
9. Alsamydai Ali et-al, "Pharmacological Aspects of Curcumin: Review Article", International Journal of Pharmacognosy,Vol.5, Page no:313-326.Available from:doi.org/10.3390/biom9020056.
10. F. Onyenweaku et-al, "Health Benefits of Probiotics", International Journal of Innovative and Applied Research, Vol.4, Issue(3), Page no:21-30. Available from: doi.org/10.1016/j.jfda.2018.01.002
11. Bairagi R Ghanshamdas et-al, "Nutraceutical a review on: Basic need, classification, recent trends in industry and delivery systems", JETIR Publication, Vol.8,Issue-5, Page no:183.
12. Chaudhari .Pshilpa and Pratapwar .N Mahesh et-al, "Nutraceuticals: A Review", World Journal of Pharmacy And Pharmaceutical Science,Vol.6,Issue-8,Pageno.681-739.Availabe from:doi.org/10.3390/biology10121351
13. Hewlings .J Susan et-al, "Curcumin: A Review of Its Effect on Human Health", MDPI Publication, Page no.1-11. Available from: doi.org/10.3390/foods6100092.
14. Fadus .C Matthew et-al, "Curcumin: An age-old anti-inflammatory and anti-neoplastic agent, Journal of Traditional and Complementary Medicine, Page no.1-8. Available from: DOI:10.1186/s12906-016-1147-4
15. Lopresti L Adrian, "The Problem of Curcumin and Its Bioavailability: Could its Gastrointestinal Influence Contribute to its Overall Health Enhancing Effects", ASN Publication, Page no.41-50. Available from: doi.org/10.1093/advances/nmx011.
16. Thunder Jalili PhD , Robert E. C. Wildman PhD RD & Denis M. Medeiros PhD RD, "Nutraceutical Roles of Dietary Fiber", Journal of Nutraceuticals, Functional & Medical Foods, Page no.19-34. Available from:doi.org/10.1300/J133v02n0403
17. Javad Sharifi-Rad*, Youssef El Rayess , Alain Abi Rizk et-al, "Turmeric and Its Major Compound Curcumin on Health: Bioactive Effects and Safety Profiles for Food, Pharmaceutical, Biotechnological and Medicinal Applications", Curcumin Health Applications and Safety,Vol.11, Page no.1-23.Available from: doi:10.3389/fphar.2020.01021
18. Aggarwal B.B., Kumar, A., Bharti A.C., "Anticancer potential of curcumin: Preclinical and clinical studies" ,Anticancer Res. 2003, 23, 363–398. Available from: doi: 10.1002/mnfr.200700238.
19. Havenaar R, Huis in't Veld JHJ, "Probiotics: a general view. In: Wood BJB, editor. The lactic acid bacteria in health and disease" ,London: Elsevier Applied Science; 1992, Page no. 151-70.
20. Shahverdi E. "Probiotics and gastrointestinal diseases" , Int J Dig Dis ,2016,2:1-2.Available from: doi: 10.1016/j.jfda.2018.01.002.
21. Madhu K, Chanda K, Saji M, "Safety and efficacy of Curcumalonga extract in the treatment of painful knee osteoarthritis: a randomized placebo-controlled trial" ,Inflammopharmacology. 2013;21:129–136.Available from: doi: 10.1007/s10787-012-0163-3.
22. Vuksan, V., D.J. Jenkins, P. Spadafora, J.L. Sievenpiper, R. Owen, E. Vidgen,F. Brighenti, R. Josse, L.A. Leiter, and C. Bruce-Thompson, "Konjac-mannan (glucomannan) improves glycemia and other associated risk factors for coronary heart disease in type 2 diabetes. A randomized controlled metabolic trial", Diabetes Care,1999; 22:913-919. Available from: doi: 10.2337/diacare.22.6.913
23. Kuptniratsaikul V, Dajpratham P, TaechaarpornkulW, et-al. "Efficacy and safety of Curcuma domestica extracts compared toibuprofen in patients with knee osteoarthritis: amulticenter study" , Clin Invest Aging. 2014;9:451–458. Available from: doi: 10.2147/CIA.S58535.
24. Reddy, B., A. Engle, S. Katsifis, B. Simi, H.P. Bartram, P. Perrino, and C. Mahan.1989. Biochemical epidemiology of colon cancer: effect of types of dietary fiber on fecal mutagens, acid, and neutral sterol's in healthy subjects. Cancer Res. 49:4629-4635. Available from: doi: 10.1016/0016-5085(92)91704-8.
25. Sanidad K, Sukamtoh E, Xiao H, McClements DJ, Zhang G, "Curcumin: recent advances in the development of strategies to improve oral bioavailability" , Ann Rev Food Sci Technol. 2019; 10:597–617.Available from: doi:10.1146/annurev-food-032818-121738.
26. Dias, B. L. (2022). Predictive Analytics for Early Detection of Chronic Diseases Using Multimodal Healthcare Data. International Journal of Humanities and Information Technology, 4(01-03), 36-52.
27. Kushi L.H., Meyer K.A., and Jacobs D.R., "Cereals, legumes, and chronic disease risk reduction: evidence from epidemiologic studies" Am J Clin Nutr.1999; 70:451S-458S. Available from: https://doi.org/10.1007/978-3-030-68828-8_2
28. Liu, S., M.J. Stampfer, F.B. Hu, E. Giovannucci, E. Rimm, J.E. Manson, C.H. Hennekens, and W.C. Willett. , "Whole-grain consumption and risk of coronary heart disease: results from the Nurses' Health Study"1999, Am J Clin Nutr. 70:412-419. Available from: doi: 10.2105/ajph.90.9.1409
29. Tuntipopipat S, Judprasong K, Zeder C, et-al, "Chili, but not turmeric, inhibits iron absorption in young women from an iron fortified composite meal" J Nutr. 2006;136:2970–2974. Available from: doi: 10.3390/foods4030463
30. Smith T, Ashar B, "Iron deficiency anemia due to high-dose turmeric" ,Cureus. 2019;11:e3858. doi:10.7759/cureus.3858.
31. Wildman, R.E.C., and D.M. Medeiros, "Advanced Human Nutrition" ,1999; CRC Press, Boca Raton. Available from; doi: 10.1016/j.jnutbio.2019.01.004