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Review Article

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A Review on the Effects of Functional Food on Humans and Microorganisms

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Abstract

There is a surge in microbial resistance to some antibiotics used in disease treatment and unfavourable side effects of some commonly prescribed medications against infectious and non-infectious disorders. This calls for alternative unconventional treatment strategies that include functional foods. It has been observed that foods have health promotion, and this has been approved in the late 90s, which has also brought the concept of "food as medicines". Functional foods have been discovered as a result of a particular nutrition preventative effects on disease which was first introduced in Japan. Functional food also known as "Nutraceuticals" are products that contain a variety of biologically substances and which when introduced in a regular diet, aid in the enhancement of the population's well-being or lower risk of disease. Recently probiotics and fermented foods are known to possess nutraceutical effects due to their biochemical and biological constituents. Examples of common functional foods in Nigeria are sweet potato, yoghurts, ogi, garlic, bio-solution (collection of plant extracts) etc. They have been used to treat infectious diseases like diarrhoea, dysentery, typhoid, covid, measles, etc. Presently, much attention is now on development of functional foods, their health benefits, bioavailability and the potential roles they play in subsiding diseases.

Keywords: Functional-Foods, Nutrients, Human, Microorganisms.

1. Introduction

There is an old Chinese thought meaning that medicine and food are isogenic. In Japan, a national research project started to endorse the thought scientifically, In the 1980s, as the ageing society began to manifest itself in many countries of the world, prompt increases in the so-called life-style related diseases became a matter of public concern [1]. Growing awareness was then observed of the need for eating to beat the odds. The purpose was to prevent life-style related diseases such as diabetes, arterio, sclerosis, osteoporosis, allergies, cancer, and even some kinds of infectious diseases which recently includes COVID-19, through improved dietary practices in daily life. This gave a strong impetus to food science in Japan hence, the terminology and concept of "Functional foods" were first proposed [1]. Functional foods according to the European Consensus provided the commonest and most recent definition, which states that 'a food can be regarded as functional if it is satisfactorily demonstrated to affect beneficially one or more target functions in the body, beyond adequate nutritional effects, in a way that is relevant to either improved stage of health and well-being and/or reduction of risk of disease [2].

Research and discovery have been made in reaction to the finding of functional foods over the years, and each year there is new information revealed. Researchers from the various fields of Nutrition, Pharmaceutical, Microbiology, Dairy sciences, Medical sciences and Food sciences are reporting their research findings on many interesting characteristics of food components in terms of their physiological functions. Functional foods are now acknowledged by the group of customers who are interested in following healthy food choices and nutritional benefits. In a nutshell, functional foods are the healthy food products of the future.one of the problems in the world most especially in rural areas the development of functional foods and nutraceuticals from different ingredients and retention of these functional ingredients in different food products have not been adequately investigated. There are several articles on functional foods, but the novelty and importance of this review are to correlate the health effects of different component and bring them together in a concise description.

Functional Foods

Functional foods, also known as nutraceuticals, are defined as foods containing bioactive compounds that have beneficial effects on consumer health. Bioactive compounds are phytochemicals extracted and consumed as supplements or may have medicinal value when engulfed as whole food. Functional food has gained popularity to prevent numerous diseases, boost growth, and enhance host metabolic activity. In addition, such functional foods may be useful for preventing communicable such like

Covid-19 and non-communicable diseases [3].

Public health authorities consider prevention and treatment with nutraceutical as a powerful instrument in maintaining health and to act against nutritionally induced acute and chronic diseases, thereby promoting optimal health, longevity and quality of life. Recent studies have demonstrated that diets high in antioxidants shield people from degenerative illnesses like cancer, diabetes, cardiovascular disease, and neurodegenerative conditions like Parkinson's disease, Alzheimer's disease, multiple sclerosis, and amyotrophic lateral sclerosis caused by free radicals. Prior to attacking cells, free radicals can be stabilized or deactivated by antioxidants. They can also chelate metal catalysts, activate antioxidant enzymes, reduce -tocopherol radicals, and block oxidases. They are thought to be the first line of Défense against free radical damage, making them essential for maintaining optimal cellular and systemic health and wellbeing [4]. It was discovered in Japan that a rice bran extract treated with a mixed Lactobacillus-Saccharomyces culture generates a significant amount of g-amino butyric acid as a beneficial food component for lowering the risk of hypertension and neurological problems, however the product has not yet been authorized [1]. The conventional approach to generating functional foods is to maximize elements that are beneficially functional and that regulate the immunological, endocrine, nervous, circulatory, or digestive systems of the body. But occasionally, a novel strategy can be used, and this strategy could result in the prevention of chronic disease [5]. An example is sulfur, it is essential for the health of plants and is an indispensable dietary component for human health and disease prevention Uniqueness is discovered in the reduction of unfavourable functional aspects by genetic engineering or even enzyme technology. Since the first study started in 1984, the significance of applying this idea to the design and production of functional foods has been underlined [6, 1].

Medical Importance of Functional Foods

The amazing potential of functional foods produced from natural resources to treat some chronic diseases has been demonstrated by the growing number of research articles published in the previous several decades [1]. A food product can only be termed functional if all its properties has beneficial effects on human health by either improving the general and physical conditions and/or decreasing the risk of the evolution of infectious diseases [7].

Functional foods have been attributed with anti-inflammatory properties. As a result, consumers' interest in the relationship between health, disease prevention, and well-being has significantly increased globally. The reservoirs from which functional foods, nutraceutical, and biomedical goods are derived can be found both in terrestrial and marine environments. Terrestrial resources such as fruits, vegetables, cereals, probiotics, and mushrooms; however, is by far more explored than the marine resources even though the majority of those products in the marketplace are of terrestrial origin, marine organisms-based products are gaining attention due to their unique features, which are not found in terrestrial based metabolites for example the sea cucumbers [8].

Functional ingredients from sea cucumbers have become an increasingly interesting way to develop new foods as well as biomedicine products. Sea cucumbers are a source of high value-added compounds with health effects to be used as functional ingredients. Bioactive peptides, vitamins, minerals, fatty acids, saponins, carotenoids, collagens, gelatins, chondroitin sulfates, amino acids, fatty acids and other bioactive compounds are example of such sea cucumber derived functional ingredients that can be added at different stages of the food and biomedicine production process [8].

Of all the plant secondary metabolites, phenolic compounds have been extensively studied and are commonly used as antioxidants for a wide range of applications. Several vegetables, particularly medicinal plants, have been widely studied for their natural antioxidant activity. They can act as suitable natural antioxidants to replace synthetic ones and interfere with the oxidation process and the alteration of lipids, proteins, and DNA. Natural antioxidants can also provide protection against degenerative diseases particularly cardiovascular diseases and cancer by inhibiting and scavenging free radicals function, for example the Tossa jute leaves is an example of the terrestrial habitat that contains high phenolic metabolites [9].

Fermented Foods

The many geographic regions where fermented foods are made have a variety of customs and cultural preferences. In temperate and cooler climates, fermentation helped our ancestors survive the winter, while it helped those in the tropics endure slumps. Fermentation is a metabolic process that uses organic components as fuel without the use of an external oxidizer, from a biochemical perspective [10]. Zymology is a term used frequently to refer to the scientific study of fermentation [11]. One of the first biotechnologies used to produce food products with beneficial qualities including good organoleptic characteristics and a long shelf life is fermentation for instance, fermentation creates lactic acid, which is utilized to preserve foods like sour foods like yoghurt, kimchi, and pickled cucumbers [12]. The microbiological stability and safety of finished fermented foods are typically increased, and some can even be stored at room temperature. The term "fermentation" is also used widely to refer to the mass growth of microorganisms on a growth medium, frequently in order to produce specialized chemicals like vaccines, antibiotics, enzymes, and addictive foods [12].

Types of Fermentation

According to the final products formed, Fermentation can be categorized into;

- Lactic acid fermentation
- Acetic acid fermentation
- Butyric acid fermentation
- Alcohol acid fermentation

Lactic and Fermentation

Lactic acid fermentation is a bacterial process that happens during the production of food products variety. The lactic acid bacteria (LAB) are one type of bacterium capable of lactic maturation (i.e. they produce lactic acid in relatively large amount from carbohydrates which serves as substrates). The primary metabolite produced during the maturation of sugars by the lactic corrosive microorganisms is lactic acid, which emerged in the

20th century to represent a heterogeneous collection of microscopic organisms that are anaerobic, gram-positive, appear rod-shaped formed, non-sporulating, catalase-negative, aerotolerant, stationary, and are the makers of sugars [13].

Depending on the LAB species, the substrate, and the ambient factors, variations in the lactose metabolism's metabolic products have led to the two main kinds of fermentation, homofermentation and heterofermentation. Lactic acid is the principal byproduct of homofermentative pathways, whereas acetic acid, ethanol, and carbon dioxide are among other metabolites produced by heterofermentative metabolism. A homofermentative metabolism can also switch to a mixed-acid metabolism with a variety of metabolites under specific circumstances (carbon shortage, carbon surplus of slowly metabolized carbohydrates, aerobic conditions). Several fragrance molecules or scent precursors, including acetaldehyde, ethanol, and diacetyl, are among these metabolic byproducts [14].

Acetic Acid Fermentation

Acetobacter aceti convert ethanol into acetic acid during the production of acetic acid, which can be done both aerobically and anaerobically. Yeasts normally start this fermentation by converting glucose to ethyl alcohol. Grain and natural product starches and sugars deteriorate into vinegar and fixes with an unpleasant flavor. Acetobacter aceti are commonly found on plants, flowers, and fruits. These aerobic environments are rich in carbohydrates, sugar alcohols, and/or ethanol. This enables A. aceti to rapidly and incompletely oxidize these substrates into organic acids for energy production through a specific respiratory chain. Consequently, an acidification of the environment takes place, thereby preventing the growth of competitors, while the producing cells possess several mechanisms to tolerate the acidity. Also, they can utilize the accumulated organic acids later to further sustain their growth. Acetobacter aceti cells capable of cellulose production form biofilms that allow their retention on the culture surface, which is favorable for the survival of these strictly aerobic bacteria. All these physiological features explain their occurrence and underlines their functional role in the production of diverse fermented foods and beverages such as Lambic beer, water kefir, kombucha, and cocoa.

Butyric and Fermentation

Obligate anaerobic bacteria of the genus Clostridium exhibit this sort of fermentation. This happens during the retting of jute fiber, the processing of tobacco and leather, and the use of rancid butter. Dietary fiber fermentation results in the production of butyric acid in the human colon. The colonic epithelium relies on it as a significant source of energy. Glycolysis converts sugar first into pyruvate, which is then further oxidized by the oxidoreductase enzyme system to generate acetyl-CoA and produce Hyand CO2. Butyric acid is created after more acetyl-CoA reduction. A considerably higher production of energy results from this kind of fermentation. A total of three Adenosine triphosphate molecules are created [13]

Biological Activities of Functional Foods

Anticancer Activities: Cancer is the leading cause of death around the world cancer is not only the first leading cause of death worldwide and accounting for 8.2 million deaths in 2012, but also has diet as one of the most important modifiable risk factors [15]. Anticancer activities from many functional food sources have been reported in years, the extracts of garlic, horseradish, currykale as well as green and black tea were the most effective in lowering the viability of ovarian cancer cells Functional foods [bioactive compounds] have been identified as one of the means of reducing the predisposition to cancer, extracts from beans, lettuce, oats, eggs, and various nuts reduced the activity of pita vastatin [16-18]. These functional foods may inhibit various stages in the process of cancer formation. The bioactive compounds in functional foods such as polyphenol compounds. An example is the ferulic acid which ia a polyphenol compound with proven anticancer properties the effects of ferulic acid on tongue carcinomas and preneoplastic lesions have been studied in rats. The findings of the workers describe that the rats fed with a diet containing ferulic acid at a dose of 0.5 g/kg and exposed with 4-nitroquinoline-1-oxide in drinking water for 5 weeks at a dose of 0.02 g/kg reduced the impact of the carcinogen significantly [19]. The findings also reported that a significant reduction in oral cancer in the rat groups fed with ferulic acid compared with those that were exposed to carcinogens alone. This result suggests that ferulic acid has a preventive mechanism against oral cancer. In addition, some pharmacological properties in flavonoids are inhibitory to cell damage [16].

Black soybean (Glycine max) is a nutritious legume that is high in proteins, essential amino acids, dietary fiber, vitamins, minerals, anthocyanin, phenolic acids, isoflavones and flavones [20]. Different researchers proved its anticancer activities against different cancer types. For example, made a report that Saponin present in soybean has potent anti-proliferation activity in in-vitro coca mouse colon cancer cells (Figure 1). Fermented Soy foods are a beneficial and healthy alternative to animal proteins, which possess peptides active against human colon cancer, liver tumor cancer and breast cancer cells [16]. The peptides from the protein hydrolysates were tested against cancer cell lines employing 3-(4,5-dimethyl thiazole-2-yl)-2,5-diphenyl tetrazolium bromide (MTT) colorimetric titre method. The fraction with the best activity (F2-c) was further purified and the amino acid sequence was known as Leu/Ile-Val-Pro-Lys (L/IVPK), which is a tetra peptide due to its combination of four peptide. Molecular studies indicated that the purified peptide (L/IVPK) had maximum effectiveness against four apoptosis-related proteins namely Bcl-2 caspase-3, caspase-7 and XIAP, through the hydrophobic activities and hydrogen bonds, while caspase-3 binding exhibited the greatest binding energy [21]. The tetrapeptide named peptide L/IVPK possessed antioxidant and anticancer activities against Hela, HepG2, and MCF-7 cancer cell lines, while a peptide obtained from high oleic acid soybean variety exhibited significant activity against colon, liver and blood cancer cell lines. The purified peptide L/IVPK, which possessed anticancer and antioxidant activities, can be utilized as a functional food ingredient for prophylaxis in the prevention and treatment of cancer. The peptide obtained from high oleic acid soybean is suggested to be a value-added ingredient to enhance soy meal by-product (Figure 1) [22].

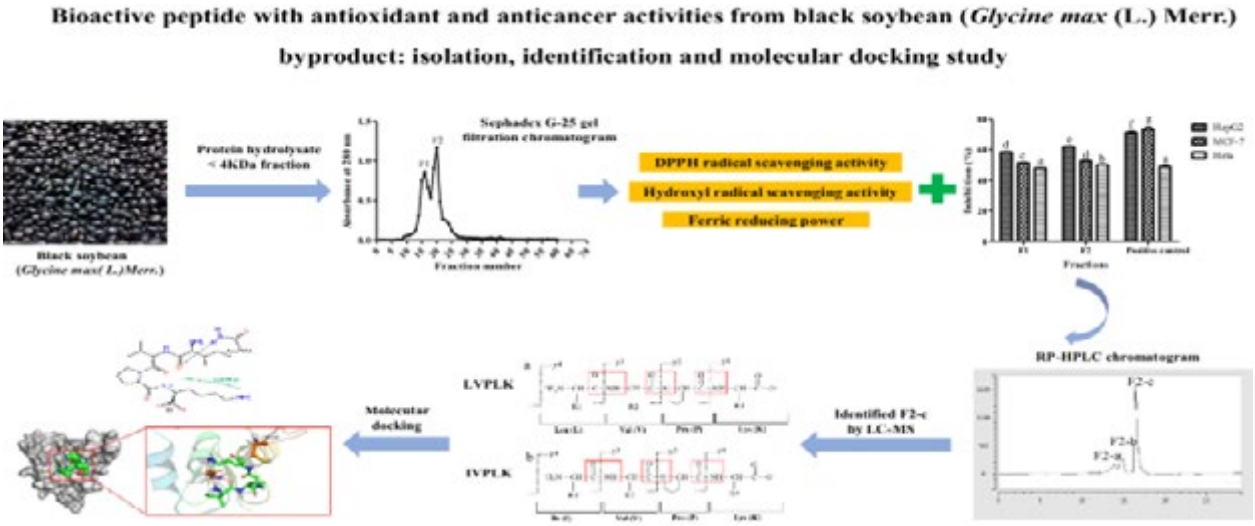

Figure 1: Antioxidant and anticancer activities from black soybean.

Antimicrobial Activities

The presence of phenolic compounds in plant extracts and/or essential oils has been linked to the antibacterial properties of those substances [21]. Essential oils (EOs) have been long recognized for their antibacterial, antifungal, antiviral, insecticidal and antioxidant properties. Phenolic compounds, such as flavonols, which are frequently found in green tea and fruits, have demonstrated antibacterial activity [16]. Studying the polyphenol in teas revealed that they have an antibacterial effect that stopped the development of caries. The growth of Salmonella spp. and Escherichia coli was significantly inhibited by extracts from strawberries and raspberries [16]. Also, the antibacterial properties of plant oils and extracts have been used in a variety of applications, such as pharmaceuticals, alternative medicine, and natural therapy [16]. The possible antimicrobial activities of essential oil on bacterial cell is shown in Figure 2 below.

Essential oils are widely used in medicine and the food industry for these purposes. The antimicrobial properties of EOs have been reported in several studies. In many cases the activity results from the complex interaction between the different classes of compounds such as phenols, aldehydes, ketones, alcohols, esters, ethers or hydrocarbons found in EOs. Though in some cases, the bioactivities of EOs are closely related with the activity of the main components of the oils. Several studies have found that a number of these compounds exhibited significant antimicrobial properties when tested separately [22]. It has been reported that EOs containing aldehydes or phenols, such as cinnamaldehyde, citral, carvacrol, eugenol or thymol as major components showed the highest antibacterial activity, followed by EOs containing terpene alcohols. Other EOs, containing ketones or esters, such as β-myrcene, α-thujone or geranyl acetate had much weaker activity. While volatile oils containing terpene, hydrocarbons were usually inactive High antimicrobial activity of Thymus and Organum species has been attributed to their phenolic components such as thymol and carvacrol and those of Eugenia caryophillus, Syzygium aromaticum, Ocimum basilicum to eugenol [22].

Examples of Bioactive Compounds in Functional Foods

Carotenoids: Carotenoids, also known as carotenes, belong to the group of lipid-soluble hydrocarbons; and their oxygenated derivatives are called xanthophyll. Some carotenoids can be converted into retinoid exhibiting vitamin A activity also they are much more versatile as they are relevant in foods not only as sources of vitamin A, but also as natural pigments, antioxidants, and health promoting compounds which is essential for humans [23]. The color of egg-yolk and some fish is also due to carotenoids. Some of the rich sources of carotenoids are carrots, plums, apricots, mangoes, cantaloupes, sweet potatoes, kale, spinach, cilantro (coriander), collard greens, fresh thyme, turnip greens, and winter squash and health benefits include; singlet oxygen quencher, enhancement of the immune system, inhibition neuroblastoma tumor growth, protective effects against testicular and spermatozoa toxicity [24]. Importantly, the β-carotene is a precursor of vitamin A which is needed for robust immune system, healthy skin and mucous membranes, and good eye health and vision [25].

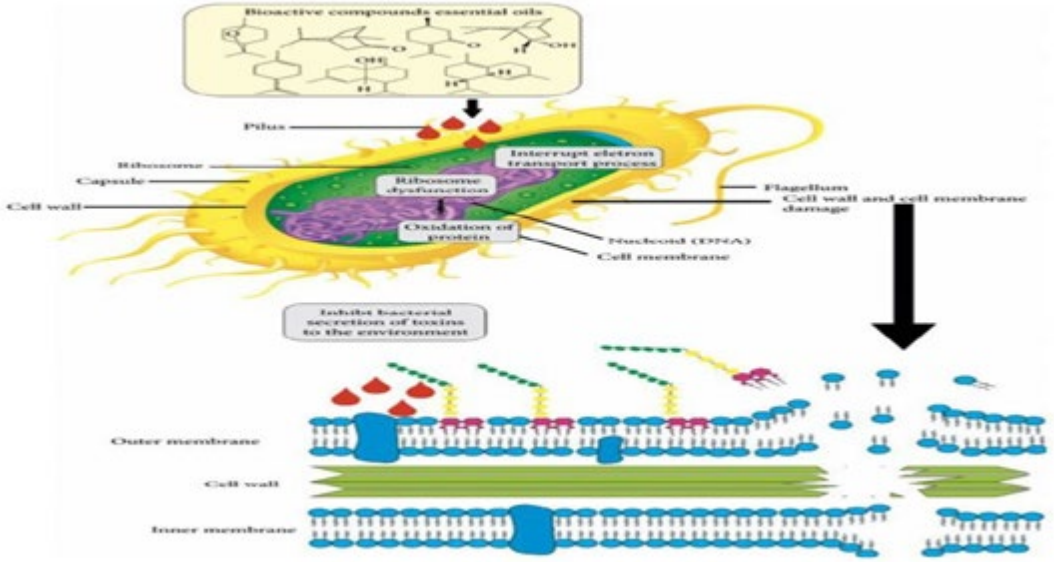

Figure 2: Possible mechanisms of essential oil in a bacterial cell

Flavonoids

The flavonoids form the largest and a diverse group of bioactive compounds, known as phytonutrients or phytochemicals, which are the major constituents of polyphenols and can be considered more into flavanols, flavones, is flavones, flavanones, anthocyanin's, flavanonols, and flavans (catechins and proanthocyanidins) [24]. Each subgroup and its type of flavonoids have a distinctive range of plant source, functions, and health benefits. This collection of plant bioactive compounds is known to possess benefits to human health due to their identified antioxidant and anti-inflammatory effects. Flavonoids exist in every fruit and vegetable, and along with carotenoids, they are responsible for their unique colors. There are more than 6,000 different identified types of flavonoids which are beneficial in human diet. Flavonoids are generally soluble in water and grow in cell vacuoles. Their basic molecular structure is two benzene rings bonded to a three-carbon chain that forms a closed pyran ring. Flavonoids are ample in a range of fruits and vegetables. Its major sources include berries, leeks, ginger, grapefruit, carrot, apple, onion, broccoli, cabbage, kale, tomato, lemon, parsley, buckwheat, and legumes. Coffee, tea, chocolate, a range of spices, herbs and red wine are also bursting with health-giving flavonoids. Many studies have revealed that a diet rich in phytonutrients is good for human health. Flavonoids are beneficial in this regard as they act as influential antioxidants; they also neutralize free radicals and limit damage to cells and other body tissues.

Terrenes

Terpenes are organic compounds that comprise the five-carbon isoprene building blocks, the cyclic molecule; monoterpene consists of two isoprene units, while terpenoids are a genre of secondary metabolites obtained from terpenes with several cyclic groups and oxygen. Terpenoids and terpenes are used substitution ally, but each has its own denotation. Terpenoids are terpenes with additional functional groups which are exceptional such as the esters, carboxylic acids, and alcohols [23]. Terpenes and terpenoids are employed as flavouring agents in foods and as fragrances due to their volatilities. Terpenes are characteristically volatile while terpenoids are either non-volatile or semi-volatile. These BACs are found in plant-based foods where they elicit medicinal properties and activities. The synergistic activities of these natural compounds enhance the psychological and physiological activities in humans. Hence, the many plants with these compounds are essential in the diet where they boost the potential endocannabinoid system directly or indirectly. The vital compounds present as terpenes and terpenoids in foods act as essential oils, cannabidiol (CBD), cannabigerol (CBG), and tetrahydrocannabinol (THC). The CBD groups act as an anti-inflammatory and analgesic, blocks hepatic carcinogenesis by aflatoxin, and aids in the regaining memory loss by acetyl cholinesterase's inhibition, THC acts as local anaesthesia and sedative, improves gastro-oesophageal reflux, while CBG up regulates the gamma (γ)-aminobutyric acid compositions and as an anti-dermatophyte. Foods containing terpenes and terpenoids include lemon, lemongrass, lavender, pepper, orange, green tea, bay leaves, basil, pine, pine nuts, etc.

Functionality of Probiotic Foods

Probiotic Definition: The term "probiotic" was originally used in 1965 by Lilly and Stillwell to refer to substances generated by one organism that promote the growth of another [26]. Probiotics are living microorganisms that, when given to the host in large enough doses, produce beneficial physiological effects. Due to their positive health effects, some lactic acid bacteria are typically considered to be safe and are categorized as probiotics in foods like yogurt, cheese, and pickles that have undergone fermentation. It was proposed that probiotics should be taken daily in levels of 108 to 1010 CFU to promote human health.

Prebiotics are non-digestible dietary ingredients that benefit the host by selectively triggering one or more colonic bacteria with probiotic qualities. Prebiotics and probiotics are collectively referred to as synbiotics. Probiotic preparations most frequently contain microorganisms from the genera Lactobacillus, Bifidobacterium, Escherichia, Enterococcus, Bacillus, and Streptococcus [26].

Properties of Probiotics

The criteria of probiotics are given below. Five billion colony forming units per day have been suggested as the optimal dosage for at least five days to provide an adequate level of health benefits the microorganisms used in probiotic preparations should be generally recognized as safe (GRAS), resistant to pancreatic juice, bile, and hydrochloric acid, have anti-carcinogenic activity, and stimulate the immune system. They should also have reduced intestinal permeability, produce lactic acid, and be able to survive both acidic conditions in the stomach and alkaline conditions in the duodenum [26]. Probiotic preparations utilize both isolated and combined cultures of living organisms [26].

Consideration for selecting an ideal probiotic candidate include cell viability, thus they must be resistant to low pH and acids. Besides, probiotics must be able to adhere to the gut epithelium to cancel the flushing effects of peristalsis. They should be able to interact or to send signals to the immune cells associated with the gut, be of human origin and be nonpathogenic. Viability and activity of probiotics during storage and when passing through the GIT must be considered [27].

Mechanisms of Action of Probiotics

Major Probiotic mechanisms of action include enhancement of the epithelial barrier, increased adhesion to intestinal mucosa, and concomitant inhibition of pathogen adhesion, competitive exclusion of pathogenic microorganisms, production of anti-microorganism substances and modulation of the immune system [16].

Enhancement of the Epithelial Barrier

Major Probiotic mechanisms of action include enhancement of the epithelial barrier, increased adhesion to intestinal mucosa, and concomitant inhibition of pathogen adhesion, competitive exclusion of pathogenic microorganisms, production of anti-microorganism substances and modulation of the immune system [28]. The intestinal epithelium is in permanent contact with luminal contents and the variable, dynamic enteric flora. The intestinal barrier is a major defense mechanism used to maintain epithelial integrity and to protect the organism from the environment. Defenses of the intestinal barrier consist of the mucous layer, antimicrobial peptides, secretory IgA and the epithelial junction adhesion complex. Once this barrier function is disrupted, bacterial and food antigens can reach the sub mucosa and can induce inflammatory responses, which may result in intestinal disorders, such as inflammatory bowel disease. Consumption of non-pathogenic bacteria can contribute to intestinal barrier function, and probiotic bacteria have been extensively studied for their involvement in the maintenance of this barrier. However, the mechanisms by which probiotics enhance intestinal barrier function are not fully understood [28].

Probiotics in Immunoregulation

It has been demonstrated that probiotic bacteria have a lot of positive immunological and health impacts. They play a role in controlling the bacterial ecosystem and modulating immune cells in addition to improving the bioavailability of nutrients and maintaining general health [29]. In addition to enhancing health and nutritional absorption, they also play a role in regulating the bacterial environment and immune cell modules.

Dendritic cells (DCs) are expert antigen-presenting cells that coordinate innate and adaptive immunity throughout the course of infections, autoimmune disorders, and cancers [30]. Natural killer (NK) cells play a crucial role in the early immune response to viral infections, especially when it comes to the removal of virus-infected cells. Probiotic strains of Lactobacillus can cause DCs to release IL-12, which in turn prompts NK cells to release IFN-gamma, a cytokine crucial for the eradication of lung bacteria (S. aureus) and viruses. DC can be stimulated by the gut microbiome to prime these cells. In actuality, L. reuteri and L. casei stimulate IFN-gamma synthesis and activate pro-inflammatory Th1 cells.

The first cells to come into touch with bacteria and viruses are monocytes, which are found in the peripheral circulation [30]. When probiotics are consumed or the gut microbiota interact with them, they develop into tissue macrophages and release a variety of cytokines. Macrophages release the pro-inflammatory cytokine IL-12, which prompts the release of IFN-gamma by CD4+ Th1 cells and natural killer cells, which is necessary for the destruction of viruses60. In addition, probiotic strains of L. acidophilus, B. bifidum, L. delbrueckii, and L. gasseri stimulate the production of IFN-alpha by monocytes. THP-161, a human monocyte cell line, produces more TNF-alpha, IL-6, and IL-8 in response to the probiotic L. paracasei DG. As recently noted, S. thermophilus induces TNF-alpha, IL-6, and IL-8 profile, which is necessary for antiviral actions [29]. Consuming probiotics has the goal of utilizing their advantages in a symbiotic or commensal connection with the gut bacteria. The most prominent probiotics found in functional foods and other fermented foods include Leuconostoc spp., Lactobacilli, Enterococci, and Bifidobacteria. In addition to this category of lactic acid bacteria, yeasts such Saccharomyces spp. are also utilized as probiotics (REF).

Probiotic bacteria may be crucial in the control of intestinal and systemic immunity because of their capacity to stick to intestinal epithelial cells (IELs) and to modify and stabilize the makeup of gut flora. Dendritic cells (DCs), NK cells, monocytes, macrophages, and, to a lesser extent, B cells may all be affected by probiotics in terms of how well they operate. Some probiotics, especially lactic acid bacteria (LABs), stick to the epithelial gut wall to facilitate their capture in the Peyer's patches, where they directly control DC activation and proliferation. The production of TNF-a and IL-6 by DCs as well as IL-10 and IL12 by myeloid DCs (mDCs), which support Th1-Th2/Treg polarization, can all be stimulated by probiotics. A number of LABs also encourage plasmacytoid DCs to produce IFN-and trigger IL-12 and TNF-a production, which leads to the maturation of DCs (pDCs). Through the release of cytokines like IL-12 and IL-15, which promote NK cell activation, proliferation, and cytotoxic activity, mature DCs are effective NK cell stimulators. Additionally, some probiotic strains can induce monocytes to create IL-12 and NK cells to produce that IFN-g (REF).

Probiotics in Allergic Disorder

The term “allergy” was introduced in 1906 by von Pirquet, who recognized that in both protective immunity and hypersensitivity reactions, antigens had induced changes in reactivity. In recent decades, allergic illnesses have become a major global

issue. Being one of the most prevalent causes of chronic illness that requires hospitalization, allergic disorders have a typically tremendous impact on healthcare systems and society. The start of mucosal/systemic immune responses is caused by probiotics' ability to influence the innate/acquired immune system [31]. Food allergy (FA) is now one of the most common chronic diseases of childhood often lasting throughout life and leading to significant worldwide healthcare burden [32]. One of the most frequent causes of chronic and hospitalized illness, allergic illnesses have a typically notable impact on healthcare systems and society. An insufficient immunological response of T helper (Th2) cell lymphocytes to environmental or dietary stimuli is a description of allergic disorders. When this response is triggered, interleukins (IL)-4, IL-5, IL-13, and IgE made particularly for allergens are secreted. The expression of the transcription factors GATA-3 (Th2) and T-bet controls the stability of the Th1/Th2 equilibrium (Th1) [31].

Probiotics may alter enterocytes' toll-like receptors and proteoglycan recognition proteins which would activate dendritic cells and trigger a Th1 response. Th1 cytokine production is stimulated, which can reduce Th2 responses [33]. According to pediatric studies, probiotic administration in children with atopic diseases such atopic dermatitis increases IFN production and decreases IgE- and antigen-induced TN F-, IL-5, and IL-10 secretion [33].

However, in many cases of food allergy, probiotics and prebiotics have emerged as potential therapeutic agents. This type of treatment is aimed to minimize inflammation and correct diverse allergic symptoms, which in turn leads to better management of allergic diseases. Probiotics and prebiotics enhance the tolerogenic microenvironment inside the gut, which is essential for the treatment of food allergies. The nutraceuticals-based treatments provide highly efficient as well as cost-effective. However, there are certain cases where probiotics and prebiotics may fail to treat food allergies.

Dietary prebiotics are typically those fibrous, indigestible substances that pass through the upper gut to encourage the growth of probiotics. Indigestible FOS, a simple case study, is specially digested by bifidobacteria and bacteroides among others as energy sources for reproduction in the gastrointestinal tract [2]. Indigestible FOS is composed of 1-kestose (GF2) and nystose (GF3). Based on a series of bacterial dynamics and the transfer of their metabolites, this process modifies the gut ecology and stimulates the release of IgA, a crucial component of the intestinal immune system. The bigger GF3 molecule can boost intestinal bacteroides throughout the same procedure to promote IgA synthesis [2].

Fermented Food Probiotics

Probiotics has been packaged recently as functional foods. In fact, the market for probiotics is ever increasing in size, and consumers' demands have risen spontaneously based on the immune-enhancing benefits of probiotics. They are already being sold as conventional foods, dietary supplements, medical foods and drugs in the United States, and are often administrated in capsules, liquid or powder forms and used in the treatment or management of diseases done which is allergic diseases [2]. Several studies have shown that supplementation of probiotics to food provides several health benefits such as reduction of serum cholesterol, improved gastrointestinal function, enhanced immune system, and lower risk of colon cancer [34]. Fermentation of vegetables and fruits is a common practice to maintain and improve the nutritional and sensory features of food commodities. A great number of potential lactic acid bacteria (LAB) were isolated from various traditional naturally fermented foods. Asian traditional fermented foods are generally fermented by LAB such as Lactobacillus plantarum, L. pentosus, L. brevis, L. fermentum, L. casei, Leuconostoc mesenteroides, L. kimchi, L. fallax, Weissella confusa, W. koreenis, W. cibaria, and Pediococcus pentosaceus, which are considered as the probiotic source of the food practice. Availability of certain specific nutrients such as vitamins, minerals, and acidic nature of fruits and vegetables provides conducible medium for fermentation by LAB [34].

Fruit and Vegetable-Based Fermented Probiotics Foods

Lactic acid fermentation represents the easiest and the most suitable way for increasing the daily consumption of fresh-like vegetables and fruits. Fruits and vegetables are perishable foods because of their high-water activity and nutritional richness. These circumstances are fundamental and essential in tropical and subtropical countries because they encourage the growth of bacteria that cause deterioration. In addition to extending the time that fruits and vegetables can actually be consumed, lactic acid fermentation also enhances several beneficial qualities, such as nutritional content, flavor, and lethality. The lactic acid bacteria Lactobacillus plantarum, L. pentosus, L. brevis, L. acidophilus, L. fermentum, Leuconostoc fallax, and L. mesenteroides are among those found in fermented fruits and vegetables, making them a possible source of probiotics. There are many fruits and vegetable pigments such as flavonoids, carotenoids and anthocyanins which protect us from various diseases [35].

Vegetables and fruits are fundamental sources of water-soluble vitamins (vitamin C and group B vitamins), provitamin A, phytosterols, dietary fibers, minerals and phytochemicals for the human diet. Scientific evidences encouraged the consumption of vegetables and fruits to prevent chronic pathologies such as hypertension, coronary heart diseases and the risk of stroke. Increased consumption of vegetables can increase the plasma antioxidant capacity and is associated with the lower risk of cancer in order to preserve and produce a wide variety of foods, lactic acid bacteria are used [35]. Examples include fermented fresh vegetables like cabbage (sauerkraut, Korean kimchi) and cucumbers (pickles).

Kimchi

Kimchi is the name given to various traditional fermented vegetables, which are emblematic of the Korean culture. Kimchi is mainly manufactured with Chinese cabbages (Brassica pekinensis) and radish, but other seasonings ingredients such as garlic, green onion, ginger, red pepper, mustard, parsley, fermented seafood (jeotgal), carrot and salt may be used. Due to its nutritional properties, kimchi was recently included in the list of the top five "World's Healthiest Foods" (http://eating.health.com/2008/02/01/worlds-healthiest-foods-kimchi-korea/). These ben-

eficial effects are attributed either to functional components (vitamins, minerals, fiber and phytochemicals) or to fermentation by lactic acid bacteria. The main pickles are tongbaechu-kimchi, tongkimchi and bossam-kimchi. After soaking with water, cabbages are cut and placed into a salt solution (7% for 12 h), which favours an increase of the concentration of NaCl up to 4.0% of the total weight. Further, cabbages are rinsed several times with fresh water and drained. The fermentation is carried out by autochthonous lactic acid bacteria, which vary depending on the main ingredients, temperature (30° C) and concentration of salt. Usually, Leuconostoc mesenteroides starts the fermentation but it is suddenly inhibited by the increasing concentration of lactic acid. Acid-tolerant species such as Lactobacillus brevis dominate during the middle stage, being replaced by Lact. plantarum during late fermentation. Nevertheless, the best tasting kimchi is obtained before the overgrowth of Lact. plantarum and Lact. brevis, at an optimal pH of 4.5. After fermentation, kimchi is left to ripen for several weeks under refrigeration conditions.

Stalk Vegetables

The best examples to be given to stalk vegetables are celery and asparagus. They contain minerals and vitamins in proportion to the green color Asparagus is a particularly rich source of folic acid. Fruit and flower vegetables Broccoli, cauliflower, and artichoke are frequently consumed flowering vegetables. Broccoli is a good source of iron, phosphorus, vitamins A and C, and riboflavin. Cauliflower is also a good source of vitamin C. The nutritional value of the outer leaves of cauliflower and broccoli is much higher than the flower buds. They can be consumed raw in salads or cooked. Artichoke is a good source of minerals, especially potassium, calcium, and phosphorus, and has high dietary fiber content. Tomatoes and peppers are the most common fruit vegetables. Both are rich in vitamin C. Other fruit vegetables include cucumber, zucchini, and eggplant. A dark green or yellow color indicates high β-carotene content. The darker the yellow color, the higher the content of β-carotene. In cauliflower Erwinia carotovora can be found.

Safety of Probiotics

Probiotics' safety for human health is one of their most critical qualities and a deciding factor in choosing which ones to use. In specifically, the characterization of a probiotic strain is based on the absence of virulence factors and resistance to clinical or veterinary antibi biotics. The identification of bacterial strains is essential for both safety and efficacy reasons since different strains of the same species can have varied effects on the host. Although probiotics are "generally regarded as safe" (GRAS) and their use has expanded recently, numerous researches have produced conflicting findings regarding both their safety and clinical usefulness. In 2002, FAO/WHO created Operating Standards, which served as guidelines for all companies making probiotic goods These recommendations include.

The formulation of probiotic usage recommendations;

• Phase I, II, and III clinical studies to demonstrate health benefits equivalent to or superior to accepted preventative or curative measures for a certain ailment or disease;

• Good manufacturing practices and the creation of items of high quality

• Investigations to determine the in-vivo mechanism of action

• Clear and informative labeling;

• Creation of probiotic organisms that can deliver vaccinations to hosts and/or probiotics that fight viruses;

• Expansion of effective strains to treat cancer, allergies, and the healing process after surgery or injury as well as the oral cavity, nasopharynx, respiratory tract, stomach, vagina, bladder, and skin.

Impact of Some Functional Foods on Specific Diseases

Fruits: There are scientific evidences encouraging the consumption of fruits for disease prevention due to their high nutritive values and antioxidant activities.

Apple and Cardiovascular Disease

Apples (Fi are rich sources of selected micronutrients (e.g., iron, zinc, vitamins C and E) and polyphenols (e.g., procyanidins, phloridzin, 5′-caffeoylquinic acid) that can help in mitigating micronutrient deficiencies (MNDs) and chronic diseases. Essential or bioactive compounds in apples include macronutrients, vitamins, minerals, elements, flavanols, hydroxycinnamic acids, flavonols, dihydrochalcones, anthocyanins, and others. Numerous studies over the last three decades have shown that these compounds in apples exhibit significant biological effects on improving human health and this backs up the poplar saying, “an apple a day keeps the doctor away” The vitamins and minerals in apples also provide essential micronutrients that aid the normal functions of biological and biochemical reactions in the body [36]. For example, vitamins C and E in apples contribute to the total antioxidant potential widely attributed to the fruit by donating single hydrogen equivalents to free radicals rendering them stable and leading to their eventual detoxification.

Apple consumption for the prevention of cardiovascular diseases CVDs) including coronary heart disease, stroke, atherosclerosis, hypertension, cerebrovascular, and so on, remain the number one health challenge and cause of mortality globally and accounted for close to 18 million deaths in 2017 alone [37]. This huge health burden, therefore, warrants urgent disease-management approaches to lower the prevalence and mortality. Dietary flavonoids were shown to exert an inverse relationship with CVD-associated mortality in prospective cohort studies supporting the recommendation that the regular consumption of fruit and vegetables may help in reducing the risk of developing CVD. The intake of apples decreased atherogenic cholesterol levels [38]. enhanced endothelial function and decreased the bone mass index in clinical trials. These collective research findings could be crucial in preventing CVD. It has been suggested that the modulation of the gut micro- biota by apples should be considered a major link to its ability to reduce CVD risk markers [39].

Banana and Obesity

Banana and plantain (Figure 3) are monocotyledonous plants belonging to the genus Musa, family Musaceae, and order Zingiberene’s. There are studies on banana fruit reporting their potential contribution to health promotion effects both in in vitro and in vivo models. The results suggest that phenolic compounds play an important role against a wide range of physiological

disorders, e.g., obesity, cancer, diabetes, neurodegenerative impairments, cardiovascular disorders, gastrointestinal lesions, and bone damage [40].

Banana is of utmost liking preference crop in mature and edible form that is abode of starch as macromolecule and also embedded with various micronutrient in it. Unripe banana is also of same interest because it is preferred by commercial exploitation as of available starch. Commercially and of course primarily it can be modified to resistant form to be

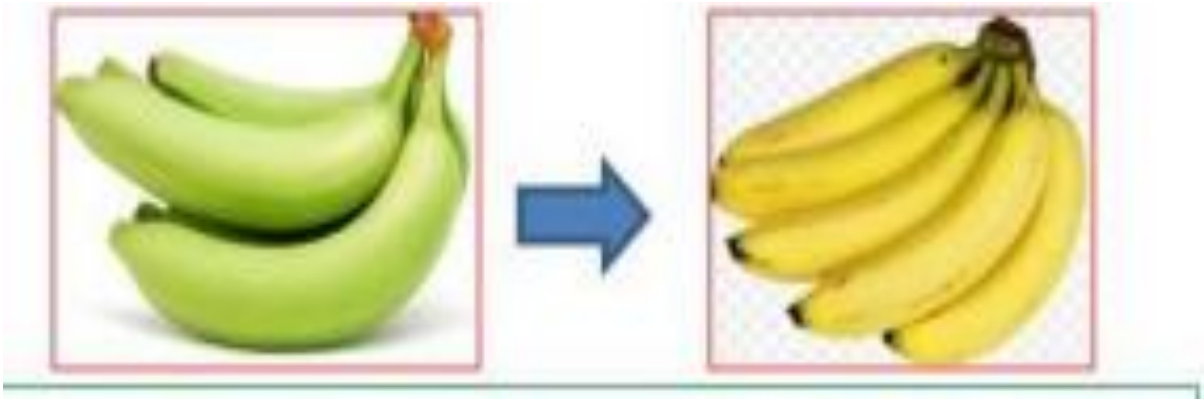

Figure 3: Pictorial view of banana

Functional in the way of slow digestibility and low blood glycemic index features. This is the reason why it is hit choices by the diabetics, obese and cardiovascular patients for maintenance of their health [41]. Bananas are good sources of starch, fibers, minerals (potassium, magnesium, phosphorus, manganese), and vitamin B6 for consumers. In addition, raw and mature bananas have a characteristic matrix of bioactive compounds such as phenolic, carotenoids, biogenic amines, and phytosterols, which are highly desirable in the diet as they have many positive effects on human health and well-being. Banana and plantain pulp and peel have the potential to be exploited in the food and pharmaceutical industries, mainly for their catechin and rutin content [42].

4.1.3 Pectinase Treated Probiotic Banana Juice

Traditionally the banana fruit, Musa paradisiaca is used for better digestion, diarrhea, dysentery, intestinal lesions in ulcerative colitis, sprue, uremia, nephritis, gout, lower blood pressure, cardiac disease, stronger bones. But, banana peels are considered as a waste, thrown without use. In fact, banana peels are nutritionally good source for fiber, smagnesium, potassium, calcium, iron, vitamin B6, vitamin C, omega fatty acids, resistant starch, proteins, antioxidants, oxalates, phytates, saponins and also a good source of other types of fiber, such as pectin which is water-soluble. But, it is reported that pectinase enzymes are mostly produced from yeast cultures by using pectin as a substrate in sub-merged fermentation (SMF) techniques. Banana peel contains 35% weight of total banana fruit with a very much useful in production of valuable fermented products.

A study was carried out by in the investigation on effects of Saccharomyces cerevisiae probiotic yeast fermented from pectinase treated probiotic banana juice (PPBJ) on obesity induced by high fat diet (HFD) for 20 weeks which prone to develop hyperglycemia, hyperinsulinemia, hyperleptinemia, hypertriglyceridemia and hepatic steatosis [43]. This study gave an insight to the action of pectinase treated probiotic banana juice (PPBJ) in prevention and management of the obesity induced insulin resistance, type 2 diabetes (T2D). The result gotten from the study concluded that the increased intestinal Saccharomyces cerevisiae yeast can switch synergetic antioxidant effect and to an antagonistic effect towards the lipid radicals and may induce synthesis of polyunsaturated fatty acids which have anti-obesity, antidiabetic, antioxidative stress, antioxidant and anti-hepatosteatosis effect. The anti steatotic effect of PPBJ is associated with the enhancement in the antioxidant potential of the liver by reduction in the oxidative stress triggered by High fat diet (HFD). Banana juice increased the concentration of gut microbes and allowed the gut microbes to interact with the host's liver tissues and to regulate its energy metabolism and also played a role in control of nutrient absorption and metabolism, the integrity of the gut barrier [43]. This investigation is the evidence, suggesting the potential therapeutic action of pectinase treated probiotic banana juice on HFD induced obesity, obesity associated insulin resistance lipid peroxidation and hepatic steatosis prevention and treatment [43].

Banana consumption and most importantly the peel can potentially decrease the occurrence of different diseases since this fruit is rich in several bioactive compounds, such as secondary metabolites, minerals, and fibers. Additionally, new strategies to use banana biomasses have been employed, e.g., the extraction of bioactive compounds from different parts of the plant [41]. These extracts have been studied mostly for the determination of their antioxidant activity.

Herbs and Spies

Ginger and covid19: Ginger (Zingiber officinale Roscoe) (Figure 4) contains several components, including about 3.0%-6.0% fatty oil, 9.0% protein, 60.0%-70.0% carbohydrates, 3.0%-8.0% crude fiber, about 8.0% ash, 9.0%-12.0 % water and approximately 2.0% volatile oil the pharmacological effects of ginger are largely attributed to its terpenes and phenolic compounds [44]. Terpene ingredients of ginger include zingiberene, bisabolene, farnesene, sesquiphellandrene, limonene, cineole, linalool, borneol, geranial and curcumene. The ginger-derived phenolic

compounds include gingerols, paradols, shogaols, and zingerone. Ginger also contains other gingerol- or shogaol-related compounds such as 1- dehydrogingerdione, 6-gingerdione and 10-gingerdione as well as gingerdiols and diarylheptanoids. The major pungent ingredients of fresh ginger are gingerols. Although 6-gingerol is the most abundant gingerol in ginger, other types of gingerols, such as 8-, 10- and 12-gingerols as well as 6-gingerdione are also present [45]. Gingerol is a phenol phytochemical compound found in fresh ginger that activates spice receptors on the tongue. In vivo tests in rats that were immunosuppressed using cyclophosphamide showed that ginger essential oil given once a day orally for a week could increase the humoral immune response. Humoral immunity involves interaction between B-cells and antigens for subsequent proliferation and differentiation into plasma cells that secrete antibodies.

Coronavirus disease 2019 (COVID-19) is a type of disease caused by a virus from the coronavirus group, namely the severe acute respiratory syndrome coronavirus 2 or SARS-CoV-2.1 COVID-19 can cause respiratory system disorders, ranging from dyspnea, fever, nonproductive cough, pneumonia, fatigue, and myalgia, emerge after an incubation stage of 2 to 14 days [46]. Currently, there are no specific therapies, such as relevant antiviral drugs, available for COVID-19 social distancing &boosting the body's immune system may prevent the disease from spreading [44]. Herbs can provide valuable sources of compounds that have immunomodulatory, anti-inflammatory, antioxidant, and antiviral properties, exerting beneficial effects on systems affected by viruses. Experimentally and clinically, ginger (the rhizome of Zingiber officinale) has exhibited numerous therapeutic activities, including anti-inflammatory, antioxidant, immunomodulatory, antimicrobial, antifungal, anticancer, neuroprotective, antimigraine, hepatoprotective, hypocholesterolemic, cardiovascular protective, respiratory protective, antiobesity, antidiabetics, anti-nausea and anti-emetics [47].

Ginger Potential Activities Against Covid-19

According to the molecular docking analyses, it was also found that 6-gingerol (a component in ginger) exhibit a high binding affinity with a number of virus proteins (main protease, SARS-CoV3C like molecule and cathepsin K) which are essential for SARS-CoV-2 replication. 6-gingerol also binds to the S protein and several RNA binding proteins of SARS-CoV-2. Docking analyses also revealed that gingerol, geraniol, shogaol, zingiberene, zingiberenol, and zingerone interact with key residues in the catalytic domain of the MPro. Meanwhile, geraniol, shogaol, zingiberene, zingiberenol and zingerone can interfere with S protein-ACE2 binding. Docking studies indicated that 6-gingerol, 8- gingerol, 10-gingerol, 10- shogaol, 8-paradol, and 10-paradol interact with the RBD of the virus S protein as well as human ACE2, thus they can inhibit the spreading of SARS-CoV-2.The results from a computational analysis indicate that a ginger-derived terpene namely sesquiphellandrene binds to S protein and thus interferes with the S protein-ACE2 interaction another reason is PL pro can be considered as a proper target of anti-SARS-CoV-2 drugs in order to effectively prevent virus replication and survival. Molecular docking approaches indicated that 8- gingerol, 10-gingerol, 6-gingerol and another class of the ginger's ingredients potently inhibit PLpro [48].

Some in vivo observations in a study in Saudi Arabia indicate the consumption of ginger by COVID-19 patients was increased from 36.2% prior infection to 57.6% after infection. The proportion of patients' hospitalization for COVID-19 treatment was also lower among ginger users (28.0%) than in non-users (38.0%) (REF).

In a study from Bangladesh, a few cases of cured COVID-19 patients were described who consumed home medicines containing ginger in mixes of various herbs with or without the use of additional treatments (REF). According to the results from a Tunisian study, treatment of a few cases of COVID-19 with home medicines containing ginger in combinations with other herbs reduced disease symptoms. In some parts of Africa, acclaimed remedies containing ginger in mixes of various herbs were also used for the management of COVID-19 (REF).

The results from a clinical trial study from Iran indicate that a combination therapy by ginger and Echinacea in suspected COVID-19 outpatients attenuated some of their clinical symptoms (breath shortness, coughing and muscular pain) in comparison with those treated with a standard protocol using hydroxychloroquine, alone (REF).

Figure 4: Zingiber officinale Roscoe

Cinnamon and Type 2 Diabetes

Cinnamon was derived from a Greek word that means sweet wood, comes from the inner bark of tropical evergreen cinnamon trees (Figure 5) [47]. Cinnamon is a genus of the Lauraceae family, many of whose members are used as spices. It is one of the most widely used flavoring agents used in the food and beverage industry worldwide and well recognized for its medicinal properties since antiquity and has recently become increasingly popular for its benefits in glycemic control. It has been used for the treatment of coronary risk factors, particularly diabetes mellitus, and obesity, and for ameliorating dyslipidemia. Its leaf and bark have digestive, blood purifier, astringent, carminative, warming stimulant, antiseptic, antibacterial, antifungal, and antiviral properties and can help to reduce cholesterol and blood sugar levels [49]. Different mechanisms of action have been suggested in the scientific literature for cinnamon and its bioactive compounds regarding their beneficial properties and this includes; Cinnamon mediate antidiabetic effects by preventing inflammation. In a study, it was found that treatment with cinnamon extract resulted in the decreased expression of interleukin (IL)-1β, IL-6 and tumour necrosis factor (TNF)-α mRNA, while increasing the expression of IR, IRS1, IRS2, PI3K and Akt1 in hamster enterocytes Another potential mechanism of action of cinnamon extract involves the activation of the transcription factors, peroxisome proliferator-activated receptors (PPARs) [48]. PPARs have been shown to be involved in the regulation of insulin resistance and adipogenesis, and PPAR agonists such as thiazolinediones have long been used clinically in the treatment of T2D and insulin resistance [50].

Figure 5: Structure and different presentations of Cinnamon

The major components found in cinnamon are identified as cinnamaldehyde, procyanidin type-A polymers, cinnamic acid, and coumarin. The polyphenol-rich cinnamon has been demonstrated to be a potential source of natural antioxidants, exhibiting strong free radical scavenging properties in vitro, which may contribute to protecting against oxidative stress [50]. Moreover, cinnamon has been employed as a potential therapeutic agent to treat Type 2 diabetes mellitus, Type 2 diabetes mellitus (T2DM) is a major global health disorder, and it constitutes an important contribution to morbidity and mortality worldwide. Type 2 diabetes is defined as a complex metabolic disorder of insulin sensitivity and action on peripheral tissues like skeletal muscle and adipose tissue and of impaired insulin secretion this occurs in certain individuals as a result of lifestyle factors, such as diet and obesity, as well as genetic predisposition. Glycemic control presents a constant challenge for those with diabetes with this, cinnamon has demonstrated its effectiveness in decreasing fasting blood glucose, serum lipids and insulin resistance improvement, and the functionality to which cinnamon expresses its effect on blood glucose can be attributed to its active component cinnamaldehyde [51].

Studies on Cinnamon

A study was conducted on the effect of cinnamon on diabetic patients by on mainly 37 participatants, with no significant differences in baseline characteristics, dietary intake and physical activity between groups. In the treatment group, the levels of fasting blood glucose, HbA1c, triglyceride, weight, BMI and body fat mass decreased significantly compared to baseline, but not in placebo group. No significant differences were observed in glycemic status indicators, lipid profile and anthropometric indicators between the groups at the end of intervention. And the conclusion on the experimental study is that, the data suggest that cinnamon may have a moderate effect in improving glycemic status indicators. Effects of cinnamon consumption on glycemic status, lipid profile and body composition in type 2 diabetic patients.

In a meta-analysis of 10 RCTs (n = 543 patients), cinnamon doses of 120 mg/d to 6 g/d for 4 to 18 weeks reduced levels of fasting plasma glucose (−24.59 mg/dL; 95% CI, −40.52 to −8.67 mg/dL), total cholesterol (−15.60 mg/dL; 95% CI, −29.76 to −1.44 mg/dL), LDL-C (−9.42 mg/dL; 95% CI, −17.21 to −1.63 mg/dL), and triglycerides (−29.59 mg/dL; 95% CI, −48.27 to −10.91 mg/dL). Cinnamon also increased levels of HDL-C (1.66 mg/dL; 95% CI, 1.09 to 2.24 mg/dL). No significant effect on hemoglobin A1c levels (−0.16%; 95%, CI −0.39% to 0.02%) was seen. High degrees of heterogeneity were present for all analyses except HDL-C (I2 ranging from 66.5% to 94.72%).

Based on the experiment made the conclusion that was drawn is that the consumption of cinnamon is associated with a statis-

tically significant decrease in levels of fasting plasma glucose, total cholesterol, LDL-C, and triglyceride levels, and an increase in HDL-C levels; however, no significant effect on hemoglobin A1c was found. The high degree of heterogeneity may limit the ability to apply these results to patient care, because the preferred dose and duration of therapy are unclear [51-76]. Cinnamon use in type 2 diabetes: an updated systematic review and meta-analysis.

2. Conclusion

A food can be regarded as functional if it is satisfactorily demonstrated to affect beneficially one or more target functions in the body. Functional foods have demonstrated efficacy in preventing and treating various medical conditions particularly those involving the gastrointestinal tract. For instance, the microbes in probiotic foods have the ability to manipulate the gut/lung microbiome and this is promising for the prevention/treatment of various diseases including COVID-19, owing to the immunomodulatory qualities associated with the probiotics and this has been an advantage in the field of medicine.

There is highly good possibility for the use of fruits, vegetables, herbs, spices and probiotics foods, consumed in right proportions, in the prevention or treatment of infectious disease owing to safety, effectiveness, and cheap cost. There is no denying that prioritizing our natural foods, we also support the overall health of our communities.

Recommendation

Locals are aware of the advantages of these bioactive substances in the treatment of disease, but precautions should be taken before consuming these foods in which they are not fully educated to know because, at high doses, some components become toxic and poisonous to human cells. There is still need for more studies on the safety and effectiveness of functional foods on health to draw more concrete statements. Thus, upcoming Microbiologists should consider the field of food microbiology as more research is needed for the functions of natural bioactive foods in the field of medicine

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