REVIEW: A LINK OF FUNCTIONAL FOOD WITH DEGENERATIVE DISEASES

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ABSTRACT:

Functional foods are foods that provide health benefits beyond basic nutrition due to certain physiologically active components, which may or may not have been manipulated or modified to enhance their bioactivity. Mounting evidence supports the observation that functional foods containing physiologically-bioactive compounds such as polyphenols, vitamins, and carotenoids found in vegetables and fruits can have antioxidant and anti-inflammatory effects. There is a link between functional foods and its impact on degenerative disease (Alzaimer's disease, Parkinson's disease, diabetes, cancer, cardiovascular disease). Health-conscious consumers are increasingly seeking functional foods in an effort to control their own health and wellbeing. This Scientific Status Summary reviews the literature for the primary plant and animal foods that have been linked with physiological benefits and in degenerative diseases.

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Keywords: Functional foods, Bioactive Compounds, antioxidant, Degenerative disease, Health promotion

INTRODUCTION:

The American Dietetic Association (ADA) states that functional foods include "whole foods and fortified, enriched, or enhanced foods, have a potentially beneficial effect on health when consumed as part of a varied diet and on a regular basis, at effective levels," (Hassler *et al.*, 2004). The International Food Information Council (IFIC) states that functional foods "provide health benefits beyond basic nutrition (Hassler *et al*., 2004)."

The American Council on Science and Health states that functional foods are "whole, fortified, enriched, or enhanced foods that provide health benefits beyond the provision of essential nutrients, when they are consumed at efficacious levels as part of a varied diet on a regular basis," (Hassler 2002).

Functional foods, an overall healthy diet including fruits, vegetables, unrefined grains, fish, and low-fat dairy products, and foods low in saturated fats and sodium (Katan and De Roos 2002), and exercise, combine to encompass the healthy lifestyle needed for disease prevention. The definition of functional foods expands on one aspect of a healthy lifestyle; this definition is meant to recognize foods and food ingredients, whether natural, added, or modified, that provide disease prevention and health promotion benefits.

FOOD: SOURCES AND CLASSIFICATION

Functional foods are classified by source of origin, including plant, animal, microbial, and miscellaneous (algae, mushrooms, other). Regardless of the source of origin, the target of functional foods includes CVD, cancer, immune enhancement, gastrointestinal and women's health, aging, diabetes mellitus, and stress management.

Plant-Derived Functional Foods

Plant-derived functional foods are separated into primary and secondary metabolites; primary metabolites are plant compounds necessary for growth, while secondary metabolites are not essential for growth, but are used for plant survival mechanisms. Primary metabolites include plant proteins, beta-glucans, and omega-3 fatty acids. Plant proteins include texturized vegetable protein, soy protein isolate, and amino acids; these proteins act as functional foods by helping to decrease the amount of meat consumption, which decreases the consumption of fat and cholesterol. Beta-glucans, found in oats, act as functional foods by decreasing cholesterol absorption. Omega-3 fatty acids, found in flaxseed, act as a functional food by reducing platelet aggregation. Secondary metabolites include phytoestrogens, antioxidants, vitamins, tocopherols, steroids, gamma-linolenic acid (GLA), and phase II enzyme inducers. Phytoestrogens, estrogen-like compounds in plants, are found in soybeans and flaxseed and act as functional foods by decreasing post-menopausal cancer development. Antioxidants, such as anthocyanins, act as functional foods by quenching reactive oxygen species. Vitamins, which are abundant in fruits and vegetables, act as functional foods by preventing deficiencies; certain vitamins, such as vitamins C and E, also act as quenchers of reactive oxygen species. Tocopherols, which are vitamin E compounds found in oilseeds, act as quenchers of reactive oxygen species. Steroids are also found in oilseeds and act as functional foods by competing for cholesterol absorption. GLA is a fatty acid involved in the formation of prostaglandins and acts as an inflammatory modulator (Arai, 2005). Phase II enzyme inducers, found in Brassica vegetables, act as functional foods by glycosylating insoluble toxins to produce soluble compounds that are excreted. Consumption of foods containing phase II enzyme inducers also limits the phase I enzyme detoxification system; the phase I enzyme system produces reactive oxygen species.

Animal-Derived Functional Foods

Zoo chemicals, which are animal-derived functional foods, include omega-3 and six fatty acids, conjugated linolenic acid (CLA), small peptides, whey and casein, and glucosamine and chondroitin sulphate. Omega-3 fatty acids include alpha-linolenic, docosahexaenoic (DHA), and eicosapentaenoic (EPA) fatty acids. Sources of alpha-linolenic acid include soy and canola oils, walnuts, and flaxseed. The main source of EPA and DHA is fatty fish, such as salmon. Omega-6 fatty acids include linolenic, gamma-linolenic, and arachidonic fatty acids. Sources of these fatty acids include some vegetable oils, nuts, and whole grains. Omega-3 and six fatty acids act as functional foods by enhancing immunity, modulating inflammation, and protecting against neurodegenerative diseases. CLA is a fatty acid present in milk that reportedly acts as a functional food by reducing cancer risks and adipose differentiation; however, a fatty liver may develop as a side effect (Hassler 2002). Whey and casein are milk proteins that act as functional foods by being easily digested and absorbed, and help build muscle mass; small peptides function in the same manner. Glucosamine and chondroitin sulphate are required for collagen formation and were stated to act as functional foods by alleviating pain associated with osteoarthritis; however, this claim has been disproved (Arai, 2005).

Microbial Functional Foods

Microbial-derived functional foods include probiotics, prebiotics, symbiotics, and synbiotics. Probiotics are natural microflora that occur in the gut, such as L. casei or numerous Bifidobacter species, which promote health (Hassler, 2002). Prebiotics are dietary components that promote growth of probiotic bacteria. Symbiotics contain probiotics and prebiotics combined randomly, while synbiotics contain specific probiotics and prebiotics mixed together to benefit one another. Functional foods of microbial origin act by promoting the growth of probiotic bacteria so that the growth of pathogenic bacteria is limited.

Miscellaneous Functional Foods

Some functional foods are derived from miscellaneous compounds such as algae and mushrooms. Algae function by proving omega-3 fatty acids, which enhance immunity, modulate inflammation, and protect against neurodegenerative diseases. Functional foods derived from mushrooms contain antiviral, antibacterial, and anti-inflammatory properties.

BIOACTIVE COMPOUNDS

Bioactive compounds are defined as components of food that can regulate metabolic processes in human or animals and improve health. They are found largely in vegetables, fruits, and whole grain and can be consumed daily. Plant foods such as vegetables, fruits, cereals, spices, and legumes have been reported to play crucial roles in the protection against and prevention of various chronic diseases such as diabetes, obesity, cancer, erectile dysfunction, cardiovascular diseases, and Alzheimer's disease by modulating several metabolic processes (Oboh *et al.*, 2004) Functional food bioactive compounds are extra nutritional constituents that occur naturally in plants and can exert biological effect (Ghanbari et al., 2012; Lobo et al.,2010). The intake of natural dietary bioactive compounds is associated with low incidence of these chronic diseases (Lima et al., 2014; Zhang et al., 2015). Epidemiological, clinical, and biochemical studies have revealed that these bioactive compounds through different mechanisms have various activities in the human body such as antioxidant, antidiabetic, antihypertensive, anti-Alzhemic, Anti proliferative, and antimicrobial activities (Gupta and Prakash,2015; Chu *et al.*,2002) These unique properties have been linked to some bioactive food components/compounds that can promote health and prevent diseases (Liu,2003;Hasler,1998).

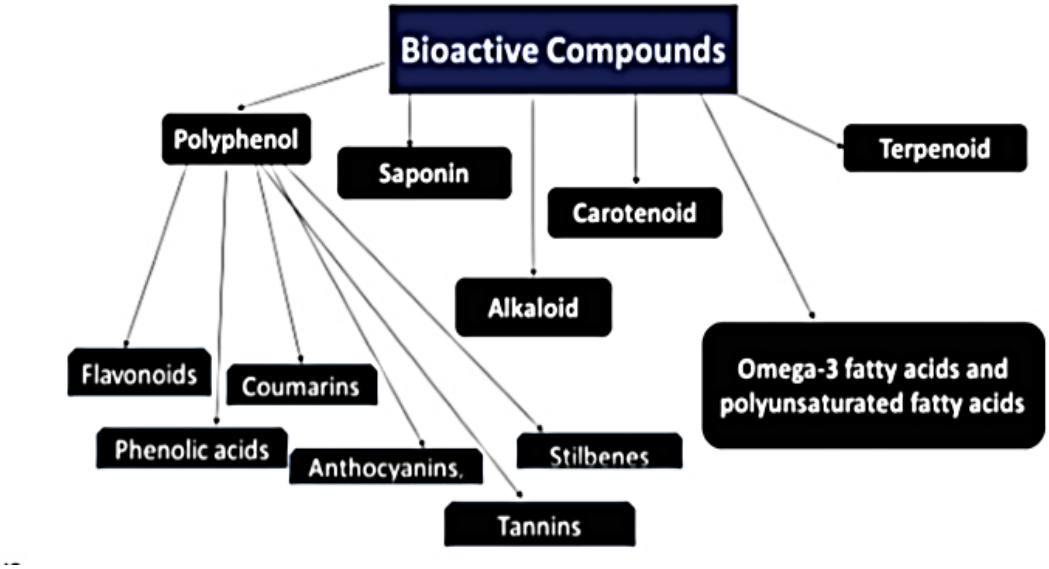

Figure: Functional food bioactive components/compounds

ROLE OF BIOLOGICAL BIOACTIVE COMPOUNDS

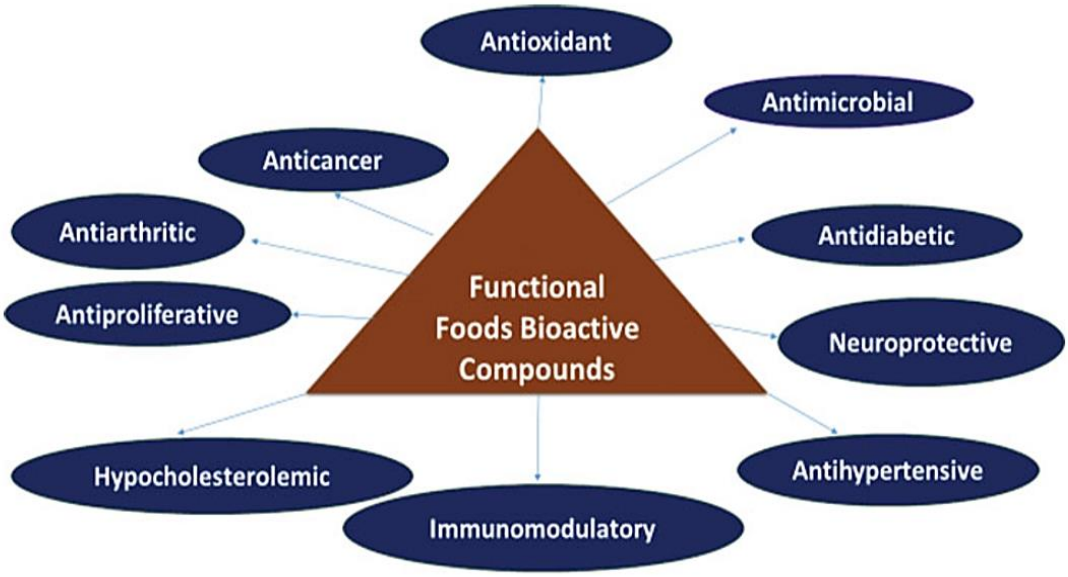

Figure: Biological properties of functional food bioactive components/compounds

DEGENERATIVE DISEASE

Degenerative disease is the result of a continuous process based on degenerative cell changes, affecting tissues or organs, which will increasingly deteriorate over time. Many diseases previously classified as degenerative are now known to be associated with specific metabolic deficiencies or have other definite causes. Degenerative/chronic diseases such as cancer, platelet aggregation, thrombosis, sexual dysfunction, arthritis, diabetes, obesity, stroke, and respiratory, cardiovascular, and neurodegenerative diseases are among the leading causes of

morbidity and mortality globally (WHO, 2002). Degenerative diseases have a high significant impact on health, quality of life, and life expectancy (Somrongthong *et al.*, 2016)

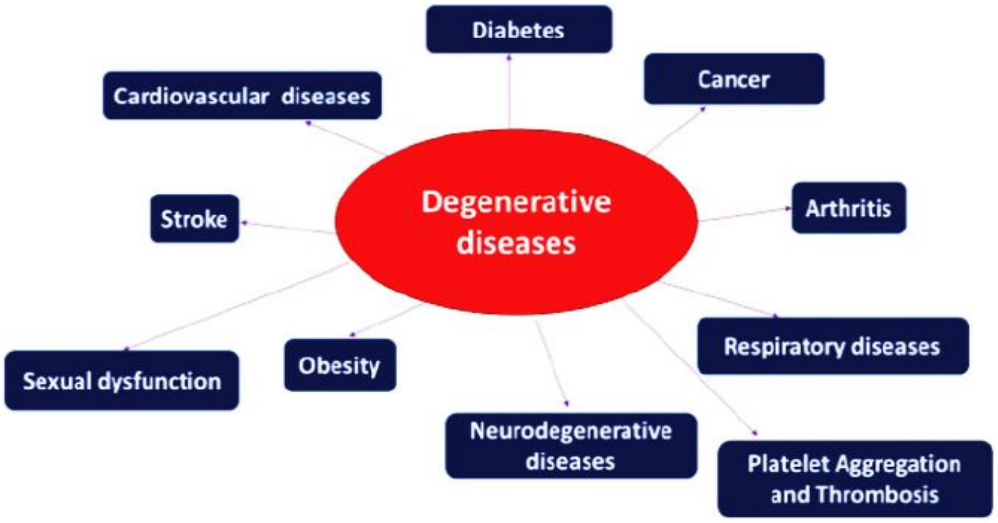

Figure: Some degenerative/Chronic disease

ROLE OF FUNCTIONAL BIOACTIVE COMPOUNDS IN ALZAIMER'S DISEASE, PARKINSON'S DISEASE AND DIABETES

Alzheimer's disease (AD) and Parkinson's disease (PD) are the two most prevalent neurodegenerative diseases worldwide. These devastating diseases are characterized by progressive and irreversible neuro-degeneration of particular neuronal networks in the brain that lead to severe cognitive and behavioural dysfunction. AD is the most common neurodegenerative disease in the world. At present, the disease affects 24 per cent of the population over age 85.3. In the year 2000, it was estimated that 4.5 million individuals in the United States had AD, a number that is projected to rise to 14 million by 2050.

Alzaimer's Disease is clinically characterized by a progressive loss in cognitive function that typically begins with memory loss, anxiety, and depression. As the disease progresses, the symptoms evolve to severe motor dysfunction, profound cognitive deterioration, and loss of independent function.

The phosphorylation state of tau modulates the stability of the microtubules and is regulated by various protein kinases and phosphatases. However, in the case of Alzaimer's Disease, tau is found to be aberrantly hyper phosphorylated, rendering it incapable of microtubule interaction, consequently impacting normal neuronal functions, morphology, and viability. Recent evidence suggests that, in addition to being a microtubule stabilizer, tau may regulate neuronal excitability and serve as a master regulator of the trafficking of molecules within the cell that contribute to synaptic function.

Parkinson's disease is the second most common neurodegenerative disease that affects 0.3per cent of the population of industrialized countries. Parkinson's disease involves a progressive loss of neurons in the brain manifesting into characteristic motor and non-motor symptoms. Motor symptoms include rigidity, resting tremor, postural instability, and gait

impairment. Non motor symptoms include anosmia, depression, anxiety, sleep disorders, gastrointestinal symptoms, autonomic dysfunction, and cognitive impairment.

Alphasynuclein (α-syn) has been identified as the primary protein aggregate found in Lewy bodies. Alpha-syn has been identified as a key factor implicated in PD, because it plays an important role in controlling the function of dopaminergic neurons; thus, the dysfunction of this protein at dopaminergic synapses is thought to contribute to the initiation of neuro degeneration. Additionally, it is suggested that the aggregation of α-syn has a pathogenic role in PD through exerting Parkinson's disease negative effects on the cell membrane and proteasomal functionality, disrupting gene expression regulation, influencing cell signalling and cell death pathways, promoting inflammation, and modifying the storage and release of dopamine.

Dopamine metabolism is accelerated in PD, and contributes to oxidative stress through the concurrent production of free radicals such as quinones and peroxides. The vulnerability of dopaminergic neurons to neuro degeneration in PD compared to other neuronal systems may be linked to unique morphological and physiological properties. The dopaminergic neurons consist of long, narrow, branched projections that have higher basal energy requirements than other neurons, rendering them more susceptible to damage caused by mitochondrial dysfunction.

ROLE OF FUNCTIONAL BIOACTIVE COMPOUNDS IN CANCER

Increasing bioactive compounds and antioxidant defence through dietary phytochemicals, present in fruits, vegetables, whole grains, and other plant foods, may prevent, reduce, or delay the oxidation of DNA and affect cellular signal transduction pathways controlling cell proliferation and apoptosis (Liu, 2004). The evidence supporting a high consumption of fruits and vegetables to reduce the risk of the development of cancer is reviewed in the following.

In vitro, and clinical trial data indicates that a plant-based diet can reduce the risk of chronic disease, particularly cancer. In 1992, a review of 200 epidemiological studies (Block *et al.*, 1992) showed that cancer risk in people consuming diets high in fruits and vegetables was only one-half that in those consuming few of these foods.

ROLE OF FUNCTIONAL FOOD IN CARDIOVASCULAR DISEASE

Functional foods and food products such as cocoa, coffee, and condiments are beneficial in the prevention and treatment of hypertension and heart-related diseases (Pastor-Villaescusa *et al.*, 2015). Moreover, the therapeutic effects exerted by these functional foods have been attributed to their bioactive constituents (Bawa *et al.*, 2015). Recent investigations show that these bioactive compounds play a beneficial role by normalizing the abnormal lipids, lipoproteins, blood pressure, and inhibition of platelet aggregation and increasing antioxidant status.

CONCLUSION

Functional foods "provide health benefits beyond basic nutrition". Diet including antioxidants, phenols, polyphenols, and also contains bioactive compounds which reduces the free radicals in the body and maintains the immune system. Diet is only one component of an overall lifestyle that can have an impact on health; other components include smoking, physical activity, and stress. On including in diet it prevents the body from many degenerative diseases such as cardiovascular disease, Diabetes, Arthritis, Alzaimer's disease, Parkinson's disease, Obesity etc. Therefore, the anti-inflammatory activity of phytochemicals may play an important role in the prevention of CVD. In addition, dietary phytochemicals have been shown to have roles in the regulation of prostaglandin synthesis, reduction of platelet aggregation, regulation of cholesterol synthesis and absorption, and reduction of blood pressure. Additional research is necessary to substantiate the potential health benefits of those foods for which the diet-health relationships could be understand better.

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