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PHYTOCHEMICALS AND CHRONIC DISEASE: A NATURAL PATH TO BETTER HEALTH

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ABSTRACT

Plants produce bioactive compounds called phytonutrients or phytochemicals in response to changes in their environment. These compounds, found in whole grains, nuts, fruits, and vegetables, add colour, flavour and sent to the food. They also offer health benefits by potentially reducing the risk of chronic conditions like cancer, diabetes, obesity and heart disease. There are about 10,000 known phytochemicals, which fall into four main categories: carotenoids, organosulfur compounds, phenolic phytochemicals and alkaloids. Carotenoids, found in colorful fruits and vegetables, act as antioxidants and can be converted into vitamin A, essential for immune function and vision. Flavonoids are known for their protective effects on the brain and their ability to fight viruses and cancer. Resveratrol, found in peanuts and grapes, helps prevent heart disease and may also ward off diabetes and Alzheimer's. Phytonutrients play a key role in managing chronic diseases by supporting immune health, reducing inflammation and acting as antioxidants. For example, resveratrol and omega-3 fatty acids can help lower cholesterol and prevent heart disease. Other compounds like curcumin, β -carotene and lycopene also support heart health by reducing inflammation and oxidative stress. In cancer treatment, substances like curcumin and procyanidin may help prevent cancer cell growth. However, the long-term effects and potential risks of consuming too many phytonutrients are not fully understood. Overconsumption of certain phytonutrients, like resveratrol and phytoestrogens, could lead to health issues such as an increased cancer risk or gastrointestinal problems. Therefore, while phytonutrients have many health benefits, people with existing health conditions should be cautious, especially when using supplements.

KEYWORDS

Phytochemicals, Cardiovascular diseases and Cancer.

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INTRODUCTION

Bioactive compounds, known as phytochemicals, are produced by secondary plant metabolism in response to environmental changes^{1,2}. Furthermore, phytochemicals are known to provide potential benefits for human health and nutrition and to add colour, flavour and scent to plants. Actually, we
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usually acquire them by eating fruits, vegetables, whole grains, nuts, beans, herbs, tea and coffee³. Whole plant meals are a great source of fibre, vitamins and minerals, but they also include a significant class of molecules known as phytochemicals or phytonutrients. Naturally occurring plant chemicals, or phytochemicals (phyto is Greek for "plant"), have been shown to have health-promoting properties that include lowering blood cholesterol, reducing inflammation and avoiding cancer, diabetes, obesity and cardiovascular disease⁴. Phytonutrients are found in most foods, including whole grains (oats, rice, sorghum, wheat), beans, fruits (grapes, blueberries, raspberries, blackberries, melons), vegetables (tomatoes, potatoes, garlic, broccoli, kale, parsley, spinach) and herbs.

Classification of phytonutrients

More than 10,000 phytonutrients have been identified in dietary plants. Their concentrations differ greatly between species and cultivars and also vary according to environmental conditions, agricultural modes, storage, processing and home uses⁵⁻⁷. The phytochemicals are classified into four main families

Phenolic phytochemicals

Alkaloids

Organosulphar compounds

Carotenoids.

Numerous kinds of phytonutrients have been used in the treatment of various diseases, including the following

Carotenoids

Ellagic acid

Flavonoids

Resveratrol

Glucosinolates

Phytoestrogen

Carotenoids

In fruits and vegetables, more than 600 carotenoids give them their yellow, orange and red hues. In the human body, carotenoids function as antioxidants. The carotenoids beta-carotene, beta-carotene and beta-cryptoxanthin are among those that might offer additional health advantages. All of these can be

converted by your body into vitamin A, which is essential for maintaining the health of your eyes and immune system. Alpha and beta-carotene rich foods include carrots and pumpkins, as well as other yellow and orange produce. Beta-cryptoxanthin is also present in these and sweet red peppers⁸.

Ellagic Acid

Ellagic acid is a substance that exists naturally. Blackberries, cherries, walnuts, raspberries, and strawberries are the best dietary sources of ellagic acid. Ellagic acid is prescribed for a variety of conditions, including diabetes, cancer, melasma, and dark spots on the face. However, there isn't enough solid scientific data to back up these claims. Interaction Blood sugar levels may be lowered by ellagic acid. Combining ellagic acid with diabetes drugs may result in dangerously low blood sugar levels. Keep a watchful eye on your blood sugar.

Flavonoids

Flavonoids, also known as bioflavonoids and derived from the Latin word flavus, which means yellow in nature, are a class of secondary metabolites that are multifunctional and are primarily found in plants. As a result, they are frequently included in human diets⁹.

Chalcones, flavones, flavonols, and isoflavones are some of the subclasses of flavonoids. These subgroups possess distinct primary sources. Two important dietary sources of flavonols and flavones are onions and tea. Different types of Flavonoids are

Anthocyanidins

Quercetin

Proanthocyanidins

Resveratrol

Flavanols

Flavanones, such as hesperetin

Flavones

Isoflavones

Catechins

Nonetheless, the medical field is where these polyphenols are most prominently used. As anticancer, antibacterial, antiviral, antiangiogenic, antimalarial, antioxidant, neuroprotective,

antitumor, and anti-proliferative drugs, flavonoids have been widely utilised^{10,11}. Flavonoid-rich apple peel extracts are an efficient antihypertensive agent and inhibit acetylcholinesterase (ACE) in vitro. Additionally, it has been shown to better preserve cognitive function with ageing and avoid cardio-metabolic problems¹². Dietary flavonoids are so named because they are plentiful in plant-based meals and beverages, including fruits, vegetables, tea, chocolate and wine.

Resveratrol

Resveratrol, also known as 3, 5, 4'-trihydroxy-trans-stilbene, belongs to the polyphenol class of plant micronutrients. Because of its anti-inflammatory and antioxidant qualities, resveratrol helps prevent diseases including diabetes, Alzheimer's and cancer. Resveratrol is an effective treatment for skin irritation and arthritis due to its anti-inflammatory properties. Additionally, resveratrol contains antifungal and antibacterial qualities that aid in the treatment of urinary tract and digestive system infections. The skin of grapes, blueberries, raspberries, mulberries, and peanuts are among the food sources of resveratrol¹³.

Glucosinolates

A naturally occurring compound found in a wide variety of aromatic plants, including horseradish, mustard, and cabbage. Brussels sprouts, kale and other cruciferous vegetables contain sulphur-containing substances called glucosinolates. They decompose into metabolites that assist in shielding your cells from the damaging effects of free radicals.

In the intestines and other regions of the body, they can help prevent bacterial, viral and fungal infections and have an impact similar to an antibiotic. A diet high in cruciferous vegetables may also reduce your risk of developing some malignancies, according to a number of recent studies. Benefits of glucosinolates, such as direct antibacterial qualities and regulatory roles in phase I metabolism, stress response, inflammation, and antioxidant activities¹⁴.

Phytoestrogens

Phytoestrogens are substances found in plants naturally. The Greek root word "phyto-" means "plant." Phytoestrogens are plant-based chemicals that resemble 17 β -oestradiol in structure and have an oestrogenic effect. The four phenolic substances coumestan, lignan, stilbene, and isoflavones are classified as phytoestrogens. Phytoestrogens can be found in nuts, seeds, fruits and vegetables. Soybeans, rice, wheat, celery, carrots, potatoes, red clover, sweet potatoes, apples, pomegranates, chaste berries and coffee are examples of food sources¹⁵⁻¹⁸.

Uses of phytoestrogen

Phytoestrogens may have some utility as a natural form of hormone replacement treatment. Phytoestrogens have heart-healthy benefits and can lower total cholesterol.

Isoflavones' vasodilatation properties can lower blood pressure.

Moreover, phytoestrogens influence blood sugar control. Additionally, phytoestrogens reduce the risk of endometrial cancer. This has to do with the abilities of phytoestrogens, which include pro-apoptotic, anti-mutagenic, anti-angiogenic, antioxidant and anti-cancer effects.

Because they are antioxidants and neuroprotectors, phytoestrogens can lower the risk of Alzheimer's. In older women, phytoestrogens may help halt bone loss.

Maintaining appropriate bone density is known to be aided by natural oestrogen. Phytoestrogens may potentially be used to treat acne.

PHYTOCHEMICALS IN MANAGEMENT OF CHRONIC DISEASES

They may offer medical health benefits, such as the prevention and/or treatment of disease and a variety of physiological abnormalities and they have a significant influence on the healthcare system. By preserving and regulating immune function, phytonutrients can help avoid certain diseases. Since they are natural products, they have significant potential for use in clinical therapy because they don't have any of the negative

consequences that come with radiation or chemotherapy. They also save health care costs tremendously because they are relatively inexpensive. Antioxidant phytochemicals may be useful in the management and prevention of chronic illnesses. Antioxidant phytochemicals typically have potent anti-inflammatory, free radical-scavenging, and antioxidant properties that underpin other bioactivities and health advantages¹⁹. The several chronic disease in which phytonutrients plays a major role are

Protection action on cardiovascular diseases

Protection against Alzheimer's disease

Protection against inflammatory bowel Disease.

Anti-obesity activity

Anti-Diabetes activity

Anti-cancer activity

Anti-ageing activity

Anti-microbial

Hypolipidemic activity

Neuroprotective agent

Treatment of Osteoporosis

CNS stimulant

Analgesic

Immuno-modulator and carminative.

Phytochemicals in treatment of cardiovascular diseases

Resveratrol, a flavonoid, and omega-3 polyunsaturated fatty acids (PUFA) have significant beneficial effects on vascular dysfunction, SASP, and CVD. Alpha-linoleic acid (18:3) (ALA), eicosapentaenoic acid (EPA) (20:5n-3), and docosaehaenoic acid (DHA) (22-6n-3) are examples of omega-3 poly-unsaturated fatty acids (PUFAs). While EPA and DHA are mostly present in fish, ALA is a plant-derived omega 3 that is not synthesised in humans²⁰. The main mechanism of action for omega-3 polyunsaturated fatty acids (PUFAs) is their ability to reduce lipid levels, which in turn lowers the risk of atherosclerosis. By suppressing adhesion molecules and reducing leukocyte adherence to the arterial wall, omega-3 polyunsaturated fats have been demonstrated to lessen vascular inflammation^{21,22}.

Actually, it has been shown that the effects of omega-3 PUFA on enhanced endothelium regenerating capacity and preservation of vascular endothelial cell homeostasis due to membrane stabilising ability have substantial implications for CVD prevention. Therefore, increased PUFA intake had no overall meaningful effect on all-cause or cardiovascular disease mortality, but it did marginally reduce the risk of coronary heart disease and CVD acute events (such as stroke) and mortality. The majority of the beneficial outcomes were linked to changes in lipid metabolism. In the end, vascular dysfunction and oxidative stress are two detrimental consequences of ageing and metabolic illnesses, such as diabetes, which can have an adverse influence on the cardiovascular system. However, due to their many beneficial effects on vascular homeostasis, phytonutrients like resveratrol and omega 3 can still find therapeutic application as useful adjuvant therapy after CVD pathologies have been established. Ultimately, other phytochemicals possessing antioxidant properties have been documented to mitigate the risk or progression of cardiovascular disease (CVD), leading to their recommendation as crucial dietary components. Examples of such phytochemicals include curcuma and β -carotene. Several studies highlight the potential anti-atherogenic properties of lycopene, specifically in relation to its ability to decrease the release of proinflammatory cytokines²³.

Consuming 0.8mg of folic acid may lower the incidence of stroke by 24% and coronary heart disease by 16%, which is defined as a reduction in the blood supply to the heart muscle. Flavonoids are substances that can be found in many foods, including tea, onions, and apples. They may also lower the risk of coronary heart disease. Nuts can decrease cholesterol because they are low in saturated fats and high in unsaturated fatty acids. Isoflavones, which are found in soy products, may offer protection against coronary heart disease, according to a number of animal studies. Allium-family natural sulphur-containing compounds may affect atherosclerosis and plasma cholesterol levels.

These compounds are particularly present in leeks, onions, and garlic, with garlic being the most prevalent. The pharmacopoeia of the Babylonians and other ancient peoples included garlic oil. Human studies have demonstrated the hypolipidemic effects of garlic oil; a recent meta-analysis found that consuming one half clove of garlic daily reduced serum cholesterol by about 9%.

Phytochemicals in treatment of cancer

Cancer is a disease, which involves abnormal growth of cells with the potential to invade and metastasize to other parts of the body. Cancer chemoprevention is the application of artificial, natural, or biological chemicals to reduce the risk of cancer in healthy individuals. Chemopreventive drugs prevent the growth of cancer by preventing DNA damage, which is the first step towards malignancy, or by stopping or reversing the division of premalignant cells that have DNA damage. Certain dietary ingredients, which have shown inhibitory effects on cancer cells, may be used as chemopreventive drugs. These include piperlongumine, benzyl isothiocyanate, phenethyl isothiocyanate, isoflavones, catechins, lycopenes and capsaicin²⁴. Curcumin, a turmeric derivative, is taken out of the *Curcuma longa* plant's roots. Numerous cancer cell lines experience cell cycle arrest, suppression of proliferation and induction of apoptosis as a result of their down regulation of cyclin D1, cyclin E and MDM2 and enhancement of tumour suppressors p21, p27 and p53^{25,26}.

Procyanidin

High concentrations of procyanidin can be found in chocolate, berries, apples and grapes. Procyanidin has been proposed as a supplement to conventional therapy because it potently inhibits P-gp, a gene that is resistant to drugs, and enhances the mRNA expression of PTEN and the tumour suppressor genes IGF-2R and PTEN. Procyanidin has been shown to have chemopreventive properties against breast and lung cancer²⁷.

Folate and folic acid

Broccoli, asparagus and other green leafy vegetables are sources of folate and folic acid. According to pre-clinical research, folate plays a

role in DNA repair and regulates S-adenosylmethionine, which is a methyl group donor for DNA methylation. Dietary folate may reduce the chance of developing stomach, lung, pancreatic, colorectal, and breast cancers, according to several large-scale studies. Pungenta granatum, or pomegranates, contain ellagic acid, which has anti-proliferative properties and stimulates apoptosis in prostate cancer cells through the cyclin kinase inhibitor-cyclin CDK pathway. Ellagic acid inhibits cyclins D1, D2, cdk 2, 4 and 6, as well as Bcl-XL and Bcl-2. It has also been demonstrated to lessen ovarian and breast cancer metastases. Because ellagic acid can target pathways associated with histone deacetylase 6, studies have shown that it has anti-cancer properties^{28,29}.

Side effects and complications of phytonutrients

For the majority of phytonutrients, the long-term effects, adverse effects and toxicity of overconsumption are unknown. Excessive intake of certain substances, such as phytoestrogen, has been linked to negative health outcomes. Long-term usage (weeks or longer) and daily doses of 1000mg or more of resveratrol are associated with a number of adverse effects, including nausea, flatulence, diarrhoea and stomach pain³⁰ negative consequences of glucosinolate, including anaemia, gastrointestinal distress, goitre, hepatic and renal lesions and decreased feed intake and growth. Synthetic oestrogen has a terrible reputation due to its unfavourable side effects in recent years. This includes higher chances of cardiovascular disease, cancer, obesity, and reproductive issues.

When phytonutrients are taken as supplements, they are in a more concentrated and strong form, which carries some danger. Therefore, for those who are hypersensitive, some may result in allergic responses. Additionally, they must be out of children's reach. As with any dietary supplement, anyone with health issues or those who are pregnant or nursing should speak with a healthcare provider before using it. Cauliflower, for instance, contains goitrogens, which can affect how well the thyroid gland functions. Those who already have health issues may need to stay away from certain

phytonutrients. The use of supplements containing phytonutrients should be stopped in the event of an unpleasant or allergic reaction³¹.

CONCLUSION

Naturally occurring substances found in plants called phytochemicals have demonstrated great promise in the management and avoidance of a number of chronic illnesses. These bioactive substances, which include polyphenols, alkaloids, flavonoids and carotenoids, have antibacterial, anti-inflammatory and antioxidant qualities that support their therapeutic benefits. Studies have indicated that phytochemicals are useful in the treatment of diseases like cancer, diabetes, heart disease, and neurological problems because they can affect important biological processes, lower oxidative stress, and control immunological responses. The efficacy of phytochemicals is subject to variation based on individual variability, dosage, and bioavailability, despite their apparent advantages. Furthermore, although a number of studies have demonstrated the potential of phytochemicals, the majority of the evidence originates from preclinical research and larger-scale clinical trials are required to confirm their safety and effectiveness in humans. However, adding phytochemicals to a diet high in fruits, vegetables, and whole grains, or using supplements with strict guidelines, may be an additional benefit to standard medical care in the prevention and treatment of chronic illnesses.

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CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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