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Short Communication

Phytochemicals and health benefits

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ABSTRACT

Phytochemicals are naturally occurring chemicals in plants. They are also known as phytonutrients and possess bioactive compounds. These compounds are abundant in a diverse range of foods including fruits, vegetables, legumes, whole grains, nuts, seeds, fungi, herbs, and spices. These phytochemicals possess many health benefits such as lowering the risk of obesity, cardiovascular disease, boost immune system, decreases growth of cancer cells, suppresses inflammation, act as anti-inflammatory, anti-diarrheal, anti-allergic, stops bleeding, antioxidant activity, antimicrobial effects, adjustment of detoxification enzymes, reduction of platelet clumping, regulation of hormone metabolism. Hence, this article discusses the role of phytochemicals and its effects in disease management.

1. Introduction

The name "phyto" stems from the Greek word, meaning "plant." Phytochemicals are naturally occurring compounds in plants, offering health benefits to humans as medicinal elements and nutrients.[1] Phytochemicals shield plants from disease and also add color, smell, and taste. Generally, these are the substances that safeguard plants from various environmental threats like pollution, stress, drought, UV rays, and attacks by pathogens.[2]

Phytochemicals gather in various parts of plant such as roots, stems, leaves, flowers, fruits, and seeds. Certain phytochemicals, especially pigments like anthocyanins and flavonoids, tend to be most concentrated in the outer layers of plants such as leaves and fruits. However, the amounts of these substances differ among plants due to factors like plant species and the climate where they grow.[3] Phytochemicals are also referred to as functional foods with antioxidant benefits, nutraceuticals, phytonutrients, anti-nutrients and phytotoxins.[4]

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2. Classification of Phytochemicals

Phytochemicals are categorized into primary and secondary metabolites based on their roles in plant metabolism. Primary metabolites, such as carbohydrates, amino acids, proteins, lipids, and nucleic acids, are essential for plant growth and basic functions. Secondary metabolites, produced through pathways derived from primary metabolism, include compounds like alkaloids, glucosinolates, cyanogenic glycosides, phenylpropanoids, flavonoids, and terpenes. These substances, which protect plants from pathogens, UV light, and herbivores, have been used in traditional medicine for centuries and are now important in industries such as pharmaceuticals, cosmetics, and fine chemicals.[5]

Secondary metabolites are grouped into three main categories based on their biosynthetic origins: nitrogen-containing compounds, phenolic compounds, and terpenes. Nitrogen-containing compounds like alkaloids and glucosinolates are produced in response to environmental conditions and have diverse biological activities. Phenolic compounds, derived from pathways like the shikimate

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pathway, serve as antioxidants and UV protectants. Terpenes, the most abundant group, are found in various plant parts and have a wide range of biological effects, including reducing cholesterol and blood pressure. These metabolites, including glycosides, toxic proteins, and organic acids, play crucial roles in plant defence and development. They also serve as signalling molecules and are increasingly valuable as raw materials for various industries. These paper discusses some of the secondary metabolites and its relevance to health.[6]

2.1. Carotenoids

Carotenoids are vibrant pigments in yellow, red, and orange hues that occur in plants, algae, and photosynthetic bacteria. Fruits are particularly rich in carotenoids, while vegetables such as sweet potatoes, carrots, pumpkins, and spinach are also abundant sources.[7] These compounds are prevalent in daikon radish (*Raphanus sativus L.*), spinach (Spinacia oleracea L.), carrots (*Daucus carota L.*), parsley (*Petroselinum crispum L.*), oranges (*Citrus sinensis L.*), cabbage (*Brassica oleracea L.*), fenugreek (*Trigonella foenum-graecum L.*), tomatoes (*Solanum lycopersicum L.*), purple turnip (*Brassica rapa var. rapa L.*), and various green leafy vegetables. The most commonly found carotenoids include α-carotene, β-carotene, β-cryptoxanthin, lutein, zeaxanthin, lycopene, and fucoxanthin.[8]

In most fruits and vegetables, β-carotene is the most prevalent carotenoid, with α-carotene as the second most common. Tangerines, persimmons, and oranges contain significant amounts of β-cryptoxanthin. Lutein and zeaxanthin are primarily present in green leafy vegetables, while lycopene is abundant in tomatoes. Fucoxanthin is mainly seen in brown algae.[7] The presence of lutein, α and β-carotene in foods regulate gene transcription; β-carotene enhances gap junction communication[9]; and lutein boost the immune system. Additionally, α-carotene, β-carotene, lycopene, and zeaxanthin provide protection against lung and prostate cancers. Fucoxanthin has been shown to have anticancer, antihypertensive, anti-inflammatory, radioprotective, and anti-obesity properties.[10]

2.2. Polyphenols

Polyphenols are a group of natural compounds characterized by phenolic structures and include four primary subclasses: flavonoids, stilbenes, phenolic acids, and lignans. Flavonoids are further divided into flavanones, flavones, flavonols, and anthocyanidins. Polyphenols are commonly found in a variety of foods such as spinach (*Spinacia oleracea L.*), artichoke (*Cynara cardunculus var. scolymus L.*), flax (*Linum usitatissimum L.*), broccoli (*Brassica oleracea var. italica L.*), plum (*Prunus subg. Prunus L.*), chicory (*Cichorium intybus L.*), cherry (*Prunus avium L.*), apple (*Malus domestica L.*), pear (*Pyrus L.*), grape (*Vitis vinifera L.*), and onion (*Allium cepa L.*). Beverages like olive oil, tea, and red wine are also rich sources of polyphenols.[9]

Anthocyanidins exist in nature as their sugar-bound forms known as anthocyanins, they give red, blue, and purple hues found in fruits and flowers. Polyphenols offer numerous health benefits, such as fighting free radicals, protecting against heart disease, cancers, and age-related conditions, and reducing inflammation and allergies. Flavonoids have been shown to help with angina pectoris, traumatic cerebral infarction, cervical lesions, diabetes, chronic venous insufficiency, menopausal symptoms, skin disorders, gastrointestinal ailments, rhinitis, and lymphocytic leukemia.[11]

2.3. Isoprenoids

Isoprenoids, also referred to as terpenoids form a class of natural compounds that includes terpenes, sesquiterpenes, ubiquinone, limonoids, camphor and menthol. These organic compounds have specific pattern for hydrocarbons arrangement. They can be found in cannabis (*Cannabis sativa L.*), poplar (Populus alba L.), turpentine tree (*Syncarpia glomulifera L.*), eucalyptus (*Eucalyptus L.*), juniper (*Juniperus communis L.*), oak (*Quercus suber L.*), lime (*Citrus latifolia L.*), and orange (*Citrus sinensis L.*). Limonene, myrcene, and pinene are some of the isoprenoids present in plants. Limonene is a common monoterpene in aromatic plants and fruits, known for its lemon-like taste and fragrance. Myrcene, an acyclic monoterpene alkene, is recognized as the active sedative element in hops and lemongrass. Isoprenoids offer numerous benefits, including appetite reduction, pain relief, stress and anxiety relief, antioxidant properties, digestive support, improved sleep quality, and Alzheimer's disease management.[12]

2.4. Phytosterols

Phytosterols, encompassing both plant sterols and stanols, are compounds that help regulate plant physiological functions. These substances are found in olive oil as well as the oils of peanuts *(Arachis hypogaea L.), corn (Zea mays L.), beans (Phaseolus vulgaris L.), sesame (Sesamum indicum L.), sunflower (Helianthus annuus L.), macadamia (Macadamia tetraphylla L.) nuts, and almonds (Prunus dulcis L.).*[13]

Plant sterols include compounds such as campesterol, sitosterol, and stigmasterol, while plant stanols consist of campestanol, sitostanol, and stigmastanol. Sitostanol, a plant stanol derived from sitosterol, has been shown to help reduce serum cholesterol levels by inhibiting cholesterol absorption. Phytosterols promote prostate health, supporting hair growth, lowering LDL cholesterol, and providing high antioxidant activity.

2.5. Saponins

Saponins are plant-based glycosides composed of sapogenin and sugar components. They are categorized into steroidal and triterpenoid saponins depending on the type of aglycone they contain. These compounds are predominant in legumes such as black gram (*Vigna mungo L.*), garden pea (*Pisum sativum L.*), pigeon pea (*Cajanus cajan L.*), and common bean (*Phaseolus vulgaris L.*). Notable examples of saponins include dammarane, tirucallane, and oleanane.[14]

Saponins demonstrate a range of beneficial activities, including hypoglycemic, virucidal, antifungal, antimicrobial, and hypolipidemic properties. They have also been reported to have a positive impact on acute injuries, erectile dysfunction, venous edema caused by chronic deep vein incompetence, and systemic lupus erythematosus. Additionally, saponins have shown effectiveness at lower concentrations of 10 μg/mL on the transverse tubular system and sarcoplasmic reticulum.[15]

2.6. Polysaccharides and dietary fibres

Polysaccharides consist of sugar monomer units connected by glycosidic bonds. These compounds can serve as energy storage molecules, such as starch and glycogen, or as non-digestible components that contribute to dietary fiber, including cellulose, pectin, beta-glucan, hemicelluloses, resistant starch, and lignin.

Plant-based foods provide dietary fibre, with some particularly rich sources including Jerusalem artichoke (*Helianthus tuberosus L.*), corn, oats (*Avena sativa L.*), carob beans (*Ceratonia siliqua L.*), chicory, tamarind (*Tamarindus indica L.*), barley (*Hordeum vulgare L.*), wheat (*Triticum aestivum L.*), and green beans (Phaseolus vulgaris L.). Consuming dietary fiber regularly helps to prevent various health issues such as cancer, inflammation, hypertension, hyperlipidemia, hypercholesterolemia, obesity, and cardiovascular diseases. It also improves insulin sensitivity and supports healthy gut microbiota. Additionally, dietary fibres can enhance textural and health properties, reduce cooking loss and production costs, and serve as a fat substitute in food products.[16]

3. Conclusion

Thus, consumption of plant based foods will help the population to lead a healthy life devoid of diseases. The understanding of phytochemicals and its mode of action are of great importance for the development of safe drugs.

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5. Conflict of Interest

None.

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