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Review Paper

Biological Activity of Flavonoids

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ABSTRACT

Flavonoids are a diverse group of plant derived polyphenolic compound that exhibit a wide range of biological activities, making them a focus of extensive research in recent years. This review explores the multifunctional properties of flavonoids, including their antioxidant, anti-inflammatory, anticancer, antimicrobial and cardioprotective effects. Furthermore, it empathizes how flavonoids can help prevent chronic illnesses like diabetes, cardiovascular disease and neurological diseases. These through analysis emphasizes how flavonoids are used in both nutrition and medicine.

INTRODUCTION

A particular class of plant organs, including leaves, fruits, roots, and stems can accumulate polyphenols, which are chemical products of secondary plant metabolism. They are broad class of bioactive compounds with the variety of biological roles. All vascular plants contain flavonoids, which are phenolic compounds (Karak, 2019). They have several beneficial biochemical and antioxidant properties linked to a number of illnesses, including atherosclerosis, cancer, and Alzheimer's diseases. Flavonoids are a vital part of many pharmacological, cosmetic, nutraceutical and medicinal applications and are associated with a variety of health advantages. This is due to their ability to modify important cellular enzyme functions as well as their antioxidative, anti-inflammatory, anti-mutagenic, and anti-carcinogenic qualities. They are also known to be potent inhibitors of certain enzymes, such as xanthine oxidase (XO), lipoxygenase, cyclo-oxygenase and phosphoionositide 3-kinase (A.N.Panche, 2016). In 1930, a Hungarian scientist named Albert Szent-Gyorgyino conducted an experiment that resulted in the discovery of flavonoids using a novel chemical that was extracted from orange. It was initially categorized as vitamin P, but later on, researchers determined that it was actually a flavonoid. Other

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types have also been found. Amidst scientific and human evidence demonstrating its range of biological and therapeutic effects. The flavonoids category has emphasized its significance since this historical event. Over 8,000 distinct flavonoids have been identified to date. They belong to a class of polyphenolic chemicals with low molecular weights. Their primary classes fall under a variety of names, including anthocyanins, isoflavones, flavonols, flavones and flavanones (Juca, 2018). Plants naturally produce flavonoid compounds, which are found in different parts of the plant. Vegetables use flavonoids to promote growth and defend against plaques. These low molecular weight phenolic chemicals are abundantly distributed across the plant world. They are a key class of chemicals found in higher plants. Many flavonoids are easily identified as floral colours in most angiosperm families. However, they can be found in all parts not just flowers. The term 'dietary flavonoids' refer to the abundance of flavonoids found in plant-based foods and drinks, including fruits, vegetables, tea, chocolate and wine. Flavonoids functions as UV filters, signal molecules, allopathic compounds and protective agent against biotic and abiotic stress in plants, phytoalexins, detoxifying agents, and antimicrobial defence compounds. Flavonoids can improve cold hardiness, drought resistance, plant heat acclimatization and freezing tolerance (A.N.Panche, 2016). Because of their strong antioxidant potential in both in vitro and in vivo systems, flavonoids are believed to have health promoting qualities. Flavonoids can activate the enzyme systems that protect humans (kumar, 2013). The extraction, isolation, and characterization of these compounds from various plant families has been the focus of recent research. This has led to the focus of recent research. This has led to the development of modern, environmental friendly extraction techniques, such as microwave-assisted extraction, ultrasound-assisted extraction, supercritical fluid extraction, pressurized liquid extraction, matrix solid phase dispersion, pulsed electric field extraction and enzyme-assisted extraction which may also have industrial applicability in a number of sectors, including the food, pharmaceutical, and cosmetic industries. Traditional extraction methods, such as maceration, decoction, percolation, and Soxhlet extraction have been replaced by these techniques (liga, 2023)

Biological Activities of Flavonoids:

In addition to their primary antioxidant function, flavonoids have a wide range of biological actions that contribute to human heath. These include anti-inflammatory, anti-ulcer, antiviral, anti-cancer, anti-diabetic, and cytotoxic properties, among others (Karak, 2019).

Antioxidant Activity:

Numerous investigations have demonstrated the wide ranging nutritional benefits of flavonoids to antioxidant activity. The majority of chemical tests for antioxidants demonstrate pathways for scavenging free radicals. Reactive chemical substances called antioxidant shield cells in plants, animals, and humans from the harm that reactive oxygen species (ROS) can cause. One of the finest phytochemicals for preventing disease is flavonoids, which function as antioxidants. The configuration of functional groups in the flavan nucleus determines antioxidant activity (Karak, 2019). Direct scavenging of ROS, (b) inhibition of ROS formation through the chelation of trace elements (quercetin for example, has iron-chelating and iron stabilizing properties) or inhibition of the enzyme involved in the production of free radicals (such as glutathione S-transferase, microsomal monooxygenase, mitochondrial succinoxidase, NADH oxidase,

xanthine oxidase) are some of the antioxidant action mechanisms of flavonoids and (c) activation of antioxidant. A combination of some of these processes, such as radical scavenging action and enzyme activity suppression, may also occur. The majority of flavonoids appear as glycosides, and the number and position of sugar linkages influence the flavonoids antioxidant effects. Aglycone forms, on the other hand, are less readily available despite having a greater antioxidant capability (dias, 2021).

Anti-inflammatory Activity:

The intricate biological reactions of bodily tissues to damaging stimuli, including pathogens infection, damaged cells, tissue injury, and chemical irritation, is known as inflammation. It is a defence mechanism that includes blood vessels, immune cells and molecular mediators. The release of chemical mediators at the site of tissue damage and the migration of immune cells from blood vessels start this. Leukaemia sepsis, asthma, sclerosis, atherosclerosis, porosis, allergic rhinitis illnesses, colitis, rheumatoid arthritis and other conditions have been linked to flavonoids crucial involvement in inflammation. In order to eradicate invading pathogens and heal damaged tissues, this process is followed by the recruitment of inflammatory cells and the release of ROS, RNS and proinflammatory cytokines (Karak, 2019).

Anti-bacterial Activity:

Flavonoids have the ability to combat germs through a variety of techniques. By causing bacterial membrane disruption, they can break lipid bilayers and prevent a number of functions, including the generation of ATP cells envelopes, biofilms, nucleic acids, and electron transfer chains. Catechin epicatechin and epigallocatechin galatte, as well as the flavonol quercetin, appears to cause an oxidative burst, which raises the generation of ROS and damages the permeates membranes. Apigenin can break down the structure of membranes and result in membrane leakage by disorganizing and confounding the membrane lipids. While quercetin, luteolin, myricetin, and baicalein prevents bacterial DNA replication, flavonoids such as apigenin, chrysin, naringenin, kaempferol, quercetin, daidzein, and geninstein disrupt the formation of biofilms (dias, 2021).

Antiaging Activity:

The effect of oxidative damage, which is caused by macromolecules like carbohydrates, DNA, proteins, and lipids that gradually build up in the cells, is one of the cause of aging. This buildup result from the body's normal metabolic processes, which generate waste products that the body can't always properly get rid of as we age. According to a study the high polyphenolic content of acai pulp has a high capacity to eliminate superoxide and peroxyl radicals, indicating antiaging properties. flavonoids with their antioxidant capacity, may represent a viable source of elimination of this metabolic waste. Drinking red wine has also been linked to a lower risk of developing age related illnesses (Juca, 2018).

Anticancer Activity:

The potential anti cancer property of flavonoids, which are found in fruit, fruit juices, and vegetables have been well investigated. For example cranberry juice is widely drunk in North America because of its ability to prevent urinary tract infections, which is mostly attributed to cranberry protocyanidins. Phenolic substances found in cranberry fruit include triterpenoids, a range of phenolic acids, the most important of which is p-hydroxycinamic acid, catechins flavan-3-ols, and flavonoids (flavonols and

protoanthrocyanidins). Cranberry extracts have been found to prevent oxidative damage to neurons, vascular endothelium, and LDL oxidation based on preliminary research. Cranberry extracts are therefore seen to be a promising candidate for anti-tumor activity due to their antioxidant properties (Atmani, 2009).

Antiviral Activity:

Since the 1914s and many reports show that naturally occurring flavonoids exhibit a remarkable antiviral activity. They aid in the Suppression of several enzymes involved in the viral life cycle. It has been noted how flavonoids structural and functional relationships relate to their ability to inhibit enzymes. Flavon-3-ol was found to be more effective than flavones and flavonones in selective inhibition of HIV-1 & HIV-2 and similar immunodeficiency virus causing infections. The different study show that quercetin, hesperetin, and naringin also possess anti dengue activity (Karak, 2019).

CONCLUSION

It is well recognised that phytochemical substances, particularly flavonoids can be used to prevent and cure diseases. Fruits and vegetables naturally contain flavonoids. These phytochemicals, known as flavonoids, have a variety of biological characteristics that are advantageous to human health. In human diets, they are abundant in naturally occurring antioxidants. flavonoids help prevent numerous diseases by effectively counteracting the negative effect of free radicals. Antioxidant, free radicals scavenger, anti inflammatory, anti bacterial, antiviral, antiaging and particularly anti-cancer capabilities are only a few of the many cellular targets they interact with. The dietary sources and several significant biological activity of flavonoids that contribute to their positive effects on human health are highlighted in this review. Their industrial uses extend beyond the realm of therapeutic candidate compounds and nutraceuticals.

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