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The biochemical and biological role of polyphenols in medicinal plants

Ruqaia Hadi Rehman

Babil Governorate Education Directorate

Email: rdadrda1979@gmail.com

Abstract:

This article explores the biochemical and biological roles of polyphenols in medicinal plants. Polyphenols are a class of bioactive compounds synthesized by plants through the phenylpropanoid pathway. These compounds exhibit high antioxidant capacity due to their ability to neutralize free radicals and ROS. They also modulate various cellular signaling pathways, including those involved in inflammation, apoptosis, and cell proliferation, contributing to their potential health benefits. Polyphenols have been found to exhibit a range of pharmacological activities, including antioxidant, anti-inflammatory, antimicrobial, and anticancer properties. Flavonoids, stilbenes, and phenolic acids are medicinal plants' most commonly studied polyphenols. Polyphenols play a crucial role in the biological activity of medicinal plants and contribute to their therapeutic potential.

Keywords: polyphenol, antioxidant, apoptosis, flavonoids, medicinal plants.

Introduction:

Medicinal plants include a broad variety of polyphenols, a type of bioactive chemicals. Antioxidant, anti-inflammatory, antibacterial, and anticancer characteristics are just some of the reasons why these chemicals have garnered so much interest. Here, we'll delve into the biochemical and biological functions of polyphenols in plants used for medicine [1].

Polyphenols' Biochemical Importance in Medicinal Plants:

Plants produce polyphenols through the phenylpropanoid pathway, which is a secondary metabolic route. The amino acid phenylalanine is transformed to cinnamic acid through this route, which in turn is used to produce a wide variety of phenolic compounds. In response to biotic and abiotic stressors such UV radiation, disease assault, and drought, polyphenol production increases [2].

Polyphenols have the potential to mop up free radicals and reactive oxygen species, giving them a strong antioxidant capability (ROS). Highly reactive chemicals such as free radicals and ROS may harm cells and have a role in the onset of illnesses such as cancer, diabetes, and cardiovascular disease [3]. Polyphenols prevent harm by these compounds because they donate an electron or hydrogen atom to them, making them stable [4].

Polyphenols have been demonstrated to have antioxidant characteristics in addition to modulating inflammatory, apoptotic, and proliferative cellular signaling pathways. Interactions between these molecules and other cellular proteins and enzymes, such as transcription factors, kinases, and phosphatases, mediate these effects. Polyphenols are known to bind to these proteins and alter their activity, controlling a wide range of cellular activities in the process [5].

Medical Plant Polyphenols: Their Biological Functions

The medicinal value of plants relies on their biological activity, which is enhanced by polyphenols. Antioxidant, anti-inflammatory, antibacterial, and anticancer capabilities are only some of the pharmacological effects observed in studies of these substances. In medicinal plants, flavonoids, stilbenes, and phenolic acids are some of the most researched polyphenols [6].

Flavonoids are a class of polyphenols that are abundant in plants used for therapeutic purposes. Several pharmacological activity, such as antioxidant, anti-inflammatory, antibacterial, and anticancer effects, have been attributed to these substances. Of the many flavonoids, quercetin, kaempferol, and apigenin are among the most researched.

Several therapeutic plants also contain stilbenes, a kind of polyphenol. Antioxidant, anti-inflammatory, and cancer-fighting effects have all been seen in these substances. Resveratrol, the most well-known stilbene, is an antioxidant present in grapes and wine. It has been linked to a lower risk of cardiovascular disease and cancer, among other health advantages [7].

There is a third class of polyphenols called phenolic acids, and these are often found in herbal remedies. Antioxidant, anti-inflammatory, and antibacterial effects have all been seen in these substances. Caffeic acid, a phenolic acid present in coffee, has been the subject of the most research due to its wide-ranging health advantages, including a lower risk of type 2 diabetes and cardiovascular disease [6].

The bioactive chemicals known as polyphenols may be found in many different types of medicinal plants. These chemicals are essential to the plants' biological activity and help make them therapeutically useful. Polyphenols' biochemical and biological functions are mediated via their interactions with cellular proteins and enzymes, free radical scavenging, and modulation of cellular signaling pathways. In medicinal plants, flavonoids, stilbenes, and phenolic acids are some of the most researched polyphenols [8].

Plants produce polyphenols through the phenylpropanoid pathway, which is a biosynthetic route for bioactive chemicals. The ability of these chemicals to quench free radicals and ROS gives them a potent antioxidant profile. Moreover, they have the potential to improve health through modulating inflammatory, apoptotic, and proliferative cellular signaling pathways. Antioxidant, anti-inflammatory, antibacterial, and anticancer characteristics are only some of the

pharmacological actions attributed to polyphenols. Polyphenols found in medicinal plants are investigated extensively, with flavonoids, stilbenes, and phenolic acids being the most studied. The polyphenols found in medicinal plants are essential to their biological activity and therapeutic value [9].

The biological function of polyphenols in the management of type 2 diabetes:

Hyperglycemia, caused by a lack of insulin or its ineffective use, characterizes diabetes mellitus (DM), a chronic metabolic condition. An estimated 592 million people will have diabetes by the year 2035, as the global prevalence of the disease continues to rise. Dietary and physical activity changes, as well as oral hypoglycemic medicines and insulin treatment, are all part of the management of diabetes mellitus. Traditional medicine, and especially plant-based medications, have been receiving more and more attention owing to their potential efficacy and safety. The positive benefits of polyphenols, a class of bioactive chemicals present in many plants, on DM have been shown. The biological function of polyphenols in diabetes management is discussed [10].

Inhibiting intestinal glucose absorption, increasing insulin secretion, and increasing insulin sensitivity are all hypoglycemic processes linked to polyphenols. Fruits and vegetables include a family of polyphenols called flavonoids, which has been examined extensively for its potential anti-diabetic effects. In animal models of diabetes, quercetin, a flavonoid included in many fruits and vegetables, increased insulin sensitivity and decreased blood glucose levels. Grapefruit and other citrus fruits contain a flavonoid called naringenin, which has been proven to increase insulin sensitivity and decrease glucose tolerance in rats. Animal models of diabetes have revealed that the polyphenol resveratrol, present in grapes and red wine, may increase insulin sensitivity and decrease blood glucose levels [11].

Since inflammation plays such a pivotal role in the progression of diabetes mellitus (DM), polyphenols have been studied for their potential to mitigate its effects. Insulin resistance and poor glucose metabolism may be caused by inflammatory cytokines including tumor necrosis factor-alpha (TNF-) and interleukin-6 (IL-6). Reducing inflammation and stopping their formation are two benefits of polyphenols. Turmeric contains the polyphenol curcumin, which has been demonstrated to inhibit IL-6 and TNF- production in DM animal models [12].

Polyphenols are also effective antioxidants, and oxidative stress is a known contributor to the development of diabetes type 2. Neuropathy, retinopathy, and nephropathy are all consequences of diabetes that are exacerbated by high blood glucose levels because they harm cells by creating reactive oxygen species (ROS). Polyphenols have been shown to reduce reactive oxygen species (ROS) and protect cells from oxidative stress. The polyphenol in green tea known as epigallocatechin gallate (EGCG) has been proven to enhance glucose metabolism and lower oxidative stress in animal models of diabetes mellitus [13].

In addition to their antioxidant properties, polyphenols have been shown to improve lipid metabolism, a process that is often disrupted in DM. Atherogenesis and cardiovascular disease are aided by the creation of triglycerides and low-density lipoprotein (LDL) cholesterol when blood glucose levels are consistently high. Improved lipid metabolism and reduced triglyceride and

LDL cholesterol synthesis have both been linked to polyphenol consumption. Studies in animal models of diabetes mellitus have indicated that catechins, a kind of polyphenol found in green tea, may lower triglyceride and LDL cholesterol synthesis [14, 15].

Conclusion

Due to their hypoglycemic, anti-inflammatory, antioxidant, and lipid-lowering qualities, polyphenols are helpful for treating diabetes. Further study is required to completely understand the mechanisms of action and possible therapeutic uses of polyphenols in the treatment of DM, however there is hope in their usage. Nevertheless, care is needed when using polyphenols as therapeutic agents since they may have deleterious effects at high dosages and might mix with other drugs.

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