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PHARMACOLOGICAL ACTIVITIES OF DENDROBIUM ORCHIDS

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Abstract

Orchids are among the most beautiful flowers in the world, and Dendrobium orchids, part of the Orchidaceae family, have long been used in traditional herbal medicine due to their numerous therapeutic properties. The widely distributed Dendrobium genus has been researched for a long time because of its significant economic value in both medicine and ornamental uses. Dendrobium includes a large number of orchid species, with around 1,500 found worldwide, primarily in the tropical and subtropical regions of South Asia and beyond. Various active compounds have been identified in Dendrobium orchids. Various bioactive compounds have been identified in different parts of Dendrobium orchids, which exhibit a range of biological activities. These orchids have demonstrated several pharmacological effects, including antioxidant, anti-inflammatory, anti-tumor, immunomodulatory, anti-cancer, anti-diabetic, and neuroprotective properties. The compounds in Dendrobium show promising potential in treating cancer and managing neurodegenerative diseases. Additionally, Dendrobium has been utilized in the preparation of herbal remedies.

Key Words: Dendrobium nobile Lindl., alkaloid, orchids, Dendrobium, Orchidaceae.

Introduction

Dendrobium is the second-largest genus in the Orchidaceae family, consisting of numerous species that are widely found in the tropical and subtropical regions of Asia, Australia, and the Pacific Islands. This family represents a rich and diverse group of flowering plants. Orchids are renowned not only for their ornamental appeal but also for their use in herbal medicine. Traditional Chinese medicine, one of the oldest medical systems, includes Dendrobium orchids as an ingredient in many of its

formulations. Pharmaceutical research on Dendrobium orchids reveals the significant potential of this plant for treating various diseases. These orchids are considered advanced due to their diverse colors, sizes, shapes, habitats, and fragrances. While they are primarily cultivated for their attractive flowers and recognized for their economic value, their medicinal applications are less well-known. The earliest documentation of orchids used for medicinal purposes dates back to the 20th century BC. Dendrobium orchids are commonly utilized in traditional Chinese medicine, and several species have been the focus of phytochemical and pharmacological investigations. India is one of the richest habitats for orchids. Certain compounds found in Dendrobium orchids, including alkaloids, flavonoids, terpenoids, biobenzoyl derivatives, and phenanthrenes, indicate potential medicinal properties. Dendrobium orchids can be categorized as epiphytic (growing on trees or shrubs), saprophytic (growing on dead and decaying matter), or terrestrial (growing on the ground). They are particularly sensitive to habitat degradation and fragmentation. These plants are also utilized to extract a range of natural products, including perfumes and medicines. Around 60% of orchids are used annually for various medicinal applications, and they are recognized for their rich content of chemical constituents such as flavonoids, alkaloids, and terpenoids. Purified compounds derived from Dendrobium extracts demonstrate a variety of bioactive properties, including antimicrobial, antioxidant, anthelmintic, insecticidal, antiviral, analgesic, antipyretic, antiallergic, wound healing, anti-aging, anti-cancer, and anti-inflammatory effects.

Anti-inflammatory

Numerous members of the orchid family have been identified to possess anti-inflammatory properties. Various compounds exhibiting anti-inflammatory activity have been extracted from Dendrobium orchids. Dendrobium orchids show notable anti-inflammatory activity, as evidenced by various studies. Compounds extracted from these orchids, including alkaloids and polysaccharides, have been shown to inhibit inflammatory responses by decreasing the production of pro-inflammatory cytokines and enzymes. This positions Dendrobium as a promising candidate for developing treatments for inflammation-related conditions. Its historical use in herbal medicine further reinforces its potential for modern pharmacological applications aimed at addressing inflammation.[1]Dendrobium nobile Lindle, a renowned herbal medicine, possesses significant pharmacological activity and considerable medicinal value. Alkaloids and polysaccharides are key bioactive components found in Dendrobium nobile Lindle.[2] Compounds inhibit the production of cytokines such as TNF-α (tumor necrosis factor-alpha) and IL-6 (interleukin-6), both of which play a central role in promoting inflammation. Dendrobium chrysanthum, like other Dendrobium species, may help reduce inflammation by inhibiting pro-inflammatory cytokines such as TNF-α and IL-6. Additionally, several inflammatory cytokines, including TNF-α, IL-8, and IL-10, have been shown to be inhibited.[3]

Anti-oxidant activity

The Dendrobium orchid contains various bioactive compounds that contribute to its antioxidant properties. Dendrobium extracts neutralized free radicals such as superoxide anions and hydroxide radicals that cause oxidative stress and damage to lipid, protein, and DNA. Research indicates that the antioxidant capacity of Dendrobium varies significantly depending on the species and the extraction method used, such as aqueous, methanol, or ethanol extractions.[4][5] Dendrobium extract can enhance the activity of natural antioxidant enzymes like SOD, catalase, and glutathione peroxidase, which help neutralize harmful ROS.[6] Dendrobium orchids exhibit potent antioxidant activity, largely due to their high levels of flavonoids, phenolics, and polysaccharides.[7] Polysaccharides isolated from species like Dendrobium nobile, Dendrobium huoshanense, Dendrobium chrystoxum, and Dendrobium fimbriatum demonstrate strong antioxidant and free radical scavenging properties. [8][9]

Anti-microbial Activity

The Dendrobium orchid is known for its antimicrobial properties, which are linked to the presence of diverse bioactive compounds. Species like Dendrobium officinale and Dendrobium nobile are effective against harmful bacteria, including Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa.[10] Numerous bioactive compounds in Dendrobium orchids function by damaging the cell walls of bacteria and fungi, leading to a loss of integrity and eventual cell death.[11][12] Flavonoids and other compounds found in Dendrobium species interact with microbial DNA replication, hindering the proliferation of bacteria and fungi.[13] Researchers have also discovered that Dendrobium nobile Lindle exhibits significant antimicrobial activity. Extracts from Dendrobium nobile Lindle demonstrate a strong inhibitory effect against five common drug-resistant bacteria: Staphylococcus aureus, methicillin-resistant Staphylococcus aureus, Pseudomonas aeruginosa, Escherichia coli, and Klebsiella pneumoniae.[14][15] The significant antimicrobial activity of Dendrobium nobile Lindle not only makes it effective for treating infectious diseases but also serves as a reference for the research and development of new antimicrobial drugs.[16]

Anti-cancer Activity

Dendrobium orchids are increasingly recognized for their anti-cancer properties attributed to a variety of bioactive compounds. Extracts from various orchid species possess anticancer properties. Dendrobium species demonstrate cytotoxic activity against leukemia, melanoma, and cancers of the brain, cervix, stomach, liver, and lungs.[17][18] It is hypothesized that polyphenol compounds present in orchid extracts inhibit cancer cells by affecting xenobiotic-metabolizing enzymes and altering the metabolic activation of potential carcinogens. Conversely, flavonoids may influence hormone production and inhibit the growth of cancer cells. The extract of Dendrobium chrysanthum disrupts cell cycle progression, leading to delayed cell growth, and also exhibits anticancer activity. Another species, Dendrobium crepidatum, shows significant cytotoxicity against both cervical cancer and glioblastoma cell lines. Additionally, Vanda cristata, Pholidota articulata, and Papilionanthe uniflora

have demonstrated cytotoxic activity against cervical cancer cells.[19] Autophagy is a natural process in cells where they break down and recycle damaged or unnecessary components. This helps maintain cellular health by removing harmful materials and can be triggered in response to stress or nutrient shortages. In cancer, increased autophagy can sometimes help slow tumor growth by eliminating damaged parts of the cancer cells. AS a result, Dendrobium officinale could potentially be used as a straightforward, safe, and practical supplementary therapy for cancer treatment.[20] Many bioactive compounds extracted from orchid plants, including Dendrobium longicornu Lindl., Dendrobium transparens, Vanda cristata, and exhibit anticancer properties. These compounds work by altering the biotransformation of potential carcinogens through xenobiotic-metabolizing enzymes, modifying hormone synthesis, inhibiting cancer cell proliferation, suppressing protein expression, disrupting the cell cycle, and impairing cell growth. In vitro studies have shown that extracts from Dendrobium nobile and other species can inhibit cancer cell growth and induce apoptosis in various types of cancer. [21]

Immunomodulary Activity

Dendrobium orchids are acknowledged for their ability to modulate immune responses, indicating their influence on the immune system. Lymphocytes can be categorized into T-lymphocytes, B-lymphocytes. These immune cells are crucial and play a key role in the reactions and responses of the immune system. Polysaccharides derived from Dendrobium can boost the activity of several immune cells, such as macrophages, natural killer cells, and lymphocytes. This activation may result in enhanced phagocytosis and increased cytokine production. Dendrobium extracts can promote the secretion of cytokines, including interleukins (IL-1, IL-6) and tumor necrosis factor alpha (TNF-alpha), which are essential in coordinating the immune response. Some studies indicate that Dendrobium extracts can boost antibody production, which is vital for the adaptive immune response against pathogens.[21] The flavonoids and other compounds found in Dendrobium orchids may help regulate inflammation in the body, fostering a balanced immune response that prevents excessive inflammation while strengthening defense against infectionsinfections.[22]

Antidiabetic Activity

Dendrobium orchids have attracted interest for their potential antidiabetic effects, largely due to the bioactive compounds they contain, which may aid in regulating blood sugar levels and enhancing insulin sensitivity. Numerous studies have investigated how these orchids can aid in managing diabetes, primarily by examining their impact on blood glucose levels and insulin sensitivity. The antidiabetic activities include improved insulin sensitivity and hypoglycemic effects. These abilities are attributed to the presence of compounds such as phenolics, flavonoids, terpenoids, alkaloids, and glycosides, which enhance insulin secretion from pancreatic tissue or reduce the intestinal absorption of glucose.[23][24] Freeze-dried stems of Dendrobium huoshanense (DHP), Dendrobium officinale (DOP), Dendrobium nobile (DNP), and Dendrobium chrystoxum (DCP) were examined using alloxan-induced diabetic male Kunming mice models. The study revealed that these orchids displayed hypoglycemic and antioxidative activities, which were primarily attributed to the polysaccharides

isolated from these plants. Metformin was used as a control, and the findings are referenced from Pan et al. 2014.[25][26][27] Polysaccharides are regarded as key active components with hypoglycemic effects, as they enhance insulin sensitivity and help regulate blood glucose levels. Alkaloid compounds may also play a role in antioxidant activity, which is vital for protecting pancreatic beta cells from oxidative stress, a common problem in diabetes. Dendrobium extracts have demonstrated the ability to increase glucose uptake by cells and improve insulin receptor function.[27][28] The acetonic extract of Dendrobium longicornu contains phenolic compounds, which are responsible for its antioxidant properties, these antioxidants may aid in the treatment of cancer, diabetes.[29] Additionally, certain extracts inhibit critical enzymes such as alpha-glucosidase and alpha-amylase, which are involved in carbohydrate digestion, resulting in reduced postprandial blood sugar spikes.[30]

Conclusion

Orchids are recognized for their beautiful flowers but are less known for their medicinal properties. However, various compounds have been extracted from different parts of the plants that possess medicinal benefits. This highlights the chemical composition of Dendrobium orchids and their application in treating clinical diseases. Due to their significant pharmacological activity and high medicinal value, Dendrobium orchids are being utilized in various treatments for clinical conditions. The primary chemical constituents of Dendrobium orchids include alkaloids, polysaccharides, bibenzyls, phenanthrenes, sesquiterpenes, and tannins. Recent studies on the chemical composition and pharmacological effects of Dendrobium orchids. Orchids are part of a large family of flowering plants and have been traditionally utilized in folk medicine to address various infections and tumors. In studies aimed at treating clinical diseases, Dendrobium orchids have shown pharmacological benefits for treatment. Orchids are very sensitive to environmental changes, highlighting the urgent need to protect these valuable species and preserve traditional knowledge while researching their medicinal properties. In addition to their direct antidiabetic effects, various drugs derived from orchids with antioxidant, anti-inflammatory, and healing properties are being studied worldwide. If a long-term cure or remedy for diabetes is to be discovered in the future, it will likely come from herbal sources, with the Orchidaceae family playing a significant role.

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