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Investigating bioactive compounds from traditional herbs for treating chronic diseases

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Abstract

Mechanistic investigations of the pathogenicity of these diseases and the employment of various pharmaceutical and natural treatments to prevent them have focused on the inflammatory processes linked to several chronic illnesses, such as cancer and cardiovascular disease. Inflammation is a hallmark of many long-term health problems; this paper summarizes what is known about the anti-inflammatory effects of natural extracts from traditional plant species that have received very little scientific attention. Furthermore, the goal is to reveal the recognized action routes and possible synergistic effects of the chemicals included in the extracts being discussed. Medicinal plants are rich in bioactive compounds that might have tremendous medical use. The purpose of this study is to delve into the wide variety of bioactive chemicals found in medicinal plants and the pharmacological effects they have. In the first section of the review, the importance of medicinal plants as potential new medication sources is emphasised. The methods used to identify and extract bioactive components from these plants are addressed in depth, with an emphasis on the applicability of different extraction techniques and analytical processes. Different types of bioactive chemicals and the pharmacological effects they produce are the subject of the sections that follow. We take a look at the antibacterial properties and potential use of bioactive compounds derived from medicinal plants in the treatment of infectious diseases. We also take a look at these compounds' antioxidant and anti-inflammatory capabilities, highlighting their promise as medicines for oxidative stress and inflammatory disorders. The review delves into the potential of bioactive chemicals derived from medicinal plants to combat cancer, shedding light on how these substances work and suggesting new avenues for treatment. Also covered are these chemicals' neuropharmacological and neuroprotective actions, with an emphasis on their potential use in treating neurological diseases. The study also delves into the immunomodulatory effects and cardiovascular health advantages of bioactive chemicals derived from medicinal plants, offering valuable information on their possible uses in immunotherapy and the treatment of cardiovascular diseases.

Keywords: Anti-inflammatory, medicinal plants, chronic diseases, bioactive compounds

Introduction

When an organism is exposed to a cascade of mechanical, chemical, or viral stimuli, it goes through a biological process known as inflammation. The goal of this localized defense mechanism is to isolate, eradicate, or diminish the threat. According to the features of the humoral response and the molecules that are involved, inflammation may be either acute or chronic. Physiological harm may happen when the inflammatory equilibrium is disturbed, leading to an overabundance of pro-inflammatory signals, as in the cyclooxygenase pathway, for instance.

In physio pathogenic conditions like metabolic syndrome or

inflammatory bowel disease, which include long-term exposure to several potentially harmful chemicals, chronic inflammation develops. Some molecules, such as tumour necrosis factor alpha (TNF- α), which are inflammatory mediators, are associated with the start of cancer. Inflammatory cytokines such as TNF- α , interleukin (IL)-6, and IL-1 β , which are linked to cardiometabolic disorders, increase when these variables are combined, creating an imbalanced inflammatory condition.

Because of their antioxidant and anti-inflammatory characteristics, botanic extracts of spices and herbs may be used to avoid inflammation, which can cause cancer or heart

disease. This is why anti-inflammatory phytochemicals may be an external factor that is vital in the fight against inflammatory-mediated chronic illnesses.

Traditional medical systems have made extensive use of medicinal plants for many years as a source of therapeutic medicines. They have been helpful in the search for new bioactive chemicals with various pharmacological effects. Medicinal plants are home to a diverse variety of chemical components, many of which may have positive effects on human health. Medicinal plants include a wide variety of bioactive compounds, including essential oils, phenolics, alkaloids, flavonoids, terpenoids, and more. Many studies have looked at the pharmacological properties of these compounds, including their ability to modulate the immune system, reduce inflammation, fight cancer, and prevent the spread of germs. The bioactive compounds derived from medicinal plants have shown potential in the management and avoidance of a number of diseases. For example, alkaloids produced from plants such as *Vinca rosea* have been used as chemotherapeutic medicines to treat cancer. Ginkgo biloba and other plant flavonoids have antioxidant and neuroprotective properties that make them promising therapeutic options for neurodegenerative diseases. Furthermore, it has significant therapeutic promise. Because of their all-natural origin, people tend to choose bioactive chemicals derived from medicinal plants over synthetic medications. This is because they are seen as safer and better for the environment. Additionally, new bioactive chemicals have been discovered thanks to traditional knowledge and practices related to medicinal plants, which has laid a solid basis for contemporary medication development. The significance of medicinal plants to ethnobotany and environmental protection is another important point. Medicinal plants have long been believed by indigenous peoples to have curative effects, and their traditional knowledge has played a key role in the discovery and use of bioactive compounds.

Literature Review

Chowdhary, Rajeev & Taqa, Amer & Lam, Vivien. (2016)^[1]. Innovative strategies are needed to effectively manage chronic illnesses, which are characterised by long-term and persistent health issues. The potential of herbal formulations as a treatment for long-term health conditions is discussed in this abstract. Herbal medicines have a long history of use in traditional medical systems, which attests to their safety and efficacy. This research sifts through the mountain of literature on medicinal plants in search of specific bioactive chemicals that have shown promise in the treatment of chronic diseases. Formulating herbal extracts and components into effective medicinal agents is the primary emphasis of the study, which makes advantage of developments in pharmaceutical sciences. To make sure the herbal remedies are consistent and effective, the extraction techniques, standardization procedures, and quality control measures are closely monitored. The abstract also details clinical and pre-clinical trials that assessed the effectiveness and safety of the herbal formulations that were produced. Diabetes, cardiovascular illnesses, and inflammatory ailments are only a few of the chronic diseases that are covered by these examinations. These studies show that herbal remedies have the ability to slow or stop the course

of illness, improve quality of life, and reduce symptoms. Standardization, regulatory concerns, and public acceptability are some of the obstacles that the abstract mentions as being present when attempting to incorporate herbal medicine into conventional treatment. It stresses the need of regulatory agencies, healthcare providers, and researchers working together to close the gap between conventional wisdom and cutting-edge medical practice. The creation of herbal remedies for the treatment of long-term health conditions is, in conclusion, an exciting new area of medical study. There may be accessible, inexpensive, and long-term answers to the increasing global burden of chronic illnesses if modern scientific methods are combined with traditional knowledge. In order to effectively treat chronic diseases, this abstract calls for further research into herbal compositions and their efficacy.

Tao, Hongxun. (2023)^[2]. Illnesses that do not pose a threat of infection, manifest gradually over time, and have a protracted duration are known as chronic illnesses. When it comes to global mortality, chronic illnesses including cardiovascular disease, cancer, lung disease, inflammatory bowel disease, and diabetes account for about 60% of all fatalities. Presently, western medicine in clinics is associated with harmful side effects that make it unsuitable for long-term use. Due to their high price tag, biopharmaceuticals are unable to satisfy the overwhelming demand. Furthermore, the burden of chronic illnesses on human health is outpacing the capabilities of medication research and development, which is beset by lengthy cycles, high costs, and an inadequate success rate. Herbal remedies and functional foods, which are rich in resources, reasonably safe to use over the long term, and inexpensive, have therefore replaced conventional medicine as the preferred forms of alternative and complementary medicine. Biologically active natural components abound in functional meals and herbal remedies. Polyphenols, saponins, and sterols are just a few examples of the natural materials that have emerged as a gold mine for the advancement of western medicine. Herbal medicine and functional food are more suited for long-term use in chronic conditions than western medication since their biological action is less harsh. The most significant hurdle to the advancement of herbal remedies and functional foods is the unsolved material base. Its intricate chemical process is another significant obstacle to investigation. Although the beneficial biological effects of functional foods and herbal remedies have been validated by many research, our understanding of their mechanisms and material foundation is still limited. This special issue highlights the use of herbal medicines, functional foods, and their bioactive natural products to draw more attention to the subject of finding innovative plant- and food-based treatments for chronic disorders. All submissions should be either reviews or original research on the subject. We take into account research on functional food extracts and herbal medicine extracts that have well established chemical underpinnings. Research into new pharmacological targets and processes is highly encouraged. Research that is conducted only in a computer model is often rejected.

Spence, Charles. (2024)^[3]. Herbs, spices, and other foods include bioactive chemicals that have health advantages beyond what the components themselves contribute in terms

of nutrition. In this article, we'll take a look at the many potential health benefits of herbs and spices. Recent Discoveries Given the diverse array of purportedly positive impacts on human health, there is mounting evidence to suggest that individuals should be encouraged to increase their intake of herbs and spices. Summary At now, there is only minimal evidence to back up many of the health claims claimed or published in the literature, as a result of the statistical underpowering of many studies that reported health benefits linked to the bioactive chemicals in herbs and spices. Moreover, the most reliable method for determining a drug's effectiveness-a Randomized Controlled Trial (RCT)-has been underutilized so far. Additionally, we touch briefly on the documented relevant safety risks. On the other hand, when all the evidence is considered, the positive benefits of the many bioactive chemicals found in spices and herbs seem to have reasonably substantial backing. As we look forward, we should promote more herb and spice use in our food due to their possible health advantages and appealing sensory aspects. However, more randomized controlled trials (RCTs) evaluating the purported health benefits of herbs, spices, and their bioactive components, either alone or in synergistic combinations, would certainly be beneficial.

S S, Vasanthkumar & Prabhu, T & Shenbagavalli, S & Rajangam, J & Sankaralingam, Vallal & Baskaran, A & Vallalkannan, S. (2024) ^[4]. This article delves into the medical uses and preclinical data around the bioactive chemicals discovered in spices and herbs, and how they may be used therapeutically. The wide diversity of bioactive chemicals found in spices and herbs has allowed them to be used in traditional medicine for ages. These compounds offer a number of health benefits. This review compiles the most recent findings about the anti-inflammatory, antioxidant, antibacterial, and anticancer pharmacological properties of these substances. The paper showcases the potential therapeutic effects of these bioactive chemicals by analysing preclinical research that show how they might influence biological pathways. We also talk about the ways these chemicals work and what it means for finding new ways to cure diseases. These findings support the need for more study into the medicinal properties of spices and herbs and highlight the significance of incorporating them into contemporary therapeutic methods.

Serrano Martínez, Antonio & Ros, Gaspar & Nieto, Gema. (2018) ^[5]. Various pharmaceutical and natural approaches to disease prevention have focused on the inflammatory processes linked to chronic illnesses, such as cancer and cardiovascular disease, in mechanistic investigations of their pathogenicity. Here we take a look at what we know so far about how natural extracts from traditional plant species that haven't gotten much attention might help reduce inflammation in a variety of long-term health problems. The goal of revealing the mentioned extracts' individual chemical constituents and their known action routes is to also highlight the possibility of synergistic effects. Extracts from various plants, including black garlic (S-allylcystein rich), devil's claw (*Harpagophytum procumbens*), camucamu (*Myrciaria Dubia*), blackcurrant (*Ribes nigrum*), and citrus fruits (hesperidin rich), were found to have effects that were comparable to or even stronger than those of other, more researched plants, like tea and cocoa. When

used together, these extracts have the potential to provide synergistic effects that are more biologically relevant at lower dosages.

Methods for identifying and isolation of bioactive metabolites from medicinal plants

The process of developing novel medications begins with the identification of medicinal plants and the extraction of bioactive compounds from them. These compounds have been isolated and characterised using a variety of methodologies and techniques, opening the door to their possible use in medicinal applications and further investigation.

Phytochemical Screening: In order to find the bioactive chemicals in medicinal plants, phytochemical screening is the first step. It comprises qualitatively assessing plant extracts for certain chemical categories, including glycosides, phenolics, alkaloids, flavonoids, and terpenoids. Colour responses, thin-layer chromatography (TLC), and spot tests are common methods for screening phytochemicals.

Extraction Techniques: Isolating bioactive components from medicinal plants involves the use of many extraction procedures. With these techniques, we want to maximise the yield of our target compounds while reducing the number of byproducts. Maceration, percolation, ultrasonic extraction, supercritical fluid extraction (SFE), and Soxhlet extraction are some of the most used extraction processes.

Chromatographic Techniques: Chromatographic techniques are vital for the isolation, cleansing, and evaluation of bioactive compounds. Popular methods for material separation and quantification based on chemical properties include gas chromatography (GC) and high-performance liquid chromatography (HPLC). Preparative techniques such as thin-layer chromatography (TLC), column chromatography, and flash chromatography are also used for the separation and purification of certain compounds.

Antimicrobial properties of secondary metabolites of medicinal plants

It has long been recognized that bioactive compounds derived from medicinal plants have antimicrobial properties. Inhibited by these compounds include several microorganisms, including viruses, fungi, and bacteria. These chemicals are useful for fighting microbial diseases and creating new therapeutic agents because of their antibacterial properties.

Antibacterial Activity: The antibacterial activity of several bioactive components derived from medicinal plants is rather high. Some plant-derived alkaloids, such as sanguinarine from the Papaveraceae family and berberine from the *Berberis* spp., have strong antibacterial properties that may kill a wide range of microorganisms. Plants such as *Allium cepa* and *Camellia sinensis* include flavonoids like kaempferol and quercetin, which have antibacterial properties by destroying bacterial cell walls and blocking key enzymes.

Antifungal Activity: Bioactive chemicals found in medicinal plants also have antifungal characteristics, which make them useful in combating fungal infections. The polyphenols in green tea, for instance, have shown to inhibit the development of fungus such as *Aspergillus* spp. and *Candida* spp., as shown in research. This is in contrast with other common beverages. Oregano oil (*Origanum vulgare*) and tea tree oil (*Melaleuca alternifolia*) are two examples of plant essential oils that are very effective against a range of harmful fungus.

Antiviral Activity: Medicinal plants include bioactive chemicals that have antiviral activity, meaning they can suppress the multiplication of viruses. Flavonoids like quercetin and hesperidin, for example, have antiviral characteristics that make them effective against a number of viruses, including HSV, influenza, and HIV. Furthermore, research has shown that some plant tannins, such as those found in pomegranates and green tea, may inhibit the development of certain viruses. These viruses include RSV and HCV, among others.

Mechanisms of Action: Bioactive chemicals derived from medicinal plants may have different antibacterial actions. Certain chemicals cause cell lysis and eventual death in microbes by interfering with their membrane potential. Some of them stop microbes from growing and metabolizing by blocking very important enzymes. In addition, there are chemicals that alter the immune response, making the body more resistant to diseases.

Anti-cancer activities of biologically active compounds from medicinal plants

Medicinal plants include bioactive compounds that may have anti-cancer effects. Substances with anti-metastatic and antiangiogenic properties, as well as those that may inhibit tumour growth and cancer cell death, have attracted a lot of attention from the cancer research community. The vast array of bioactive compounds derived from medicinal plants offers great promise for the creation of novel anti-cancer therapies.

Polyphenols: Polyphenols are a class of bioactive compounds that have shown substantial anticancer activity; they are present in a wide variety of medicinal plants. Resveratrol, an antioxidant found in berries and grapes, has been studied extensively for its potential to prevent cancer. Among these actions are the following: inhibition of cell proliferation, induction of apoptosis, suppression of angiogenesis, and metastasis. The anti-cancer properties of green tea have been shown to be due to its high concentration of epigallocatechin gallate (EGCG), a compound that affects many signalling pathways related to cell survival, proliferation, and angiogenesis.

Alkaloids: There is promising evidence that alkaloids extracted from medicinal plants may inhibit cancer growth. As an example, several malignancies, such as leukaemia and lymphoma, have responded to chemotherapy drugs produced from *Catharanthus roseus* (Madagascar periwinkle), such as vincristine and vinblastine. As an additional example, camptothecin has anti-cancer

characteristics by inhibiting topoisomerase I, an enzyme crucial for DNA replication and repair. It is derived from the plant *Camptotheca acuminata*.

Terpenoids: Terpenoids, found in a wide variety of medicinal plants, are another group of bioactive compounds that may have anti-cancer effects. Paclitaxel, a famous terpenoid derived from the Pacific yew tree (*Taxus brevifolia*), is used in cancer treatment. It fights cancer by stopping cells from multiplying and getting them to die. According to Fulda and Effenberger *et al.*, betulinic acid has anti-cancer properties via targeting many signalling pathways related to cell survival, proliferation, and apoptosis. This compound is found in several plant species, including *Betula* spp.

Sulfur-containing compounds: Medicinal herbs that contain sulphur have shown encouraging results in combating cancer. Cruciferous vegetables, such as broccoli and cauliflower, contain the chemical sulforaphane, which has anti-cancer effects. These effects include inhibiting cancer cell proliferation, increasing apoptosis, and activating phase II detoxification enzymes. The anti-cancer properties of allyl isothiocyanate, found in garlic and other *Allium* species, include a reduction in metastasis, a slowing of tumour growth, and the activation of apoptosis.

Mechanisms of Action: A wide variety of bioactive chemicals derived from medicinal plants have anti-cancer effects. Inflammation, angiogenesis, metastasis, cell proliferation, and survival are all impacted by the signaling pathways that they may affect. In addition to promoting DNA repair and epigenetic alterations, these chemicals may also show antioxidant action and inhibit enzyme systems important for tumour development.

Conclusion

It is worth noting that medicinal plants include bioactive substances that show great promise in treating a range of health issues and improving general wellness. More investigation, new ideas, and teamwork will reveal their therapeutic potential, paving the way for the development of tailored, risk-free treatments derived from nature's pharmacy. Herbal remedies derived from physiologically active compounds have promising anti-cancer properties. Bioactive substances including sulfur-containing chemicals, alkaloids, terpenoids, polyphenols, and others show promise as anti-cancer agents via a number of pathways. The development of innovative and effective anticancer therapies may benefit from more investigation into these compounds. A growing number of preclinical studies have shown the anti-inflammatory, antibacterial, and anticancer effects of bioactive chemicals derived from spices and herbs, and this has led to their increased recognition by the pharmaceutical sector. These natural compounds possess all the necessary qualities to be developed into effective treatments in the near future, thanks to the relentless push for innovation in drug development driven by scientific progress. We need more standardization, quality control, and clinical validation to make sure herbal supplements are safe and effective, but the regulatory environment is still complicated and not always uniform across areas. In

addition, there is a rising need for holistic and patient-centered healthcare, and the incorporation of bioactive substances into personalised medicine presents potential pathways for individualized therapies with less adverse effects. Innovations in biotechnology and conventional wisdom about natural products might usher in a new age of effective treatments.

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