THERAPEUTIC PLANTS:

RECENT ADVANCES IN THE USE OF HERBS AS ALTERNATIVE MEDICATIONS

Editors:
V. V. Sathibabu Uddandrao
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Therapeutic Plants: Recent Advances in the Use of Herbs as Alternative Medications

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CONTENTS

FOREWORD

I am delighted to write this foreword not only because I know the editors but also for their extraordinary contribution to research, especially in the field of herbal medicine. I was excited when they started writing this book titled "Therapeutic Plants: Recent Advances in the Use of Herbs as Alternative Medications", and I was the first reader. The editors have sent me a copy of the manuscript, and I thoroughly enjoyed while reading this book and gained abundant knowledge from this book.

It was not only a great book, but it also shows a great way to write and construct chapters. This book covers advances in traditional medicine, which is as old as civilization, for treatment and prevention. Medicinal plants used in traditional medicine have relatively low or no negative effects and toxicity, and their application has become widespread because of their accessibility, affordability, ease of availability, and acceptable effectiveness. The primary use of herbal medicines is treating chronic and life-threatening chronic diseases.

Looking through this magnificent volume, I am absolutely amazed at the introduction of herbal medicines and their novel therapeutic applications against various diseases. It is not only a book with beautiful illustrations but also a source of information in the field of pharmacognosy. This book is unique and a treasure for anyone interested in herbal medicines. Therefore, I strongly recommend that you read it, enjoy it, and learn from it.

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PREFACE

Many believe that herbal medicine provides an alternative treatment for various diseases, especially lifestyle diseases, which require lifelong drug treatment and pose safety concerns. Traditional medicine practitioners also believe that the phytocomponents contained in herbal medicine have better compatibility with the human system. Phytochemicals in herbs are being actively investigated for their direct use as therapeutic agents and prototype lead compounds for developing new synthetic or semi-synthetic drugs.

Herbal medicines have become an important source and primary target for future drug development and human healthcare. This book provides a detailed view and perspective of the research topic of herbal medicine used to treat various diseases such as metabolic disorders, cardiovascular diseases, cancer, microbial infections, etc. This book also highlights research on herbs' therapeutic effects and underlying mechanisms. This book provides valuable information from various sources and presents it to readers in figures and convenient tables. This book also offers information about various herbs and herbal mixtures (products) in preliminary and clinical studies. This book increases the awareness among the public about the undesirable side effects of allopathy drugs and is a step towards better understanding and utilizing natural plant products for human welfare.

Chapter 1 provides the fundamental information about the herbal medicine and current research in this field. This chapter explains how herbal medicine's future ultimately lies in the harmonic fusion of traditional knowledge with cutting-edge scientific research, providing potentially safer, more individualized, sustainable, and globally accessible healthcare choices.

Chapter 2 discusses different herbal medicines and their potential therapeutic mechanism of action against chronic diseases. This chapter emphasizes the herbs that have potential in the management of diabetes, hypertension, and arthritis.

Chapter 3 points out the most significant medicinal plants in India, which also have a good market potential. This chapter highlights the plants' unique characteristics, the parts used in medicine, and therapeutic principles.

Chapter 4 explains natural products and their bioactive compounds for preventing and treating diabetes mellitus. Particular emphasis was given to the most beneficial antidiabetic chemicals from edible mushrooms and medicinal plants in this chapter.

Chapter 5 points out the comprehensive strategy required for reducing the global impact of cancer, which includes awareness-raising, prevention, early detection, and cutting-edge treatments.

Chapter 6 reveals the role of prognostic biomarkers and their importance as a drug therapeutic target in colorectal cancer therapy.

Chapter 7 encompasses an extensive review of breast cancer's histological and molecular classification, delving into its intricate pathophysiology and associated risk factors. In addition, this chapter consolidates comprehensive insights into breast cancer, emphasizing the potential therapeutic impact of bioactive compounds and medicinal plants.

Chapter 8 details the therapeutic effects of medicinal plants and how they contribute to sustainable development goals by treating numerous chronic ailments, which restores the

health and well-being of every individual.

The concept of Ayurvedic pharmacology is covered in Chapter 9, along with a discussion of the plant Aushadhi Dravya, which has been linked to cardioprotective effects. This chapter primarily discusses the inherent Ayurvedic properties of the fruit of Aushadhi Dravya, their incorporation into polyherbal formulations, and some functional food recipes.

Chapter 10 comprehensively explores the application of nanoparticles in treating cardiovascular diseases. This chapter highlights nanomedicine's ethical and regulatory aspects, emphasizing its significant potential in revolutionizing cardiovascular disease treatment.

Chapter 11 explains the detailed information on Barleria longiflora L.F., including pharmacognostical, preliminary phytochemical, and antibacterial properties.

Chapter 12 explains the metabolomics of plants for drug design using in silico studies. This chapter highlights various computational strategies formulated for predicting chemical and biological properties based on chemistry and experimental basis.

Chapter 13 demonstrates the results of phytochemical compounds present in Lawsonia inermis leaves and their effect on the Hbx protein of the hepatitis B virus by in silico analysis.

Chapter 14 highlights the medicinal applications of Terminalia chebula in traditional and modern medicine. This chapter points out the therapeutic properties of Terminalia chebula against cancer, liver damage, cardiovascular diseases, and diabetes.

Chapter 15 depicts the findings that contribute to the understanding that silver nanoparticles may significantly inhibit the growth of aflatoxigenic fungi isolated from poultry feed.

Chapter 16 discusses the promising prospects, challenges, and future directions in leveraging eco-friendly and biocompatible nanoparticles in diverse biomedical scenarios. Also, this chapter describes the vast array of biomedical applications for plant-extract-mediated hydroxyapatite nanoparticles.

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CHAPTER 1

The Future of Herbal Medicine: Research and Innovation

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Abstract: Herbal medicine has a bright future ahead of it, one marked by constant innovation and research. The scientific underpinnings of herbal treatments are being uncovered by biomedical research, which enhances their legitimacy and therapeutic potential. A key component of this future is personalised herbal medicine, which is based on genetics and data-driven methods and enables individualised treatments that take individual variability into account. With genetic modification and plant tissue culture improving the potency and sustainability of medicinal plants, biotechnology is at the forefront of innovation. Novel delivery technologies, such as transdermal patches and nanoparticles, are improving the targeted administration and bioavailability of herbal ingredients. By integrating herbal medicine into global health programmes and practising responsible sourcing, ethical concerns, and sustainability difficulties are being addressed. Herbal medicine is also well-positioned to provide comprehensive and preventive answers for new health concerns, such as mental health problems and antibiotic resistance. In order to guarantee the consistency and safety of herbal products, the area must address issues related to quality control, intellectual property rights protection, and ethical considerations as it develops. Herbal medicine's future ultimately lies in the harmonic fusion of traditional knowledge with cutting-edge scientific research, providing potentially safer, more individualised, sustainable, and globally accessible healthcare choices.

Keywords: Biotechnology, Biomedical research, Herbal medicine, Integrative healthcare, Personalized medicine.

INTRODUCTION TO THE FUTURE OF HERBAL MEDICINE

The field of medicine is about to enter a revolutionary period in which traditional medical practises and drugs will give way to new approaches that combine old wisdom with cutting-edge research as shown in Fig. (**1**). This paradigm change is

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V. V. Sathibabu Uddandrao & G. Saravanan (Eds.)

being driven by how herbal medicine is developing and how traditional treatments—many of which have their roots in centuries-old indigenous knowledge are redefining what constitutes appropriate medical care. This chapter takes us on a journey to investigate "The Future of Herbal Medicine: Research and Innovation," an area that holds the potential to fundamentally alter our perception of, ability to utilise, and take advantage from nature's pharmacy [1]. For thousands of years, herbal medicine also referred to as phytotherapy or botanical medicine has been a crucial component of human healing. Herbal treatments have a long history that spans decades, continents, and civilizations, providing a wealth of traditional medical knowledge [2]. These herbal traditions have seen a rise in popularity recently, not just as a substitute for or addition to modern medicine but also as a vibrant and developing discipline unto itself. Our knowledge of herbal medicine has expanded tremendously as science and technology have progressed, creating new avenues for investigation and creativity. In light of these expanding prospects and growing curiosity, we venture into the undiscovered terrain of herbal medicine's future [3].

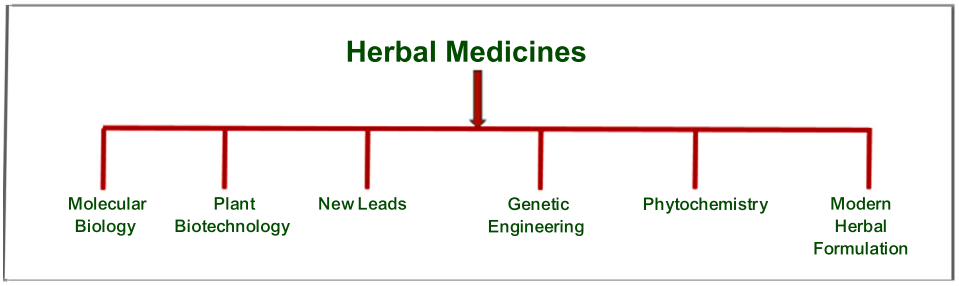

Fig. (1). Future of herbal medicines.

Herbal medicine's future depends on striking a careful balance between holding onto the knowledge of the past and seizing the opportunities presented by modernity. The purpose of this chapter is to shed light on the innovative advancements and state-of-the-art studies that are bringing herbal therapy into the twenty-first century [4]. The developments in the field of herbal medicine research, are progressively combining the best practises of traditional medicine with cutting-edge scientific techniques. In order to solve the puzzles surrounding herbal treatments, scientists are currently figuring out the complex chemistry of medicinal plants, recognising and defining bioactive chemicals, and applying cutting-edge analytical methods like nuclear magnetic resonance and mass spectrometry [5].

However, herbal medicine's future extends beyond the lab bench. It includes the farms and fields where therapeutic plants are grown. The way we access and grow these essential botanicals is being revolutionised by biotechnology and sustainable agricultural methods [6]. New methods for increasing the production of therapeutic plants, assuring their availability while minimising ecological damage, are being made possible by genetic manipulation and plant tissue culture. Furthermore, the idea of personalised herbal medicine is gaining popularity as it acknowledges that genetic variability causes individual responses to herbal treatments to differ. Pharmacogenomics is enabling customised treatment regimens by illuminating the genetic variables that affect a person's reaction to herbal treatments [7]. Changes in the sector are also being driven by innovations in the delivery of herbal medicine. Herbal chemicals are being used with nanotechnology and microencapsulation to increase their bioavailability and efficacy. Herbal medicines are becoming increasingly potent and convenient through the use of transdermal patches, herbal nanoparticles, and herbal nanoemulsions [8].

Moreover, herbal medicine's promise goes beyond complementary therapies. More and more people are realising that it can be used as a source for new drug discovery, since many plants have unique molecules that can be used to treat unmet medical requirements. This bright future is not without its difficulties and moral dilemmas, though. The protection of herbal product quality and safety is still a top priority, and biopiracy and intellectual property rights are major concerns [9]. Maintaining our natural heritage requires sustainable growing methods and the ethical procurement of medicinal herbs. Examples from everyday life will offer verifiable proof of how studies and applications in herbal medicine are revolutionising health and well-being. This chapter will focus on the significance of partnerships and collaborations, which are critical to the global advancement of herbal medicine research. International collaborations are creating new channels for information exchange and innovation, and academia, business, and government organisations are joining forces to support and fund research [10]. Herbal medicine's future is an exciting, multifaceted, and all-encompassing voyage into the uncharted. It promises to combine the knowledge of conventional medicine with the accuracy of contemporary research, providing answers to the urgent problems facing healthcare today [11].

ADVANCES IN HERBAL MEDICINE RESEARCH

Research on herbal medicine is at the forefront of converting conventional treatments into a cutting-edge area of study. This progression has the potential to fully realise the therapeutic potential of plants by combining cutting-edge science and traditional knowledge in a harmonious way. Finding and characterising the

CHAPTER 2

Herbal Medicine and Chronic Disease Management

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Abstract: "Herbal Medicine and Chronic Disease Management" provides a thorough examination of the complex and dynamic field of herbal medicine with an emphasis on how it might be used to treat chronic illnesses. This multifaceted journey starts with a historical overview, following the origins of ancient herbal therapeutic methods and their present rebirth. It explores the mechanisms of action that herbs use to address chronic illnesses, emphasising their ability to reduce inflammation, function as an antioxidant, and regulate blood sugar. The chapter highlights the possible advantages of particular herbs in the treatment of common chronic conditions, such as diabetes, hypertension, and arthritis. These claims are supported by an increasing amount of data from trials and clinical research. Notable herbs that can lessen adverse effects and improve general well-being include bitter melon, cinnamon, hawthorn, and turmeric. These herbs can be used in addition to traditional pharmaceutical therapies. However, there are obstacles and restrictions on the way of incorporating herbal therapy with conventional therapies. Variability in herbal products, irregular dosage, and possible interactions with medications are some of the factors that highlight the significance of careful and educated use. The chapter offers important recommendations for using herbal medicines safely, stressing the value of speaking with medical professionals and selecting reliable sources. Herbal medicine's introduction into conventional treatment is an example of a comprehensive strategy that recognises the synergistic potential of both conventional and alternative medicinal approaches. By combining the best aspects of both worlds, this collaborative paradigm enables people to set out on a journey towards holistic well-being, optimising health results and achieving a lasting sense of vitality.

Keywords: Chronic disease management, Clinical studies, Complementary and alternative medicine, Herbal medicine, Integrative healthcare.

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V. V. Sathibabu Uddandrao & G. Saravanan (Eds.)

INTRODUCTION

"Herbal Medicine and Chronic Disease Management" takes readers on a tour of both modern healthcare and ancient healing methods while shedding light on the powerful but frequently overlooked role that herbal medicine plays in the treatment of chronic illnesses [1]. With their protracted length and often progressive nature, chronic diseases have become a major worldwide health concern. These disorders, which include a broad spectrum of illnesses like diabetes, hypertension, arthritis, and cardiovascular disease, have a substantial negative influence on people's quality of life and put a heavy strain on healthcare systems around the globe [2]. To improve quality of life, lessen suffering, and lower the rising costs of healthcare related to chronic illnesses, effective treatment is essential [3]. Traditional medical methods have long served as the cornerstone of care and usually involve medication, surgery, and lifestyle changes. On the other hand, a growing number of people are looking for complementary and alternative therapies to enhance traditional treatments and their general health. In this endeavour, herbal medicine, which is based on the application of plant-based therapies, presents an intriguing and frequently unexplored path [4].

It is crucial to comprehend the historical foundations of herbal therapy as well as its current renaissance in order to completely appreciate its significance in the context of managing chronic diseases. The first section of this chapter examines the historical relevance of herbal medicine and traces its roots to traditional healing practices that are ingrained in many different cultures worldwide. For millennia, various traditional practices have depended on the medicinal properties of herbs, including Ayurveda from India, Traditional Chinese Medicine, and Native American cures. The chapter also explores the increased interest in natural and holistic therapeutic methods, which has led to the resurgence of herbal medicine in modern healthcare [5]. The need for more individualised, patient-centered care as well as the awareness of herbal treatments' possible advantages in the management of chronic illnesses is the driving force behind the current interest in them. A wide range of plant-based medicines, each with specific qualities and uses, are included in herbal medicine. The principles of herbal medicine are examined in this chapter, along with information on various herbal medicines in the form of teas, tinctures, capsules, and topical applications [6]. Additionally, it highlights how crucial it is to have safety and regulations in place when using herbal products in order to safeguard customers and guarantee product quality. Because chronic illnesses can have multiple facets, managing them requires an all-encompassing and integrative strategy. Given the complexity of these illnesses, herbal medicine is used in this setting as an adjunctive and alternative therapy to traditional medical treatments. The chapter clarifies the different channels by which herbs interact with the human body and affect disease

processes, illuminating the mechanisms by which they may have therapeutic effects in managing chronic diseases [7].

The chapter explores particular plants that are well-known for their effectiveness in treating common chronic disorders in order to give readers a concrete understanding of the role that herbal medicine plays in controlling chronic diseases. For instance, cinnamon and bitter melon are studied in relation to managing diabetes. Herbs like garlic and hawthorn are also talked about in relation to hypertension, while turmeric and ginger are emphasised for their possible role in reducing arthritic symptoms. Beyond these particular instances, the chapter provides information on using herbs to treat a range of other long-term illnesses [8]. Scientific research provides solid evidence for the effectiveness of herbal treatment, rather than relying only on anecdotal information. This chapter explores the corpus of evidence from trials and clinical investigations, highlighting the significance of evidence-based herbal remedies. It does, however, also recognise the shortcomings and difficulties that come with conducting research on herbal medicine, including finance, standardisation, and methodological problems. When managing chronic diseases, the integration of herbal medicine with traditional medical practices is crucial. In order to navigate the often confusing array of treatment options, patients frequently turn to healthcare professionals for advice. This chapter emphasizes the importance of consulting with medical specialists in order to guarantee a well-informed and coordinated approach to care. When appropriate, this integration can entail using prescription drugs in addition to herbal therapies to maximise therapy results while lowering dangers.

When using herbal medicines, safety and preventive measures are crucial. Although herbs have medicinal value, there is a chance that they will interact with prescription medications and cause dangers. The chapter gives advice on how to utilise herbal medicines safely, enabling people to make knowledgeable decisions about their health. This chapter's main focus is patient education, which emphasizes the need to inform people about the possible advantages and disadvantages of herbal therapy [9]. It promotes proactive self-care and emphasizes the value of being informed, healthcare consumers. In order to provide people with a better understanding of herbal medicine and its uses, learning resources are provided. The chapter offers real-world case studies to demonstrate the practical application of herbal therapy in the management of chronic diseases. These case studies highlight people who have effectively included herbal treatments in their treatment plans, offering insights into the real advantages and difficulties encountered on the path to improved health.

CHAPTER 3

Traditionally Occurring Therapeutic Plants in India

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Abstract: Plant-derived medicinal products are the most widely accepted and recognized form of medicine in modern human civilization. Secondary metabolites are bio-synthetically produced by plants from primary metabolites, and these phytocompounds are the primary sources of herbal, pharmaceutical, and nutraceutical formulations. The medicinal and nutritional needs of these plants are found in various phytomolecules that have specific biological actions on the human organ system. Various traditional medicinal plants would be the best alternative source to obtain quality and vital herbal formulations for treating and protecting against a variety of diseases. The therapeutic plants of India possess a profound historical significance in addressing a variety of health issues. Ethnobotanicals, along with their derivatives, have demonstrated promising efficacy in the management of various diseases. The intake of fruits, vegetables, and ethnomedicinal plants, as well as their derivatives, offers substantial protection against these health conditions. This is attributed to the high concentration of phytochemicals found in medicinal plants, including flavonoids, tannins, terpenoids, polyphenols, steroids, alkaloids, glycosides, chlorophyll, carotenoids, proteins, minerals, vitamins, and other vital nutrients, all of which exhibit potent antioxidant properties and various biological activities. It is estimated that numerous Indian ethnic communities utilize over 7,500 distinct plant species for medicinal purposes.

Keywords: Medicinal, Phytochemicals, Secondary metabolites, Therapeutic plants.

INTRODUCTION

Since ancient times, numerous natural medicinal plants have been utilized to cure a variety of diseases, and they are regarded as a potential source of phytochemicals for the development of novel drugs. Based on the unique geological features and environmental circumstances, India has a rich tradition of

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V. V. Sathibabu Uddandrao & G. Saravanan (Eds.)

using medicinal plants in various traditional systems like Ayurveda, Siddha, and Unani. Our medicinal plant database includes information such as scientific names, family names, vernacular names, medicinal applications, species location, and photos of herbarium specimens. For approximately 1000 years, some plant species have been explored as a source of medicinal compounds, and most pharmaceuticals in use today are plant-derived natural products [1]. There are reports of the survival of written evidence dated 2600 BC concerning the medicinal properties of the herbs, and medicinal plant records from the ancient Mesopotamia period have paved the path for the creation of future drugs based on plants and natural goods. There are four biodiversity hotspots in India, namely the Himalayas, Sundaland, Indo-Burma, and Western Ghats-Sri Lanka, making it one of the world's seventeen mega biodiversity centers [2]. According to reports from the Botanical Survey of India, out of the 45,000 plant species mentioned, at least 30,000 (or two-thirds) are of significant interest due to their potential therapeutic properties. Some of these plants are used by the locals as herbal remedies, and they work well against a variety of illnesses. In India, using traditional remedies to treat skin conditions is a well-recognized and often-used practice [3].

In India, a wide array of herbal remedies has been recorded for the treatment of various skin conditions, including acne, bruises, and burns. Furthermore, medicinal plants are frequently utilized to manage issues such as cuts, wounds, skin diseases, ringworm, eczema, leprosy, scabies, and others. The use of Indian medicinal plants for treating diverse ailments dates back to ancient times. Globally, over 80,000 plants are recognized for their medicinal properties, with a significant number being traditionally utilized across generations. This indicates that medicinal plants form the foundation of traditional or folkloric medicine. Currently, traditional medicinal plants are receiving considerable attention from mainstream medical science and healthcare systems [4]. A substantial portion of the populations in developing or underdeveloped countries continue to rely on traditional medicine as a primary source of healing for various ailments. These indigenous medicinal plants are extensively employed as a powerful alternative for health issues. In primary healthcare systems, medicinal plants are essential components for individuals, contingent upon their availability, acceptability, compatibility, and affordability [5].

Medicinal and aromatic plants serve as essential and valuable sources of primary and secondary metabolites, which are utilized as templates in lead optimization programs and are regarded as the foundation for safe and effective herbal formulations. Given their potential, availability, and cost-effectiveness, numerous health practitioners and researchers consistently recommend the use of various ethnomedicinal plants or their derivatives to provide protection against a range of health issues [6]. This review article highlights plants that have demonstrated

significant medicinal utility since ancient times and are abundant in diverse bioactive compounds. These plants are particularly effective in addressing serious health conditions, including viral and microbial infections, diabetes, kidney and lung diseases, cancer, and other critical ailments. Ethnobotanicals and natural products, along with their derivatives, have exhibited promising activities in the treatment of these diseases. The consumption of fruits, vegetables, or ethnobotanical plants and their products can effectively contribute to protection against these various health concerns [7]. Medicinal plants represent a rich natural resource of numerous phytochemicals, including flavonoids, tannins, terpenoids, polyphenols, steroids, alkaloids, glycosides, chlorophyll, carotenoids, proteins, minerals, vitamins, and other essential nutrients, all of which possess strong antioxidant properties and various biological activities. According to general statistics, approximately 80% of the global population primarily relies on ethnobotanical and herbal medicines, such as morphine, codeine, camptothecin, taxol, allicin, artemisinin, quinine, quinidine, colchicine, nicotine, and caffeine [8].

SIGNIFICANCE OF PLANTS

The following is a brief description of the most significant medicinal plants in India, which also have a good market potential. This description emphasizes the distinctive features of each plant, the specific parts utilized for medicinal purposes, and the underlying therapeutic principles.

Tulasi-ocimum Sanctum

The leaves exhibit an elliptical-oblong shape, characterized by entire or slightly serrated edges, and are covered in fine hairs on both surfaces (Fig. **1**). The flowers are small and can be purple or reddish, arranged in a whorled cluster. The seeds are somewhat flattened and range in color from pale brown to reddish-brown, featuring black markings. This herb possesses numerous therapeutic benefits, including antifungal, anti-inflammatory, antivenom, and antidiabetic properties, as well as effects against various diseases and epilepsy. It is effective in treating ailments such as the common cold, coughs, fevers, respiratory issues, and bronchitis, in addition to skin conditions, gastrointestinal disorders, diabetes, and dysentery. Furthermore, it can alleviate headaches, convulsions, sore throats, chest discomfort, and dyspepsia, particularly in women. The herb contains a range of phenolic compounds, including phenolics, flavonoids, phenylpropanoids, terpenoids, fatty acids, ursolic acid, apigenin, luteolin, steroids, eugenol, and carvacrol [9].

CHAPTER 4

Natural Products and their Bioactive Compounds for the Prevention and Treatment of Diabetes Mellitus: A Systematic Review

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Abstract: Diabetes mellitus is a long-term condition characterized by increased blood glucose levels, frequently referred to as hyperglycemia, and irregular protein and fat metabolism. Patients have an increased risk of major health issues in the future, particularly cardiovascular issues, due to the disease's chronic metabolic imbalance. DM treatment with the use of phytotherapy has a promising future since it has attained solid clinical practice. Numerous synthetic medications are used to treat the disease; however, due to their drawbacks and adverse effects, attention is being given to the use of plants and plant components in the creation of herbal remedies. A significant section of the world's population has been encouraged to switch to this alternative form of medication by the accessibility, cost, and little side effects associated with the use of herbal remedies. Since the beginning of time, plants have been the source of numerous goods for human welfare. The most beneficial antidiabetic chemicals from edible mushrooms and medicinal plants that are accessible through a variety of literature sources and databases are reviewed in this review.

Keywords: Diabetes mellitus, Mushrooms, Medicinal plants, Natural product.

INTRODUCTION

Hyperglycemia and irregular protein and lipid metabolism are hallmarks of diabetes mellitus (DM), a chronic illness. Patients are at a heightened risk of developing major health issues in the long run, particularly in the cardiovascular

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V. V. Sathibabu Uddandrao & G. Saravanan (Eds.)

system, due to the disease's chronic metabolic imbalance [1]. According to the IDF, there currently exist over 436 million individuals affected with DM globally; by 2045, this number is expected to increase to over 700 million or more [2]. Worldwide, type 2 diabetes (T2DM) affects around 90% of persons with DM. Patients with DM and those living in developing nations, in particular, face a significant financial burden due to the rising cost of healthcare associated with the disease and its secondary consequences [3]. A significant worldwide health concern is T2DM, whose occurrence is influenced by a number of hereditary and non-genetic variables, including age, obesity, stress, food, ethnicity, lack of exercise, and inflammation.

Globally, the prevalence of T2DM and its primary complications is rising [4]. Numerous macro- and microvascular complications are linked to DM. Numerous variables contribute to these problems, but the primary cause is persistent hyperglycemia in individuals with DM. Retinopathy, nephropathy, and neuropathy are examples of microvascular consequences (Fig. **1**) [5]. The most harmful consequences of DM are macrovascular ones, which frequently result in death. These consist of myocardial infarction, stroke, and peripheral cardiovascular disease [6]. One of the biggest issues facing scientific communities today is the management and treatment of chronic diseases. Scientists are still unable to eradicate serious chronic illnesses like DM, even with significant improvements in the healthcare system [7]. The most prevalent non-pharmacological therapies to manage glucose levels are food and exercise [8, 9]. Individuals may need pharmaceutical therapies, such as biguanides, sulfonylureas, thiazolidinediones, and glucagon-like peptide 1 (GLP-1) agonists, due to unfavorable lifestyle changes. Since DM is a chronic illness that progresses over time, managing it needs a long-term pharmaceutical regimen, which can result in significant medical expenses over time [10]. Furthermore, long-term use of these drugs results in a variety of adverse consequences, including hypoglycemia shock, rapid body weight gain, decreased bone density, and an increased risk of cardiovascular diseases (CVD) [11, 12].

Current research has moved toward natural products, which typically have strong therapeutic effects and the same timeless or no side effects, in an effort to counteract these negative consequences [13]. Therefore, we covered the role of natural products against DM (Fig. **2**) and its related difficulties in the current review.

MATERIAL AND METHODS

The databases Science Direct, PubMed, Wiley, Scopus, and Springer were searched for relevant studies on diabetes and medicinal plants. “Medicinal

plants," "diabetes," "Mushrooms," "natural products," "antidiabetic," "bioactive compounds," "symptoms," "herbal," and "treatment" are among the study's keywords. The flow of data across the review's various phases (Fig. **3**).

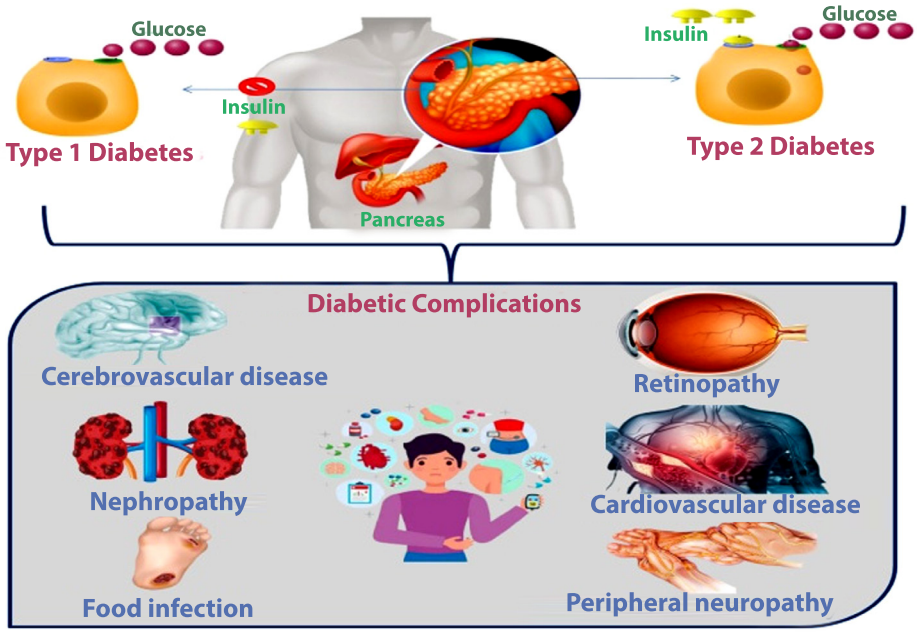

Fig. (1). Diabetes types and major complications associated with diabetes.

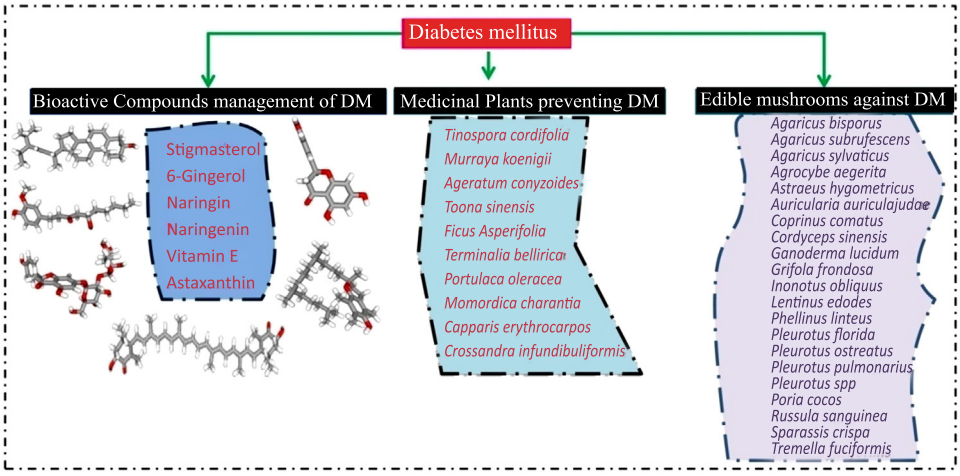

Fig. (2). Bioactive compounds from medicinal plants and mushrooms against diabetes.

CHAPTER 5

Cancer: Initiation, Progression and Spread; A Molecular Insight

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Abstract: Cancer remains a threat to global health and medical progress. Uncontrolled cell proliferation is a complicated aspect of this disease, making prevention and treatment strategies extremely difficult. The rising incidence of cancer in India highlights how urgently comprehensive strategies to address the rising cancer burden are needed. Cancer presents in a variety of ways, classified according to the organs or tissues that are impacted. Accurate staging is essential for customized treatments and prognoses. Uncontrolled cell division is largely caused by the dysregulation of essential proteins like cyclins and CDKs, which require a basic understanding of the normal cell cycle phases. Tumor suppressors, including p53, are essential for controlling the proliferation of cells and are involved in the complex process of cancer initiation. Cancer is preceded by processes such as neoplasm development, epithelial-mesenchymal transition (EMT), and metastasis, which can be impacted by genetic changes, exposure to carcinogens, or persistent inflammation. Using the immune system's defense mechanisms, immunotherapy has the potential to identify and eradicate aberrant cells, opening up new treatment options. In conclusion, reducing the global impact of cancer requires a comprehensive strategy that includes awareness-

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V. V. Sathibabu Uddandrao & G. Saravanan (Eds.)

raising, prevention, early detection, and cutting-edge treatments. Future cancer treatments could be more precise and effective thanks to ongoing research, especially in immunotherapy.

Keywords: Cancer, Epithelial-mesenchymal transition, Immunotherapy, Treatment, Tumour suppressor.

INTRODUCTION

A major global health issue that impacts millions of individuals is cancer. The illness is complicated and deadly, affecting millions of individuals globally. The body's abnormal cells proliferate and spread uncontrollably, symbolizing the condition [1]. Cancer can take many distinct forms, and each one has unique characteristics and treatment modalities [2]. Cancer remains one of the leading causes of mortality worldwide, even with all the advances in research and treatment. One of the key traits of cancer is the abnormal cells' ability to proliferate rapidly in the absence of any regulatory control. Any area of the body may experience this unchecked cell proliferation, which has the potential to infect surrounding tissues and impair organ function. Cancer's precise causes are frequently complex and multifaceted [3].

As per the latest global data, cancer has emerged as one of the primary causes of mortality worldwide, with an estimated 10 million deaths due to it in 2020 [4]. In addition, projections indicate that by 2040, the worldwide cancer burden will increase to almost 28.4 million cases [5]. These concerning figures demonstrate the critical need for worldwide efforts to raise cancer awareness and promote cancer prevention and treatment. India has been dealing with a major increase in the illness burden with regard to the prevalence of cancer [6]. According to data from the Indian Council of Medical Research (ICMR), there were roughly 1.16 million new cases of cancer and 0.87 million deaths from cancer in India in 2018 [7]. Today, cancer ranks as the second most common cause of death in the country [8].

A multifaceted strategy that includes early detection, prevention, and readily available, reasonably priced treatment is needed to address the cancer burden in India. In order to reduce the risk of developing liver and cervical cancers, respectively, efforts are being made to increase public awareness of the significance of leading a healthy lifestyle, getting screened frequently, and getting vaccinated against hepatitis B and the human papillomavirus (HPV) [9]. The establishment of specialist cancer institutes and increased financing for research and development are further efforts by the Indian government to improve the accessibility and cost of cancer therapy. The incidence of cancer is rising

gradually in India; thus, it is critical to have early detection plans, efficient prevention measures, and easily accessible treatment alternatives in place. Our best chance of lessening the effects of cancer is to prioritize healthcare infrastructure development, research, and awareness [10].

In addition, the discrepancies in cancer care and treatment accessibility that exist in India must be addressed. Access to high-quality healthcare services is severely hampered for many people living in remote places and marginalized populations. Investing in the growth of these neglected areas' healthcare infrastructure and ensuring that cancer prevention, detection, and treatment services are easily accessible to everyone are crucial in the fight against this [11]. Enhancing the public's understanding of the significance of routine screenings and early detection can also aid in the early identification of cancer cases, improving treatment outcomes and boosting survival rates. By keeping these things in mind, we can work toward a time when no one is left behind in the fight against cancer.

Types of Cancer

Cancer comes in different forms, each with unique traits and damaged organ systems. The organ or tissue where the disease first appears is one typical way to classify cancer [12] (Fig. **1**). For example, lung cancer starts in the lungs, but breast cancer affects the cells in the breast. Certain cancers, including leukemia, start in the bone marrow or other tissues that generate blood [13]. For the purpose of diagnosis, treatment, and the creation of effective medicines, knowledge of the many forms of cancer is essential.

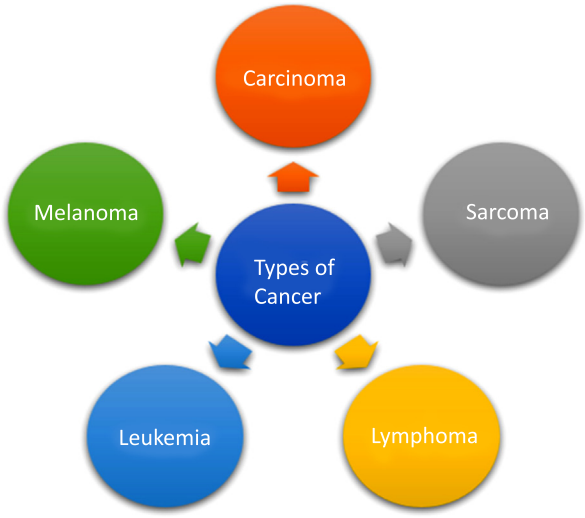

Fig. (1). Types of cancer.

CHAPTER 6

Role of Prognostic Biomarkers and their Importance as a Drug Therapeutic Target in Colorectal Cancer Therapy

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Abstract: Cancer, a multifaceted disease, continues to challenge the global healthcare landscape, with colon cancer being a prominent contributor to its burden. Colon cancer, also known as colorectal cancer (CRC), arises from the colon or rectum and ranks among the most prevalent malignancies worldwide. Its emergence can be attributed to a complex interplay of genetic, environmental, and lifestyle factors. Despite advancements in diagnostics and treatment modalities, the incidence of CRC has witnessed a concerning rise in recent years, prompting an urgent need for innovative therapeutic strategies. Surgical resection remains the primary curative option for localized disease, while systemic treatments are employed for advanced stages. Biomarkers, pivotal in elucidating CRC pathogenesis and progression, play a crucial role in guiding therapeutic interventions and prognostication. Molecular biomarkers like microsatellite instability (MSI) and mutations in genes like KRAS, BRAF, and TP53 serve as prognostic indicators and guide treatment selection. Understanding the intricate signaling pathways involved in CRC development has led to the exploration of novel therapeutic targets. Targeting key signaling pathways, such as the Wnt/β-catenin pathway, PI3K/Akt/mTOR pathway, and the MAPK pathway, has shown potential in preclinical studies and clinical trials, offering avenues for innovative treatment modalities. Overall, the evolving landscape of CRC demands a multidisciplinary approach integrating advanced diagnostics, targeted therapies, and personalized medicine. Biomarkers, with their pivotal role in elucidating molecular pathways and guiding treatment decisions, stand as a beacon of hope in the pursuit of more effective and tailored therapeutic interventions for colorectal cancer.

Keywords: Biomarkers, Cancer, Colorectal cancer (CRC), Liquid biopsies, Molecular profiling, Ppersonalized medicine, Signaling pathways, Therapeutic strategies, Targeted therapy, Wnt/β-catenin pathway.

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INTRODUCTION

Colorectal cancer initiates when cells within the body undergo uncontrolled growth, potentially spreading to other areas. This type of cancer can arise in various regions of the large intestine, including the colon and rectum (Fig. **1** and **2**). Depending on the site of origin, it may be termed colon cancer or rectal cancer, although they share many common characteristics and are often grouped together [1]. The predominant form of colorectal cancer, constituting over 95% of cases, is adenocarcinoma. This type of cancer originates from glandular cells in the colon or rectum, which produce mucus to aid in lubrication. Symptoms of colorectal cancer can vary but commonly include the presence of blood in the stool, changes in bowel habits, unintended weight loss, persistent fatigue, increased frequency of bowel movements, diarrhea, constipation, abdominal pain, bloating, a sense of abdominal fullness, and vomiting.

Colorectal cancer predominantly affects individuals aged 50 and above, with approximately 75% of cases occurring in this age group. Typically, it begins as a benign growth, often in the form of a polyp, which may progress to cancerous over time [2].

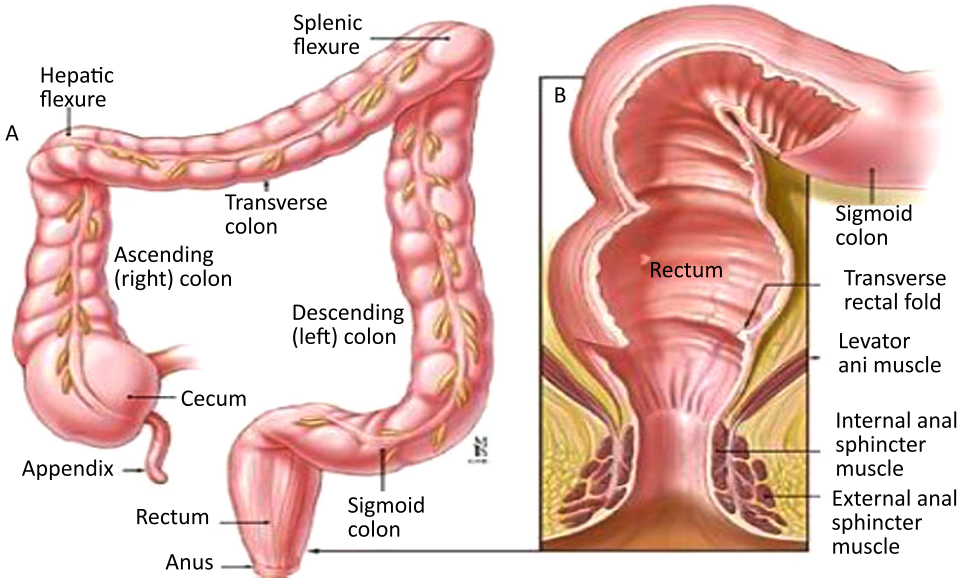

Fig. (1). Colorectal anatomy; A) Anatomy of the colon B) Anatomy of the rectum (Source: www.jhmicall.org, 2010).

The majority of colorectal cancers originate from abnormal growths on the inner lining of the colon or rectum, known as polyps. While some types of polyps can progress into cancer over several years, not all polyps undergo this transformation

[3]. Detecting and removing polyps before they become cancerous can greatly increase the likelihood of a cure, emphasizing the importance of screening. The incidence of colorectal cancer varies across different regions of the world, with developed countries often facing higher risks due to unhealthy lifestyles and sedentary behaviors. Additional risk factors include advancing age, genetic predisposition, and exposure to radiation [4].

Conversely, diets low in dietary fiber are also linked to higher colorectal cancer risk. Women with a history of breast, ovary, or uterus cancers, as well as individuals with a family history of colorectal cancer or ulcerative colitis, are at heightened risk. Furthermore, being overweight or obese and smoking tobacco are significant risk factors for colorectal cancer development.

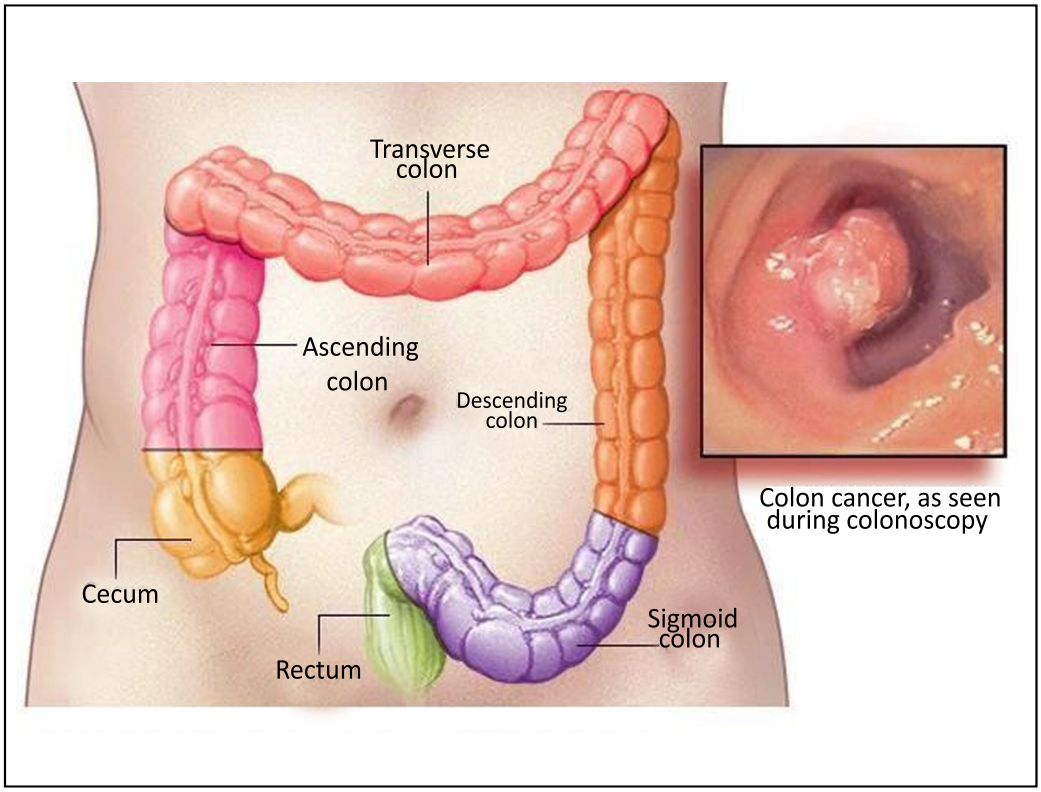

Fig. (2). Anatomy of the human colon and rectum [15].

The staging of cancer serves as a critical measure to assess the extent of the disease, aiding in the selection of the most appropriate treatment for patients. In the context of colon cancer, staging plays a pivotal role in determining the course of action (Fig. **3**). Treatment decisions for colorectal cancer are influenced by

CHAPTER 7

A Comprehensive Review of Molecular Targets and Therapeutic Potential of Phytomedicine for the Treatment of Breast Cancer

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Abstract: Breast cancer remains a pervasive global health concern demanding comprehensive understanding and innovative management approaches. This review encompasses an extensive examination of breast cancer's histological and molecular classification, delving into its intricate pathophysiology and associated risk factors. Within this scope, we delineate non-modifiable factors, including genetic predisposition, hormonal influences, lifestyle, and environmental determinants, alongside modifiable risk elements. Critical signaling pathways implicated in breast cancer pathogenesis are dissected, elucidating their pivotal roles in disease progression. Additionally, a detailed analysis of 37 bioactive compounds and their therapeutic potential in breast cancer management is provided. Furthermore, the review comprehensively discusses medicinal plants renowned for their preventive properties against breast cancer. This review underscores the promising prospects of bioactive compounds and medicinal plants in both prevention and treatment strategies for breast cancer. The intricate molecular pathways and diverse array of natural compounds and medicinal plants elucidated herein offer valuable insights into potential therapeutic interventions. In conclusion, this review consolidates comprehensive insights into breast cancer, emphasizing the potential therapeutic impact of bioactive compounds and medicinal plants. Future studies must uncover precise molecular mechanisms, conduct strong clinical trials, and use advanced technologies to create effective treatments, ultimately lessening the burden of this challenging disease.

Keywords: Breast cancer, Medicinal plants, Natural products, Phytomedicine.

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INTRODUCTION

Breast cancer (BC) stands out as one of the most widespread cancers globally and continues to be a leading cause of cancer-related deaths among women worldwide, impacting the lives of millions [1, 2]. According to estimates, in 2021, approximately 2.1 million new cases of BC were expected to be diagnosed worldwide, with this number projected to exceed a quarter-million cases in the United States alone. Over the years, BC has consistently ranked among the most prevalent malignancies affecting women, both in terms of incidence and fatality rates. Notably, there has been a concerning increase in mortality rates among men, particularly in 2018, with rates reaching 9.09% in men compared to 1.87% in women [3, 4]. This comprehensive analysis amalgamates current research findings, offering valuable insights into potential therapeutic interventions. By illuminating molecular pathways and exploring the diverse array of natural compounds and medicinal plants, this review aims to contribute to the evolving landscape of BC research.

REVIEW METHODOLOGY

The databases Science Direct, PubMed, Wiley, Scopus, and Springer were searched for relevant studies on breast cancer, medicinal plants, and bioactive compounds. “Medicinal plants”, “cancer”, “breast cancer”, “natural products”, “anticancer”, “bioactive compounds”, “symptoms”, “herbal”, and “treatment” are among the study's keywords. The flow of data across the review's various phases is shown in Fig. (**1**).

HISTOLOGICAL AND MOLECULAR CLASSIFICATION OF BREAST CANCER

Histological Classification

The morphological examination of BC necessitates an understanding of whether the tumor is confined within the epithelial component of the breast or has infiltrated the surrounding stroma and whether its origin is within the mammary ducts or lobes [5]. However, in the field of histopathology, the determination of whether a tumor is ductal or lobular, along with its sub-classifications, relies on various factors such as cell type characteristics, cell count, secretion type and location, immunohistochemical profile, and architectural characteristics rather than solely on its precise location in mammary tissue [6]. Approximately 50% to 80% of newly diagnosed BC cases are identified as invasive ductal carcinoma (IDC), while the remaining cases are categorized as invasive lobular carcinoma [7]. IDCs might be categorized as “no specific type” due to a lack of adequate morphological characteristics for definitive histological typing. Alternatively, they

can be designated as a "special type" if they exhibit distinct characteristics along with specific cellular and molecular behavior [7, 8]. The commonly observed special types of BC include medullary carcinoma, metaplastic carcinoma, apocrine carcinoma, mucinous carcinoma, cribriform carcinoma, tubular carcinoma, neuroendocrine carcinoma, classic lobular carcinoma, and pleomorphic lobular carcinoma [8].

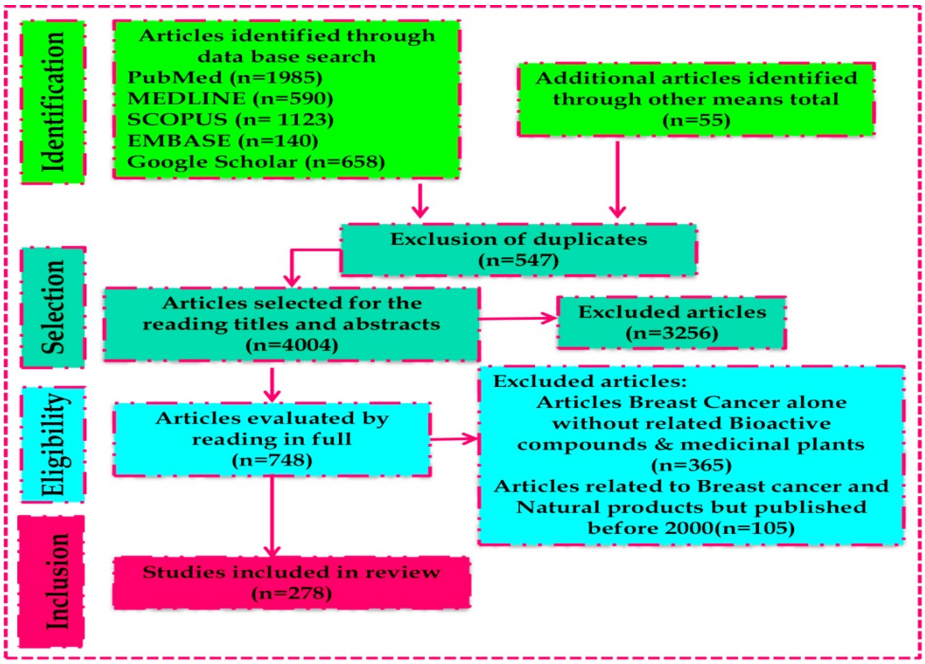

Fig. (1). The flow of data across the review's various phases.

Invasive Ductal Carcinoma

Invasive ductal carcinoma, no specific type (IDC-NST), is the most common histological subtype, accounting for about 40% to 75% of all invasive breast carcinomas. It typically displays a wide range of morphological variations and clinical behaviors [8]. Tumor cells show pleomorphism, with protruding nucleoli and numerous mitoses. More than half of the cases exhibit areas of necrosis and calcifications [6, 8].

Medullary Carcinoma

Medullary carcinoma is a distinctive subtype, responsible for approximately 5% of all cases, and associated with better clinical outcomes and lower rates of axillary lymph node involvement [9]. It often affects individuals between 30 and 40 years old and is sometimes linked to mutations in the BRCA1 germline (Breast

CHAPTER 8

Role of Medicinal Plants in the Sustainable Development Goals

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Abstract: Traditional knowledge about medicinal plants and their therapeutic values has been used to treat numerous diseases. SDG goal 3 focuses on the health and well-being of the people. Medicinal plants can contribute to SDG-3 by implementing their usage in our daily lives and by creating awareness about their therapeutic value. For thousands of years, the usage of herbal remedies has been intrinsically tied to the health of people, rendering traditional medical resources perhaps the first gifts from nature to promote wellness for humanity. The current chapter focuses on the therapeutic effects of medicinal plants and how they contribute to the SDG by treating numerous chronic ailments, which restores the health and well-being of every individual.

Keywords: Medicinal plants, SDGs, Therapeutic, Traditional medicines.

INTRODUCTION

The 17 goals and 169 indicators that make up the UN Sustainable Development Goals (SDG) are supposed to be accomplished by 2030. The United Nations' Agenda 2030 calls for an all-encompassing strategy that prioritises humanity and the environment to accomplish these objectives [1]. A distinctive fully integrated strategy adhering to the targets of the Sustainable Development Goals stresses environmental issues and social welfare and wellness *via* multifaceted benchmarks to address the growing need for healthcare that is value-driven. Medicinal plants are anticipated to contribute substantially to SDG 3 due to their firmly rooted use and scientific study in India. The SDG3 goal focuses on good health and well-being [2].

Each plant that has compounds in some or all of its parts that have medical value or that serve as building blocks for the creation of effective medications is considered therapeutically valuable. With the help of this statement, it will be

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V. V. Sathibabu Uddandrao & G. Saravanan (Eds.)

easy to discern species that are considered healing plants albeit have yet to undergo extensive scientific investigation, and their therapeutic qualities and ingredients are currently being shown by science [3].

Every community on the planet frequently employs traditional therapies. The entirety of life's wisdom, morals, and first-hand encounters are gathered through traditional methods. A variety of illnesses are treated with traditional medicines. The use of plants from nature as medicine dates back far before the prehistoric era. Research suggests that Mediterranean societies, Indian Hakims, and vaids have been constantly utilising herbs as medicine for almost 4,000 years, in accordance with the National Health Portal (2020) [4].

For almost a millennium, several kinds of plants have been utilised as a means of creating medicinal compounds, and the majority of medications currently in use are naturally derived from plants. The path for future medication formation based on plants and natural goods has been cleared by reports of documented drafts dated 2600 BC regarding the medical benefits of plant-based remedies and the medicinal plant archives of the ancient Mesopotamia era. The most preserved record, “Ebers Papyrus”, which dates back to 2900 BC and is based on Egyptian traditional medicine, contains 700 plant medications. The history of the Indian Ayurvedic system and traditional Chinese medicine spans several millennia, beginning around the first millennium BC. It is rather amazing how many different kinds of medicinal plants are found all over the world [5].

Many significant wild healing plants and aromatic herbs are consumed by a large percentage of people for therapeutic purposes. The shortage of improved healthcare policies in developing Asian and African nations that guarantee a healthy existence and promote well-being for all individuals of all generations (SDG 3) supports the significance of ethnomedicinal plants. The increasing rate of reliance on plant-based medications, particularly in recent decades, indicates that the market for these products will keep expanding in the centuries to come, potentially placing challenges on the supply of plants for medicinal use. The development of plant-based medications requires to be accelerated *via* sources from native groups in cooperation with professionals from many disciplines, considering the increasing prevalence of disease and related problems like population expansion and climate change. In addition to improving nourishment and eradicating hunger, SDG 2 aims to establish efficient systems for producing sustainable food or farming by putting robust agricultural practices into place that boost productivity while preserving the well-being of communities. People have learned a great deal about the different facets of agriculture and crops *via* their close relationships with flora and pursuits associated with agricultural operations [1]. Biologically active chemicals are abundant in the seeds, leaves,

flowers, fruits, stems, and roots of plants used for medicinal purposes. It is vital to think about bioactive substances as supplementary nutrition [6].

TRADITIONAL MEDICINAL PLANTS

In the Ladakh region, people practice the Tibetian medicinal system with medicinal plants. *Thermopsisbarbata, Rheumemodi, Clematis tibetana, Juniperus indica, Rhodiolatibetica*, and *Angelica glauca* are a few of the well-known ones [7].

The earliest and simplest method of utilising the medicinal qualities of nature is through medicinal plants or medications that only consist of vegetable material. The World Health Organisation (WHO) states that having access to primary medical services for every individual worldwide relies on the use of ancient and herbal remedies that are high-quality, safe, and effective. While there is growing scientific proof concerning herbal treatments, there is still a long way to go before herbal medications are widely used as the major natural health providers. Although the health benefits of plant bioactive substances are widely acknowledged, there are still significant gaps in our grasp of the presence, prevalence, and prospective applications of these molecules as therapeutic resources. Nearly 70% of all recognised natural goods originate from plants and their endophytes, like well-known pharmaceuticals like paclitaxel, a chemotherapy compound derived from yew, the anti-malarial medication artemisinin from sweet wormwood, which won the Nobel Prize, and morphine, which is extracted from opium poppy vegetation. Yet, only 6% of the roughly 374,000 varieties of plants that people are currently cognizant of were recently examined phytochemically [8].

Overuse of natural resources for medicinal purposes can lead to threats, which may include farming expansion that reduces the number of species of therapeutic plants; on the other hand, threats arising from oral knowledge transmission, confidentiality, and the hesitation of younger individuals to acquire knowledge may diminish the understanding of therapeutic plants. To protect and maintain traditional knowledge and therapeutic plants, especially those that are regularly exploited for their roots, awareness-raising efforts must be supported. The public should be involved in the governance, protection, and restoration of locally available plant resources that are employed in medicine as well as related knowledge. It ought to be made easier to cultivate plants with several uses. It is important to promote the creation of grassroots organisations in ecological areas of focus to preserve forests and, in particular, their medicinal flora treasures [9].

CHAPTER 9

Therapeutic Potential of Cardioprotective Fruits: An Ayurvedic Perspective

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Abstract: Plants have always been exploited for medicinal purposes since time immemorial. Even animals have an instinct to use selective plant parts for cure. Highly evolved and intellectual Homo sapiens have explored and taken the knowledge of the plant kingdom to a new dimension in the field of therapeutics for prevention and cure. Even though therapeutic plants have been extensively studied, humans have not used them appropriately. This is because of advancements in the field of drug development synthetically. Terminally sick candidates have been seen to benefitfrom this development. However, this has led to serious and adverse drug reactions in vital organs. Drugs such as doxorubicin are popularly used in cancer, but there is compelling documented evidence of its cardiotoxicity. Authors from classical Ayurvedic texts have given an exhaustive list of therapeutic plants that counter this toxicity. Exploring the concept of Ayurvedic pharmacology, along with the knowledge of Aushadhi Dravya (AD) as cardioprotective therapeutic plants, especially their fruits, will be the focus of this chapter. Furthermore, a review of their innate properties from an Ayurveda perspective and their inclusion in polyherbal formulation, along with some functional food recipes, will be the objective of this chapter.

Keywords: Cardiotoxicity, Cardioprotective, Drug development.

INTRODUCTION

'Every vegetation on earth is a potential healer', is a strong statement from Vedas. If used appropriately, it can save one's life and vice versa otherwise. Right from the era of Rigveda, medicinal plants have always been exploited as therapeutic reservoirs for the prevention and cure of disease, wellness, and longevity. In spite of such compelling evidence, appropriate use of medicinal plants has not been properly established. This is because scientists evaluate the plant's therapeutic potential conventionally *in vitro* or *in vivo* but lack the knowledge to correlate the

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V. V. Sathibabu Uddandrao & G. Saravanan (Eds.)

latent nature innate in them, along with pathological events in humans per se. At the same time, traditional healthcare providers have the expertise to interpret ancient knowledge through herbal remedies, prevent untoward pathological events, and achieve wellness and longevity, but they lack the ability to convince the scientific community with statistical evidence. There is a barrier in broadly accepting their sciences since one is proof of its time-tested existence, whereas the other validates it analytically. Hence, it causes a communication gap between the two sciences in knowledge sharing as their concepts are explained in different languages.

Man has adopted many unhealthy habits to survive and, at the same time, constantly struggles to upgrade his living. This has led him to many lifestyle-related metabolic disorders. Cardiovascular diseases (CVD) and cancer are the most prevalent diseases that target vital organs [1].

Nearly 31% of all global deaths are caused by CVD, accounting for 17.9 million, making the highest death score worldwide in 2016. Whereas cancer is next in line with 10 million deaths in 2020, predominantly 2.26 million deaths from breast cancer and 2.21 deaths from lung cancer [2].

Significant advancement in the field of medicine has certainly reduced their mortality rate, but their chronic and acute toxic side effects have given the entire medical fraternity a great challenge to overcome their complications. Agents such as anthracycline, antiandrogen, antiestrogen, antiangiogenic antibodies, and many more are certainly saviors during acute conditions, but their chronic and acute toxic effects on vital organs have led to serious complications and adverse events [3]. This has led the majority of the population to opt for herbal remedies. Hence, there is a global radical shift of medicine from synthetic chemical drugs to remedies of natural origin. Be it as a single isolated compound, a crude plant part, or a polyherbal formulation, the green revolution has made its way to developing and developed countries for the sake of good health.

According to the World Health Organization, 60% of the world's population relies on herbal medicine, and about 80% of the population in developing countries depends almost totally on it for their primary healthcare needs. Recent statistics show that half of the global population is dependent on it, including the USA 42%, Australia 48%, Canada 70%, and France 49% [4].

Ayurveda, an ancient reservoir of knowledge aiming at wellness and longevity, expounds on remedies right from a single herb to polyherbal formula. There is an exhaustive list of herbs as potential therapeutic agents documented in Sanskrit. The authors of classical texts of Ayurveda have provided details for mankind from various stages of life, be it from any environmental set-up. They have shared

knowledge of nutritional and herbal strategies to counter intrinsic pathological events and protect the ailing organ.

Drugs, such as doxorubicin (DOX; Adriamycin), are effective anticancer agents used to treat several forms of solid tumors, leukemia, and lymphomas. The main limiting consequence is acute and chronic toxicity. This drug is reported to have acute cardiotoxicity, manifested as arrhythmias, and chronic toxicity as irreparable cardiomyopathy, affecting around 30-40% of individuals receiving DOX. It is a toxin to all biological components, including the kidney, heart, and liver, as well as myocardial tissue, leading to acute cardiac failure, thus limiting its effectiveness [5].

There are many plant parts that have been shown to be highly effective in reducing cardiotoxicity. Be it an isolated bioactive compound as phytochemicals from plants or the use of plant parts per se, their commitment to mankind as cardioprotective (CP) is certain [6]. Whether in the form of bark, roots, leaves, flowers, or fruits, their unique combinations have the potential to counter any pathological condition [7]. Caraka Samhita, one of the oldest Ayurvedic texts, has provided a huge list of single herbs that protect the target organs such as the heart, kidney, liver, *etc* [8].

Comprehending and translating the age-old concept to the scientific world would certainly benefit mankind. Testimonials on the immense therapeutic potential of CP fruits (CPF) from the ancient texts of Ayurveda have inspired the making of this chapter. This chapter will focus mainly on medicinal fruits that are not only conducive to the heart but counter the toxic drug effects on it, too. This chapter will primarily clarify the concept of Ayurvedic pharmacology, followed by listing and explaining the CP nature of selective fruits, along with various therapeutic formulations and functional food recipes.

CONCEPT OF AYURVEDIC PHARMACOLOGY (*DRAVYA GUNA KARMA*)

The basic fundamental unit of the Universe is *Panchamahabhuta*. Whether animal kingdom or plant kingdom, all are combinations of these five elements in different proportions, working as *Vatta, Pitta*, and *Kapha* as *Doshas*. Hence, every medicinal plant is a combination of these elements and units. Whether it is an herb, shrub, or tree, or their parts such as leaves, roots, stem, latex, fruits, and flowers, all are commonly termed as *Dravya*, the physical form or substrate that holds all the innate qualities to function [9]. The term ‘drug’ involves synthetic chemicals, whereas ‘*Aushadhi Dravya’* (AD) is the term used for medicines of natural origin, such as therapeutic plants.

CHAPTER 10

Innovative Drug Delivery Systems in Cardiovascular Therapeutics

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Abstract: This chapter comprehensively explores the application of nanoparticles (NPs) in treating cardiovascular diseases (CVDs). It discusses various types of NPs, including organic and inorganic, and their specific roles in addressing different CVDs. Further, it explores the mechanisms and advantages of using NPs for targeted drug delivery, highlighting their potential in improving therapeutic outcomes and minimizing side effects. It also examines the challenges and future prospects in the field, including the need for further research on the structural design, targeting mechanisms, and safety of NPs. Additionally, the chapter considers the ethical and regulatory aspects of nanomedicine, emphasizing its significant potential in revolutionizing CVD treatment.

Keywords: Cardiovascular diseases, Drug delivery, Nanoparticles, Nanomedicine.

INTRODUCTION

Heart failure, arrhythmia, atherosclerosis, coronary heart disease, myocardial infarction (MI), peripheral arterial disease, deep vein thrombosis, inflammatory heart disease, and other cardiovascular diseases (CVDs) are leading global causes of mortality. Over 500 million individuals worldwide are still impacted by CVDs, resulting in 20.5 million fatalities in 2021.

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V. V. Sathibabu Uddandrao & G. Saravanan (Eds.)

This accounts for over one-third of all global deaths and is a significant rise from the anticipated 121 million deaths caused by CVD [1]. CVDs impact the heart or blood vessels and can result from a combination of socio-economic, metabolic, behavioral, and environmental risk factors. The factors contributing to this include hypertension, poor dietary habits, elevated levels of cholesterol, diabetes, air pollution, excessive body weight, tobacco consumption, renal dysfunction, lack of physical exercise, excessive alcohol consumption, and stress. Further, the report emphasized that hypertension, atmospheric pollution, tobacco consumption, and increased levels of LDL cholesterol were the primary factors contributing to fatalities caused by CVDs. In general, the important discovery is that risk factors differ among countries, underlining the importance for countries to understand their specific risk profile. The study also discovered a correlation between a country's healthcare expenditure as a percentage of its gross domestic product (GDP) and its CVD death rates [2].

Treatment options for CVDs are chosen according to the patient's risk classification and the severity of their condition. The primary objective of all treatment protocols for CVDs is to enhance blood circulation and reduce tissue damage in order to minimize the loss of cardiomyocytes and increase the contractile area. Surgery is the typical treatment for severe cases of CVD. It involves removing blood clots, implanting mechanical cardiac pacemakers to address arrhythmia, and repairing any abnormal organic cardiac alterations. Unsurprisingly, adhering to a consistent drug regimen is rather challenging; in the majority of cases, the treatment will need to be continued indefinitely [3]

To effectively treat these disorders, it is necessary to use an alternative and efficient method that involves directly administering cardioprotective medications to the cardiovascular system. The necessity to transport these medications to specified targets has resulted in the advancement of various techniques for targeted drug delivery [4]. Strategies for averting CVDs have been advocated in conjunction with a wholesome way of life, encompassing abstaining from smoking, adhering to a nutritious diet, engaging in regular physical activity, shedding excess weight, participating in aerobic exercise training, managing blood pressure, and reducing blood lipids [5]. Nevertheless, numerous treatment approaches and medications currently in use rely on the use of artificial substances. This illness has the potential to cause several instances of detrimental impacts on the body. These subjects prompt researchers to concentrate on safer and more promising therapy approaches.

Nanotechnology is an interdisciplinary research domain that encompasses the fields of electronics, biology, and medicine. Nanomedicine, also known as nano-biotechnology, has been widely recognized as a highly dynamic and rapidly

advancing field within nanotechnology, garnering global interest in recent decades. Nanoparticle-based drug delivery systems (DDSs), also known as nano-DDSs, rely on the characteristics and manufacturing techniques of distinct nanomaterials to create and develop optimal nanocarriers with diverse forms, sizes, topologies, and transport capabilities. Nanoparticles (NPs) use the higher permeability and retention effect to accurately transport medications to atherosclerotic plaques, leading to improved therapeutic outcomes and reduced tissue harm [6].

Nano-DDSs have significant potential for enhancing therapeutic effectiveness, extending drug duration, boosting drug absorption, targeting passively or actively, mitigating drug resistance, and minimizing adverse drug reactions. Nanobiotechnology has advanced to the point that it can now be used to treat CVDs. Nanoparticles have demonstrated their efficacy and dependability as a platform for the precise and targeted administration of medications to treat lipid abnormalities, thrombosis, inflammation, and angiogenesis in atherosclerotic plaques. This chapter provides a comprehensive overview of the various nanoparticle-based medication carriers currently utilized for the treatment of CVDs.

NANOTECHNOLOGY IN CARDIOVASCULAR DRUG DELIVERY

NPs are structures, either organic or inorganic, that typically have a size of less than 100 nm in at least one dimension [7]. Organic NPs are composed of various materials that can be broken down naturally, such as lipids, liposomes, micelles, proteins, dendrimers, polymeric vesicles, or hyaluronic acid. Inorganic NPs, on the other hand, are made up of tiny structures like quantum dots, mesoporous silicon, graphene, carbon nanotubes, metals, or metal oxides [8]. Metal-organic frameworks, sometimes referred to as porous coordination polymers, are crystalline polymers formed by the bonding of organic ligands with metal ions/metal clusters through coordinate bonds. These polymers exhibit a high degree of porosity. The surfaces of metal-organic framework nanomaterials are completely covered with polyethylene glycol, resulting in a reduction in clearance by the immune system [9]. It is shown in Fig. (**1**).

The attributes of NPs, such as their size and form, interconnected macropores, adjustable porosity, chemical composition, and simple surface modification, have garnered worldwide interest in drug delivery studies in recent years, as displayed in Fig. (**2**). The integration of cellular carriers and nano-drug delivery technology is gaining significant attention due to its utilization of the inherent properties of circulating cells to overcome the immunogenicity associated with nanoparticles [10]. Furthermore, these biomimetic NPs have shown to be more effective in

CHAPTER 11

Barleria longiflora L.F. - A Promising Source for Therapeutics

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Abstract: *Barleria longiflora* L.F. is one of the significant plants in the Acanthaceae family. Various species, such as *B. cristata*, *B. obtusa*, *B. prionitis*, and others, have been traditionally utilised for a broad range of ethnomedical purposes and possess a diverse array of medicinal characteristics. *B. longifolia* L.F. is a shrub with a maximum height of two metres. The stem is hispid, erect, and bluntly quadrangular. It is prevalent throughout Tamil Nadu's marshes, wetlands, and tank margins. A decoction of the roots of *B. longiflora* L.F. is used to treat kidney stones and dropsy (Ganthi *et al*., 2018), while its seeds are beneficial for sexual illnesses and seminal debility. In Indian medicine, the roots and leaves have been used as diuretics and to treat rheumatism, dropsy, jaundice, and anasarca. However, due to the lack of pharmacological information, this chapter provides detailed information on the plant *Barleria longiflora* L. F., including its pharmacognostical, preliminary phytochemical, and antibacterial properties. This chapter provides insightful data that will aid in accurately identifying this plant for future use as a reference.

Keywords: Antibacterial properties, *Barleria longiflora*, Pharmacognostical properties, Preliminary phytochemical properties.

INTRODUCTION

Many indigenous tribes have a long history of using medicinal plants as helpful tools for treating a variety of illnesses. The principles and practices of traditional medicine trace back hundreds of years, predating the creation and dissemination of contemporary medicine. Herbal medicines are very popular these days. The main reason for this interest is the perception that herbal remedies are risk-free, affordable, and non-adverse. Due to an increase in people looking for cures and health approaches, medicinal plants are more widely used. It is estimated that

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V. V. Sathibabu Uddandrao & G. Saravanan (Eds.)

80% of people on the planet practice traditional medicine. As of right now, 170 out of the 194 WHO Member States have reported using traditional medicine, and their governments have requested assistance from WHO in compiling trustworthy data and evidence on traditional medicine procedures and supplies. According to WHO Director-General Dr. Tedros Adhanom Ghebreyesus, "Traditional medicine is the first port of call for hundreds of millions of people across the globe in order to treat various diseases." Nonetheless, a significant barrier that has impeded the adoption of alternative medications in affluent nations is the absence of proper documentation and strict quality control. Records of studies conducted on traditional remedies are required. Against this background, it becomes imperative to work towards standardising the plant material that is to be employed in medicinal applications. Stepwise phytochemical and pharmacognostic research can be used to accomplish the standardisation procedure. The plant material is identified and standardised with the aid of this research. Proper identification and quality control of the raw materials are crucial preconditions for guaranteeing herbal medicine's consistent quality, which will enhance its safety and effectiveness. Keep in mind that in this chapter, we will learn about *Barleria longiflora* L.F., one of the significant plants in the Acanthaceae family. Plants in the genus *Barleria* belong to the Acanthaceae family. Various species, such as *B. cristata*, *B. obtusa*, *B. prionitis*, and others, have been traditionally utilised for a broad range of ethnomedical purposes and possess a diverse array of medicinal characteristics [1 - 3].

Strong, upright plants, *Barleria longiflora* L.F., can be annual or perennial. Their stems are subquadrangular, pinkish, and heavily hairy below the nodes. Six axillary spines at each node, six sessile leaves in whorls of six to eight, the outer pair bigger, lanceolate, and lineolate, with many stiff hairs on the lamina and tiny hairs on the border; the spines can be straight or curved. At each node, there are four to eight axillary whorls of flowers encircled by slightly recurved spines; the bracts are lanceolate, spathulate, and leafy, with long, stiff hairs along the papery white margins and a purple-green part along the centre; the bracteoles are linear-lanceolate [4, 5]. *Barleria longiflora* L.F. is beneficial for rheumatism, dropsy, jaundice, and urinogenital tract diseases. In Indian medicine, the stems, roots, leaves, and seeds have been used as diuretics and to treat rheumatism, anasarca, dropsy, and jaundice [6]. Many traditional books recommend using a variety of herbs to treat inflammatory illnesses. One such plant used in Ayurveda that is highly regarded for its adaptability in treating a variety of ailments, including inflammation, is *Barleria*. Approximately 300 species make up the genus Barleria, of which 32 are known to occur in India. Notable medicinal species include *B. buxifolia* Linn., *B. courtallica* Nees., *B. cristata* Linn., *B. longifolia* Linn., *B. prionitis* Linn., *B. lupulina* Lindl., and *B. strigosa* Willd. The well-known traditional applications of Barleria include the whole plant for a number of

illnesses, such as catarrh in children, which is accompanied by fever and copious amounts of mucus; leaves for toothaches; roots for boils and glandular swellings; bark for coughing and anasarca. Strong anti-inflammatory, analgesic, antileukemic, anticancer, antihyperglycemic, anti-amoebic, virucidal, and antibiotic properties were reported in the biological literature for *Barleria* species [7].

B. longifolia L.F. is a shrub with a maximum height of two metres; the stem is hispid, erect, and bluntly quadrangular. It is prevalent throughout Tamil Nadu's marshes, wetlands, and tank margins. A decoction of the roots of *B. longiflora* L.F. is used to treat kidney stones and dropsy [8], and its seeds are beneficial for sexual illnesses and seminal debility. In Indian medicine, the roots and leaves have been used as diuretics and to treat rheumatism, dropsy, jaundice, and anasarca. Since the pharmacognosy of *B. longiflora* L.F. has not yet been thoroughly investigated, the current chapter will detail the physicochemical, phytochemical, and pharmacognostic properties of the plant.

MORPHOLOGICAL STUDIES

The *B. longiflora* leaf is pale green in colour, glabrous, small petiolate, opposite, with an ovate, deltoid, acute, tightly gently grey-tomentose edge that is whole and covered in reticulate venation, measuring up to 1.75 cm in width. The stem is long and cylindrical, with a diameter of 1-4 mm, branched, green in colour, glabrous, and has opposing leaves at nodes. When the stem is young, it is herbaceous, but as it ages, it becomes woody (Fig. **1**).

Fig. (1). Macroscopic characteristics of *Barleria longiflora*

Bracts are leafy, lanceolate, spathulate, 1.5-2.5 cm long, 4-6 mm wide, with long stiff hairs along papery white margins, purplish green along the central portion;

CHAPTER 12

Exploration of Metabolomics of Plants for Drug Design Using *In Silico* Studies

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Abstract: Computational tools are a boon for pharmaceutical industries and researchers to design and develop novel drugs against the constantly emerging drug-resistant strains. Drugs are created by manipulating molecules and representing them in three-dimensional structures. The designed molecules and their related physicochemical properties are called molecular docking. Various computational strategies are formulated to predict biological and chemical properties based on chemistry and an analytical basis. Molecular docking is a promising aid for drug design and a rapid task setter that promotes identifying a valuable position in the modern scenario of structure-based drug design. The current era has developed a platform for investigating target molecules' 3D structures and virtual screening between receptor and molecule. Docking score analysis is done using computer-based drug design tools. Docking score is a structural-based virtual screening method that positions a target molecule's structure. This improves the visualization of the orientation and conformation and refines the complexities associated with the lead molecule and biological pathway estimation, aiming to achieve the highest level of predictive accuracy. Ligand and protein docking deals with sampling algorithms, scoring functions, and the availability of diverse software.

Keywords: Conformational sampling, Computer-aided drug design, Drug discovery, Molecular docking, Scoring functions, Virtual screening.

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INTRODUCTION

Molecular docking is a technique that anticipates suitable positioning between ligand, test molecule, receptor, and cell wall target location. This technique facilitates obtaining the favored binding orientation between ligand and receptor protein and estimating their strength with the help of scoring functions. The drug-receptor affinity predicts the efficacy of a drug. Therefore, *in silico* chemical docking plays a vital role in modern drug discovery. Ligand receptor protein must form a stable complex to provide encouraging outcomes against pathogens cells or pathogens. To achieve conformation optimization, molecular docking is utilized to identify the effective molecules and computationally simulate the molecules. Therefore, the free energy of the overall system can be minimized [1]. It is important to understand the difficulties and hurdles in constructing a valuable drug by identifying active compounds with minimal toxicity, maximum compatibility using the host cell, and bioavailability in terms of cost and innovation to release onto the market [2].

Initially, the key role of disease progression must be targeted for the synthesis of new active principles to be identified, which can terminate the advancement of the illness. The discovery of compounds that demonstrate their effectiveness in a straightforward *in vitro* screening is the first step in this phenomenon known as “hits”. The technique of screening involves examining a large number of chemicals for biological activity in high throughput screening (HTS) assays from natural products and internet databases. Enormous molecular libraries capable of performing millions or thousands of assays enable academics and small pharmaceutical businesses to continue the drug development process at the expense of larger industries. Next, to improve the pharmaceutical properties of the selected “hits”, compounds are chemically modified; such compounds are often called “leads”.

Even though the journey to drug design is a huge, challenging, laborious task, there is an urgent to treat multi-drug resistant strain variants. According to research conducted by the same organization in 2003, the average cost of creating a new medicine from scratch was expected to be $2.5 billion in 2014. This signifies a 145% increase from the previous study [3].

IN-SILICO AIDED DRUG DISCOVERY

1. Computer-Aided Drug Discovery (CADD) is the process of designing, finding, and improving drugs and related physiologically active molecules through the use of computer-based chemistry techniques.

2. This method is an important way to share biological and chemical knowledge regarding ligands and/or targets in order to find and improve new medications.

3. *In silico* filters are designed to reduce the amount of chemical compounds with undesirable characteristics and choose the most promising molecules for the target sites.

4. CADD is being used to identify hits (drug candidates), new drug target sites, and their retrieval *via* target protein structure databases, such as the Protein Databank (PDB) www.pdb.org.

5. Virtual effect on the confirmation between leads and target sites helps to find out unique drug compounds from various active principles and chemical scaffolds by exploring databases [4, 5] (Fig. **1** & Table **1**).

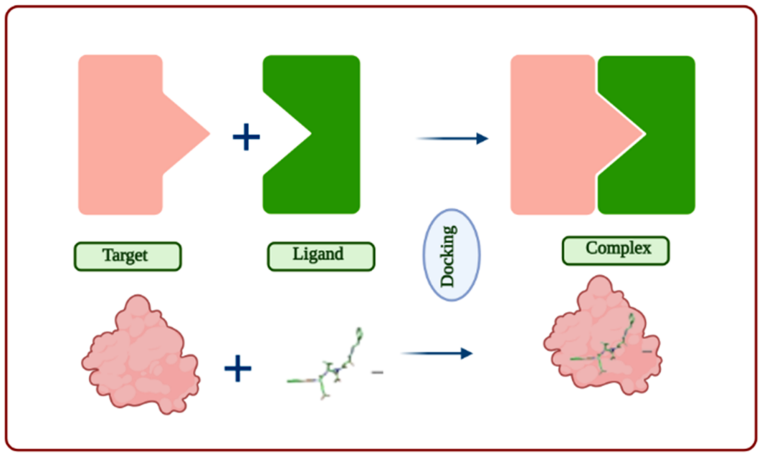

Fig. (1). Basic mechanism of *in silico* aided drug delivery.

Types of Interactions

Interaction forces are classified into four classes:

1. Dipole-dipole, charge-dipole, and charge-charge electrostatic forces.
2. Van der Waals interaction and electrodynamic forces.
3. Steric forces: Entropy is the cause.
4. Hydrogen bonds and hydrophobic interactions are forces associated with solvents [6, 7].

Algorithm in Docking

The optimum number of configurations should be acknowledged by the trial method to determine binding modes using search algorithms. Various algorithms

CHAPTER 13

Identification of Phytochemical Compounds from *Lawsonia inermis* Leaves against Hbx Protein of Hepatitis B Virus: An In Silico Analysis

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Abstract: Plants have many medicinal properties, and they play a major role in drug discovery nowadays. Lawsonia inermis is commonly known as Henna and has numerous medicinal properties. Lawsonia inermis (Family: Lythraceae) contains carbohydrates, phenolics, flavonoids, saponins, proteins, alkaloids, terpenoids, quinones, coumarins, xanthones, fat, resin, and tannins. The pharmacological studies showed that Lawsonia inermis has antibacterial, antifungal, antiparasitic, antioxidant, hepatoprotective, central nervous, analgesic, anti-inflammatory, antipyretic, wound and burn healing, immunomodulatory, antiurolithiatic, antidiabetic, hypolipidemic, antiulcer, antidiarrhoeal, diuretic, anticancer, and many other pharmacological effects. *In silico* studies play a major role in the drug designing process, and they make the process of drug designing easier, more cost-effective, and less time consuming than *in vivo* and *in vitro* processes. In the last century, the emergence of *in silico* tools has improved the quality of healthcare studies by providing high-quality predictions. These methods have also helped medical biotechnologists design various vaccines, such as multi-epitope vaccines using reverse vaccinology and immunoinformatics methods, among which some have shown promising results through *in vitro* , *in vivo*, and clinical trial studies. Hepatitis is a worldwide disease caused by HBV, HBC virus, *etc*. By finding protein-ligand interactions using software like AutoDock graphically, accurate results for the binding sites can be obtained. Drug likeliness and ADMET properties decide the nature of the leaves in their efficiency for the production of drugs. This study will give a detailed report on the *in silico* analysis of Lawsonia inermis leaves against the Hepatitis virus.

Keywords: AutoDock, ADMET property, Drug likeliness, Hepatitis B virus, *In silico*, Lawsonia inermis.

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INTRODUCTION

Plants are the main source of many modern medicines [1]. Plants synthesize hundreds of chemical compounds for various functions, including defense against insects, fungi, and herbivorous mammals [2]. Numerous phytochemicals with potential or established biological activity have been identified. However, since a single plant contains widely diverse phytochemicals, the effects of using a whole plant as medicine are uncertain. Further, the phytochemical content and pharmacological actions of plants having medicinal potential remain unassessed by rigorous scientific research to define efficacy and safety [3].

Medicinal plants are also known as medicinal herbs. Since prehistoric times, plants have been discovered and used in traditional medical practices for the treatment of diseases. Drug research makes use of ethnobotany to search for pharmacologically active substances in nature, and in this way, hundreds of useful compounds have been discovered. Approximately one-quarter of prescribed drugs contain plant extracts or active ingredients obtained from or modeled on plant substances [1]. These include common drugs like digoxin, quinine, and opium. The compounds found in plants are of many kinds, but most of them fall under four major biochemical classes: alkaloids, glycosides, polyphenols, and terpenes [2].

Since the dawn of civilization, medicinal plants have been part and parcel of human societies to combat diseases [4]. There exists a plethora of knowledge, information, and benefits of herbal drugs in our ancient literature on Ayurvedic (Traditional Indian Medicine), Siddha, Unani, and Chinese medicine. According to the World Health Organization (2003), about 80% of the population of developing countries are unable to afford pharmaceutical drugs and rely on traditional medicines, mainly plant-based, to sustain their primary healthcare needs [5]. Herbal medicines are in great demand in developed as well as developing countries for primary healthcare because of their wide biological and medicinal activities, higher safety margins, and lower costs [6].

Plant Profile

Lawsonia inermis Linn, which is commonly known as henna, is mainly present in subtropical and tropical areas and is used all over the world. It is a small tree that is 2–6 m tall. Leaves are opposite, entire, elliptic-to-broadly lanceolate, 1.5–5 cm × 0.5–2 cm, and acuminate. Flowers are numerous, large, pyramidal, calyx with a 2 mm long tube, and 8 stamens inserted in pairs. Fruits are globose capsules with 4–8 in diameter [7].

Henna is a medicinal plant that has been used in traditional medicine as a sedative, astringent, and hypotensive and to treat leprosy, jaundice, and headaches. Leaves were also used to treat spermatorrhea, smallpox, and skin and venereal problems. Powered seeds proved beneficial in treating liver problems and diarrhea. The bark was used for a number of ailments, including skin diseases, calculus, spleen enlargement, burns, and jaundice. Root was used as an abortifacient, as a strong medication for gonorrhea, herpes infections, and painful eyes, and for the treatment of many neurological disorders [8].

Hepatitis

The liver is an important organ that plays many important roles in our body, such as maintenance, performance, and regulating homeostasis of our body. Maintaining a healthy lifestyle is good for individuals' well-being [9]. There are less number of drugs in modern days despite having many advanced technologies that help to protect the liver from damage [10]. Therefore, this leads to the necessity of searching for new drugs to treat liver diseases as replacements for the current drugs. Our plant kingdom has so many valuable medicinal agents that help in drug discovery. Approximately 25% of the medicinal products are derived from plant sources. A variety of chemical constituents such as phenols, coumarins, lignans, essential oil, monoterpenes, carotenoids, glycosides, flavonoids, organic acids, lipids, alkaloids, and xanthenes are present in hepatoprotective plants [11]. However, among numerous plant materials used for liver protection, many of them lack the scientific properties to prove their claims [12].

Computer-Aided Drug Designing

A huge investment in time and money is needed for the production of drugs in the market. In the last decade, the cost of drug production has increased by 150%, and more than 2 billion dollars are needed for the development of a drug in the competitive market, as estimated by the Tufts Center for the Study of Drug Development [13]. Due to lack of efficacy or adverse side effects, even though huge amounts, like more than 3/4 of the funds, are utilized, drugs failto pass through the clinical trials, and the failure rate has also increased to almost 90%. Commercialization of a drug to the market takes more than 10 – 15 years, which is now made easier by innovations in combinatorial chemistry [14].

The majority of researchers and pharmaceutical corporations have shifted to using computer-aided drug discovery (CADD) techniques as an alternate approach to drug development, thus reducing failure rate and costs. CADD techniques aid in the various stages of drug discovery and development. With this technology, thousands of compounds may be immediately screened, and effective candidates can be chosen based on how well they match the target proteins. In cases where

CHAPTER 14

The Application of Medicinal Plants in Traditional and Modern Medicine: A Review of *Terminalia chebula*

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Abstract: The advancement of human civilization has been greatly influenced by the use of medicinal plants. These plants have served as valuable resources for traditional remedies, and indirectly, many modern medicines have been derived from them. According to the World Health Organization (WHO), herbal medicines meet the healthcare needs of approximately 80 percent of the global population, especially those living in rural areas of developing nations. In developed countries, there is a growing disillusionment with conventional healthcare, leading individuals to actively seek alternative options. The significance of medicinal plants in human culture cannot be overstated. They have been used for centuries as sources of traditional medicine, and even today, many modern medicines are derived from them. This review highlights the crucial role that both traditional and modern medicines play in treating and managing various human illnesses and the antioxidant, anti-microbial, anti-inflammatory, hypolipidemic, and hypoglycemic potential of medicinal plants. These properties are believed to contribute to their potential effectiveness against cancer, liver damage, cardiovascular diseases, and diabetes. Furthermore, these plants exhibit pharmacological activities, such as anti-ulcer and wound healing abilities.

Keywords: Bioactive compounds, Medicinal plants, Modern medicine, *Terminalia chebula*, Traditional medicine.

INTRODUCTION

The healthcare system in resource-limited communities heavily depends on traditional medicine, which has been proven to be the most economical and easily accessible form of treatment. The local communities have a long-standing tradition of utilizing traditional plants for their medicinal properties, thus deeply ingraining the practice of using plants for medicinal purposes in their culture. In

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V. V. Sathibabu Uddandrao & G. Saravanan (Eds.)

the past few years, the increasing number of elderly individuals and unfavorable changes in lifestyle have significantly affected the field of nutrition. As a result, new and inventive ideas and preventive measures have emerged, highlighting the significance of maintaining a balanced diet. The advancement of the 21st century brought about a transition from balanced nutrition to optimal nutrition, leading scientists to create innovative foods and ingredients that enhance human health. Notably, medicinal plants have emerged as a promising source of rich phytochemistry [1]. Medicinal plants have long been a fundamental component of traditional medicine systems, particularly in Chinese and Ayurvedic practices. While they have been widely recognized and extensively utilized in regions such as South Asia, South Africa, and South America for their effectiveness and affordability, it is crucial to acknowledge that their excessive and improper usage can pose serious risks to human health, potentially leading to fatal consequences [2]. In 2012, the worldwide export of various plants possessing remarkable medicinal qualities amounted to around 2.2 billion USD. Subsequently, in 2017, the global market for herbal medicines witnessed investments worth several hundred billion dollars. Researchers worldwide have conducted studies to determine the safe dosages of these plants due to the deficient scientific and evidence-based knowledge surrounding them. *Terminalia chebula*, a medicinal plant belonging to the Combretaceae family, is widely found in India, Burma, and Sri Lanka.

TAXONOMIC CLASSIFICATION

- Kingdom: Plantae
- Phylum: Tracheophyta
- Class: Magnoliopsida
- Order: Myrtales
- Family: Combretaceae
- Genus: Terminalia
- Species: *Terminalia chebula*

MORPHOLOGICAL CHARACTERISTICS

Taste

There are seven distinct taste profiles, excluding salt. The outer skin offers a pungent taste, the ridge provides a sour taste, the seed has an astringent taste, the stem offers a bitter taste, and the endosperm presents a sweet taste.

Tree

It is covered with woody scales and has a relatively short, cylindrical trunk measuring 5m in length and 60-80cm in diameter. The tree's crown is rounded and its branches spread out.

Leaves

The leaves can be arranged alternately or opposite each other. They are thin, leathery, and have an oval or elliptical shape. They measure about 7-12cm in length and 4-6.5cm in width. The base of the leaves is rounded, while the tip is either obtuse or slightly pointed. The underside of the leaves is covered in fine hairs, and the leaf stalk can reach up to 2cm in length.

Flower

The flowers are very small, measuring 2mm in length, and have three bracts that are almost hairless. The calyx is triangular in shape, and there are ten stamens that are 3-4mm long. The ovary is smooth and oval-shaped, measuring 1mm in length, and the style is also smooth and measures 2.5-3.0mm in length.

Fresh fruit

The fruit is smooth, shiny, and shaped like an ellipse or a broad oval. It has a slightly angular and shallowly grooved surface. The color of the fruit is greenish-yellow. It is about 25 mm wide or even smaller.

Dry fruit

The dry fruit's surface is a bit wrinkled and has five slightly thick but clearly visible ridges running lengthwise. These ridges are about 2–3 mm wide and 2 mm thick.

Seed

The seed of the rough ellipsoid is generally 2–6 cm long and pale yellow in color. It has ridges and is globose in shape [3].

CHEMICAL CONSTITUENTS

The hydrolyzable tannins present in *Terminalia chebula*, which can range from 20-50% and vary depending on the geological location, are responsible for its pharmacological activities. In addition to these tannins, showed a rich proximate composition (Table **2**) and other compounds such as flavonol glycosides, tri-terpenoids, coumarin-conjugated compounds with gallic acid (known as

CHAPTER 15

Phyto-Assisted Synthesis of Silver Nanoparticles for Effectively Combating Toxin-Producing Fungi in Poultry Feed

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Abstract: The present study aimed to investigate *Carica papaya*-mediated silver nanoparticle synthesis and its role in mitigating aflatoxigenic fungi isolated from poultry feed. Proximate analysis of the feed samples revealed their moisture content, crude protein percentage, and crude fat percentage. Fungal isolates were enumerated, and their abundance and frequency were determined. Toxin production by *A. flavus* isolates, which contributes about 33%, was assessed by PCR amplification targeting specific genes associated with aflatoxin production. Phytochemical analysis was conducted on different plant extracts, and the presence of various compounds was determined. Silver nanoparticles were synthesized using *Carica papaya*, and their characterization was performed using various techniques, including UV-Spectroscopy, Fourier-transform infrared spectroscopy, and scanning electron microscopy. Finally, the antifungal activity of the *Carica papaya* extract and silver nanoparticles was evaluated against aflatoxigenic fungi in which the AgNPs showed greater inhibition value between 10 mm and 22 mm. These findings contribute to the understanding that silver nanoparticles may significantly inhibit the growth of aflatoxigenic fungi isolated from poultry feed.

Keywords: Antifungal activity, Aflatoxigenic fungi, *Carica papaya*, Poultry feed, Silver nanoparticles.

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V. V. Sathibabu Uddandrao & G. Saravanan (Eds.)

INTRODUCTION

The poultry sector in India has experienced significant growth over the past decade, with broiler meat volumes increasing at a rate of more than 10% annually and egg production growing at 5-6% annually [1]. This growth is primarily driven by increased domestic consumption. To meet the rising demand, the poultry industry has transitioned from rearing country birds to rearing hybrid birds, which offer faster growth, higher egg production, increased hatchability, lower mortality rates, and improved feed conversion [2]. However, the quality of animal feed is crucial for ensuring healthy end products. Commercially mixed animal feeds play a vital role in animal production with high productivity, containing a mixture of cereals, imported commodities, and other ingredients [3]. Unfortunately, the use of such kinds of ingredients often leads to contamination of the ready-mixed feed with fungi [4]. Mold contamination is widespread in tropical countries like India, where poultry and its by-product production are expanding at a great rate. This contamination occurs during pre-harvest and post-harvest periods, where temperature and humidity create favorable conditions for fungal growth and mycotoxin contamination [5].

Fungi not only affect the organoleptic characteristics and nutritional quality of the feed but also pose health risks to animals and humans. Mold growth on feed materials can result in the loss of nutrients and impairment of the immune system of the ingesting animals and acquired resistance to infections in animals, leading to economic losses through decreased productivity [6]. Maize, groundnut, rice, cottonseed, and some millet have been identified as high-risk commodities for fungi contamination in India [7]. Poultry feeds are tremendously susceptible to mycotoxicoses due to aflatoxins, trichothecenes, ochratoxins, and other fusariotoxins [8]. These mycotoxins can have detrimental effects on animal health, including reduced growth, poor egg production, anorexia, hemorrhage, embryotoxicity, and increased susceptibility to environmental and microbial stresses. Aflatoxins, in particular, are considered the most significant mycotoxins, posing a health risk to both animals and humans. Chronic dietary exposure to aflatoxins has been associated with liver cancer in humans [9].

Periodical monitoring of the toxigenic mycoflora of animal feeds and food is essential to develop methodologies to control or counteract mycotoxin exposure in animal feed and human populations [10]. Conventional methods such as thin-layer chromatography (TLC) and plate culturing have been used to determine mycotoxin-producing fungi, but they are time-consuming and require expertise [11]. Therefore, there is a need for more rapid and objective methods for identifying mycotoxigenic fungi in food and feed [12]. Due to their unique properties and wide range of applications, silver nanoparticles (AgNPs) have

gained attention, particularly in the medical field. The application of silver nanoparticles has shown inhibitory effects on the growth and production of mycotoxins by toxigenic fungi [13, 14]. Further studies are needed to explore the effects of silver nanoparticles on aflatoxin-producing fungal strains.

The present study aims to explore the prevalence of toxin-producing *Aspergillus flavus* in feed materials used in poultry farms in Namakkal, India, and evaluate the inhibition of these isolates using silver nanoparticles synthesized from plant extracts. By understanding the prevalence of mycotoxigenic fungi and exploring potential inhibitory agents like silver nanoparticles, it is possible to develop strategies to mitigate the risks associated with mycotoxin contamination in poultry feed and protect the health of animals and humans.

MATERIALS AND METHODS

Sample Collection

A total of 10 samples of poultry feed mixtures were collected from different parts of farming areas in Namakkal district, Tamil Nadu, India.

Proximate Analysis

The proximate analysis of moisture content involves weighing an appropriate moisture dish and taking 10 g of the sample. The dish is then placed in a hot air oven at 120°C for approximately 2 hours. After removal from the oven, the dish is covered, cooled in a desiccator, and weighed. The percentage of moisture is calculated using the formula provided [15]. For the determination of protein content, the Kjeldahl method is employed. A sample of 0.5 g is mixed with concentrated H_2SO_4 in a digestion flask. A selenium catalyst is added, and the mixture is heated until a clear solution (the digest) is obtained. The digest is diluted and used for analysis. In the distillation step, a portion of the digest is mixed with NaOH solution and distilled into a boric acid solution with an indicator. The distillate is titrated, and the nitrogen content is used to calculate the protein content using the provided formula. Crude fat is determined by a solvent extraction gravimetric method. The sample is wrapped in porous paper and placed in a thimble, which is then mounted in a soxhlet reflux flask containing petroleum ether. The solvent is heated, vaporized, and condensed, repeatedly extracting the fat from the sample. After the extraction process, the fat extract is dried, cooled, and weighed. The weight of the fat extract is calculated as a percentage of the weight of the analyzed sample [16].

CHAPTER 16

Therapeutic Plant Extract-Mediated Green Synthesis of Hydroxyapatite Nanoparticles for Biomedical Applications

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Abstract: The convergence of green synthesis has sparked considerable interest in the development of innovative nanomaterials for therapeutic applications. Hydroxyapatite (HAp) nanoparticles have emerged as promising candidates in the biomedical field owing to their biocompatibility, bioactivity, and resemblance to the natural mineral component of bone tissue. The phytochemicals within therapeutic plant extracts contribute significantly to the formation and stabilization of HAp nanoparticles. The synergistic interactions between phytochemicals and the formed nanoparticles augment their biocompatibility and therapeutic potential for various biomedical applications. This chapter provides an exploration of the synthesis techniques involving plant extracts and their constituents, elucidating their role as efficient biomolecular templates in the controlled fabrication of HAp nanoparticles. Also, this chapter describes the wide array of biomedical applications for plant-extract-mediated HAp nanoparticles. The integration of therapeutic plant extracts in the green synthesis of HAp nanoparticles presents a sustainable and promising avenue, fostering advancements in biomedical research and applications with profound implications for healthcare and regenerative medicine. The discussion encompasses the promising prospects, challenges, and future directions in leveraging these eco-friendly and biocompatible nanoparticles in diverse biomedical scenarios.

Keywords: Green synthesis, Hydroxyapatite, Nanoparticles, Phytochemicals, Therapeutic plants.

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INTRODUCTION

Nature has been a repository of powerful medicinal compounds containing a range of bioactive constituents [1, 2]. The convergence of these natural resources with the emerging field of nanotechnology represents a paradigm shift. Green synthesis, utilizing plant extracts as reducing and capping agents, offers a sustainable, eco-friendly route to fabricate nanoparticles [3]. Engineered nanoparticles through green synthesis methodologies involving plant extracts are rich in phytochemicals and exhibit enhanced biocompatibility and multifaceted functionalities. Various aspects of healthcare are set to be revolutionized by this new generation of biomedical materials [4, 5]. The biomedical significance of these nanoparticles transcends traditional boundaries. Primarily, their enhanced biocompatibility ensures minimal adverse reactions in biological systems, presenting a safer alternative to conventionally synthesized materials. Additionally, these nanoparticles act as the backbone of therapeutic delivery systems with precise and controlled release profiles, thereby improving therapeutic efficacy and reducing side effects [6]. In the realm of biomedical research, the convergence of nature's bounty and cutting-edge technology has sparked a revolution. Therapeutic plant extract-mediated green synthesis of nanoparticles stands at the forefront of this revolution, heralding a new era in biomedical applications. The plant extract-mediated green synthesis of nanoparticles is an innovative approach that involves using extracts from various parts of plants (such as leaves, stems, roots, *etc*.) in the production of nanoparticles [7, 8]. This method is gaining significant attention due to its eco-friendly nature, cost-effectiveness, and potential for large-scale production. The field of plant extract-mediated green synthesis of nanoparticles holds immense promise due to its sustainable and eco-friendly approach [9]. Among the different nanoparticles, the synthesis of hydroxyapatite (HAp) nanoparticles using therapeutic plant extracts stands as a promising development that holds immense potential for diverse biomedical applications [10]. This chapter delves into the significance, process, and applications of therapeutic plant extract-mediated green synthesis of HAp nanoparticles in the realm of biomedicine.

HYDROXYAPATITE (HAP) NANOPARTICLES AND THEIR BIOMEDICAL RELEVANCE

HAp is a naturally occurring mineral form of calcium apatite, belonging to the family of apatite compounds. It is primarily composed of calcium, phosphorus, and hydroxide ions. Its chemical formula, $Ca_5(PO_4)_3(OH)$, reflects the arrangement of these elements in its structure [11]. HAp exhibits two forms of crystal structure: hexagonal and monoclinic crystal structure. However, HAp mostly has a hexagonal crystal structure with cell parameters $a = b = 9.4225$ Å

and $c = 6.8850$ *Å*, space group P63/m, and direction of crystal growth along the c-axis [12]. The basic structural unit is composed of phosphate groups (PO_4) that form the backbone of the crystal lattice as shown in Fig. (**1**) [13]. Each phosphate group contains one phosphorus atom bonded to four oxygen atoms. Within the HAp structure, the calcium ions are surrounded by oxygen atoms, forming a series of calcium layers. The phosphate groups then link these calcium layers together [14]. Additionally, hydroxide ions (OH^-) occupy positions within the crystal lattice, contributing to its chemical composition and stability. Also, hydroxide ions influence the reactivity and surface properties of HAp, allowing for interactions with biological molecules [15]. HAp's structure closely resembles the mineral phase found in bone tissue, contributing to its biocompatibility and suitability for various biomedical applications. HAp's crystal structure is primarily held together by ionic bonds between calcium and phosphate ions [16]. This structure provides HAp with its unique properties, such as its role in the formation and strength of bones and teeth due to its biocompatibility and ability to support mineralization. Understanding the crystal structure of HAp is crucial for developing biomaterials, understanding bone physiology, and designing medical interventions aimed at improving bone health and regeneration.

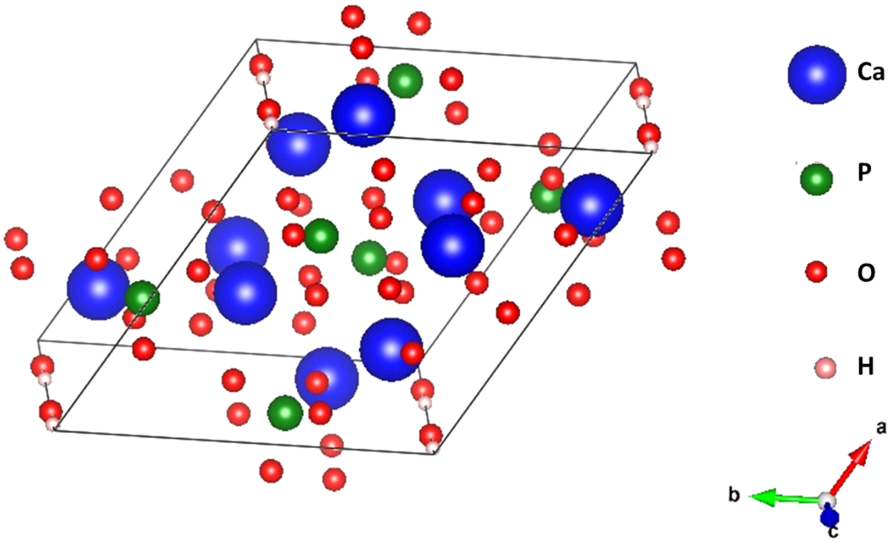

Fig. (1). Crystal structure of HAp revealed the arrangement of calcium, phosphate, and hydroxyl ions.

HAp plays a crucial role in the structure and strength of bones. In the human body, bones are composed of both organic and inorganic components. The inorganic component, primarily HAp, provides the bone with its hardness and

SUBJECT INDEX

A

B

C

D

E

F

G

H

I

K

L

M

N

O

P

R

S

T

U

W

X

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