

Innovation in Phytomedicine: From Ancient Remedies to Modern Therapies

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Abstract

Phytomedicine, the use of plant-derived substances for therapeutic purposes, has evolved from ancient herbal remedies to modern clinical applications, significantly influencing healthcare practices worldwide. This review explores the historical context of phytomedicine, highlighting its roots in ancient civilizations, such as Egypt, China, and India, where plants were recognized for their healing properties. We discuss key innovations in the field, including advancements in pharmacognosy, clinical research, and biotechnology, which have led to the validation and standardization of herbal medicines. Additionally, we address the challenges faced by phytomedicine, such as variability in plant quality, regulatory hurdles, and public perception issues. The future of phytomedicine lies in the integration of traditional knowledge with modern scientific approaches, promoting personalized therapies, and sustainable practices. Ultimately, this article underscores the potential of phytomedicine to provide innovative and effective health solutions while enhancing global health outcomes.

Keywords: Phytomedicine, herbal medicine, plant-based therapies, traditional medicine, ancient remedies, active plant compounds, natural medicine

INTRODUCTION

Phytomedicine, the practice of using plant-derived substances for medicinal purposes, has a long and rich history that spans across cultures and continents. From the ancient Egyptians who documented herbal remedies on papyrus scrolls to Traditional Chinese Medicine (TCM) and Ayurveda in India, civilizations have long recognized the therapeutic potential of plants [1]. These initial practices established the groundwork for a wide range of herbal remedies that are still in use today. In recent decades, the resurgence of interest in natural products has prompted a reevaluation of phytomedicine within the context of modern healthcare. The global shift toward integrative and

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holistic approaches has highlighted the value of herbal therapies, often complementing conventional medicine. This renewed focus has sparked significant advancements in the field, driven by innovations in pharmacognosy, phytochemistry, and biotechnology, which have enabled the isolation and standardization of bioactive compounds from plants. As scientific research validates the efficacy and safety of numerous herbal remedies, the potential for phytomedicine to address various health issues becomes increasingly apparent. However, this journey is not without its obstacles, such as concerns over quality assurance, regulatory guidelines, and societal perception. Understanding the evolution of phytomedicine – from its ancient roots to its modern applications – provides crucial insights into its role in contemporary healthcare and paves the way for future innovations.

This article aims to explore this dynamic landscape, emphasizing the importance of bridging traditional knowledge with modern scientific research to harness the full potential of phytomedicine in promoting global health [2].

HISTORY OF PHYTOMEDICINE

From Ancient Remedies to Modern Therapies

Phytomedicine boasts a long and varied history, showcasing humanity's timeless connection to nature and pursuit of healing. The use of plants for medicinal purposes can be traced back thousands of years, with evidence from various ancient civilizations demonstrating the integral role of herbal remedies in traditional healthcare systems [3].

Ancient Civilizations

1. *Egypt*: The ancient Egyptians were among the first to document medicinal plants. The Ebers Papyrus, dating back to approximately 1550 BCE, documents more than 700 treatments, many of which are based on plants like garlic, onion, and myrrh. These texts illustrate a sophisticated understanding of herbal medicine, with treatments tailored to specific ailments.
 2. *China*: TCM, with origins dating back over 2,500 years, emphasizes the holistic use of plants in conjunction with other modalities like acupuncture and dietary therapy. Texts, such as the "Shennong Bencao Jing," attributed to the legendary Emperor Shennong, categorize hundreds of medicinal plants based on their therapeutic properties and effects on the body [4].
 3. *India*: Ayurveda, among the world's oldest medical systems, has relied on plant-based therapies for thousands of years. Ancient texts, like the "Charaka Samhita" and "Sushruta Samhita", detail the use of herbs, such as turmeric, ashwagandha, and tulsi for promoting health and treating illness, reflecting a deep understanding of the connection between plants and health.
- Importance of Phytomedicine in Modern Healthcare. Phytomedicine plays a crucial role in contemporary healthcare, offering numerous benefits that complement conventional medical practices. Its significance can be understood through several key aspects:

Diverse Therapeutic Options

Phytomedicine provides a vast array of therapeutic options for managing various health conditions. Many plant-derived compounds have demonstrated efficacy in treating ailments, such as chronic pain, inflammation, anxiety, and digestive disorders. For instance, herbal remedies, like ginger and turmeric, have been recognized for their anti-inflammatory properties, while St. John's Wort is widely used for mild to moderate depression.

Integrative Approaches to Health

With the growing interest in integrative and holistic health approaches, phytomedicine complements conventional treatments by addressing the whole person – physically, emotionally, and spiritually. This synergy can enhance patient outcomes, reduce the side effects of pharmaceuticals, and improve overall well-being. Many healthcare providers now incorporate herbal therapies into treatment plans, recognizing their potential to support conventional medicine [5].

Cultural Relevance and Accessibility

Phytomedicine is often rooted in cultural practices and traditional knowledge, making it particularly relevant in diverse communities. It offers readily available treatment solutions, particularly in regions where conventional healthcare is scarce. For many people, herbal remedies are familiar and trusted, allowing for a sense of empowerment in managing their health.

Preventive Health Benefits

Many phytomedicines are rich in antioxidants, vitamins, and other bioactive compounds that contribute to preventive health. Consistent use of herbal supplements and teas can strengthen the immune system, support digestive health, and lower the likelihood of chronic illnesses like heart

disease and diabetes. The emphasis on prevention aligns with modern healthcare's focus on promoting wellness rather than just treating illness.

Scientific Validation and Research Opportunities

Ongoing research into phytomedicine has led to the discovery of novel compounds with potential therapeutic applications. Ongoing scientific research continues to confirm the effectiveness and safety of numerous herbal remedies, reinforcing evidence-based medicine. This work paves the way for new drug development, as many contemporary medications originate from plant-based compounds [6].

Sustainability and Environmental Considerations

Phytomedicine emphasizes the use of natural resources, which can contribute to more sustainable healthcare practices. Phytomedicine fosters biodiversity and environmental responsibility by advocating for the cultivation and utilization of medicinal plants. This approach is especially significant as the healthcare sector strives to minimize its environmental impact [7].

Patient-Centered Care

The growing interest in personalized medicine aligns well with phytomedicine, as herbal treatments can be tailored to individual health profiles and preferences. This patient-focused approach promotes collaboration between healthcare professionals and patients, increasing compliance with treatment plans and leading to better health results.

Innovative Phytomedicine

Innovative phytomedicine, the integration of plant-based therapies with cutting-edge scientific advancements, has gained traction as health care systems seek effective and holistic treatment options. This review explores the evolution of phytomedicine, highlighting how ancient remedies have informed modern therapeutic innovations, while also addressing the challenges and future directions of this dynamic field [8].

History

Ancient Practices

For millennia, cultures around the world have utilized plant-based remedies. Ancient texts, like the Ebers Papyrus and the Huangdi Neijing, demonstrate the vast understanding of medicinal plants. These traditions laid the groundwork for the scientific exploration of phytomedicine.

Transition to Modern Science

The discovery of active compounds in the 19th century represented a significant turning point. The development of pharmaceutical chemistry allowed for the identification of potent plant-derived substances, such as morphine and quinine, fostering the birth of modern pharmacology [9].

Challenges in Phytomedicine

Quality Control and Standardization

A major challenge remains the variability in herbal products. Inconsistencies in plant sourcing, processing, and formulation can affect the quality and potency of phytomedicines. Enforcing strict quality control practices and standardization procedures is crucial for ensuring consumer safety [10].

Future Directions

Research and Innovation

Future research should focus on elucidating the mechanisms of action of phytochemicals and exploring their potential interactions with conventional drugs. Utilizing omics technologies can help researchers uncover the complex biological effects of plant-derived compounds.

Sustainable Practices

As demand for herbal products rises, sustainable harvesting and cultivation practices must be prioritized. This method helps preserve biodiversity while also guaranteeing the sustainable availability of medicinal plants. Collaboration between traditional healers and modern agricultural scientists can foster sustainable phytomedicine [11].

Personalized Medicine

The potential for personalized phytomedicine is on the horizon, where treatments are tailored to individual genetic and lifestyle factors. This approach could improve the effectiveness of herbal treatments and reduce side effects, providing a more tailored healthcare experience.

Phytomedicine, rooted in centuries of traditional healing practices, has become increasingly relevant in contemporary health care. From the use of herbs in ancient civilizations to today's evidence-based approaches, this field bridges the gap between historical knowledge and modern science. This article aims to detail the innovations in phytomedicine that are transforming health care practices [12].

Innovations in Phytomedicine**Scientific Validation**

Recent advances in phytochemical research have provided robust evidence for the efficacy of traditional remedies. For example, double-blind studies have confirmed the antidepressant effects of St. John's Wort, and randomized trials have demonstrated the immune-boosting properties of echinacea [13].

Novel Drug Development

Innovations in drug discovery have led to the identification of new pharmacologically active compounds from plants. The development of artemisinin from *Artemisia annua* for malaria treatment exemplifies how ancient knowledge can inform modern medicine. Additionally, advances in biotechnology enable the synthesis of complex phytochemicals, enhancing their therapeutic potential [14].

Integrative Approaches

Integrative medicine, which combines phytotherapy with conventional treatments, is gaining popularity. This comprehensive approach not only improves treatment results but also meets the increasing consumer interest in natural and complementary therapies. Standardized herbal products are now being created to guarantee consistent dosage and effectiveness [15].

Challenges in Phytomedicine**Quality Control and Standardization**

A key challenge continues to be the inconsistency in herbal products. Variations in plant sourcing, processing, and formulation can impact the quality and strength of phytomedicines. It is crucial to implement strict quality control measures and standardization protocols to ensure consumer safety.

Regulatory Challenges

The regulatory standards for herbal medicines differ across countries, influencing market availability and consumer confidence. While some nations have clear guidelines in place, others lack proper regulatory oversight [16].

Harmonizing these regulations will be crucial for promoting safe and effective phytomedicine.

Public Perception and Misconceptions

Although there is an increasing amount of evidence backing phytomedicine, misunderstandings about its safety and effectiveness continue to exist. Public education initiatives are necessary to

inform consumers about the proper use of herbal remedies and the importance of consulting healthcare professionals [17].

CASE STUDY

Introduction

Curcumin, the active compound found in turmeric (*Curcuma longa*), serves as a compelling case study in innovative phytomedicine. Once used in traditional medicine for its anti-inflammatory and antioxidant benefits, curcumin has attracted significant interest in modern research, resulting in its incorporation into current therapeutic practices. This case study explores the journey of curcumin from an ancient remedy to a scientifically validated treatment for chronic inflammation.

BACKGROUND

Traditional Use

Curcumin has been used in Ayurvedic medicine for centuries, primarily for its anti-inflammatory and analgesic properties. It is traditionally consumed as a spice in food or prepared as a paste for topical applications. Ancient texts record its use in addressing a range of health problems, such as arthritis, skin disorders, and digestive issues.

Scientific Exploration

In recent decades, researchers have sought to validate the health benefits of curcumin through rigorous scientific studies. Initial investigations focused on its bioactive properties, which include the modulation of inflammatory pathways and the regulation of oxidative stress.

METHODOLOGY

Research Design

A systematic review of clinical trials was conducted to assess the efficacy of curcumin in managing chronic inflammation, particularly in conditions like arthritis, cardiovascular diseases, and inflammatory bowel disease (IBD).

Data Collection

The review covered randomized controlled trials (RCTs) published in reputable, peer-reviewed journals. Data was extracted regarding study design, participant demographics, dosages of curcumin used, outcome measures, and results.

FINDINGS

Efficacy in Chronic Inflammation

1. *Rheumatoid Arthritis*: A meta-analysis of 10 RCTs indicated that curcumin supplementation significantly reduced markers of inflammation, such as C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR). Patients reported decreased joint pain and improved function.
2. *Cardiovascular Disease*: Research involving patients with metabolic syndrome demonstrated that curcumin enhanced endothelial function and helped decrease arterial stiffness. Participants experienced a notable decrease in inflammatory markers, suggesting potential cardiovascular benefits.
3. *Inflammatory Bowel Disease (IBD)*: Curcumin demonstrated promise in reducing the severity of flare-ups in IBD patients. Clinical trials showed significant reductions in disease activity indices and improved quality of life scores.

Safety and Tolerability

Curcumin was generally well-tolerated across studies, with few reported adverse effects. Most participants experienced mild gastrointestinal disturbances, which were temporary and manageable.

DISCUSSION

Mechanisms of Action

The anti-inflammatory effects of curcumin are attributed to its ability to inhibit various signaling pathways, including NF- κ B and COX-2, which are pivotal in the inflammatory response. Additionally, curcumin acts as a potent antioxidant, further mitigating oxidative stress associated with chronic inflammation.

Integration into Modern Therapies

The successful validation of curcumin through clinical research has resulted in its inclusion in dietary supplements and functional foods. Many healthcare providers now suggest curcumin as an adjunctive treatment for managing chronic inflammatory conditions.

Challenges and Limitations

Despite promising findings, challenges remain. Curcumin's bioavailability is relatively low, which limits its effectiveness. Innovative formulations, such as nanoparticle delivery systems and phytosome technology, are being explored to enhance absorption [18].

TOXICITY AND SAFETY IN INNOVATIVE PHYTOMEDICINE

Introduction

Phytomedicines are often perceived as safer alternatives to synthetic pharmaceuticals, primarily due to their natural origins. However, as ovative phytomedicine gains traction, the safety and toxicity of herbal compounds have become critical topics of research. Although numerous plant-based compounds provide therapeutic advantages, it is crucial to understand their potential risks to ensure their safe use in contemporary treatments.

This overview explores the safety profiles, toxicity concerns, and regulatory challenges associated with phytomedicines [19].

Safety Profiles of Phytomedicines

General considerations perception can be misleading. The safety of phytomedicines depends on several factors, including:

1. *Source of Plant Material*: The species, part of the plant used, and cultivation conditions can significantly affect safety.
2. *Preparation Methods*: The methods of extraction and formulation affect the concentration of active compounds and the presence of possible toxins.
3. *Dosage and Duration of Use*: Higher doses and prolonged use can increase the risk of adverse effects [20].

Commonly Used Phytomedicines and Their Safety

1. *Curcumin*: Generally regarded as safe at dietary levels, high doses may cause gastrointestinal issues and interfere with anticoagulant medications. Research indicates potential hepatotoxicity at excessive doses in specific populations.
2. *St. John's Wort*: While effective for mild to moderate depression, it can interact with various medications (e.g., antidepressants, contraceptives) by affecting liver enzyme activity, leading to decreased efficacy of those drugs.
3. *Echinacea*: Commonly used for immune support, it is usually safe for short-term use. However, it can trigger allergic reactions, particularly in those with a history of allergies to similar plants [21].

TOXICITY CONCERNS

Types of Toxicity

1. *Acute Toxicity*: Refers to harmful effects occurring shortly after exposure. Certain phytomedicines may lead to immediate negative reactions, including allergic responses or digestive issues.

2. *Chronic Toxicity*: Long-term use of certain herbal products may lead to cumulative toxic effects. For example, excessive consumption of herbal teas containing *Aristolochia* species has been linked to nephrotoxicity and carcinogenicity.
3. *Potential Contaminants*: Phytomedicines may be contaminated with heavy metals, pesticides, or pathogens during cultivation and processing, posing additional safety risks.

Specific Cases of Toxicity

1. *Kava*: Known for its anxiolytic properties, kava has been associated with hepatotoxicity, leading to regulatory restrictions in some countries.
2. *Comfrey*: Contains pyrrolizidine alkaloids that can cause severe liver damage, prompting health authorities to issue warnings against its internal use.

Regulatory Framework

Global Perspectives

Regulatory oversight of phytomedicines varies widely across countries:

- *United States*: Herbal supplements are categorized as dietary supplements and face less rigorous regulations than pharmaceuticals. Manufacturers must ensure safety but are not obligated to provide proof of effectiveness before marketing.
- *European Union*: The European Medicines Agency (EMA) takes a more organized approach with the Traditional Herbal Medicinal Products Directive (THMPD), which mandates safety and efficacy data for herbal products [22].

Importance of Standardization

The lack of standardization in the preparation and dosage of phytomedicines can lead to variability in safety profiles. Establishing quality control measures and standardized formulations is crucial to mitigate risks.

Future Directions

Research and Development

- Ongoing research is needed to Evaluate the long-term safety and possible interactions of phytomedicines with traditional medications.
- Investigate the mechanisms of toxicity to better understand risk factors.

Introduction

The global phytomedicine market is witnessing significant expansion, fueled by growing consumer awareness of natural remedies and a rising demand for alternative therapies. Phytomedicines, which are derived from plant sources, are used in various therapeutic applications, including herbal supplements, cosmetics, and pharmaceuticals. This analysis offers insights into market trends, key players, challenges, and future opportunities within the phytomedicine industry [23].

Market Overview

Market Size and Growth

- *Current Value*: The global phytomedicine market was valued at approximately USD 100 billion in 2023.
- *Projected Growth*: It is forecasted to grow at a compound annual growth rate (CAGR) of 8–10% from 2024 to 2030, driven by increased interest in herbal products and greater health awareness.

Market Segmentation

By Product Type

- *Herbal Supplements*: Vitamins, minerals, and herbal extracts.
- *Pharmaceuticals*: Prescription and over-the-counter products.
- *Cosmetics and Personal Care*: Skin care, hair care, and oral care products.

By Distribution Channel

- *Online Retail*: E-commerce platforms are growing in popularity for purchasing phytomedicines.
- *Pharmacies and Drugstores*: Traditional retail continues to be a key channel.
- *Health Food Stores*: Specialty stores focused on natural health products.

By Region

- *North America*: Dominant market due to high consumer awareness and advanced healthcare infrastructure.
- *Europe*: Strong demand for herbal remedies, especially in Germany and the UK.
- *Asia-Pacific*: Rapid expansion driven by traditional medicine practices and increasing disposable income.

KEY DRIVERS

Growing Consumer Demand for Natural Products: There is an increasing trend toward natural and organic products as consumers seek alternatives to synthetic medications. This shift is driven by concerns over side effects, long-term health impacts, and a preference for holistic health approaches.

- *Rising Health Awareness*: The global focus on preventive healthcare and wellness has led to a surge in interest in phytomedicines. Consumers are increasingly seeking products that support immunity, digestion, and overall well-being.

Scientific Validation

As research validates the efficacy of various phytomedicines, consumers and healthcare professionals are becoming more confident in recommending these products. Clinical studies and evidence-based practices enhance credibility and acceptance.

Competitive Landscape

Key Players

- *Herbalife Ltd.*: A global leader in nutrition and weight management products.
- *Gaia Herbs*: Specializes in organic herbal supplements with a focus on sustainability.
- *Nature's Way*: Offers a wide range of herbal supplements and is known for its quality control.
- *Schwabe Pharmaceuticals*: A prominent player in the European market, known for its high-quality herbal medications.

Market Strategies

- *Product Innovation*: Companies are developing new formulations and delivery systems, such as liquid extracts and gummies, to appeal to a broader consumer base.
- *Environmental Responsibility*: Numerous businesses are embracing eco-friendly sourcing and manufacturing methods to appeal to consumers who prioritize sustainability.
- *Alliance Building*: Partnerships with research organizations and healthcare entities boost credibility and expand market presence.

CHALLENGES

Regulatory Hurdles

The regulatory framework for phytomedicines differs widely between regions, creating difficulties in ensuring compliance and accessing markets. Varying regulations can affect product quality and consumer safety.

Quality Control Issues

Fluctuations in the quality and effectiveness of herbal products present a threat to consumer safety and can damage brand reputation. Ensuring rigorous quality control and standardization is crucial for market growth [24].

Competition from Synthetic Drugs

Despite the growing interest in natural products, the dominance of pharmaceutical companies and synthetic medications poses a challenge to phytomedicine. Consumers may still prefer established pharmaceuticals for serious health conditions.

FUTURE OPPORTUNITIES

Integration with Conventional Medicine

The increasing acceptance of integrative medicine presents opportunities for phytomedicines to complement conventional treatments. Collaboration between healthcare providers and herbal medicine practitioners can enhance patient outcomes [25].

Emerging Markets

The increase in disposable incomes and growing health consciousness in emerging markets, especially in Asia-Pacific and Latin America, offer substantial growth potential for phytomedicine.

E-commerce Growth

The growth of online retail platforms is reshaping distribution channels. Businesses can utilize e-commerce to access a broader customer base, especially younger consumers who favor shopping online [26].

CONCLUSIONS

Innovation in phytomedicine offers an exciting path that connects the knowledge of traditional remedies with the progress of contemporary science. As society increasingly seeks holistic and natural alternatives to conventional treatments, the relevance of plant-based therapies has never been greater. The integration of rigorous scientific research with traditional knowledge has validated many herbal remedies, enhancing their acceptance and application in contemporary healthcare.

Nevertheless, the journey ahead comes with its challenges. Concerns, like quality assurance, inconsistent regulations, and possible toxicity, need to be tackled to guarantee the safe and effective use of phytomedicines. Emphasizing sustainable practices and consumer education will further bolster confidence in these therapies.

In the end, the future of phytomedicine depends on its capacity to evolve and innovate, utilizing emerging technologies and research to fully harness the benefits of plant-based compounds. By fostering collaboration between traditional healers, researchers, and healthcare professionals, we can create a robust framework for the responsible and effective use of phytomedicine, enriching the health and well-being of individuals worldwide.

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