

From Ancient Wisdom to Modern Breakthroughs: Herbal Medicine in the Era of Advanced Pharmacotherapy

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Abstract

Herbal medicine has been an integral part of human healthcare for millennia, providing the foundation for many modern pharmaceuticals. This manuscript explores the continuum from ancient herbal wisdom, particularly the teachings of Avicenna, to contemporary pharmacotherapy. Principles such as personalized care, lifestyle modification, and holistic wellness are echoed in modern concepts of pharmacogenomics, immunomodulation, and integrative medicine. Advances in nanotechnology, analytical chemistry, and artificial intelligence now allow precise identification, formulation, and evaluation of bioactive compounds derived from plants. The example of *Pereskia bleo* demonstrates the potential of traditional herbs in anticancer research, including apoptosis induction in triple-negative breast and cervical cancer cells, as well as immunostimulatory effects on natural killer cells. Challenges in standardization, bioavailability, and clinical validation remain, yet integrating traditional knowledge with modern scientific tools presents opportunities for safer, personalized, and effective therapeutics. The dialogue between past and present underscores the value of combining ancestral wisdom with modern pharmacology to shape the future of medicine.

Keywords: Herbal medicine, *Pereskia bleo*, Immunomodulation, Avicenna's principles, Advanced pharmacotherapy

Abstrak

Dari Kebijakan Kuno hingga Terobosan Modern: Obat Herbal di Era Farmakoterapi Lanjut. Obat herbal telah menjadi bagian integral dari perawatan kesehatan manusia selama ribuan tahun, menyediakan dasar bagi banyak obat modern. Naskah ini mengeksplorasi kontinuitas dari kebijakan herbal kuno, khususnya ajaran Ibnu Sina (Avicenna), hingga farmakoterapi kontemporer. Prinsip-prinsip seperti perawatan yang dipersonalisasi, modifikasi gaya hidup, dan kesejahteraan holistik tercermin dalam konsep modern farmakogenomik, imunomodulasi, dan pengobatan integratif. Kemajuan dalam nanoteknologi, kimia analitik, dan kecerdasan buatan kini memungkinkan identifikasi, formulasi, dan evaluasi senyawa bioaktif yang berasal dari tumbuhan secara tepat. Contoh *Pereskia bleo* menunjukkan potensi tanaman tradisional dalam penelitian antikanker, termasuk induksi apoptosis pada sel kanker payudara triple-negatif dan sel kanker serviks, serta efek imunostimulator pada sel natural killer. Tantangan dalam standardisasi, ketersediaan hayati, dan validasi klinis masih ada, namun mengintegrasikan pengetahuan tradisional dengan alat ilmiah modern membuka peluang untuk terapeutik yang lebih aman, personal, dan efektif. Dialog antara masa lalu dan masa kini menekankan nilai menggabungkan kebijakan leluhur dengan farmakologi modern untuk membentuk masa depan kedokteran.

Kata Kunci: Obat herbal, *Pereskia bleo*, Imunomodulasi, Prinsip Avicenna, Farmakoterapi lanjut

Introduction

Herbal medicine has historically been a cornerstone of human health, with documented use dating back thousands of years across diverse civilizations. Avicenna (Ibnu Sina, 980–1037), often regarded as the father of modern medicine, emphasized the preservation of health and restoration of balance in his seminal work, *The Canon of Medicine*, which served as a primary medical reference for centuries in both Europe and the Islamic world.¹ His principles—including the four humors, personalized treatment, the healing power of nature, hierarchical interventions, and holistic care—anticipated many concepts central to contemporary medicine.

Modern pharmacotherapy, encompassing pharmacogenomics, nanotechnology, and molecular medicine, increasingly recognizes the relevance of these ancient ideas. Personalized medicine, systems biology, immunomodulation, and integrative care echo Avicenna's vision of a balanced approach to health.^{2–4} The transition from traditional herbs to isolated bioactive molecules exemplifies a continuum of discovery rather than a dichotomy between old and new.

Building on this continuity between traditional knowledge and modern science, *Pereskia bleo*—a herb traditionally used in Malaysia and Indonesia—illustrates how ancient practices can contribute to contemporary pharmacotherapy. Our findings demonstrate that extracts of *P. bleo* induce apoptosis in triple-negative breast cancer and cervical cancer cells, accompanied by upregulation of pro-apoptotic markers such as Bax, caspase-3, and p53.^{5,6} Additionally, *P. bleo* enhances anticancer immune responses by stimulating natural killer (NK) cell cytotoxicity and increasing the expression of key immunomodulatory molecules, including IFN- γ , IL-12, IL-18, perforin, and granzyme B.^{7,8} These activities align with Avicenna's emphasis on harnessing the body's innate healing mechanisms, reinforcing the relevance of traditional herbs in the era of advanced pharmacotherapy.

Herbal medicine has inspired numerous therapeutic breakthroughs. Classic examples include aspirin from *Salix alba*, vincristine and vinblastine from *Catharanthus roseus*, morphine from *Papaver somniferum*, digoxin from *Digitalis purpurea*, and paclitaxel from *Taxus brevifolia*.^{9–13} These examples demonstrate that empirical observations recorded in ancient texts have provided a blueprint for modern drug discovery.

This manuscript provides a conceptual overview of how herbal medicine, particularly *Pereskia bleo*, informs contemporary pharmacological research, highlighting integrative strategies, immunomodulatory potential, and future directions for safer, effective therapeutics.

Experimental Section

This study aims to explore the connection between the ancient herbal principles described in Avicenna's *The Canon of Medicine* and modern pharmacotherapy, with a particular focus on Malaysian and Indonesian traditional herbs. The approach involves a comparative analysis of Avicenna's principles—such as personalized care, lifestyle modification, holistic wellness, and the healing power of nature—and their parallels in contemporary concepts of pharmacogenomics, immunomodulation, and integrative medicine. Information on plants that inspired modern drugs, including *Salix alba* (willow bark), *Catharanthus roseus* (periwinkle), *Papaver somniferum* (opium poppy), *Digitalis purpurea* (foxglove) and *Taxus brevifolia* (Pacific yew), was obtained from historical and contemporary literature sources, including pharmacognosy textbooks, peer-reviewed reviews, and classical references such as Avicenna's *The Canon of Medicine*.^{1, 9–13}

Several traditional herbs with potential for pharmacological development were considered as examples. Malaysian and Indonesian plants, including *Pereskia bleo*¹⁴, *Curcuma* species (temulawak)¹⁵, *Centella asiatica* (pegaga)¹⁶, and *Andrographis paniculata*¹⁷, were analyzed in terms of their traditional uses, known bioactive compounds, and potential pharmacological applications.

This comparative framework highlights the continuum from traditional knowledge to modern pharmacotherapy, demonstrating how ancestral wisdom can guide the rational identification and application of bioactive compounds. By emphasizing herbs from Malaysia and Indonesia alongside globally recognized medicinal plants, this approach underscores the relevance of local ethnomedicine in contemporary drug discovery, preventive care, and personalized therapy.

Results and Discussion

Continuity from Avicenna's Principles to Modern Pharmacotherapy

Analysis of Avicenna's principles, as outlined in *The Canon of Medicine*, highlights several key concepts that resonate with modern pharmacology: personalized care, lifestyle modification, holistic wellness, and the healing power of nature. These ideas find modern parallels in pharmacogenomics, immunomodulation, integrative medicine, and rational stepwise therapy. For example, the concept of balancing humors corresponds to the modern understanding of homeostasis and individualized therapy, while the emphasis on the body's innate healing aligns with immunomodulatory approaches currently investigated in herbal pharmacology.

Traditional Herbs with Pharmacological Potential

Selected Malaysian and Indonesian herbs demonstrate the potential of traditional medicine to guide contemporary pharmacotherapy.

- *Pereskia bleo* exhibits anticancer and immunomodulatory activities, including apoptosis induction in triple-negative breast and cervical cancer cells, and stimulation of natural killer cell cytotoxicity
- *Curcuma* species (temulawak) contain curcuminoids with anti-inflammatory, antioxidant, and anticancer effects.
- *Centella asiatica* (pegaga) demonstrates wound-healing, neuroprotective, and immunomodulatory properties.
- *Andrographis paniculata* has bioactive diterpenoids that show anti-inflammatory, antiviral, and anticancer activities.

These plants, like classical examples that inspired modern drugs (*Salix alba*, *Catharanthus roseus*, *Papaver somniferum*, *Digitalis purpurea*, *Taxus brevifolia*), illustrate a continuum from traditional knowledge to scientifically validated pharmacological applications. Integrating local ethnomedicine with modern pharmacology may accelerate the discovery of novel therapeutics while supporting preventive and personalized medicine.

Integrating Traditional Knowledge with Modern Drug Development

The comparison between historical medicinal plants and contemporary pharmacotherapy underscores the importance of systematic study of traditional herbs. Techniques such as metabolomics, molecular profiling, and computational modeling now allow precise identification of bioactive compounds, formulation optimization, and prediction of drug synergy. These approaches not only validate traditional claims but also provide a scientific basis for safety, efficacy, and dosage standardization.

Challenges and Future Directions

Despite promising pharmacological potential, traditional herbs face challenges in drug development, including variability in bioactive compounds, poor bioavailability, and limited clinical validation. Focusing on Malaysian and Indonesian herbs may uncover unique bioactive compounds with lower toxicity and higher efficacy. Future research should emphasize standardized extracts, mechanistic studies, and integration of local ethnobotanical knowledge with modern drug discovery platforms.

Conceptual Take-Home Message

This analysis demonstrates that the principles of Avicenna remain relevant: traditional wisdom, when evaluated through the lens of modern pharmacotherapy, can inform the development of safer, personalized, and integrative therapies. The dialogue between past and present not only honors ancestral knowledge but also provides a roadmap for future medicinal innovations.

Conclusions

The principles of Avicenna remain relevant in modern pharmacotherapy, emphasizing personalized care, holistic wellness, and the healing power of nature. Malaysian and Indonesian herbs, including *Pereskia bleo*, *Curcuma* species, *Centella asiatica*, and *Andrographis paniculata*, illustrate the potential of traditional plants to inspire safe and effective therapies. Integrating ethnobotanical knowledge with modern scientific tools can guide the development of innovative, evidence-based, and individualized treatments, bridging ancient wisdom with contemporary medicine.

Conflict of Interest

The authors declare no conflict of interest.

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