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## Review Article

# Herbal Constituents in Modern Formulations: An Innovative Approach

Sakshi Kumari, Sukhjeet Kaur, Prabhjot Kaur, Arsh Saini, Dr. Satnam Singh\*

*Amar Shaheed Baba Ajit Singh Jujhar Singh Memorial College of Pharmacy, Bela, Ropar, Punjab, India*

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### ABSTRACT

Herbal treatments have been used in traditional medical systems for the treatment and prevention of various diseases for a long time. However, the poor water solubility, low bioavailability, instability, rapid metabolism, and low target specificity of botanical components often compromise their clinical applications despite their therapeutic potential. Modern pharmaceutical technology has revolutionized herbal medicines by developing sophisticated delivery systems that can improve the pharmacokinetic and pharmacodynamic properties of phytoconstituents. Potential approaches to improve the efficacy and safety of herbal drugs are phytosomes, liposomes, nanoparticles, nanoemulsions, solid lipid nanoparticles, nanostructured lipid carriers, transfersomes, ethosomes, dendrimers, microspheres and polymeric nanoparticles. Modern herbal formulations can be successfully used for the treatment of cancer, diabetes, neurological disorders, inflammatory diseases, cardiovascular disorders, skin disorders and antimicrobial therapy. Since ancient times, many traditional medical systems have employed herbal remedies for treatment and prevention of various diseases. However, the therapeutic potential of botanical components is often limited by their poor water solubility, low bioavailability, instability, rapid metabolism and low target specificity for clinical applications. Modern pharmaceutical technology has revolutionized herbal medicines by developing sophisticated delivery systems which can improve the pharmacokinetic and pharmacodynamic properties of phytoconstituents. Phytosomes, liposomes, nanoparticles, nanoemulsions, solid lipid nanoparticles, nanostructured lipid carrier, transfersomes, ethosome, dendrimers, microspheres and polymeric nanoparticles are potential approaches for improving efficacy and safety of herbal drugs. Modern herbal formulations can be successfully used for the treatment of cancer, diabetes, neurological disorders, inflammatory diseases, cardiovascular disorders, skin disorders and antimicrobial therapy.

### INTRODUCTION

Medicinal herbs are widely used in traditional medical systems such as Ayurveda and traditional

**\*Corresponding Author:** Satnam Singh

**Address:** Amar Shaheed Baba Ajit Singh Jujhar Singh Memorial College of Pharmacy, Bela, Ropar, Punjab, India

**Email** ✉: [drssb13pu@gmail.com](mailto:drssb13pu@gmail.com)

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Chinese medicine, according to the World Health Organization. The major therapeutic effects are due to the presence of phytoconstituents such as alkaloids, flavonoids, terpenoids, and polyphenols with antioxidant, anti-inflammatory, antibacterial, and anticancer properties<sup>(1)</sup>. However, the therapeutic use of these substances is often limited by poor solubility, low bioavailability, volatility, and rapid metabolism. Curcumin has potent pharmacological activity, but its oral bioavailability is extremely low because of its poor solubility and rapid degradation<sup>(2)</sup>. Resveratrol too is heavily metabolized, which diminishes its therapeutic effectiveness. To overcome these limitations, modern drug delivery techniques like liposomes, phytosomes, nanoemulsions, and nanoparticles have been developed. These techniques enhance the absorption and targeted delivery, increase the solubility, and protect the phytoconstituents from degradation<sup>(3)</sup>. Various studies have proven the significance of herbal nanoformulations in improving therapeutic efficacy and bioavailability. Nanocarriers also help in overcoming biological barriers such as the blood–brain barrier and provide sustained drug release. Such developments have increased the use of herbal remedies for conditions such as cancer and skin conditions where improved drug delivery is desirable<sup>(4)</sup>.

**Herbal Constituents:** These compounds display diverse pharmacological traits and exhibit chemical diversity. Alkaloids, flavonoids (alkali compounds), terpenoids, and polyphenols, as well as glycoside substances and essential oils, are the main classes<sup>(5)</sup>. Alkaloids, which include nitrogen, exhibit potent pharmacological properties such as antibacterial, antidiabetic, and cancer-preventive effects. Polyphenolic compounds found in plants, known as flavonoids, possess anti-inflammatory and antioxidant properties. Certain compounds, such as quercetin and rutin (which also appear to reduce oxidative stress), are not very effective in the therapeutic context due to their high metabolism time and low water solubility<sup>(6)</sup>. A broad range of biologically relevant secondary metabolites, known as terpenoids, are present in the organism<sup>(7)</sup>. Resveratrol and other polyphenols are powerful antioxidants with neuroprotective and cardioprotective properties. Due to their rapid metabolism and insufficient systemic availability, their therapeutic effectiveness is limited. Even though volatile molecules of essential oils have shown antibacterial and anti-inflammatory properties, they are not commonly used in medicine due to their high volatility and instability<sup>(8)</sup>.

**Table 1: Major Herbal Constituents and Their Limitations**

Class	Example	Activity	Limitation
<b>Alkaloids</b>	Berberine	Antidiabetic	Poor absorption
<b>Flavonoids</b>	Quercetin	Antioxidant	Low solubility
<b>Terpenoids</b>	Curcumin	Anticancer	Low bioavailability
<b>Polyphenols</b>	Resveratrol	Cardioprotective	Rapid metabolism
<b>Essential oils</b>	Menthol	Antimicrobial	Instability

### Need for Modern Formulation of Herbal Constituents

The primary disadvantage of herbal remedies is their ineffective absorption, not their

pharmacological effect. Many phytoconstituents have strong effects *in vivo*, but they are not comparable to the clinical outcomes achieved with other compounds due to their poor physicochemical and pharmacokinetic properties.



Among the major problems is the low solubility in water<sup>(9)</sup>. Oral administration of quercetin and curcumin, due to their lipophilicity and poor solubility in biological fluids, results in limited absorption. Despite being greater in dosage, only a small amount is circulated through the body. Another major problem is the low bioavailability, most of it due to poor permeability and high first-pass metabolism. As an example, the fast metabolism of resveratrol and berberine leads to extremely low plasma levels<sup>(10)</sup>. Lipid-based carriers and nanoparticles are among the latest delivery methods that reduce metabolic loss while increasing absorption. The sensitivity of phytoconstituents to pH, light and oxygen changes, as well as heat properties, causes problems with stability. These substances are made more stable and secure by encapsulation in nanocarriers<sup>(11)</sup>.

**Table 2: Key Reasons for Modern Formulation**

Limitation	Impact	Solution
Poor solubility	Low absorption	Nanoformulations
Low bioavailability	Reduced efficacy	Lipid/nanocarriers
Instability	Drug degradation	Encapsulation
No targeting	Less drug is at the site.	Targeted delivery
Short half-life	Frequent dosing	Sustained release

### Classes of Modern Herbal Formulations

The primary focus of modern herbal formulations is to enhance the way phytoconstituents function in the body, rather than relying on their intrinsic pharmacological activity. Most herbal chemicals are toxic due to their low bioavailability, volatility (vulnerabilities), poor solubility, and lack of targeting. The development of drug delivery methods, particularly those based on lipids and nanoparticles, has been driven by the need to

overcome these issues and enhance therapeutic efficacy.<sup>(12)</sup>

**Phytosomes:** Phytosomes, which are complexes formed by phosphatidylcholine and phytoconstituents in the presence of phospholipids, have a molecular interaction. Absorption and permeability of the membrane are amplified. In contrast to simple encapsulation, phytosomes are more stable and bioavailable. Traditional extracts have been compared to curcumin, quercetin, and silymarin phytosome in terms of absorption and therapeutic results<sup>(13)</sup>.

**Liposomes:** Phosphorlipid bilayers known as liposomes serve as vesicular carriers that contain hydrophilic and lipophilic medications. These molecules can also be used as scaffolds for the packaging of these drugs. Enhanced compatibility and better medication distribution are achieved through their structural similarities to biological membranes. Controlled release, reduced toxicity, and improved medication stability are the benefits of herbal liposomes. Inflammatory diseases and cancer, they are very useful<sup>(14)</sup>.

**Nanoemulsions:** Nanoemulsions, which are nanosized dispersions, enhance the solubility and absorption of lipophilic herbal substances. They increase surface area by being a smaller droplet and improve drug absorption and solubility<sup>(15)</sup>.

**Solid Lipid Nanoparticles (SLNs) and Nanostructured Lipid Carriers (NLCs):** Solid lipid precursors (SLNs) are responsible for safeguarding unstable phytoconstituents and facilitating the release of medications. NLCs enhance drug loading capacity by utilizing both liquid and solid lipids, which also prevents drug leakage. Such systems work especially well with lipophilic substances such as resveratrol and curcumin<sup>(16)</sup>.



**Polymeric Nanoparticles:** Biodegradable polymers, including chitosan and PLGA, are utilized to generate polymeric nanoparticles. By modifying them, they can be distributed more efficiently and for an extended duration. As the drug concentration of cancer and chronic conditions can persist over time, these systems are highly beneficial for treating these diseases<sup>(17)</sup>.

**Vesicular Systems (Transfersomes and Ethosomes):** To improve transdermal distribution, transfersomes and ethosomes are flexible vesicular carriers. Their flexible structure allows for greater penetration into the skin compared to conventional systems. This is an innovation<sup>(18)</sup>.

### **Modern Formulation of Herbal Constituents in Different Diseases**

➤ **Cancer:** Contemporary herbal formulas have been extensively studied for their ability to target cancer, as many phytoconstituents act on molecular sites that play a role in tumor development. Apoptosis, angiogenesis, inflammation, and metastases can be regulated by substances like curcumin, quercetin or other dietary supplements<sup>(19)</sup>. Nevertheless, their rapid systemic clearance, instability, and low water solubility severely restrict their practicality. Contemporary nanoformulation methods have resolved these limitations by optimizing the intracellular transport and storage of such materials. Unlike free curcumin, curculipin-loaded polymeric nanoparticles exhibit better absorption and increased apoptosis properties<sup>(20)</sup>. Liposomes can enhance the pharmacokinetics by protecting their structure from rapid metabolism and prolonging the circulatory time of resveratrol. The EPR effect, which allows tumor tissues to accumulate in the targeted site due to leaky vasculature, is a significant benefit of nanoparticle-based delivery<sup>(21)</sup>.

➤ **Diabetes Mellitus:** Diabetes mellitus is a chronic metabolic condition marked by the presence of oxidative stress, inflammation, and insulin resistance. The use of herbal components like quercetin, curcumin and berberine has been shown to help preserve pancreatic  $\beta$ -cells, increase insulin sensitivity, and regulate glucose metabolism. However, their therapeutic efficacy is sometimes hindered by rapid metabolism and poor absorption. The development of nanoformulations has been significant in this respect. Enhanced glycemic control is achieved through the use of Berberine-loaded nanoparticles, which increase intestinal permeability and decrease efflux mechanisms. Similarly, curcumin nanoformulations offer superior systemic absorption and anti-aging properties compared to traditional formulations. This is also true for other compounds<sup>(22)</sup>.

➤ **Neurological Disorders:** The BBB's tightness poses a significant challenge for administering drugs in neurological conditions like Parkinson's and Alzheimer's. The brain cannot be efficiently accessed in therapeutic quantities due to the presence of phytoconstituents that possess neuroprotective, antioxidant, and anti-inflammatory effects. This obstacle has been overcome by delivery methods that utilize nanotechnology. To increase brain uptake, nanoparticles can be created through transcytosis or receptor-mediated transport across the blood-brain barrier. In experimental models, curcumin-loaded nanoparticles have been found to have superior neuroprotective effects and reduce the formation of amyloid plaque<sup>(23)</sup>.

➤ **Skin Disorders:** Dermatological diseases are largely caused by the ability of herbal remedies to penetrate the skin barrier and reach deeper



into the body. The use of phytoconstituents, including essential oils, flavonoids, and terpenoids to treat wounds. These substances are effective in combating inflammation and antibacterial activity. In spite of this, conventional topical treatments often do not penetrate as well. The use of innovative delivery methods like ethosomes, transfersomes and nanoemulsions greatly enhances the effectiveness of skin penetration. They are able to transport drugs into deeper layers of the skin without interfering with the stratum corneum due to their nanoscale size and flexible shape<sup>(24)</sup>.

- **Cardiovascular Disorder:** Cardiovascular disorders are directly related to oxidative stress, inflammation, and endothelial dysfunction.[M]. Significant cardioprotective effects have been observed with phytoconstituents, including resveratrol and flavonoids, that also promote endothelial function, reduce reactive oxygen species (oxidative damage), or manage fat stores. They have a restricted therapeutic use due to their rapid metabolism and reduced absorption rate. The stability and bioavailability of these drugs are enhanced by contemporary formulations, particularly lipid-based nanoparticles and nanoemulsions<sup>(25)</sup>.

### Challenges and Limitations of Modern Herbal Formulations

- **Standardization and Variability:** A fundamental issue is the lack of consistency in herbal formulas. Herbal ingredients, unlike synthetic drugs, are derived from plants and their composition can vary significantly based on various factors such as seasonality, harvesting methods, geographic location, and extraction methods. The effectiveness, safety and consistency of the final formulation are directly linked to this heterogeneity<sup>(26)</sup>.

- **Toxicity and Safety Concerns:** Drugs are distributed through nanocarriers, but there is a risk of toxicity. There is still a lot to be learned about the long-term safety of various nanomaterials, especially polymeric and lipid-based carriers. Certain investigations have exposed issues like accumulation in organs, oxidative damage, and unantibondimetal responses. Some studies also indicate these problems. Depending on the composition, size, and surface charge of nanoparticles themselves may interact with biological systems and potentially lead to cytotoxicity<sup>(27)</sup>.
- **Stability Issues:** Despite attempts to improve stability in contemporary formulations, both physical and chemical instability persist. Phase separation, drug leakage, and particle aggregation may occur during storage, especially in lipid-based systems and nanoemulsions. In addition, environmental conditions like temperature (oil and moisture), light, and humidity may affect the stability of a formulation, which in turn could reduce its efficacy and decrease its shelf life<sup>(28)</sup>.
- **Scale-Up and Manufacturing Limitations:** The vast majority of modern herbal formulas are manufactured in laboratories, and it's still a daunting task to make them industrial. High-pressure homogenization, solvent evaporation, and nanoprecipitation are processes that can be difficult to control precisely in large-scale manufacturing<sup>(29)</sup>.
- **Regulatory Challenges:** There are no established guidelines for herbal nanoformulations, and regulatory frameworks for both herbal medicines and nanomedicines are still being developed. This results in delayed product development and unclear



clearance procedures. Different countries have different regulations, making global commercialization difficult<sup>(30)</sup>.

- **Limited Clinical Evidence:** Although several studies in vitro and animal models demonstrate positive results, the safety and efficacy of modern herbal formulations in humans remain unsupported by well-designed clinical trials. There is limited clinical practice translation, and the majority of the data available is preclinical<sup>(31)</sup>.

### Future Prospects of Modern Herbal Formulations

Modern herbal formulations are rapidly evolving from basic nano-delivery systems to more patient-specific and targeted approaches. Despite the fact that existing systems have resolved some problems, such as solubility and stability, future research is focused on improving the accuracy, safety, and clinical translation of phytoconstituents. Developing targeted delivery systems for medicines is one of the most promising paths to take. Currently, advanced nanocarriers are being developed with surface modifications such as peptides, ligands, or antibodies that can identify specific receptors on sick cells<sup>(32)</sup>. These techniques are likely to enhance the therapeutic efficacy of the phytoconstituents to a large extent. A new field of development is the development of stimulus-responsive drug delivery systems which release medication in response to internal or external stimuli such as pH, temperature, enzymes or redox conditions. The differences in pH and enzyme levels in tumor tissues make these methods very useful. Smart nanocarriers can enhance therapeutic efficacy via targeted and controlled drug release<sup>(33)</sup>. Another important development is the use of machine learning and artificial intelligence (AI) in formulation development. AI can be used to predict drug-

excipient interactions, to optimize formulation parameters and to design effective delivery systems with improved performance. This accelerates the development process and reduces the amount of trial-and-error experimentation. Furthermore, green nanotechnology is becoming more popular. The technology utilizes plant extracts and eco-friendly methods for the synthesis of nanoparticles, thereby minimizing the use of toxic chemicals and enhancing the sustainability of the process<sup>(34)</sup>. Green synthesis is environmentally friendly and improves the biocompatibility of the final formulation. Another important trend is the emergence of combination medicines, which include the use of several phytoconstituents in a single formulation or the co-delivery of herbal ingredients with synthetic pharmaceuticals. These systems can reduce drug resistance, improve therapeutic efficacy, and offer synergistic effects, particularly in chronic diseases like diabetes and cancer. The delivery of herbal medication is also expected to be affected by developments in personalised medicine. The formulations can be tailored to the individual genetic and metabolic characteristics of a specific group of patients to achieve optimal treatment outcomes. This is still an early-stage strategy but has a lot of promise for the future<sup>(35)</sup>.

### CONCLUSION

Pharmaceutical research has advanced significantly with the adoption of herbal medicine from traditional practice to modern therapeutic application. The medicinal uses of herbal components are limited due to their poor solubility, low bioavailability, instability, and lack of customized delivery, despite their wide range of pharmacological activity. Modern formulation methods have been instrumental in overcoming these difficulties and unlocking the complete therapeutic value of phytoconstituents. Lipid-



based carriers, vesicular systems, and nanoparticle-derived formulations are among the advanced delivery techniques that have been shown to improve absorption, stability, regulation, or site-specific drug release. These advancements are particularly relevant for the management of complex and chronic illnesses, which require consistent therapeutic doses and tailored treatment options. The investigation of herbal ingredients' medicinal properties is now being conducted more extensively to explore their potential medicinal benefits. In spite of this, there are several barriers that prevent the widespread adoption of present-day herbal remedies. Important barriers to address include variability in plant sources, a lack of uniformity, long-term safety issues, challenges encountered in large-scale manufacturing, and the absence of well-defined regulatory mechanisms. Moreover, their inclusion in standard medical practice is hindered by the absence of robust clinical evidence. The future of modern herbal formulations remains bright despite these challenges. The continued progress and enhancement of these systems are expected to be facilitated by the integration of smart and stimuli-responsive systems, targeted drug administration, green synthesis techniques, and the use of cutting-edge technology like artificial intelligence.

## REFERENCES

1. Vinod Kumar S, Prakash Babu D. "Perovskite SrTiO<sub>3</sub> for photo-catalytic and optoelectronic applications." *Mater Today Proc* [Internet]. 2024 Mar; Available from: <https://linkinghub.elsevier.com/retrieve/pii/S2214785324001032>
2. Teja PK, Mithiya J, Kate AS, Bairwa K, Chauthe SK. Herbal nanomedicines: Recent advancements, challenges, opportunities and regulatory overview. *Phytomedicine* [Internet]. 2022 Feb;96:153890. Available

from:

<https://linkinghub.elsevier.com/retrieve/pii/S094471132100430X>

3. Saito J, Miyamoto S, Yamada M, Yamatani A, Ruiz F, Vallet T. Adherence and Acceptability of an Oral Antibiotic Used for the Prevention of Pediatric Urinary Tract Infection in Japan. *Pharmaceutics* [Internet]. 2021 Mar 6;13(3):345. Available from: <https://www.mdpi.com/1999-4923/13/3/345>
4. Duan Y, Dhar A, Patel C, Khimani M, Neogi S, Sharma P, et al. A brief review on solid lipid nanoparticles: part and parcel of contemporary drug delivery systems. *RSC Adv* [Internet]. 2020;10(45):26777–91. Available from: <https://xlink.rsc.org/?DOI=D0RA03491F>
5. Trapani M, Scala A, Mineo PG, Pistone A, Díaz-Moscoso A, Fragoso A, et al. Thiolated amphiphilic  $\beta$ -cyclodextrin-decorated gold colloids: Synthesis, supramolecular nanoassemblies and controlled release of dopamine. *J Mol Liq* [Internet]. 2021 Aug;336:116880. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0167732221016044>
6. Vetvicka D, Sivak L, Jogdeo CM, Kumar R, Khan R, Hang Y, et al. Gene silencing delivery systems for the treatment of pancreatic cancer: Where and what to target next? *J Control Release* [Internet]. 2021 Mar;331:246–59. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0168365921000298>
7. Mahapatra DK, Patil S, Patil AG. The Progressive Journey of Phytosomes in Herbal Based Pharmacotherapeutics. *Curr Bioact Compd* [Internet]. 2020 Oct 2;16(6):853–86. Available from: <https://www.eurekaselect.com/171689/article>
8. Sogut O, Aydemir Sezer U, Sezer S. Liposomal delivery systems for herbal



- extracts. *J Drug Deliv Sci Technol* [Internet]. 2021 Feb;61:102147. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S1773224720314362>
9. Iskandar B, Liu T-W, Mei H-C, Kuo I-C, Surboyo MDC, Lin H-M, et al. Herbal nanoemulsions in cosmetic science: A comprehensive review of design, preparation, formulation, and characterization. *J Food Drug Anal* [Internet]. 2024 Dec 14;32(4):428–58. Available from: <https://www.jfda-online.com/journal/vol32/iss4/4>
  10. Barakat AM, El-Razik KAA, El Fadaly HAM, Saleh WM, Ali FAZ, Gouda AA, et al. Parasitological, Molecular, and Histopathological Investigation of the Potential Activity of Propolis and Wheat Germ Oil against Acute Toxoplasmosis in Mice. *Pharmaceutics* [Internet]. 2023 Feb 1;15(2):478. Available from: <https://www.mdpi.com/1999-4923/15/2/478>
  11. Issue Information. *Drug Dev Res* [Internet]. 2023 Apr 11;84(2):141–2. Available from: <https://analyticalsciencejournals.onlinelibrary.wiley.com/doi/10.1002/ddr.21944>
  12. de Juan Mora B, Filipe L, Forte A, Santos M, Alves C, Teodoro F, et al. Boosting Antimicrobial Activity of Ciprofloxacin by Functionalization of Mesoporous Silica Nanoparticles. *Pharmaceutics* [Internet]. 2021 Feb 5;13(2):218. Available from: <https://www.mdpi.com/1999-4923/13/2/218>
  13. Nangare S, Dugam S. Smart invasome synthesis, characterizations, pharmaceutical applications, and pharmacokinetic perspective: a review. *Futur J Pharm Sci* [Internet]. 2020 Dec 13;6(1):123. Available from: <https://fjps.springeropen.com/articles/10.1186/s43094-020-00145-8>
  14. Demirbaş A, Eker H, Elmas ÖF, Ulutaş Demirbaş G, Atasoy M, Türsen Ü, et al. COVID-19 and human papillomavirus: Paradoxical immunity. *J Cosmet Dermatol* [Internet]. 2021 Jul 9;20(7):2001–3. Available from: <https://onlinelibrary.wiley.com/doi/10.1111/jocd.14022>
  15. Nishiga M, Qi LS, Wu JC. Therapeutic genome editing in cardiovascular diseases. *Adv Drug Deliv Rev* [Internet]. 2021 Jan;168:147–57. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0169409X20300090>
  16. Khogta S, Patel J, Barve K, Londhe V. Herbal nano-formulations for topical delivery. *J Herb Med* [Internet]. 2020 Apr;20:100300. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S2210803319300478>
  17. Panda P, Mohapatra R. Herbal nanoparticles: a targeted approach for neurodegenerative disorder treatment. *J Drug Target* [Internet]. 2024 Nov 25;32(10):1233–46. Available from: <https://www.tandfonline.com/doi/full/10.1080/1061186X.2024.2391913>
  18. Skotland T, Sagini K, Sandvig K, Llorente A. An emerging focus on lipids in extracellular vesicles. *Adv Drug Deliv Rev* [Internet]. 2020;159:308–21. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0169409X20300144>
  19. Gunes S, He Z, van Acken D, Malone R, Cullen PJ, Curtin JF. Platinum nanoparticles inhibit intracellular ROS generation and protect against cold atmospheric plasma-induced cytotoxicity. *Nanomedicine Nanotechnology, Biol Med* [Internet]. 2021 Aug;36:102436. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S1549963421000794>
  20. Siri-Angkul N, Chattipakorn SC, Chattipakorn N. The mechanistic insights of



- the arrhythmogenic effect of trastuzumab. *Biomed Pharmacother* [Internet]. 2021 Jul;139:111620. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0753332221004054>
21. Kumar V, Taleuzzaman M. Editorial: Cancer prevention and therapy using herbal formulations of natural immune modulators. *Front Immunol*. 2026 Mar 11;17.
  22. Tyagi A, Singh AP. Epilepsy: Modern Treatment Approaches, Clinical Aspects, and Patent Status. *CNS Neurol Disord - Drug Targets*. 2026 Mar 13;25.
  23. Shahrajabian MH, Sun W. Study of Traditional Chinese Medicine to Treat Skin Diseases and Improve Skin Health. *Curr Nutr Food Sci*. 2025 Oct;21(8):864–82.
  24. Bolatkyzy N, Shepilov D, Turmanov R, Berillo D, Vassilina T, Ibragimova N, et al. Medicinal Plants for Skin Disorders: Phytochemistry and Pharmacological Insights. *Molecules*. 2025 Aug 6;30(15):3281.
  25. Fatima G, Khan S, Shukla V, Awaida W, Li D, Gushchina YS. Nutraceutical formulations and natural compounds for the management of chronic diseases. *Front Nutr*. 2025 Oct 15;12.
  26. Jaisankar D, Ramamoorthy S, Ramasamy J. Therapeutic potential of flavonoid-enriched Chinese medicinal herbs in atherosclerosis, hypertension, myocardial infarction, and heart failure. *Pharmacol Res - Mod Chinese Med*. 2025 Dec;17:100701.
  27. Shah P, Banerjee S, Singh A, Kulhari H, Anand Saharan V. From Traditional to Modern Medicine: The Role of Herbs and Phytoconstituents in Pharmaceuticals, Nutraceuticals, and Cosmetics. In: *Formulating Pharma-, Nutra-, and Cosmeceutical Products from Herbal Substances*. Wiley; 2025. p. 3–73.
  28. Etaware P, America oshua, Egara O, Ekun V. Herbal Medicine: Scientific Validation and Future Prospects. *Int J Pharm Chem*. 2025 Aug 18;11(3):67–75.
  29. Banerjee D, Banerjee S, Shah P, Singh A, Saharan VA. Evidence-Based Clinical Assessment of Herbal Formulations: Traditional and Modern Insights. In: *Formulating Pharma-, Nutra-, and Cosmeceutical Products from Herbal Substances*. Wiley; 2025. p. 703–42.
  30. Hajipour S, Ghonoudi A, Alinia-Ahandani E, Riaz A. A Short Review of the Current and Future Prospects of Herbal Medicine and Natural Products. *J Hum Environ Heal Promot*. 2024 Oct 1;10(4):191–8.
  31. Kumar R. Nanotechnology in herbal medicine: Challenges and future perspectives. In: *Nanotechnology in Herbal Medicine*. Elsevier; 2023. p. 515–48.
  32. Regulation and standardization of herbal drugs: Current status, limitation, challenge's and future prospective. In 2024. p. 153–99.
  33. Bulbul EO, Okur NU. Difficulties in Using Natural Herbal Substances and Their Current use in Some Pharmaceutical Dosage Forms. *Curr Pharm Des*. 2025 Aug;31(28):2252–66.
  34. Singh SK, Sahu N, Katiyar P, Arya V. Challenges, recent notions, and advances in the Indian traditional medicinal system and governance. In: *Integrated Pathy*. Elsevier; 2025. p. 241–91.
  35. Rath P, Bhardwaj LK, Khanna S, Sharma YK, Kumar A. Limitations and Challenges of Medicinal Plant-Based Nanoformulations. In 2026. p. 383–403.

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