AG Publishing House

Modern Trends in Medicinal Chemistry: Techniques, Applications, and Innovations (volume-1)

Volume 1
Year: 2025

AG PH Books

Natural Products in Drug discovery: Current Trends

Dr. Santosh Kumar Nathsharma [1*]

[1]*Lecturer in Chemistry, Stewart Science College, Cuttack, Odisha*

Abstract

Medical chemicals have been found in nature for thousands of years, and a staggering number of modern medicines have been shown to have natural roots. For many years, people have employed plants as herbal remedies to cure a variety of illnesses, and the numerous natural compounds they produce have served as inspiration for the creation of new medications. This demand will be met in large part by natural goods via the ongoing investigation of the world's biodiversity, much of which is yet unknown. In this article review the various literature's study on "natural products in drug discovery". In conclusion, natural products have been a fundamental component of drug discovery for an extended period, providing useful lead compounds for the development of new therapeutics. Advances in technology have enhanced the selection, identification, and optimization of plant-derived phytochemicals, improving their efficacy and safety. Despite challenges in natural product development, innovative strategies continue to drive drug discovery, addressing both communicable and non-communicable diseases. Plant-based biologics have been further emphasised as a potential vaccine development strategy during the COVID-19 pandemic. In areas such as "immunosuppression, anti-infectives, and metabolic disorders", natural products continue to be a critical source of innovative treatments, as a result of the renewed interest in them as a result of the constraints of alternative drug discovery methodologies.

Keywords: Natural products, Drug discovery, and development, Medicinal chemistry, Drug designs, Automation, Artificial intelligence (AI), etc.

[*] ISBN No. - 978-93-49028-76-0

Dr. Santosh Kumar Nathsharma

1 Introduction

The majority of early medications were made from natural sources, which have also been crucial in drug development. For many serious illnesses for which there is now no effective therapy, these natural ingredients have been discovered to be a vital source of novel medications [1]. Drug prospects have long been abundant in nature, which also presents medicinal chemists and researchers with previously unheard-of chances to consistently provide the lead molecules [2]. According to the World Health Organization's study, approximately 65% of the global populace consumes natural bioactive components as the initial critical defensive measure for the treatment of numerous maladies. China, India, and many other nations have long used a wide variety of natural ingredients in their ancient medical systems [3]. Natural materials are still regarded as a useful source of medication leads in the modern period. This method was common in the pharmaceutical business. Minerals, plants, and animals are examples of natural goods that have been used to cure human illnesses [4]. Ancient knowledge, however, has served as the foundation for contemporary medicine and will continue to be a significant source of future treatments and medical knowledge. Almost as long as human civilisation has been, medicine has existed. Natural products and chemicals produced from them have traditionally provided the bulk of new pharmaceuticals (secondary metabolites) [5], [6].

A. Drug discovery

The process of finding new potential drugs is known as drug discovery in the domains of pharmacology, biotechnology, and medicine. The active component of traditional treatments was traditionally identified, or drugs were discovered by coincidence, as was the case with penicillin. In order to identify compounds with the intended therapeutic effect, classical pharmacology, a more modern method, contained screening chemical libraries of natural products, synthesised small molecules, or extracts in whole organisms or intact cells [7]. Since the human genome has been sequenced, allowing for the quick cloning and synthesis of large amounts of purified proteins, reverse pharmacology—the high-throughput screening of large compound libraries towards isolated biological targets thought to be disease-modifying—has become a standard procedure. These screens' hits are further evaluated for effectiveness in cells and subsequently in animals [5].

B. “Importance of plant-derived natural products in drug discovery”

In the treatment of infections, natural compounds and its "structural analogues" have long been important in pharmacotherapy. Apart from the physiologically active bioactive compounds derived from plants that have been shown to have direct therapeutic utility as drug substances, many additional naturally occurring bioactive chemicals have proven promise as "leads" or model molecules for drug synthesis or semi-synthesis [8]. These difficulties have recently been resolved, and a variety of technological and scientific developments, including advances in microbial culture, genome extraction, engineering methods, and enhanced analytical tools, have generated new opportunities. These developments are shown by the intricacy of bioassays employed in the creation of medicinal plants. Additionally, they provide rapid and accurate "mode of action" information at the molecular level. Consequently, there is

renewed interest in natural chemicals as possible therapeutic candidates, particularly for the treatment of antibiotic resistance [9].

C. "Multidisciplinary approach to natural products drug discovery using innovative technologies"

To package natural product molecules for use in medicine and drug research, a multidisciplinary strategy using cutting-edge technology is necessary for new drug discovery from natural products. A successful implementation of this strategy will enable the creation of next-generation medications to address the growing health issues of the present and the future [8]. Since most components of medicinal extracts work together to create their therapeutic benefits, it may not be helpful to isolate individual constituents. Researching and using these molecules, which may successfully result in novel medications, requires creative methods. Additionally, a systems biology-based approach offers an alternative perspective on natural products. Pharmacy science [10].

Utilising existing technologies like transcriptomics, proteomics, metabolomics/metabonomics, genomics, automation, and computational techniques in conjunction with a systems biology approach may open the door to novel drug design that produces superior therapeutic candidates. Molecular libraries of lead compounds derived from natural product research and development will be used to generate lead compounds and herbal tinctures for novel medications [11]. Applying cutting-edge technology in conjunction with systems biology should prioritise the synergistic effects of chemicals rather than a reductionist strategy that seeks to identify a single active ingredient. A non-reductionist approach will be necessary to comprehend the intricate molecular mechanisms of action of natural products in order to develop novel drugs [12].

D. "Computer-aided drug design from natural products"

Many global health challenges might be addressed by synthetic chemicals that are patterned after natural products. However, in numerous instances, these substances would have been denied as unsuitable for therapeutic uses. Several of the innovative designs would have failed because to the excessively strict criteria of "the rule of three and rule of five", which are often utilised when choosing drug leads [13]. In actuality, a lot of the rules utilised in medication design exhibit human bias, which limits their applicability and efficacy, particularly when it comes to natural goods. Using computer-aided designs, several medicinal synthetic chemicals, including a number of anticancer medicines, have been created. For instance, the Scaffold Hunter program was used to create virtual pieces of tiny, chemically appealing molecules by simplifying complicated natural items [14]. Such computer program must display small molecules that maintain the same biological activity as the mother substance. In fact, this technique has previously been used to find pyruvate kinase activators and inhibitors. But it's also feasible that simple molecules produced from natural products will have less activity than the original chemical [15]. A number of basic structures or chemical compounds generated from the mother material have had their biological activity predicted using the PASS software with great effectiveness. The antitumor properties of a number of marine alkaloids have been predicted using the PASS program [10].

2 Literature Review

(Chaachouay & Zidane, 2024) [9] This demand will be met in large part by natural goods via the ongoing investigation of the world's biodiversity, much of which is yet unknown. The exploration of these natural resources requires interdisciplinary, national, and international collaborations in design, synthesis, drug development, and discovery methods. The existing and upcoming methods for finding natural products, such cures for illnesses and ailments, are covered in this review article. Additionally, it lists ways to encourage future plant-based medication discoveries by standardising the therapeutic use of natural compounds produced from plants globally.

(Zeng et al., 2024) [11] Natural products (NPs) are useful resources for drug development because of their wide range of chemical structures and biological activity. The several uses of these databases in drug development, including molecular creation, knowledge graph building, and virtual screening, are next examined. Talk about the database development challenge in more detail, paying particular attention to data quality and updates. Lastly, highlight how important teamwork and toolkit innovation are to maximising the enormous potential of databases connected to NPs in order to speed up production, structural modification, and bioactivity mining. In order to support researchers in creating and managing top-notch NP databases for drug development, this paper attempts to clarify the essential characteristics and uses of NP databases.

(Sj & Shetty, 2024) [16] discusses some of the developments in the use of contemporary drug discovery technologies to create innovative treatments that are effective natural products. Along with related techniques in medicinal chemistry, nanotechnology, combinatorial chemistry, and high-throughput screening, the development prospects in natural product research are examined with the application of some of the new information technology trends, such as big data, automation, artificial intelligence (AI), computer-aided drug design, and omics strategies. The evaluation specifically focusses on the advancement of novel approaches, interdisciplinary applications, and procedures with upcoming objectives and possibilities.

(Newman, 2022) [17] Angiotensin converting enzyme inhibitors and type 2 diabetes (T2DM) medications are discussed after the recent history of a number of highly significant natural products and their derivatives that are either in use or being evaluated in the fields of anti-infectives and significant cancer treatments, such as antibody drug conjugates, are covered. The agents' present structures are shown, while some peptides used in T2DM medications utilise the usual one-letter shorthand for an amino acid.

(Nasim et al., 2022) [18] Nature provides a wealth of medications that must be found and refined for usage as necessary biologics, either alone or in combination, in the contemporary medical sector. The advancement of systems biology and computational methods for therapeutic target identification are covered in this article along with a summary of several approaches to phytopharmaceutical drug development. To make it easier for medications to reach their objectives efficiently, we examine the current drug delivery techniques. The various analytical methods for plant material fingerprinting and

authenticity are also described. Lastly, we discuss how biopharming is used to create biologics derived from plants.

(Chopra & Dhingra, 2021) [19] discusses the significance of natural products for the development and discovery of new drugs. With minor adjustments and fresh viewpoints, it explains how the natural elements may be used. An exceptional chance to create a novel molecular entity with improved pharmacological potential is presented by a number of novel structural changes. With an emphasis on finding and discovering new, effective molecules—referred to as "new entities of natural product drug discovery"—new efforts are being made in the present period to use chemicals generated from natural sources as innovative therapeutic candidates, it was found.

(Tresina et al., 2021) [20] The availability of new molecules that are easily synthesised from plant, yeast, or bacterial sources has expanded recently due to the use of molecular biological methods. Additionally, screening libraries that closely mimic drug-like molecules are being created using combinational chemistry techniques based on natural product scaffolds. By using these technologies, we have the opportunity to conduct research on screening novel compounds using a database and algorithms to identify natural products as a significant source for drug development. Finally, it leads to the discovery of the lead structure. This study covers the importance of advanced technology in the next-generation drug discovery, plant-based natural product medication development, and features from published research on plants as sources of anti-inflammatory pharmaceuticals.

3 Conclusion

Since natural products provide a wealth of bioactive chemicals for therapeutic development, they have long been a mainstay of drug discovery. The optimization of plant-derived phytochemicals has led to the creation of effective and safe drug analogs. In response to the difficulties in drug development, sophisticated methods for "the selection, identification, isolation, and characterisation" of natural components have been developed as medicinal chemists' interest in this field has grown. Despite the complexities involved, technological advancements have improved the success rate of identifying novel therapeutic agents. The ongoing need for innovative drug development strategies is evident, particularly in response to global health crises such as COVID-19. Plant-based biologics offer promising avenues for developing antiviral vaccines, highlighting the significance of natural products in combating emerging diseases. Moreover, the failure of alternative drug discovery approaches to yield sufficient lead compounds has renewed interest in natural product research, particularly in areas like immunosuppression, anti-infectives, and metabolic disorders. Reiterating their vital significance in contemporary medicine, the ongoing investigation of natural substances continues to be a crucial tactic for the creation of innovative pharmaceutical medications.

References

[1] G. Atanasov, S. B. Zotchev, V. M. Dirsch, and C. T. Supuran, “Natural products in drug discovery: advances and opportunities,” *Nat. Rev. Drug Discov.*, vol. 20, no. 3, pp. 200–216, 2021, doi: 10.1038/s41573-020-00114-z.

[2] S. P. Singh, S. K. Shukla, and R. Yadav, “Artificial intelligence and Machine learning- based approaches for Neurodegenerative Diseases Diagnosis,” pp. 31–37, 2023.

[3] J. B. Calixto, “The role of natural products in modern drug discovery.,” *An. Acad. Bras. Cienc.*, vol. 91, pp. 1–7, 2019, doi: 10.1590/0001-3765201920190105.

[4] J. Ribeiro-Filho, Y. C. F. Teles, J. O. Igoli, and R. Capasso, “Editorial: New trends in natural product research for inflammatory and infectious diseases,” *Front. Pharmacol.*, vol. 13, no. August, pp. 1–4, 2022, doi: 10.3389/fphar.2022.975079.

[5] M. Lahlou, “The Success of Natural Products in Drug Discovery,” *Pharmacol. & Pharm.*, vol. 04, no. 03, pp. 17–31, 2013, doi: 10.4236/pp.2013.43a003.

[6] S. Sahu, J. Boaddh, and V. S. Pawar, “Machine Learning in Diabetes Diagnosis : A Comprehensive Review,” pp. 80–85, 2024, doi: 10.69968/ijisem.2024v3i480-85.

[7] D. Wright, “Unlocking the potential of natural products in drug discovery,” *Microb. Biotechnol.*, vol. 12, no. 1, pp. 55–57, 2019, doi: 10.1111/1751-7915.13351.

[8] Najmi, S. A. Javed, M. Al Bratty, and H. A. Alhazmi, “Modern Approaches in the Discovery and Development of Plant-Based Natural Products and Their Analogues as Potential Therapeutic Agents,” *Molecules*, vol. 27, no. 2, 2022, doi: 10.3390/molecules27020349.

[9] N. Chaachouay and L. Zidane, “Plant-Derived Natural Products: A Source for Drug Discovery and Development,” *Drugs Drug Candidates*, vol. 3, no. 1, pp. 184–207, 2024, doi: 10.3390/ddc3010011.

[10] N. E. Thomford *et al.*, “Natural products for drug discovery in the 21st century: Innovations for novel drug discovery,” *Int. J. Mol. Sci.*, vol. 19, no. 6, 2018, doi: 10.3390/ijms19061578.

[11] T. Zeng, J. Li, and R. Wu, “Natural Product Databases for Drug Discovery: Features and Applications,” *Pharm. Sci. Adv.*, vol. 2, no. August, p. 100050, 2024, doi: 10.1016/j.pscia.2024.100050.

[12] Jalil, J. M. Rollinger, A. G. Atanasov, R. K. Singla, A. D. Kinghorn, and M. Heinrich, “Core publications in drug discovery and natural product research,” no. November, pp. 1–12, 2024, doi: 10.3389/fntpr.2024.1493720.

[13] R. Shrivastava, G. Modi, P. S. Satpathy, S. Bandyopadhyay, Y. Kumar, and I. Yadav, “Natural Products Revolutionizing and Innovative Drug Discovery and Development Strategies: Healthcare Challenges and Future Perspectives,” *J. Appl. Bioanal.*, no. July, 2024, doi: 10.53555/jab.v10i1.76.

[14] G. Conrado, R. da Rosa, R. D. Reis, and L. R. Pessa, “Building Natural Product–Based Libraries for Drug Discovery: Challenges and Opportunities from a Brazilian Pharmaceutical Industry Perspective,” *Rev. Bras. Farmacogn.*, vol. 34, no. 4, pp. 706–721, 2024, doi: 10.1007/s43450-024-00540-9.

[15] J. Newman and G. M. Cragg, “Natural Products as Sources of New Drugs over the Nearly Four Decades from 01/1981 to 09/2019,” *J. Nat. Prod.*, vol. 83, no. 3, pp. 770–803, 2020, doi: 10.1021/acs.jnatprod.9b01285.

[16] R. Sj and N. P. Shetty, "Advances in designing Next-generation drugs from Natural products," pp. 1–21, 2024.

[17] J. Newman, "Natural products and drug discovery," *Natl. Sci. Rev.*, vol. 9, no. 11, 2022, doi: 10.1093/nsr/nwac206.

[18] N. Nasim, I. S. Sandeep, and S. Mohanty, "Plant-derived natural products for drug discovery: current approaches and prospects," *Nucl.*, vol. 65, no. 3, pp. 399–411, 2022, doi: 10.1007/s13237-022-00405-3.

[19] Chopra and A. K. Dhingra, "Natural products: A lead for drug discovery and development," *Phyther. Res.*, vol. 35, no. 9, pp. 4660–4702, 2021, doi: 10.1002/ptr.7099.

[20] P. S. Tresina, M. S. Selvam, A. Rajesh, A. Doss, and V. R. Mohan, "Natural Products in Drug Discovery: Approaches and Development," *J. Pharm. Res. Int.*, vol. 33, pp. 93–110, 2021, doi: 10.9734/jpri/2021/v33i35a31879.