



EDITORIAL

Plant Lectins: The Next Frontier in Precision Glycan-Targeted Medicine

Emadeldin Hassan E Konozy^{1*} and Alkhair Adam K Mohamed^{2,3}

① Biomedical and Clinical Research Centre (BCRC), College of Health and Allied Sciences (CoHAS), University of Cape Coast, Cape Coast, Ghana | ② Department of Biomedical Sciences, School of Allied Health Sciences, College of Health and Allied Sciences, University of Cape Coast, Cape Coast, Ghana | ③ Department of Pharmaceutical Chemistry, College of Pharmacy, Karary University, Omdurman, Sudan

*Correspondence should be addressed to Emadeldin Hassan E Konozy (email: ehkonozy@ucc.edu.gh)

Precision medicine is revolutionizing healthcare by shifting away from the traditional “one-size-fits-all” approach to treatments. This new approach focuses on developing therapies tailored to each individual. It takes into account a person’s unique genetic makeup, environmental factors, and lifestyle choices¹. To achieve effective precision medicine, highly accurate molecular tools are essential. These tools must be able to detect and target specific disease-related markers with very few errors. Among the promising options in this field are plant lectins. These proteins can bind reversibly to specific sugars². Plant lectins are attracting considerable interest because they can attach accurately to certain sugar structures found on cell surfaces³.

Glycosylation, the enzymatic process of anchoring glycans to proteins and lipids, is important in cellular communication, immune targeting, and disease progression. Numerous pathological conditions, such as cancer, infectious diseases, and neurodegenerative disorders, are characterized by abnormal glycosylation⁴. Given their notable ability to selectively recognize and bind specific carbohydrate assemblies, plant lectins have emerged as powerful tools to exploit these glycan alterations for both therapeutic and diagnostic applications^{3,5}. These proteins present an exciting avenue toward precision medicine by utilizing their high specificity, which enables targeted therapies based on glycan modifications associated with disease^{3,6}.

The ability to recognize and take advantage of patient-specific molecular signatures is essential for the shift from traditional therapies to precision medicine. Carbohydrate-binding proteins, such as plant lectins, are essential tools for diagnosis and treatment because glycosylation plays a crucial role in disease mechanisms. The high glycan selectivity of these proteins makes them useful for immune modulation⁷, targeted drug delivery

⁸, and biomarker identification⁹. The variety of their structure and function enables accurate interactions with cell-surface receptors, impacting immune responses and signaling pathways—a crucial aspect of tailored treatments. According to their preferences for binding carbohydrates, plant lectins are categorized as follows: lectins that bind mannose, such as Concanavalin A (ConA); lectins that bind galactose, such as Erythrina indica lectin; lectins that bind N-acetylglucosamine, such as *Griffonia simplicifolia* lectin; and lectins that bind fucose, such as *Lotus tetragonolobus*¹⁰. According to new research, some plant lectins may alter signaling pathways and cellular receptors involved in pain perception and the defense of the stomach mucosa. Lectins’ specificity could be used to create customized antinociceptive treatments^{11,12} and gastroprotective effects¹³⁻¹⁵ that address individual differences in disease mechanisms. For example, lectins that selectively target sialylated glycans—which are overexpressed in neuropathic pain¹⁶—could deliver localized analgesia with fewer side effects than opioids. *Maackia amurensis* lectins (MAL-I and MAL-II), which bind specifically to α 2,3-linked sialic acid (MAL-I) and α 2,6-linked sialic acid (MAL-II), illustrate this potential¹⁷. Patients who take NSAIDs long term may benefit from lectins such as *Calotropis procera* Leaf Lectin (ProLec), which can help increase mucus secretion and protect the digestive tract¹⁴. This precision-based method may pave the way for new approaches for the treatment of gastrointestinal issues and chronic pain.

In conditions such as cancer, where tumor cells frequently exhibit altered glycan profiles, these proteins exhibit abnormal glycosylation patterns. They are perfect for therapeutic and diagnostic applications because of their binding specificity, which allows for targeted interactions⁵. By attaching to tumor-associated glycans,

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lectins such as ConA and Wheat Germ Agglutinin (WGA) can be used to differentiate malignant tissues for cancer biomarker detection, facilitating early diagnosis¹⁸. Lectins such as BanLec are used in infectious disease diagnostics to detect pathogen-specific glycans¹⁹, which speeds up the identification of bacterial and viral infections. Using lectin-based assays, neurodegenerative disease screening can identify altered glycans in Parkinson's disease and Alzheimer's disease, potentially leading to early intervention²⁰. By selectively binding to glycans specific to neurodegenerative diseases such as Parkinson's disease (PD) and Alzheimer's disease (AD), plant lectins can help with glycan-targeting precision medicine. For example, Concanavalin A (ConA) and Wheat Germ Agglutinin (WGA) can identify tau and amyloid-beta glycans in AD^{21,22}.

Targeted drug delivery systems are one area where the therapeutic potential of plant lectins is most noticeable. Glycan recognition, in which lectins bind disease-specific carbohydrates; cellular uptake via receptor-mediated endocytosis; and controlled release for intracellular drug delivery that reduces systemic toxicity are all components of their lectin-mediated targeting mechanism²³. With distinct disease applications, several lectin-based delivery systems, such as lectin-drug conjugates, lectin-coated nanoparticles, and lectin hydrogels, have been created. T/Tn-specific lectins extracted from *Artocarpus integrifolia* are used in cancer treatment to target aberrant O-glycans expressed on the surface of cancer cells²⁴. *Urtica dioica* agglutinin (UDA), which is specific to N₁N₂N₃-triacylchitotriose, inhibits SAR-CoV replication by blocking the ability of the virus to bind to the host cell spike protein²⁵.

To fully utilize plant lectins in clinical settings, several obstacles need to be overcome. The development of hypoallergenic lectins is necessary to address toxicity and immunogenicity concerns²⁶. Glycan heterogeneity demands customized glycan profiling, and pharmacokinetic issues necessitate stability and controlled release optimization²⁷. To improve clinical applicability, future studies should concentrate on lectin engineering, bioinformatics-driven glycan analysis, and nanotechnology integration³.

In conclusion, plant lectins have great potential for precision medicine because they provide glycan-specific targeting, accurate diagnosis, and adaptable treatment options. Advances in protein engineering, drug delivery systems, and glycomics could unlock their full potential in treating cancer, infections, and immune disorders. For their clinical translation to be successful, however, issues with safety, bioavailability, and regulatory barriers must be resolved. With further

development, plant lectins could soon transform personalized medicine and usher in a new era of patient specific, targeted treatments that harness the power of glycobiology to improve healthcare outcomes.

REFERENCES

1. Konig IR, Fuchs O, Hansen G, von Mutius E, Kopp MV. What is precision medicine? *Eur Respir J*. Oct 2017;50(4)doi:10.1183/13993003.00391-2017
2. Konozy EHE, Dirar AI, Osman MEM. Lectins of the Araceae family: Insights, distinctions, and future avenues-A three-decade investigation. *Biochim Biophys Acta Gen Subj*. Sep 2024;1868(9):130667. doi:10.1016/j.bbagen.2024.130667
3. Konozy EHE, Osman MEM, Dirar AI, Osman RSH. Revolutionizing therapeutics: The dazzling world of plant lectins. *Journal of King Saud University-Science*. 2024;103318. doi:10.1016/j.jksus.2024.103318
4. Reily C, Stewart TJ, Renfrow MB, Novak J. Glycosylation in health and disease. *Nat Rev Nephrol*. Jun 2019;15(6):346-366. doi:10.1038/s41581-019-0129-4
5. Konozy EHE, Osman MEM. Plant lectin: A promising future anti-tumor drug. *Biochimie*. Nov 2022;202:136-145. doi:10.1016/j.biochi.2022.08.002
6. Osterne VJS, Nascimento KS, Cavada BS, Van Damme EJM. The future of plant lectinology: Advanced technologies and computational tools. *BBA Adv*. 2025;7:100145. doi:10.1016/j.bbadv.2025.100145
7. Konozy EHE, Osman MEM. From inflammation to immune regulation: The dual nature of dietary lectins in health and disease. *Heliyon*. Oct 30 2024;10(20):e39471. doi:10.1016/j.heliyon.2024.e39471
8. Konozy EHE, Osman MEM, Dirar AI, Ghartey-Kwansah G. Plant lectins: A new antimicrobial frontier. *Biomed Pharmacother*. Nov 2022;155:113735. doi:10.1016/j.biopha.2022.113735
9. Hashim OH, Jayapalan JJ, Lee CS. Lectins: an effective tool for screening of potential cancer biomarkers. *PeerJ*. 2017;5:e3784. doi:10.7717/peerj.3784
10. Radhakrishnan A, Park K, Kwak I-S, Jaabir M, Sivakamavalli J. Classification of lectins. *Lectins: Innate immune defense and Therapeutics*. Springer; 2022:51-72.

11. Dafalla MB, Elmubarak SA, Naser EH, et al. Isolation, Purification, and Characterization of a Lectin from *Cassia senna* Seeds with Analgesic and Gastroprotective Effects. *Phytomed Plus*. 2025;100768.
12. Elmubarak SA, Dafalla MB, Idries AH, et al. Purification and Characterization of Phoenix dactylifera Lectin: μ -Opioid Receptor-Mediated Antinociceptive and Gastroprotective Activities. *Phytomed Plus*. doi:10.1016/j.phyplu.2025:100767.
13. Idries AH, Naser EH, Dafalla MB, et al. Biological activity and characterization of leaf and seed lectins from *Terminalia brownii*: Insights into their analgesic and antiulcer properties. *Heliyon*. Oct 30 2024;10(20):e39351. doi:10.1016/j.heliyon.2024.e39351
14. Al-Thobaiti SA, Konozy EHE. Purification, Partial Characterization, and Evaluation of the Antiulcer Activity of *Calotropis procera* Leaf Lectin. *Protein Pept Lett*. 2022;29(9):775-787. doi:10.2174/0929866529666220803162457
15. Naser EH, Idries AH, Elmubarak SAA, et al. Isolation, purification, and characterization of lectins from medicinal plant *Combretum glutinosum* seeds endowed with analgesic and antiulcer properties. *Biochimie*. Dec 2024;227(Pt A):273-285. doi:10.1016/j.biochi.2024.08.003
16. Wu Y, Hao M, Li W, et al. N-glycomic profiling reveals dysregulated N-glycans of peripheral neuropathy in type 2 diabetes. *J Chromatogr B Analyt Technol Biomed Life Sci*. Apr 1 2023;1220:123662. doi:10.1016/j.jchromb.2023.123662
17. Geisler C, Jarvis DL. Letter to the Glyco-Forum: Effective glycoanalysis with *Maackia amurensis* lectins requires a clear understanding of their binding specificities. *Glycobiology*. 2011;21(8):988-993. doi:10.1093/glycob/cwr080
18. Lastovickova M, Strouhalova D, Bobalova J. Use of Lectin-based Affinity Techniques in Breast Cancer Glycoproteomics: A Review. *J Proteome Res*. May 1 2020;19(5):1885-1899. doi:10.1021/acs.jproteome.9b00818
19. Dragacevic L, Djordjevic B, Gavrovic-Jankulovic M, Ilic V, Kanazir D, Minic R. ELLSA based profiling of surface glycosylation in microorganisms reveals that ss-glucan rich yeasts' surfaces are selectively recognized with recombinant banana lectin. *Glycoconj J*. Feb 2020;37(1):95-105. doi:10.1007/s10719-019-09898-8
20. Araujo JRC, Coelho CB, Campos AR, de Azevedo Moreira R, de Oliveira Monteiro-Moreira AC. Animal Galectins and Plant Lectins as Tools for Studies in Neurosciences. *Curr Neuropharmacol*. 2020;18(3):202-215. doi:10.2174/1570159X17666191016092221
21. Sun X, Ma R, Yao X, et al. Concanavalin agglutinin levels are decreased in peripheral blood of Alzheimer's disease patients. *J Alzheimers Dis*. 2016;49(1):63-72. doi:10.3233/JAD-150539
22. Chauhan NB, Davis F, Xiao C. Wheat germ agglutinin enhanced cerebral uptake of anti-Abeta antibody after intranasal administration in 5XFAD mice. *Vaccine*. Oct 13 2011;29(44):7631-7. doi:10.1016/j.vaccine.2011.08.009
23. Gavrovic-Jankulovic M, Prodanovic R. Drug delivery: plant lectins as bioadhesive drug delivery systems. *Journal of Biomaterials and Nanobiotechnology*. 2011;2(5):614-621.
24. Poiroux G, Barre A, van Damme EJM, Benoist H, Rouge P. Plant Lectins Targeting O-Glycans at the Cell Surface as Tools for Cancer Diagnosis, Prognosis and Therapy. *Int J Mol Sci*. Jun 9 2017;18(6):1232. doi:10.3390/ijms18061232
25. Konozy EHE, Osman M, Dirar A. Plant lectins as potent Anti-coronaviruses, Anti-inflammatory, antinociceptive and antiulcer agents. *Saudi J Biol Sci*. Jun 2022;29(6):103301. doi:10.1016/j.sjbs.2022.103301
26. Pusztai A, Clarke EM, King T. The nutritional toxicity of *Phaseolus vulgaris* lectins. *Proceedings of the nutrition Society*. 1979;38(1):115-121.
27. Bies C, Lehr CM, Woodley JF. Lectin-mediated drug targeting: history and applications. *Adv Drug Deliv Rev*. Mar 3 2004;56(4):425-35. doi:10.1016/j.addr.2003.10.030