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The Handbook of Medicinal Plants
Biochemistry & Medicinal Properties

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THE HANDBOOK OF MEDICINAL PLANTS - BIOCHEMISTRY & MEDICINAL PROPERTIES

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Nitya Publications

CHAPTER 8

GLYCOSIDES: STRUCTURAL PROPERTIES, BIOLOGICAL ROLES, AND HEALTH IMPLICATIONS

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Abstract

Glycosides represent a broad class of compounds with diverse structural properties, playing essential roles in plant defense, human nutrition, and therapeutic applications. This chapter examines the structure, synthesis, and biological significance of glycosides, focusing on their implications for health. The structural classification of glycosides is reviewed, with emphasis on the types of glycosidic bonds and aglycone (non-sugar) components. The chapter explores glycosides' roles in various biological processes, including cellular signaling, antioxidant defense, and microbial inhibition. Health implications are examined, with an emphasis on glycosides' potential for promoting cardiovascular, neurological, and digestive health. While

glycosides have promising therapeutic applications, including anti-cancer and anti-inflammatory potential, certain glycosides can be toxic when ingested in high concentrations. As research continues, glycosides' potential in drug development and functional foods represents a promising avenue for improving public health.

8.1 Introduction to Glycosides

Glycosides are compounds in which a sugar molecule (glycone) is bound to a non-sugar molecule (aglycone) via a glycosidic bond. This bond typically forms between the anomeric carbon of a monosaccharide and a hydroxyl group of an aglycone, which can vary from phenols to steroids or terpenes, contributing to glycosides' diverse structural and functional roles (Roberts et al., 2016). Glycosides are widely distributed in the plant kingdom, where they act as defense compounds and play crucial roles in ecological interactions, including plant-microbe and plant-herbivore relationships.

8.2 Structural Properties of Glycosides

Structurally, glycosides can be classified based on the type of aglycone and the glycosidic bond involved:

- O-glycosides: These are the most common and involve a glycosidic bond between the sugar and the hydroxyl group of the aglycone. They are prevalent in plants and often contribute to flavor and medicinal properties, as in flavonoid glycosides (Tanaka et al., 2018).

- C-glycosides: Here, the sugar is directly attached to the carbon atom of the aglycone. This bond is more stable

and resistant to hydrolysis, contributing to the bioavailability of certain C-glycosides.

- N-glycosides: In these glycosides, a nitrogen atom from the aglycone participates in bonding. Examples include certain nucleosides, which play crucial roles in cellular energy and DNA/RNA synthesis.

- S-glycosides: These contain a sulfur atom in the glycosidic bond and are rarer but significant, especially in certain glucosinolates known for their role in cancer prevention.

The structural diversity of glycosides enables their involvement in various biological processes, including molecular recognition and cellular signaling. The pharmacokinetics of glycosides, such as solubility and metabolic stability, are also influenced by the type of glycosidic linkage, aglycone structure, and degree of glycosylation (Kang et al., 2020).

8.3 Biological Roles of Glycosides

Glycosides play essential biological roles in both plants and humans. In plants, they serve as defense mechanisms, deterring herbivores and pathogenic microorganisms. For example, cyanogenic glycosides release toxic cyanide upon hydrolysis, protecting plants from herbivores (Jones, 2017).

In humans, glycosides influence several physiological processes:

1. Antioxidant Activity: Many plant-based glycosides exhibit antioxidant properties, scavenging free radicals and

reducing oxidative stress. For instance, flavonoid glycosides, found abundantly in fruits and vegetables, contribute to cardiovascular health by improving endothelial function and reducing inflammation.

2. Anti-cancer Properties: Some glycosides, such as saponins and certain phenolic glycosides, show anti-cancer effects through mechanisms like apoptosis induction and inhibition of cancer cell proliferation. For example, saponins in soybeans and legumes have shown promise in reducing tumor growth in vitro and in vivo (Tanaka et al., 2018).

3. Immune Modulation: Glycosides can modulate immune responses, as seen with polysaccharide glycosides from medicinal plants like ginseng, which are believed to stimulate macrophage activity and improve immune resilience (Kang et al., 2020).

8.4 Health Implications of Glycosides

While glycosides offer several health benefits, they can also pose risks, especially when consumed in high concentrations. For instance, cardiac glycosides, such as digoxin, have been used in heart disease management due to their ability to increase cardiac contractility. However, they require careful dosing, as their narrow therapeutic range can lead to toxicity (Roberts et al., 2016).

Other glycosides, like cyanogenic glycosides found in foods such as cassava, can release cyanide upon hydrolysis, posing risks of cyanide poisoning. Nevertheless, when

processed properly, these foods are safe to consume and provide important nutritional benefits.

8.5 Therapeutic Potential and Future Directions

The therapeutic potential of glycosides has attracted significant research interest. Advances in pharmacology have led to the isolation of bioactive glycosides with promising medicinal applications, including treatments for inflammation, infections, and cancers. For example, glycoside derivatives are being developed for drug delivery, using the glycosidic moiety to enhance drug solubility and targeting specific tissues. Future research may explore glycoside analogs with reduced toxicity, increased stability, and improved bioavailability.

The development of functional foods enriched with glycosides is another promising area. By incorporating glycosides into dietary supplements, there is potential to leverage their antioxidant, anti-inflammatory, and immune-enhancing properties for preventive healthcare.

8.6 Conclusion

Glycosides are a structurally diverse group of compounds with a broad spectrum of biological roles and health implications. Their therapeutic applications, particularly in treating cardiovascular diseases, cancers, and immune disorders, illustrate the importance of glycosides in both traditional and modern medicine. As research advances, glycosides' role in developing functional foods and novel

therapeutics may further solidify their place in promoting human health.

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Dr. Ruchita ShrivastavaThe Editor is the President of SARPS, a well known for her great work in the field of Botany especially in Ethnobotany and Medicinal Plants as Academician and Researcher. She has pursued her M.Sc & Ph.D in Botany From Barkatullah University, Bhopal. She has attended more then 10 National & International Seminars & Webinars and also published more than 45 research papers and 04 book chapter in National and International Journal and book. She has also published 10 books in national/international level. She has also research experience in quantitative & qualitative extraction of medicinal plants of madhya pradesh. Beside this, she got the "Best Researchers Award 2022" from reseach education solution affiliated from Govt. Of India & AICTE. She is also a reviewer in two reputated journal.Editor is the Member of National Bodies like IBS, IAAT, SEB, Science Advisory Board, etc. She is editorial board member of Innovaer journal of life science and also the chief editor of journal of emerging trands of medicinal plants and research. Also, she was the keynote speaker and resource person in some internation conferences 2022.

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Published & Printed By :

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Nitya Publications, Bhopal MP India
Web: www.nityapublications.com
Email : info@nityapublications.com
Mob. : +91-9009291840

MRP RS.500.00

Isbn 978-93-5357-666-9