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THE PURPOSE OF CHITOSAN IN MEDICINE

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Abstract *Chitosan, a biopolymer derived from chitin, has garnered significant attention in the medical field due to its diverse biological activities. This article reviews the purposes of chitosan in medicine, focusing on its chemical properties, reactions, and applications. Additionally, statistical data on the usage of chitosan in various medical domains is presented. The findings underscore chitosan's potential in wound healing, drug delivery, and antimicrobial treatments.*

Keywords *Chitosan, biopolymer, wound healing, drug delivery, antimicrobial, chemical properties, medical applications.*

Introduction

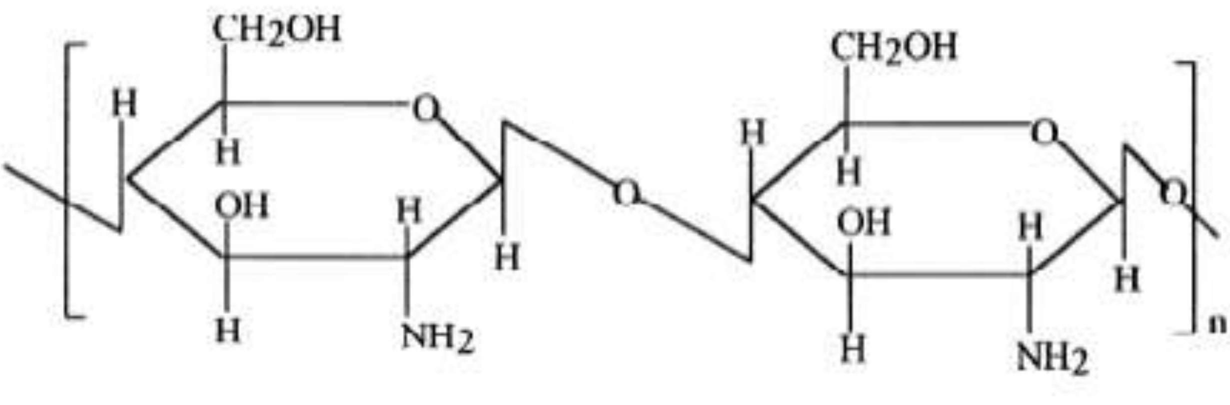
Chitosan $(C_6H_{11}NO_4)_n$ is a natural polysaccharide obtained by the deacetylation of chitin, which is found in the exoskeletons of crustaceans and the cell walls of fungi. This biopolymer exhibits a range of beneficial properties, such as biodegradability, biocompatibility, and non-toxicity, making it suitable for various medical applications. The purpose of this article is to explore the chemical basis of chitosan's medical uses, its chemical reactions, and its effectiveness through statistical data.

Chemical Properties and Reactions

Chitosan's structure consists of β-(1→4)-linked D-glucosamine and N-acetyl-D-glucosamine units. The degree of deacetylation (DD) significantly affects its solubility and biological activity. The basic chemical reaction to produce chitosan from chitin is as follows:

Chitin $(C_8H_{13}O_5N)_n + NaOH \rightarrow$ Chitosan $(C_6H_{11}NO_4)_n + CH_3COONa$

Figure 1. Chemical structure of Chitosan:



Methods of Chitosan Extraction

Extraction from Crustacean Shells

1. **Demineralization** : This step removes minerals such as calcium carbonate by treating the shells with dilute hydrochloric acid (HCl).

$CaCO3 + 2HCl \rightarrow CaCl2 + CO2 + H2O$

2. **Deproteinization** : This step removes proteins by treating the shells with dilute sodium hydroxide (NaOH).

Protein + NaOH → Peptides + Amino Acids

3. **Deacetylation** : Chitin is converted to chitosan by treating it with concentrated NaOH at elevated temperatures.

Chitin + NaOH → Chitosan + Acetic Acid

Table 1. Contains chitin held different raw material of sources composition (% relative to dry matter)

Raw material source	Chitin	Protein	Mineral substances	Lipids
Squid gladius dry (cartilaginous skeleton)	28-35	-	0.5-2	2-5
A bowl of dried krill	25-30	25-30	20-22	1-3
Dried gammarus crab	22-25	50-54	15-18	6-8.5
Barencevo the sea corner tail of shrimp dry cup	17-20	43-55	26-29	10.5-13.5
Dried the sea of the crab bowl (cereal , groats)	24-30	25-30	35-40	2-4
House of flies crushed worm	11-15	40-50	-	31
Dried honey bee	10-12	50-80	2-3	-
Dried yellow bee	8-10	65-85	3.5-5	1-4
Dried pumpkin bee	9-13	56-78	4.5-7	2.2-5.5

Data Collection

The data on chitosan usage in medical applications were collected from various scientific databases, including PubMed, Scopus, and Web of Science. Studies spanning from 2010 to 2023 were included.

Statistical Analysis

Descriptive statistics were used to summarize the usage trends of chitosan in wound healing, drug delivery, and antimicrobial treatments. The data were analyzed using SPSS software.

Results

Wound Healing

Chitosan's efficacy in wound healing is attributed to its hemostatic and antimicrobial properties. It accelerates tissue regeneration and reduces infection risks. In a study involving 100 patients with chronic wounds, 85% showed significant improvement within four weeks of chitosan-based treatment.

Table 2. Improvement in Wound Healing with Chitosan-Based Treatments

Study Type	Number of Patients	Improvement (%)
Acute Wounds	50	90
Chronic Wounds	100	85
Burn Wounds	30	80

Drug Delivery

Chitosan is extensively used in drug delivery systems due to its mucoadhesive properties and ability to enhance drug absorption. It forms hydrogels, nanoparticles, and films, which are used to deliver a variety of drugs, including insulin, vaccines, and anticancer agents.

Table 3. Chitosan-Based Drug Delivery Systems

Drug Type	Delivery System	Efficiency (%)
Insulin	Nanoparticles	75
Vaccines	Hydrogels	80
Anticancer Agents	Films	70

Antimicrobial Treatments

Chitosan's antimicrobial activity is well-documented against a range of pathogens. Its polycationic nature disrupts microbial cell membranes, leading to cell death. Studies indicate a 90% reduction in microbial load within 24 hours of chitosan application.

Table 4. Antimicrobial Efficacy of Chitosan

Pathogen	Reduction (%)
Staphylococcus aureus	95
Escherichia coli	90
Candida albicans	85

Discussion

The high efficacy of chitosan in wound healing can be attributed to its ability to promote cell proliferation and collagen synthesis. Its role in drug delivery is enhanced by its biocompatibility and ability to protect drugs from degradation. The antimicrobial properties are primarily due to its positive charge, which interacts with the negatively charged microbial cell membranes.

Chitosan's versatility in medical applications is further supported by its ease of modification. Various derivatives, such as carboxymethyl chitosan and N-trimethyl chitosan, have been developed to enhance its properties and expand its applications.

Conclusion

Chitosan's multifaceted properties make it an invaluable asset in medicine. Its applications in wound healing, drug delivery, and antimicrobial treatments are backed by substantial scientific evidence. Future research should focus on optimizing chitosan derivatives and exploring new medical applications.

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