Chapter 9
Therapeutic Implications of Chitosan and Its Derivatives:
Focus on Cancer Treatment

Youssef Ait Hamdan
https://orcid.org/0009-0005-8616-8852
Cadi Ayyad University, Morocco & University of Rennes, France

Imade Armadi
https://orcid.org/0009-0003-3063-5058
Cadi Ayyad University, Morocco

khawla Rachmoune
Cadi Ayyad University, Morocco

Fatima Ezzahra Elamrani
https://orcid.org/0009-0009-0248-1964
Cadi Ayyad University, Morocco

Maryem Mekouar
Faculté de Médecine et de Pharmacie de Rabat, Morocco

Adil El Housseini
https://orcid.org/0009-0007-9294-2685
Ibn Zohr University, Morocco

Aicha Moufakkir
Chouaib Doukkali University, Morocco

Samia Elouali
https://orcid.org/0009-0008-8014-9249
Cadi Ayyad University, Morocco

Souad Loqman
Cadi Ayyad University, Morocco

Anass Belbachir
https://orcid.org/0009-0002-4828-0251
Laboratory of Innovations in Biotechnology, Pharmaceutical Bioengineering, and Artificial Intelligence, Morocco

Mohammed Rhazi
https://orcid.org/0000-0003-2736-1802
Cadi Ayyad University, Morocco

ABSTRACT

Chitosan and its derivatives have garnered increasing interest in oncology due to their unique properties, such as biocompatibility, bioactivity and their ability to interact with molecules. These characteristics make them promising candidates for the development of novel anticancer therapies. Chitosan can be employed as drug delivery systems, enhancing the availability and targeted release of therapeutic agents into cancer cells. Additionally, they have demonstrated the ability to inhibit cell proliferation, induce apoptosis, and modulate immune responses, positioning them as multifunctional tools in the fight

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against cancer. Recent research has focused on the development of chitosan-based nanoparticles for targeted drug delivery in chemotherapy, reducing side effects on healthy cells. Furthermore, Chitosan systems have been used to deliver siRNA and other therapeutic molecules, inhibiting tumor growth at the genetic level. These advancements highlight chitosan's potential in developing more effective and less toxic cancer treatments.

1. INTRODUCTION

Chitosan, a natural polysaccharide derived from chitin, has remarkable physicochemical and biological properties, making it a material of choice for oncology applications (Mawazi et al., 2024). Its biocompatibility, essential for any material in contact with living tissue, means it can be integrated into a variety of medical devices without provoking an undesirable immune response. What's more, its biodegradability ensures that chitosan and its derivatives break down naturally in the body into non-toxic products, reducing the risk of accumulation and long-term toxicity, a crucial aspect for anti-cancer treatments. Discovery of chitosan and its many applications, explored as early as the mid-twentieth century, have enabled scientists to envisage innovative uses for this multifunctional substance. Although chitin has long been recognized as a versatile material, recent advances have enabled chitosan to distinguish itself in the biomedical field (Ahmad et al., 2020).

Oncology research shows that chitosan and its derivatives are particularly promising for targeted drug delivery. As therapeutic delivery systems, chitosan derivatives offer the ability to transport therapeutic agents in a targeted and controlled manner to cancer cells, maximizing their bioavailability and reducing effects on healthy cells (Herdiana et al., 2023). This targeted approach is essential in chemotherapy, as it reduces the side effects of traditional treatments, which are often associated with toxicity to healthy cells. In addition to their role as vectors, these derivatives have direct biological effects, such as inhibiting cell proliferation by disrupting growth signals and inducing apoptosis, or programmed cell death, which is essential for specifically targeting cancer cells without harming healthy tissue.

The bioactivity of chitosan has been investigated using a variety of dosage forms, including chitosan nanoparticles (El-Baz et al., 2023), chitosan hydrogels (Kong et al., 2023) and chitosan films (Xu et al., 2005). Its anti-inflammatory and antimicrobial properties, as well as its ability to stimulate cell growth and blood vessel formation, give it a notable advantage in the field of wound healing. Chitosan has also been used as a support material in tissue engineering to promote cell adhesion and proliferation (Machałowski et al., 2021). A major innovation in nanomedicine is the use of chitosan-based nanoparticles. These nanoparticles are designed to reach tumor cells and progressively release chemotherapeutic agents, thereby increasing treatment efficacy and reducing the dose required to minimize adverse effects. In addition, chitosan-based systems are used for the delivery of small molecule interference (siRNA) and other gene therapies (Al-Absi et al., 2023). By targeting specific genes associated with cancer cell growth, these siRNAs can inhibit tumor proliferation at the genetic level, offering a personalized, precision approach in the fight against cancer.

These advances underscore chitosan's potential as a multifunctional tool in the design of innovative, more effective and less toxic oncology treatments. With its versatility and capacity for chemical modification, chitosan paves the way for targeted and personalized cancer therapies, optimizing clinical outcomes while reducing adverse effects for patients. This chapter explores the use of chitosan and its

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