Polysaccharide-based drug delivery system rooted in traditional Chinese medicine unveils a gateway to immunotherapy

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Tumor immunotherapy represents a pivotal scientific advancement, and the traditional Chinese medicine tenet of harmonizing the body's equilibrium through the ‘Yin-Yang (Yin and Yang refer to the two basic properties of things and things that are opposed to each other) balance’ aligns conceptually with tumor immunotherapy’s goal of reinstating the immune system’s functionality [1]. Current research suggests that incorporating the ‘Yin-Yang balance’ philosophy to guide traditional Chinese medicine polysaccharides in immune anti-tumor therapy may amplify their effectiveness in treating tumors [2]. However, prevailing studies on the anti-tumor immune response of traditional Chinese medicine polysaccharides primarily focus on enhancing immune function, often overlooking a comprehensive exploration of immunosuppressive factors. Concurrently, the intricacies involved in analyzing and deciphering the composition and structure of traditional Chinese medicine polysaccharides have exacerbated the challenges associated with studying their oral absorption metabolism and in vivo mechanisms of action. This article addresses these intricacies by consolidating research on the structure-activity relationship, absorption and metabolism processes, and the molecular mechanisms influencing tumor immunity related to traditional Chinese medicine polysaccharides. Furthermore, it proposes a strategic framework for advancing the regulation of tumor immune responses through traditional Chinese medicine polysaccharides. This comprehensive exploration aims to establish a robust foundation for the development of novel oral Chinese herbal polysaccharide drugs tailored for the field of tumor immunotherapy.

Research on the role of traditional Chinese medicine polysaccharides in tumor immunology has been actively pursued by various teams [3]. Our research team highlight the significant role of bacterial-derived glucans within traditional Chinese medicine polysaccharides, particularly in the development of innovative oral drug delivery systems [4]. In the field of glioma treatment, a groundbreaking oral prodrug delivery system, utilizing β-glucans derived from bacteria, adeptly penetrates the intestinal epithelial barrier and the blood-brain barrier. This achievement establishes a promising gut-to-brain platform for precise glioma therapy. Similarly, in the domain of vaccination, bacterial-derived glucans take center stage in an oral vaccine system [5]. This system encapsulates antigens and triumphs over gastrointestinal challenges, operating as an engineered delivery platform akin to a “Trojan Horse.” This emphasizes the remarkable potential of bacterial-derived glucans for the efficient oral administration of prophylactic or therapeutic antigens, offering a compelling avenue for advanced vaccination strategies.

The varied categorization of polysaccharides in traditional Chinese medicine extends beyond fungal yeasts to encompass a range of other sources. Derived from entities such as Astragal Radix [6], Ganoderma lucidum [7], Pleurotus leucophyllus [8], Lycii Fructus [9], Grifola frondosa [10], and Ginseng Radix [11], these polysaccharides display distinct biological activities owing to their intricate chemical compositions. For instance, polysaccharides from Astragal Radix showcase immunomodulatory effects, enhancing immune responses, while those from Ganoderma lucidum demonstrate potent antioxidant properties [12]. Lentinan, a mushroom polysaccharide from Lentinula edodes, exemplifies successful commercialization as an anticancer agent, showcasing its immunomodulating effects [13]. Additionally, polysaccharides from Pleurotus species and Grifola frondosa exhibit diverse antitumor functions, emphasizing the potential of mushroom-derived compounds [14]. Ginseng polysaccharides and those from Salvia species, including Salvia Miltiorrhiza Radix et Rhizoma, exhibit significant antitumor potential, with diverse mechanisms of action [15]. This comprehensive exploration underscores the potential of Chinese herbal polysaccharides in tumor immunotherapy, providing a foundation for targeted interventions within the realm of traditional Chinese medicine (Figure 1).

In the realm of traditional Chinese medicine, polysaccharides showcase significant potential for anti-tumor applications. However, challenges persist in fully unlocking their efficacy. One notable issue involves the imperative for a more profound understanding of the intricate mechanisms underlying the anti-tumor effects of these polysaccharides. Additionally, there is a call for comprehensive studies to unveil potential immunosuppressive factors and augment the overall anti-tumor immune response. Addressing these challenges requires concerted efforts to consolidate research on the structure-activity relationship, absorption and metabolism processes, and the mechanisms influencing tumor immunity.

Figure 1 Absorption, metabolism and immunoregulatory effects of polysaccharides

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and the molecular mechanisms influencing tumor immunity associated with traditional Chinese medicine polysaccharides. Future endeavors should aspire to establish a robust foundation for the development of innovative approaches, ensuring the effective utilization of Chinese herbal polysaccharides in the realm of tumor immunotherapy.

References


Author contributions
Hong-Xia Ren designed the research project; Yang-Bao Miao wrote the manuscript.

Competing interests
The authors declare no conflicts of interest.

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