Chapter 19

Investigation of Potential Neuroprotective Role of Chitosan-Based Biomaterials and Their Derivatives by Targeting Glial Cells

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ABSTRACT

Glial cells, although often overlooked in comparison with neurons, play a crucial role in the structure and function of the nervous system. Their loss can lead to impairment of functions such as learning and memory, contributing to neurodegenerative diseases. To combat these diseases effectively, therapeutic strategies must restore the function of neuronal and glial cells. Natural resources offer promising thera-

DOI: 10.4018/978-1-6684-9675-6.ch019

peutic molecules for the treatment of neurodegenerative diseases. Chitosan (CTS), chitooligosaccharide (COS) and their derivatives from arthropod exoskeletons have attracted the attention of neuroscientists because of their neuroprotective effects and their ability to transport therapeutic substances across the blood-brain barrier (BBB). This chapter explores the role of natural resources in the fight against neuronal diseases.

INTRODUCTION

In the nervous system, there are two main cell types: neurons and glial cells. Surprisingly, glial cells account for up to 90% of all cells in the human brain. Although the term "glia" derives from the Greek word for "glue", now the understanding these cells do more than simply hold nerve cells together, and should not simply be regarded as passive support for the neurons of the nervous system (Parpura *et al*., 2012). In fact, recent convincing studies suggest that glial cells play an active and crucial role in brain development and function, far beyond what we previously thought (Allen & Barres, 2005; Seifert *et al*., 2006; Parpura *et al*., 2012). Given their crucial role in the functioning of the nervous system, any pathological alteration of glial cells would have significant and damaging consequences for the brain. Many neurodegenerative disorders are at the root of glial cell dysfunction. As a result, one of the major challenges in the treatment of these neurological disorders and neurodegenerative diseases lies in the fact that some drugs do not cross the Blood Brain Barrier (BBB) to reach brain tissue (Gao, 2016). Consequently, it is very important to develop new drugs and approaches to target these disorders.

Based on neuroprotective mechanisms, several neuroprotective agents can be used to treat neurological disorders (Pellicciari et al., 1998; Chandrasekaran et at., 2003) such as antioxidants (Pellicciari et al., 1998; Behl & Moosmann, 2002) and agents with anti-inflammatory effects (Agnello et al, 2002; Gao et al., 2003). Natural substances, as a source of potential therapeutic molecules, have not received much attention in the treatment of neurodegenerative diseases, although they can play an important role. For example, the marine environment is known for its nooks and crannies in the structures of bioactive compounds with promising neuroprotective biological activities (Alonso et al., 2005). Recent reports on chitosan (CTS) and its derivatives as plausible molecules to target neurodegenerative disorders are well documented in several studies (Hao et al., 2017; Hamdan et al., 2023). This chapter discusses the use of CTS derivatives to treat glial cell-related neurological disorders. It focuses on neuroprotective mechanisms and controlled drug release, with potential therapeutic implications.

GLIAL CELLS DISEASE AND THEIR PATHOGENESIS

The glial cells of the central nervous system play a fundamental role in maintaining the balance of nerve tissues and contribute to the protection and support of neurons. They fulfill several essential functions, including providing nutrients and oxygen to neurons, removing dead cells, fighting against pathogens, and producing myelin. There are two categories of glial cells: non-myelinating cells, such as ependymocytes that line the ventricular cavities, microglia that act as sentinels in the inflammatory response of the central nervous system, and astrocytes that contribute to cerebral homeostasis. Additionally, there are myelinating cells, the oligodendrocytes, which are responsible for forming the myelin sheath around axons.