ISSN: 2754-4737

Journal of Neurology Research Reviews & Reports

SCIENTIFIC Research and Community

Review Article

Open Access

Search for Natural Compounds - Based Therapeutic Approach against Alzheimer's disease: Chitin and Chitosan – The Choice

Mohammad Azizur Rahman[1*], Nabidur Rahman[1], Umme Habiba[1,2], Md. Salman Shakil[1,3] and Shahdat Hossain[1]

[1]Department of Biochemistry and Molecular Biology, Jahangirnagar University, Bangladesh

[2]Healthcare Pharmaceuticals Limited, Dhaka, Bangladesh

[3]Primeasia University, Dhaka, Bangladesh

ABSTRACT

As the number of aged people is increasing globally, so is the case of neurodegenerative disease Alzheimer's disease (AD). Though different treatment strategy have been applied against AD, success rate is meager. Thus, search for natural compounds capable of withstanding AD progression has received momentum. Present article evaluates the potentiality of chitin and chitosan, the natural bio-polymers, in ameliorating AD. Information presented here would be of immense importance to the AD patients, patients' care givers, health care providers, researchers and policy makers round the world.

***Corresponding author**

Mohammad Azizur Rahman, Department of Biochemistry and Molecular Biology, Jahangirnagar University, Bangladesh. Tel: 008801727195484; E-mail: azizbmb@juniv.edu

Received: July 28, 2021; **Accepted:** August 04, 2021; **Published:** August 10, 2021

Keywords: Alzheimer's disease, Bio-polymer, Chitin, Chitosan, Amyloid beta, Neurofibrillary Tangles, Natural compounds.

Introduction

Alzheimer's disease (AD) is the most severe neurodegenerative disorder affecting memory and learning and behavior of the elderly. People over sixty years of old suffer from AD. AD patients become fully dependent on their family members and care-givers. They remain as burden to the family, society and affect the national economy negatively [1-3]. Currently, more than 45 million have been suffering from AD [4]. Unfortunately, no treatment stratagem has been found effective against AD. The available treatment strategies only ameliorate the symptoms associated with AD On the other hand, they cause some side effects that ultimately worsen the patients' physical and mental state [1-3]. Thus, attempts have been made to discover natural, safe, easy to use, cost-effective treatment stratagem against AD [5]. Among different bio-polymers, chitin and chitosan seem promising as anti-AD agents. This article reviews the rationale in favor of chitin and chitosan as AD therapeutic agents.

Chitin and Chitosan

Chitin is a bio-polymer, formed by the repeated units of N-acetyl-D-glucosamine and chitosan is chitin's deacetylated product [Fig. 1]. Chitin forms the exoskeletons of the lobsters, prawns, shrip, crustaceans, arthropods, mollusks and also the cell walls of the fungi [6-7]. Their extraction process is easy and both chemical and biological especially enzymatic processes have been applied worldwide. Their role as anti-oxidants, food preservatives, nano-materials, drug delivery agents, water purifying chelates and as bio-fertilizers have been hailed [7-8]. As dietary fiber and cholesterol lowering agent, chitin and chitosan have also gained medicinal concern [9]. Their usage in some other aspects such as in ameliorating neurodegenerative diseases seems promising.

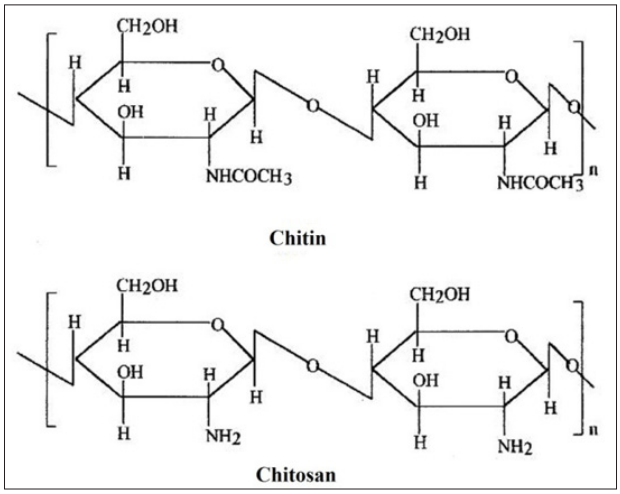

Figure 1: Structure of Chitin and Chitosan

Probable Role of Chitin and Chitosan in AD Amelioration

Among different etiological factors of AD are oxidative stress, excessive activity of acetyl choline esterase (ACE), pro-

inflammatory cytokines, apoptosis, neurodegeneration. Formation of amyloid beta (Aβ) plaques and neurofibrillary tangles (NFT) are the two hallmarks of AD [1, 10]. Fragmented product of chitin, named as chitosan oligosaccharides, have been found effective in down regulating the production of the pro-inflammatory cytokine tumor necrosis factor alpha (TNF α) and interleukin 6 (IL-6). It also lowers the production of inducible nitric oxide synthase (iNOs) activity [11]. Their inhibitory role against ACE activity, even at the case of Aβ25-35- induced ACE activity, have been noticed [12]. Chitosan oligosaccharide conjugated with caffeic acid have been found effective in inhibiting the activity of β-site amyloid precursor protein-cleaving enzyme (BACE), the regulatory enzyme of amyloid beta (Aβ) synthesis [13-14]. AD pathogenesis is aggravated through Aβ fibrillization [1, 10]. Chitosan oligosaccharides inhibit Aβ fibrillization as well as destabilize the already fibrilized aggregate and lowers neurotoxicity in hippocampal neurons [15]. Their roles in repairing of nerve injury and axonal outcome and sensory and motor function improvement have been recognized [16]. Thus, chitin, chitosan and their derivatives seem promising as AD ameliorating agents.

Conclusion

Alzhemier's disease is posing threat to global health care and economic sectors highly. Natural compound-based medicinal approaches would benefit the AD patients, their care givers and health care providers immensely. In this regard, chitin and chitosan seem promising as anti-AD agents. Further studies including clinical trials are necessary to ascertain the therapeutic potentiality of these natural compounds against AD.

References

1. Rahman MA, Rahman MS, Alam N (2020) Heightened Vulnerability of Alzheimer's disease in COVID-19 Cataclysm and Putative Management Strategies. Annals of Alzheimer's disease and Care 4: 027-029.
2. Rahman MA, Habiba, U (2021) COVID-19 and neuropsychiatric disorders: Common links and extended networks. J Neurol Neurol Sci Disord 7: 024-026.
3. Rahman MA, Islam K, Rahman S, Alamin M (2020) Neurobiochemical Cross-talk Between COVID-19 and Alzheimer's Disease. Molecular Neurobiology 19: 1–7.
4. 2020 Alzheimer's disease facts and figures. Alzheimers Dement. 2020 Mar 10. doi: 10.1002/alz.12068. Epub ahead of print. PMID: 32157811. https://alz-journals.onlinelibrary.wiley.com/doi/full/10.1002/alz.12068
5. Rahman MA, Hossan T, Hsan K, Alam N, Shafique MR (2020) Alternative Medicine-Based COVID-19 Therapy: Lesson from a Bangladeshi Patient. Medical Research and Clinical Case Reports 4.2: 15-27.
6. Khoushab F, Yamabhai M (2010) Chitin research revisited. Mar Drugs 8: 1988-2012.
7. Younes I, Rinaudo M (2015) Chitin and chitosan preparation from marine sources. Structure, properties and applications. Mar Drugs 13: 1133-1174.
8. Muxika A, Etxabide A, Uranga J, Guerrero P, de la Caba K (2017) Chitosan as a bioactive polymer: Processing, properties and applications. Int J Biol Macromol 105: 1358-1368.
9. Hossain S, Rahman A, Kabir Y, Shams AA, Afros F, et al. (2007) Effects of shrimp (Macrobracium rosenbergii)-derived chitosan on plasma lipid profile and liver lipid peroxide levels in normo- and hypercholesterolaemic rats. Clin Exp Pharmacol Physiol 34: 170-176.
10. Qiu C, Kivipelto M, von Strauss E (2009) Epidemiology of Alzheimer's disease: occurrence, determinants, and strategies toward intervention. Dialogues Clin Neurosci 11: 111-128.
11. Kim MS, Sung MJ, Seo SB, Yoo SJ, Lim WK, et al. (2002) Water-soluble chitosan inhibits the production of pro-inflammatory cytokine in human astrocytoma cells activated by amyloid beta peptide and interleukin-1beta. Neurosci. Lett 321: 105–109.
12. Lee SH, Park JS, Kim SK, Ahn CB, Je JY (2009) Chitooligosaccharides suppress the level of protein expression and acetylcholinesterase activity induced by A_25-35 in PC12 cells. Bioorganic Med. Chem. Lett 19: 860–862.
13. Eom TK, Ryu B, Lee JK, Byun HG, Park SJ, et al. (2013) β_-secretase inhibitory activity of phenolic acid conjugated chitooligosaccharides. J. Enzym. Inhib. Med. Chem 28: 214-217.
14. Dai X, Chang P, Li X, Gao Z, Sun Y (2018) The inhibitory e_ect of chitosan oligosaccharides on beta-site amyloid precursor protein cleaving enzyme 1 (BACE1) in HEK293 APPswe cells. Neurosci. Lett 665: 80–85.
15. Dai X, Hou W, Sun Y, Gao Z, Zhu S, et al. (2015) Chitosan oligosaccharides inhibit/disaggregate fibrils and attenuate amyloid _-mediated neurotoxicity. Int. J. Mol. Sci 16: 10526–10536.
16. Hou H, Zhang L, Ye Z, Li J, Lian Z, et al. (2016) Chitooligosaccharide Inhibits Scar Formation and Enhances Functional Recovery in a Mouse Model of Sciatic Nerve Injury. Mol. Neurobiol 53: 2249–2257.