Journal of Innovations in Applied Pharmaceutical Science
(JIAPS)

Content available at: www.saap.org.in ISSN: 2455-5177

Quantum dots and its advancement in the treatment of Parkinson's disease: a review

Rupesh Kumar Mani, Chandan K*, Bharathi D R, Syed Sagheer Ahmed, Gurusidda

Department of Pharmacology, Sri Adichunchanagiri college of Pharmacy, Adichunchanagiri university, B G nagara, Mandya, Karnataka

Article History

Received: 04-03-2022
Revised: 15-03-2022
Accepted: 22-04-2022

Abstract

Quantum dots are also known as zero-dimensional Nanomaterials, which have very distinctive Properties Such as Electro chemiluminescent, Fluorescent, and Photoluminescent. Because of their unique properties, quantum dots have a revolutionary role in Biomedical research. Quantum dots Like Zinc oxide quantum dots, Graphene Quantum dots, Glutathione conjugated carbon quantum dots (GSH-CQDs) and L-cysteine capped ZnS:Mn quantum dots have many applications in diagnosis and treatment. They can easily cross the blood-brain barrier hence they be used as drug carriers furthermore because of their capabilities they gather widespread attention in biomedical research.

Keywords: Quantum dots, Nano materials, GSH-CQDs, Parkinson's disease.

This article is licensed under a Creative Commons Attribution-Non Commercial 4.0 International License.
Copyright © 2022 Author(s) retain the copyright of this article.

*Corresponding Author
Chandan K

https://doi.org/10.37022/jiaps.v7i1.316

Production and Hosted by
www.saap.org.in

Introduction

Nanotechnology is the science and engineering that goes into the design, synthesis, characterization, and use of materials and devices whose smallest functional organization, in at least one dimension, is on the nanoscale scale, or one billionth of a meter [1].

Nanotechnology may appear to be a new technology, although its presence has been documented since ancient times. The Lycurgus cup, a piece of Roman glass craftsmanship from the fifth century, is one of the most interesting. Amborsia drags king Lycurgus into the underworld in this exquisite cup. Stained glass windows from the Middle Ages, which can be seen in many churches today, are constructed of a glass composite containing nano-sized metal particles [2].

Nanotechnology's great potential in diagnostics for the identification of biomarkers and infections is another emerging use in medicine. The use of biosensors to detect analytes in solutions and bodily fluids is one of them [3]

Curiosity, wonder, and inventiveness are human attributes that have existed since the dawn of time. People all throughout the world have been channeling their interest into scientific inquiry and methods. The field of nanoscience has seen tremendous expansion in study in recent years [4].

Parkinson's disease, A chronic disorder of the nervous system, Parkinson's disease (PD) manifests both in the motor and non-motor systems. It is primarily associated with elderly patients, but it can also affect young people. After Alzheimer's parkinson's is the most common Neurodegenerative diseases Which is which is affected by the dopaminergic loss in the substantia nigra Many neurodegenerative Disorders can mimic the Idiopathic Parkinson's disease [5]. James Parkinson's was the one who described Parkinson's disease in 1817 in an essay called "An essay on shaking palsy". Parkinson's disease is caused by the progressive and extensive loss of dopaminergic neurons of the nigrostriatal pathway and loss of neurons in the substantia nigra pars compacta [6].

Advancements in nano technology plays a revolutionary role in the treatment of diseases and disorders, so nano materials in the biomedical field are very important and very focused area of research.

Quantum dots in Parkinson's disease

Quantum dots are semiconducting nanoparticles that have unique size and shape-dependent optoelectronic characteristics. These unusual features have gotten a lot of interest in the biomedical profession in recent years because they can be used for real-time tissue imaging (bioimaging), diagnosis, single molecule probes, and medication administration, among other things. Quantum dots' optical characteristics may be tweaked by changing their size and composition, and their great brightness, photobleaching resistance, multiplexing capability, and high surface-to-volume ratio make them ideal for intracellular tracking, diagnosis, in vivo imaging, and therapeutic application [7].

ZnO quantum dots

Lin D et.al., developed a novel brain-targeted ZnO quantum dots (QDs) nanoplatform delivering gene to interfere SNCA expression for PD treatment. They observed that the ZnO QDs can cross blood brain barrier and release the gene in lysosomal escape further more they demonstrated that it could provide neuroprotection and also reverse neurodegenerative process in PD models [8].

Graphene quantum dots

Kim D *et.al.*, GQDs permeate the blood–brain barrier and protect against dopamine neuron loss induced by α-syn preformed fibrils and behavioral deficits.

Preparation of GQDs.

Kim D *et.al.*, synthesized Graphene quantum dots by adding 0.9 g of carbon fibres in a mixture of 300ml sulphuric acid and 100ml nitric acid at 80ºC for 24 h and then subjected to acid removal and the solution was vacuum-filtered using porous inorganic membrane filter with a specification of cat. no. 6809–5002, Whatman-Anodisc 47. The solution was then subjected to rotary evaporation and the powder was obtained as a final product [9].

Graphene quantum dots

Ghaeidamini M *et.al.*, demonstrated that the graphene quantum dots inhibit α-syn amyloid formation via differential interactions with monomers and fibrils [10].

L-cysteine capped ZnS:Mn quantum dots

Diaz-Diestra D *et.al.*, developed Dopamine phosphorescence sensor based on L-cysteine capped ZnS:Mn QDs to determine PD and also it can be used for imaging neurodegenerative disorders in the nervous system.

Synthesis of l-cysteine capped ZnS:Mn quantum dots

ZnS:Mn QDs capped with l-cysteine were prepared with some modifications. Briefly, 90 mg of ZnSO4·H2O 3.0 mg of MnCl2 and 121 mg of l-cysteine were dissolved into a 25 mL three-neck round-bottom flask using high-purity deionized water (HPDW). The pH of the solution was made to 11 using 1 M NaOH and subjected to purging with argon, 5 mL of 0.2 M aqueous solution of Na2S was added. The mixture was stirred under controlled reflux for 14 h at 50 °C in open air. The flocculate was separated from the supernatant by ultracentrifugation, and in more quantity rinsed with HPDW, and then freeze-dried. The final products were re-dispersed in HPDW and produced a deep orange solution in presence of UV light. This orange color is a clear indicator of the compound formation [11].

GSH-CQDs - The glutathione-conjugated carbon quantum dots GSH-CQDs are developed for sensitive and selective detection of levodopa.

Park SW *et.al.*, demonstrated that Levodopa can be detected by the quenched fluorescence of GSH-CQDs under alkaline conditions. These quantum dots have high specificity towards Levodopa. The drug shows many side effects so these fluorescence sensor plays an important role in specific and selective detection of Levodopa [12].

Conclusion

A number of research has been carried out using quantum dots in the field of nanotechnology. quantum dots have been gaining attraction because of their unique properties. They can be used as a delivery system because of their capacity to cross the blood-brain barrier and Quantum dots can be used as fluorescent sensors in the specific detection of certain drugs. These Nanomaterials have widespread applications which are yet to be identified by the researcher.

Conflict of interest Statement

No conflict of interest has been declared.

References

1. Saini R, Saini S, Sharma S. Nanotechnology: the future medicine. Journal of cutaneous and aesthetic surgery. 2010 Jan;3(1):32.
2. Singh A, Dubey S, Dubey HK. Nanotechnology: the future engineering. Nanotechnology. 2019 Apr;6(2):230-3.
3. Azzawi M, Seifalian A, Ahmed W. Nanotechnology for the diagnosis and treatment of diseases. Nanomedicine. 2016 Aug;11(16):2025-7. Azzawi M, Seifalian A, Ahmed W. Nanotechnology for the diagnosis and treatment of diseases. Nanomedicine. 2016 Aug;11(16):2025-7

4. Patil M, Mehta DS, Guvva S. Future impact of nanotechnology on medicine and dentistry. Journal of Indian society of periodontology. 2008 May;12(2):34
5. Beitz, J.M., 2014. Parkinson's disease: a review. *Front Biosci (Schol Ed)*, *6*(6), pp.65-74.
6. Mendes Filho, D., dC Ribeiro, P., Oliveira, L.F., de Paula, D.R., Capuano, V., de Assunção, T.S. and da Silva, V.J., 2018. Therapy with mesenchymal stem cells in Parkinson disease: history and perspectives. *The Neurologist*, *23*(4), pp.141-147.
7. Wagner AM, Knipe JM, Orive G, Peppas NA. Quantum dots in biomedical applications. Acta biomaterialia. 2019 Aug 1;94:44-63
8. Lin D, Li M, Gao Y, Yin L, Guan Y. Brain-targeted gene delivery of ZnO quantum dots nanoplatform for the treatment of Parkinson disease. Chemical Engineering Journal. 2022 Feb 1;429:132210.
9. Kim D, Yoo JM, Hwang H, Lee J, Lee SH, Yun SP, Park MJ, Lee M, Choi S, Kwon SH, Lee S. Graphene quantum dots prevent α-synucleinopathy in Parkinson's disease. Nature nanotechnology. 2018 Sep;13(9):812-8.
10. Ghaeidamini M, Bernson D, Sasanian N, Kumar R, Esbjörner EK. Graphene oxide sheets and quantum dots inhibit α-synuclein amyloid formation by different mechanisms. Nanoscale. 2020;12(37):19450-60.
11. Diaz-Diestra D, Thapa B, Beltran-Huarac J, Weiner BR, Morell G. L-cysteine capped ZnS: Mn quantum dots for room-temperature detection of dopamine with high sensitivity and selectivity. Biosensors and Bioelectronics. 2017 Jan 15; 87:693-700
12. Park SW, Kim TE, Jung YK. Glutathione-decorated fluorescent carbon quantum dots for sensitive and selective detection of levodopa. Analytica Chimica Acta. 2021 Jun 22;1165:338513.