VII CONGRESO NACIONAL DE NANOTECNOLOGÍA
12 AL 15 DE NOVIEMBRE 2023
PUCÓN, CHILE

Nanorods with plasmonic properties in the second biological window (NIR-II) functionalized with peptides capable of inhibit and disaggregate β-amyloid aggregates

Elizabeth Cortés-Adasme[1]
Pablo Cabrera[1]
Freddy Celis[2]
[2]Laboratorio de Procesos Fotónicos y Electroquímicos, Facultad de Ciencias Naturales y Exactas, Universidad de Playa Ancha, Valparaíso; ATMOS-C, Centro de Espectroscopía Atómica y Molecular, Universidad de Playa Ancha, Valparaíso, Chile.
Marcelo Kogan[1]
[1]Departamento de Química Farmacológica y Toxicológica, Facultad de Ciencias Químicas y Farmacéuticas, Universidad de Chile, Santiago 8380494, Chile; Advanced Center for Chronic Diseases (ACCDiS), Sergio Livingstone 1007, Independencia, Santiago 8380494, Chile

One of the hallmarks of Alzheimer's disease (AD) is the aggregation of β-amyloid peptide (Aβ). Aβ is formed by the action of β-secretase and γ-secretase enzymes on the amyloid precursor protein and is associated with the formation of toxic oligomers, amyloid fibers, and senile plaques, which deposit in brain regions related to memory. Therefore, Aβ is considered an important biomarker for the diagnosis of the disease, and its soluble species such as oligomers and insoluble forms such as fibers are indicated as responsible for neuronal death and subsequent cognitive decline in the disease [1-2].

Given the significant role of Aβ aggregation, its disaggregation and inhibition of aggregation to reduce its toxicity represent a convenient strategy for potential Alzheimer's therapy. In this context, gold nanoparticles (GNPs) emerge as one of the promising scientific areas for possible diagnosis and treatment of AD. This is due to their physicochemical properties, low toxicity, and attractive biological applications [3]. GNPs possess properties such as plasmon resonance, which causes oscillation of free electrons when interacting with incident electromagnetic radiation. This property can occur in the visible to the infrared wavelength range [4]. In the case of gold nanorods (GNRs), this plasmon resonance can be tunable across these wavelengths simply by modifying their size. This advantage allows them to operate within the first and second biological windows (NIR-I, 700-950nm or NIR-II, 1000-1200nm).

The NIR-II window is more suitable for biological applications due to its greater tissue penetration depth, lower autofluorescence background, reduced photon scattering, and higher maximum permissible exposure compared to NIR-I [5]. However, it is necessary for these nanoparticles to specifically recognize these toxic aggregates. Therefore, various targeting molecules that specifically recognize Aβ toxic aggregates have been investigated. These molecules can be functionalized on the surface of these nanoparticles to guide the nanosystem towards the targets. Among these targeting molecules are D-type peptides as D1 peptides, which can recognize and bind predominantly to fibrillar aggregates, and D3 peptides, which recognize and bind to oligomeric aggregates of Aβ [6]. Additionally, these peptides are capable of disaggregating and inhibiting the formation of these toxic aggregates.

In this study, GNRs with plasmon resonance in the NIR-II range were synthesized and functionalized with polyethylene glycol to impart biocompatibility. Functionalization with D1

and/or D3 peptides as targeting molecules was performed to create a potential theragnostic system for Alzheimer's disease, aiming at the inhibition and disaggregation of β-amyloid toxic aggregates in vitro. The physicochemical characteristics of these systems were characterized using various techniques, along with the evaluation of peptide functionalization efficiency based on nanorod concentration.

Acknowledgments

Beca doctoral ANID 21200403; Fondap 15130011; Fondecyt 1211482.

References

[1] Hettiarachchi S.D. et al. (2019), doi.org/10.1016/j.jconrel.2019.10.034
[2] Sanati M. et al. (2019), doi.org/10.1021/acschemneuro.8b00622.
[3] Park J. E. et al. (2017), doi.org/10.1002/smtd.201600032.
[4] Jauffred L. et al. (2019), doi.org/10.1021/acs.chemrev.8b00738.
[5] Cai K. et al. (2018), doi.org/10.1021/acsami.8b12758.
[6] Bartnik D. et al. (2010), doi.org/10.1089/rej.2009.0924.