Impact of serum albumin on binding ability of dopamine and L-dopa on differently coated gold nanoparticles

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Introduction

Efficient and safe treatment of patients suffering Parkinson's disease faces many challenges such as a poor blood brain barrier (BBB) penetration [1]. Nano-drug delivery systems may overcome these problems and can be designed to penetrate through the BBB and interact with the central nervous system [2]. However, their efficiency largely depend on their stability in biological fluids like human plasma [3]. This study evaluated impact of serum albumin on ability of novel gold nanoparticles (AuNPs) to be used as delivery system for dopamine or L-dopa.

Methods

AuNPs were prepared by reduction method and functionalized with three different coating agents: polyethylene glycol (PEG), 1-adamantyl-amine (Ad-NH_2) and 1-adamantyl-glycine (Ad-Gly). The hydrodinamic diameter (d_H) and z potential were obtained by dynamic and electrophoretic light scattering, respectively (Table 1) Shape and primary size (d) of AuNPs were examined by transmission electron microscopy (TEM, Figure 1). Binding affinity of dopamine and L-dopa to these AuNPs was evaluated in the presence or absence of serum albumin using steady-state fluorescence quenching spectroscopy.

Results

Table 1. Hydrodynamic diameters (d_H) with corresponding volume percentages, zeta potential (ζ) and primary diameter obtained from TEM for novel AuNPs in ultrapure water (UPW) at 25˚C.

Nanoparticles type	d_H /nm (% mean volume)	ζ/mV	d_{TEM}/nm
AuNP-PEG	50.3 ± 1.1 (90.9) 5.2 ± 0.4 (9.1)	-22.2 ± 5.2	15.2 ± 1.7
AuNP-Ad-NH_2	85.6 ± 3.4 (93.2) 15.8 ± 6.8 (6.8)	-33.7 ± 0.9	23.8 ± 3.3
AuNP-Ad-Gly	99.8 ± 4.2 (96.3) 13.0 ± 4.6 (3.7)	-34.9 ± 1.2	30.2 ± 4.2 11.9 ± 1.4

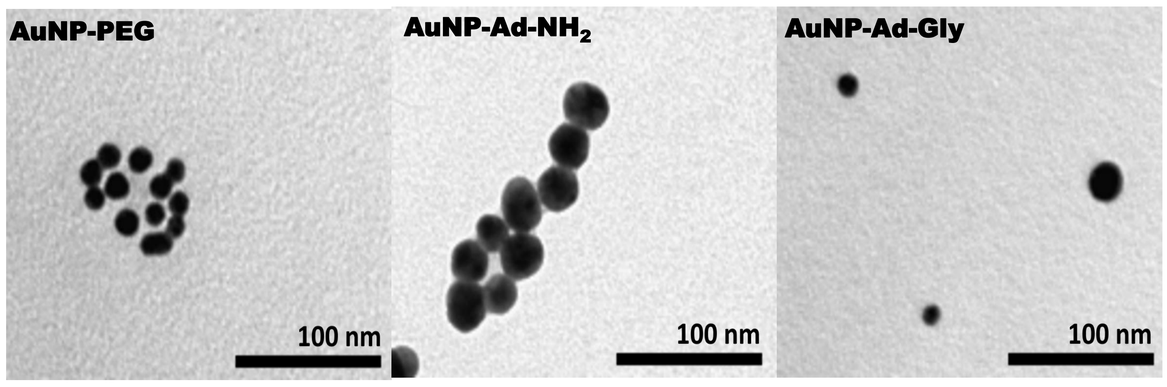

Figure 1. TEM micrographs of AuNPs

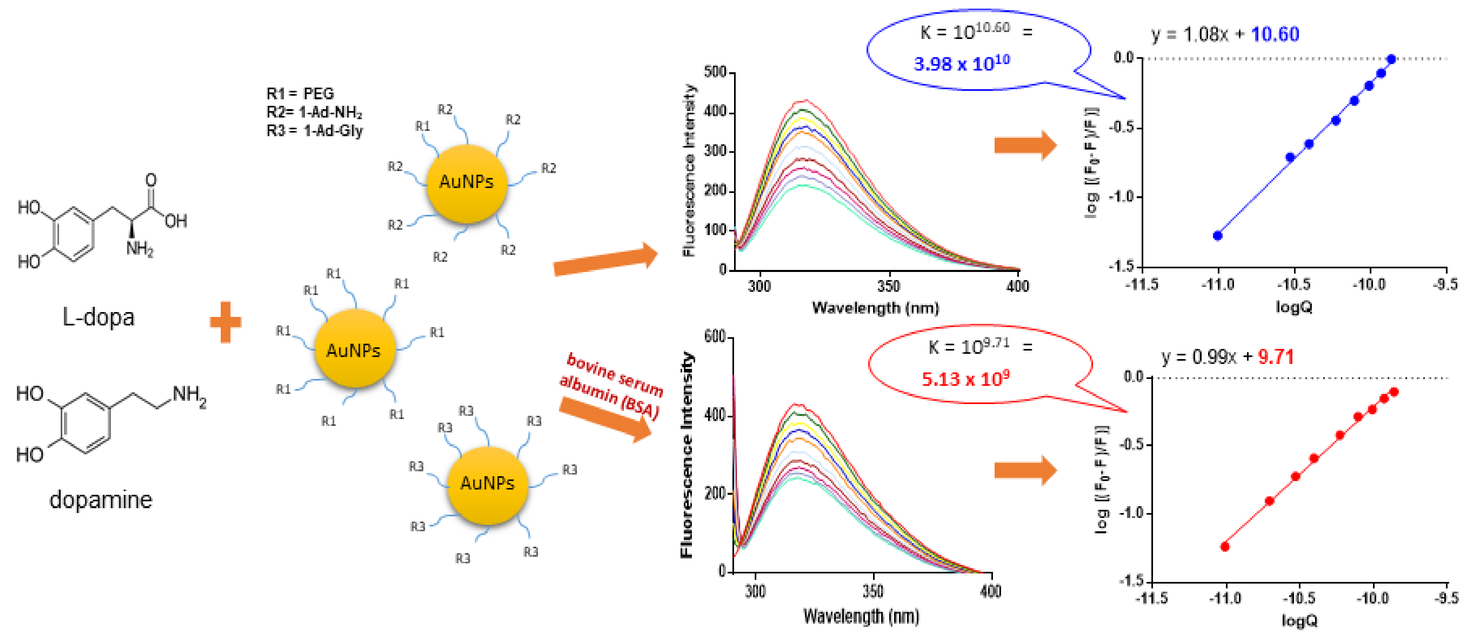

Figure 2. Scheme of steady-state fluorescence quenching method that provide binding constants for novel AuNPs-dopamine/L-dopa systems using the Hill's equation

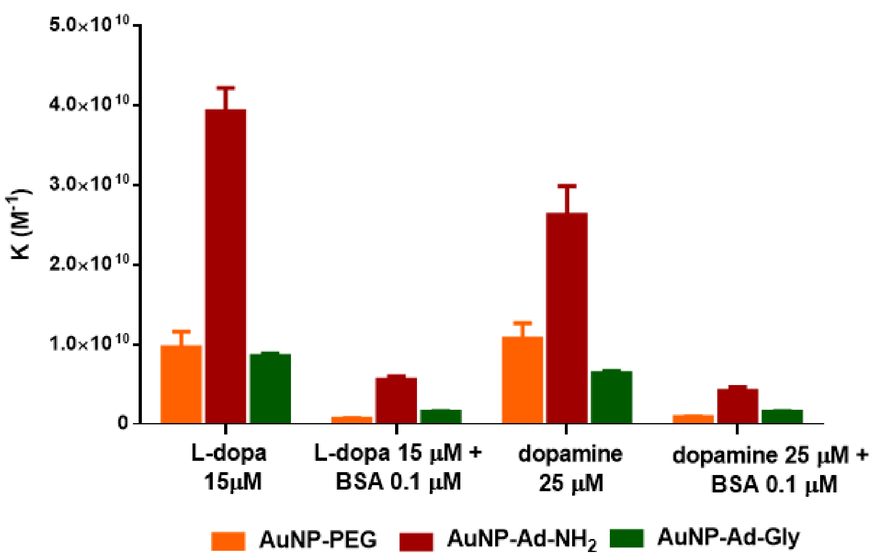

Figure 3. Binding constants for AuNPs-dopamine/L-dopa systems in the presence and the absence of serum albumin

Conclusion

- Differences in binding constants were observed for L-dopa/dopamine on differently functionalized AuNPs.
- The presence of serum albumin affected L-dopa/dopamine binding on AuNPs by reducing the binding constant of AuNPs-dopamine/L-dopa systems.

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