Polydopamine-coated selenium nanoparticles as a stable and reuseable catalyst for tuneable nitic oxide generation

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Nitric oxide (NO) is a signaling molecule involved in a wide range of physiological and pathological processes. Its effects are concentration dependent, promoting cell survival and proliferation at low concentrations (nM), or exhibiting antibacterial/anticancer properties at higher concentrations (μM).[1] The significant role of NO in neuroscience, physiology, and immunology has promoted the development of NO delivery strategies. However, a key limitation of NO delivery is its short half-life (5s), which restricts its diffusion distance in human tissue. To address this issue, catalytic approaches have emerged, employing nanomaterials as catalysts to decompose endogenous NO donor S-nitrosoglutathione (GSNO) to generate NO *in-situ*.

Selenium, an essential element in various enzymes/proteins, has been found to catalytically generate NO from NO donors.[2,3] Our previous study established that selenium nanoparticles (SeNPs) are highly efficient NO-generating catalysts with low cytotoxicity. However, the stability of SeNPs under physiological conditions requires improvement. To address this issue, we modified SeNPs with a polydopamine (pDA) coating, creating core-shell nanoparticles known as Se@pDA NPs. These Se@pDA NPs exhibit increased stability compared to SeNPs in PBS buffer for up to 24 hours. Furthermore, the pDA coating overcomes the pH-dependent NO generation limitation of SeNPs, enabling NO delivery across physiological conditions ranging from pH 5.5 to 8.5, thus broadening its potential therapeutic applications. Considering the concentration-dependent nature of NO's effect, achieving tunable NO generation is crucial. This can be accomplished by varying the thickness of the pDA coating. Additionally, our study investigated the long-term stability and sustainability of Se@pDA NPs, demonstrating their potential as a stable and controlled platform for NO-induced therapeutic applications.

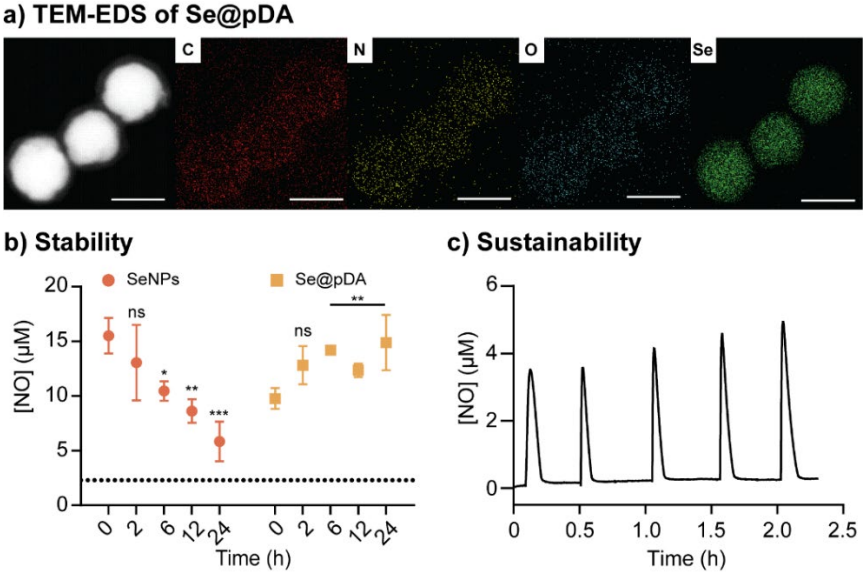

Figure 1: a) TEM-EDS of Se@pDA NPs. b) Cumulative NO generation catalysed by SeNPs or Se@pDA NPs, particles were incubated in PBS 7.4 for 0, 2, 6, 12, and 24 hours followed by the addition of GSNO (50 μM) (dashed line represents GSNO control). c) Sustainable NO generation catalysed by Se@pDA NPs in the presence of GSH (1 mM).

References

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