Surface-engineered silica nanoparticles as versatile platforms for bioconjugation of MAGE and other bioactive molecules

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Cancer progression is strongly influenced by the biochemical complexity of the tumor microenvironment, where advanced glycation end-products (AGEs), including the recently identified melibiose-derived AGE (MAGE), are emerging as important modulators of cellular responses. However, the biological role of MAGE is still not fully understood, and its endogenous origin in tissues remains unknown, clearly indicating the need for further research [1-3]. To enable systematic investigation of MAGE-related processes, there is also a growing need for well-defined, multifunctional, surface-engineered nanomaterial platforms capable of controlled bioconjugation and delivery of MAGE.
In this study, we report the development and preliminary evaluation of silica-based nanoparticle systems functionalized using organosilane chemistry to introduce reactive surface groups enabling controlled bioconjugation. A set of functional silanes, including amino-, aldehyde-, and N-hydroxysuccinimide-terminated precursors, was employed to modulate surface reactivity and provide anchoring sites to attach MAGE, fluorescent probes, as well as model therapeutic agents (doxorubicin). The resulting nanosystems were characterized using SEM, TEM, XPS, FTIR, and EDS to get detailed picture of their morphology, surface functionalization, and chemical composition, while DLS and zeta potential data provided valuable insights into colloidal properties of the obtained systems.
Overall, these preliminary results demonstrate the feasibility of constructing stable, chemically versatile nanoplatforms for MAGE bioconjugation, where both, porosity and surface chemistry affects the bioconjugation efficiency. The developed systems provide a robust foundation for future studies on MAGE-loaded nanoparticles as the potential carriers of drugs targeting different cells within the tumor microenvironment and thus their potential application in bioanalytical and therapeutic contexts.

Keywords:
Silica nanoparticles, Surface functionalization, Organosilane chemistry, Biomolecule immobilization, Bioactive surface design, Nanocarriers, MAGE

References:

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