Project SAVE: Silica Adsorption Vaccine Encapsulation

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It is estimated that 50% of vaccines produced annually are wasted because effectivity is dependent on protein structure and heat exposure disrupts the intermolecular interactions needed to maintain structure. Since 90% of vaccines require a temperature-controlled supply chain, it is necessary to create a cold chain system to minimize vaccine waste. A more sustainable technology was developed via the adsorption of invasion plasmid antigen D (IpaD), onto mesoporous silica, improving the thermal stability of this protein-based therapeutic. Multiple silicas were characterized to determine the effects of pore diameter, pore volume, and surface area on protein adsorption. The silica-IpaD complex was then heated above the IpaD denaturing temperature and *N*,*N*-dimethyldodecylamine *N*-oxide (LDAO) was used to remove IpaD from the silica. Circular dichroism (CD) confirmed that the adsorbed IpaD after the heat treatment maintained its native secondary structure rich in α-helix content. In contrast, the unprotected IpaD after heat treatment lost its secondary structure. Isotherms modeled using Langmuir, Freundlich and Temkin models demonstrated that the adsorption of IpaD onto silicas is best fit by the Langmuir model. If pores are less than 15 nm, adsorption is negligible. If the pores are between 15-25 nm, then monolayer coverage is achieved and IpaD is protected from thermal denaturing. If pores are larger than 25 nm the adsorption is multilayer coverage and it is easier to remove the protein from the silica due to a less developed hydrogen bond network. This case study provides strong evidence that IpaD is thermally stabilized via adsorption on mesoporous silica with the proper pore size range.