Evaluating the Impact of Protein Coronas on Blood Circulation Dynamics of Silk Fibroin Nanoparticles Designed to Enhance Oxygen Delivery

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Over the past decade, there has been an increased demand for blood transfusions and in January 2024, the American Red Cross declared a national emergency due to the shortage of blood, recording the lowest number of people donating blood in the last 20 years. The global shortage of blood highlights the need for a new effective method of improving oxygen capacity. The purpose of this study was to contribute to the development of silk fibroin nanoparticles specifically tailored for oxygen delivery via maintained blood circulation. In this study, silk nanoparticles were prepared and characterized. The response of blood proteins to their presence was recorded by measuring the average particle size, polydispersity, zeta potential, and electrophoretic mobility. It was found that the protein corona not only increased the average size of the particles, but also brought the size of the silk nanoparticles out of the threshold for successful circulation. Additionally, it was found that the proteins interacting with the silk nanoparticles do not cause a sizable difference in charge. iNOS expression in MO macrophages is found to be generally lower than in M1 control macrophages upon treatment with silk nanoparticles with protein corona indicating that, under the conditions tested, silk nanoparticles with protein coronas do not significantly modulate the pro-inflammatory response in MO macrophages compared to M1 macrophages. The results of this study indicate a need to further investigate the potential of silk fibroin nanoparticles as an injectable drug delivery mechanism by focusing on the effect of blood plasma on the oxygen binding kinetics in silk nanoparticles loaded with hemoglobin, along with whether or not this phenomenon is variable from individual to individual.

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