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MS Thesis: Quality by design in the scalable manufacturing and stabilization of therapeutic extracellular vesicles.

Author: Lindsey is from Vancouver Island, Canada, where she graduated from the University of Victoria with a BSc in Microbiology in 2019. After graduation, she worked at a preclinical pharmaceutical CRO, contributing to antibody discovery across cell culture, protein expression, and assay teams. Lindsey moved to Iceland in 2024, along with her husband, to pursue an MSc in Applied Biotechnology. She is interested in biopharmaceutical manufacturing and characterization, particularly analytical assays, quality and formulation of biologics. In addition to her research, she has been involved in assistant teaching a laboratory course in protein expression and purification.

Short summary: Extracellular vesicles (EVs) are promising biocompatible nanocarriers, but their clinical translation is challenged by limited process understanding, lack of standardization and storage instability. This thesis applied Quality by Design (QbD) to define critical quality attributes (CQAs) influencing HEK293E-derived EV yield and purity and identify critical process parameters (CPPs) using Design of Experiments. Time to harvest and affinity resin volume were identified as significant upstream and downstream CPPs, respectively, influencing EV yield and purity. EV buffer formulations were evaluated to improve stability, showing improved preservation during short-term cold storage. Finally, spray drying was explored and successfully generated dry powder EVs with retained characteristics upon rehydration. These results demonstrate the value of a QbD-guided approach and provide insights into manufacturing of quality EVs for clinical purposes.