Natural Secreted Nano Vesicles as a Source of Novel Biomass Products for Circular Economy

This BioFuture2025 project targets the nano- and microvesicles that are called collectively here as extracellular vesicles (EVs). The EVs represent a new humoral, systemic layer that controls homeostasis. Since the EVs are around the size of viruses and that they are also present in saliva and sweat, the EVs may function as a novel bioaerosol class. The EVs transmit various types of relevant cellular biomolecules such as proteins, RNA/DNA and the metabolites. Due to these reasons the EVs may offer openings to target (biological) drugs, image tissues and organs in vivo and ways to develop even non-invasive surgery therapies at the end. The EVs can be expected to offer fundamental opportunities for disease diagnostics. Individual EVs may themselves serve as biological drugs when produced in mass quantities for medical practise. In summary the EVs offer important opportunities to develop significant bioeconomically valuable products.

In this project we have developed ways to utilize nanocellulose to isolate EVs from biological fluids and air. By adding proper functional groups to cellulose chain, we have succeeded to prepare nanocellulose with cationic charge that affect electrostatically with the anionic charge of the EVs surface. We have got promising results using nanocellulose for EV enrichment from bovine milk and cell culture medium samples. We have also prepared ultralight, high porosity sponge-like aerogels from nanocellulose. They can be used as high efficient air filters. With these aerogels we have captured from air tiny, only tens of nanometers size particles with over 99,99% efficiency.

EVs as bioaerosols

We have defined size distributions for milk- and Renca (renal carsioma cell line)-derived EVs in aerosol phase. In this method, EVs are sprayed into aerosol phase via nebulizer and EV size distributions are measured by using Differential Mobility Particle Sizer (DMPS) setup. EVs are classified by their electrical mobility (Differential Mobility Analyzer (DMA) and the concentration is typically measured by the Condensation Particle Counter (CPC). This method has proved to be sensitive in the EV size-range (30 nm – 100 nm) and the results compare well with the previous EV size definitions.

Part of the samples were measured also by using a short DMA and high resolution setup as well as an electrometer for the additional reference detector. In continuing measurements, the size distribution and concentration from the human sweat derived EVs and Renca-based samples have been further examined.

Nanocellulose as an air filter

We characterized the filtration properties of the MCB aerogel (MCB = milk carton board) in the 10-250nm size range. We produced NaCl particles from salt water, and measured their size distribution using a Differential Mobility Particle Sizer (DMPS) setup. The DMPS setup had two Airmodus A20 condensation particle counter, to which the sample flow was divided. The other A20 had the filter material in the path of the sample flow, and the other sample flow route was unimpeded. The MCB-based aerogel in question worked well as an air filter, and increasing the mass-% of the MCB in the material was found to improve the overall filtration efficiency. At best a filtration efficiency of 99.99% was observed in the 10-250nm size range.

More information:
Professor Seppo Vainio, University of Oulu, Seppo.Vainio@oulu.fi