Natural Nanoemulsions for Waterproofing and Softening Mycelium Textiles

Researchers
Renko de Vries, Costas Nikiforidis, Ben van den Broek, Iris Houthof, Emma Luijtjens

Focus
To make biomass sources such as mycelium more flexible and water repellant nano-emulsions coated with water-soluble polysaccharides can have potential.

Innovative idea and objective

Biomass, such as plants and microorganisms, can replace fossil feedstocks for the production of textiles and films. One of the problems is turning biomass into a flexible and water-repellent material. The idea is to use nano-emulsions as water repellent agents to be homogenously distributed throughout the biomass. Nano-emulsions are a heterogeneous dispersion of two immiscible liquids (oil in water or water in oil). The droplets of these emulsions will be coated with water-soluble polysaccharides that will have sorption with the biomass. The objective is to redesign the physical interactions between the biomass and the nano-emulsion droplets. The aim is that after incorporation of the nano-emulsion and subsequently drying the water-repellent behavior of the material will be increased.

Relevance to the materials transition in textiles and/or building materials?

Most biomass is hydrophilic and becomes brittle and glassy in the absence of water, its natural plasticizer. It is relatively easy to replace the water with a hydrophilic plasticizer such as glycerol, but that leads to rather hydrophilic materials with poor water resistance. It is very hard to replace the water by a hydrophobic plasticizer. To use of abundant biopolymers such as chitin, cellulose or amply available proteins such as zein directly for making bioplastics, films, fibres or non-woven textiles is therefore limited. The problem of turning intrinsically hydrophilic biomass into water resistant and flexible materials in a sustainable manner is essentially unsolved, and this has significantly held back the performance of many biobased materials as compared to the equivalent fossil-feedstock-based materials. In this project we studied the possibilities to tune the physical interactions between the nano-emulsion droplets and the biomass. In order to achieve nano-emulsion formulations that naturally and homogeneously will spread throughout the biomass and remain stable also during and after drying and results in improved properties of such as flexibility and increased water repellent properties.

What did you do?

The project is divided into three main subjects.

- Definition of water-soluble polysaccharides and the biomass to be used. Development of the sorption screening assay between biomass and water-soluble polysaccharides.
- Preparation of nano-emulsions and coating of the droplets with the most promising water-soluble polysaccharide and also proteins.
- Investigation of the formation of films made of nano-droplets and polysaccharides or proteins.
- Measurement of the nano-emulsion droplets into the biomass.

The focus was on the development of the sorption screening assay.

Main result, achievement and highlight

Mycelium was chosen as a biomass source and as polysaccharides arabinogalactan and pectin. Setting up the sorption procedure had some drawbacks as coupling of the fluorophore did not result in the desired

coupling, although different coupling methods were used. Using a different characterization method we noticed that the pH is important for the sorption of the water-soluble polysaccharides to the biomass source. For the measurements of the nano-emulsion into the biomass, we have acquainted ourselves with the use of confocal laser scanning microscopy (CLSM). The insight that we obtained is that the conditions are important to obtain good sorption of the polysaccharides.

Key message

To make biomass sources such as mycelium more flexible and water repellant nano-emulsions coated with water-soluble polysaccharides can have potential.

Visual abstract

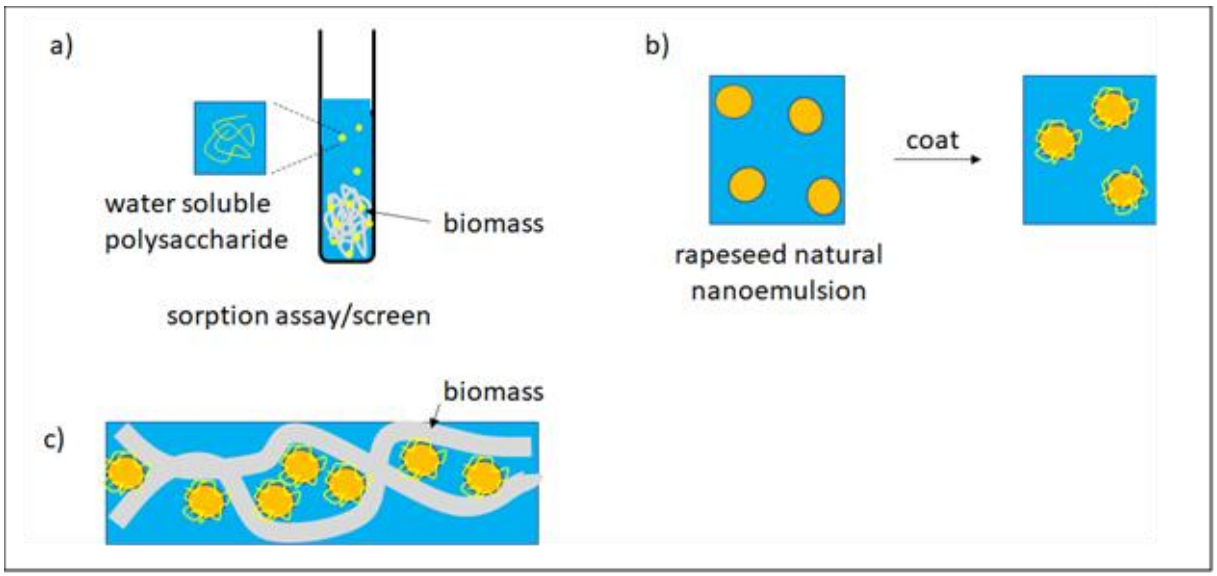

Figure 1: Project approach.

a) Partition assay/screening to determine sorption of water-soluble polysaccharides into biomass as a function of polysaccharide type and sorption conditions (time, pH, salt,...)

b) Coating of rapeseed natural nano-emulsions (oil bodies) with water soluble polysaccharides selected from screening

c) Polysaccharide coating facilitates sorption of nano-emulsion droplets into biomass and ensures homogeneous distribution.