Final Report

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Publishable project summary

In COMPIO the AIT Austrian Institute of Technology, the “Petru Poni" Institute of Macromolecular Chemistry and the three SMEs Aglykon, Orba and Melodea have addressed in joint efforts the development, upscaling and field testing of synthetic and biobased high performance composites for microbial spray formulations and seed coatings:

- Molecularly imprinted polymer particles (MIPs) with cavities of the size and shape of selected bacteria
- Polymer/clay nanocomposites
- Nano crystalline cellulose from Melodea as carrier, natural filler and dispersion agent

The integration of the three types of composites in microbial formulations was expected to create formulations and seed coatings with clearly improved water vapour and O_2 barrier properties and thus enhanced bacterial viability by reducing oxidative stress through reactive oxygen species, significantly improved mechanical strength / abrasion of seed coatings to prevent sloughing off during transport and seed drilling operations, good moisture absorption and retention capabilities to help seed germination, enhanced microbial viability and shelf life at warehouse conditions, and improved UV protection.

Among the tested MIP approaches the solgel method was most promising both in terms of costs and ease of imprint generation, however bacterial cell numbers dropped significantly in the dry material and upscaling was very complex. By contrast polypyrrol imprints could easily be upscaled and a protocol was established by Aglykon. However it was not clear whether all toxic pyrrol polymerized during the long reaction time, that´s why it finally was not tested in the field.

Several CNC/biopolymer composite formulations were developed using whey protein, gelatin, carboxymethyl cellulose (CMC) etc. as biopolymers and unmodified CNC or CNC modified with CTAB, aminosilane or dopamin as the filler. Composite formation between the ingredients was examined with IR spectroscopy and water sorption measurements. CNC alone was not UV absorbent while it was a good UV absorber when modified with dopamine or surfactant. Bacteria were stable in liquid CNC composite formulations for several months, but died quickly upon drying, probably due to lack of oxygen. Interestingly, in the field tests CNC-based sprays resulted in enhanced yield which leads to the assumption that CNC could act as a plant nutrient.

Nanoclay-based composite formulations are the apparently most suitable composite formulations. Certain compositions improve significantly germination of maize seeds, protect well against UV light and favor also bacterial viability compared to CNC. Highly pure bentonite was tested as well as bentonite modifications and industrial cationic Cloisite which performed best in combination with bacteria.

Nanocomposite materials were tested with Gram negative bacteria *Paraburkholderia phytofirmans* PsJN, *Pseudomonas* sp., Gram positive *Bacillus* sp. and Trichoderma harzianum from Orba in pot experiments in Turkey and field trials in Austria.

Some composites will be further tested in microbial formulations of Orba, a producer of formulated seeds.