# Microbial interactions in soil improvement, circulation bioprocesses and health promotion

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### Implications

Microbiological communities form inner balances between their member strains. Their natural interactions can be used for producing various fermented foods, organic preservation strategies, and means for maintaining human or animal health by pre- and probiotic products. The microbiomes of soil, foods and their supplementations, animal feed as well as in our digestion form a continuum, which can be monitored and adjusted during the entire production chain. This includes also the recycled biomass, which is returned to the food and feed production.

### Background and objectives

Undefined Mixed Cultures (UMC) were used together with some industrial GMO-free strains for the processing of food and agricultural wastes, such as chicken litter form the ecological henhouse and abattoir in Sweden (Schwede et al. 2016), potato industry waste and sorted biowaste in Poland (den Boer et al. 2016), or bovine rumen contents in Finland (del Amo and Hakalehto 2015, Hakalehto et al. 2016), could facilitate circulation loops from the industries to the agriculture. The results from various bioprocesses indicated that the processing strategies with natural microbes could form a basis for the implementation of novel ecological production units, cultivation means and health-promoting organic goods.

Microbiological composition of the process broth had been studied by the PMEU (Portable Microbe Enrichment Unit) in a simulation of the microbial interactions together with prebiotic flax and some other organic raw materials (Hakalehto and Jaakkola 2013). The joint effects of the fibres and probiotic bacteria were to get further investigated to indicate the balancing effects that could help in maintaining intestinal well-being and health. It also seemed possible to achieve such balances between moulds and bacterial species in the production process (Hakalehto and Hallsworth 2017).

### Key results and discussion

The management of the organic product and its microbiome should start from the primary production, and continue during the processing phase being combined with the return of the process side streams. We added the productivity in the greenhouse cultivation by about 50% by using the AurobionTM microbiological supplementation of organic fertilizers produced out of the side streams.

In the waste management, the strong inherent microflora could compete out harmful strains, thus also hygienizing the process broths. The probiotics could attenuate as additions with the crushed flax seeds the enterobacterial growth up to 100-fold in the simulation of the intestinal conditions. This offers means for supporting the Bacteriological Intestinal Balance (BIB) of the individuals along the digestive tract. Consequently, the intestinal disorders could be relieved by the microbiological approach. The present findings support the view that the microbial strains tend to form a balanced community on all phases of the succession (Hakalehto et al. 2008, 2010).

With a holistic approach to the organic raw materials, microbial strain supplementation, production process, product hygiene, circulation of side streams and health implications, we could establish production strategies which will improve the productivity, sustainability and healthiness of the organic goods and their manufacturing. The microbial loads at all stages were studied with emphasis on their interactions.

### How work was carried out?

The testing of the microbial interactions was carried out in a simulation experiment. Some probiotic bacteria were cultivated together with intestinal microflora, such as *Escherichia coli*, *Salmonella* sp., *Klebsiella* sp., and *Staphylococcus aureus* in the PMEU (Portable Microbe Enrichment Unit) equipment, together with some organic additives, such as crushed flax seeds and antioxidants from various berries. The growth curves were obtained from the cultivation, and could indicate the interactive effects. They could be effectively monitored by this method, combined with the NMR analysis (Nucleic Magnetic Resonance) for the screening of the metabolites.

The field trials were conducted at the greenhouses of the Helsinki University Viikki campus. During three month cultivation period the growth of Chines cabbage, Rye grass and Water grass was measured by dry and wet weight of the plants.

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