## THE INDUSTRIAL CHALLENGE

Freeze drying is an important process in many industries, particularly in life sciences, where dry products are necessary to obtain a long shelf life. Sensitive biological structures such as probiotic bacteria can be preserved in a dry porous material obtained by freeze drying. For BioGaia, it is essential to understand where water is located in both the material and the bacteria. It is also important to understand how the bacteria are influenced by drying and rehydration in order to improve product uniformity and shelf life.



Figure 1. BioGaia freeze-dried pellets being analysed for water content in a Karl-Fischer titrator at BioGaia laboratory in Eslöv. This technique can determine trace amounts of water in a sample, but gives no information on where in the sample the water is located.

WHY USING A LARGE SCALE FACILITY? Neutrons are likely to be advantageous as they can identify where specific components occur in samples, such as the presence and location of water. Neutrons can measure the shape of objects and also distinguish if objects for example have a core that is different from its shell. Neutrons are able to penetrate deep into samples and also through the walls of containers suitable for doing freeze drying in. This suggests that a neutron-based technique, such as ultrasmall angle scattering, diffraction and tomography, may be needed.

## THE RESULTS AND EXPECTED IMPACT

The neutron techniques we have identified as relevant have not been used previously to explore these types of samples so there is potential great impact of this work. The next step will be to design and make a purpose-built sample environment for imaging instruments where we plan to do controlled drying and simultaneously measure loss of mass. Other experiments can explore the size and shape of objects as well as determining the core-shell structure by using ultra-small angle scattering instruments.

The project consortium consisted of BioGaia, freeze-drying specialist and experts in scattering techniques from RISE and Uppsala University. Discussions with instrument responsible at a neutron scattering facility has proven very fruitful in finding suggested a design of suitable experiments. A beam-time proposal has also been prepared and submitted to the facility.

"We believe that the use of neutronbased techniques is the next step for gaining an even deeper understanding of our processes" / Sebastian Håkansson, Director Process R&D, BioGaia AB







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