New Driving Forces for Dry Fractionation

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Background

Current wet bio-refining techniques or waste valorization processes are carried out under harsh conditions (high temperature, addition of acids, etc.), which degrade (native) functionality of components. Wet extraction processes usually require copious amounts of water (or other solvents). The use of excessive amounts of solvent also leads to large energy consumption due to the required drying of the final product (Schutyser & van der Goot, 2011).

Dry fractionation is an attractive alternative, which can strongly reduce energy usage and retain (native)functionality of components. However, conventional dry separation processes such as air classification and sieving suffer from poor separation efficiency.

In this project, dry separation is achieved by using a novel driving force: the electrostatic force. Powder particles are charged by triboelectrification and separated in an external electrostatic field.

Principle

Triboelectrification involves charging of two materials when they come into contact with each other and then separate.

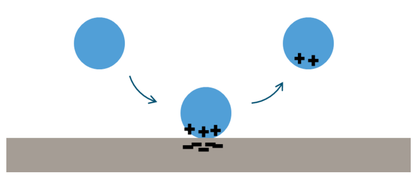

Figure 1. Triboelectrification

Objective

- Understanding the charging and subsequent separation behavior as a function of design and operational parameters for different model powder mixtures during electrostatic separation.
- Developing an efficient electrostatic separation process for (industrially) relevant feed streams.

Experimental set-up of electrostatic separation (ES)

Figure 2. Schematic drawing of the electrostatic separation process: particles are blown through the tube to let the particles take charge by triboelectrification. Then the two fractions with different charge are separated in a high-voltage electrostatic field.

Results

Triboelectrification of polystyrene microspheres

- The influence of particle size, gas velocity and tube length on triboelectric charging was tested with polystyrene microspheres. As shown in figure 3 and 4.

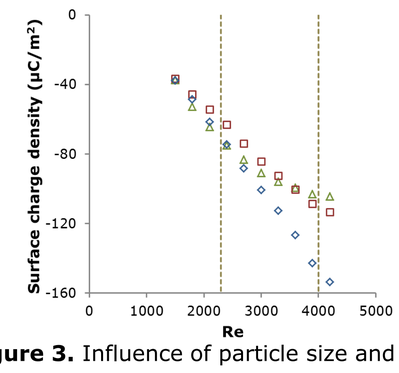

Figure 3. Influence of particle size and gas velocity

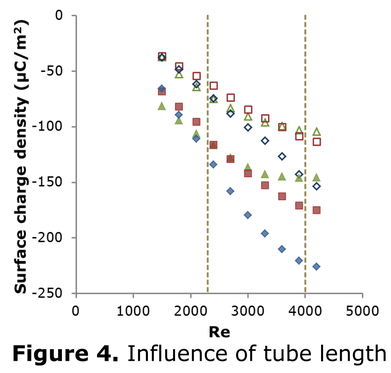

Figure 4. Influence of tube length

Fractionation of wheat bran

- Figure 5 and 6 show regular and SEM images of fractions obtained by electrostatic separation of milled wheat bran. Positively charged fractions contain a lot of starch and small pieces of aleurone layer. Negatively charged fractions contain mostly broken pericarp tissue.

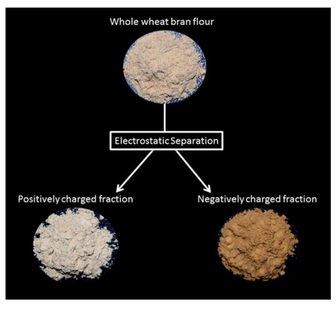

Figure 5. ES of wheat bran flour

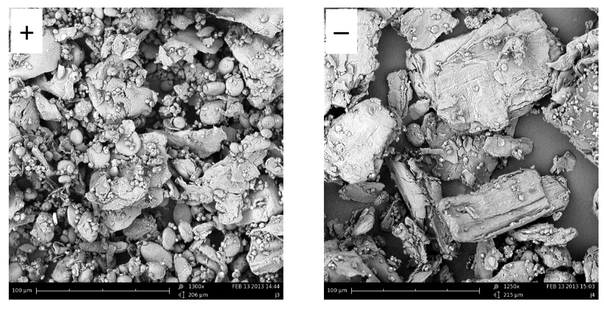

Figure 6. Scanning electron micrograph of two fractions

- ES, applied alone or in combination with sieving, proved to give higher purity of arabinoxylans than sieving only (Figure 7). The fraction rich in arabinoxylans exhibits more than twice the water holding capacity of wheat bran

Figure 7. Comparison of fractions rich in arabinoxylans obtained by different separation processes

Conclusion

- Dry fractionation is sustainable and retains (native) functionality of ingredients.
- Electrostatic separation enhances performance of dry fractionation processes using a different driving force for separation. It delivers a wheat bran enriched in arabinoxylans (from 23% to 44%)

Acknowledgements

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