Influence of grinders loading modes on the dissociation and hydration properties of wheat brans

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Keywords: Wheat bran, grinding, electrostatic separation, hydration

Wheat bran is a co-product of the conventional roller milling process. Bran has a multi-layered composite structure (testa, pericarp, aleurone and residual starchy endosperm), whose different tissues present contrasting physicochemical and mechanical properties. The different tissues are characterized by distinct compositions. Some of them contain molecules with interesting nutritional and functional properties [1, 2, 3]. Currently, bran is mainly intended for animal feed purposes, principally due to the difficulty to separate the high nutritional value tissue (aleurone layer) from the low nutritional ones (pericarp). In particular, the aleurone layer contains many bioactive compounds like vitamins, as well as about half of the minerals and a high protein content. There is strong interest in separating wheat bran into different purified fractions that could be used as ingredients and incorporated directly into food products for human consumption or from which bioactive compounds can be extracted.
Incorporation of bran in cereal-based products receives more attention these last years. Most of the studies investigated the incorporation of whole common wheat bran under the form of fine powders into wheat-based food [4, 5, 6]. It has been reported that the milling process influences the rheological properties of the dough, the quality of the final food products and the consumer acceptance [7]. This could be explained by differences in water retention capacity related to the size, and dissociation of the different layers constituting the bran. In particular, the dissociation state among the bran layers in ground common wheat bran can be evidenced by electrostatic separation after milling [8]. In the bran, different binding strengths between bran components and water molecules can be distinguished. Recently, a distinction was made between weakly bound water in bran, *i.e.* water between stacked bran particles and in micropores of empty pericarp cells and strongly bound water in bran, *i.e.* water bound in cell wall nanopores and through hydrogen bonding [9]. However, the relation between the milling process used, the state of dissociations of the different bran layers and the molecular impact on hydration water in bran was not yet elucidated.

The aim of this study is to investigate the influence of the loading modes (high shear grinder and impact grinder) generated by two different grinders on the hydration properties and dissociation of the common and durum wheat brans. An original study at the molecular scale to target the distribution and the intensity of the bonds of hydration water was carried out by gravimetric (sorption isotherms) and spectroscopic (Fourier transform infrared spectroscopy, low field NMR) methods. Results were analyzed in regards to the particle size and shape, the dissociation state of the sample evaluated by electrostatic separation, biochemical composition and multispectral imaging (see figure 1).

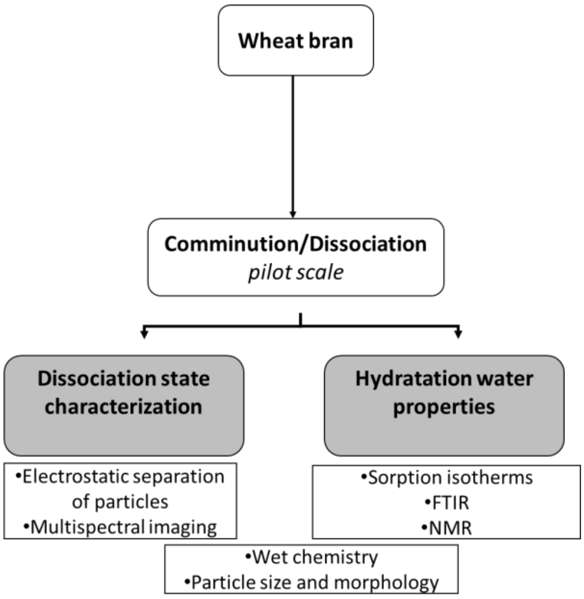

Figure 1. General strategic study plan of the impact of grinding destructuration processes on tissue dissociation and hydration water properties of common and coarse durum wheat brans.

Our study highlights that durum wheat bran has lower water sorption capacity than common wheat bran in relation with neutral sugars content. Based on sorption isotherms and FTIR measurements, we demonstrate that impact grinder has a stronger effect on sorption capacity and FTIR multimer water at 3600 cm^{-1} of durum wheat bran and induces a high decrease in residual starch crystallinity degree. On contrary high shear grinder tends to increase the proportion of water strongly bound. Electrostatic separation has been shown to be more effective for common wheat bran with a significant enrichment in aleurone layer in the positive fraction. This has been related to a better dissociation rate. As for common wheat bran a correlation is found between lower dissociation efficiency and less interactions between hydration water and the bran's backbone as found by NMR low relaxation times T_2 of most mobile protons. This study allowed to have a better mechanistic understanding of the importance of intrinsic hydration water interaction in ground wheat bran. This brings new elements to optimize the processability and the quality of cereals products enriched in bran and converges towards a better valorization of common and durum wheat bran with fractions enriched in compounds of interest (fibers, vitamins and minerals).

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