Anticipating dough behavior in baking industry by tackling gluten network structure

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Understanding the mechanical behavior of the wheat flour dough is a crucial step for the baking industry, not only to optimize end product quality, but also to save time and cost by producing a processable dough. Dough behavior is determined by its rheological properties, which are obtained at mixing, the first step of the process. Thus, the objective of this work is to use mixing power curve P(t) to assess the dough processability in the production line. In this purpose, we have analyzed dough structure and rheological behavior for different mixing conditions.

Four commercial wheat flours were selected according to their distinct mixing behavior, according to P(t). Doughs were then prepared in the Farinograph, at different kneading times (3, 9, 12 min) and at different hydration levels (50%, optimal value determined in the Farinograph, and 66% by weight of flour). The thermo-viscoelastic behavior of the dough at small deformation was determined by dynamic thermomechanical analysis (DMA) and the bi-extensional properties (at large deformation) by lubricated uniaxial compression (LSF).

DMA results are followed by the ratio E'max/E'min, where the variations of the storage module between 55 and 70°C mainly reflect the gluten cross-linking: the higher the ratio, the less the network is developed after the mixing step. At constant deformation eb, the bi-extensional viscosity of doughs follows a power law, for which the consistency index K decreases exponentially with the dough hydration ($R^2 = 0.80$) from 47 to 10 kPa.sn (eb =1), for all flours, whereas, at constant hydration, the variation of K during mixing is related to the flour tolerance during mixing. Therefore, dough consistency (K) values also reflect gluten network structuring.

These interpretations are supported by results from imaging method (TD-NMR) which show that four dough hydration states exist which correspond to different structuring gluten network, and specific interval of K values. In line, images obtained by confocal scanning laser microscopy confirm the relations between hydration states and gluten network structuring.

So, once integrated, these results will allow predicting the gluten network structuring from the mixing curve P(t) and help implement the necessary on-line settings for bakery production.