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Optimizing the sheeting of dough using Brabender® instruments

Sheeting of dough is a critical step in the manufacturing of cereal products such as croissants, pastries, crackers, cookies, biscuits, pizza crusts, noodles, pasta, refrigerated/ frozen doughs etc. All of these products require a sheeting step, which takes a mass of dough from a mixer with low surface and creates new surface area by deformation. The characteristics of the resultant dough after mechanical deformation or sheeting operation are controlled by the viscoelastic properties of the dough. Knowledge of fundamental rheological properties derived from **Brabender®** instruments, helps to control the sheeting process so as to deliver a smooth unbroken sheet of dough with correct thickness and weight per unit area. The output of **Brabender®** instruments serves as a useful guide for designers and operators of dough sheeting systems. Preparations of dough formulations with good sheeting characteristics need careful optimization of recipe components and certain unit operations to ensure good handling and smooth flow on line. This article presents overview of optimization of dough formulations at different levels or stages using **Brabender®** rheological instruments.

Flour Blending Operations:

Different products require flours of different protein quantities and qualities. In order to achieve the dough with desired optimum properties, wheat varieties or flours with different protein contents are blended together. Higher protein flours normally have stronger dough properties and larger snapback, compared with low protein flours, but also depend on the protein quality[1]. The gluten proteins governing the rheological properties of dough are composed of gliadins and glutenin fractions. Isolated gliadins appear purely viscous with negligible elasticity while glutenins are predominantly elastic. The "rheological optimum" characterizes the physical condition of a dough which, under the given processing conditions, supplies optimum dough handling properties and baking results. Changes in the proportions of flour fractions like bran and gluten can also be used as control factors to produce the doughs with varying degrees of extensibilities. The perfomance of the sheeted dough depends on the interactions among the structural elements of the doughs prepared from different flours as well as influence of additives, if any. From the **Farinograph® AT** and **Extensograph®-E** parameters, the rheological properties of the respective flours and/or flour blends can be clearly recognized. The **Glutograph®-E** is also a potential instrument to predict the dough strength for better sheeting performance. **Brabender®**'s new **GlutoPeak®** can also screen flours with specific protein quality. Based on kinetics of gluten aggregation derived from the **GlutoPeak®**, flours with desired attributes can be easily identified using small amount of sample (8-10 g) and in a short interval of time (60-600s).

Adjusting moisture:
At the mixing stage, with the input of water and energy, a range of biochemical interactions within the dough matrix detetmine the final dough properties. After starch and protein, water is the main component of the dough providing a medium for a range of chemical reactions including disulfide interchanges , while most importantly, it affects the fluidity of the dough. Dough formulations with excessive amount of water would be slack and might get stuck to the rolls during sheeting and cutting. On the other hand, insufficient water leads to stiff and less extensible doughs with poor sheeting properties. Plasticizing effect of water leads to softer and more extensible doughs while reduction in water decreases the plasticizing effect resulting in harder doughs resistant to flow. Apart from affecting dough handling and sheeting characteristics, water in the dough also affects the color of some products like noodles. It has been observed that textural characteristics, recovery, resistance to compression, and maximum cutting stress of noodles decline significantly with increasing water absorption[2]• Therefore, it is crucial to determine the optimum water content in dough formulations to control their online performance as well as the final product attributes. Water in the formulations can be adjusted using **Farinograph®-AT** while changes in the stretching properties, in particular the resistance to extension and the extensibility are assessed by the **Extensograph®-E** and **Glutograph®-E**.

Managing dough properties using additives:
Additives like enzymes, ascorbic acid, cysteine, azodicarbonamide etc. are usually added to facilitate mechanical development of dough and improve dough handling properties. Like no other instrument, the **Extensograph®-E** shows the influence of flour additives and thus, permits determination of the rheological properties of dough and adjustment of the rheological optimum for sheeting purpose. Depending on the protein content of flour and influence of additives, properties of doughs can range from tough to very extensible doughs. Proteases are usually used to treat "bucky" or overly strong or elastic doughs resulting in soft doughs with superior handling properties. The area under the **Extensograph®-E** curve determines the energy requirements as well as resistance to extension . These measurements provide a means of assessing the physical state of the dough during the sheeting process. More recently, many other enzymes such as xylanases (hemicellulases), cellulases (b-glucanases), amylases etc. are also being used commercially. The hydrolytic actions of enzymes cause redistribution of water in the dough system altering viscoelastic properties. The effects of varying enzyme concentrations on sheeting characteristics are evident from changes in the height and length of curves that can be associated with elasticity and extensibility of the doughs. Final product characteristics can also be correlated with the **Extensograph®-E** properties.

Optimizing Processing Parameters:
The **Extensograph®-E** can be a useful tool to develop process design parameters specific to a particular unit operation. The differences in the extensional properties owing to changes in modification of recipes result in changed rheological properties, demanding adjustment of the dough sheeting process on line. After the dough is sheeted, part of the energy stored in the dough must be released, so the dough springs back. With time, the dough returns to the original energy condition . The dough is under greater stress when sheeted with a larger reduction ratio, so there is more energy transferred to the dough and more energy could be released back to balance the system by snapback, if sufficient relocation time is not provided[1]. Therefore, besides the dough properties, line speed, gap of rolls, reduction ratio and rest time need to be adjusted to control the snap back for better dough handling properties. Snapback also affects the density and shape of the final product.

The **Glutograph®-E** and **Extensograph®-E** can be used to predict flours or dough formulations which can be deformed to a greater extent before the structure breaks down, yielding better sheeting performance. Also, with these instruments rest time can be optimized to produce doughs with the best extensional properties under circumstances.

To summarize, type of wheat, flour refinement, amount of added water, additives, ingredients, temperature and other process parameters all affect sheeting characteristics and final product quality attributes. When blending two or more flours with widely different properties, predictive models need to be developed to estimate the extensional properties and energy requirements of dough. Furthermore, the rheological optimum for the respective application of the flour with additives can be determined and adjusted on the basis of the evaluation data. **Brabender®** tools are sufficiently sensitive to predict the dough behavior on line and help control the dough piece size, shape and thickness at bakeries. From the standpoint of developing a standardized method, to optimize your processing conditions, selection of the appropriate **Brabender®** tools can take you a long way in terms of process improvement and productivity. Visit our website or call us to further discuss your specific requirements and our range of rheological instruments**.**

References

1. Ren D.Q., Walker C.E. and Faubion J.M. (2008) *Journal of Science of Food and Agriculture 88:2581-2588.*
2. Hatcher D.W., Kruger, J.E., and Anderson, M. J. (1999) *Cereal Chemistry 76:566-572*.