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Scientists Simulate Mixing the Perfect Dough

by Stacy Kish, CSREES

Hard-core foodies, bakers, consumers, and those who just feel the need to knead take heart—dough-making efficiency is on the rise. >>

Above: This research was featured on the cover of AIChE Journal Volume 52, Number 10.

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With funding from USDA's Cooperative State Research, Extension, and Education Service (CSREES), scientists in New Jersey used the Farinograph, a classic lab-scale batch mixer, to analyze the kneading process in order to understand the mixing properties needed to make consistent and top-quality baked products.

The researchers from Rutgers used this knowledge to develop computer models that simulate the path a particle of wheat dough follows during the mixing process. These models provide scientists the opportunity to improve quality control and efficiency in the baking industry.

Wheat flour dough is a complex material. Many time-dependant factors, including the quality of the flour, moisture availability, and the kneading process, play a role in how dough develops.

Kneading, a key component in dough production, is governed by mixing rate, type of mixing, and the type of deformation applied. As a result, dough mixers have evolved into highly complex geometries that shear, stretch, and fold the sticky mixture to create the perfect dough.

Currently, there are two main types of mixers used by industry: batch mixers and continuous mixers. Each type of mixer uses a different kneading process that affects the mixing time and gluten structure of the dough. Both properties greatly affect the texture and quality of the final product.

In industry, mixing times and mixer configurations are largely done on a trial-and-error basis.

Jozef Kokini, Robin Connelly and colleagues at Rutgers, the State University of New Jersey, have used numerical simulation with the Farinograph mixer to develop an understanding of the deformation of the dough during mixing. The work also examined energy input efficiency when transforming the flour and water into dough.

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Above: Dr. Robin K. Connelly.
Credit: Jayne Bock

These simulation results show how blade speed affects the exchange of material during the mixing process. A statistical analysis of the mixing process showed that the 'sweet spot' in the mixer lay dead center between the blades. This zone allows for excellent distributive mixing ability and results in the stretching deformation needed for effective gluten development. Outside this zone, the movement is more of a shearing or rotational nature that is not as effective for gluten development.

The results from the Farinograph mixer are being compared with the results from other types of dough mixers, including alternative batch mixing geometries and continuous mixers. With this information, the baking industry can effectively transition from mixer to mixer while maintaining the highest quality control and efficiency.

This work will allow manufacturers to design mixing systems that produce a consistent final product with the desired structural and functional characteristics that result from effective mixing.

CSREES funded this research project through the National Research Initiative Improving Food Quality and Value program. Through federal funding and leadership for research, education, and extension programs, CSREES focuses on investing in science and solving critical issues impacting people's daily live and the nation's future. For more information, visit www.csrees.usda.gov. ■

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http://www.csrees.usda.gov/funding/nri/nri.html

References

Connelly, Robin K. and Jozef L. Kokini, 2006, Mixing Simulation of a Viscous Newtonian Liquid in a Twin Sigma Blade Mixer, AIChE J., 52(10): 3383-3393..

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