Segregation of wheat protein and starch in dough and batter leading to separability by displacement.

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Gluten and starch from wheat flour may be prepared in concentrated form by applying fluid displacement to developed flour and water mixtures. A WRRC-patented process uses cold, concentrated ethanol as the displacing fluid. The technology is physically similar to both Martin and batter methods which use water as the displacing fluid. However cold ethanol displacement also removes water, produces a gluten that is easy to dry, and achieves potential energy advantages stemming from the displacement.

Objective measurements of separation were made using the cold ethanol displacement method and the process separation factor (ratio of protein to starch in the gluten fraction divided by the ratio of protein to starch in the starch fraction, $\alpha_{p/s}$). Using this criterion, the best separation was found for water content of 0.8 to 0.9 g /g flour and a development time of 25 min in a Farinograph. (**I**)

Basic dough rheology measured in the Farinograph was applied to "fingerprint" the flour used here (upper) and to characterize the flow properties of the flour and water mixture at the optimum water concentration (lower). The consistency of the separation mixture was low with regular features of development, but the peak consistency followed the peak separability by 10 min. (**II**)

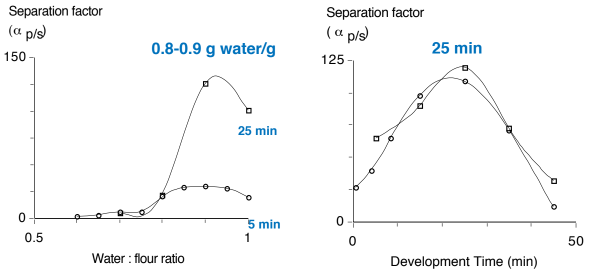
Enhancement of protein structure visibility both by color difference and surface starch displacement was effected by applying a protein dye to the surface of the developed mixture. This revealed protein structural features related to separability. An open, heavily banded protein matrix (blue) correlates with the development time providing most effective separation (center). Additional development led to the creation of a fine, interlaced matrix which would entrap starch and partially break apart in contact with the displacing ethanol leading to poorer separation. Insufficient development (top) includes a variety of partially aggregated structures with fibrillar and globular regions. (**III**)

An image sequence from a video of a simulated displacement separation are reproduced here. The displacement is simulated on the microscope by gentle manipulation of the optimally developed flour and drop-wise addition of water. The images (top to bottom) show segregation of the spherical starch particles into the fluid water phase, regions of rapid movement of starch (slight blurring), and the starch-free underlying yellow protein structure. (**IV**)

References of interest:
Robertson and Cao Cereal Chemistry 75(4):508-513, 1998.
Robertson and Cao, US Patent # 5,851,301, December 22,1998.

Studies are underway to upscale and simplify the method and characterize protein quality, protein distribution, and gluten drying properties.

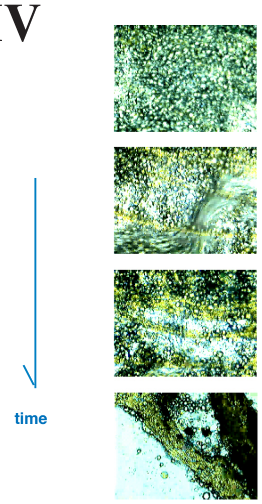
I



Lower:
(5min development, displace with 90% ETOH, at-7°C)
Upper:
(25 min development, displace with 90% ETOH at -12°C)

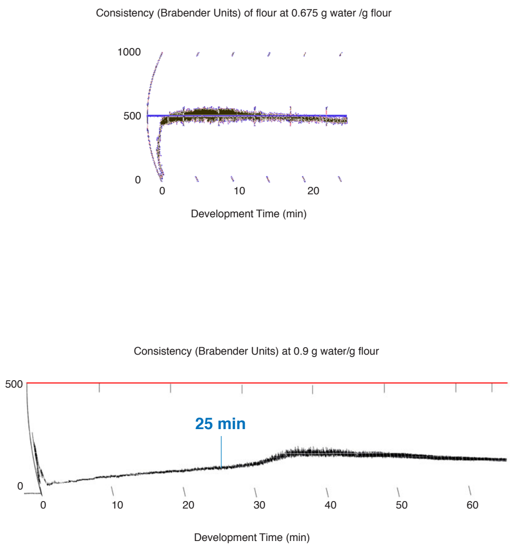
Lower:
(0.9 g, displace with 90% ETOH, at-7°C)
Upper:
(0.9 g, displace with 90% ETOH at -12°C)

IV

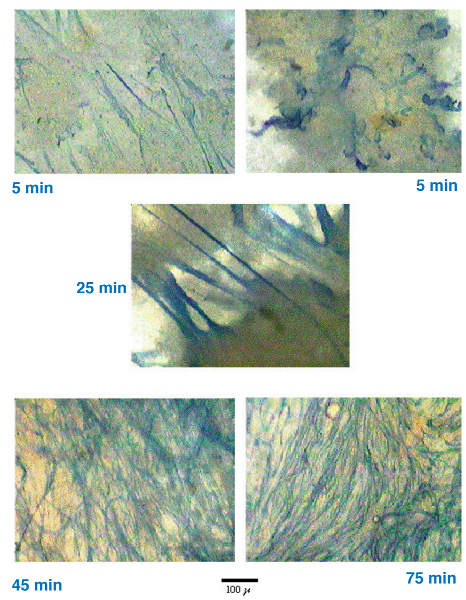


$$\alpha_{ps}=(x_p/x_s)_{\text{protein fraction}}/(x_p/x_s)_{\text{starch fraction}}$$

II



III



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