A Note on the Effect of Potassium Iodate and Thioacetic Acid on the Birefringence of Stretched Gluten[1]

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Birefringence of stretched gluten was first reported by Ritter in 1938 (1). Hanssen (2) proposed that the birefringence was due to the presence of small starch granules remaining in the gluten, after washing, rather than to the protein component. Bloksma and Isings (3), using gluten purified by Lusena's method (4), obtained an absolute birefringence of the order of 0.4×10^{-3} for a gluten sample stretched to about ten times its original length. They also found a decrease in relative birefringence with time at constant deformation. This observation, together with the apparent absence of a large number of starch granules with diameters less than the resolving power of the objective used (0.1 μ), which might account for the birefringence, suggested that it was the gluten protein that was responsible for the birefringence. The way in which it decreased with time after stretching was similar to the relaxation of stress in gluten and dough, although proceeding rather more slowly. Hence it was suggested that stress relaxation was due to a chemical reaction (probably the interchange of cross-links) or viscous flow (5).

Since chemorheological studies have shown a fairly rapid action of potassium iodate and thioacetic acid on the course of stress relaxation of dough, the effect of these chemicals on the decrease of birefringence of gluten with time was studied.

A commercial bread flour dough (12.6% flour protein at 14% moisture) was washed with tap water and the gluten dispersed in 0.01*N* acetic acid. The remaining starch was removed by centrifugation at 2,000 r.p.m. in an M.S.E. Magnum Centrifuge (approx. $900 \times g$) for 20 min., and the remaining dispersion was freeze-dried. The birefringence experiments were conducted in a constant-temperature room at 25°C. The microscope was a Cooke "Intermediate" polarizing instrument fitted with rotating analyzer and graduated scale with vernier accurate to 0.1°. Sodium light and the Sénarmont method were used. The thickness of the sample was estimated by focusing the microscope successively on the top and bottom surfaces of the gluten strand and measuring the movement of the microscope tube with a traveling microscope.

For the test, the gluten was rehydrated by immersion in water or in solutions of 100 p.p.m. of potassium iodate or thioacetic acid. Rehydration was rapid, air was expelled manually, and the gluten ball (¼-in. diam.) was allowed to rest in the liquid for 45 min. The gluten was then stretched to about ten times its original length and sealed into a small cell (made from a microscope slide, coverslip, and Plasticine) and containing the respective solution.

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The absolute birefringence of the gluten after stretching in water was of the order of 0.3×10^{-3}.

Figure 1 shows the decrease of relative birefringence of gluten, after stretching, in water and in solutions of 100 p.p.m. of potassium iodate and thioacetic acid. In water, the birefringence fell to about 0.3 of its original

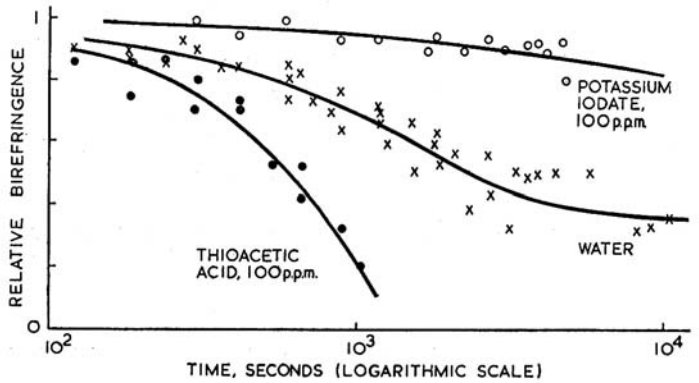

Fig. 1. The decrease of birefringence with time at constant deformation in water (five separate runs) and solutions of 100 p.p.m. potassium iodate (two separate runs) and thioacetic acid (three separate runs). The birefringence is given on an arbitrary scale, its value at first observation taken equal to unity. The time is measured from the first observation.

value in 100 min., and even after 175 min. did not fall below this value. This contrasts with the observation of Bloksma and Isings (3) where birefringence fell to zero after about 100 min.

In the presence of potassium iodate the birefringence decreased only to about 0.8 of its original value after 80 min. In thioacetic acid the decrease was greatly accelerated compared with the behavior in water.

The effect of these chemicals on the birefringence of stretched gluten is therefore similar to their effect on stress relaxation as determined rheologically.

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