NOTE

Hydrophobic Character of Heat-Treated Wheat Starch

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ABSTRACT

Wheat prime starch was extracted from wheat flour and heated at 120° C for 0, 1, 2, or 5 hr. The heat-treated samples were shaken in water with isoamyl alcohol, and the stability of the air bubbles was evaluated. Air bubble stability increased with the heat treatment levels.

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Heat treatment of wheat flour is known to improve cake-baking properties, and it has been suggested as an alternative to chlorination of wheat flour (Russo and Doe 1970). Seguchi and Matsuki (1977) studied the mechanism of chlorination of wheat flour and reported that improvement of pancake texture parameters for springiness and gumminess after chlorination were related to the hydrophilic-hydrophobic nature of wheat starch granules. Seguchi (1984a) also reported the same increase in hydrophobicity of wheat starch granules after heat treatment. The hydrophobic (lipophilic) character of wheat prime starch granules through chlorination and heat treatment was attributed to a change in the proteins on the starch granule surface (Seguchi 1984a,b). However, the relationship between the hydrophobicity of the wheat prime starch and the improvements in pancake texture is still obscure. Seguchi (1987) showed that chlorinated and resulting hydrophobic wheat prime starch granules did bind to air bubble membranes and contributed to air bubble stability. This was believed to contribute to the improvement in pancake texture. Cake structure is thought to be related to clusters of air bubbles with proteins. The hydrophobic character of wheat prime starch may contribute to the stability of the air bubbles and thus to final cake structure.

In this study, the stability of air bubbles through heat treatment and the resulting hydrophobic wheat prime starch granules was evaluated.

MATERIALS AND METHODS

Materials

Wheat prime starch granules were separated from nonchlorinated wheat flour, K Alps (Nitto Flour Milling Co. Ltd.), by the acetic acid fractionation method (Sollars 1958). Samples of the granules were air-dried for 24 hr at room temperature before heat treatment. Protein (N × 6.25) was determined by the method of Smith (1964). Reagents were all reagent grade.

Heat Treatment

Wheat prime starch granules were heated in an open Yanagimoto oven heater (Seguchi 1984a) at 120° C for 1, 2, or 5 hr.

Preparation of Aqueous Suspensions of Wheat Prime Starch

Aqueous (5.0%) suspensions of wheat prime starch (500 mg) containing 2.0% isoamyl alcohol (Seguchi 1987) were prepared in 25-ml calibrated test tubes (15 × 150 mm) fitted with glass stoppers. The tubes were shaken on an up and down shaker (Miyamoto Riken Kogyo Co. Ltd., MW-S) with a 4,700 rpm motor for 30 min at room temperature. Photographs showing the bubble layer volume were taken just after the shaking action was stopped, and about every 2 sec subsequently. This procedure was performed three times for each treatment. Standard deviations of this method ranged between 2 and 4%.

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RESULTS AND DISCUSSION

The protein content of the wheat prime starch sample was 0.275%. Hydrophobicity (lipophilization) of heated wheat prime

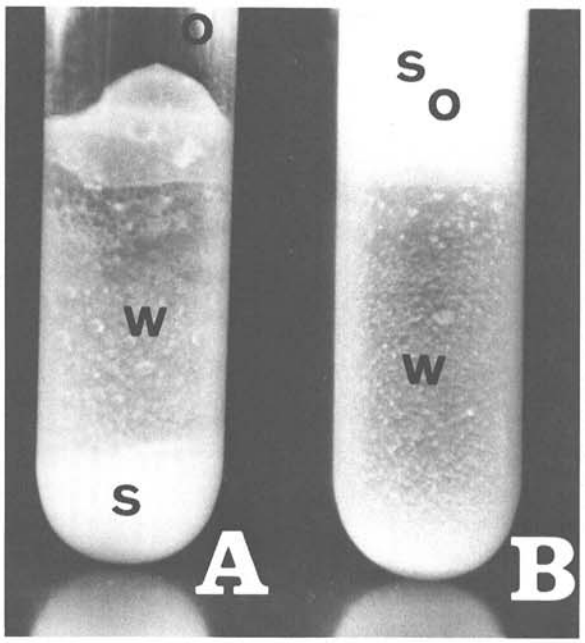

Fig. 1. Mixtures of unheated starch (**A**) or starch heated at 120° C for 5 hr (**B**) with oil in water. **O** = oil, **S** = starch, **W** = water.

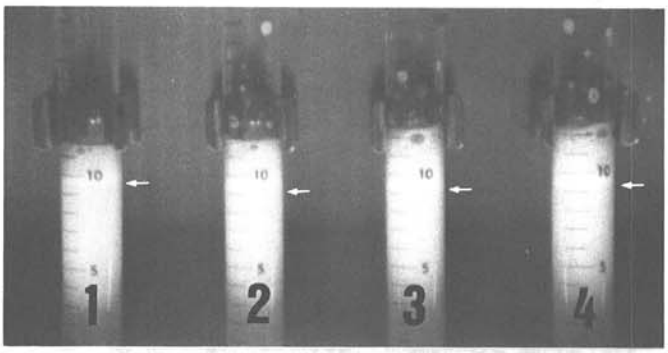

Fig. 2. Air bubble layers in mixtures of starch, water, and 2.0% isoamyl alcohol. **1,** Unheated; **2,** heated at 120° C for 1 hr; **3,** heated at 120° C for 2 hr; **4,** heated at 120° C for 5 hr. Arrow indicates the border of air bubble layer and mixture.

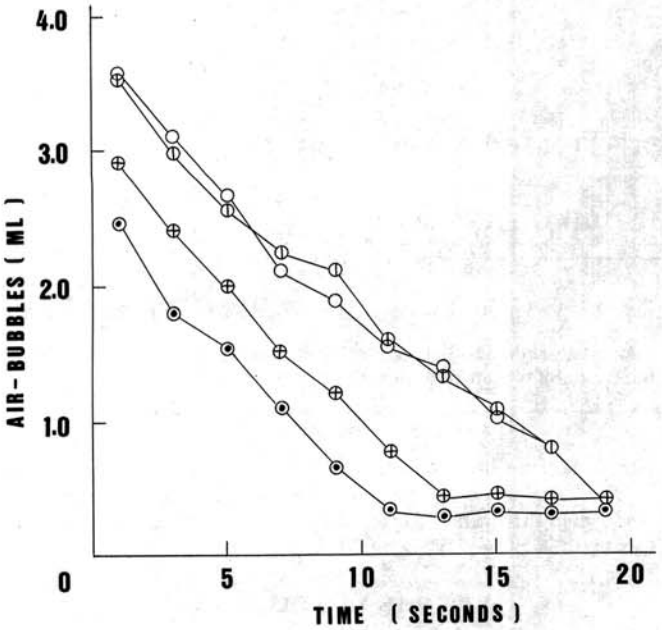

Fig. 3. Stability changes of air bubble layers (in milliliters) in aqueous starch suspension. Heating level of wheat starch samples were ⊙ = unheated, ⊕ = heated at 120° C for 1 hr, ◐ = heated at 120° C for 2 hr, and ○ = heated at 120° C for 5 hr.

starch granules was reported by Seguchi (1984a) as occurring between 80 and 160° C. The results of this experiment (Fig. 1) showed that unheated wheat prime starch was more hydrophilic than wheat prime starch heated for 5 hr at 120° C.

Air bubble layers within 1 sec after the shaking action was stopped for aqueous starch suspensions containing 2.0% isoamyl alcohol are shown in Figure 2. The heights of the white air bubble layers gradually increased from tube 1 to 4 as the heating times went from 0 to 1, 2, and 5 hr, respectively. Figure 3 shows the change in air bubble volume for each heat treatment after the rest period. It was observed that the volumes as an indication of the stability of the air bubble layer were increased with heating time from 0 to 2 hr. However, the results for heating at 2 or 5 hr at 120° C were almost the same. This indicated that the increase in hydrophobicity after 2 hr reached a maximum level. These results are similar to those reported to Seguchi (1987) previously, where the stability of air bubbles was found to be increased by the hydrophobic nature of wheat starch granules after chlorination. It is possible that hydrophobic wheat starch granules bind to the membrane of air bubbles, thus stabilizing the bubbles. Cakes are known to form by the assembly of many air bubbles. Thus, hydrophobic starch granules could contribute to the stability of cake batter and to the improvement of cake structure and texture.

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