PHASE SEPARATION IN THE GELATIN–STARCH–WATER SYSTEM

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The gelatin–starch–water system has been studied at different temperatures, at a total biopolymer concentration of 5·0 wt%. The weight ratios (W) of gelatin/starch used were 9:1, 8:2 ········· 2:8, 1:9, with pH values between 5·82 (at W = 9:1) and 6·50 (at W = 9:1). The systems were characterised rheologically and by turbidity measurements, to construct a phase diagram with temperature (T) and composition (W) as variables.

The T, W-quadrant consists of three regions: a single-phase solution region (A) and regions of complete and incomplete phase separation (B and C, respectively). The system in region C is a gel. Region B, lying between A and C, corresponds to a solution with sediment.

The transition from A to C (obtained by cooling the system at constant W) involves intersection with region B. Gel properties depend on the rate of this intersection. For example, the gels formed on rapid cooling have an even distribution of turbidity, whereas slow cooling gives two gel layers of different tubidity. The likely origin of this behaviour, and other properties of the gels, will be discussed.

RHEOLOGICAL PROPERTIES OF HIGHLY CROSS-LINKED WAXY MAIZE STARCH IN SKIM MILK

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In food systems, starch is often used as a thickening agent in combination with other ingredients, like milk in custard. We have measured the rheological behaviour of highly cross-linked waxy maize starch in suspensions of skim-milk powder in water. It was observed that the viscosity and modulus of a suspension of a given concentration of starch are much higher in skim milk than in water.

It is thought that the milk proteins are excluded from the swollen starch granules. This results in a phase separation between the starch and the milk proteins. The concentrations of the components in their phase become higher than in the whole solution. When the concentration of starch is above a critical value, it is possible that the concentration in the milk protein phase became high enough to form a gel of casein or beta-lactoglobulin.

We used a model proposed by Clark to describe the rheological behaviour of the starch–milk system. In this model the rheological behaviour of the combined system is determined by the viscosity and the modulus of a phase and the volume fraction of that phase. The water in the solution is distributed between the two phases by a relative affinity parameter (p). This parameter has to be estimated or measured by comparing the temperatures of the onset of gelation in pure and mixed systems (Svegmark & Hermasson, 1993). We used the volume of the swollen starch granules (Steeneken, 1989) and the hydration volume of the milk proteins (Walstra, 1984). In this manner a model can be made which describes the rheological behaviour of a starch–milk system reasonably well. However, the model needs further refinement.

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EFFECT OF SODIUM CASEINATE ON THE PASTING BEHAVIOUR OF STARCHES FROM DIFFERENT ORIGINS

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A number of food formulations imply the pasting of starch in the presence of casein. We report here some results on the effect of sodium caseinate on the swelling and solubility of starches from different botanical origins (wheat, potato and tapioca) and on the rheology of the pastes. These different starches are known to exhibit a wide range of pasting behaviours and, therefore, of rheological properties. The swelling and solubility patterns of starch during the pasting procedure were established. Meanwhile, the flow properties of the pastes were studied at 60°C and their viscoelastic behaviour characterised at the same temperature by dynamic measurements on the 0·01–10 Hz frequency range. The addition of caseinate decreased by a factor of 2 to 3 the swelling and solubility indices for wheat starch. The decrease was as high as six-fold for potato and tapioca starches. Solubility also was dramatically decreased. These effects result in a large decrease in the volume fraction occupied in the pastes by the swollen starch granules and in the concentration of starch macromolecules (essentially amylose) solubilised in the continuous phase. The rheological properties of the pastes also were strongly influenced by the presence of caseinate. On the basis of the swelling–solubility results, one could expect the caseinate to cause a large drop in the consistency of the pastes. Actually, a decrease in apparent viscosity was seen only in case of casein/tapioca starch mixtures. But, the opposite overall effect was observed with the two other starches, its magnitude depending on starch concentration. In addition, the presence of caseinate tended to reduce the thixotropic character of the pastes. This last effect can be accounted for by the lowering of starch granules deformability and mechanical fragility entailed by the diminution of their swelling. But the interpretation of the consequences of the presence of caseinate on other flow characteristics clearly requires the consideration of the interactions between caseinate and starch macromolecules in the continuous phase. The caseinate also modified the viscoelastic character of the pastes. However, each type of starch yielded a specific result and no clear tendency emerged. The effect of caseinate on starch pasting, particularly the swelling–solubility behaviour, can be discussed