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EFFECT OF THE GEL STRUCTURE IN THE ALKALINE DISSOLUTION OF β-LACTOGLOBULIN HEAT-INDUCED GELS

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ABSTRACT

Protein gels are, along with mineral deposits, the main element of the fouling deposits formed during the heat-treatment of milk. The alkaline dissolution of whey protein concentrate (WPC) gels made at high temperatures has been shown to behave differently depending on the pH (Mercadé-Prieto and Chen, 2005). Below pH 13-13.5 the dissolution rate of the protein gels is constant over time and increases proportionally with the sodium hydroxide concentration. However, on increasing the dissolution pH further, the dissolution process is not enhanced. As a first stage, an extensive study has been performed to elucidate the mechanism involved in the dissolution of protein gels in the low pH range (pH 7-13). β-Lactoglobulin has been used as a model protein, and it has been confirmed that it presents the same dissolution profile than WPC gels. Under a wide range of gelling conditions (gelling temperature: 65-90ºC, gelling time: 2.5-4000 min), the solubility of the gels in a pH 8 buffer solution with denaturans (6M urea, 0.5% wt SDS) correlates well with the dissolution rate constant (k'_g) found below pH 13 (Figure 1). This good agreement supports the hypothesis that k'_g is directly related to the disulfide crosslinking degree of the protein gel. A common activation energy for k'_g is found for gels formed at different gelling conditions (44 kJ/mol). The activation energy value is reduced below 30 kJ/mol at high dissolution temperatures, provably due to mass transfer limitations for the NaOH inside the gel. It has been further found that gels made at extreme conditions (90ºC for >45 min) feature covalent non-disulfide bonds in the gel structure. Solubility experiments in the presence of DTT and SDS-PAGE of the supernatant show that these new covalent bonds can represent a significant part of the total gel interactions. In conclusion, the dissolution of β-lactoglobulin gels at pH below 13 is limited by the chemical reactions that breakdown the covalent crosslinks of the gel structure.

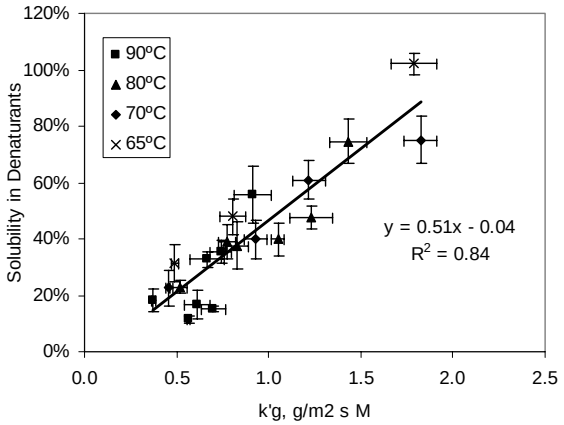

Figure 1. Correlation between the percentage of heat-induced gel soluble in a pH 8 buffer with denaturants (Urea/SDS) with the first-order alkaline dissolution constant, for β-lactoglobulin gels made at different gelling temperatures and times.

Reference:
Mercadé-Prieto, R. and Chen, X.D., *Dissolution of Whey Protein Concentrate Gels in Alkali*, submitted to AIChE Journal.