Modelling whey protein gelation under ohmic heating - effects of electric field strength, frequency and heating kinetics

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Whey protein gelation is dependent of the method used for their preparation. In heat-induced gelation, besides the protein solution characteristics (*e.g.* protein concentration, pH, ionic strength), other factors as temperature, exposure time, heating kinetics and heating method, are decisive to define the gel properties[1]. Ohmic heating is an emerging technology in food processing and its application in heat-induced gelation of whey proteins have demonstrated the capacity to influence the physicochemical properties of protein gels[2]. In this work we studied the variables that differentiate ohmic heating from other heating methods (i.e. electric field strength, frequency and heating kinetics) in order to establish their individual and conjugated influence in the gel properties. Fluid gels were produced using solutions of WPI at 7.5% (w/v) in 25 mM phosphate buffer; the gelation was induced by exposing the samples at 90 °C for 10 minutes, using different levels of electric field strength (0 to 20 V/cm), electrical frequency (50 Hz to 20 kHz) and heating kinetics (0.5 to 5 min). The obtained gels were characterized in terms of viscoelastic properties, turbidity, aggregates size (including polydispersity index) soluble protein and free thiol groups reactivity. The presence of the electric field during ohmic heating mostly results in gels with higher fractions of soluble protein, lower content of reactive thiol groups, smaller aggregates, lower turbidity and lower viscosity. The increase of the electric field strength particularly conjugated with lower frequencies and faster heating rates contributed to the decrease of the aggregates size and viscosity. While the low electric field and high frequency treatments resulted in gels with characteristics closer to the conventional (indirect heat transfer) method, presenting higher level of protein aggregation. The free thiol content was mostly affected by the heating method and less dependent of the electrical variables used. All the factors tested had significant influence ($p < 0.05$) in the gels properties. These results open novel perspectives for the use of electroheating processing as a tool for fine-tuning protein gel networks aiming enhanced functionality for intended applications (e.g. use as texturizer or encapsulating agents).

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References:

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