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Characterization of β-Lactoglobulin nano-hydrogels formed upon heat treatment and under selective pH range conditions

Oscar L. Ramos[a, b, c], Ricardo N. Pereira[a], F. Xavier Malcata[a, b, c], António A. Vicente[a]

[a]Institute for Biotechnology and Bioengineering, Centre of Biological Engineering, University of Minho, Braga, Portugal; [b]Institute of Chemical and Biological Technology, New University of Lisbon, Oeiras, Portugal; [c]Department of Chemical Engineering, Faculty of Engineering of University of Porto, Porto, Portugal

Bovine β-lactoglobulin (β-lg) is a globular protein from milk that has considerable potential as a functional ingredient in food, cosmetic and pharmaceutical applications. It is the major component (i.e. 50 wt%) and the primary gelling agent of whey proteins. β-Lg is known to be stable at low pH and highly resistant to proteolytic degradation in the stomach. Other property includes its ability to act as an encapsulating agent. The objective of this work was to understand the kinetics of aggregation during heat treatment under narrow pH range conditions that leads to the formation of food-grade β-lg nano-hydrogels and to propose a model for the mechanism of aggregation. In this study, aqueous dispersions of β-lg were generated and the formation of stable β-lg nano-aggregates were evaluated after heating under different temperatures (i.e. 75, 80 and 85ºC), holding periods (i.e. 5, 10, 15 and 20 min), and pH values (i.e. 4, 5, 6 and 7), with particular emphasis around pH 6.0. The protein aggregates formed were characterized as to their stability (turbidity), morphology, size, surface charge and content in accessible thiol groups. Stable dispersions of β-lg nano-hydrogels were obtained at pH 6, corresponding to an aggregation yield of about 65, 77 and 92% at 75, 80 and 85ºC, respectively, during a holding period of 20 min. Nano-hydrogels at pH 6 were characterized by a particle size between 160 and 250 nm and low polydispersity (<0.2). Their ζ-potential was +20 or −40 mV, depending on the pH values. Nano-hydrogels obtained at pH 5 displayed a lower content of accessible thiol groups as compared to those obtained at pH above or below this value. Between pH 5 and 6, large sedimenting protein particulates were obtained, whereas soluble aggregates were formed at pH <5 or ≥6.