Characterization of Micro- and Nanostructures from β-Lactoglobulin Formed Upon Heat Treatment and Under Selected Environmental Conditions

Lívia de Souza Simões, Rui Rodrigues, Oscar L. Ramos, Ricardo N. Pereira, Ana C. Pinheiro, José A. Teixeira, F. Xavier Malcata, Antonio Vicente

Introduction:
Bovine β-lactoglobulin (β-Lg) is a globular protein obtained from milk that has great potential as a functional ingredient in food, cosmetic, and pharmaceutical applications. It corresponds to the major protein fraction in bovine whey serum (ca. 50 % of its protein content), and the primary gelling agent of whey ingredients. The gelation capacity of this protein coupled with its high nutritional value, stability at low pH and resistance to proteolytic degradation in the stomach, makes it a suitable base material for the development of micro- and nanostructures (e.g. particles and hydrogels).

The objective of this work was to understand the kinetics of aggregation during heat treatment that leads to the formation of bio-based β-Lg micro- and nanostructures and to propose a model for the mechanism of aggregation.

Method:
β-lactoglobulin powder (10 mg·mL-1) was solubilized in water, under various environmental conditions: heating treatment (from 50 to 90ºC), holding times (from 5 to 30 min) and pH (from 2 to 7). Afterwards, the protein aggregates were characterized in terms of their stability to sedimentation (i.e. turbidity) by spectrophotometry; morphology by transmission electron microscopy; size, surface charge and polydispersity by dynamic light scattering (DLS); and content of accessible thiol groups of aggregates after heat treatment. Additionally, the changes in secondary structures of the protein upon heating were followed by circular dichroism (CD).

Significance:
The understanding of the effect of combined environmental conditions is of fundamental interest for the design of protein structures with improved or novel functionalities.

Results:
Stable dispersions (no sedimentation for 10 min) of individualized β-Lg nanostructures were obtained at pH <3.0 and >6.0. They were characterized by a spherical shape and low polydispersity in size (<0.2) for pH values <3.0 and >6.0. The size of protein structures determined by DLS was between 140 and 250 nm, and their surface charge of +30 or -40 mV; depending on the pH. DLS experiments also showed that before heating β-Lg was mainly present in an oligomeric state at pH 5. This result was confirmed by CD measurements indicating the stronger contribution of intermolecular β-sheets in the pH range of 4.0-6.0.

Category:
Food Engineering