Ref: 4364

Design of nanostructures, obtained from assembling of α-lactalbumin and lysozyme upon heat treatment and selective environmental conditions

Monteiro, Adenilson A.[1,2,3]; Monteiro, Marcia R.[3,4]; Ramos, Óscar L.[3,5]; Pereira, Ricardo N.[3]; Diniz, Renata[6]; Costa, Angélica R.[1]; Malcata, F. Xavier[5,7]; Teixeira, José A.[3]; Teixeira, Álvaro V.[1]; Oliveira, Eduardo B.[1]; Vicente, António A.[3]; Coimbra, Jane S.[1,6]

[1]Department of Food Technology, Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brasil; [2]COLUNI – Colégio de Aplicação da Universidade Federal de Viçosa, Viçosa, Brasil;
[3] CEB - Centre of Biological Engineering, University of Minho, Braga, Portugal;
[4]Department of Nutrition, School of Nursing, Universidade Federal de Minas Gerais, Belo Horizonte, Brasil;
[5]LEPABE - Laboratory for Process Engineering, Environment, Biotechnology and Energy University of Porto, Porto, Portugal;
[6]UFPA - Universidade Federal do Pará, Belém, Pará, Brasil;
[7]Department of Chemical Engineering, University of Porto, Porto, Portugal

E-mail: os.silva.ramos@gmail.com

Keywords: Nanostructures, α-lactalbumin and lysozyme, food applications, bio-based materials

Abstract

Protein assembly into supramolecular structures (e.g. aggregates, fibrils and nanotubes) is a widespread phenomenon in biological sciences. Nowadays, it is well documented that the amphiphilic properties of proteins is a driving force to their self-assembling into innovative micro- and nanostructures of high interest in the food and pharmaceutical fields. Formation of such structures is strongly dependent on physicochemical conditions and protein conformation.

In this study, bio-based nanostructures were produced from assembly of hen egg white lysozyme (Lys) and bovine α-lactalbumin (α-La) – i.e. two homologous globular proteins with opposite charge), under various processing conditions: heating treatment (55 °C and 75 °C), holding time (25 and 35 min) and pH (3 and 11). The nano-scale structures prepared by solubilization of 2 mg mL^{-1} of Lys and α-La powders in water, at a molar ratio of 1:0.54, were characterized via dynamic light scattering (in terms of particle size, polydispersity and zeta potential), and further analyzed by transmission electron microscopy (TEM). Smaller sized particles (75 nm) and low podydispersity values (0.24) were produced at pH 11 after heating at 75 °C for 25 min, whereas at pH 3 (and similar conditions) the average mean particle size was ca. 402 nm with polydispersity of 0.45. The nanostructure stability was also assessed; higher stability was obtained at pH 11 than 3, with zeta potentials of -35 and +27 mV, respectively, by 60 d. The nanostructure entities prepared at pH 11 were shown by TEM to possess a well-

defined spherical shape. Protein assembly mechanisms and intermolecular interactions involved appear to be controlled by the environmental conditions applied; therefore, an understanding of the quantitative effects of these conditions are crucial for rational design of new protein assemblies with tailor-made functionalities

Acknowledgements: A.A.M and M.R.M gratefully acknowledge their grants to CNPqz and CAPES (Brazil), and their support to FAPEMIG and CNPEM-LNBio, both from Brazil. O.L.R and R.N.P gratefully acknowledge their Post-Doctoral grants (SFRH/BPD/80766/2011 and SFRH/BPD/81887/2011, respectively) to Fundação para a Ciência e Tecnologia (FCT, Portugal). The authors thank FCT Strategic Project PEst-OE/EQB/LA0023/2013 and project “BioInd - Biotechnology and Bioengineering for improved Industrial and Agro-Food processes", REF. NORTE-07-0124-FEDER-000028, co-funded by the Programa Operacional Regional do Norte (ON.2 – O Novo Norte), QREN, FEDER.