Laboratoire d'Ingénierie de Biomolécules LIBio – pôle scientifique A2F – Université de Lorraine
Ecole doctorale RP2E

Self-assembly of polyphenol conjugated acacia gum: structural and thermodynamical study.

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The conception of new systems that can encapsulate active molecules to a defined target is a major research focus of the Laboratory of Biomolecules Engineering. The originality of LIBio deals in the formulation of innovative vectors whose constituents are derived from renewable agro-resources. One of the research axes of the laboratory is focused on the functionalization of natural polysaccharides in order to bring them new functional properties useful for the formulation of new colloidal carriers.

In this thesis work, the original approach of enzymatic functionalization of polysaccharide developed at LIBio will be implemented to modify acacia gum in order to give it self-assembly properties. This modification will rely on the use of a laccase for grafting phenolic compounds onto the polysaccharide. This enzymatic modification process has already been tested on chitosan, pectin and acacia gum (in progress) (Theses A. Aljawish, N. Karaki and M. Vuillemin). Acacia gum present a very complex structure (Lopez-Torrez *et al.,* 2015) and interesting functional properties such as a high emulsification ability and a low viscosity in aqueous solution (Shotton and Wibberley 1960 ; McNamee, O'Riorda, and O'Sullivan 1998 ; Hosseini *et al.,* 2015). Moreover, it has been demonstrated that acacia gum is able to encapsulate hydrophobic compounds (Aberkane *et al.,* 2012). The possibility to graft phenolic compounds using an enzymatic route on this polysaccharide has been confirmed in several studies (Master F. Yahiaoui 2015-2016, Master K. Mahfoudi 2016-2017, PhD M Vuillemin in progress). The grafting of curcumin onto acacia gum modify in particular the hydrophilic/hydrophobic balance of the polymer, which becomes more hydrophobic. The acacia gum solubility has then been modified and the spontaneous formation of colloidal monodisperse particles at low concentration has been evidenced. A self-assembly phenomenon or simple coacervation analogous to a micellization seemed to appear for curcumin-conjugated polysaccharide. The particles formed may be interesting for the development of new carriers made of natural resources.

The proposed subject deals then with the enzymatic functionalization of acacia gum with phenolic compounds and the induced modification, especially on self-assembly properties. The influence of physical-chemical properties such as polymer concentration, temperature, ionic strength and pH on the self-assembly ability of the modified polymer will be studied. The structure of formed particles will

be established from scattering measurements (light, XRays, neutron) and microscopy's methods. The self-assembly thermodynamical parameters will be determined by isotherm titration calorimetry.

This original approach should also bring new information to understand the relation between the polymer structure and its physical-chemical properties. The study will start with the curcumin grafting onto acacia gum and will evolve using other phenolic compounds to answer the question: is it possible to modulate the self-assembly properties of acacia gum by grafting more or less hydrophobic molecules?

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Aljawish, Abdulhadi, Isabelle Chevalot, Jordane Jasniewski, Anne-Marie Revol-Junelles, et al. 2014 Laccase-Catalysed Functionalisation of Chitosan by Ferulic Acid and Ethyl Ferulate: Evaluation of Physicochemical and Biofunctional Properties. Food Chemistry 161: 279–287.
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McNamee, Brian F., E. Dolores O'Riorda, and Michael O'Sullivan 1998 Emulsification and Microencapsulation Properties of Gum Arabic. Journal of Agricultural and Food Chemistry 46(11): 4551–4555.
Shotton, E., and K. Wibberley 1960 The Emulsifying Properties of Gum Acacia. Journal of Pharmacy and Pharmacology 12(S1): 105T–107T.

Keywords : self-assembly, colloidal particles, enzyme, acacia gum, phenolic compounds

Director : Jasniewski Jordane MCF

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Skills required or acquired during the thesis :

Biochemistry : enzymatic functionnalization

Physical-chemistry : biopolymers characterization (FTIR, SEC), amphiphilic molecules characterization (surface tension, emulsifying properties), nano- and micro-particles (size, structure, surface charges), thermodynamical parameters.