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Chewing behavior of high-protein expanded pea flour

Magdalena Kristiawan *(INRA, UR 1268 Biopolymers Interactions and Assemblies (BIA), 44316 Nantes, France), Thomas Mégaradémy (CSGA (Centre des Sciences du Goût et de l'Alimentation), CNRS, INRA, Université de Bourgogne Franche-Comté, F-21000 Dijon, France), Azad Emin (Karlsruhe Institute of Technology, Institute of Process Engineering in Life Sciences, 76131 Karlsruhe, Germany), Valérie Micard (Montpellier SupAgro-INRA-UMII-CIRAD, JRU IATE 1208, 34060 Montpellier, France), Guy Della Valle (INRA, UR 1268 Biopolymers Interactions and Assemblies (BIA), 44316 Nantes, France), Christian Salles (CSGA (Centre des Sciences du Goût et de l'Alimentation), CNRS, INRA, Université de Bourgogne Franche-Comté, F-21000 Dijon, France)*

Legume-based protein foods can overcome the challenges of protein transition and sustainable agriculture. Extrusion is a convenient process to fabricate such a food. Due to the reactivity of the protein components, extrusion produce foams with various texture and composite morphologies, which govern extrudates chewing performance. At an onset extrusion temperature, the protein solubility decreases due to aggregations and the dispersed protein aggregates make a bi-continuous phase with starch. The aim of this study is to determine the relationship between multi-scale structure and texture of high-protein solid foams with oral destructuration mechanism.

Extruded samples (1.4g) were selected for in-vitro chewing according to their density, cellular architecture, texture, water absorption index of starch and solubility of protein aggregates. In vitro chewing was performed using artificial salivary fluid rate (0; 2; 4 mL/min) and chewing time (5-25s). Shearing angle was 1°, maximum jaw force 350 N and initial volume of saliva 3mL. The boluses were collected at three chewing times. The size distribution of bolus fragments was determined by scanner and image analysis by granulometry. Bolus consistency and saliva uptake were determined by capillary rheometry and gravimetric method, respectively.

Median particle size D50 of dry and humid boluses decreased with chewing time. Dry boluses D50 (0.35-0.75 mm) was found 80% smaller than the one of real chewing, likely due to the absence of fragment agglomeration by saliva. Viscosity of humid boluses exhibited shear thinning behaviour, following a power law with a nearly constant flow index (≈0.11). Bolus consistency index was correlated negatively to saliva uptake, and depended strongly on foam texture. The evolution of bolus properties during chewing, i.e. granulometry, saliva uptake, and consistency were expressed as a function of the foam Young modulus and starch and protein solubility, in order to build a phenomenological model of the oral processing of these foods.