Rheological and 3D printing behavior of pea and soy protein pastes

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There has been an increasing demand for the utilization of plant-based proteins as substitute for those of animal-origin in food formulations. Furthermore, manufacture of food products by three-dimensional (3D) printing is receiving increased attention as a way to produce foods with wide customization possibilities in terms of shape, flavor, texture, color, and nutritional value.
The aim of this study was to gain a better understanding of the importance of the rheological behavior of plant-protein food inks on their ‘printability’ following extrusion 3D printing. The viscoelastic properties of pea and soy protein pastes with concentrations ranging from 10-21%w/w were correlated with their ‘printability’. The rheological parameters G?, tan? and ?y were affected by the protein concentration, and a different viscoelastic behavior was observed for PPI and SPI pastes. At low protein concentrations (10-16%w/w) SPI is more elastic than PPI, whereas at higher protein concentrations their behavior was similar. For both protein systems the tan?, was only slightly affected by the protein concentration, while both the G? and ?y increased exponentially as a function of the protein concentration. No self-supporting structures could be printed for pastes with protein concentrations <15%w/w, and for concentrations >19%w/w imperfections and inhomogeneity in the surface structure are observed. In the protein range of 15-17%w/w, SPI formed more stable 3D printed objects compared to PPI. SPI shows a more elastic structure that increases stability against collapse during the 3D printing. At higher protein concentrations (>17%w/w) for PPI, the increase of G?, ?y and K counteracted the importance of n and tan?, resulting in self-supporting 3D printed products becoming more similar to SPI. Having quantified both rheological and printing properties, multicomponent analysis was performed to identify correlations. Among the different rheological parameters analyzed a modest correlation to printability was found with the G?. This work provides a better understanding of the importance of rheology of plant-protein food inks to printability by attempting to establish printing predictors, which is important for the development of new inks for 3D printed foods.