Designing 3D printable food based on unexploited seafood: printability assessment

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Fish discards are a worldwide phenomenon resulting from fisheries and have been the subject of great concern on the part of all players in the sector, whether they are government, fishermen or scientists. Numerous species of low or no commercial value are discarded every year and most of them have a high nutritional value. However, due to economic reasons and/or consumer acceptance, they do not reach our food chain. In recent years, numerous studies on three-dimensional food printing (3DFP) have demonstrated the value of this technology. However, adapting the existing 3D-printing technology to the food sector has generated new challenges, as food materials often consist of many different components with distinct properties. Traditionally, food materials such as fish, present unsuitable properties for printing, requiring the addition of hydrocolloids and other viscosity-modifying materials to induce the appropriate properties to the formulations. The aim of this work was to design and development printable seafood-based formulations. Unexploited fish species and by-products from the seafood industry, attractive at multiple scales with excellent sensory and nutritional properties, were selected, contributing to the transformation of seafood "waste" back into perfectly edible foods. Food inks were prepared by adding different hydrocolloids and other viscosity-modifying agents. The characterization of the fish-based formulations and the optimization of the printing process were done to yield the best printing products. First, the raw fish-based inks were subjected to dynamic oscillatory analysis to characterize its viscoelastic behavior with the best formulations being chosen for the optimization of the printing process. Second, the parameters of printing speed and flow level were optimized resulting in the best printed structures. Preliminary results showed that the addition of corn starch and carrageenan increase the consistency index in the fish formulations and improve the printability using extrusion-based 3D-printing. This work contributed to the development of innovative, healthy, and sustainable food products and to reshaping food waste into new highly valuable ingredients employable to create nutritious and attractive edible food.