Impact of macronutrient composition on 3D printability of pea-based food formulations

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The emerging technology of 3D food printing is promising for production of personalized foods. Personalized foods are ideal for individual dietary requirements of a consumer, thereby helping to sustain a healthier diet. However, especially changing the macronutrient composition of foods, i.e. the amount of carbohydrates, proteins and fat, is known to strongly affect the printability—extrudability and buildability—of food formulations. In addition, the amount of added water used for preparing formulations plays an important role. The influences of macronutrients and water are complex and have not been studied systematically before. Therefore, the aim of this study was to investigate the influence of macronutrient composition on printability and rheology using a quantitative experimental design approach. For this, a pea-based model food formulation varying in fibre, starch, and protein content was evaluated in terms of printability namely: (a) extrudability and (b) buildability which was further linked with their rheological properties. A systematic study was conducted by varying one macronutrient at a time. Water content was adapted based on water holding capacity of the various ingredients. From the results, it was found that water holding capacity is a good starting point for systematic formulation of printed foods with various macronutrient composition. Subsequently, it was observed that fibre and protein had a stronger effect on extrusion force and flow point than starch, which may be explained by the microstructure of the formulations. Compositions containing 30-80% fibre, 10-50% protein, and 0-60% starch on dry basis were identified as the ranges within which stable printed samples could be obtained. The knowledge obtained from this research provides a window of operation for successful 3D printing of pea-based formulations and the approach may be used for other printable food formulations as well.

Keywords: Macronutrient composition, personalized foods, 3D food printing