Improving the quality 3D printed food products by the full control of the printing movements and material deposition

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3D Food Printing is a promising technology that converts a digital model into edible food structures. Its nature, with extraordinary degrees of freedom, makes creating food structures impossible to realize with traditional manufacturing technologies. The interest of researchers and food industries in 3DFP is exponentially increasing due to the great opportunities for market innovation, on-demand productions, personalized food manufacturing, novel sensory perceptions, etc. However, to build 3D printed food products, there is the need to use CAD software to design the digital model and, second, to use slicing software to define the printing conditions and to convert the digital model into G-codes consisting of the information for printing movements and materials deposition. Such software contains limitations that hinder the creation of precise 3D food structures and the obtaining desired functionalities (i.e. texture, structural stability, etc.); such limitations also generate several difficulties in understanding the underlying causes and effects. For instance, the slicing software allows only limited printing paths that often reduce the structural stability of 3D-printed food products. We used a novel approach based on the concept of Full Control G-codes that allows the user to define any print-path segment and control all printing parameters. After defining digital models with different levels of complexity in terms of shape, dimensions and internal structures, 3D printing experiments have been performed by using a printable cereal-based food formula. Both the traditional printing approach and the innovative G-code designers have been used. The obtained samples have been compared not only in terms of the printing fidelity of the digital model but also in terms of printing efficiency by analyzing the printing time, the ratio between printing and non-printing movements, the capability of slicing complex structures and the time for slicing such digital models. Results showed the superior quality of samples obtained by the novel approach and open for creating innovative food products with a high level of structural complexity with several benefits on sensory properties and consumer acceptance.