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Solutions for Food-Safe 3D Printing

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Abstract : Three-dimension (3D) printing, a very popular additive manufacturing technology, has recently undergone rapid growth and replaced the use of conventional technology from prototyping to producing end-user parts and products. The 3D Printing technology involves a digital manufacturing machine that produces three-dimensional objects according to designs created by the user via 3D modeling or computer-aided design/manufacturing (CAD/CAM) software. The most popular 3D printing system is Fused Deposition Modeling (FDM) or also called Fused Filament Fabrication (FFF). A 3D-printed object is considered food safe if it can have direct contact with the food without any toxic effects, even after cleaning, storing, and reusing the object. This work analyzes the processing timeline of the filament (material for 3D printing) from unboxing to the extrusion through the nozzle. It is an important task to analyze the growth of bacteria on the 3D printed surface and in gaps between the layers. By default, the 3D-printed object is not food safe after longer usage and direct contact with food (even though they use food-safe filaments), but there are solutions for this problem. The aim of this work was to evaluate the 3D-printed object from different perspectives of food safety. Firstly, testing antimicrobial 3D printing filaments from a food safety aspect since the 3D Printed object in the food industry may have direct contact with the food. Therefore, the main purpose of the work is to reduce the microbial load on the surface of a 3D-printed part. Coating with epoxy resin was investigated, too, to see its effect on mechanical strength, thermal resistance, surface smoothness and food safety (cleanability). Another aim of this study was to test new temperature-resistant filaments and the effect of high temperature on 3D printed materials to see if they can be cleaned with boiling or similar hi-temp treatment. This work proved that all three mentioned methods could improve the food safety of the 3D printed object, but the size of this effect variates. The best result we got was with coating with epoxy resin, and the object was cleanable like any other injection molded plastic object with a smooth surface. Very good results we got by boiling the objects, and it is good to see that nowadays, more and more special filaments have a food-safe certificate and can withstand boiling temperatures too. Using antibacterial filaments reduced bacterial colonies to 1/5, but the biggest advantage of this method is that it doesn't require any post-processing. The object is ready out of the 3D printer. Acknowledgements: The research was supported by the Hungarian and Serbian bilateral scientific and technological cooperation project funded by the Hungarian National Office for Research, Development and Innovation (NKFI, 2019-2.1.11-TÉT-2020-00249) and the Ministry of Education, Science and Technological Development of the Republic of Serbia. The authors acknowledge the Hungarian University of Agriculture and Life Sciences's Doctoral School of Food Science for the support in this study

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