

# APPLICATIONS OF ADDITIVE TECHNOLOGIES IN THE FOOD INDUSTRY

Daniel Besnea<sup>1</sup>, Octavian Dontu<sup>2</sup>, Victor Constantin<sup>3</sup>, Alina Spanu<sup>4</sup>, Ciprian Rizescu<sup>5</sup>, Edgar Moraru<sup>6</sup>

<sup>1-6</sup> Politehnica University of Bucharest

Post address: Splaiul Independenței nr. 313, sector 6, Bucharest

[d\\_bes@yahoo.com](mailto:d_bes@yahoo.com), [octavdontu@yahoo.com](mailto:octavdontu@yahoo.com), [victor.f.constantin@gmail.com](mailto:victor.f.constantin@gmail.com), [spanu\\_alina@yahoo.com](mailto:spanu_alina@yahoo.com), [ciprianrizescu2001@yahoo.com](mailto:ciprianrizescu2001@yahoo.com), [eddy\\_milan91@yahoo.com](mailto:eddy_milan91@yahoo.com)

**Abstract:** The article presents a new concept that can be used in the food industry by manufacturing customized food products with 3D printers. This technique allows the production of personalized food products both as shape, colour, aroma and even as a nutritional value. Applications in the food industry can offer an engineering solution for new products and a tool for design specialists by creating food products with complex shapes that cannot be obtained by classical processes. Also, this technology can be a solution for researchers exploring cosmic space and long-distance space missions.

**Keywords:** Customized Food, 3D Food Industry Printers; Foods with Complex Forms.

## 1. Introduction

Food manufacturers want to develop new techniques in this 3D printing field due to their unique features. Digital techniques used in gastronomy to produce customized food products that have the form, flavour, colour, texture and even nutritional value are strictly controlled because it is a digitally manipulated process that is based on layer coating of food by the appearance phase transitions or chemical reactions to solidify the layers. Culinary experience goes beyond taste, embracing all aspects, combining 3D printing techniques with help of which it is created personalized food with special design and layered structure. Currently 2D printers are specially designed to print with colorant jet food using cartridges that contain the basic colours and allow photographic quality reproduction of logos, images for customized decorations or photos. The print media may be various food sheets (wafer sheets, wafers, chocotransfer sheets) [1-4].

The 3D printing technique used in the food industry, in particular to obtain toppings for tortoisés, candy that could not be created by other means, a major advantage of this technology by enabling it to control food allergies or food intolerance (gluten intolerance for example), helping to avoid the introduction of certain nutrients. . Most 3D printers in the food industry work similarly to an ornate cornet, layers are gradually applied, and usually creamy ingredients such as chocolate, cheese cream, ice cream, mustard, peanut cream are used.

Also, 3D printing can not only be applied in the sweets area, it can print a mixture of wheat flour, so you can make custom pastes [3], (fig. 1).

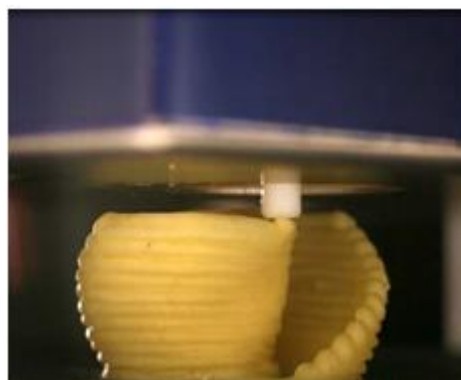


Figure 1. Customized pasta realized by 3D printing [3]

An area of interest involves creating a type of food that can be used during long-term space missions. Consumption of powdered and oily foods but with a healthy nutritional intake can mark the end of the era in which people throw away the food because the 3D printing system uses a powder that has a shelf-life of decades and does not require keeping it at low temperatures. Therefore cartridges used in 3D printers containing sugars, complex carbohydrates and proteins or other essential organic substances can be used for a very long time. Since food powders can be used, calorific sources could be any commensurable thing that contains the right organic molecules.

In the current growth rate of the Earth's population, the current food system will not be able to support 12 billion people, and once population numbers grow, we may not have the same agricultural resources [3].

Another aspect in which new 3D technology can help older people who have a healthy eating problem, with food being made from fresh food, especially vegetables, the food consumed after it has been recompressed by a 3D printer decomposes more easily into the cavity mouth than one prepared by classical methods. For example, peas, potatoes, chicken can be the basis of recipes for food preparation made by 3D food printers [3].

## 2. 3D Printing Technology for the Food Industry

The platform on which the 3D printer is built in the article is based on the concept of 3D Hypercube printers, with a Cartesian XYZ axis system and a dosing system, all the process being controlled by a computer [2]. The composition of the food can be deposited / synthesized point by point or layer by layer according to the model created by the designer.

The printhead may have various forms of construction, some use thermal energy (heating element, hot air) to sinter or melt the food powder, and others use inkjet spray heads that pulverizing binder or solvents. In this technology each layer is uniformly distributed over the manufacturing platform and a liquid binder is deposited on the print head to bind two consecutive layers of powder. The deposition material is stabilized by a fog of water and sugars and starch mixtures may be used. In the case of the depositing technology with the heating element, the depositing material is heated and then extruded through a depositing head and deposited on a metallic and cooled substrate, being especially used to create personalized chocolate or chocolate products. In the paper is presented a demonstrative model of the 3D printer with possibility of use in the food industry, offering more options for the dosing material so that the print head was designed

especially from stainless steel provided with a system of resistors that can heat the chocolate raw material and a temperature transducer that allows rigorous control of the deposition material with the possibility of optimizing the computer-controlled manufacturing process, with the advantage of being compact and low maintenance costs. The disadvantage of this 3D printing method is long manufacturing time, visible deposition areas, delamination of layers due to temperature fluctuations.

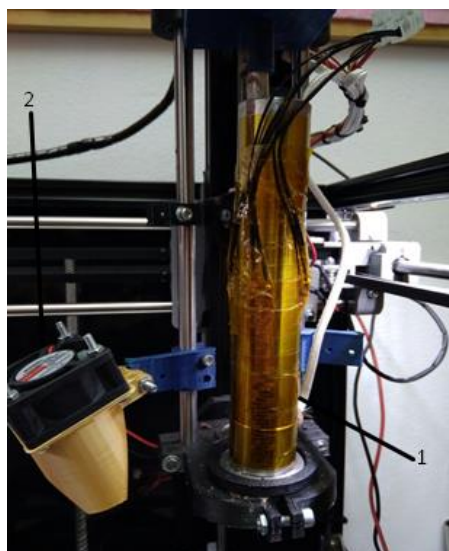


Figure 2. Stainless steel head : 1 - deposition head with transducer; 2 - cooler

An important component of 3D printing technology using different printable materials is the deposition table that ensures the stability of the first layers and the basis of the future 3D food construction. In order to ensure an optimal adhesion temperature for various materials such as chocolate, sugar blends, potato puree (which can be classified as powdered food + binder), the deposition table was adapted by placing under the stainless steel plate of two Peltier resistors which provide adequate cooling and ventilation capacity, fig. 3.

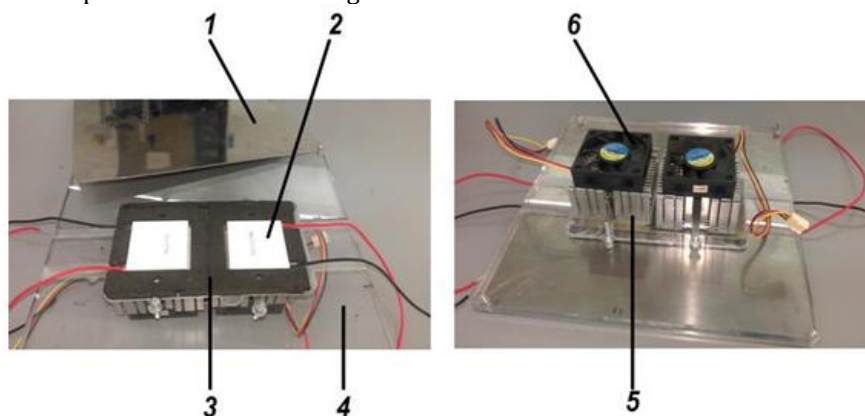


Figure 3. Deposition table 1- stainless steel support plate; 2 Peltier resistors; 3 - thermal insulator; 4 - support; 5- aluminium radiator; 6- ventilator

Some of the printable materials are stable enough to retain their shape after deposition, do not require further processing, and can be used in space applications. Other materials such as protein-based foods may require a post-deposition cooking process, this making it more difficult to keep the form. These materials used in traditional food

recipes, additives and others are non-traditional edible materials (such as extracted from algae, sugar beet or even insects). The diversity of printing materials offers consumers the possibility of designing multi-material foods with complex geometries and structures [5,6].



Figure 4. 3D printer prototype used in the food industry: a-general view; b – electronic control panels

### 3. Impact of 3D Printing in the Food Industry

In addition to artistic appearance and custom food personalization for the food industry, the 3D manufacturing process provides research tools to develop new food materials. Also, this technology, which is in the beginning, must investigate the satisfaction of customers' requirements and the potential for people to change their lives. Foods made on 3D printers are realized in experimental forms with personalized flavors involving high costs. In the future, these technologies can offer more freedom in design, shapes, colors and flavors for home users. Foods obtained through this technology allow accurate date control, providing fresh and healthy preparations, well-known food ingredients

and dosages, adapted to formulations specific to each manufacturing process. Also, 3D technologies allow us to reconsider our personalized food supply chain by bringing food to a shorter time for consumers. A barrier in the development of 3D food technologies is the composition of materials (ingredients and their structure, texture and taste) due to various combinations, handling under non-sterile conditions can damage the final product. Also an important condition is the feature of the printing materials that have to be rigid and strong enough to support the weight of the deposited layer. Key process parameters such as temperature, humidity, density, viscosity, thermal conductivity of foods should be taken into account in 3D printing of different types of food materials[1, 7].

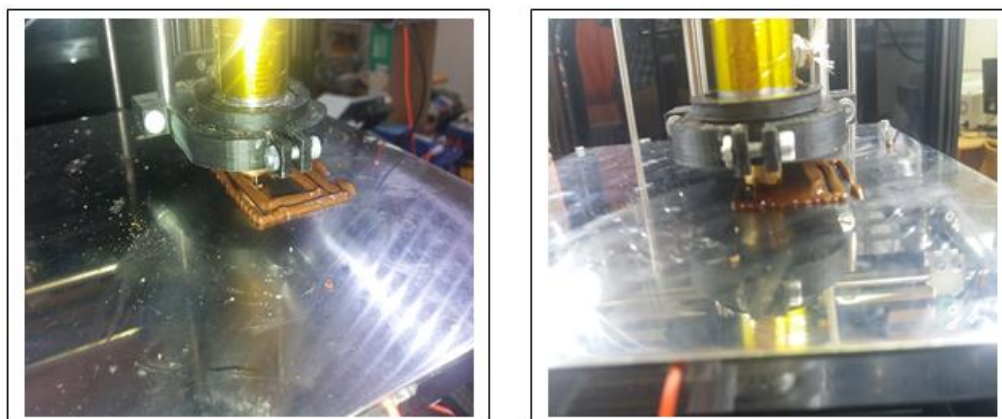


Figure 5. Chocolate printing example

## 4. Conclusions

3D printing in the food industry has demonstrated the ability to print different homogeneous products used in the confectionery. However, this technology is initially with limited materials and structures, with the need to develop new printing materials, new design platforms and control rigorous nutrition. 3D printing in the food industry can be implemented in certain product development stages, new moulds and prototypes of sweets can be created, which often could not be created without a complex production line, thereby speeding up the product development process and reducing the cost of introducing a new product to the market. With the development of these technologies, this system can become environmentally friendly, with new ingredients, preparation of food on demand, collaboration between nutritionists for healthy diets. 3D Food Print Technology is a tool for researchers to use this technology in space for ease of transport and long storage of raw materials used. 3D technologies allow designers and users to use unique shapes and materials by offering high-quality products, fresh products, allowing users to develop new flavours, textures and shapes to create new culinary experiments [1].

## Acknowledgements

This work has been funded by University POLITEHNICA of Bucharest, through the "Excellence Research Grants", Program UPB-GEX 2017. Identify: UPB-GEX2017, Grant no. 48/25.09.2017, ME 14-17-05, ID98.

## References

- [1] Jie Sun, Zhuo Peng, Weibiao Zhou, Jerry Y.N.Fuh, Geok Soon Hong, Annette Chiu, A Review on 3D printing for Customized Food Fabrication, *Procedia Manufacturing*, Volume 1, 2015
- [2] [www.lesimprimantes3d.fr](http://www.lesimprimantes3d.fr)
- [3] <http://3d4all.ro>
- [4] <http://www.novapan.ro>
- [5] J. IZDEBSKA, Z.ŻOLEK-TRYZNOWSKA *Agro FOOD Industry Hi Tech* - vol. 27(2) - March/April 2016
- [6] Z. Liu, M.Zhang, B.Bhandari, Y.Wang - 3D printing: Printing precision and application in food sector, *Trends in Food Science & Technology* 2017, doi: 10.1016/j.tifs.2017.08.018.
- [7] M.Golding et al. Design & Development of a 3-D Food Printer, Centre of Research Excellence, hosted by Massey University.