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Review on the food industry's use of 3D printing

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Abstract

In three-dimensional (3D) food printing, deposition techniques are used to shape food. Every method is distinct. Extrusion-based printing allows you to make intricate shapes and regulate the thickness of your layers. The most popular technique for 3D food printing involves viscous food ingredients to make sure the material extrudes in the desired shape. Layers of the food are assembled until it is complete. 3D printers prepare food to the right consistency without cooking it. They could then need to be baked after the printing is done. Some foods, like sugar or chocolate, are best consumed immediately after printing.

The process of creating food products using 3D printing technology is known as "3D printing" in the food industry. The most popular technique makes use of viscous food additives to guarantee that the material, upon extrusion, maintains its original form. Layers of the food are assembled until it is complete. 3D printers prepare food to the right consistency without cooking it. They could then need to be baked after the printing is done. Some foods, like sugar or chocolate, are best consumed immediately after printing.

Keywords: 3D (3 Dimension), printer, extrusion

Introduction

In 3D food printing, deposition techniques are used to shape food ^[1]. Every method is distinct. Extrusion-based printing allows you to make intricate shapes and regulate the thickness of powder layers. Powder bed fusion creates porous structures with unique textures by meticulously fusing powder particles together with heat or lasers ^[2]. Three-dimensional food printing was invented to create aesthetically pleasing food designs. It also attempted to modernise food production by increasing the efficiency and affordability of food production. Utilising 3D technology for food production is currently a relatively small niche market and has not become popular as a method of producing food. In 2006, the first 3D printer for food was developed. It has now developed into a vast array of technology and uses ^[4]. Dough or mash, melted ingredients like cheese or chocolate, and powdered ingredients like sugar are typical ingredients. Furthermore, research is being done on 3D printed meat made from either plant-derived proteins or cultured animal cells.

3D Printing in Food Industry

The hobbyist 3D printing movement was the first to employ food 3D printing. The Fab@Home 3D printer was created in 2006 by a team at Cornell University's Mechanical and Aerospace Engineering Department. One of the first 3D printers available for free was this one. The Fab@Home 3D printer was a multi-material device that deposited material using finely tuned syringes. It could print cheese, cookie dough, and chocolate.

The first 3D-printed foods were:

- **Chocolate:** It is necessary to store chocolate as a liquid. It cools very quickly after extrusion, making it the ideal food for 3D printing ^[6].
- **Cheese:** It must be kept melted before being extruded, much like chocolate. It also has a tendency to cool down quite rapidly.
- **Cookie Dough:** Cookie dough is a paste that easily takes on the required shape. However, after printing, the cookie must be baked in an oven before consumption.

Ingredients Used in 3D Printing

- **Sugar:** It is possible to successfully 3D print several types of sugar, such as castor sugar and icing sugar. One technique that's commonly employed is binder jetting.
- **Cake Icing:** Using food-based 3D printing for cake icing decoration is a great idea. It is possible to create intricate designs with little effort ^[7].
- **Dough:** When printing with dough, the right ingredient balance must be reached to guarantee the best possible consistency. Dough for pizza crusts is easily printable.
- **Hydrocolloid Systems:** These consist of components based on gelatin and xanthan gum. Tastes are improved by blending in flavours. When these raw materials are cold, they can be extruded.
- **Coloured Food Ink:** Food inks can be applied to improve already-made food items. An inkjet-style printing process is used to apply the ink to the food.

Methods used in 3D Printers for Food Preparation

- **Extrusion:** It works similarly to a Fused Deposition Modelling (FDM) 3D printer that specialises in polymers ^[8]. The ingredients are dispensed using a food-filled syringe rather than an extruder and hot end, which are components of an FDM 3D printer. Flow, Natural Machine, and Foodini are a few reputable manufacturers of machinery.
- **Binder Jetting:** An edible liquid binder is misted on top of a powdered ingredient to blend the food particles after the powder has been applied to a surface. To produce powder-based food products, 3D Systems and Brill 3D Culinary Studio manufacture binder-jetting 3D food printers.

Examples of 3D Printed Foods

Meat Cultured: To cultivate animal cells without endangering the animals, stem cells are used in a bioreactor. After that, they are printed using an inkjet-style food printer. The beef from Aleph Farms is one example of 3D printed meat. Figure 1 below shows a 3D-printed rib-eye steak.



Fig 1: 3D Printed Cultured Meat

Chocolate: One of the easiest materials to 3D print is chocolate because it melts and resolidifies quickly. As demonstrated in Figure 2 below, complex chocolate shapes can be made ^[6].



Fig 2: 3D Printed Chocolates

Pasta: Fig. 3 illustrates how intricate fresh pasta designs can be produced to produce one-of-a-kind gastronomic experiences.



Fig 3: Pasta created by 3D Printer

Conclusion

As 3D printing technology continues to progress, it is expected that food production, distribution, and storage practices will change in the future. More than 15 years ago, scientists, hobbyists, and experimental technologists initially introduced the technology with the goal of printing food using 3D printers intended for other materials. Sugar pastes and chocolate were two of the earliest substances used in cooking ^[9]. Over the past ten years, and especially the last five, larger food processing and kitchen appliance companies, a small number of startups, and a rapid increase in research and development (R&D) efforts at research institutions have caused a shift in the focus of technology away from decorative, "fun," and curious food items. These businesses are now concentrating on printing nutritious meals for specific needs, like dysphagia patients.

The field of food 3D printing has been growing internationally, and technology in this area has been steadily advancing. For this reason, the production, distribution, storage, and transportation of food will all be impacted by 3D printing technology in the future. 3D food printing

startups have the power to completely transform the food industry [2]. There are several potential applications for this technology, including innovative cooking, customised nutrition, and sustainable food production.

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