Food from the printer

Printing food sounds futuristic, but that future is approaching fast. And Wageningen is at the forefront; the latest success is a 3D plant-based 'meat' printer. 'The world of food is going to look very different in 10 years' time.'

TEXT ROELOF KLEIS **PHOTOGRAPHY** ERIC SCHOLTEN

In the process hall of the Axis campus building stands 3D printer PSP. The abbreviation stands for Protein Structuring Printer; a machine that prints plant-based 'meat' – one of the first in the world. This fulfils the wish of an anonymous donor who gave WUR one million euros to develop the machine nearly two years ago. The generous donor's assignment was clear: design a 3D printer that can make a vegetarian burger with better sensory properties than those that are currently on the market.

> 'It's striking a balance between printability and the right bite and taste'

FIBROUS STRUCTURES

And can this printer do that? A cautious 'yes' is the answer from project leader Laurice Pouvreau of Wageningen Food & Biobased Research. 'We have made progress insofar as we can make fibrous structures from plant-based material with a 3D printer. And from these fibrous structure, we can make threads with which shapes can be printed.' And yes, it has really been used to print a burger. A colleague of Pouvreau even used the product in a meal, and apparently it tasted good. But it is not as though the printer has already gone into mass production of veggie burgers in the process hall. In fact, the apparatus looks a bit forlorn there. To put it more positively, let's say she is awaiting further developments. The private funding is finished and a proposal for follow up is in progress. Pouvreau believes there is every reason to take the project further as a great deal has been achieved in a short time. Printed vegetarian meat is still in its infancy. The Israeli company Redefine Meat was first past the post last autumn. Recently, their product has been on the menu at several branches of the Dutch restaurant chain Loetje under the name Biefstuk Bali 0.0. (The 0.0 is a nod to alcohol-free beer.) This development in Israel took the Wageningen researchers by surprise, says food technologist Martijn Noort. He coordinates the 3D activities of the Digital Food Processing Initiative, a collaboration between WUR, TNO and TU/e, which has been working on food printing technologies, including the Protein Structuring Printer, since 2018. 'It's a pleasant surprise, though. Ultimately, it is our mission to en-

The 3D printer PSP prints a plant-based burger made up of several layers to give it a good 'bite'.

sure such things come into existence.'
How Redefine Meat makes the meat is not clear. According to Noort, the company is approaching printing from the medical angle. 'There is more than one road that leads to Rome. Many innovations in 3D printing come from tissue culture, so they involve printing ears and other organs. If you can print an ear, you can also print a piece of meat. Even if the raw materials used for it are not edible. We approach 3D printing from a food technology perspective.'
Pouvreau cannot go into detail about Wageningen's route to Rome because of patent applications. That is also the reason why the printer is still being kept out of the limelight. The basic steps, however, are comparable with techniques such as extrusion and shear cell technology- a process from Wageningen – for making fibrous structures from plant protein ingredients. 'It is a combination of heating and cooling,' Pouvreau explains. 'You have to heat the material to unfold the proteins and create the fibrous structure. Then you have to cool it down to fixate that structure. What we have fine-tuned is the time the material spends being heated and cooled, which is less than a minute in our process. That is very short compared to an extruder (three to five minutes) or a shear cell (up to 20 minutes).'
So far, the printer has mainly been working with bean protein ingredients. This is pushed under pressure through a narrow tube of a few millimetres in diameter, and then heated and cooled. This process produces printable threads. Pressure and temperature have to be adjusted very precisely, says Pouvreau. 'The range within which the fibrous structures are created with printable threads is very narrow. To print, you need a very flexible thread, but as soon as the >




The soft dough of plant-based proteins is inserted into the printer using a 'sausage stuffer'. Processing conditions, such as the temperature, duration and cooling, can be adjusted to change such characteristics of the burger as the firmness, bite and flavour.

'Personalized food doesn't need a supermarket'

fibre structure is created, the threads become less flexible. You have to strike a balance between printability and the right bite and flavour.'

As far as flavour is concerned, the printing process has a surprise up its sleeve. What comes out of the printer turned out to taste a lot better than expected. Pouvreau: 'Beans that come out of an extruder do not taste very nice without any added flavouring. Post-processing is needed to make a palatable meat substitute. With our printer, that is not necessary; you don't get much of a beany taste.' It's not clear yet whether this is a general principle or only works for beans. To find that out, more ingredients need to be tested first.

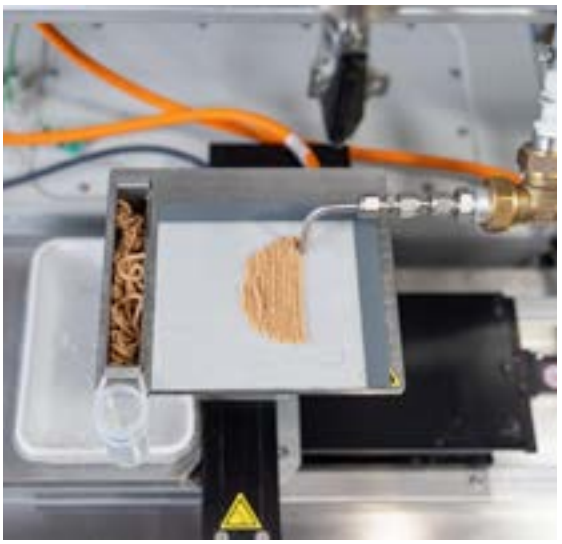
Nor is it clear why the printing process improves the flavour. 'It probably has something to do with heat transfer and the short time period,' says Pouvreau. 'We push the protein through a very narrow tube. That ensures efficient heat transfer so the fibrous structure is created in a short period of time. How a product tastes is closely related to its texture. The texture we create is probably different from what an extruder or shear cell delivers thanks to that short heating time.'

MAKING MEAT JUICIER

Crucial factors for the flavour of meat are its bite and its juiciness. Current veggie burgers are often no match for meat when it comes to these qualities. The Wageningen solution to that lies in a 'coaxial' printing method. 'That means we insert the juice into the printing thread,' explains Pouvreau. 'In effect, we print two things at once: a firm exterior resulting in the bite experience, based on protein, and a soft interior, based on an emulsion. This makes the product juicier and more appetizing once it's cooked, so it is more like beef and pork. If you cut into the thread, you can see the emulsion. It looks like spaghetti with a filling inside it. We still have to optimize the process, but we have demonstrated that it is possible.'

It is this last development in particular that Pouvreau and her colleagues are keen to research further with new funding. And as far as she is concerned, the development should not stop with vegetarian burgers that imitate meat. 'Actually, I want to get away from the idea that the end product must taste like meat. It should taste like something plant-based. Plant protein is different from animal protein, so why would we want to imitate that? It will take some time to convince consumers that plant-based products are good in themselves. It will need a new generation. Veggie burgers are an intermediate step: they look like something the consumer is familiar with. Hopefully we can then move on to plant-based food with a niche of its own on the market'.

Noort too sees plenty of scope for 3D-printed food. Consumers have a growing wish for more choice and control over their own food, he says. 'Just look at all those powders used by sportspeople, and the products for people who do not want gela-



tine, chemical additives, gluten, colourings or whatever. The diversification is increasing all the time. With smart technology and advancing digitalization, product development is booming.'

IMMEDIATE CONSUMPTION

We won't find printed food on the supermarket shelves yet, though. And the question is whether that will happen at all. The Wageningen printer was initially intended to produce food for immediate consumption. 'The aim was to create something that can be eaten immediately,' says Pouvreau. 'So you get personalized food, with a short path between production and consumption'. Noort: 'The most interesting and intriguing feature of 3D printing is that it has been a disruptive technology right from the start. 3D printing disrupts the usual way of doing things. I always compare it to the rise of Uber and Airbnb. Who invented Uber? Not the taxi companies. Who invented Airbnb? Not the Hilton. Similarly, supermarkets are not behind the development of printed food. Personalized food doesn't need the supermarket. The world of food is going to look very different in 10 years' time.' ■

www.digitalfoodprocessing.com

PRODUCTS FOR LUNG PATIENTS AND SOLDIERS

The Digital Food Processing Initiative (DFPI), a collaboration between WUR, the Netherlands Organization for Applied Science (TNO) and Eindhoven University of Technology (TU/e) was set up in 2018. The 3D burger printer is the latest success story, which was preceded by a chocolate printer for Cadbury and a pasta printer for Barilla. And there is more in the pipeline. Together with industry, researchers at the DFPI are developing a printer that will make customized products for military personnel and COPD patients, tailored to the health status and needs of the individual. Wageningen will take care of the food technology and social aspects of this project (Imagine). Food technologist Martijn Noort: 'Which ingredients should be in the product, how do you go about it, how do you make it tasty, how do you incorporate the consumer's preferences, and what requirements must the technology meet so that the consumer will use it properly?' In addition to this applied project, the Dutch Research Council is funding the fundamental research project Print Your Food. In this project, WUR and TU/e are developing a so-called digital twin of the printing system. That is a mathematical model that covers all aspects of the 3D printing process. The software can be used to predict whether certain recipes are printable and will yield the desired structure. A third line of research is the processing of residual streams in 3D printers, but this is still in its infancy.