

Rutgers food scientist uses 3D printing to introduce the first in a line of what he calls “functional foods”

A Rutgers scientist has developed a formulation of low-fat chocolate that can be printed on a 3D printer in pretty much any shape a person can conceive, including a heart.

The work heralds what the researcher hopes will be a new line of “functional foods” – edibles specially designed with health benefits. The aim is to develop healthier kinds of chocolate easily accessible to consumers. [Reporting](#) in the scientific journal, *Food Hydrocolloids*, a Rutgers-led team of scientists described the successful creation and printing of a mixture producing low-fat chocolate -- substituting fatty cocoa butter with a lower-fat, water-in-oil emulsion.

“Everybody likes to eat chocolate, but we are also concerned with our health,” said [Qingrong Huang](#), a professor in the [Department of Food Science](#) at the Rutgers School of Environmental and Biological Sciences. “To address this, we have created a chocolate that is not only low-fat, but that can also be printed with a 3D printer. It’s our first ‘functional’ chocolate.”

Huang, an author of the study, said he already is working on manipulating sugar content in the new chocolate formulation for low-sugar and sugar-free varieties.

Researchers create emulsions by breaking down two immiscible liquids into minute droplets. In emulsions, the two liquids will usually quickly separate – as is the case with oil and vinegar – unless they are held together by a third, stabilizing ingredient known as an emulsifier. (An egg is the emulsifier in a vinaigrette.)

Chocolate candy is generally made with cocoa butter, cocoa powder and powdered sugar and combined with any one of a variety of different emulsifiers.

For the study, the scientific team experimented with different ratios of the ingredients for a standard chocolate recipe to find the best balance between liquid and solid for 3D printing. Seeking to lower the level of fat in the mixture, researchers created a water-in-cocoa butter emulsion held together by gum arabic, an extract from the acacia tree that is commonly used in the food industry, to replace the cocoa butter. The researchers mixed the emulsion with golden syrup to enhance the flavor and added that combination to the other ingredients.

As delightful as it is to eat, Huang said, chocolate is a material rich with aspects for food scientists to explore.

Employing advanced techniques examining the molecular structure and physical properties of chocolate, researchers investigated the printed chocolate’s physical characteristics. They were seeking the proper level of viscosity for printing and looking for the optimal texture and smoothness “for a good mouthfeel,” Huang said. Experimenting with many different water-oil ratios, they varied the percentages of all the main ingredients before settling on one mixture.

In 3D printing, a printer is used to create a physical object from a digital model by laying down layers of material in quick succession. The 3D printer, and the shapes it produces, can be programmed by an app on a cellphone, Huang said.

Ultimately, Huang said he plans to design functional foods containing healthy added ingredients – substances he has spent more than two decades studying, such as extracts from orange peel, tea, red pepper, onion, Rosemary, turmeric, blueberry and ginger – that consumers can print and eat.

“3D food printing technology enables the development of customized edible products with tailored taste, shape and texture as well as optimal nutrition based on consumer needs,” Huang said.

Other researchers on the study included Siqi You and Xuanxuan Lu of the Department of Food Science and Engineering at Jinan University in Guangzhou, China.



Ron Huang is the co-author of a new study on low-fat chocolate.

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