3D printing of personalized nutrition

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Background

3D-printing, also known as Additive Manufacturing, is an upcoming production technique based on layer-by-layer deposition of material to reproduce a computer generated 3D design. Digitalization, personalization and consumer empowerment are important drivers for the strongly increasing interest in 3D food printing.

Personalized Nutrition

People differ not only genetically, physically, and mentally, but also in terms of their knowledge, habits, preferences, and the social environment in which they live. Personalized food and health advice, however, helps people to make healthy choices in a way that best suits them[1]; choices that fit with what their bodies need as well as with their personality and social environment. Hence, personalized nutrition can complement and extend current public health nutrition recommendations, and empower consumers to choose and maintain an optimal personalized diet. A 3D food printer could be the way to provide truly personalized food products (e.g. as in figure 1).

Figure 1. Conceptual 3D printer for personalized nutrition bars in a gym.

3D printing of cereal bars with engineered textures

A dedicated 3D printer (figure 4) was used to print biscuit type cereal bars. A dough paste is extruded by an XYZ moving extrusion head and deposited as a filament to create a predesigned 3D structure. The dough formulation was specifically formulated to meet the requirements of 3D printing in terms of extrudability, shape retention, and bake stability. In a first step, 20 x 20 x 20 mm cubic samples were printed with hexagonal cells ranging from 4 mm to 12 mm in diameter to create variations in the product morphology. Figure 2 shows that this parameter could strongly vary the hardness of the biscuits in a compression test.

Figure 2. The texture of the biscuits can be varied based on the printed cell size as well as cell direction.

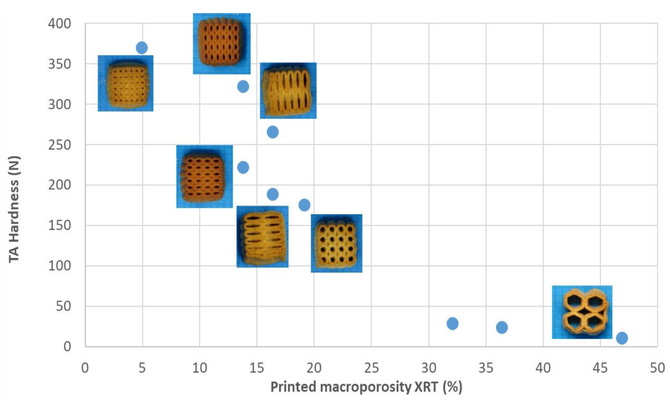
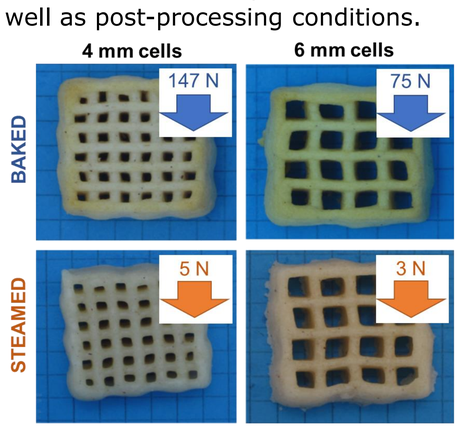
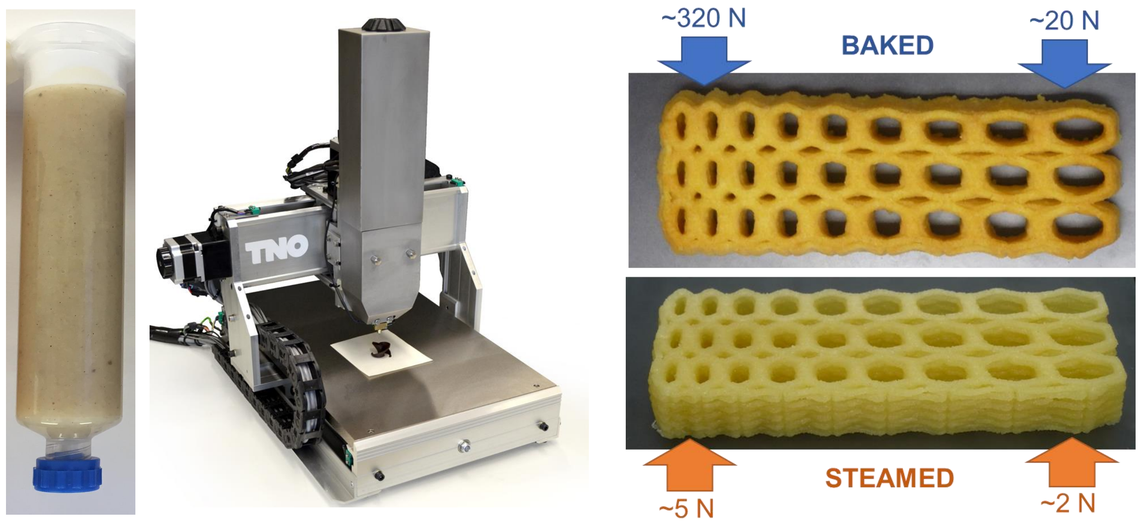


Figure 3. Texture of the biscuits can be varied based on the printed cell size as well as post-processing conditions.



Furthermore, printed biscuits with elongated cells showed anisotropic textures, varying in hardness depending on the compression direction. Also the post-processing conditions were varied: the printed biscuits were either baked in an Airfryer to create a crispy texture or were steamed to create a moist and soft texture as shown in figure 3. By applying variations in the printer settings as well as the post-processing conditions, a wide range of textural properties can be created from a fixed dough formulation (see figure 4).

Figure 4. Based on one constant dough formula, by varying the printer settings and post process a wide variation of textures can be created. Arrows indicate the local instrumental hardness (N).



Conclusions

- 3D printing is an upcoming manufacturing technique enabling local, on-demand, flexible production of foods.
- 3D printing allows to engineer a wide range of textural properties from a fixed dough formulation.
- Printing technology can hence decouple the relations between ingredient composition and product properties such as texture.
- Controlling food texture by means of printing settings is the first step to enable manufacturing of truly personalized foods.

Perspective

3D printing enables the manufacturing of personalized food products, composed and engineered to meet the nutritional and health requirements of individual consumers and at the same time meet individual consumers' liking and preferences.

To allow this, the next developments will be to design:

1) Smart dosage and mixing systems to create personal compositions.
2) Physical models to create personalized food products with desired properties based on personal food compositions.

Acknowledgements

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References:

1. Celis-Morales et al. (2017) International Journal of Epidemiology 46(2):578–588
2. Noort (2018) 3D printed cereal foods for personalized nutrition, ICC International Conference GRAINS FOR WELLBEING, 5-8 November 2018, Taipei, Chinese Taipei