3D food printing – an emerging technology delivers insights in traditional food science

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Food production and its complexity

raw materials
- composition
- nutritional value
- matrix

process
- mechanical
- thermal
- biological

food
- composition
- nutritional value
- flavor/taste
- structure & texture

analysis
- composition
- structure levels
- interactions
- human perception

1) techcrunch.com, 2) hsp.harvard.edu
Reduction of complexity

raw materials

known material properties

process

design mechanisms

structure

food system

known material properties

1) techcrunch.com, 2) hsph.harvard.edu
Reduction of complexity

1) techcrunch.com, 2) hsp.harvard.edu
Nowadays

volume production
(high demands to process engineering and automation)

static procedures, adjusted to the product quantity

experience as well as high-end engineering

case

knowledge-driven material science approach

Past

high rates of manual production steps

individual procedures, adjusted to the end product qualities

experience as well as high-end engineering
texture design by food 3D printing

process

design mechanisms

structure
Quality analysis & texturization

3D printing and additive manufacturing of cereal-based materials: Quality analysis of starch-based systems using a camera-based morphological approach

Ahmed Raouf Fahmy, Thomas Becker, Mario Jekle
Technical University of Munich, Chair of Brewing and Beverage Technology, Research Group Cereal Technology and Process Engineering, 85794 Freising, Germany

Sensory design in food 3D printing – Structuring, texture modulation, taste localization, and thermal stabilization
Ahmed Raouf Fahmy, Laura Sophie Amann, Andreas Dunkel, Oliver Frank, Corinna Daviö, Thomas Hofmann, Thomas Becker, Mario Jekle
**Quality analysis during 3D printing**

**Objectives**
- Determine the relation between rheology and printing quality
  - Comparison of gluten and non-gluten material systems
  - Characterization of geometrical measures
  - Autonomous recognition of visco-elastic induced defects
- Select & optimize materials and blends

**Approach**
- Integration of top- and side-view cameras during 3D printing process
- Using morphological image analysis to evaluate printed geometries

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**Fahmy, A.R. et al. (2020):** 3D printing and additive manufacturing of cereal-based materials: quality analysis of starch-based material systems using a camera-based morphological approach.
**Texturing and taste localization**

**Objectives**
- Study the influence of inhomogeneous taste distribution on the sensory perception
- A scientific sensory contrast study

**Approach**
- Development of a novel texturing technique for a spatial localization of aroma/flavor active compounds
- Integration of dual extrusion and NIR thermal stabilization
- Printing local distributions of sodium using different configurations
- Comparable textural properties while varying the localization configuration

Fahmy, A.R. et al. (2021): Sensory design in food 3D printing – Structuring, texture modulation, taste localization, and thermal stabilization.
**Texturing and taste localization**

**Key results**

- Comparable mechanical properties between different printing configurations using composition-based attenuation of heating and adaptive printing settings.

- The inhomogeneous spatial sodium chloride distribution caused saltiness enhancement.

Fahmy, A.R. et al. (2021): Sensory design in food 3D printing – Structuring, texture modulation, taste localization, and thermal stabilization. // brainfacts.org
Next level – food foams

- Drainage
- Coalescence
- Disproportionation
Closed-cell foam texture design

Objective

− Design closed-cell foams in point lattice cubic systems
− Hardness-targeted equation for 3D printing applications
− Texture design by means of hardness
Content of the next slides are soon published
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- Insights in Nutrition: moisture loss and starch gelatinization by heating
- Insights in Texture: relation between porosity and hardness
- Insights in Flavor: perception by means of food texture