Food 3D Printing for Personalized Nutrition

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**Food 3D Printing**

**CONCEPTS**

- Additive manufacturing
- Layer-by-layer fabrication
- Constructs complex structures at ease
- Sustainability & minimal wastage

**APPROACHES & MATERIAL SUPPLIES**

- Extrusion-type food 3DP – most popular
- 3 classes of printing inks:
  - Natively printable foods
  - Non-printable foods
  - Alternative food sources

**For further reading:**

3D printing in the food industry

- Customized food & package designs - enhanced preferences & food model prototyping
- Nutrient enrichment - focusing on health status improvement
- Cost reduction in food preparation & transport
- Personalized nutrition
- Process digitalization & versatility for domestic, retail and bulk manufacturing processes
- Food waste reduction & utilization
3D Food Printing
For Personalized Nutrition
Nutritious 3D-printed foods for children with aesthetic improvement

- School surveys - shape & flavor preferences
- Millet-pulse indigenous composite flour
- 3DP snacks
- Rich in fiber (~17.79%), protein (~10.41%) & minerals
- Customized shapes
- Egg yolk and egg white fractions
- Solves storage, handling and transportation challenges


Nutraceutical-loaded & functional 3D-printed foods

High-protein 3D-printed foods

3D printed chicken nugget & fiber-enriched nugget

3D printed mushroom - based snack


3DFP as a drug vehicle

- Most common 3DP dosage form – tablets
- Most used – soft materials with biological applications

Effect of material composition and 3D printing temperature on hot-melt extrusion of ethyl cellulose based MCT oil oleogel.

Kavimughil, Maria L., Moses, J.A., & Anandharamakrishnan, C. Effect of material composition and 3D printing temperature on hot-melt extrusion of ethyl cellulose based MCT oil oleogel.
<table>
<thead>
<tr>
<th>Why?</th>
<th>What?</th>
<th>How?</th>
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<tbody>
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<td>Long-duration missions</td>
<td>Creating foods faster and safe than a chef</td>
<td>Print and eat on site</td>
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<td>Reduce downtime in refilling supplies</td>
<td>Print on demand (real time monitoring of nutritional needs using biosensors)</td>
<td>Zero waste</td>
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<td>Boredom – the need for variety!</td>
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Digitally controlled tailor-made meals

3D printed rice starch constructs & the impact of post-processing


Noodles from potato peel waste

Utilization of potato peel, the zero-value waste

- Extraction of high value compounds
- Energy Production
- Animal feed
- Food processing and value addition
- Biopolymers and edible coatings

Observations
- Unprocessed construct
- Defoliated shape and threads
- Better shape but merged layers
- Collapsed construct
- Rigid construct
- Best structure
- Peripheral damage; brittle
- Increased browning; crisp

15-40% total mass

Food and Bioprocess Technology, 13(6), 1048-1062.
3D-printed **texture modified foods** for those with swallowing disorders

- Modifying texture and consistency
- To meet Int. Dysphagia Diet Standardization Initiative Categories
- Structured foods with controlled glycemic responses

Pearl millet fortified idli batter, 3D printed with different infill levels and fermented

Vijayakumar Raja, Moses JA, Anandharamakrishnan C. 3D printing of pearl millet fortified idli batter: Study on the effect of fermentation on the shape of printed constructs.
Probiotics for improved digestive health

Hybrid technologies for reducing dietary sodium intake


The fascinating science of

4D Printing

3D printing of polymeric materials that act as a supporting structure for the growth of cells & tissues

Self-assembly of small micro-sized smart particles that change patterns when acted upon by stimuli

Smart material changes its shape/colour/flavour/nutrition when acted upon by stimuli

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- Oral-processing
- Gastric digestion
- Intestinal absorption
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(1) Oral-processing


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Challenges & the future

- Batch consistency
- Consumer awareness & acceptance
- Speed & capacities
- Digital piracy & ethics

+ Novel range of products & new manufacturing practices
+ IoT integrated smart 3DFP & position in the digital food & nutrition market
+ 3D food printers in every kitchen?
+ Data analytics linked individual preference databases
Thank you!
Further reading
Our other recent publications in this field


Conflic of Interest

None