Role of Innovation and Digital Technologies in Food Processing

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Outline

• Historical Perspective

• Innovations Behind Development of Food Processing

• Digital Technologies in Food Processing

• Final Thoughts
The History of Food Processing

• The First Methods
  • Cooking, Salting, Pickling, Drying, Smoking, Fermenting
    • Cooking started as early as 1.5 million years ago.
    • Simple food preservation methods such as drying, smoking and salting, started as early as 9600 BC.
    • Food processing began with a number of preservation and cooking techniques that are still used today. Techniques were developed by some of the earliest empires, such as ancient Greece, India, China and Peru.

• The 19th Century
  • Pasteurization and Canning
    • Pasteurization and canning were popularized in the 1800’s.
    • Pasteurization, developed by French microbiologist Louis Pasteur, kills microbes by applying heat, without affecting the nutritional quality or taste of the food, allowing long term storage and transportation of foods.
    • Other inventors developed bottling and the canning. The tin can would become particularly popular during World War I and the high demand for cheap, long-lasting, transportable food for soldiers.

• The 20th Century
  • Mass production of packaged foods
    • Spray drying, evaporation, freeze drying and the use of preservatives for increased shelf life and artificial sweeteners and colors for palatability.
    • Household appliances such as refrigerators, freezers, microwave ovens etc paved way to the development of frozen foods,
Innovation Behind Food Processing

Traditional Experience applied to food processing
- Cooking
- Salting
- Pickling
- Drying
- Smoking
- Fermenting

Modern Science & Technology applied to food processing
- Chemistry
- Hydrolysis
- Isolation
- Synthesis
- Pasteurization
- Preservatives
- Industrial Processing

Taste and Smell Science
- Chemical Analysis
- Receptor Science
- Biotechnologies
- Fermentation Technologies
- Enzyme Technologies
- Digital Technologies
- Artificial Intelligence
- Robotics
## Example of Ancient Food Technology: Fish Sauce

<table>
<thead>
<tr>
<th>Current Fish Sauces in Asia</th>
<th>Fish Sauces of Ancient Greece and Rome</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Vietnam</td>
<td>• Ancient Greece: garon</td>
</tr>
<tr>
<td>• Thailand</td>
<td>• Ancient Rome: garum</td>
</tr>
<tr>
<td>• Philippines</td>
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<tr>
<td>• Myanmar</td>
<td>• Ancient Rome: liquamen</td>
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<tr>
<td>• Japan</td>
<td></td>
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<tr>
<td>• Cambodia</td>
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</tbody>
</table>

- nyoc-mam
- nam-pla
- patis
- ngan-pya-ye
- shottsuru、ishiri
- tak-trei
- Dr. Robert I. Curtis: U. Georgia, Professor of Classics
- Garum and Salsamenta
- Production and Commerce in Material Medica
- Studies in Ancient Medicine, Pub: E.J.Brill 1991
Sites of Ancient Fish Sauce and Salted Fish Production

(Form Curtis 1991)

Mediterranean Coast
Spain, Italy, North Africa
Written evidence for garum production in 5th century BC in Spain

Black Sea
Garum factory site from 6th century BC
Record of trade with ancient Greece
Sites of Mediterranean Fish Sauce Factories

Lixus (Morocco)

Cotta (Morocco)

Baelo (Spain)

Punta de l’Arenal (Spain)

(From Curtis 1991)
Garum Shop of Pompeii

Entrance to Garum (Fish Sauce) Shop of Pompeii
(Courtesy of Dr. Curtis)

Amphora and Doria in Back Yard of Garum (Fish Sauce) Shop
(Courtesy of Dr. Curtis)

Distribution in long vessels called amphora.

There were regions where guilds controlled the manufacturing of garum.

Name, grade, place of manufacture, main ingredient, name of distributor etc. have been found inscribed on amphora, indicating a systematic distribution of the product.
The so-called liquamen is made in this manner:

The intestines of fish are thrown into a vessel and salted. Small fish either the best smelt, or small mullet, or sprats, or wolffish, or whatever is deemed to be small, are all salted together and, shaken frequently are fermented in the sun.

Geoponica: 10th century Greek agricultural manual, from 6th century Latin treatise
After it has been reduced in the heat, garum is obtained from it in the following way:

A large, strong basket is placed into the vessel of the aforementioned fish, and the garum streams into the basket. In this way the so-called liquamen is strained through the basket when it is taken up. The remaining refuse is alex.

Geoponica: 10th century Greek agricultural manual, from 6th century Latin treatise
Modern Discoveries in Taste: Taste Receptors
1908: Discovery of umami, the fifth basic taste

An attentive taster will find out something common in the complicated taste of asparagus, tomatoes, cheese and meat, which is quite peculiar and cannot be classed under any of the well defined four taste qualities, sweet, sour, salty and bitter.

(Prof. K. Ikeda’s presentation at the 8th Int’l Congress of Applied Chemistry, Chicago, 1912)
Soup stocks / Japanese vs Western

Japanese Konbu dashi

Total free amino acids: 41mg/100ml

Western Chicken soup stock

Total free amino acids: 104mg/100ml
Free Amino Acids in Breast milk


Daily Intake of Free Glutamate: 30.3 – 48.2 mg free glutamate/kg bw for a 3.5 kg infant ingesting approximately 750 ml of milk per day

Sample Size: 2,279 mothers

Cheddar cheese

Queen Victoria received a giant wheel of cheddar cheese, weighing around 1000 pounds, as a wedding gift.

Cheese made in Cheddar, Somersetshire, UK, has been made Since the late 16th Century.

(Weaver and Roger, J. Food. Sci., 43, 579 (1978))
Start of industrial production of seasonings

1847  Concentrated beef extract developed by Justus von Liebig, cheap and nutritious meat substitute.
1886  Ready-made soup based on legume by Maggi
1889  The Bovril company
1902  Marmite Food Extract Company
1908  Bouillon cube based on HVP
1909  MSG was developed in Japan
1910  OXO cube based on beef extracts
Application of Digital Technologies in Food Processing

• **Automation and Robotics**
  • Packaged foods easy to handle
  • Raw foods more difficult but improving with advances in digital recognition technology

• **Drones**
  • Agricultural
  • Factory Inspection
    3D mapping of factory site

• **3-D Printing**
  • Designing Foods

Video Images of Robotics in Packaging: https://www.youtube.com/watch?v=ALz88MkTxNs, https://www.youtube.com/watch?v=szyiggyvPB8
Application of Digital Technologies in Food Processing

• **AI in Optimizing Operations**
  • Use of “Big-Data”
  • Supply Chain Logistics Optimization

• **Block-Chain, Distributed Ledgers**
  • Traceability
  • Preventing Fraud

• **Small Scale Digital Technology in Restaurants and Catering**
  • Ordering via Digital Devices
  • Robot Chefs
  • Robot Servers
Thoughts on Future Developments

• **Expected Future Developments**
  • Farm to Fork Automation
  • Individualized Nutrition
  • Sustainable Foods and Food Production
  • Convenience Foods vs Traditional Cooking

• **Mass vs Niche**
  • Digital automation leads to less human involvement
  • Need for Capital Expenditure = Large Sales Needed
    • Optimization for Max Popular Preference
  • Food Preferences are Diverse = Many Niche Markets
  • Scope for Small Scale Digital Technologies

• **Risks**
  • Hacking: Everything connected = Everything at Risk
  • Increasing Complexity of Algorism: Unforeseen bugs in software,
    Reliance on 3rd Party for Repairs
Thank you very much for your attention