The Role of the Food Technologist in Assuring Better, Safer and Healthier Food for All

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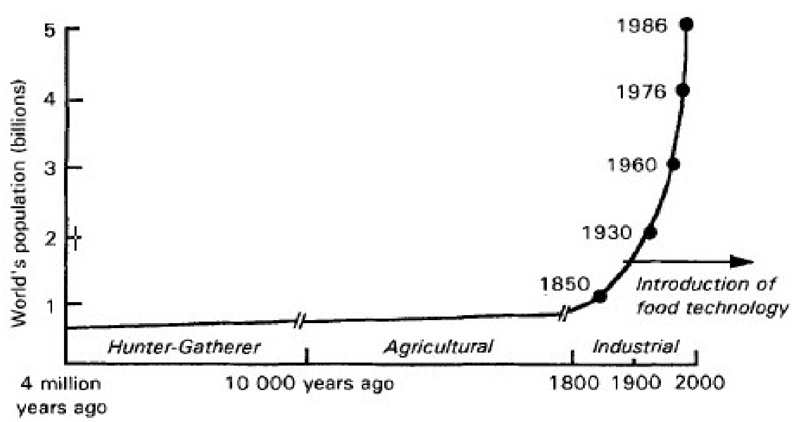
Outline

- History of Food Processing/Technology
- Current Situation
- What is on the Horizon

Food Technologist

One who works with food using
Food Chemistry
Food Biology
Food Engineering

History of Food Science



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1930s

- Fiber crates
- Cellulose packaging
- Gable-top, waxed milk cartons
- Sliced bread
- Jell-O
- Regulations e.g. Food, Drug, and Cosmetic Act

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1940s

- Automation
- Mass production
- Frozen foods
- Vending machines

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1950s

- Frozen dinners
- Foreign foods
- Food for bomb shelters
- Frozen, ready-to-eat bakery goods
- Targeted markets
- Controlled-atmosphere packaging

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1960s

- Diet foods
- Process control computers
- Clean-in-place
- Aseptic canning
- Drying improvements

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1970s

- Energy efficiency
- Water/waste utilization
- Membrane processing
- Health/organic foods
- Environmentally robust computers

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1980s

- Dechemicalization
- Automation
- Aseptic processing
- Irradiation
- Packaging

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1990s

- Intelligent Packaging
- Low Carb
- Sachet Packaging
- High Pressure Processing
- Functional Foods

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2000s

- RFID
- Nanoscale Engineering and Technology
- Packaging
- Non-thermal Processes
- Fresh-Like
- Chef-Like

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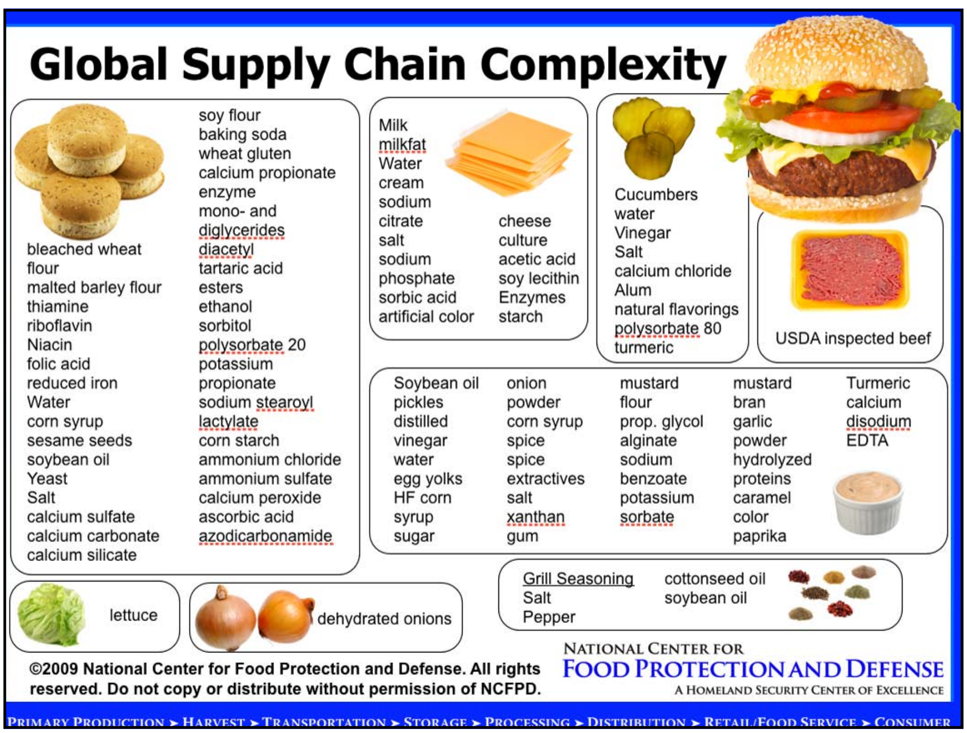
Agriculture's Paradigm Shift

FROM:
- Cheap
- Abundant
- Available

TO:
- Safe
- Wholesome
- Nutritious



Globalizing the Cheeseburger

Vinegar
Argentina, Australia, Austria, Belgium, Brazil, Canada, China, Chile, Colombia, Denmark, Dom. Rep, France, Germany, Greece, Hong Kong, Israel, Italy, Japan, S. Korea, Lebanon, Peru, Poland, Portugal, Serbia, Philippines, Russia, S. Africa, Singapore, Spain, Sweden, Turkey, Taiwan, U.K.

Garlic Powder
Brazil, Canada, China, Germany, India, Israel, Japan, S. Korea, Mexico

Tomatoes
Belgium, Canada, Colombia, Costa Rica, Dom. Rep., Guatemala, Israel, Morocco, Mexico, Netherlands, New Zealand, Poland, Spain

Beef
Australia, Canada, Chile, Costa Rica, Honduras, Japan, Mexico, Nicaragua, New Zealand, Uruguay

Wheat Gluten
Australia, Belgium, Canada, China, Czech Rep., France, Germany, Kazakhstan, Lithuania, Netherlands, Poland, Russia, Switzerland, Thailand, U.K.

National Center for Food Protection and Defense
A Homeland Security Center of Excellence

rimary Production ➤ Harvest ➤ Transportation ➤ Storage ➤ Processing ➤ Distribution ➤ Retail/Food Service ➤ Consumer

Need for New Technologies

- Maintaining/improving food safety
- Maintaining freshness
- Maintaining/improving sensory quality
- Maintaining/improving shelf-life
- Improved functionality
- Improved production/processing

(Adapted from Jason Wan, Food Science Australia, 2007)

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“Omic” Technologies

- DNA = genomics
- RNA = transcriptomics
- Protein = proteomics
- Metabolites = metabolomics
- nutrition = nutrigenomics
- Molecular gastronomics
- Cash = economics

Objective of Nutrigenomics

Prevent and potentially ***treat disease***

through ***targeted nutrition***

Nutrigenomics: The Promise

- Personalized medical treatments
- Personalized nutritional advice
- Healthier processed foods targeted to individuals

Nancy Fogg-Johnson and Jim Kaput, *Food Technology*
August 2007

"Ologies"

- Biology
- Food technology
- Biotechnology
- Nanotechology
- Culinology

Culinology

Culinology = Culinary Science +
Food Technology

Term coined by Winston Riley,
former President and Founder Research Chefs Association (RCA)

OBJECTIVE

Ability to efficiently and economically manufacture restaurant-quality “convenience foods” that look and taste like food served in a restaurant

CHEF-LIKE FOODS

Molecular Gastronomy

Term invented by Hungarian Physicist
Nicolas Kurti
in a 1969 presentation to the Royal Institution entitled:
"The Physicist in the Kitchen"

Further popularized by Herve This

Molecular Gastronomics

Application of scientific principles to

understanding and improvement of small

scale food preparation

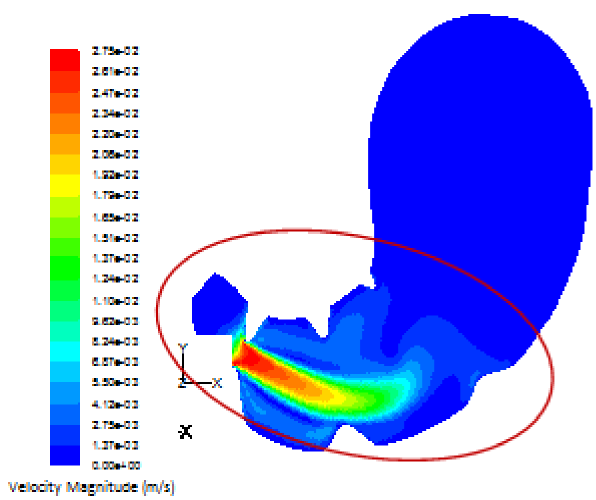
Food Process Technologies Research Needs for Health/Wellness

- **Separation processes** for extracting health- functional ingredients from natural food materials (e.g. antioxidants, pigments etc)
- **Reaction engineering** for synthesizing functional food ingredients (Oligomers etc) and quantifying the influence of environment on reaction kinetics
- Modeling the post-consumption fate of food (GUT modeling!)

From Niranjan 2008

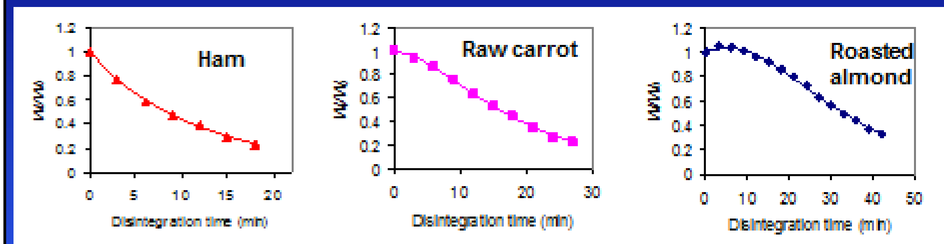
Flow Field in a Human Stomach
3-d model

- The strongest fluid motions were predicted within the lower part of the stomach model.
- The rheological properties of gastric contents has a significant effect on the behavior of the antropyloric flow.



Ferrua and Singh (2011)

Typical disintegration profiles of foods in simulated gastric environment

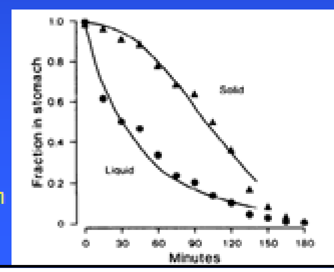


Kong and Singh (2010, 2011)

- Exponential: canned kidney beans, ham, Gummy bear candy, apple bar
- Sigmoidal: fruits such as raw carrots
- Delayed sigmoidal: dry foods such as peanuts, almonds, fried dough products

In vivo stomach emptying curves from scintigraphy data

(Camilleri et al. Am J Physiol 249: G580–G585.)



Biopharming:

- Use plants that are genetically-engineered to produce pharmaceuticals or other bioactive ingredients
- Alfalfa, corn, potato, rice, safflower, soybeans, tobacco.

Bioguided Processing

Using mechanistic understanding of biology to guide processing biomaterials for specific structure and/or functions as foods.

Processing Technologies for Extending Shelflife, Improving Nutrient Availability, Change Sensory Quality

Traditional

- Canning
- Drying
- Freezing
- Fermenting
- Packaging

Newer Processing Technologies

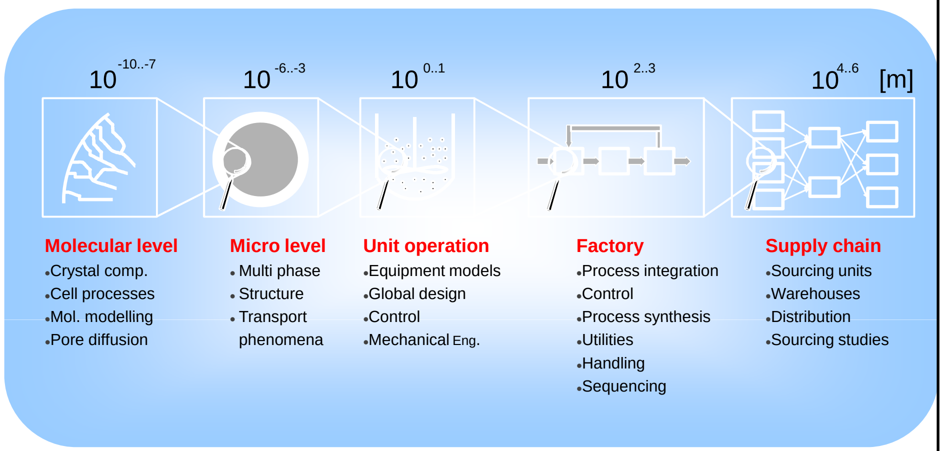
(or not used extensively)

- Irradiation
- High Pressure
- Ultrasonics
- High intensity light
- Nanotechnology
- Pulsed electric fields
- Plasma discharge

The Horizon

Moving from the macroscopic to the microscopic to the nanoscopic

Linking scales….



- *Thanks to M.L.M. Vander Steppe*

from Bruin and Jongen (2001)

Nanotechnology in Foods

- food ingredients that are processed or created to form nanostructures,
- additives of encapsulated or engineered nanoscale particles used in food,
- nanoscale materials that have been incorporated to develop new food packaging, and
- nanoscale technology-based devices and materials used in applications such as, filtration ('nanofiltration'), water treatment, and sensors for food safety and traceability.

Chaudry and Others. 2008. Food Additives and Contaminants, 25(3):241–258.

Engineering and Food Safety

- Defining the role of food engineering in safety of foods.
- "Food safety engineering is an emerging specialization that involves the application of engineering principles to address microbial and chemical safety challenges" [Balasubramaniam VM (2006)]

Food Safety Engineering

❖Predictive Microbiology

Predictive Mathematical and

Probabilistic Models

Databases and Computer Programs

from Lopez-Gomez, et al (2009)

Food Safety Engineering

❖Advanced Food Contaminants Detection Methods

Rapid Detection Tools

Parameter Integrators

from Lopez-Gomez, et al (2009)

Food Safety Engineering

- Develop methods for measuring materials in foods is absolutely of paramount importance.
- Speed and accuracy are prerequisites of the instruments since public health is dependent on the outcome.

BOTTOM LINE

- The food industry and regulatory agencies must jointly define needs!!

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Food Safety Direction

Replace analytical capability with the ***Food Safety Objective Concept***, which determines what level of public health protection is acceptable, rather than ability to detect.

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Sustainability Engineering

- Need for comprehensive analysis
- Entire food system – from production to consumption
- Include all aspects of sustainability – energy, water, wastes and carbon footprint
- Lifecycle Assessment
- Engineering emphasis on quantitative analysis

Research Directions Beyond 2012

- **Diet, Food and Health Connection:** understanding the relationship between what we eat and acute and chronic disease
- **Molecular Mechanisms of Reaction:** understanding at the molecular level the reactions that are important (pertaining to health, well-being, food deterioration, etc.)
- **Nutraceuticals/Functional Foods:** enhancing health through ingestion of chemicals that have biological and physiological function
- **Human body absorption:** Absorption of food constituents in the human body

Research Directions Beyond 2012

Real-Time Analysis:
on-line, real time analytical procedures for detecting chemical and biological agents causing health risk and/or contributing to health and wellness

Food Preservation Optimization:
continued improvements in traditional preservation technologies for increased quality shelf-life and safety of foods

Research Directions Beyond 2012

- **Non-Traditional Processes** introduction of newer technologies such as irradiation, high pressure, high intensity light, pulsed electric fields, ultrasound, and ohmic heating

- **Sensory Analysis / Consumer Perception** increased understanding of stimuli and methods of measuring responses of sensory organs and integrated perceptions of food

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Research Directions Beyond 2012

- **Nanotechnology** ability to manipulate atoms and single molecules to produce desired effects.

- **Atomic Structures** understanding structures at the atomic level including food systems and packaging

- **Food Safety** increased understanding of the cause of food intoxication and contamination that increase health risk

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What are the new research directions and challenges?

Contribute to the goals of nutrition, health and wellness

Accomplish food manufacturing under the constraints of sustainability and consumer safety

Advice

- Follow Nutrigenomics
- Follow culinology
- Follow nanotechnology

These "omics" and "ologies" will have significant impact on the future of food science and food!!!

Food in the Future

Today's global issues will remain

- Food Security
- Water & Other Natural Resources
- Health and Wellness
- Global Food Supply Chain
  - Intricacies
  - Regulatory Harmonization
- Food Safety
- Sustainability of Food Systems

Thank you!