FOOD TECH IN A SYSTEM PERSPECTIVE

Kemal Aganovic

Food Tech Lund

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Lund, Sweden

History of Preservation

- 3.000

DRYING

SMOKING

SALTING

FERMENTATION

1.800

HEAT

N.Appert

G.C.Hahn 1848

L.Pasteur 1857

R.Koch 1876

Van Ermengem 1895

Esty & Meyer 1922

R.Rausing 1951

1.900

HPP

Van't Hoff 1885

B. Hite 1899

Bridgmen 1904

V Platen 1954

Industrial Equipment

PULSED ELECTRIC FIELDS

Electropure 1920

Doeven-speck 1958

Sale 1967

Krupp 1986

IRRADIATION

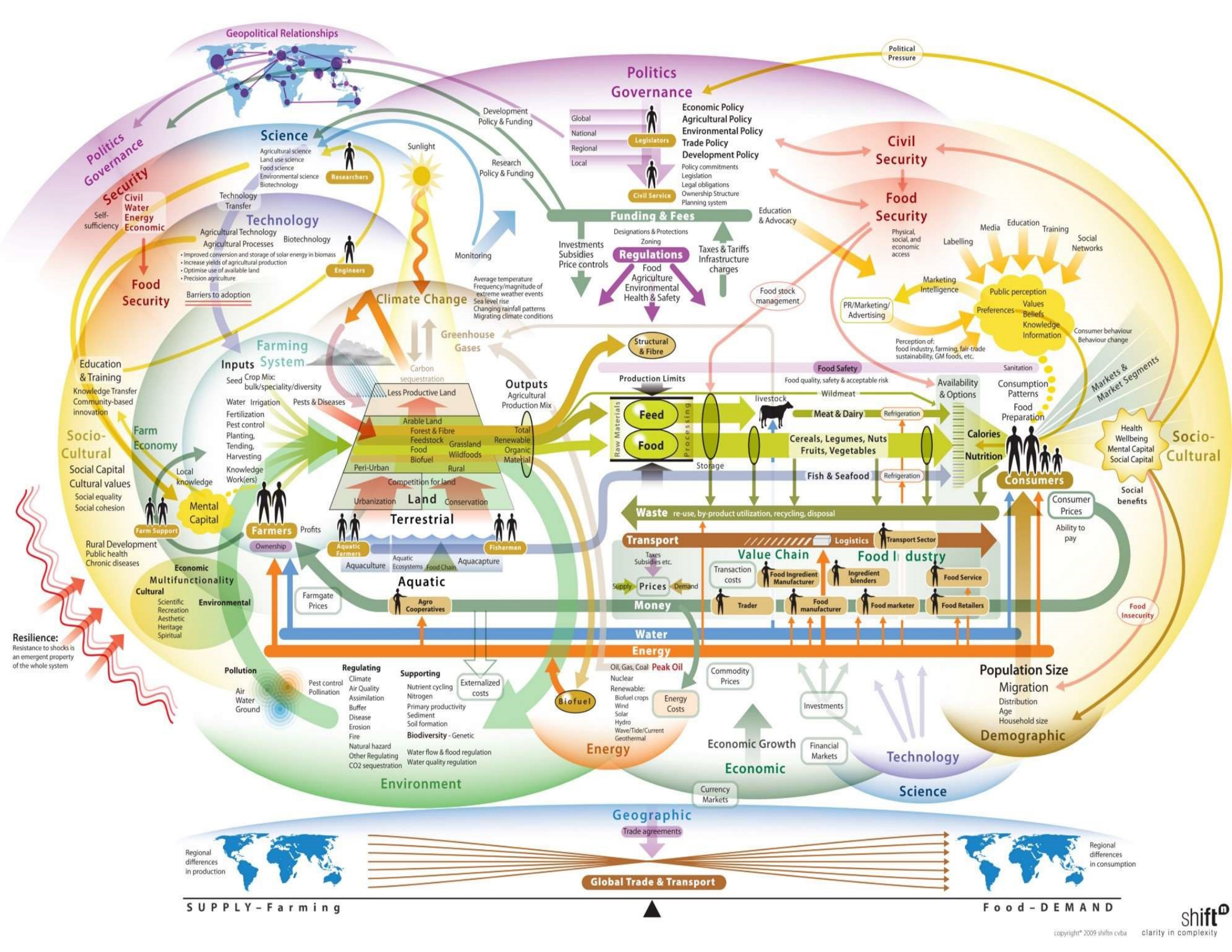
Roentgen 1895

Bequerel 1896

Gewürzmüller 1957

2.000

DIL graphics


Geopolitical Relationships
Politics
Governance
Political Pressure
Development Policy & Funding
Research Policy & Funding
Global
National
Regional
Local
Legislators
Civil Service
Economic Policy
Agricultural Policy
Environmental Policy
Trade Policy
Development Policy
Policy commitments
Legislation
Legal obligations
Ownership Structure
Planning system
Science
Agricultural science
Land use science
Food science
Environmental science
Biotechnology
Researchers
Sunlight
Technology Transfer
Technology
Agricultural Technology
Agricultural Processes
Biotechnology
• Improved conversion and storage of solar energy in biomass
• Increase yields of agricultural production
• Optimise use of available land
• Precision agriculture
Engineers
Barriers to adoption
Monitoring
Funding & Fees
Education & Advocacy
Investments
Subsidies
Price controls
Designations & Protections
Zoning
Regulations
Food
Agriculture
Environmental
Health & Safety
Taxes & Tariffs
Infrastructure charges
Civil Security
Civil
Water
Energy
Economic
Self-sufficiency
Food Security
Food Security
Physical, social, and economic access
Labelling
Media
Education
Training
Social Networks
Marketing Intelligence
PR/Marketing/ Advertising
Public perception
Preferences
Values
Beliefs
Knowledge
Information
Consumer behaviour
Behaviour change
Perception of: food industry, farming, fair-trade sustainability, GM foods, etc.
Food stock management
Climate Change
Average temperature
Frequency/magnitude of extreme weather events
Sea level rise
Changing rainfall patterns
Migrating climate conditions
Greenhouse Gases
Carbon sequestration
Structural & Fibre
Farming System
Inputs
Seed
Crop Mix: bulk/speciality/diversity
Water
Irrigation
Pests & Diseases
Fertilization
Pest control
Planting, Tending, Harvesting
Knowledge Work(ers)
Less Productive Land
Arable Land
Forest & Fibre
Feedstock
Food
Biofuel
Grassland
Wildfoods
Peri-Urban
Rural
Competition for land
Urbanization
Land
Conservation
Terrestrial
Outputs
Agricultural Production Mix
Total
Renewable
Organic
Material
Production Limits
Food Safety
Food quality, safety & acceptable risk
Sanitation
Availability & Options
Consumption Patterns
Food Preparation
Markets & Market Segments
Raw Materials
Processing
Feed
Food
Storage
livestock
Wildmeat
Meat & Dairy
Refrigeration
Cereals, Legumes, Nuts
Fruits, Vegetables
Fish & Seafood
Refrigeration
Calories
Nutrition
Consumers
Health
Wellbeing
Mental Capital
Social Capital
Socio-Cultural
Social benefits
Education & Training
Knowledge Transfer
Community-based innovation
Socio-Cultural
Social Capital
Cultural values
Social equality
Social cohesion
Farm Economy
Local knowledge
Mental Capital
Farm Support
Rural Development
Public health
Chronic diseases
Economic Multifunctionality
Cultural
Scientific
Recreation
Aesthetic
Heritage
Spiritual
Environmental
Farmers
Profits
Ownership
Aquatic Farmers
Fishermen
Aquaculture
Aquatic Ecosystems
Food Chain
Aquacapture
Aquatic
Waste re-use, by-product utilization, recycling, disposal
Consumer Prices
Ability to pay
Transport
Logistics
Transport Sector
Value Chain
Food Industry
Taxes
Subsidies etc.
Supply
Prices
Demand
Transaction costs
Food Ingredient Manufacturer
Ingredient blenders
Food Service
Trader
Food manufacturer
Food marketer
Food Retailers
Farmgate Prices
Agro Cooperatives
Money
Water
Energy
Food Insecurity
Resilience:
Resistance to shocks is an emergent property of the whole system
Pollution
Air
Water
Ground
Pest control
Pollination
Regulating
Climate
Air Quality
Assimilation
Buffer
Disease
Erosion
Fire
Natural hazard
Other Regulating
CO2 sequestration
Supporting
Nutrient cycling
Nitrogen
Primary productivity
Sediment
Soil formation
Biodiversity - Genetic
Water flow & flood regulation
Water quality regulation
Externalized costs
Biofuel
Oil, Gas, Coal
Peak Oil
Nuclear
Renewable:
Biofuel crops
Wind
Solar
Hydro
Wave/Tide/Current
Geothermal
Energy Costs
Commodity Prices
Investments
Financial Markets
Economic Growth
Economic
Currency Markets
Energy
Environment
Technology
Science
Population Size
Migration
Distribution
Age
Household size
Demographic
Geographic
Trade agreements
Regional differences in production
Global Trade & Transport
Regional differences in consumption
SUPPLY – Farming
Food – DEMAND
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clarity in complexity

UN GLOBAL SUSTAINABLE DEVELOPMENT GOALS (SDGS)

https://www.undp.org/content/undp/en/home/sustainable-development-goals.html

TOP TRENDS IN FOOD SUSTAINABILITY - GLOBAL CHALLENGES AND CRITICAL NEEDS OF FOOD SCIENCE & TECHNOLOGY

Missions:

1. More diverse and low environmental primary production
2. Design sustainable process and system engineering

   (Robotics, 3D printing, short supply chain, reduced water and energy)
3. Reduce waste – reusing side streams
4. Establish complete traceability and safety
5. Provide affordable and balanced nutrition
6. Maximise food impact in health
7. Integrate Big Date, AI, IT throughout food chain

„To sustain a growing population and its health will require all the technology we have today and more“

Adapted from:

https://futurefood.network Lillford & Hermannsson, 2019

21ST CENTURY FOOD SYSTEMS ?

Small-scale food production systems are back in towns

The plantCube.
A smart garden for your own home.

https://agrilution.com

Every Brewery in New York State, Mapped (2017). http://brewyorknewyork.com

Food processing in a box

www.fox-foodprocessinginabox.eu

„F3-Factory“ in a container
fast, flexible, future

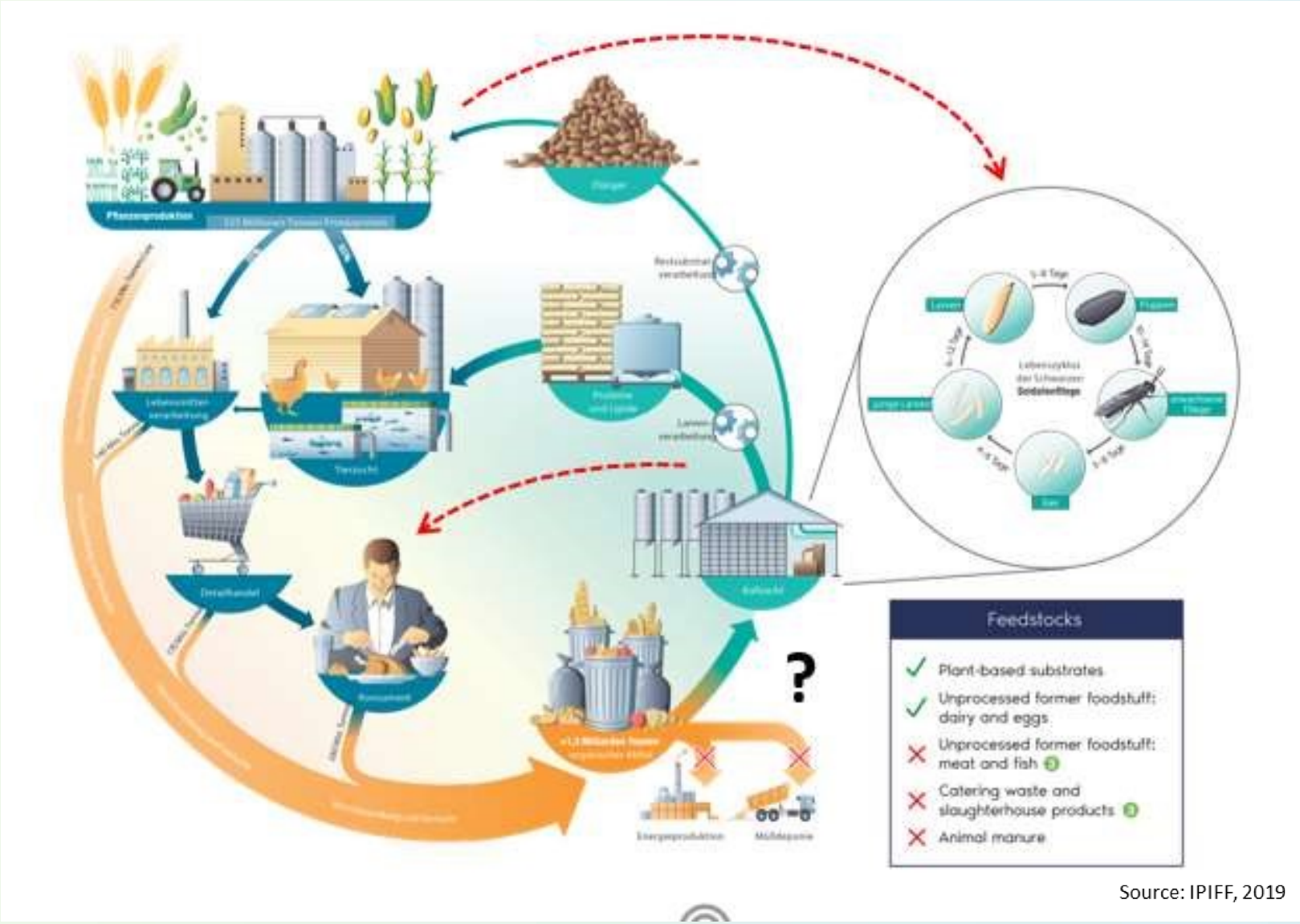
https://www.process.vogel.de/so-viel-potenzial-bietet-der-modulare-anlagenbau-gal-716925/

7,242 views | Oct 23, 2019, 05:30pm

Waterworld? Floating Cities Turn Hollywood Sci-fi Into Reality As Sea Levels Rise

www.forbes.com

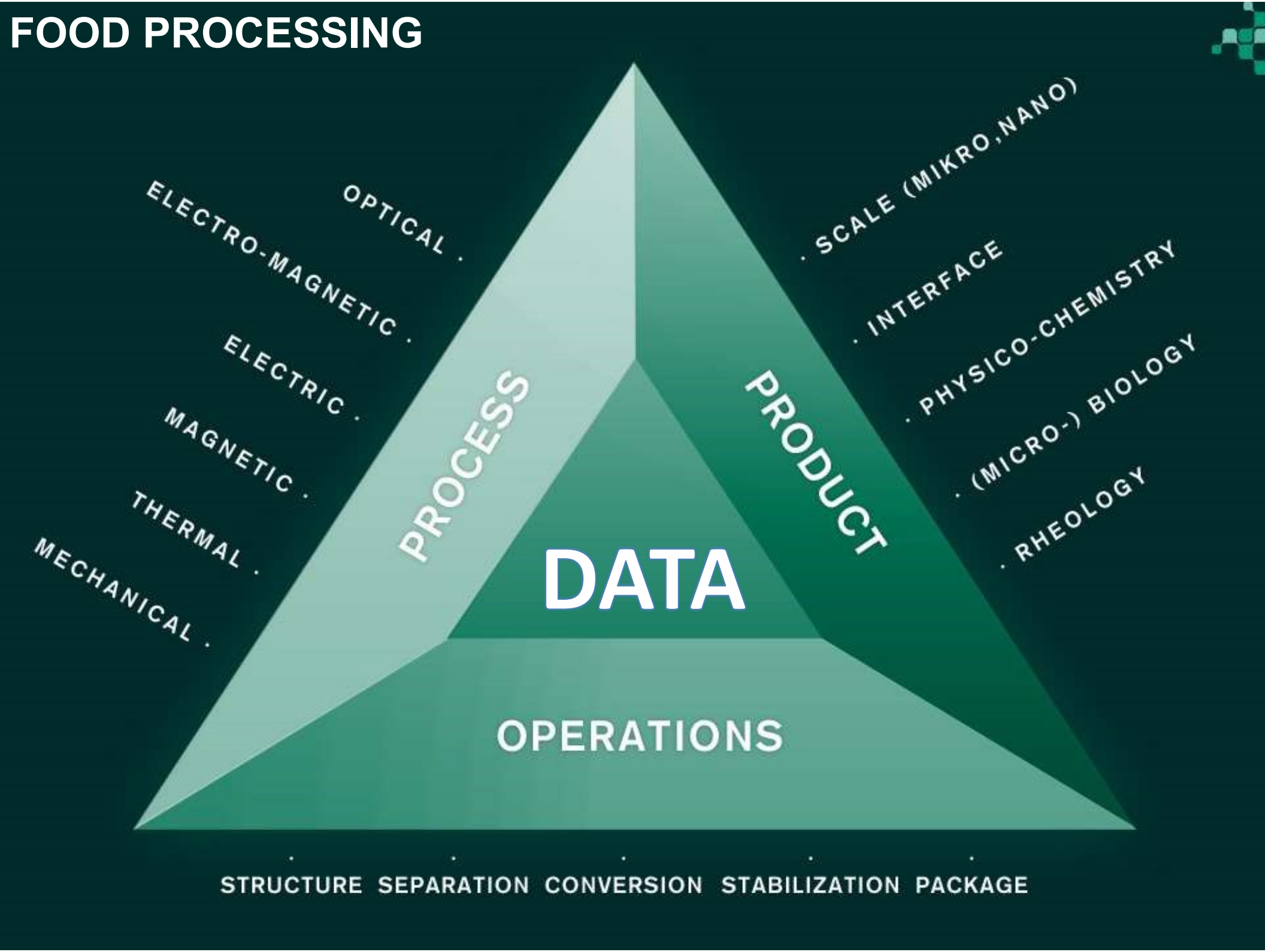
INSECTS AND FEED-FOOD



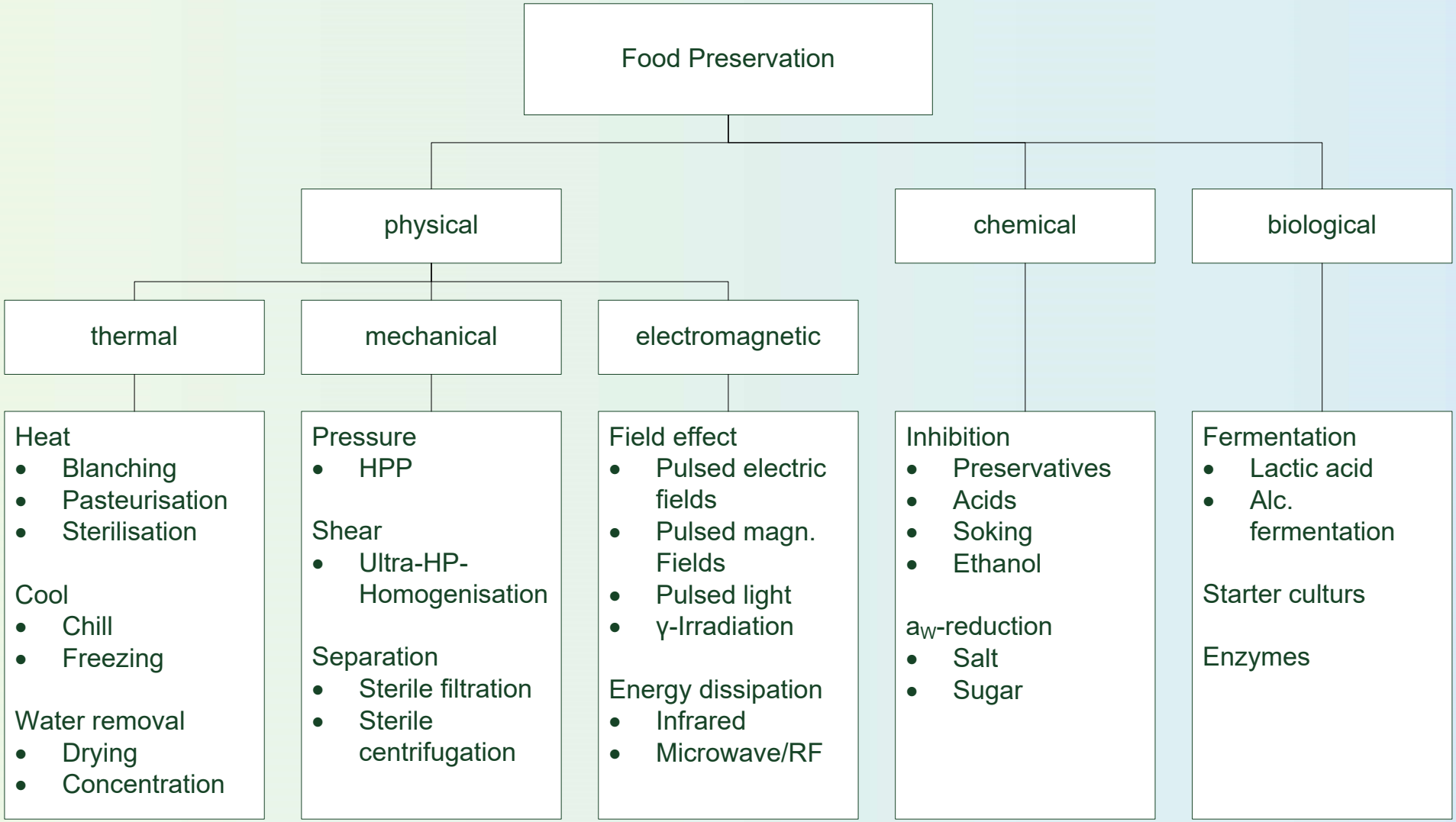
Source: IPIFF, 2019

Adapted from Diagram (2018), Buehler Magazin; Andreas Baumann, Daniel Röttele

FOOD PROCESSING



FOOD PRESERVATION APPROACHES



TECHNOLOGIES FOR GENTLE PRESERVATION, STRUCTURE MODIFICATION AND PROCESS IMPROVEMENT

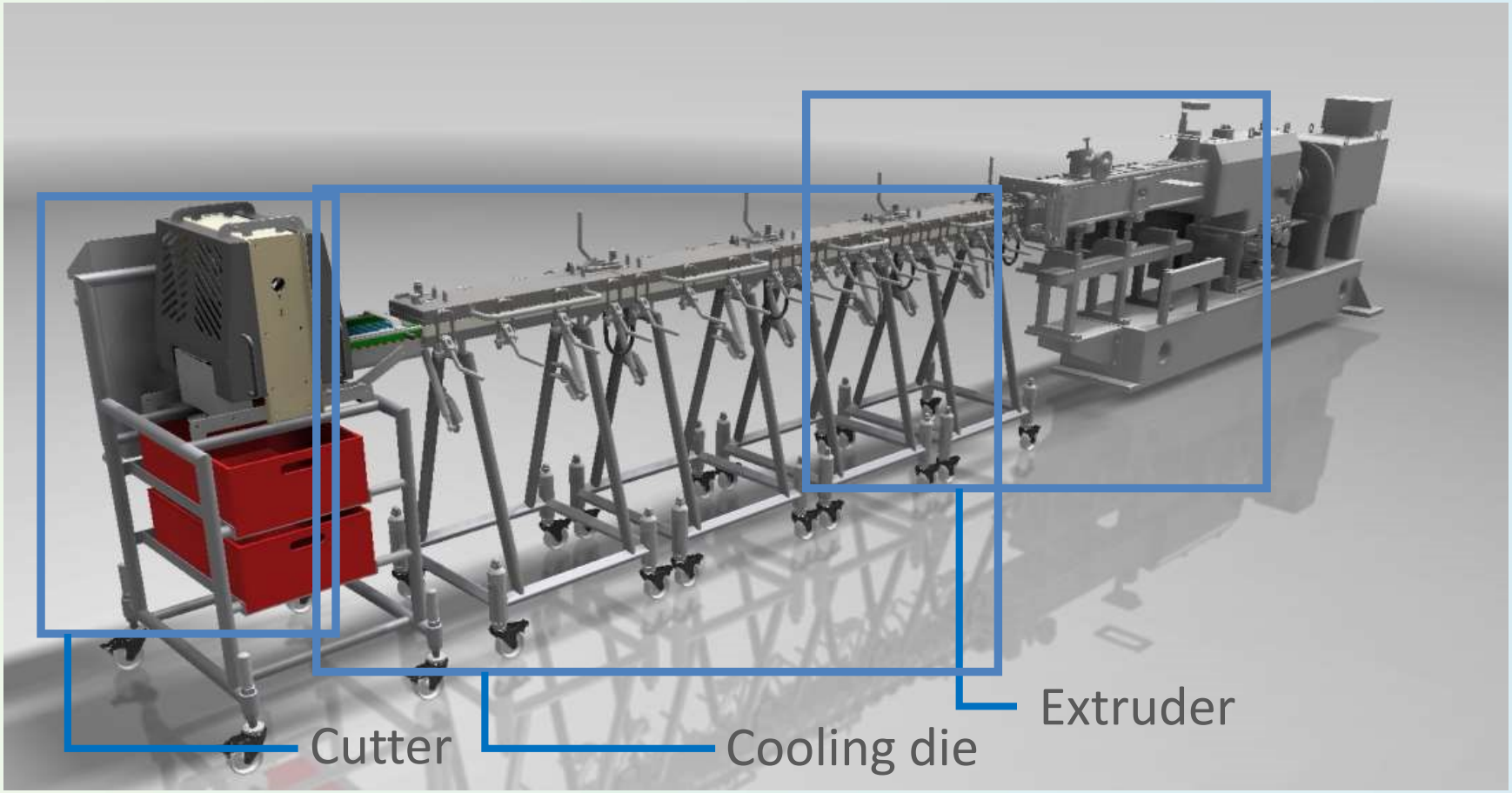
Emerging, advanced?

- High hydrostatic pressure
- High Pressure Homogenization
- Pulsed and UV light
- Irradiation
- Pulsed electric fields
- Shockwave
- Extrusion
- Ohmic heating
- …

HIGH MOISTURE EXTRUSION

HIGH MOISTURE EXTRUSION

Extrusion setup with cooling die and cutting unit



HIGH MOISTURE EXTRUSION

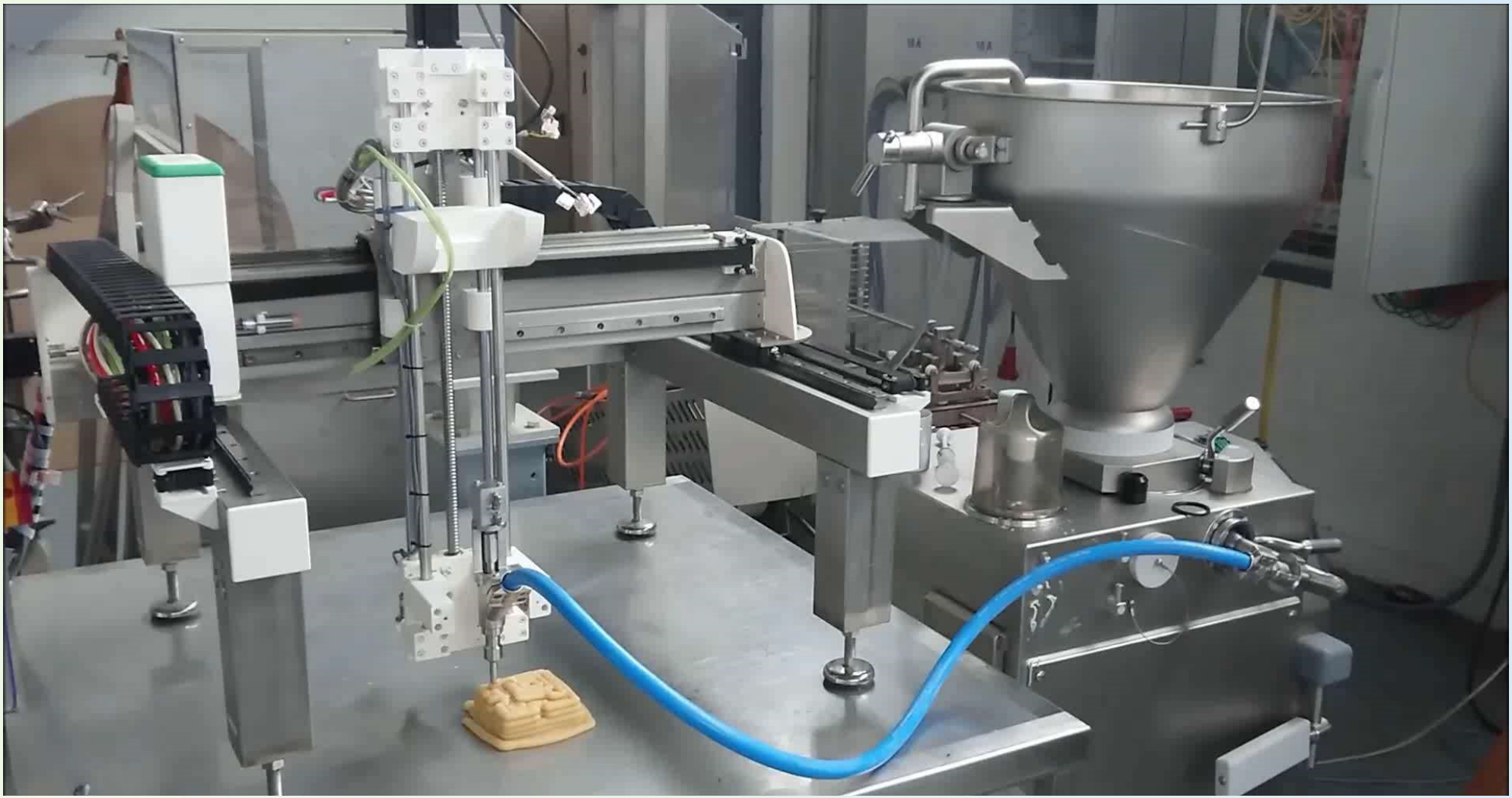
Application for protein based meat analogues

Structure design by recipe and process parameters

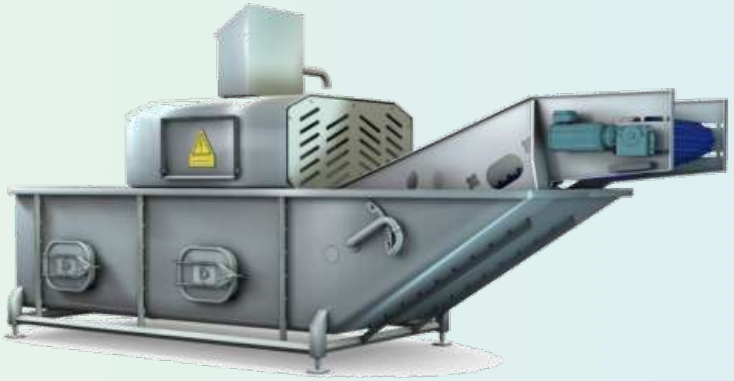
HIGH MOISTURE EXTRUSION

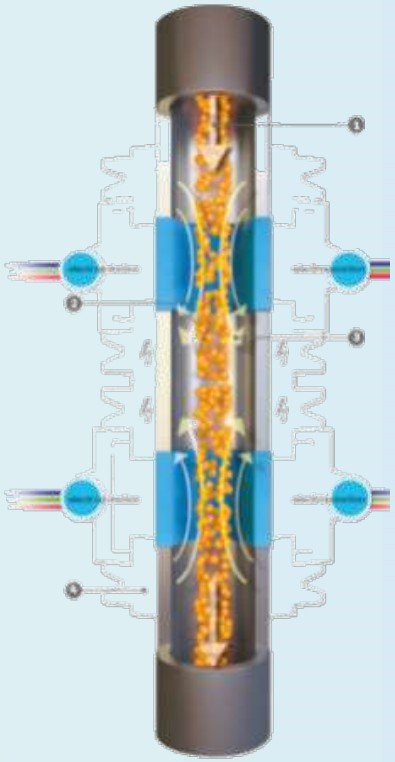
3D FOOD PRINTING

Setup for continuous printing mode



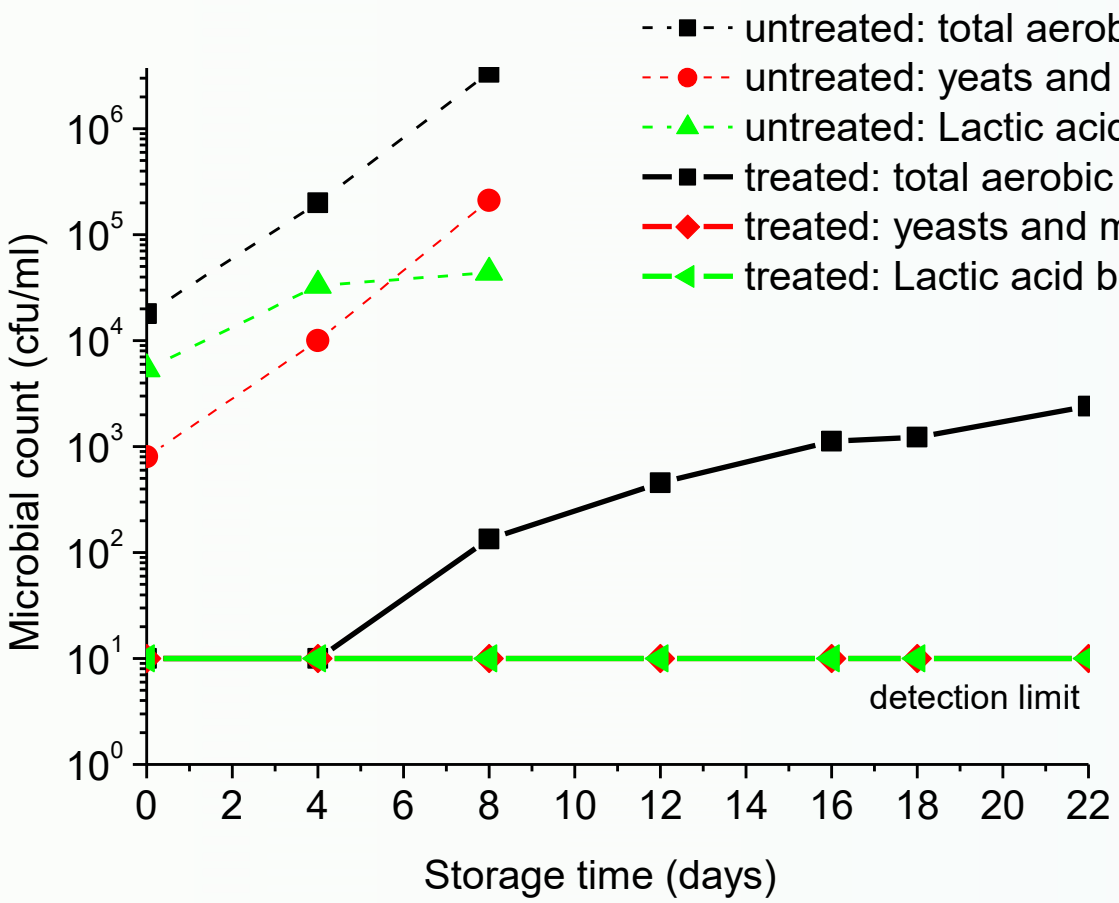
PULSED ELECTRIC FIELDS





PULSED ELECTRIC FIELDS

Electroporation for increased product quality and process efficiency

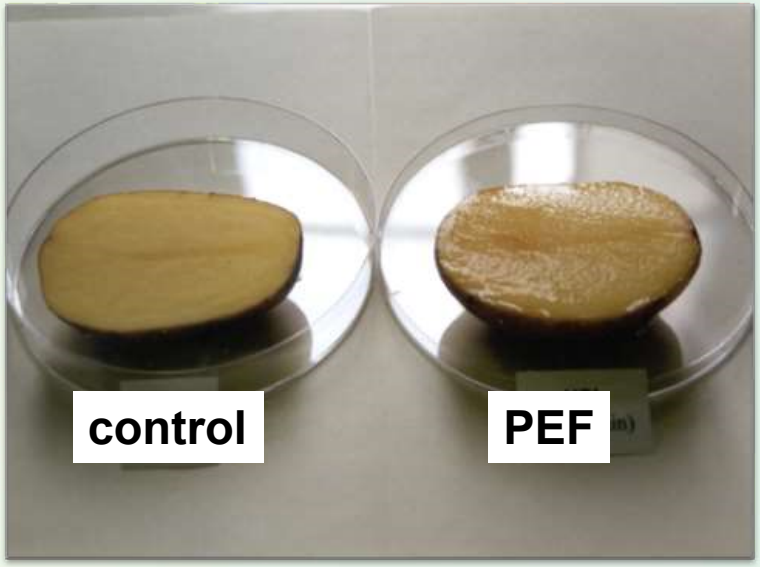


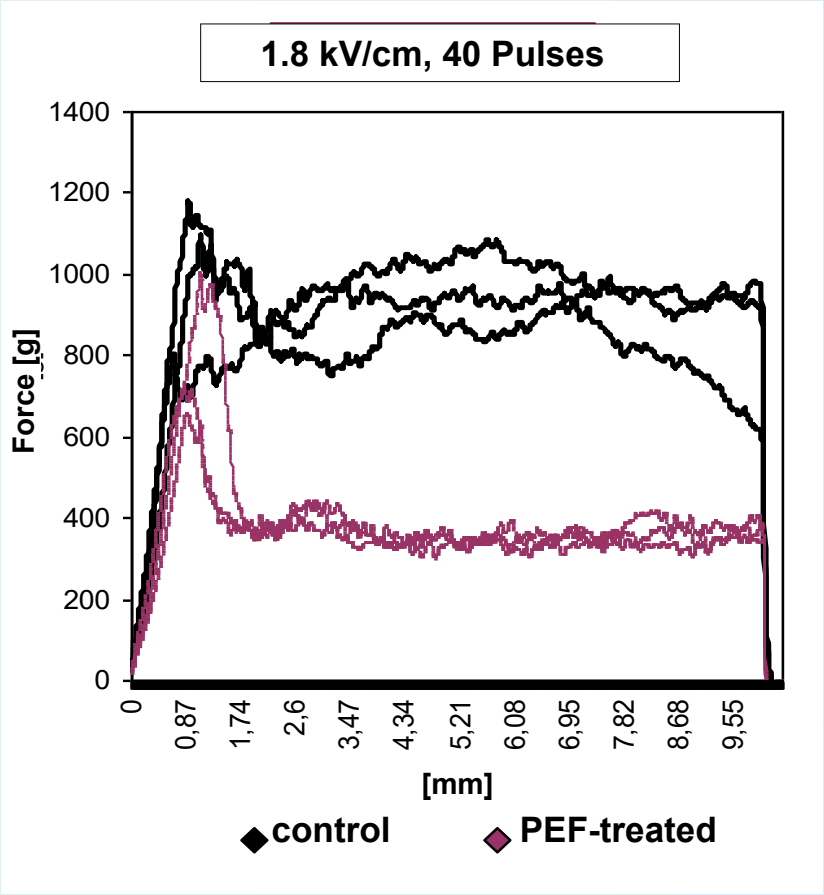
PULSED ELECTRIC FIELDS

Electroporation for increased product quality and process efficiency

Softening of tissue by loss of turgor pressure

Improvement of cutting
Smoother surface

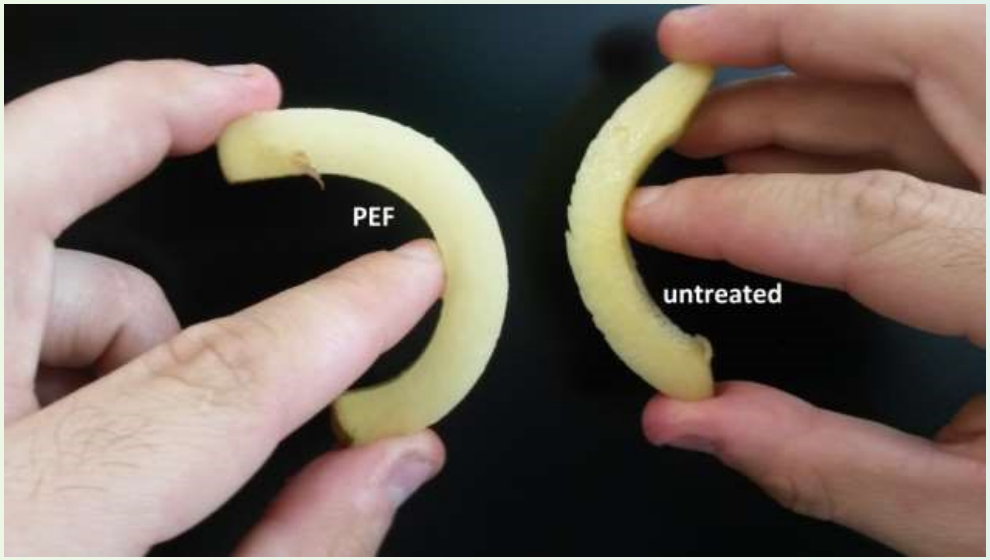


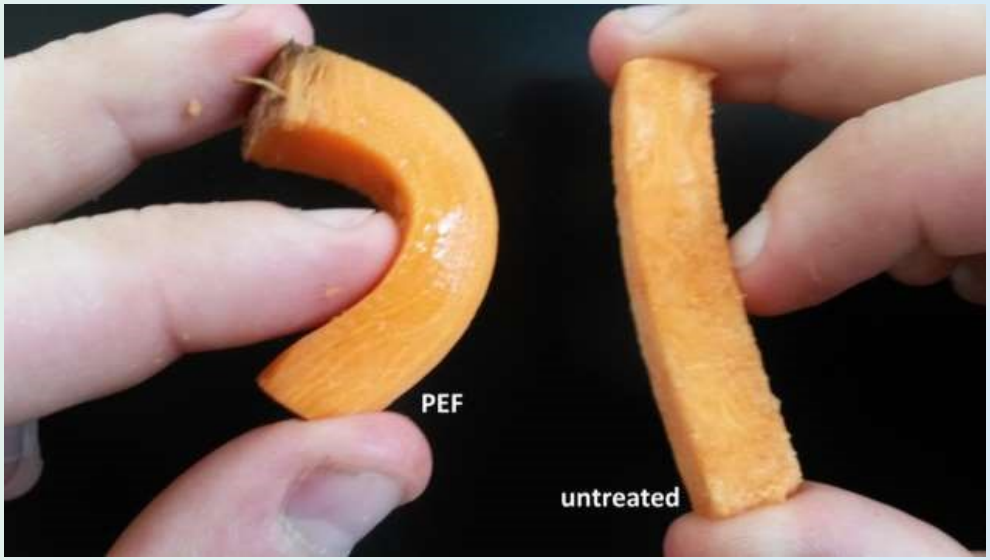


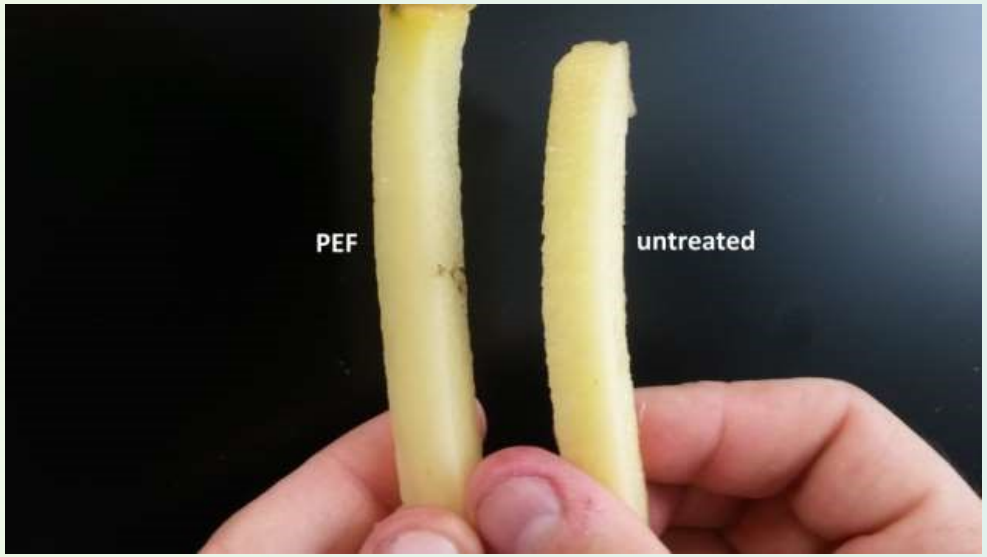
Cutting force for potato tissue after a PEF-treatment

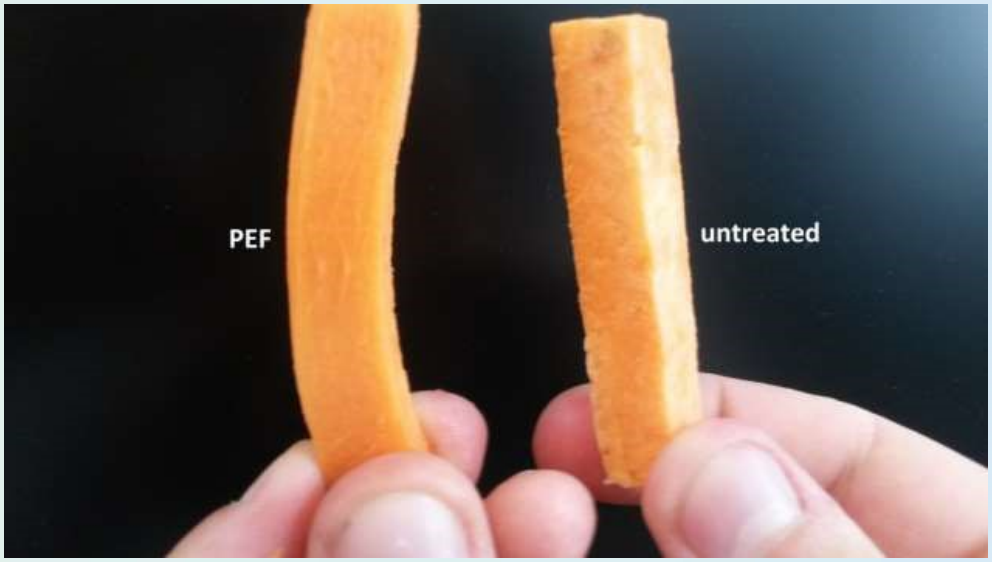
PULSED ELECTRIC FIELDS

Electroporation for increased product quality and process efficiency









BENEFITS FOR POTATO PROCESSORS

LESS HEAT

LESS FRACTURE

LESS OIL UPTAKE

LOW ENERGY USE

REDUCED BLANCHING TIME

LESS BROWNING

New amazing shapes are great with PEF.

PULSED ELECTRIC FIELDS - ENHANCED DRYING

Reducing drying time and enhancing colour

Fig. 3 Residual moisture of untreated and PEF treated (E = 1.07 kV/cm, W = 4 kJ/kg) onions at different drying temperatures for a total drying period of 300 minutes or the necessary time to dry the samples to a M_r of 7 %.

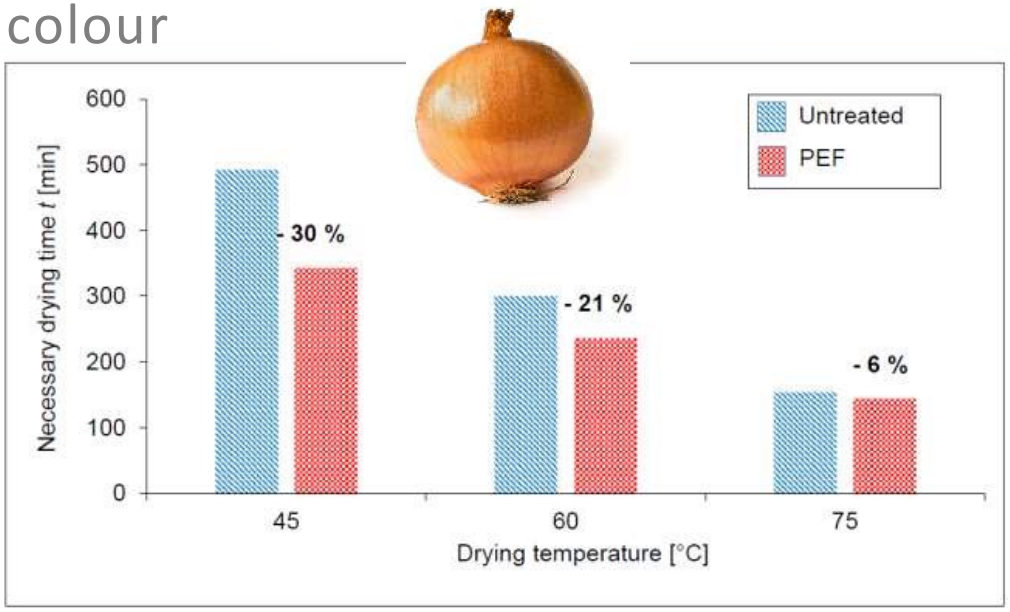
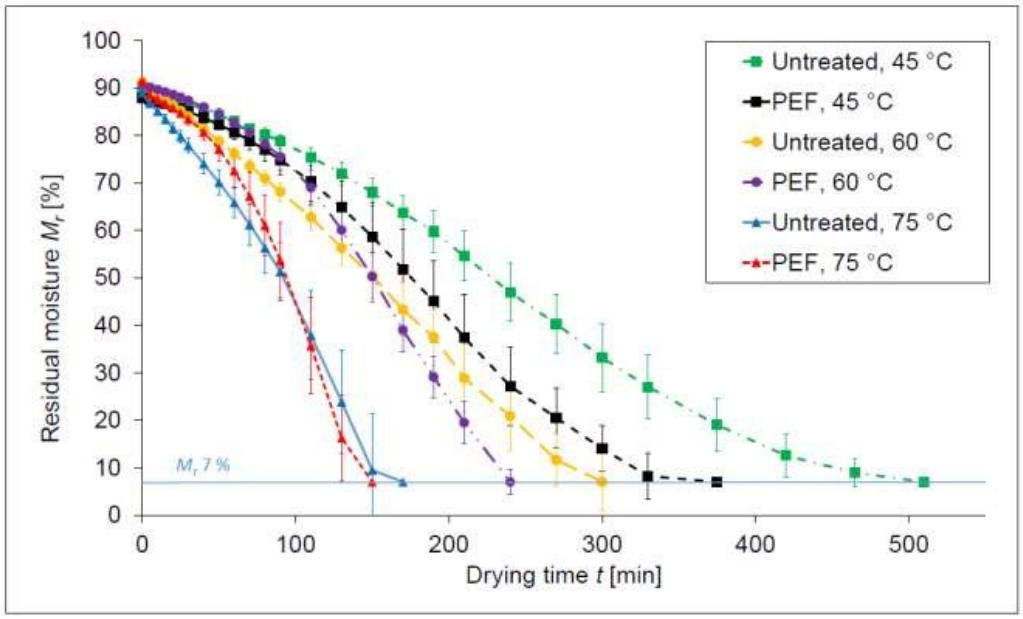


Fig. 4 Influence of different drying temperatures on the drying time of untreated and PEF treated onions dried to a M_r of 7 %.

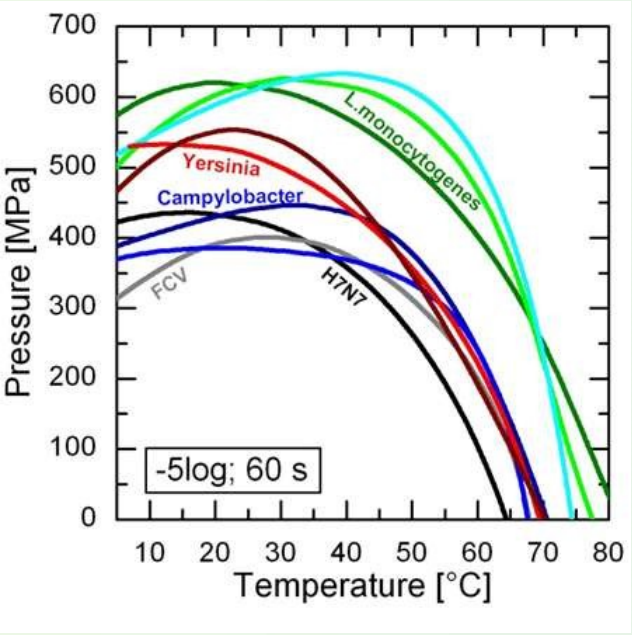


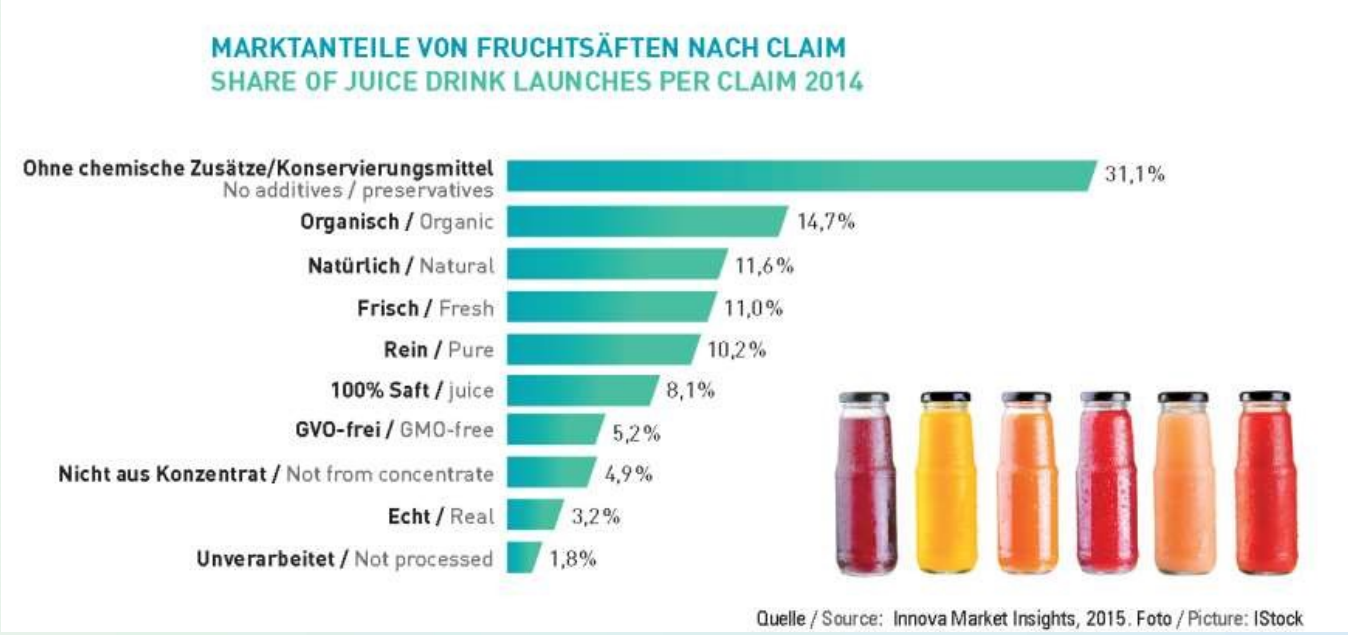
HIGH HYDROSTATIC PRESSURE

HIGH HYDROSTATIC PRESSURE

Gentle preservation and structure modification

- The uniaxial force F is split into multiaxial compressive forces – isostatic pressure applied
- No shear forces in isotropic bodies – uniform pressure
- Reversible compression
- The pressure transmission is instantaneously
- Inactivation of microorganisms and enzymes

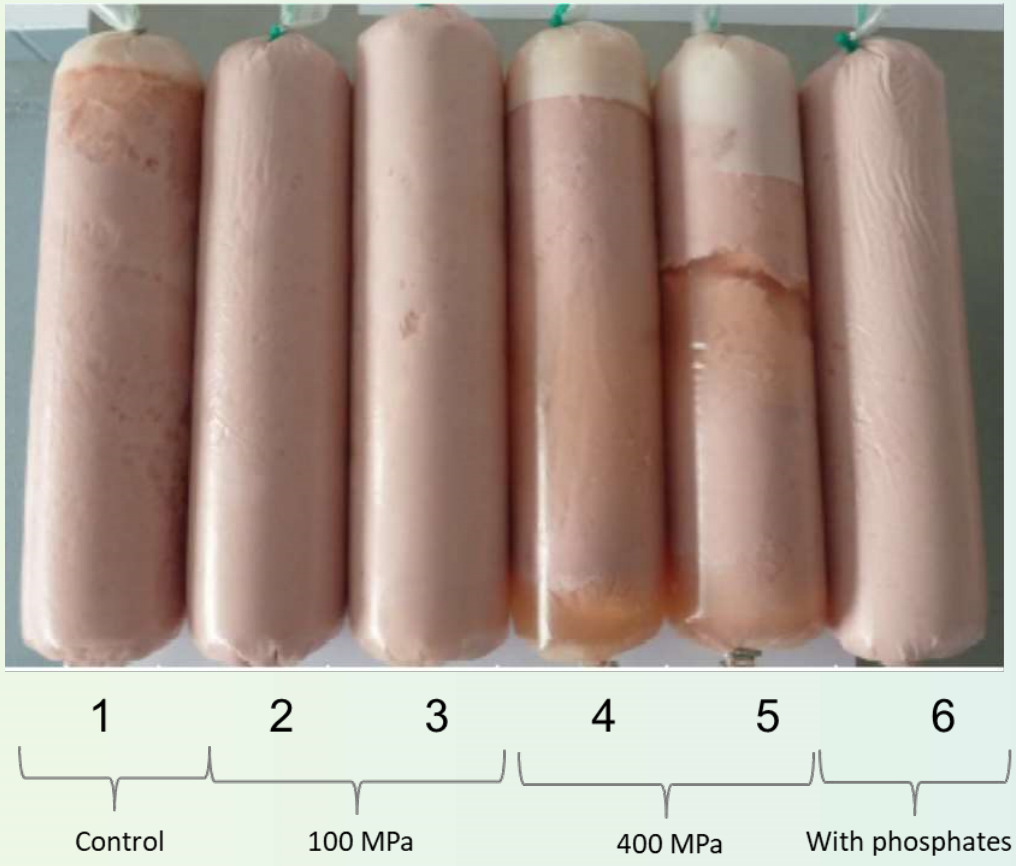




HIGH HYDROSTATIC PRESSURE

Gentle preservation and structure modification

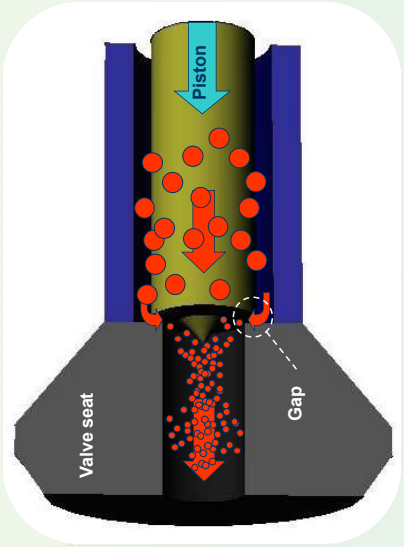
Functionalization of raw meat by HPP treatment for salt reduction in cooked sausage



Functionalization of raw meat by HPP treatment for fat replacement in salami sticks

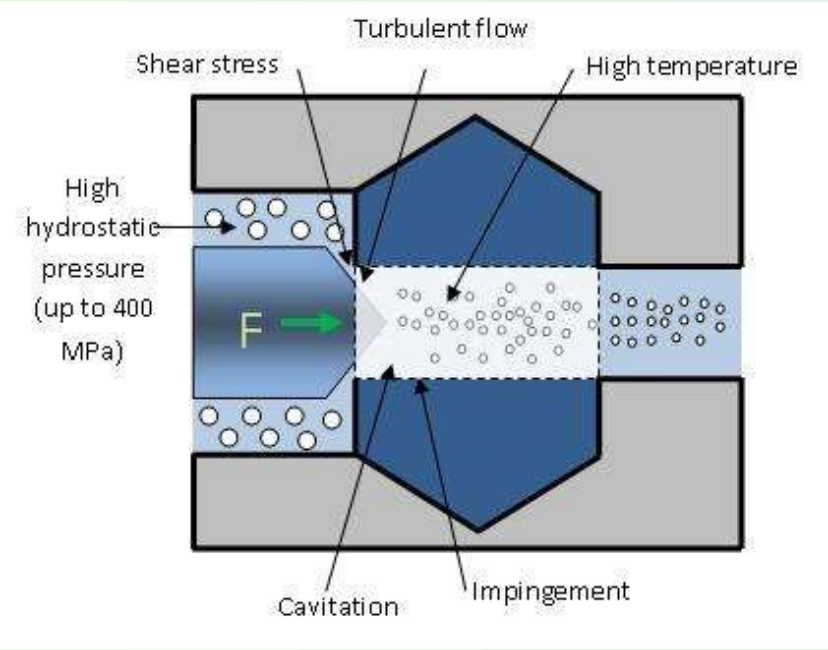
Nutrition´s per 100 g
Protein: 48,0 g
Fat: 10,0 g
Energy: 312 kcal / 1280

ULTRA HIGH PRESSURE HOMGENISATION



HIGH PRESSURE HOMOGENISATION

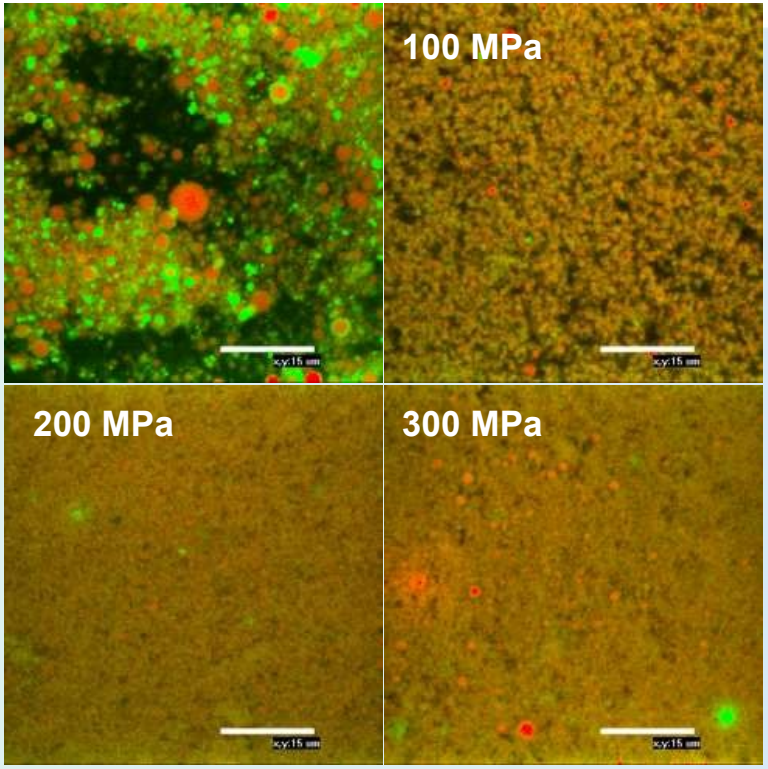
Continuous dynamic high pressure



Various physical phenomena simultaneously affecting a fluid during HPH

Low fat mayonnaise

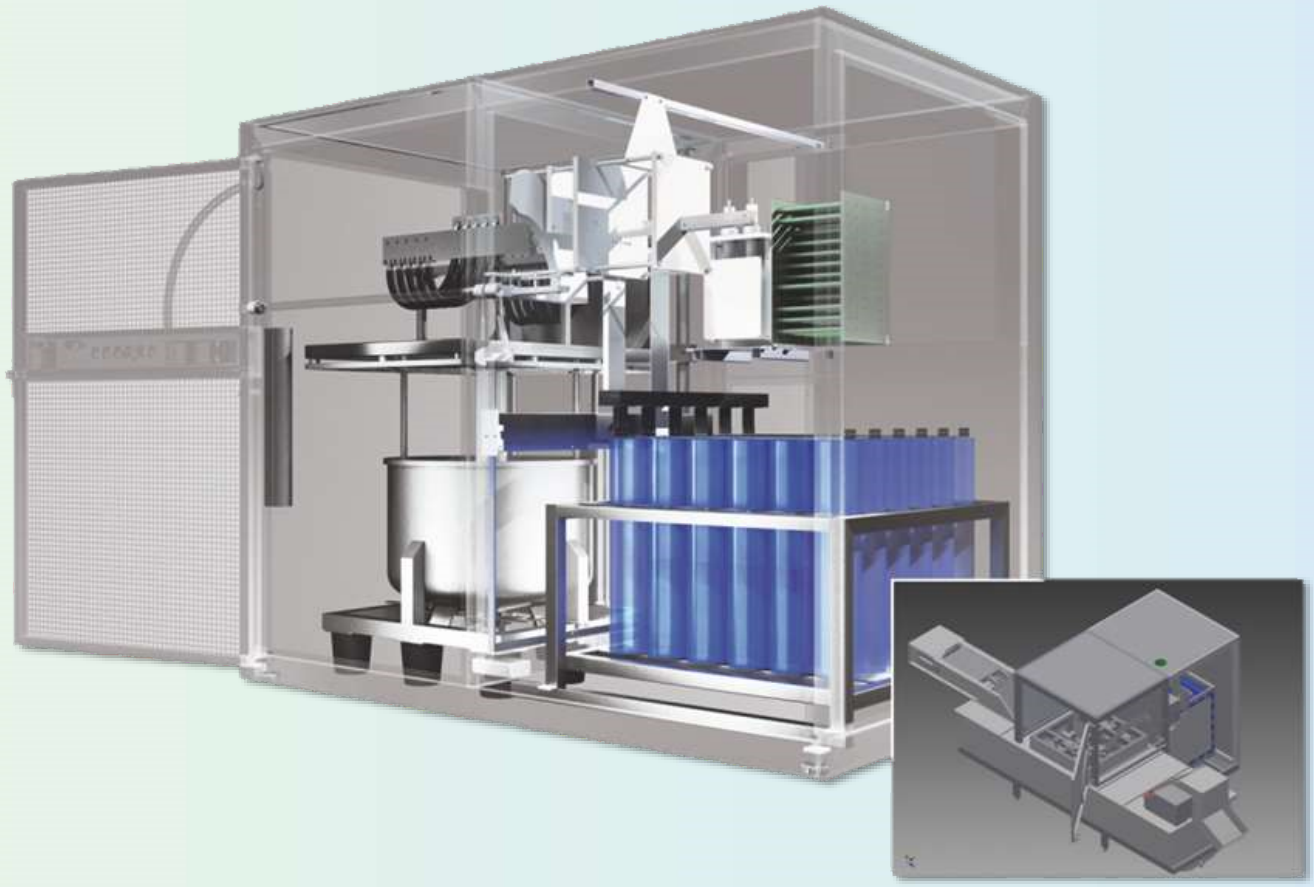
- 56% water
- **28% fat**
- 6% egg yolk
- Sugar, mustard, acid …
- No thickeners!



Confocal laser scanning microscopy (CLSM)

100 MPa **200 MPa** **300 MPa** **350 MPa**

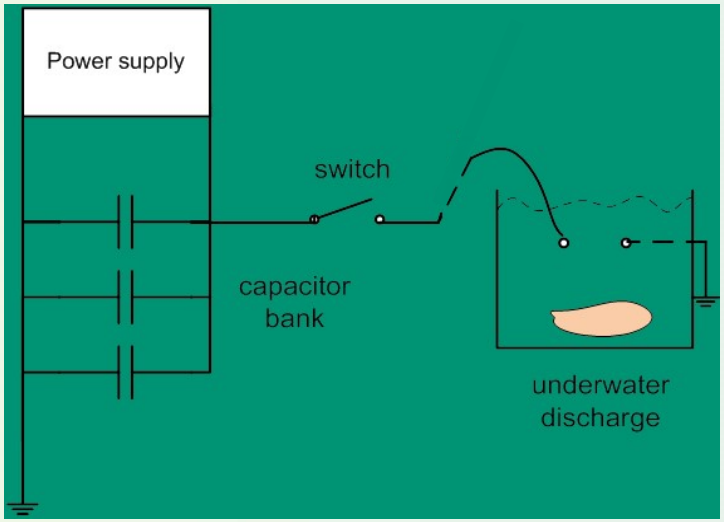
SHOCKWAVE PROCESSING

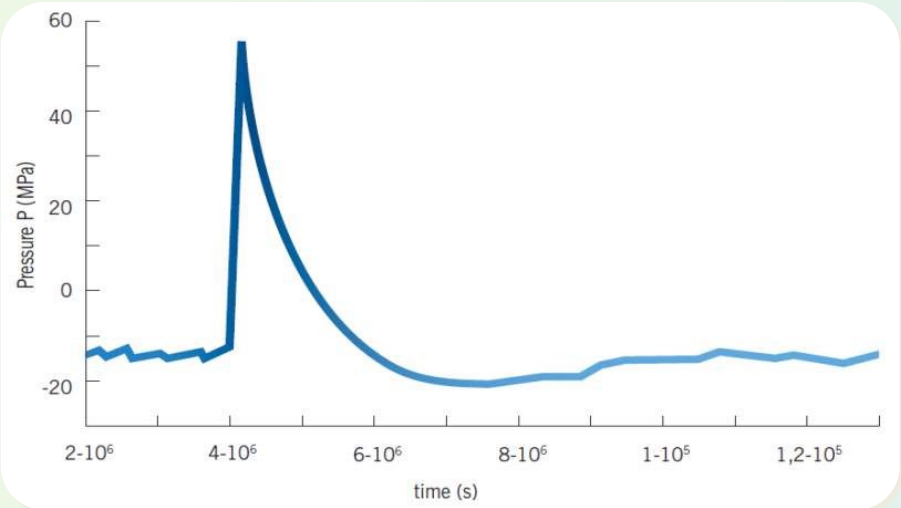


SHOCKWAVE

Hydrodynamic high pressure

High pressure levels but at µs timescale

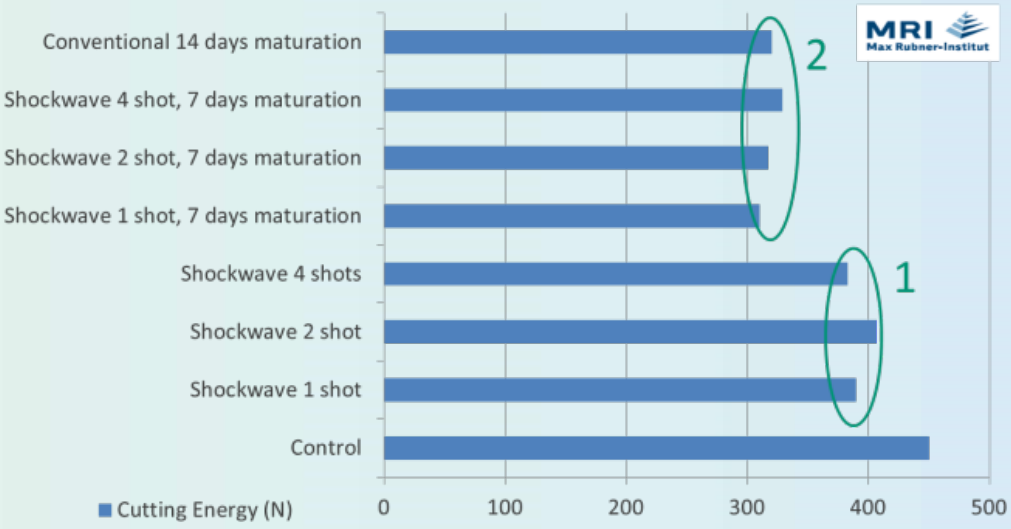




Pork silverside

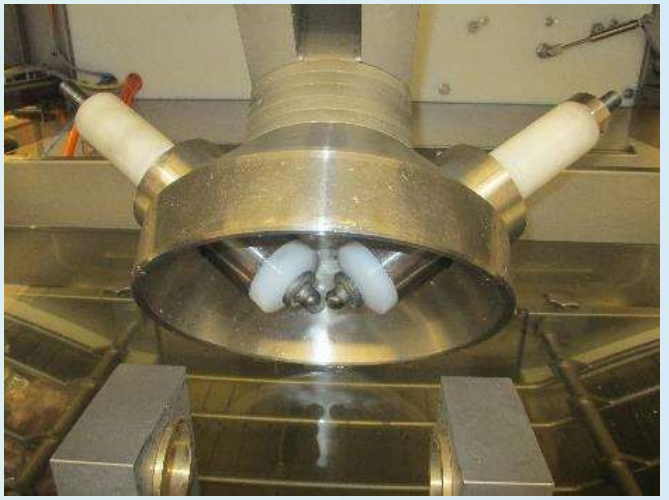
TEXTURE		Shearing force	
		Average (N)	Std (N)
Shockwave-treated		50.8	8.8
Control		70.7	10.8
Improvement	%	28.1	

Reduced resistance in samples treated by shockwave ($P < 0.05$)



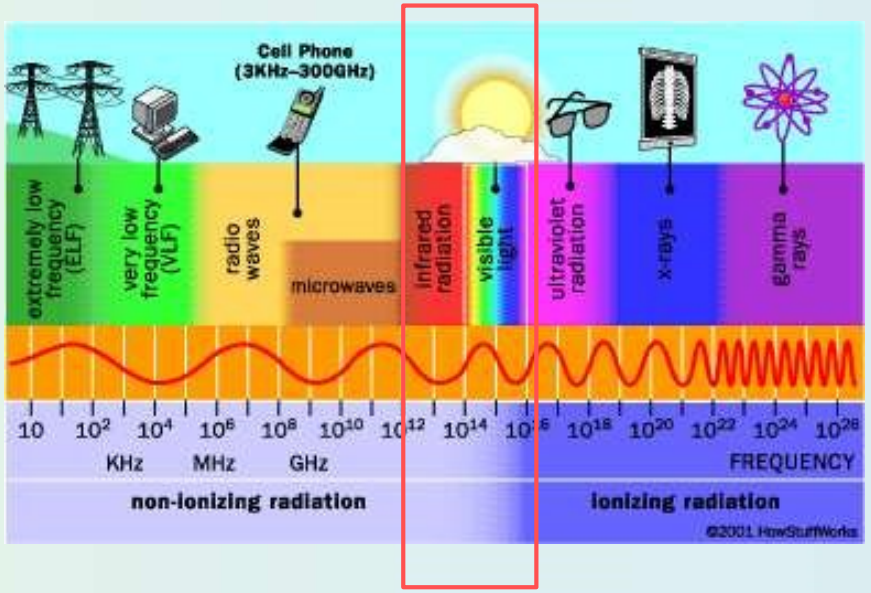
SHOCKWAVE

DIL Design



Continuous system for meat tenderisation

LIGHT AND E-BEAM FOR SURFACE DECONTAMINATION



LIGHT SYSTEMS

Surface decontamination using pulsed light

Surface decontamination of packed product

- No toxic substances
- Decontamination using UV, PL
- Contact-free
- Continuous process from all sides
- Treatment in packaging
- Moderate costs

Pulsed Light (Xenon)

Continuous UV light (DIL)

FOOD IRRADIATION

Decontamination using irradiation

DIL linear accelerator for R&D
Treatment of pallets or bulk material

Type CIRCE III

Acceleration energy	max. 10 MeV
Irradiation power	max. 10 kW
0,25 to 50 kGy	(max. dose for food 10 kGy)
Irradiation direction	vertical down
Irradiation area	75x75 cm
Belt speed	1000 mm/s

OHMIC HEATING

Food processing by advanced heating

Heating by the passage of electrical current through an object of a certain resistance, where so that heating is by internal heat generation

OH applications

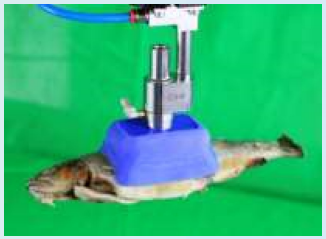
- Thawing, tempering
- Pasteurisation – sterilisation
- Cooking (e.g. sausage), Blanching (vegetables),
- Pre – treatment for extraction
- Evaporation – dehydration

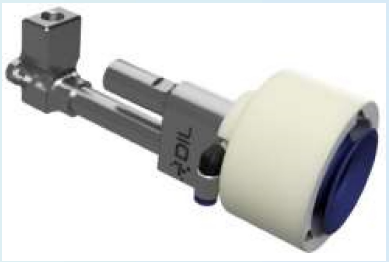
- Suitable for liquid, solid and solid – liquid mixtures

AUTOMATION AND ROBOTIC

Motivation for automation:
- Costs
- Working conditions
- Hygiene

Challenges:
Variety of foods and development of suitable grippers



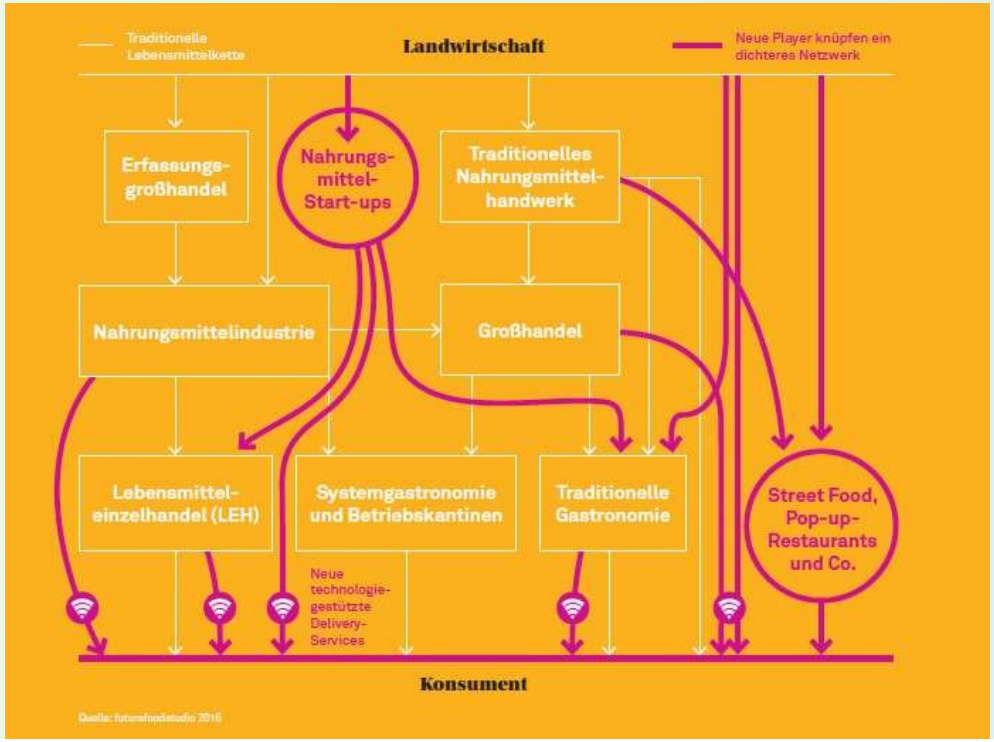


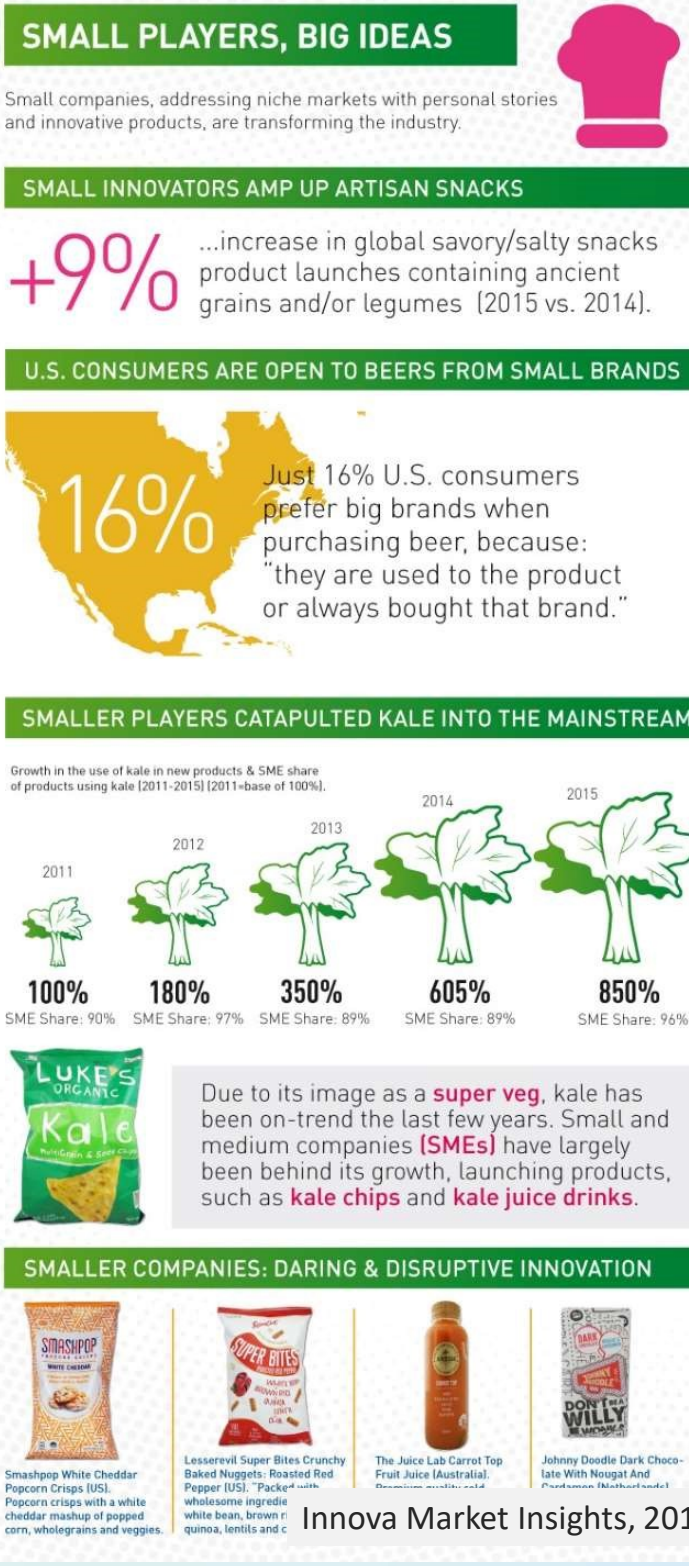
START-UPS
LABORATORIES OF THE FUTURE

- Change and Trends develop outside
- Young Entrepreneurs and people outside of the branch can identify the gaps and weaknesses of the system often better and earlier

ZukunftsInstitut, 2016

- Take unbiased actions
- Flexible and often outside of the box thinking, but from a consumer perspective





Innova Market Insights, 2016

Thank you for your attention!

Name: Dr. Kemal Aganovic
Phone: +49 5431.183-447
Mail: k.aganovic@dil-ev.de

DIL Deutsches Institut für Lebensmitteltechnik e.V.
Prof.-von-Klitzing-Str. 7
D-49610 Quakenbrück
www.dil-ev.de