New ingredients for meat products and meat analogues

Christian Zacherl

Potsdam, 06. August 2019

Content

- Challenges on world nutrition and trends in future ingredients
- Use of plant based protein ingredients as fat replacer in meat products
- Strategies and innovative ingredients for sodium and nitrite reduction in sausages
- Development of plant based meat alternatives such as meat analogues or vegan burger products mimicking structure, mouthfeel and taste of classic meat products, targeted to flexitarian consumers
- Plant based ingredients providing antimicrobial and / or antioxidant properties in meat products

Background: Top 10. energy containing products in worldwide harvests (FAO 2013)

Product**)	Amount t/a	Energy kcal/a	kcal per human and day*)
1. Maize	1,016,736,092	$3.3*10^{15}$	1276
2. Rice	745,709,788	$2.6*10^{15}$	993
3. Wheat	713,182,914	$2.5*10^{15}$	950
4. Soybeans	276,406,003	$1.2*10^{15}$	469
5. Palm oil	55,800,940	$5.0*10^{14}$	191
6. Barley	144,755,038	$4.7*10^{14}$	179
7. Sugar cane	1,877,105,112	$4.7*10^{14}$	179
8. Rapeseed	64,563,586	$3.6*10^{14}$	138
9. Potatoes	368,096,362	$2.8*10^{14}$	108
10. Sorghum	61,384,559	$2.1*10^{14}$	82

*) based on 7.2 bn humans

4,531 $\frac{kcal}{human\ day}$

146 $\frac{g\ Protein}{human\ day}$

Source: **) FAO-STAT, Data from 2013 and 2012

TOTAL (141 Products): 1.47*10^16 kcal/a: ~ **5,460** kcal/human and day

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Total use of these products for human nutrition (2,250 kcal/d)

harvests 2013:
enough food to feed 17 billion (vegan) people!

But: shortage in resources

- Food- and agricultural waste
  - >100 Mio. Tons in the EU**)
  - **33% worldwide along the food chain**)**
- Production of animals
  (Ressource-Factor~1:5)
  - Meat*): 308 Mio. t/a
  - Milk*): 753 Mio. t/a
  - Eggs*): 81 Mio. t/a
  - Fish from Aquaculture*): 67 Mio. t/a
- Use of agricultural goods for energy production

Sources: *) FAO-STAT, Data from 2012
**) European Commission, 2014

Sustainability

Development of Tailor-made Food Ingredients

Plant-based raw materials
- Oil and protein crops
- By-products of fruit and vegetable processing

Extraction

Modification

High-quality ingredients for
- Food
- Feed
- Cosmetics and technical use

Oilseeds, proteinseeds, grains:
Lupin, sunflower, soy,
rapeseed, linseed, rice

Residues from fruit and vegetable processing

Proteins,
dietary fibres,
secondary plant metabolites

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Alternative protein sources – what about future?

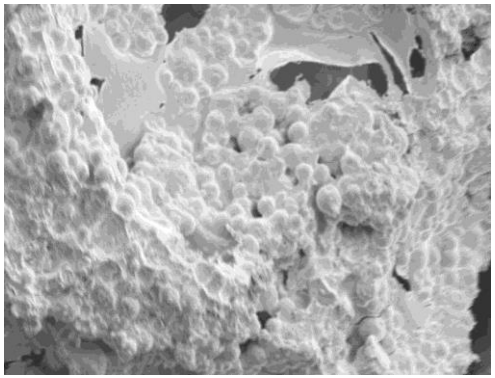
- In-vitro-meat
- Insects
- Micro + Macro algae (seaweed)
- Fungi
- Plant proteins
  grain legumes, oil seeds, cereals

New ingredients for meat products and meat analogues

Fat replacer

Fat in foods

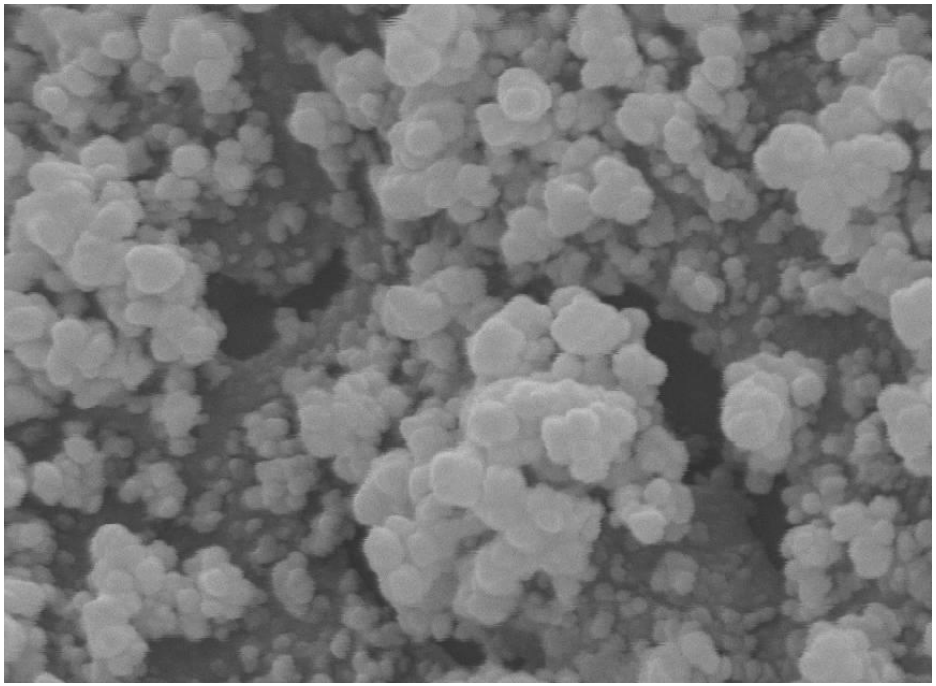
- Nutritional needs
  - Energy source
  - Supply of essential fatty acids, fat soluble vitamins and aroma compounds
  - Some fat is essential
- Physical functions:
  - Melting behaviour
  - Stabilisation, e. g. of protein in sausages
  - Heat transfer, e. g. Deep-frying
- Sensory properties:
  - Appearance, Colour
  - Aroma, Flavour
  - Taste
  - Texture, Mouthfeel



SEM image of whipped cream (40 µm)
©Fraunhofer IVV

SEM image of sausage meat.
©Behr's – meat technology

Innovative fat replacer based on lupin protein

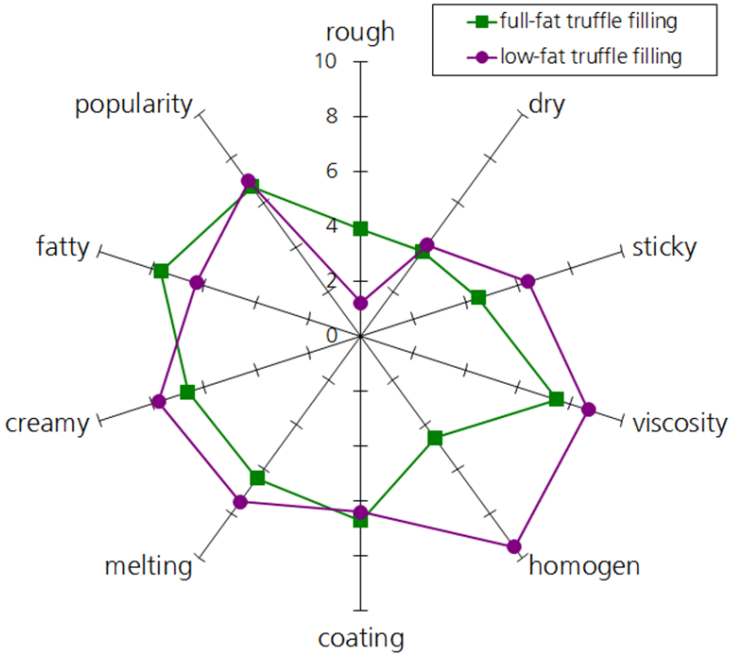


SEM image of the protein isolate from lupins

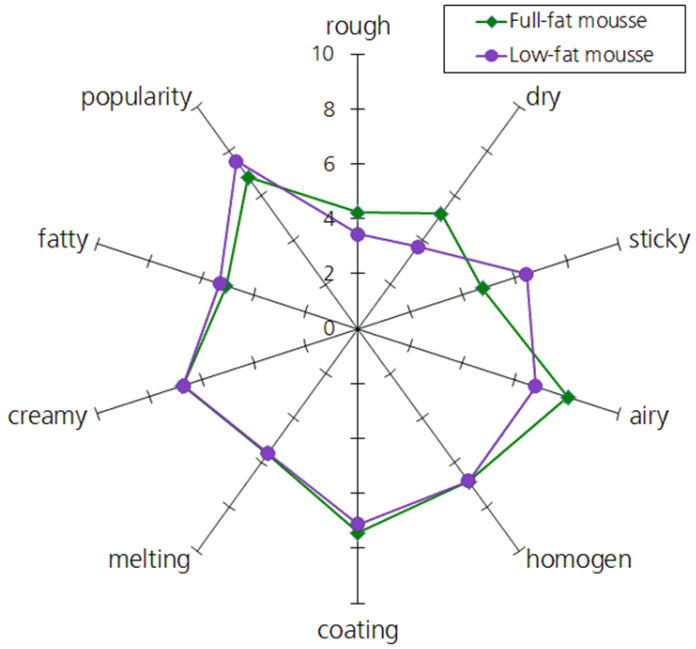
Lupin protein isolate

Application example: truffle fillings & mousse au chocolat

Descriptive analysis of the full-fat and low-fat product variant



Truffle filling



Mousse

Application example: pate sausage

Micro-fine protein spheres generate creamy consistency

Fat-like mouth-feel

Wide range of applications

Neutral taste

Depending on application, a fat reduction between 30-90% is possible

New ingredients for meat products and meat analogues

Salt reduction

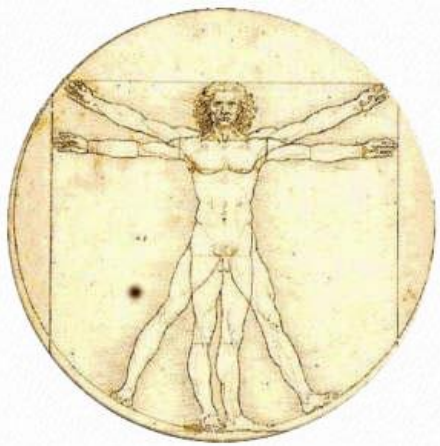
Salt vs. Consumer Health

Background:

- Average salt intake in the EU: 8-12 g / day
- Recommended dietary: 5 g salt /day

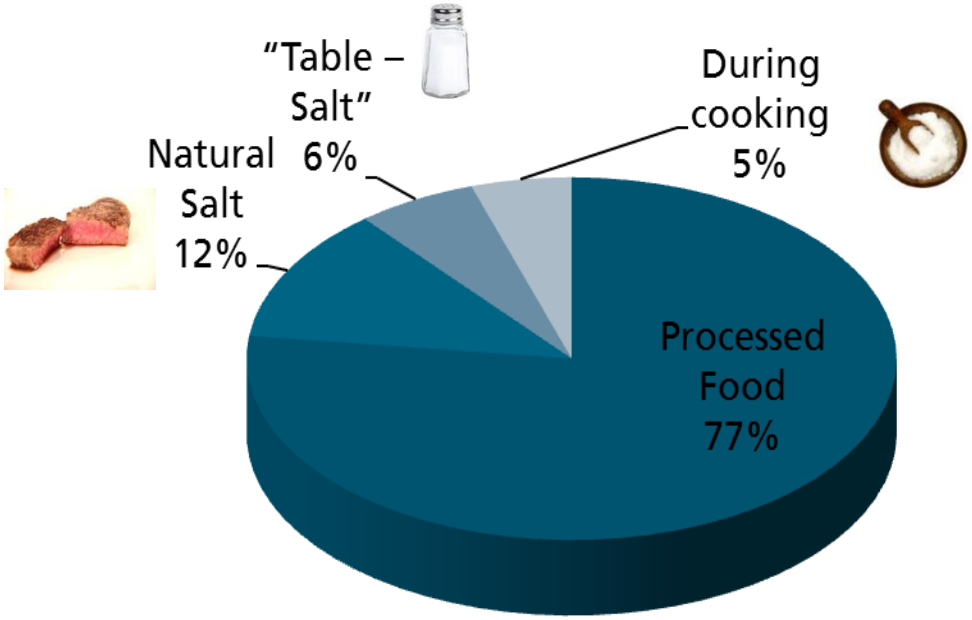
➢ Possible consequences of excessive salt intake

- increased blood pressure,
- risk of heart attack
- cardiovascular disease
- others



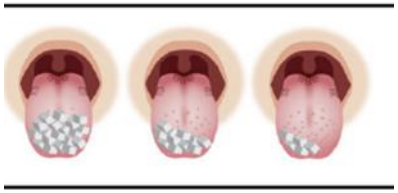
Salt Reduction

Sodium chloride / salt – Where eaten?



Salt-reduction – Strategies

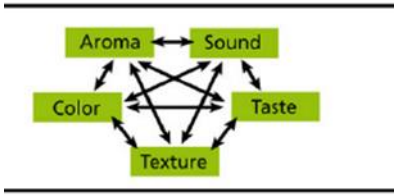
Actual strategies for salt-reduction in sausages



Step-by-step reduction

Salt-reduction with NaCl substitutes,
e.g. KCl or „not-Na^+ ions“

Salt-enhancer, e.g. Umami



Multisensorial interactions

Inhomogenous salt distrubution

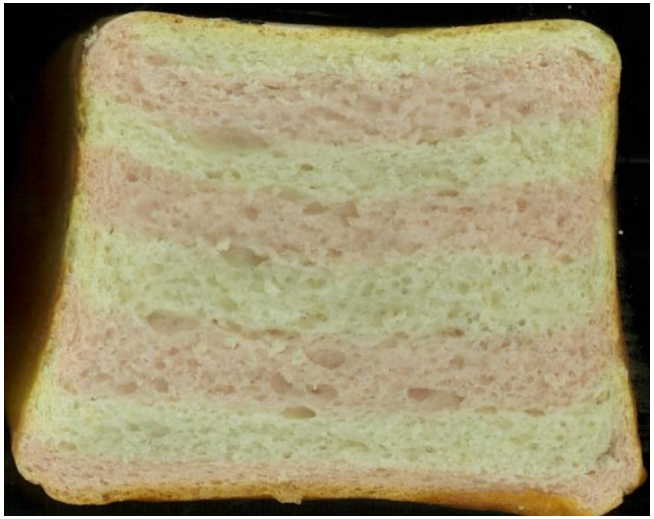
Source: Hannah Baker, Food Ingredients Conference 2011

Salt Reduction - innovative Approach

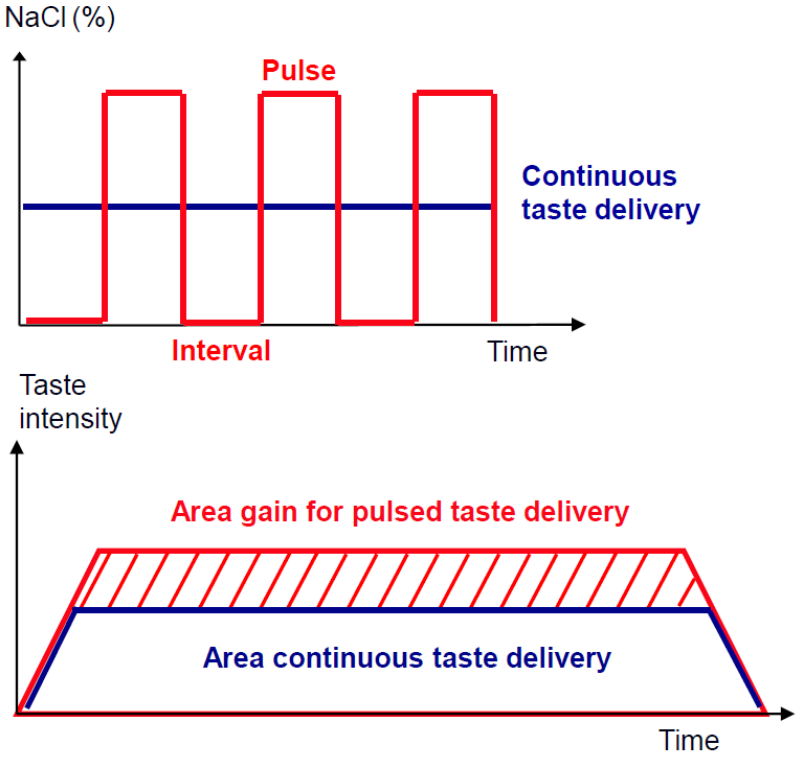
1. Inhomogenious Salt distribution:

Optimization of the salt release during chewing
Principle: Osmotic pressure + Sensory contrast

Layered batters in toast bread

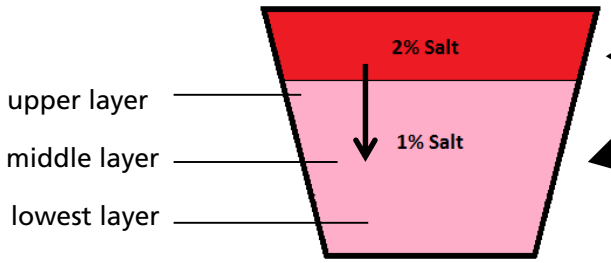


Quelle: Martijn Noort
Food Ingredients Europe Conference 2011,
Meiseman & Halpern 1973



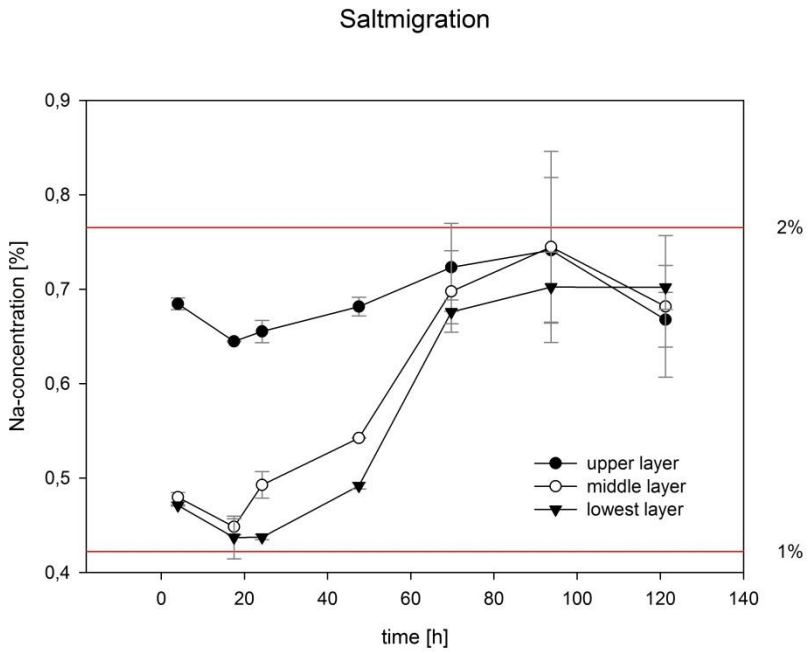
First Results – salt migration

„Island“ – Interactions:



Model:
Sausage meat with 2% of salt
Sausage meat with 1% of salt

Measurement of the sodium content with ICP-MS in 3 layers over several hours



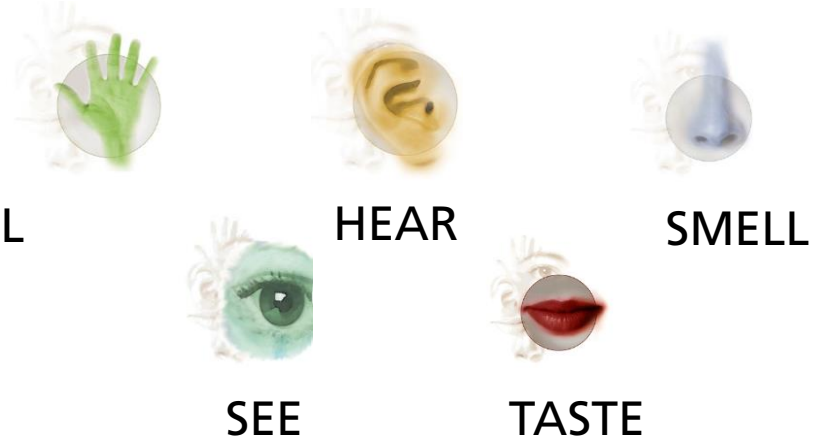
➢ Result: Equalizing sodium content between the 2 layers

Different salt contents in sausage meat will be a challenge

Salt reduction – New Approach

2. Multisensory Interaction

Interaction of basic stimuli



Two modalities are better than just one

- higher sensitivity
- higher detection rate
- faster response

Multisensory interactions in sausages:

- Incorporation of natural flavors and spices that have the potential to enhance a salty taste
- Development and identification of multisensory interactions or other sensory stimuli such as texture and color.

Salt reduction – promising ingredients

Salicornia europaea L. **(glasswort)**

- halophytic plant
- contains compounds showing antimicrobial and antioxidant properties
- contains various minerals
- very salty taste

Characteristic aroma compounds in *Salicornia europaea* L. (glasswort) and their influence on the perception of saltiness in sodium-reduced sausages
Mareike Siebert, Andrea Strube, Dominic Wimmer, Oliver Frank, Andrea Büttner, Jessica Freiherr; eingereicht 10.2017, Meatscience

Salt reduction – promising ingredients

- Similiar key aroma compounds in S. europaea and meat flavour
- can be used as a salt-enhancing tastant for sausages.
- A reduction of sausage salt content from 2% to 1.2% can be compensated by an addition of 0.75% of glasswort and those sausage products do not lead to different sensory perceptions

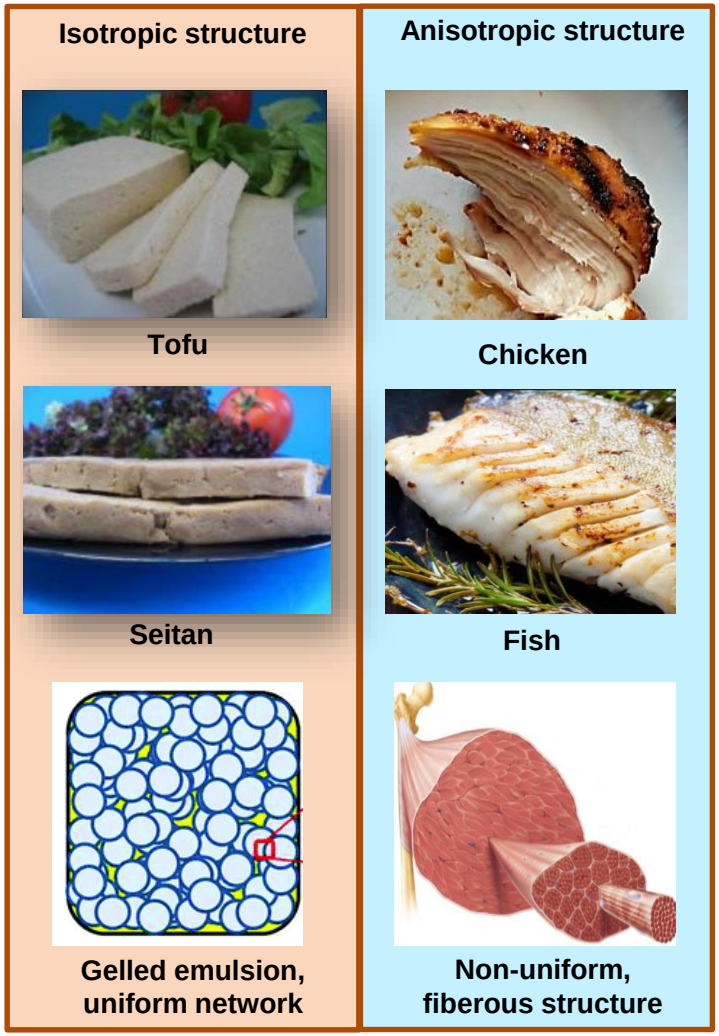
New ingredients for meat products and meat analogues

Meat alternatives

Meat substitute prototypes

Background:
- Traditional plant protein alternatives e.g. Tofu lack in meat-like appearance
- Uniform texture unlike meat or seafood texture

Goals:
- Investigate potential of the different protein ingredients (soy, wheat, pea) for their application in protein-rich meat substitutes
- Develop process for texturization of protein into intermediate textured proteins and post processing to model food products with high consumer acceptance



Source: http://images.sodahead.com/polls/000889657/meat_vs_veggies_xlarge.png

Benchmark products

Meat substitutes

- Dried/hydrated TVP

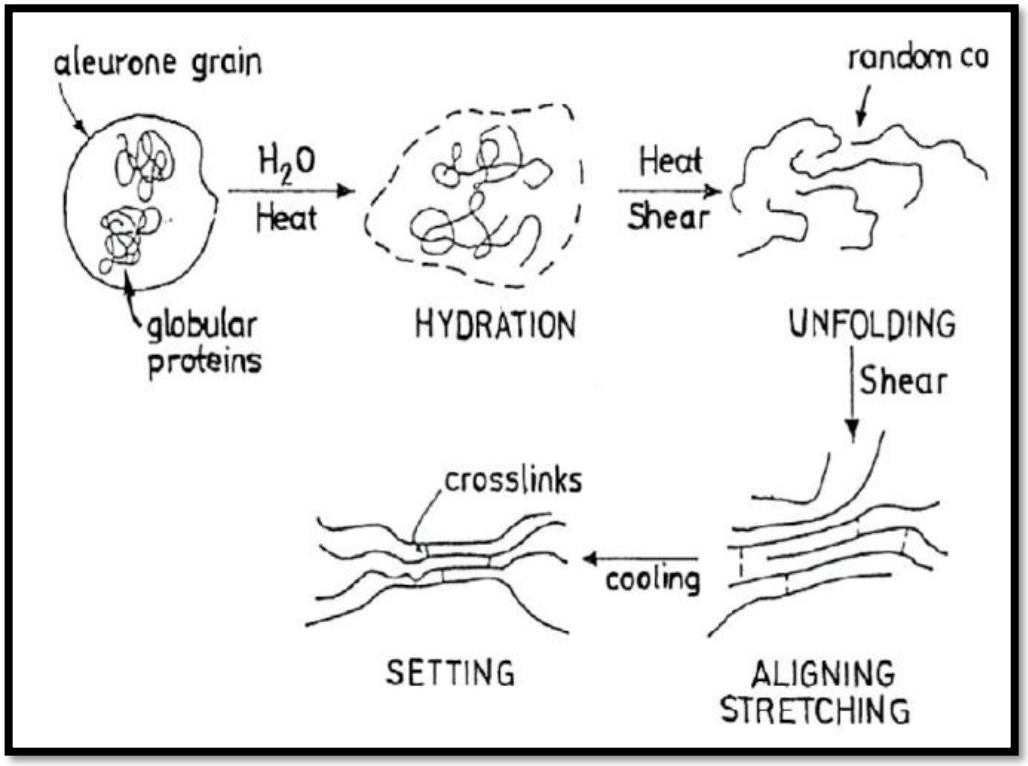
- Formed products e.g. burger patties, schnitzel, nuggets

- „Raw“ minced meat or formed burger patties

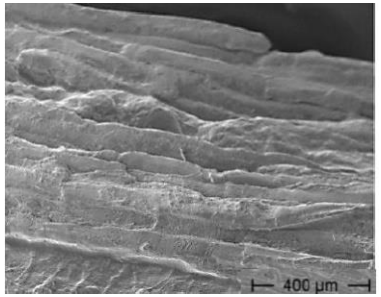
- Non-formed products e.g. strips, steaks, chunks

Which protein texturization technology?

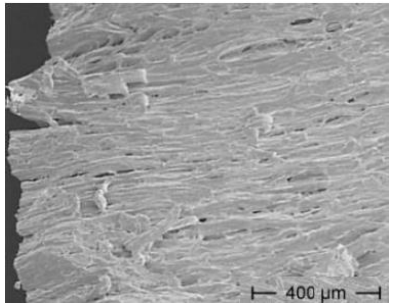
Mechanism for protein texturization



Chicken meat



Textured pea protein isolate



Joshi and Kumar 2015: Meat Analogues: Plant based alternatives to meat products

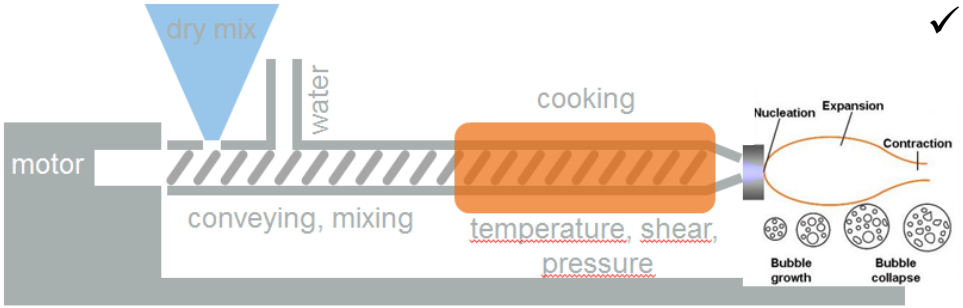
Source: Fraunhofer IVV

Protein texturization via extrusion cooking

Two processing technologies

Thermoplastic low moisture extrusion

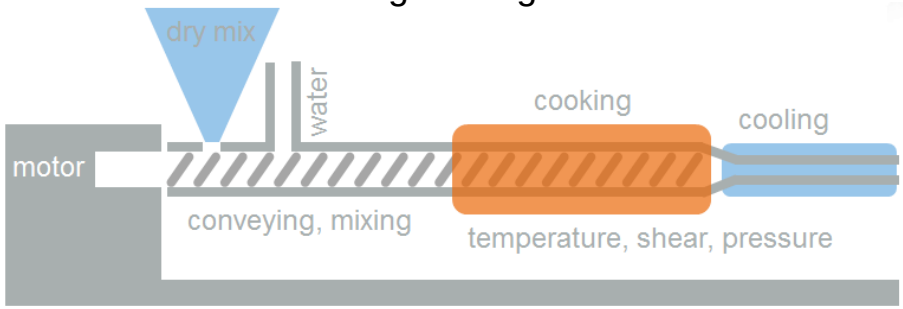
- T_m~ 150°C, moisture content 20-40% w.b.
- Texturization to porous foam-like network



- Foam-like or fibrous network
- For formed products e.g. burgers, nuggets
- ✓ Texturates used as protein ingredient to provide bite and juiciness

<u>High moisture extrusion</u>

- T_m~ 150°C, moisture content >60% w.b.
- Texturization in long cooling to fibrous network



- Compact gelled fibrous network
- For muscle-like products e.g. steak
- Elastic texture, low juicyness – not recommended for juicy burger-like products

Process steps for development of prototypes

Extrusion
- Mixing & Cooking & Texturization
- Comminution & Drying

Post-processing
- Rehydration
- Flavorization

Forming
- Gelling
- Forming

- Texturization of plant protein to intermediate texturates with foamy- or fiberous structure after drying
- Comminution, rehydration, flavorization
- Forming into burger patties, nuggets



Food extrusion know-how at Fraunhofer IVV: Meat substitute prototype products


Texturised low moisture raw Material, © Fraunhofer


Pasta-style, © Fraunhofer


Sauce mit Extrudaten aus Erbsen ©Amidori


Brötchen mit Extrudaten ©Amidori


Steak-like high moisture raw material © Fraunhofer


Stir-fried style © Fraunhofer


Tonkatsu-style © Fraunhofer

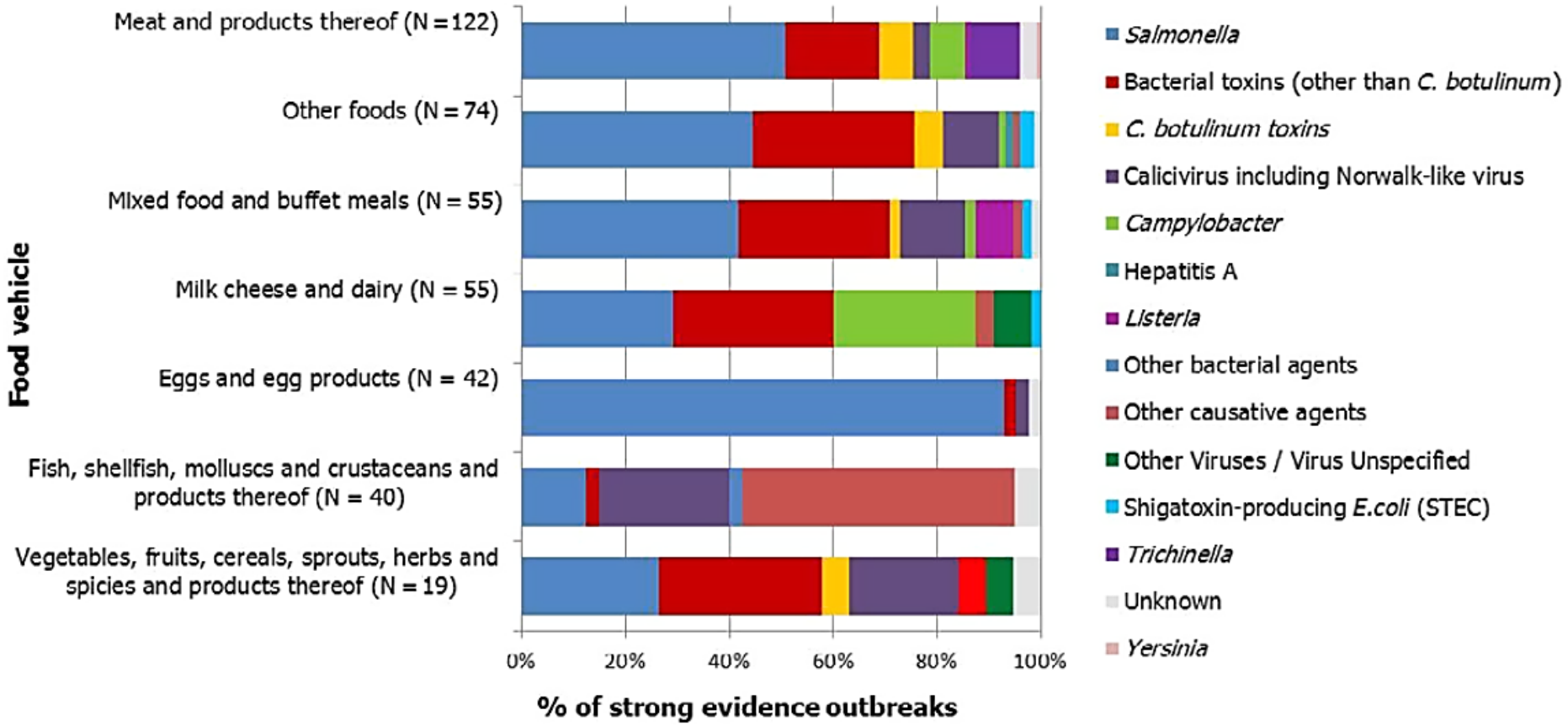

Extrudate als Pfannengericht ©Amidori

Source: Fraunhofer IVV

New ingredients for meat products and meat analogues

Plant based ingredients providing antimicrobial and / or antioxidant properties in meat products

Food borne zoonosis: outbreaks EU 2015

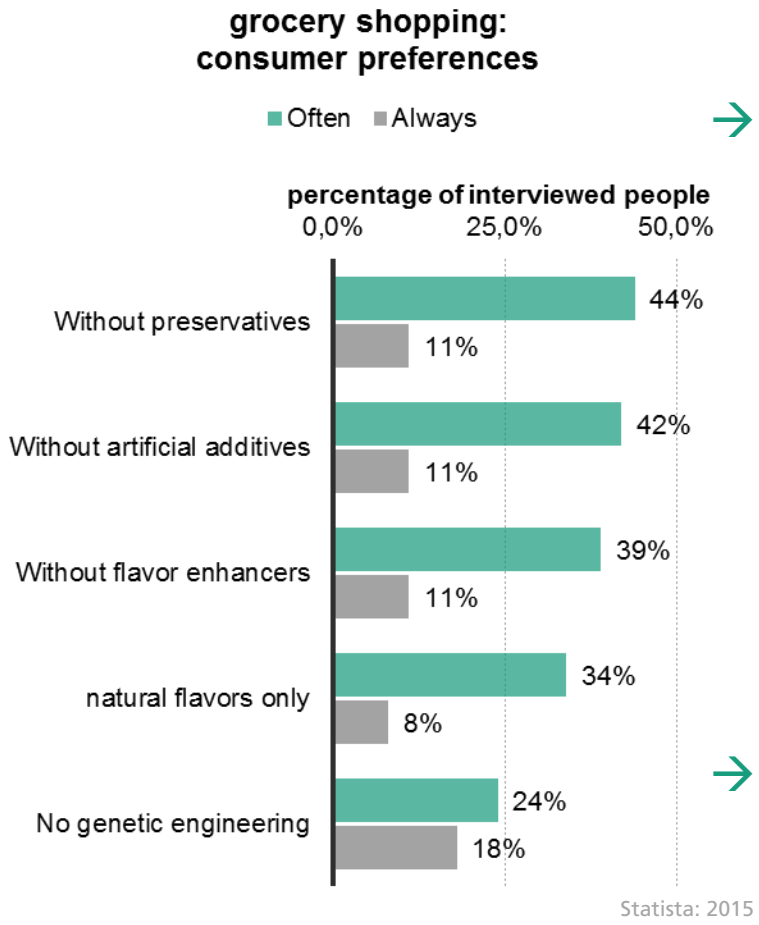


EFSA, EU summary report on zoonoses, zoonotic agents and food-borne outbreaks 2016

→ Leading causative pathogens: *Salmonella, Campylobacter*

→ Food safety remains a sensitive topic

Consumer preferences and demands concerning food:



→ **consumer preferences**

- **convenience**
- **clean labeling**
- **minimal processing:**
  - wash
  - cut
  - mix
  - pack

→ **general demands for:**

- **food safety**
- **shelf life**

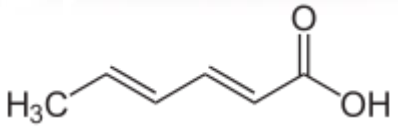
→ how to address food safety issues in regard of consumer preference?

Natural antimicrobials?

E200
E201
E202

→ **Natural food preservatives originate from**:

- **microorganisms** → Natamycin, Nisin
- **animals** → Lysozyme
- **plants** → Sorbic acid, Benzoic acid



→ traditional food preservatives also have natural origins !!

→ Consumer comprehension cannot be assumed in general

→ Easy, comprehensible labeling:

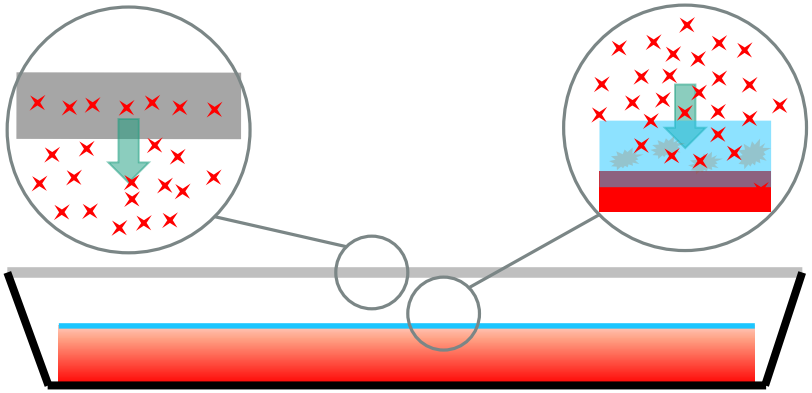
„preservative: sorbic acid“

„preservative: rosemary extract“

Antimicrobial packaging for minimally processed foods

- Antimicrobial packaging:
  - Packaging material carries preservative agent (immobilized or migrating)
  - Agent is introduced to the product's surface
- Advantage:
  - Targets surface only
  - Minimizes preservative intake
- Disadvantages/Problems
  - Physical contact
  - Uneven surfaces
  - Surface/volume ratio
  - Packaging geometry
  - Headspace

- Solution: volatile agents



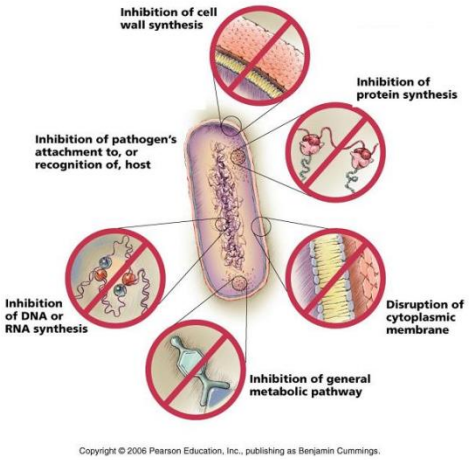
Natural antimicrobials from plants with high volatility

Phytoanticipines:

→ constituive secondary plant metabolites

→ antimicrobial activity, antioxidative activity

→ unspecific „immune system“ of the plant



Volatile Fraction:

→ essential oils

→ natural extracts free from solvents + stabilizers

→ isolated by steam-distillation

https://www.webmd.com/skin-problems-and-treatments/ss/slideshow-essential-oils

→ 3000 plant species known to produces essential oils

→ 300 essential oil varieties of industrial interest

→ Many compounds are potent aroma compounds

Functional plant extracts

Antimicrobial hop extracts – direct application

Objective:

- Natural antimicrobial agent for prolonging the shelf life (Clean labelling)

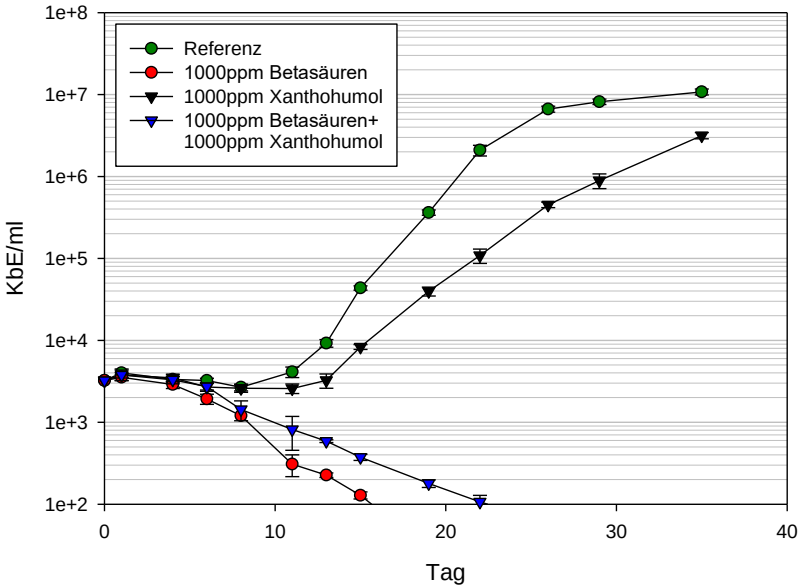
Procedure:

- Measurement of the antimicrobial effect (in vitro)
- Determination of key parameters/factors (e.g. pH value)
- Evaluation of the sensory properties (suitability) of the plant extracts
- Application tests with foods (ready-to-eat salads, diced fruit, meat marinades, pizza)

Results:

- Effective against gram+ bacteria (e.g. listeria)
- Application in marinated pork: Increased the shelf life by 2 days

Hop extracts vs *Listeria monocytogenes* (marinade)



Summary

- Demand on new innovative ingredients for improved products regarding
  - Nutritional value (reduction of salt and fat)
  - Sustainability (plant based meat alternatives, hybrid products)
  - Safety (antioxidant and antimicrobial properties), Shelf life

- We an give you a tailored solution!

Thank you!

Christian Zacherl

Business Development Manager Food
christian.zacherl@ivv.fraunhofer.de

www.ivv.fraunhofer.de

Thanks to:

- Daniela Sussmann
- Dominic Wimmer
- Julian Thielmann
- Peter Eisner
- Raffael Osen