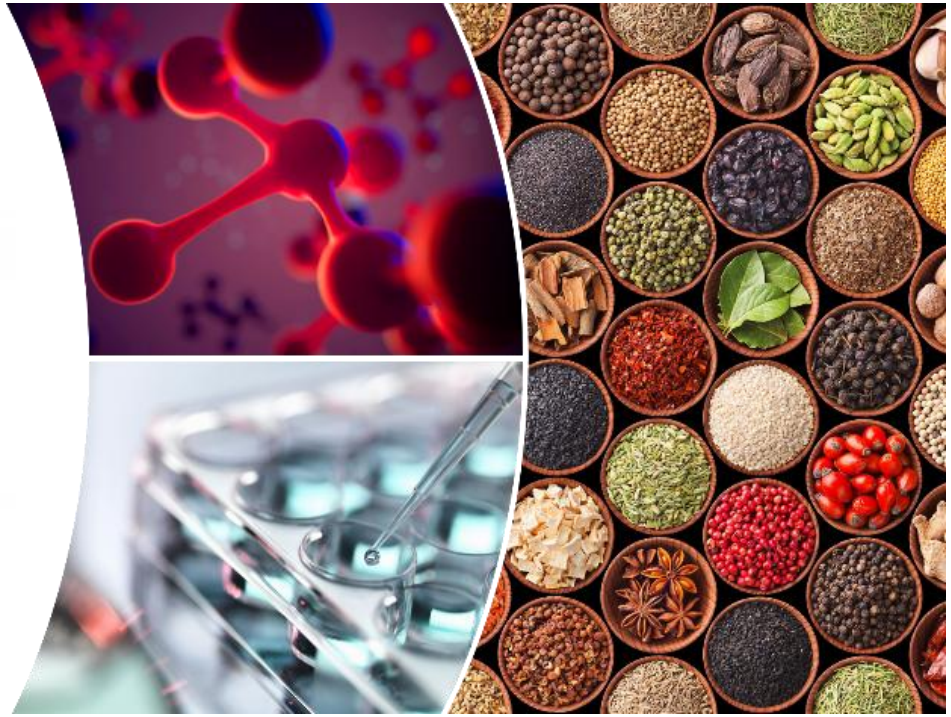


Food Science
&
Technology

Outline

- Defining food science and technology
- Examples of the main fields in food science & technology
- Case study: Designing a low digestible carbohydrate ingredient
- Q&A

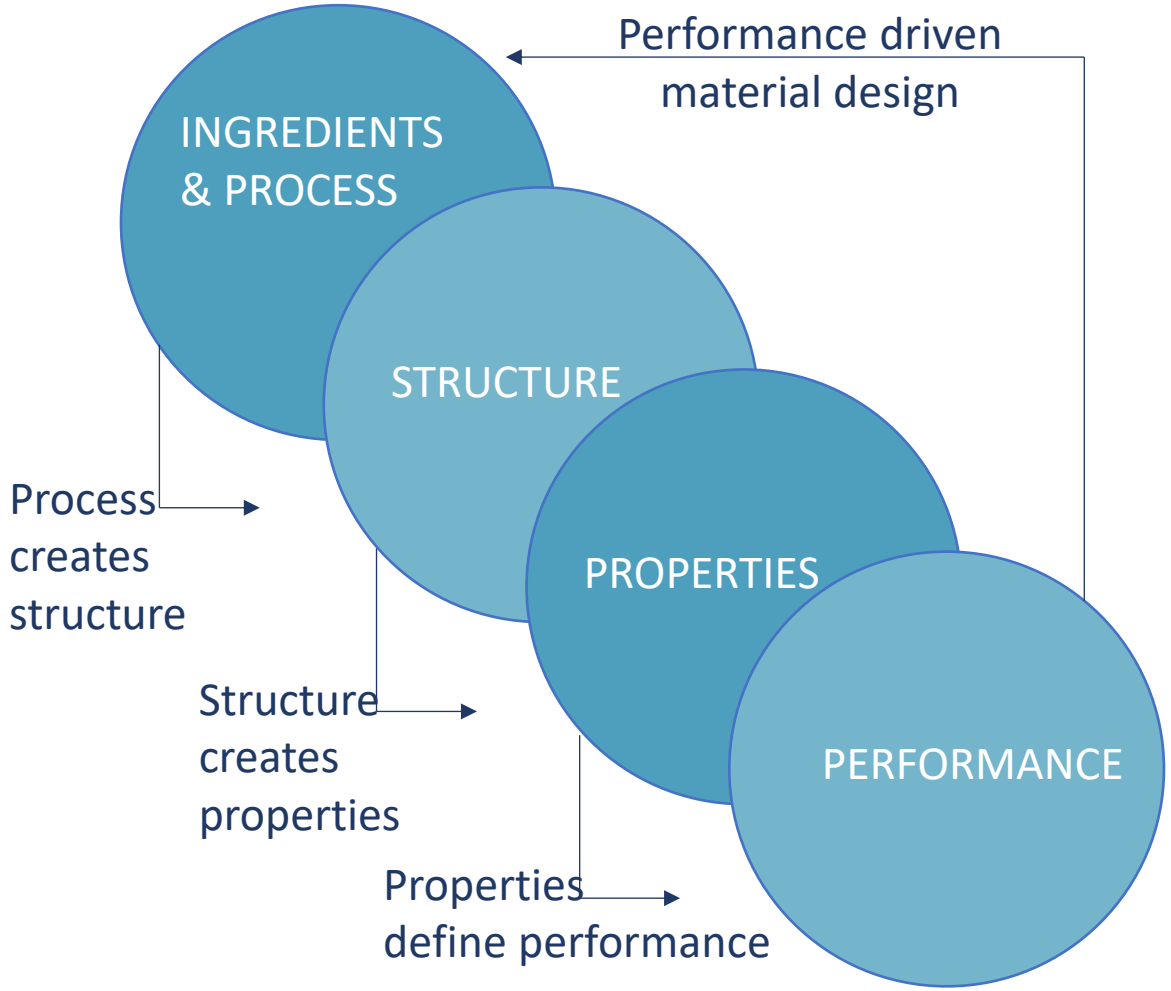
Food product break down

Ingredients
Processing
Structures
Properties

} **PRODUCT PERFORMANCE**

- A formulation and process for a material will determine its structure
- The structure and the process determine the properties of the material
- The properties determine the overall performance of the material

- The process-structure-properties relationship may be altered by an intelligent selection of the composition of raw materials and processing parameters



EPFL

Defining food science and technology

- **Food Science** is the discipline in which biology, physical sciences, and engineering are used to study the nature of foods, the causes of their deterioration, and the principles underlying food processing.
- **Food Technology** is the application of food science to the selection, preservation, processing, packaging, distribution, and use of safe, nutritious, and wholesome food.

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Primary areas in the field

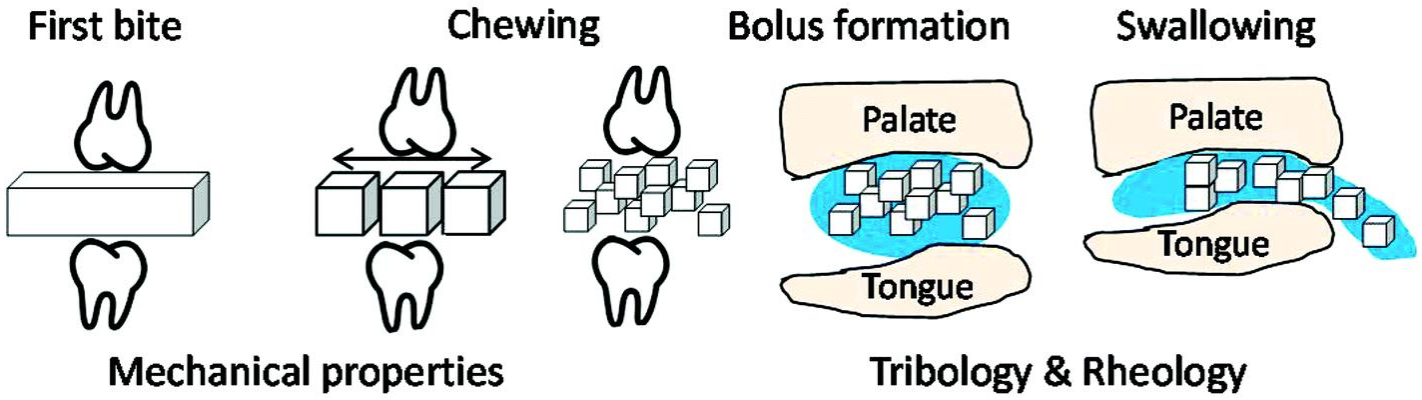
- Sensory science
- Food microbiology, chemistry & physics
- Nutrition
- Food toxicology
- Food safety
- Food preservation
- Sustainable food manufacturing
- Product design and development

- Think about your favorite meal, what about it do you enjoy?

Applying sensory science to identify preference drivers

- Sensory analysis examines the properties (texture, flavor, taste, appearance, smell, etc.) of a product or food through the senses (sight, smell, taste, touch and hearing) of the panelists.

- Oral processing is critical as it plays a role in decisions related to food choices and whether a food gets accepted or rejected.



Foods. 2021 Mar; 10(3): 582, Annu Rev Food Sci Technol. 2013, Vol 4, pg 237.

Applying sensory science to identify preference drivers

➢ *Sensory drivers of liking – taste preferences in plant-based milks*

Aim of study

- Identify sensory drivers of liking of plant-based milk coffees
- Oat, soy, almond & coconut milks tested in coffee beverage

Results:

→ Smooth, thick & "milky" attributes were top preference drivers

→ Oat & soy = most liked dairy milk in coffee

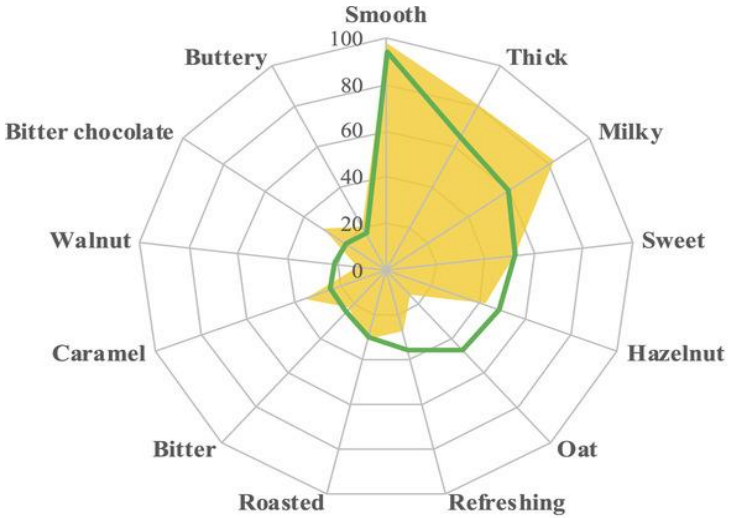
→ Neutral flavors, fibers & proteins to provide thickness

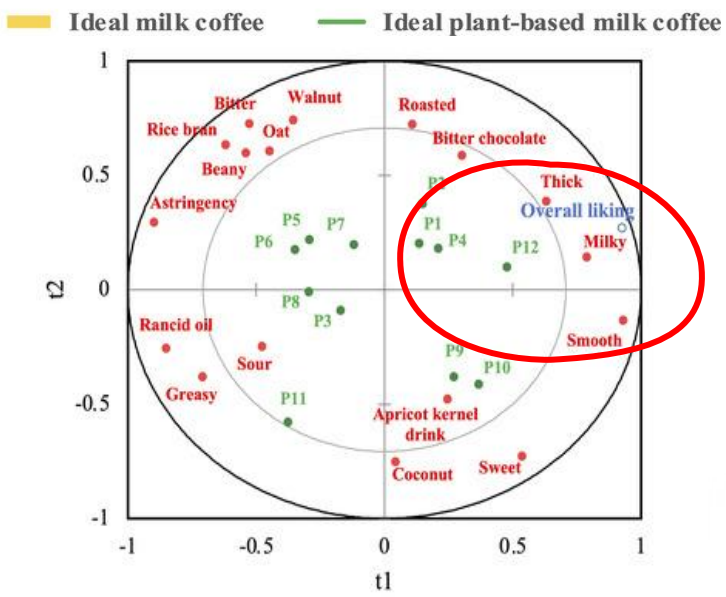
→ Almond & coconut = resemble flavored coffee

→ Intense flavors

Main application of this knowledge:

Guiding the development of plant-based products



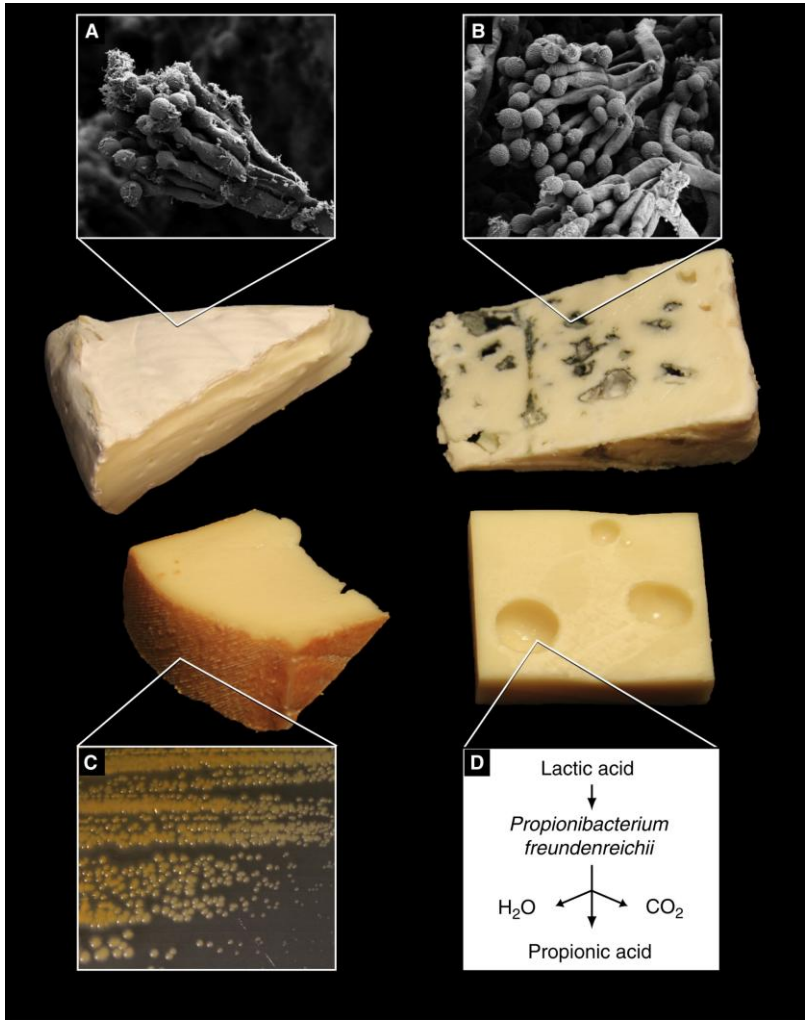


Chung et al. 2022. J Food Sci

Creating taste & texture through fermentation (food microbiology)

Food microbiology is **the study of the microorganisms that inhabit, create, or contaminate food.**

- This includes the study of microorganisms causing food spoilage & pathogens that may cause disease (especially if food is improperly cooked or stored);
- And microbes used to produce fermented foods such as cheese, beer, yogurt.



Creating taste & texture through fermentation (food microbiology)

➢ *Flavor generation through targeted fermentation*

Aim of study

- To achieve controlled coffee flavour biotransformation with a lactic acid bacteria with and without 0.5% w/w glucose supplementation.

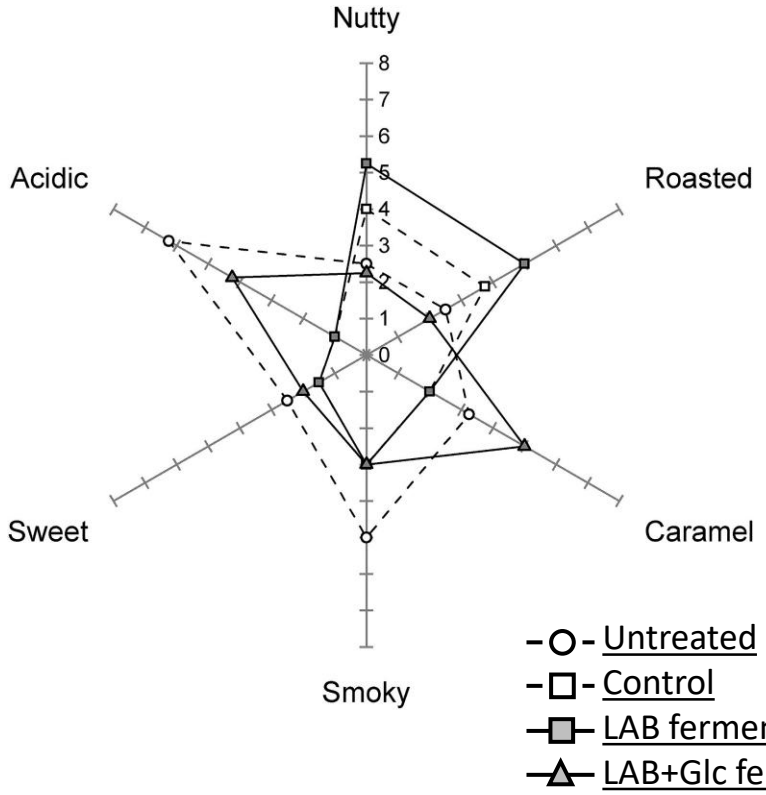
Results:

→ LAB + glucose fermentation modulated flavour of the roasted coffee.

→ LAB+ Glc fermentation = roasted coffee with an enhanced caramel aroma & preserved acidity and sweetness.

→ LAB fermentation alone = roasted coffee with elevated nutty notes.

→ smokiness in the untreated coffee was reduced



Main application of this knowledge:

Nespresso Origins
La cumplida refinada

Wang et al., 2020. LWT, Vol 20, pg 108930

EPFL

- Do you consume fermented products?

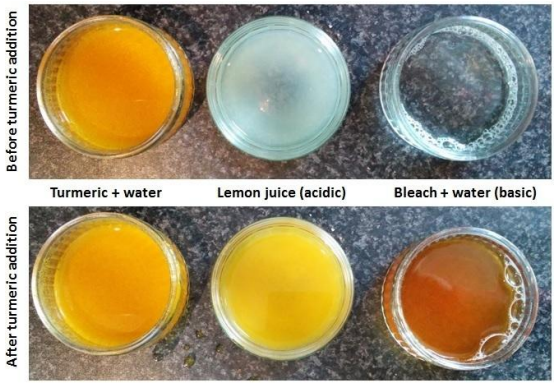
- Do you make fermented products at home? How?

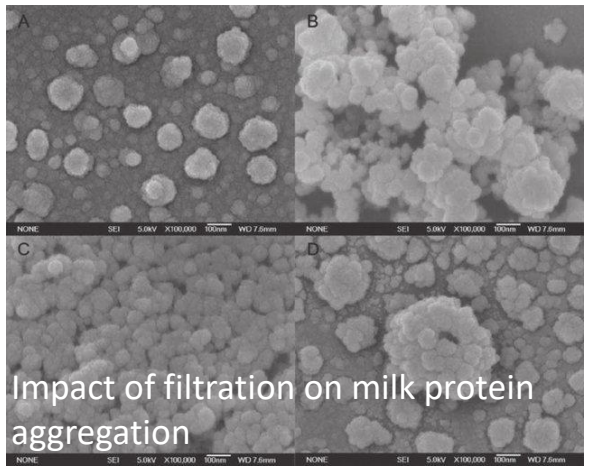
Creating taste & texture by modulating physical-chemistry of food

Food chemistry focuses on the changes in the composition and chemical, physical, and functional properties of foods and food products during their different processing stages and storage periods.

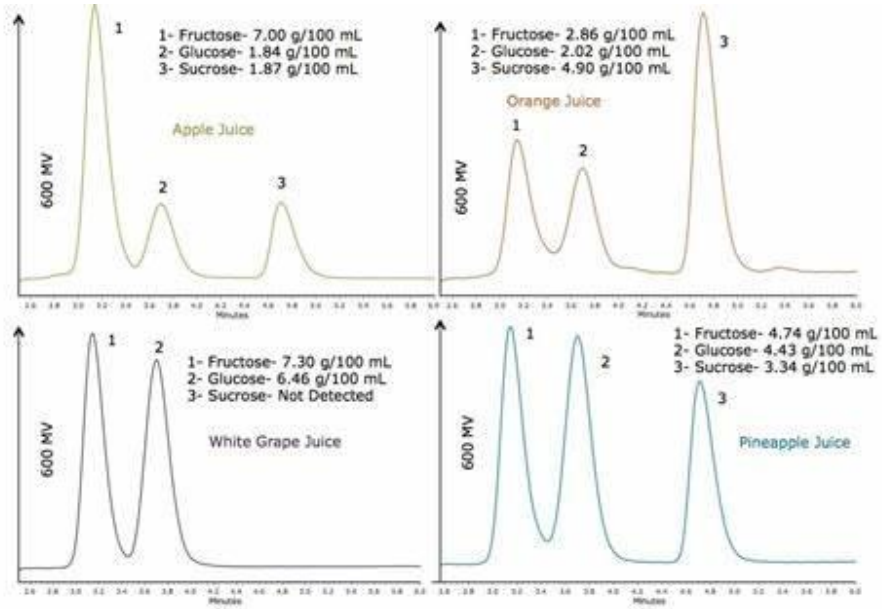
It is the study of food components, such as proteins, carbohydrates, fats, and water. In addition, food chemistry assesses the reactions these components go through during food processing, preservation and digestion in the human body.

Color change of phenolic compounds according to pH





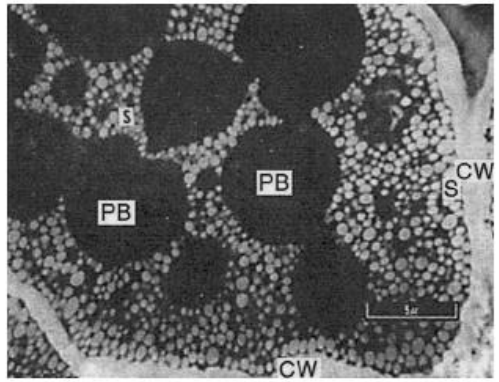
Impact of filtration on milk protein aggregation



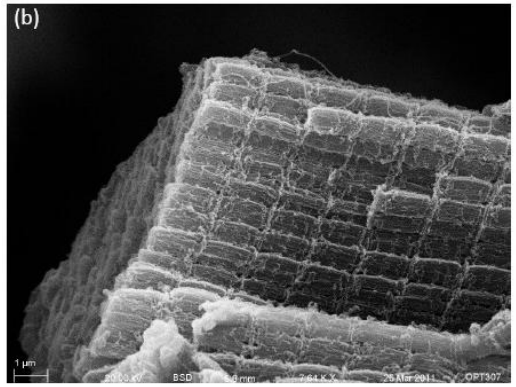
Sugars profile in fruit juices by high-performance anion exchange chromatography.

Creating taste & texture by modulating physical-chemistry of food

➢ *Texturization of plant proteins*



Electron micrograph of soybean cells.
J Am Oil Chem Soc (2014) 91:363–384



SEM BSD image of beef muscle fiber.
Structural Colored Meat (rochester.edu)

Factors to consider:

- Protein:water interactions
- Flow properties of proteins under different pressures and temperature.
- Protein chemistry to design combinations to optimize texture, sensory and cost

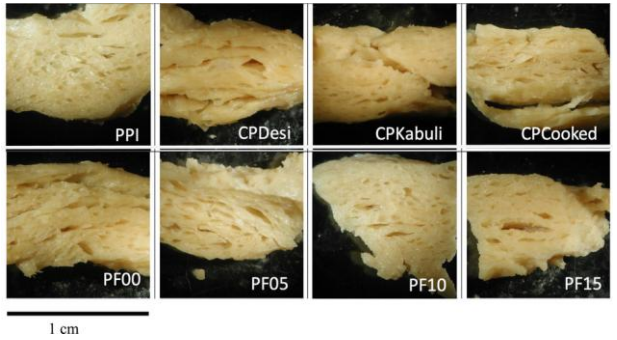
Use of legume flours and fiber for tailoring structure and texture of pea protein-based extruded meat alternatives (Webb t al., 2023. J Food Sci. Vol 88, pg 57-71))

Aim of study

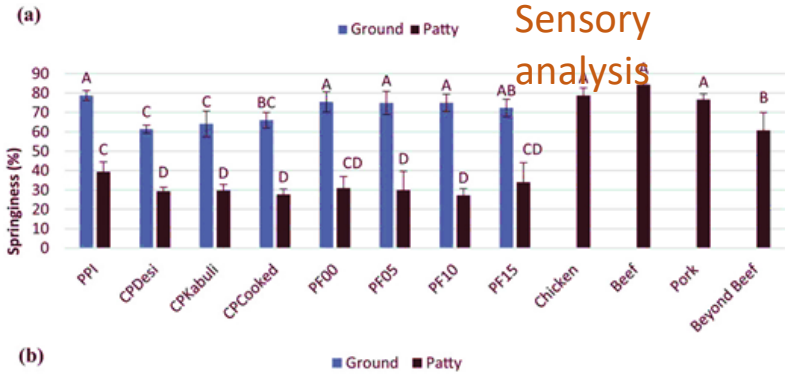
- Impact of ingredient combinations on final textures
- Pea protein, pea fiber and/or pea starch

Results

→ Fiber or starch interfere with protein interactions
→ +Fiber = porous
→ +Starch= dense



Sensory analysis

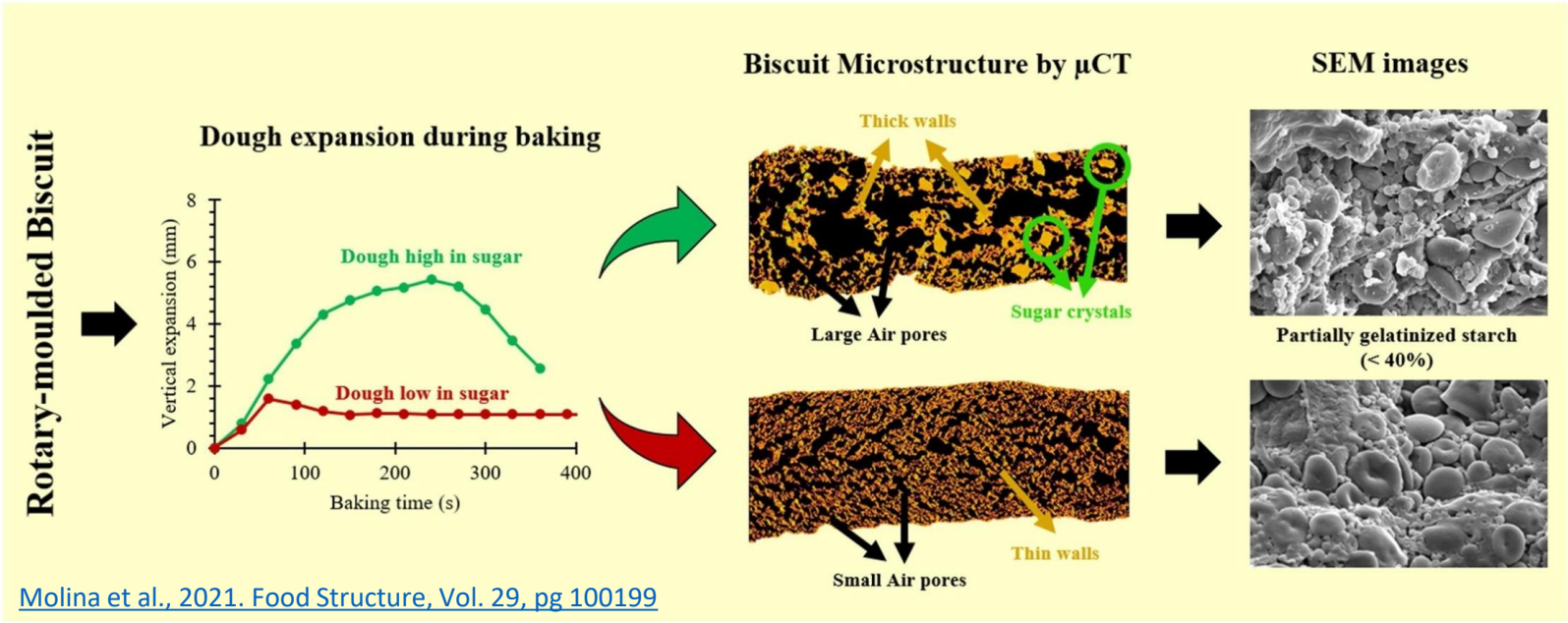


Creating taste & texture by modulating physical-chemistry of food

➢ *Reducing sugar in bakery products*

Role of white sugar in foods

→ Sweetener
→ Plasticizer
→ Preservation by reducing water activity
→ Texture generation
→ Color & aroma through maillard reaction or caramelization



Molina et al., 2021. Food Structure, Vol. 29, pg 100199

Results:

→ Sugar defines the viscoelatic properties of biscuit dough
→ Sugar modulates water migration among the dough components
→ Lower sugar = denser structure & higher starch gelatinization = harder, less crunchy texture

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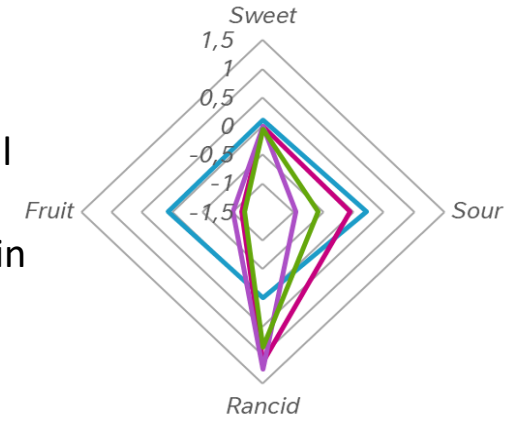
Creating taste & texture by modulating physical-chemistry of food

➢ *Reducing negative sensory impact from iron fortification of foods*

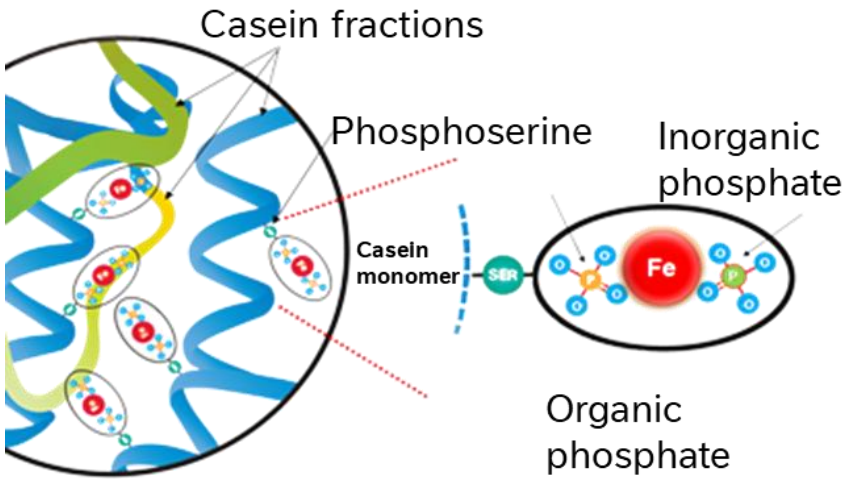
- Highly soluble forms of iron = bioavailable & reactive within food.
- The interactions between iron and macronutrients in foods → oxidation that results in off-flavors, adverse color changes.

Impact on color of banana purée

Impact on oil rancidity & off-flavours in yogurt



[Iron bioavailability of a casein-based iron fortificant compared with that of ferrous sulfate in whole milk: a randomized trial with a crossover design in adult women | The American Journal of Clinical Nutrition | Oxford Academic (oup.com)]



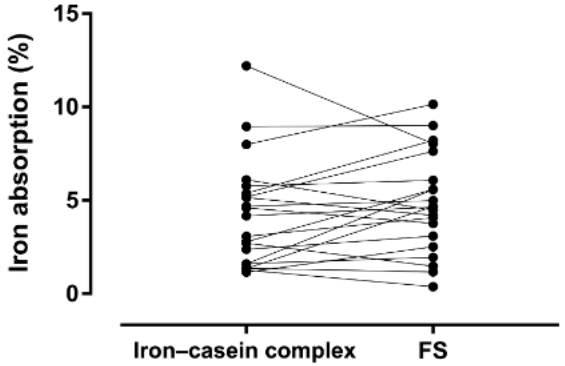


FIGURE 2 Paired values of fractional iron absorption for young nonanemic women consuming milk with an iron–casein complex or FS. There was no statistically significant difference between fractional iron absorption of the iron–casein complex and FS within subjects (paired t test $t = -1.38$, Df = 20, $P = 0.18$). FS, ferrous sulfate.

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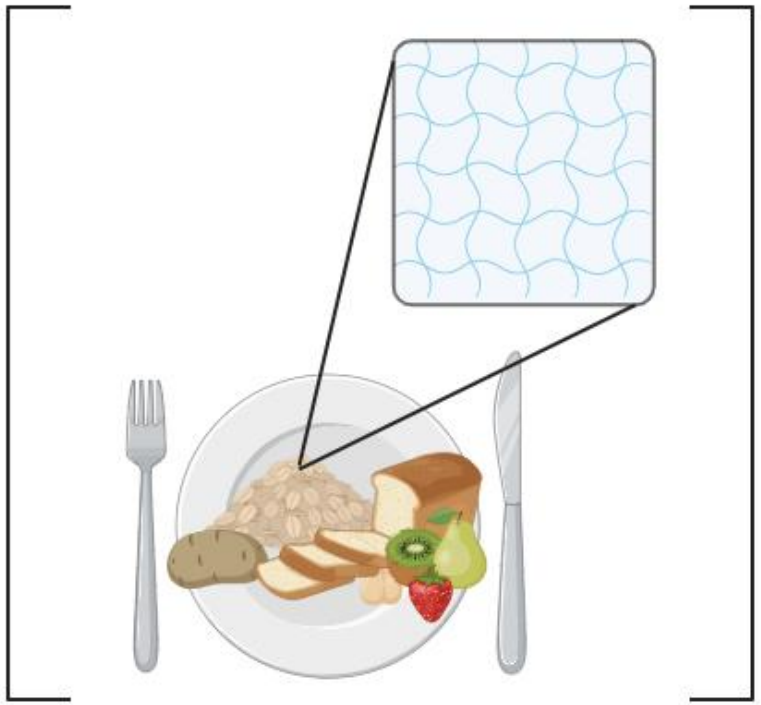
Case Study: Taylor modification of carbohydrates to improve nutritional value

Taylor modification of carbohydrates to improve nutritional value

context



Factors modulating Glycemic Response (GR):

Starch digestibility (Fast vs. slow)

Resistant starch

Indigestible carbohydrates

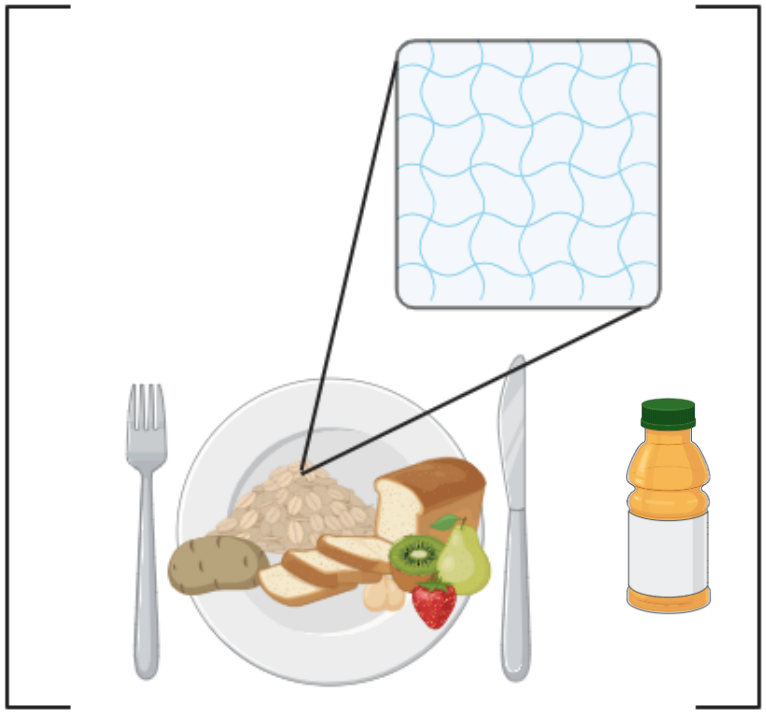
Food matrix

Glucose syrups and maltodextrins

EPFL

Taylor modification of carbohydrates to improve nutritional value

context

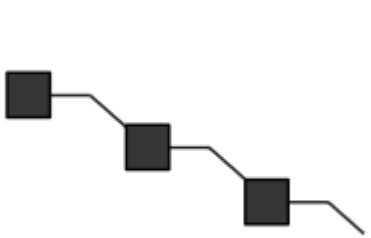


Factors modulating Glycemic Response (GR):

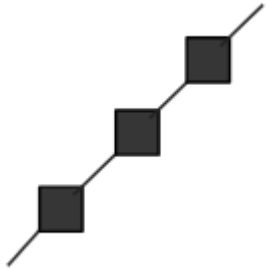
Starch digestibility (Fast vs. slow)

Resistant starch	→	Thermal instability
Indigestible carbohydrates	→	Sensory/label
Food matrix	→	Low complexity
Glucose syrups and maltodextrins	→	Fast digestion

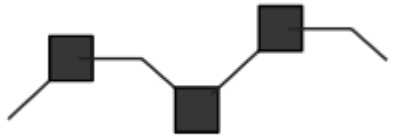
Taylor modification of carbohydrates- α-glucans



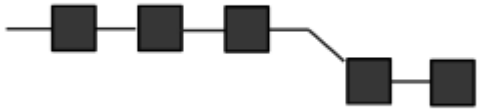
Dextran



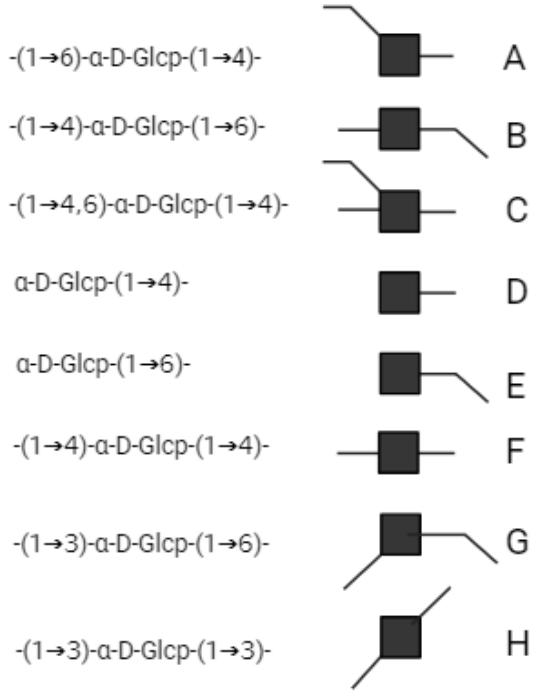
Mutan



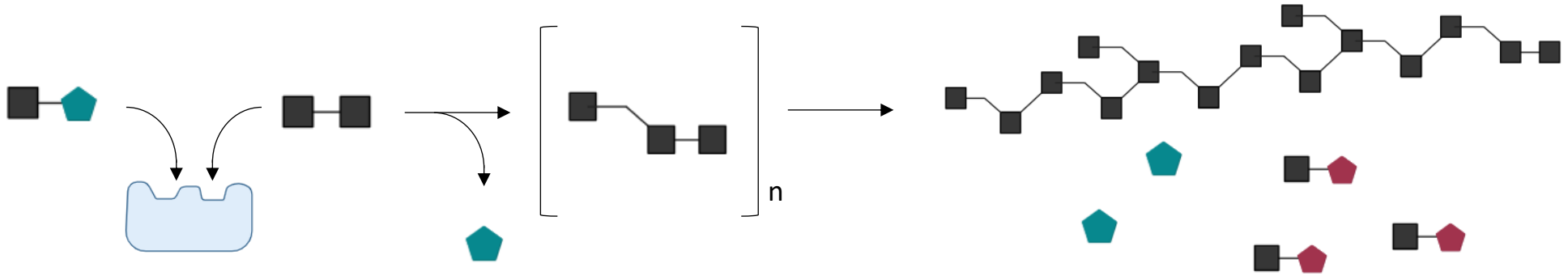
Alternan



Reuteran



Taylor modification of carbohydrates – enzymatic approach



D-Glc*p* D-Fru*f* Maltose Sucrose Leucrose Alternansucrase (*L.mesenteroides*)

DOI: 10.1016/j.carpta.2022.100256

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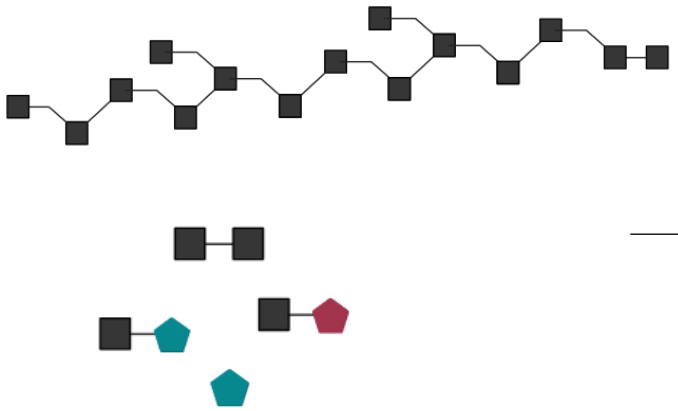
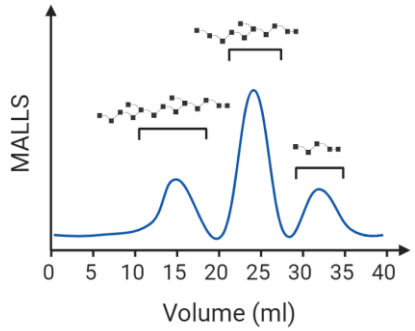
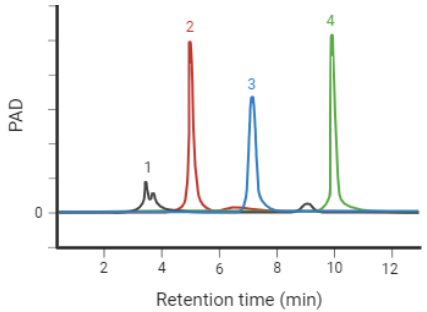
Taylor modification of carbohydrates - chemical characterization

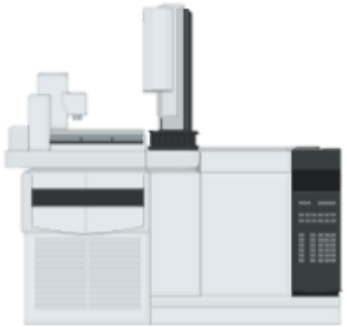


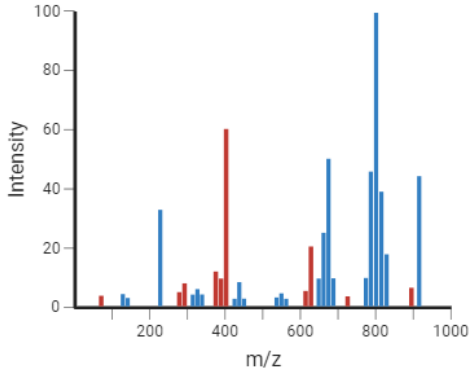


Molecular weight distribution



Sugars profiling





Linkage type analysis

D-Glc*p*

D-Fru*f*

Maltose

Sucrose

Leucrose

DOI: 10.1016/j.carpta.2022.100256, Artwork created with BioRender

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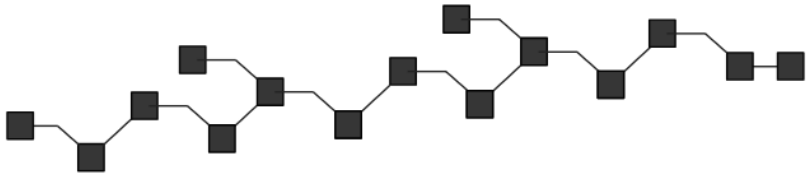
Taylor modification of carbohydrates- Chemical characterization



	AS10	AS15	MD
Degree of polymerization	12.4±0.2	15.6±0.3	3.0
Glucose [%DM]	0	0	15.4
Fructose [%DM]	0.9±0.0	2.2±0.4	0
Sucrose [%DM]	0	0	0
Leucrose [%DM]	10.6±0.5	7.6±0.2	0
Isomaltose [%DM]	0	0	0.4
Maltose [%DM]	0	0	11.5
Alternan saccahrides [%DM]	84.3±1.6	87.0±0.9	n.d.
α-D-Glcp-(1→1)-α-D-Glcp [Mol%]	31.5	29.3	n.d.
α-D-Glcp-(1→3)-α-D-Glcp [Mol%]	15.2	16.8	n.d.
α-D-Glcp-(1→6)-α-D-Glcp [Mol%]	44.1	44.3	n.d.
α-D-Glcp-(1→4)-α-D-Glcp [Mol%]	6.8	5	n.d.

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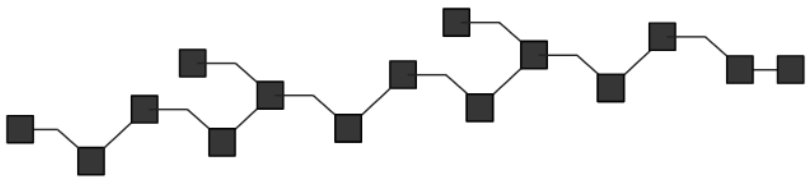
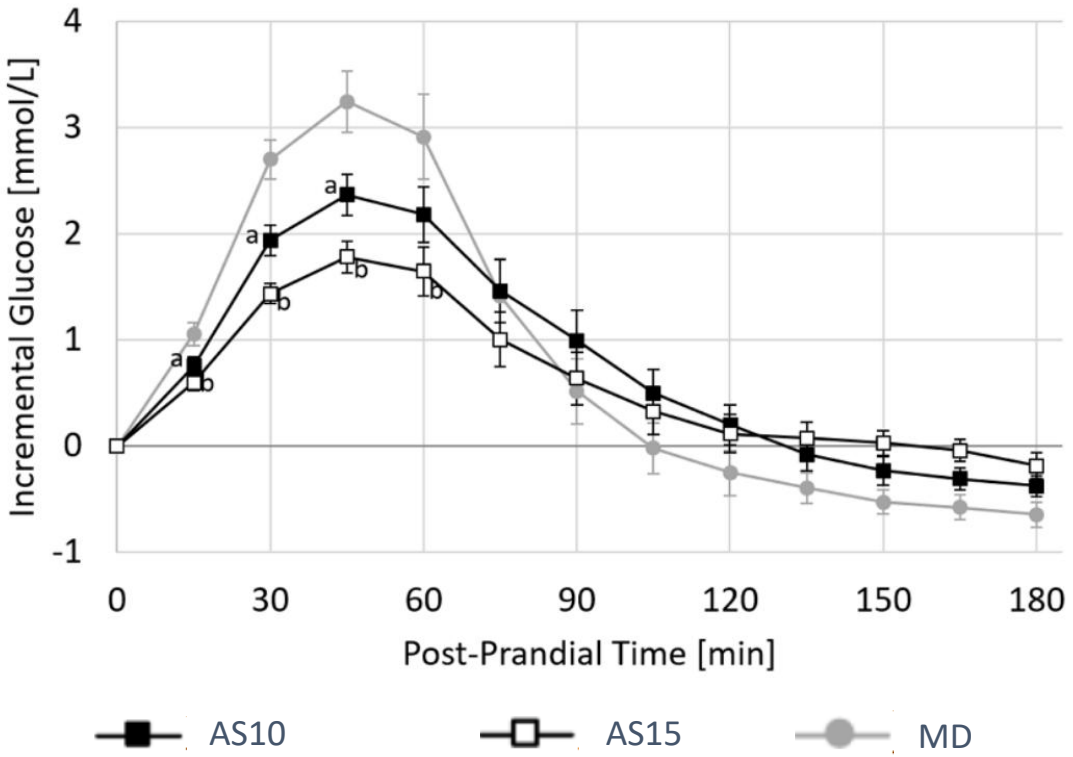
Taylor modification of carbohydrates to improve nutritional value





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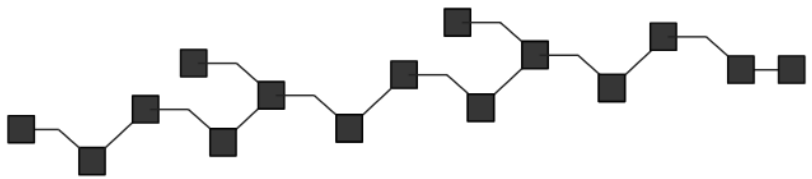
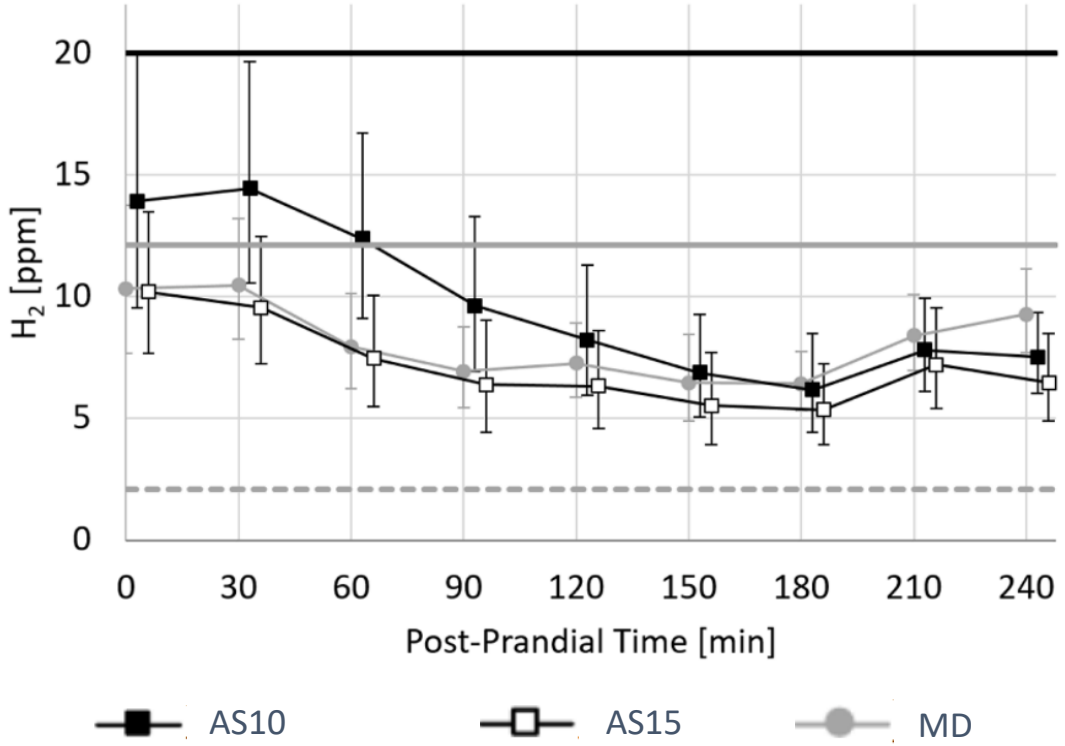
Taylor modification of carbohydrates to improve nutritional value





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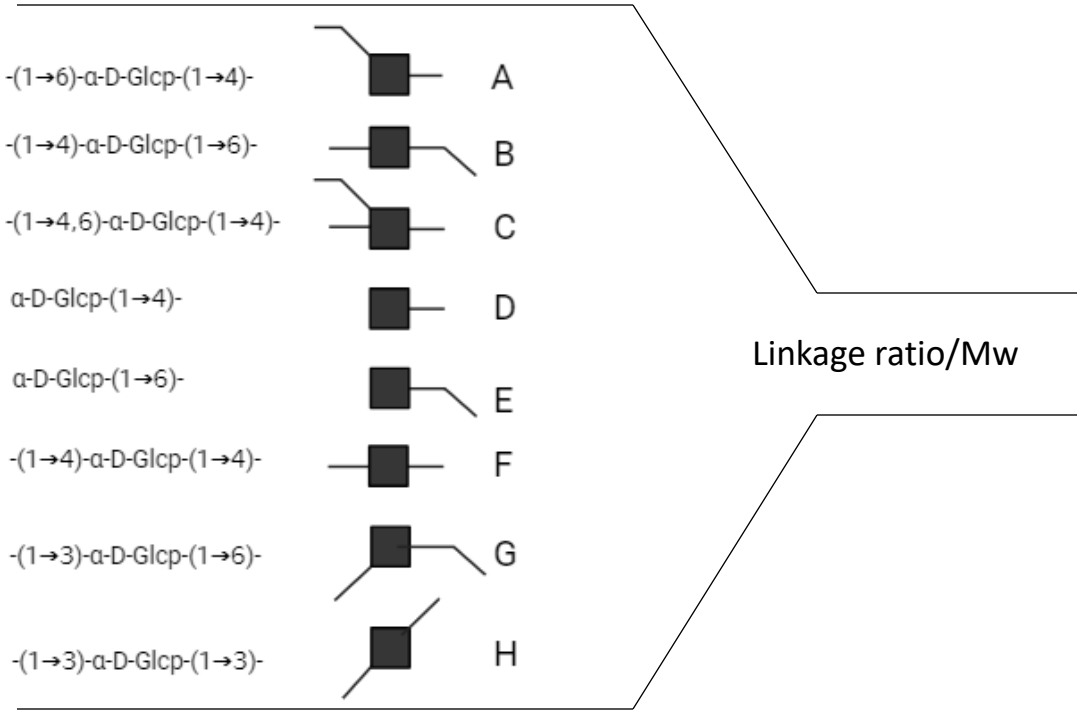
Taylor modification of carbohydrates to improve nutritional value

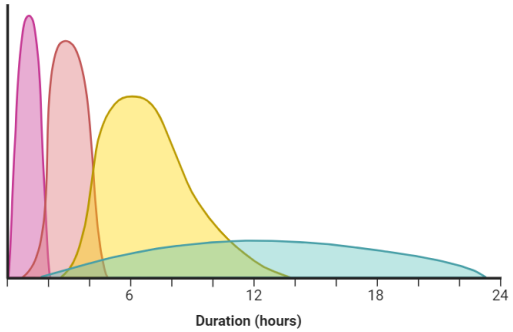


Linkage ratio/Mw

Optimal physical properties

Solubility
Viscosity
Sensory

Optimal digestibility → GR



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Take home messages

- Food science & technology is a multidisciplinary domain.
- Consumer preferences & drivers for liking are key in the development of food products & technologies
- In depth understanding of the structure function relationhips between food components helps determine taste & texture properties
- Food science & technology research is required for the development of nutritious food products that also meet consumer expectations for taste & texture.