Food reformulation: beyond less sugar

Martijn Noort, Wageningen Food & Biobased Research

✉martijn.noort@wur.nl

Futur du pain, pains du futur et autres aliments céréaliers

07 February 2019, Paris

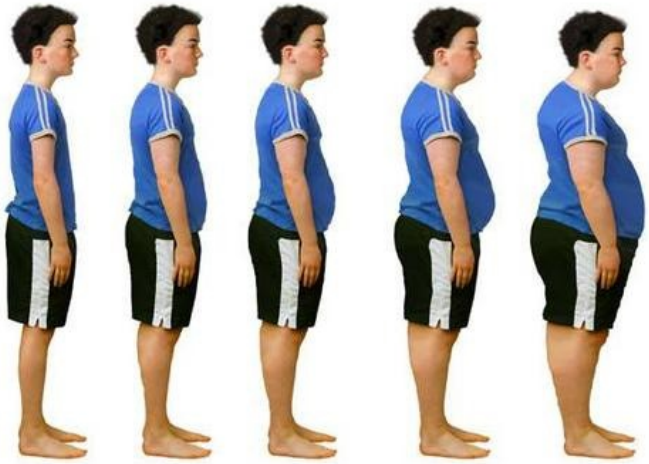
WAGENINGEN
UNIVERSITY & RESEARCH

100years
1918 — 2018

Health, lifestyle, nutrition

- Poor diet and lack of physical activity are major risk factors for non-communicable diseases.
- Up to 80% of major CVDs, and over 33% of cancers, could be prevented by eliminating shared risk factors, including tobacco use, unhealthy diet, physical inactivity and excess alcohol consumption.
- This emphasizes the importance of changing lifestyle.

→ Availability of high quality food with high nutritional quality.



WAGENINGEN
UNIVERSITY & RESEARCH

100years
1918 — 2018

Sugar: the perfect sweetener (?)

- **TASTE**
  - Sweetness
  - Aftertaste
  - Taste enhancer/masking

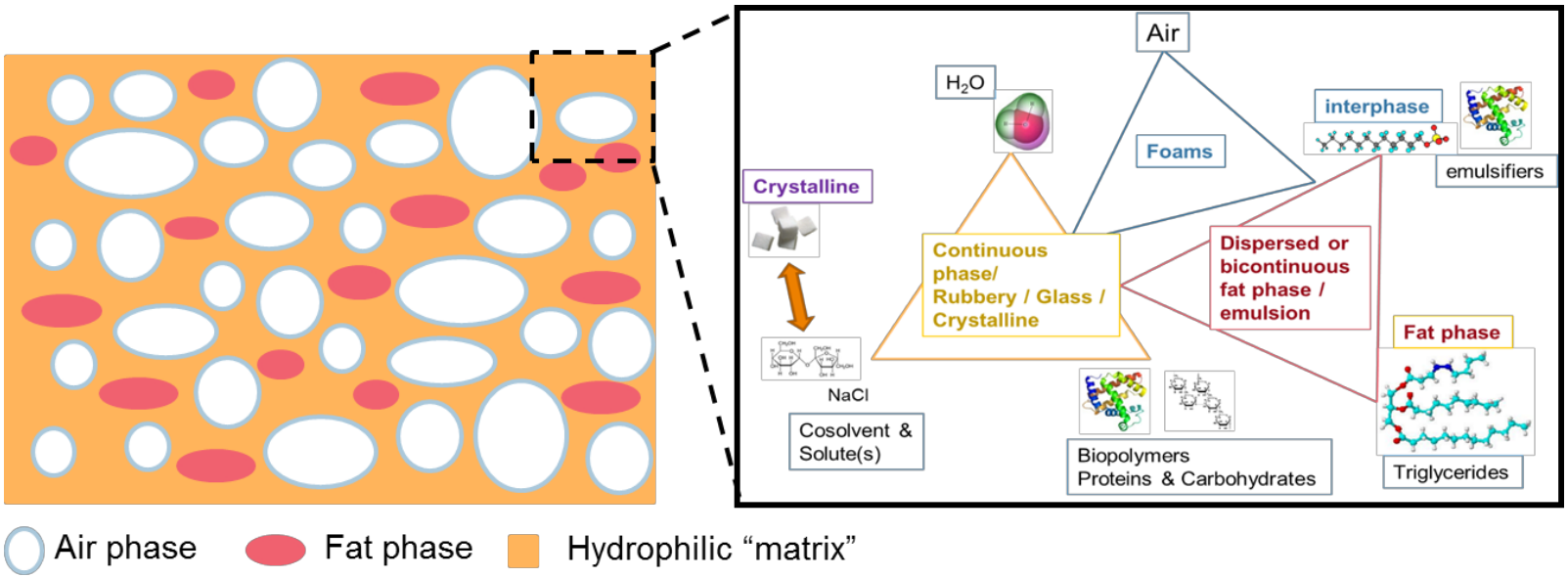
- **HEALTH**
  - Caloric value
  - Caries

Sugar: a multi-functional ingredient

- **PRESERVATIVE** via a_w
- **TASTE**
  - Sweetness
  - Aftertaste
  - Taste enhancer/masking
  - Aroma → via Maillard reactions and caramelisation
- **APPEARANCE**
  - Colour → via Maillard reactions and caramelisation
- **TEXTURE** (via structure, physical state and interactions)
  - Crystal/amorphous state
  - Network/structure formation (biopolymers-sugar interaction)
  - Filler
  - Sintered sugar network
  - Freezing point/ice crystals
- **HEALTH**
  - Caloric value
  - Caries
  - Tooth protection (polyols)
  - Laxation
  - Digestive health (soluble fibers)

Food reformulation and food structure

- Food structure largely controls sensory perception
- Understanding food structuring process allows to design better quality food



$$Rheology, Texture = \{ G/E{\downarrow}matrix\ , \Phi{\downarrow}air\ , \Phi{\downarrow}fat, G/E_{fat} \}$$

Renzetti & Jurgens, 2016. Current Opinion in Food Science 2016, 9:117–125

Reformulation in bakery products

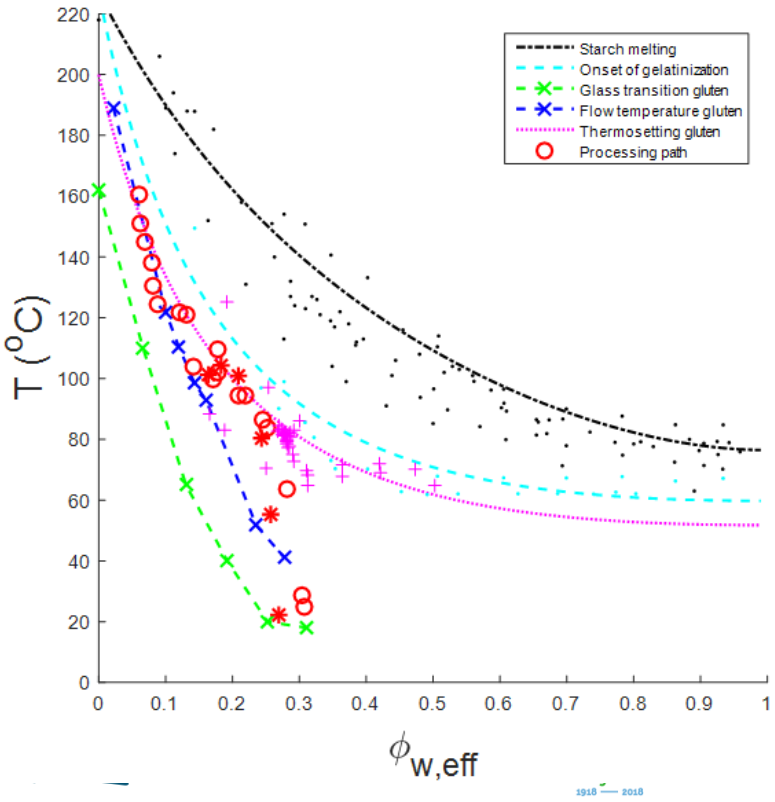
- In bakery products, impact of sugars is on:

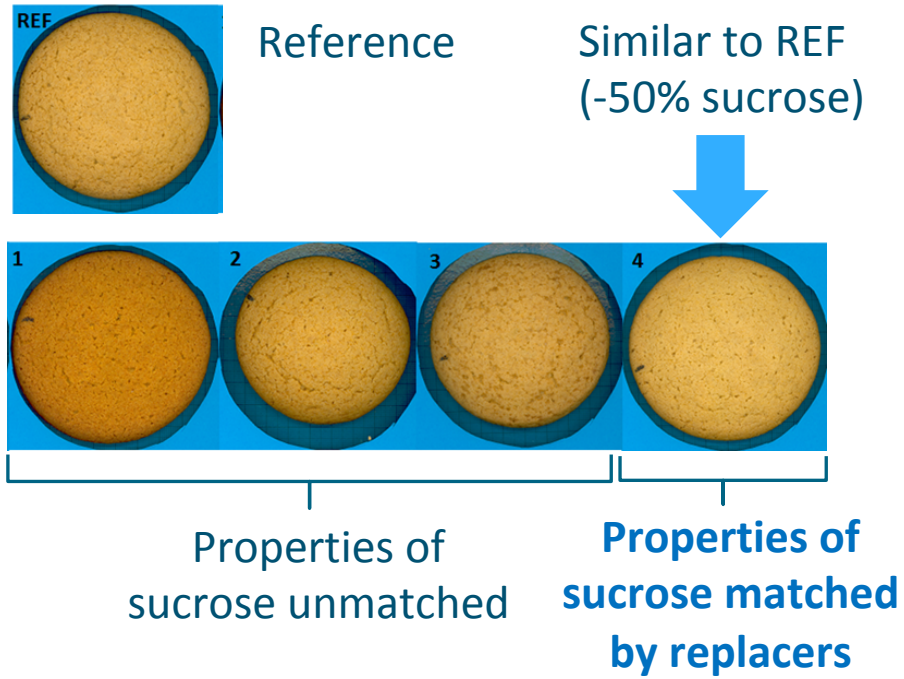
- Hydration/swelling of biopolymers and their structural arrangement → *(solvent properties and moisture partitioning)*
- Biopolymer state transitions, i.e. melting transitions → *(solvent properties)*
- Biopolymers polymerization → *(chemical interactions)*

Allows designing bakery products with specific qualities

Food structuring pathway and state transitions

- When reformulated products follow similar paths in the state diagram, similar structures and textures can be obtained

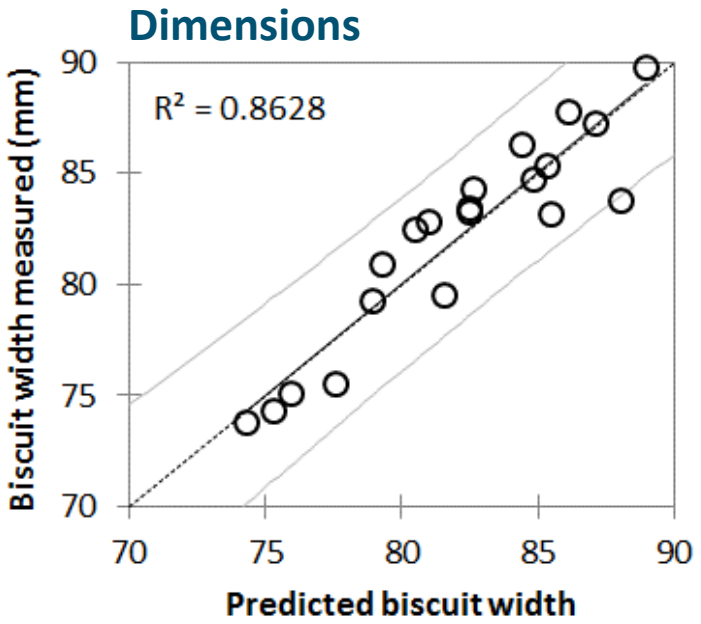


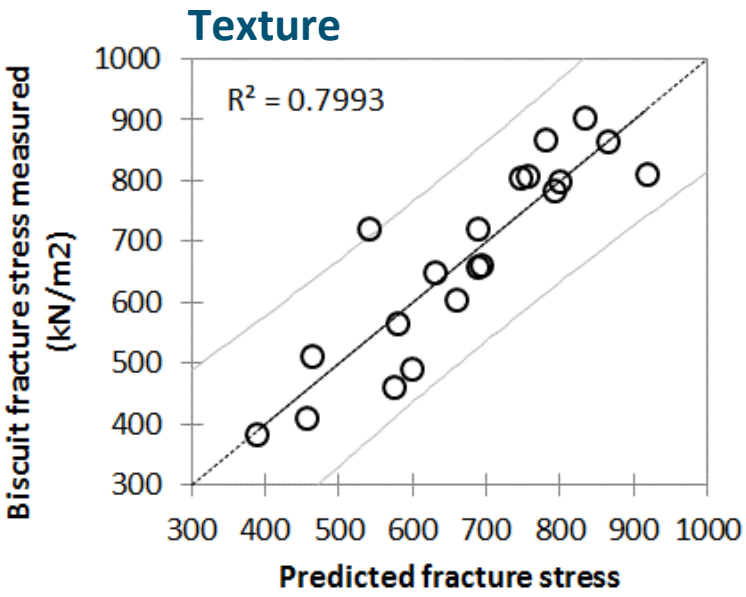


van der Sman & Renzetti, 2018. Understanding sugar functionality in biscuit for reformulation purposes. ***Critical Reviews in Food Science and Nutrition***

Application of theory to sugar reduction in biscuit (50 to 100% sucrose reduction)

- Biscuit quality predicted from formulation
- Validated with consumer sensory panel (QDA)





WAGENINGEN UNIVERSITY & RESEARCH

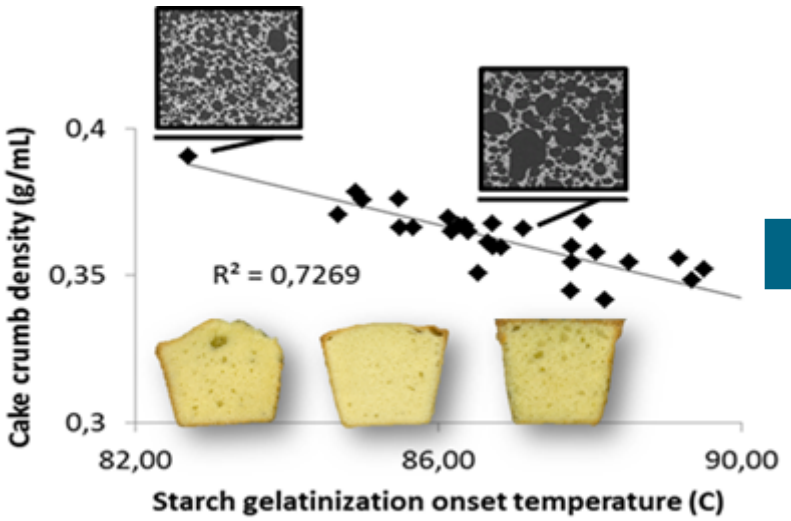
100years 1918 — 2018

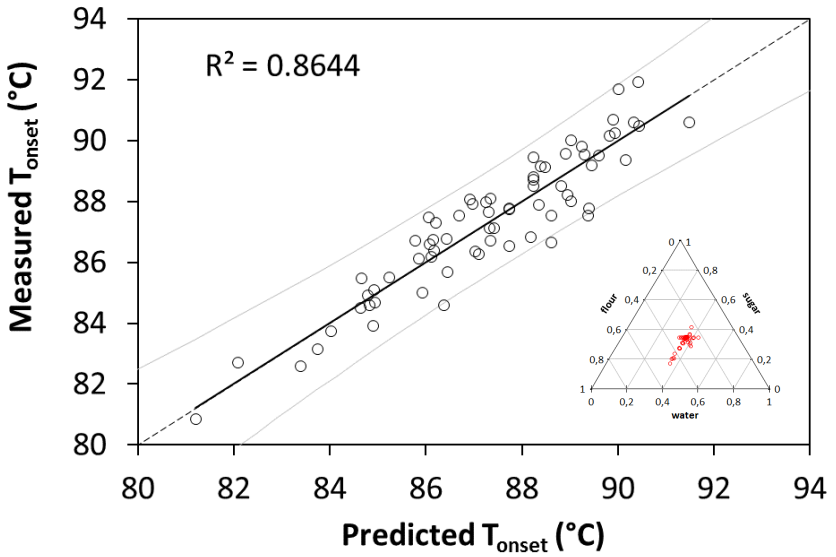
van der Sman & Renzetti, 2018. Sugar reduction: Innovation in just two numbers. **World of Food Ingredients, September 2018**.

Example Cake application

- Baking behaviour of cake batter strongly affected by starch gelatinization
- T_{onset} modulated by the properties of water-sugar mixture (solvent quality and quantity)

T_{onset} well predicted by our theories





Renzetti & Jurgens, 2016. Rheological and thermal behavior of food matricesduring processing and storage: relevance for textural and nutritional quality of food. **Current Opinion in Food Science 2016, 9:117–125**

Practical reformulation tool for product developers based on physical relations

- As optimization of formulations based on all physical relations is highly complex, physical models are being combined in automated excel tool to assist product development:
  - Base formulation: ingredient% and ratios
  - Range of desired key physical parameters
  - Selection of appropriate ingredients/replacers

  - Predicted/proposed optimized formulations

From theory to commercial success

- Peijnenburg, market leader of gingerbread (rye based pain d'epice).
- Conventional 40% sugar, reformulated 0% added sugar based on xylitol and soluble fibre (FOS).

- Huge commercial success: over 2.5M cakes sold in first 2 years. Rewarded as most healthy snack by Dutch Consumer association.
- Fulfil consumer needs: solve a problem (reduce sugar intake) whilst addressing consumers worries (natural replacers, good taste).

Awarded best in between snack

Test tussendoortjes

	MERK EN TYPE	PRIJS	TESTOORDEEL GEZONDHEID	PORTIE (G)	PRIJS/PORTIE	OORDEEL ONGEZOND VET	OORDEEL VEZELS	OORDEEL TOEGEVOEGDE SUIKER	OORDEEL KCAL/PORTIE	OORDEEL ZOUT	ETIKET	TOTAAL AANTAL SUIKERKLONTJES PER PORTIE	KCAL/PORTIE
	Weging voor Testoordeel					25%	25%	25%	10%	10%	5%		
1	**Peijnenburg** Zero%	€1,60	**7,8**	30	€0,17	★★★★★	★★★★	★★★★	★★★★★	★★★	★★★★	0,4	85
2	**Nākd** Berry Delight	€1,00	**7,8**	35	€1,00	★★★★	★★★	★★★★★	★★★★	★★★★★	★★★★	4,0	135
3	**Liga** Evergreen crunchy muesli appel-peer	€1,90	**6,9**	37,5	€0,32	★★★★★	★★★★	★★★	★★★	★★★	★★★★	2,4	150
4	**Lidl** Crownfield Muesli appel	€1,20	**6,8**	25	€0,15	★★	★★★	★★★★★	★★★★★	★★★★	★★★★	0,5	100
5	**Aldi** Nature's gift Granola reep kokos	€1,80	**6,8**	35	€0,45	★	★★★★★	★★★★★	★★	★★★★★	★★★	1,5	195
6	**Jumbo** Muesli reep cranberry & yoghurt	€1,10	**6,7**	23	€0,18	★★★★	★★★	★★★	★★★★★	★★★★★	★★★★	1,3	90
7	**Sultana** VolGraan Appel	€1,75	**6,7**	40	€0,35	★★★★★	★★★	★★★★	★★★	★★★	★★★★	2,8	160
8	**Plus** Mueslireep appel & krenten	€1,15	**6,6**	23	€0,19	★★★★★	★★	★★★	★★★★★	★★★★★	★★★★	1,4	85
9	**Kellogg's** All-bran original	€2,60	**6,6**	40	€0,43	★★★★★	★★★★★	★★	★★	★★★	★★★★	2,6	170
10	**Quaker** Havermout repen rozijn	€2,30	**6,5**	35	€0,46	★★★★	★★★	★★★	★★★★	★★★★	★★★	2,0	135
11	**Albert Heijn** Mueslireep naturel	€1,20	**6,3**	28	€0,24	★★★★★	★★	★★★	★★★★★	★★★★★	★★★★	2,0	105
12	**Sultana** Fruitbiscuit naturel	€1,75	**6,3**	43,5	€0,35	★★★★★	★★★	★★★	★★	★★★	★★★★	3,5	170
13	**Justnuts** The run run run bar	€1,00	**6,3**	30	€1,00	★★★★	★★	★★★	★★★	★★★★★	★★★★★	2,7	155
14	**Liga** Haverkick appel	€1,60	**6,0**	33	€0,26	★★★★★	★★	★★	★★★★	★★★★	★★★★	2,4	135
15	**Eat Natural** paranoot en sultanarozijn	€ 2,95	**6,0**	50	€0,98	★★★★	★★★	★★★	★	★★★★★	★★★★★	4,1	230

Further developments

Reference product	Late 2015 (Patented)	2017	2018
Gingerbread Peijnenburg 	**Gingerbread "ZERO" Peijnenburg** 	**Gingerbread "wholemeal ZERO" Peijnenburg** 	**Gingerbread "low calories" Peijnenburg** 
311 kcal per 100 g *(91 kcal per portion)*	241 kcal per 100 g *(71 kcal per portion)*	234 kcal per 100 g *(70 kcal per portion)*	200 kcal per 100 g *(50 kcal per portion)*
Dietary fibres 3.1 g per 100 g	Dietary fibres 18.3 g per 100 g	Dietary fibres 20.8 g per 100 g	Dietary fibres 18.3 g per 100 g
Sugar 39.5 g per 100 g	Sugar 5.9 g per 100 g	Sugar 2.9 g per 100 g	Sugar 3.2 g per 100 g
Main ingredients: glucose-fructose syroup, rye flour (38%)	Main ingredients: rye flour (41%), chicory fibre, sweeteners (xylitol)	Main ingredients: wholemeal rye flour (27%), chicory fibre, sweeteners (xylitol), rye flour	Main ingredients: rye flour (30%), chicory fibre, sweeteners (xylitol, erythritol), whey powder

WAGENINGEN UNIVERSITY & RESEARCH

100years 1918 — 2018

Renzetti & van der Sman, 2018. Innovative strategy for sugar reduction and fibre increase in bakery. **Ingredienti Alimentari**, issue **September/October 2018**.

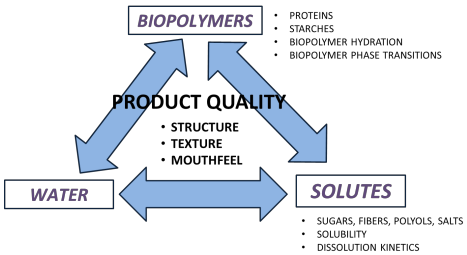
WUR sugar reduction strategy

White Paper | WUR sugar reduction strategy

*"The WUR sugar reduction strategy is based on the principles behind the physical role of **sugar** in food: it **acts as plasticiser and as humectant**.*

For food it does not matter whether these properties come from sugar or from sugar-replacing ingredients"

Ruud van der Sman & Stefano Renzetti
researchers at Wageningen Food & Biobased Research



https://www.wur.nl/en/Research-Results/Research-Institutes/food-biobased-research/Research-in-the-spotlight/Sugar-reduction.htm

Thank you for your kind attention!

Martijn Noort

Scientist and project manager

✉martijn.noort@wur.nl

Acknowledgements:

Dr Stefano Renzetti

Dr Ruud van der Sman

WAGENINGEN
UNIVERSITY & RESEARCH

100years
1918 — 2018