How quality of carbohydrates support healthy ageing

Anke Sentko, Vice President Regulatory Affairs & Nutrition Communication
BENEO-Institute, BENEO GmbH, Mannheim, Germany
The Environment
The nutrition related challenges

- Insufficient energy intake
- Overload of energy intake
- Non-nutrient influence
- Imbalances
- Eating habits
- Deficiencies
Diet related challenges

- Overweight & Obesity
- Cardiovascular diseases
- Impaired glucose tolerance & Diabetes mellitus
- Osteoporosis
- Dental health
- Several types of cancer
- Microbiota composition
- Inner resistance / Immunity
- Disturbed digestion processes
- Constipation / bowel movements

Diet related challenges
Nutrition & Health are strongly related!

Small mistakes in what we eat on a daily basis may lead to major health problems later in life!
All population groups are important!

- The older people get, the more obvious nutrition mistakes become
- The burden of diet related challenges increases with age

- The scene is often already set in the first years of life
- Corrective influences are useful throughout life!
Increasing overweight & obesity rates.....

Increasing obesity rates among adults in European countries, 1990, 2000 and 2010 (or nearest years)

Adult obesity prevalence by age
Health Survey for England 2010-2012

Prevalence of obesity: BMI ≥ 30kg/m²

The published Health Survey for England data used to produce this chart are available from:
http://www.hscic.gov.uk/catalogue/PUB13219; http://www.noo.org.uk/slide_sets; 06.11.2014
Weight gain…. Small items with big effects….

James Hill estimated based on U.S. survey data:

- Affecting energy balance by only **100 kcal/day** may prevent weight gain in most of the populations

- A typical adult gains about 1 kg/year over lifetime…

**Stop middle-aged weight gain!**
- Moderate increase in physical activity
- Eat less!
  - Appetite control
  - Lower calorie intake

**Eat smart!** - Drive your metabolism!
- Manage your blood sugar and insulin
- Increase fat burning

Hill et al, Science 2003; 299; 853-855
Weight management

Overweight prevention

Avoid weight gain!
This is equally important as weight loss

Weight loss
Overweight and obesity
A risk factor for further diseases

- Blood pressure
- Cholesterol
- Triglycerides
- Thrombosis risk
- Endothelial dysfunction
- Insulin resistance
- Glucose intolerance
- Type-2 diabetes mellitus
- Cardiovascular disease (CVD)
- Some cancers
Increasing diabetes rates.....

In Europe by 2035 one in ten is affected!

There is no simple solution – multifactorial causes require multifactorial answers
Nutrition & Health are strongly related!

Small mistakes in what we eat on a daily basis may lead to major health problems later in life!
Intake recommendations for macronutrients (% of energy intake)

- Carbohydrates: >55%
- Fat: <30%
- Protein: 10-15%
Carbohydrates in plants

- Produced by photosynthesis in plants
- Stored as carbohydrates in plants (e.g. as sucrose or starch)

Glucose in the body

- Burned in human cells to provide energy for metabolism
- The fuel of the body
- Limited storage capacity as liver and muscle glycogen

Carbohydrates – natural energizing ingredients

- Availability for the body is key: full small intestine digestibility
- The way and speed of delivery make a difference!
- Go for slow release and sustained energy delivery carbohydrates!: Go for Palatinose™ (isomaltulose)
Focus on NUTRITION

Role of essential nutrients; Deficiency diseases

1919: Protein

1932: Fat

1981: Carbohydrates

Energy intake 1900 1950 2000 2050

Role of the diet in NCDs & healthy ageing

Energy Supply

Role of macronutrients

Vit & Mineral Supply

Functional ingredients

Bioactive substances
Carbohydrates – food chemistry

Saccharides

Mono & Di (DP 1&2)

Oligo (DP 3-9)

Poly (DP≥10)
Carbohydrates – food chemistry and the consumer

Saccharides

- Mono & Di (DP 1&2)
- Oligo (DP 3-9)
- Poly (DP ≥10)

SUGARS

STARCHES and/or DIETARY FIBRES

Consumer
From food chemistry to physiology What it really means for the consumer!
When the small intestine „barrier“ is bridged….

- Digestibility
- Availability
- Speed of hydrolysis
- Release

- Blood glucose
- Insulin
- Fat oxidation
- Fuel partitioning
When the large intestine is reached…

- **Digestibility**
- **Availability**
- **Speed of hydrolysis**
- **Release**

→

- **Microbiota**
- **Obesity aspects**
- **Hunger / Satiety**
- **Immune System**
**Digestibility of carbohydrates influences energy supply and blood glucose response**

<table>
<thead>
<tr>
<th>Quick hydrolysis and complete absorption</th>
<th>Slow hydrolysis and complete absorption</th>
<th>Very low/no hydrolysis and absorption</th>
</tr>
</thead>
<tbody>
<tr>
<td>• fast glucose supply</td>
<td>• low, slow, prolonged glucose supply</td>
<td>• virtually no glucose supply</td>
</tr>
<tr>
<td>• 4 kcal/g</td>
<td>• 4 kcal/g</td>
<td>• 2.4 kcal/g</td>
</tr>
</tbody>
</table>

*Maltodextrins, starches, sucrose*

*Maltodextrins, starches, sucrose*

*Palatinose™ (isomaltulose)*

*Isomalt*

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**Graph: Rise in blood glucose (mmol/L) vs Time (min)**

- **Matodextrin**
- **Sucrose**
- **Palatinose™**
- **Isomalt**

- No absorption (= non-digestible carbohydrate/dietary fibre)
  - no glucose supply at all
  - 2 kcal/g (from SCFA)

*Chicory fibres (Inulin-type fructans)*
Metabolic Effects of Insulin

Postprandial Metabolic Regulation following CHO-rich Meal
(physiological)

High Glucose
High Insulin

Fat oxidation ↓
CHO oxidation ↑

Fat oxidation ↓
De novo lipogenesis ↑

Lipolysis ↓
Lipogenesis ↑
Fat mobilisation
Fat formation

König 2008 at the 1st European BENEÖ Scientific Symposium, 11 April, Brussels
Effects on energy partitioning and metabolic regulation

- **High glycemic, rapid release CHO**
  - Rapid increase of CHO Oxidation
  - High suppression of Fat Oxidation
  - Promote uptake of Glc
  - Inhibit lipolysis
  - Storage of Fat and Glc (excess)

- **Low glycemic, slow release CHO**
  - Promoting Fat utilisation at the expense of CHO oxidation

- **Supported for Palatinose™ (isomaltulose) by several human intervention studies**
Does a sugar exist that is slowly digested, fully available in a sustained way and does not boost the insulin profile?

YES! – it is unique! Its name is Isomaltulose (Palatinose™) You find it in honey and sugar cane molasses …. And you can buy it!
Mode of energy release from Palatinose™

Slow & sustained travel through the small intestine and release

Sustained but complete (fully digestible in the small intestine)

After absorption: Low and sustained blood glucose response

Sustained metabolic processing
Mode of energy release from Palatinose™

Rational

- Slow & sustained travel through the small intestine and release
- Sustained but complete (fully digestible in the small intestine)
- After absorption: Low and sustained blood glucose response
- Sustained metabolic processing

Proof Points

- Release
  - Speed of hydrolysis 4-5 times slower
  - Enzyme kinetics (in vitro)

- Availability
  - Digestibility study (animal, human)
  - Breath H₂ (animal) – no increase -> it is not reaching the colon

- BGR
  - > 30 human intervention studies
  - Blood glucose response always low and sustained

- Energy production
  - Carbohydrate oxidation steady and sustained (RQ) (shift to the right)
  - Labelled isotope technique - glucose flux balanced & sustained
**Digestion and absorption in the small intestine:**

Palatinose™ (isomaltulose) is slowly released

- Palatinose™ is hydrolysed at an enzyme complex that is involved in the digestion of sucrose and starch.
- It is hydrolysed at the isomaltase site.

* The amylopectine derived glucose-glucose 1-6 linkage

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The rate of hydrolysis is thereby much slower for Palatinose™ compared to sucrose, decelerated by a factor of about 4 to 5.

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Blood glucose response to Palatinose™ in comparison to other carbohydrates in healthy adults.

The curves are generated from different studies and represent the response to 50g oral carbohydrate in drinks solution (Livesey).
Palatinose™ Ileostomy Study
(Scheppach, University Würzburg)

N = 10 patients with terminal ileostoma, intake 50g Palatinose™
hourly collection of ileostoma content for 8 hours.

- Virtually complete hydrolysis and absorption in the small intestine
- No significant effect of food type

Palatinose™ is a slowly but fully digestible carbohydrate!

Incretin secretion

GIP (glucose-dependent insulinotropic peptide)

- releasing K cells are situated in the upper part of the small intestine and are stimulated by monosaccharides
- **GIP concentration after Palatinose is significantly lower**
- probably because of the slow hydrolysis
Incretin secretion

- **GLP-1** (glucagon-like peptide-1) is released from L cells in lower GI tract (distal small intestine and colon)

- Higher GLP-1 response with Palatinose

**OVERALL CONCLUSION:**

More favorable effects with Palatinose™ on glucose metabolism and pancreatic functions

The lower GIP levels and higher GLP-1 levels confirm the sustained energy release from Palatinose™

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Maeda et al (2013)
Findings from Ang & Linn 2014: Conclusion

Comparison of the effects of slowly and rapidly absorbed carbohydrates on postprandial glucose metabolism in type 2 diabetes mellitus patients: a randomized trial

- Confirms low-glycaemic and -insulinaemic properties of isomaltulose in T2DM patients
- Benefits for the incretin response after isomaltulose ingestion by lowering GIP and increasing GLP-1 levels (conform to study by Maeda et al.)
- Provides data on the glucose flux after isomaltulose ingestion in humans based on stable isotope measurements:
  - Prolonged intestinal absorption of isomaltulose
  - Suppressed endogenous glucose production
  - Lower rate of glucose appearance in the circulation

Slowly available isomaltulose improved overall postprandial glucose flux compared with ingestion of rapidly absorbed sucrose
Blood Glucose and Insulin Responses –
Summary from human trials with Palatinose™

Consistent findings
- LOWER and SUSTAINED blood glucose response
- and lower insulin with PALATINOSE™

Maximum rise in Blood glucose and insulin

Difference in blood glucose

Difference in insulin

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The Panel considers that the reduction of post-prandial glycaemic responses (as long as post-prandial insulinaemic responses are not disproportionately increased) may be a beneficial physiological effect.
Results
Better memory with Palatinose™

• After 3 hours, those having consumed the Palatinose™ based breakfast had significantly better memories (P<0.01).
• There was a significantly decrease over time in those eating the glucose based breakfast (P<0.001).
Results
Better mood with Palatinose™

• Children of the Palatinose™ group had a significantly better mood after 3 hours (P<0.03).
The glycemic load of meals, cognition and mood in middle and older aged adults with differences in glucose tolerance: A randomized trial

Hayley Young, David Benton

Department of Psychology, Swansea University, Wales SA2 8PP, United Kingdom
Older adults with better glucose tolerance and LBG above baseline responded to Palatinose™ with:

- **better mood ratings:**
  - Significant vs sucr @ 105 min (p<0.01)
  - Significant vs gluc @ 195 min (p<0.03)

- **better episodic memory:**
  - Significant vs gluc @ 105 min (p<0.03) + @195 min (p<0.05)
  - Significant vs sucr @ 30 min (p<0.029), @ 105 min (p<0.04) + @ 195 min (p<0.03)

- **better working memory:**
  - Significant vs gluc @ 180 min (p<0.05)

Palatinose™ improved cognition and mood in older adults with better GT and no cognitive decline, effects most pronounced in later test blocks.

Young, Benton (2014) e-SPEN 9(4):e147–e154
Postprandial Metabolic Regulation following CHO-rich Meal
(physiological)

High Glucose
High Insulin

Fat oxidation ↓
CHO oxidation ↑

Fat oxidation ↓
De novo lipogenesis ↑

Lipolysis ↓
Lipogenesis ↑

Fat mobilisation
Fat formation

König 2008 at the 1st European BENEON Scientific Symposium, 11 April, Brussels
Palatinose™ and Fat oxidation

Effects of Palatinose™ (isomaltulose) in comparison to conventional high glycaemic carbohydrates on fat oxidation have been studied:

- at rest and during physical activity
- trained endurance athletes and moderately active people
- normal weight and overweight people
- normal and impaired glucose tolerance

Lower postprandial glucose and insulin response results in higher fat oxidation in energy metabolism.
Published studies on Palatinose™ and body weight / body composition

3 Human studies

• **less visceral fat accumulation** (obese subjects and IGT subjects)
• 12 and 16 week interventions, ~18 g to 45 g/d Isomaltulose vs. conventional sugar/breakfast
• Yamori et al 2007, Oizumi et al 2007, Okuno et al 2010

5 Animal experiments

• 4-8 wk feeding studies with rats or mice
• lower visceral fat at equal caloric intakes
• Preliminary indications on mechanism from gene expression analysis

ğini

⇒ Lower body fat accumulation in animals
⇒ Indications for consequences for body fat composition in humans
Options to reduce the blood glucose response of foods

Carbohydrate QUANTITY consumed with the food

Carbohydrate QUALITY i.e. carbohydrate type and physiol. properties

“Food matrix” influencing the BGR of carbohydrate-based foods

Reducing the blood glucose response of available carbohydrates

Modification of glucose supply

Options:
- Smart choice of low glycaemic alternatives: Palatinose™

Replacing available carbohydrates by partially or non-available carbohydrates

Reduction of glucose supply

Options:
- Sugars replacement by polyols: Isomalt
- Sugars/starches replacement by dietary fibre: Inulin & Oligofructose
Inulin-type fructans = plant extracts and not chemically synthezised!

Extraction (hot water) → Inulin

Partial hydrolysis (enzymatic) → Oligofructose

* e.g. Orafti®P95

Chicory roots (15-17% inulin)

Terminology used in the market for this dietary fibre:

- Chicory fibre, chicory root extract
- Inulin, oligofructose, fructo-oligosaccharide, FOS, lFOS, lC Inulin
- umbrella terms: chicory fibre, ITF (inulin-type fructans)

Combination (selected chain length) → Oligofructose-enriched inulin

* Orafti®Synergy1

**Note:** scFOS is synthesized from sucrose and not a natural plant extract
Mechanism by which oligofructose / inulin exert the effect

Replacing the content of digestible and glycaemic sugars in a product partly by the non-digestible fibres oligofructose and/or inulin reduces the amount of glucose that enters the body and thus:

- lowers the postprandial blood glucose response
- without disproportionally increased insulin levels
Scientific Opinion on the substantiation of a health claim related to non-digestible carbohydrates and a reduction of post-prandial glycaemic responses pursuant to Article 13(5) of Regulation (EC) No 1924/2006

EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA)

European Food Safety Authority (EFSA), Parma, Italy

ABSTRACT

Following an application from Beneo-Orafti SA, Sensus BV and Cosucra-Groupe Warcoing SA, submitted for authorisation of a health claim pursuant to Article 13(5) of Regulation (EC) No 1924/2006 via the Competent Authority of the applicant, the Panel concludes that the food that is the subject of the health claim is fructo-oligosaccharides (FOS, oligofructose) obtained from chicory (Cichorium intybus L.) inulin, which should replace sugars in foods or beverages in order to obtain the claimed effect (i.e. reduction of post-prandial glycaemic responses).
Series of human intervention studies by Dehghan and Gargari in 2013...

...on the effects of inulin-type fructans on energy homeostasis, glycaemic control, inflammation, blood lipids
<table>
<thead>
<tr>
<th></th>
<th>HP-Inulin</th>
<th>Oligofructose-enriched Inulin</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy homeostasis</strong></td>
<td>![↑* BMI (vs. baseline)] ![↓* Body weight (vs. baseline)] ![↓* Energy intake &amp; fat intake (vs. control / vs. baseline)]</td>
<td>![↑* BMI (vs. baseline)] ![↓* Body weight (vs. baseline)] ![↓* Energy intake &amp; fat intake (vs. baseline)]</td>
</tr>
<tr>
<td><strong>Glycaemic control</strong></td>
<td>![↑* Fasting blood glucose (vs. control / vs. baseline)] ![↓* HbA1 (vs. control / vs. baseline)] ![↓* Fasting insulin (vs. control / vs. baseline)] ![↓* HOMA-IR (vs. control)]</td>
<td>![↑* Fasting blood glucose (vs. control / vs. baseline)] ![↓* HbA1 (vs. control / vs. baseline)] ![↓* Fasting insulin (vs. control / vs. baseline)] ![↓* HOMA-IR (vs. control)]</td>
</tr>
<tr>
<td><strong>Inflammation / endotoxemia</strong></td>
<td>![↑* hs-CRP (vs. control / vs. baseline)] ![↓* TNF-α (vs. control / vs. baseline)]</td>
<td>![↑* hs-CRP (vs. baseline)] ![↓* TNF-α (vs. control / vs. baseline)]</td>
</tr>
<tr>
<td>![↓* IL-10 (vs. baseline)]</td>
<td>![↓* LPS (vs. control / vs. baseline)]</td>
<td>![↔ IL-10] ![↓* LPS (vs. control / vs. baseline)]</td>
</tr>
<tr>
<td><strong>Blood lipids</strong></td>
<td>![↑* Total cholesterol (vs. control / vs. baseline)] ![↑* Triglycerides (vs. control / vs. baseline)] ![↓* LDL (vs. control / vs. baseline)] ![↑* HDL (vs. control / vs. baseline)]</td>
<td>![↑* Total cholesterol (vs. baseline)] ![↑* Triglycerides (vs. control / vs. baseline)] ![↓* LDL (vs. control / vs. baseline)] ![↑* HDL (vs. baseline)]</td>
</tr>
</tbody>
</table>

⇒ Overall, study findings support metabolic benefits
Systematic Review and Meta-Analysis on Metabolic benefits of prebiotics in human subjects

Review – Systematic

Metabolic benefits of dietary prebiotics in human subjects: a systematic review of randomised controlled trials

Nicole J. Kellow, Melinda T. Coughlan and Christopher M. Reid

RESULT:
Significantly (p<0.05) reduced postprandial glucose and insulin concentrations

Kellow NJ, Coughlan MT, Reid CM. Br J Nutr. 2014 Apr 14;111(7):1147-61
Satiety, Energy Intake & Body Weight

It works: It makes me eat less!

It has an effect on me and my body!

I can measure it

I can sense it

Energy Intake

Body Weight / Body Composition

Satiety Regulation (Hormones)

Subjective Appetite Ratings

Chicory fibres help you to eat less!
Decrease in EI demonstrated in several long-term human intervention studies
Positioning of consumer products

sugar out

fibre in

Lower blood glucose
## Physiological Properties of chicory fibres

<table>
<thead>
<tr>
<th>Type of key studies</th>
<th>Demonstrated Physiological Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mouth</strong></td>
<td>Not fermented</td>
</tr>
<tr>
<td><strong>Small Intestine</strong></td>
<td>Not digested/absorbed</td>
</tr>
<tr>
<td></td>
<td><strong>glycaemic response</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Insulin response</strong></td>
</tr>
<tr>
<td></td>
<td>When replacing sugars/available carbohydrates → reduced glycaemic response. Reduced insulin response</td>
</tr>
<tr>
<td><strong>Large Intestine</strong></td>
<td>Prebiotic</td>
</tr>
<tr>
<td></td>
<td>Selective growth of in particular bifidobacteria</td>
</tr>
<tr>
<td></td>
<td><strong>Fully fermentable</strong></td>
</tr>
<tr>
<td></td>
<td>Saccharolytic fermentation leads to 100% benefit → Short chain fatty acid ↑, pH ↓</td>
</tr>
<tr>
<td><strong>Bowel function</strong></td>
<td>Improved bowel motor function, frequency</td>
</tr>
<tr>
<td><strong>Mineral</strong></td>
<td>calcium absorption ↑ &amp; bone mineral density ↑</td>
</tr>
<tr>
<td><strong>Gastrointestinal Tolerance</strong></td>
<td>subjective perception of the increased gut activity might be noticeable at high intakes, but generally not disturbing</td>
</tr>
<tr>
<td><strong>Metabolism</strong></td>
<td><strong>Weight management</strong></td>
</tr>
<tr>
<td></td>
<td>energy intake ↓</td>
</tr>
<tr>
<td></td>
<td>Weight loss, influence on satiety, fat mass</td>
</tr>
<tr>
<td></td>
<td><strong>Inner resistance</strong></td>
</tr>
<tr>
<td></td>
<td>Incidence of illnesses ↓</td>
</tr>
<tr>
<td></td>
<td><strong>Attenuation of glycaemia / insulinaemia – long term</strong></td>
</tr>
<tr>
<td></td>
<td>Glycosylated haemoglobin and fructosamin, insulin resistance (HOMA) etc</td>
</tr>
<tr>
<td></td>
<td><strong>Calorie Reduction / Fibre enrichment/sugar replacement</strong></td>
</tr>
<tr>
<td></td>
<td>When replacing starch, sugar or fat → calories ↓ (caloric value 1-2 kcal/g depending on national legislation)</td>
</tr>
</tbody>
</table>
### Physiological Properties of Palatinose™

<table>
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<tr>
<th>Type of key studies</th>
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<tbody>
<tr>
<td><strong>Mouth</strong></td>
<td>pH-Telemetry</td>
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<tr>
<td></td>
<td>Does not promote dental caries</td>
</tr>
<tr>
<td><strong>Small Intestine</strong></td>
<td></td>
</tr>
<tr>
<td>- Hydrolysis</td>
<td>Enzyme kinetics (in vitro)</td>
</tr>
<tr>
<td></td>
<td><strong>Slow hydrolysis</strong> into glucose + fructose (4-5 times slower than sucrose)**</td>
</tr>
<tr>
<td>- Absorption</td>
<td>Ileostomy-study</td>
</tr>
<tr>
<td></td>
<td><strong>Virtually complete hydrolysis and absorption</strong> within the small intestine</td>
</tr>
<tr>
<td>Blood glucose response</td>
<td><strong>Slow increase, low glycaemic response</strong></td>
</tr>
<tr>
<td></td>
<td>Glucose (energy) delivery over a prolonged period of time</td>
</tr>
<tr>
<td>Insulin response</td>
<td>Low insulin response</td>
</tr>
<tr>
<td>glycaemic Index (GI)</td>
<td>GI= 32</td>
</tr>
<tr>
<td>Incretins (gastrointestinal hormones)</td>
<td>GIP ↓; GLP-1 ↑</td>
</tr>
<tr>
<td><strong>Large Intestine</strong></td>
<td>Gastrointestinal Tolerance</td>
</tr>
<tr>
<td></td>
<td><strong>No distress</strong> even at high levels (e.g.120g in a sports study).</td>
</tr>
<tr>
<td><strong>Metabolism</strong></td>
<td>Respiratory Quotient</td>
</tr>
<tr>
<td></td>
<td><strong>Promotes fat burning</strong></td>
</tr>
<tr>
<td>Body Composition</td>
<td>Loss of body fat and body weight/Prevention of weight gain</td>
</tr>
</tbody>
</table>
The quality of carbohydrates is key: BENEÖ ingredients contribute to a better and healthy nutrition

- **CHICORY ROOTS**
  - Reduced blood sugar response
  - Low energy value
  - Helps you to eat less on a long term
  - Regularity & fermentation benefits
  - Proven prebiotics
  - Increased Calcium absorption & stronger bones
  - Chicory fibre (Orafti® Inulin & oligofructose)

- **SUGAR BEETS**
  - Does not promote dental caries
  - Slow & complete hydrolysis and absorption
  - Low glycaemic response and low insulin response
  - Prolonged energy supply
  - Supports fat burning
  - GI tolerance as good as sugar for Palatinose™!
  - Palatinose™ (isomaltulose)

**Palatinose™ benefits**
- Does not promote dental caries
- Slow & complete hydrolysis and absorption
- Low glycaemic response and low insulin response
- Prolonged energy supply
- Supports fat burning
- GI tolerance as good as sugar for Palatinose™!

**Palatinose™ Benefits**
- Helps you to eat less on a long term
- Proven prebiotics
- Increased Calcium absorption & stronger bones

**Beneo Institute**
Connecting nutrition and health
Thank you for your attention.