



Palatinose™ (isomaltulose) –  
A slow-release carbohydrate derived from  
nature for improved metabolism and health.

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# Carbohydrate quality matters.

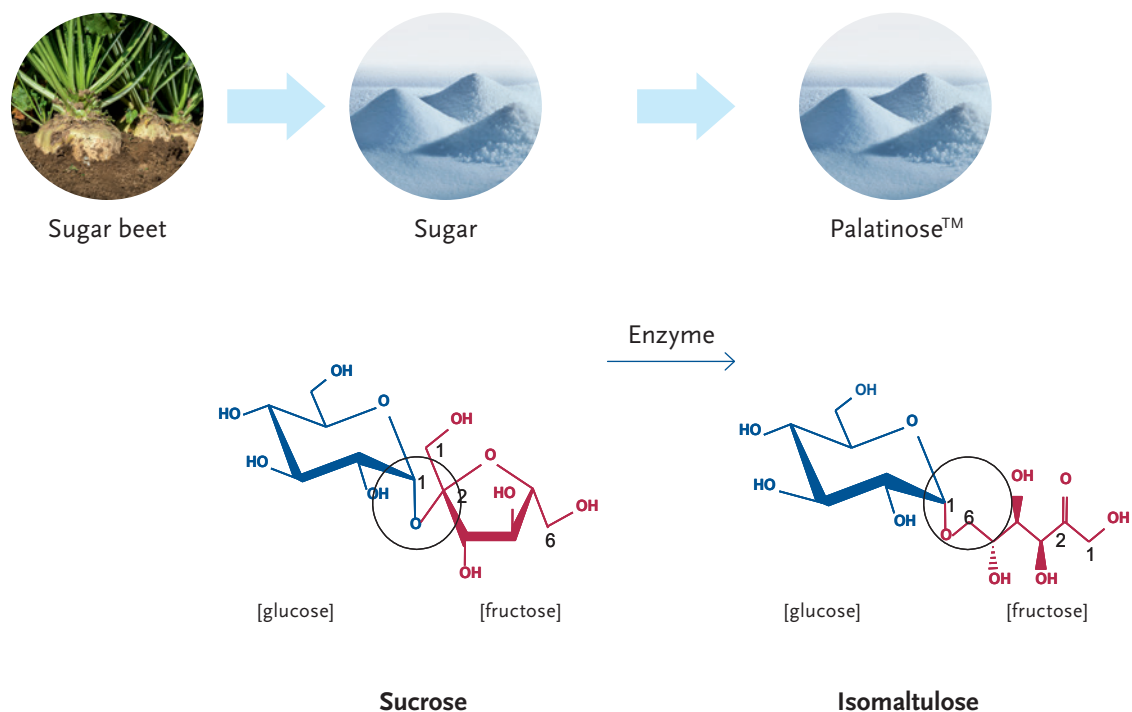
Carbohydrates play an important role in the diet as the key macronutrient that supplies the body with energy. However, not all carbohydrates are metabolized the same way and interest is growing in the characteristics of various carbohydrates – functional properties, digestibility, availability, speed of absorption, and metabolic pathways.

This paper introduces Palatinose™ (isomaltulose), a slowly digested carbohydrate that can positively impact metabolism and everyday health.

## Palatinose™ – a unique carbohydrate.

Palatinose™ (generic name isomaltulose) is the **only fully digested and slow-release carbohydrate**. This glucose-fructose disaccharide isomaltulose, discovered in Germany in 1957 and marketed under the brand Palatinose™, occurs naturally in small amounts in honey and sugar cane juice.<sup>1,2</sup> Palatinose™ is made from sugar beet by strengthening the glucose-fructose linkage with the help of natural enzymes. This enzymatic conversion rearranges the  $\alpha$ -1,2-glycosidic linkage in sucrose into a stronger, more stable  $\alpha$ -1,6-glycosidic bond (Figure 1) that is **broken down more slowly by enzymes in the gastrointestinal tract, which is the key to the unique physiological properties of Palatinose™**.

Figure 1. Origin and structure of Palatinose™ (isomaltulose)



# Health benefits linked to Palatinose™.

## Slow-release property provides sustained energy.

Palatinose™ is different from readily available carbohydrates such as sucrose or corn syrup as its digestion and absorption is much slower resulting in less insulin release. **Digestive enzymes hydrolyze Palatinose™ four to five times more slowly than sucrose** because of the strong glucose-fructose bond, resulting in a slower release of glucose, slower intestinal absorption, and a longer-lasting fuel supply to the body and brain. **This means a constant stream of energy over a longer period of time compared to quickly absorbed carbohydrates.** Palatinose™ is also different from other non-available carbohydrates in that it is slowly but fully digested and absorbed in the small intestine – which means there is no risk of gastrointestinal distress, even at high intakes. Palatinose™ provides the same 4 kcal/g as other available carbohydrates yet these calories provide energy in a more balanced way – giving the body high quality calories for steady energy release.

The **slow digestion and absorption** of Palatinose™ is reflected in the incretin response. Incretins (GIP (gastric inhibitory polypeptide) and GLP-1 (glucagon-like peptide 1)) are gut hormones that stimulate glucose-dependent insulin secretion. Monosaccharides such as glucose trigger GIP release in the upper part of the small intestine; longer chain carbohydrates stimulate GLP-1 secretion in the lower part of the small intestine. Research shows that Palatinose™ suppresses GIP release and stimulates GLP-1 secretion,<sup>3-5</sup> demonstrating that digestion and absorption of Palatinose™ occur along the entire small intestine.





## Low blood glucose response and smart glucose management benefit health.

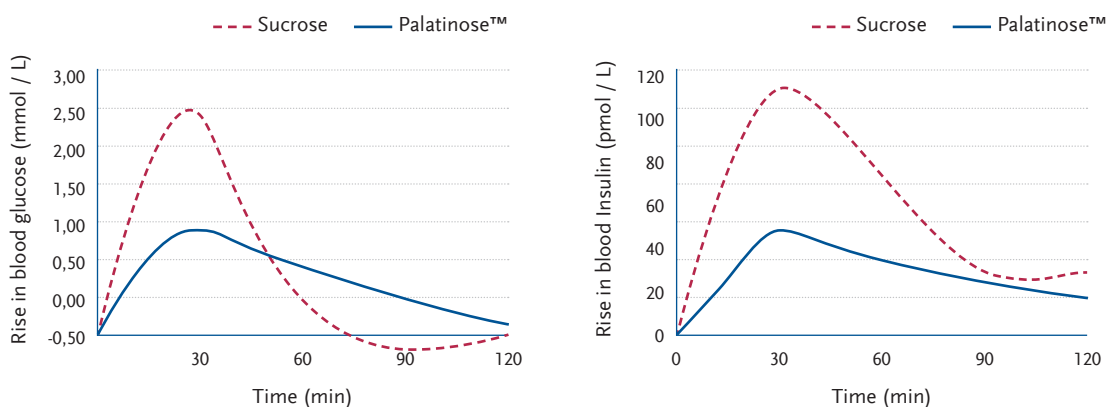
Obesity and diabetes mellitus are on the rise worldwide and are serious health problems in the U.S. The prevalence of obesity among American adults has risen to 36.5%. In the U.S., 30.3 million adults, almost 10% of the population, have been diagnosed with diabetes mellitus. Another 84.1 million, more than one out of three, have prediabetes.<sup>6</sup>

Managing blood glucose levels and reducing blood glucose fluctuations are thought to benefit health. One consensus statement concludes that

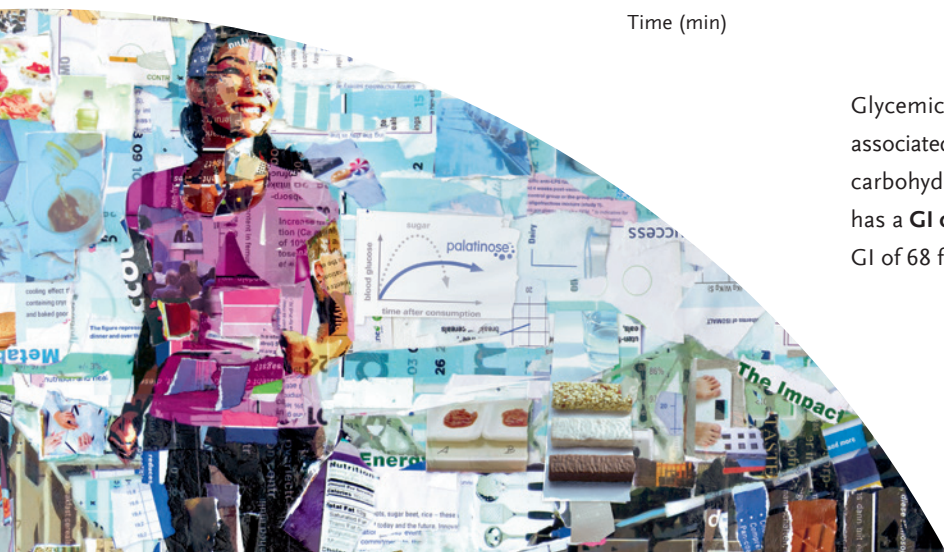
**“there is sufficient convincing scientific evidence that following a carbohydrate-based diet with lower impact on blood glucose levels reduces the risk for developing metabolic diseases like diabetes mellitus, cardiovascular disease and possibly overweight and obesity and it improves blood glucose control in people who are already affected by diabetes mellitus.”<sup>7</sup>**

The slower yet complete digestion and absorption<sup>8</sup> of Palatinose™ is characterized by a **slower, longer lasting, and steadier blood glucose response**, without the significant drops in blood glucose associated with conventional higher glycemic sugars (Figure 2). The lower and more balanced blood glucose response results in **less insulin release** and an improved metabolic profile.<sup>3,8-13,21</sup>

Figure 2. Typical blood glucose and insulin curves in response to Palatinose™ and sucrose

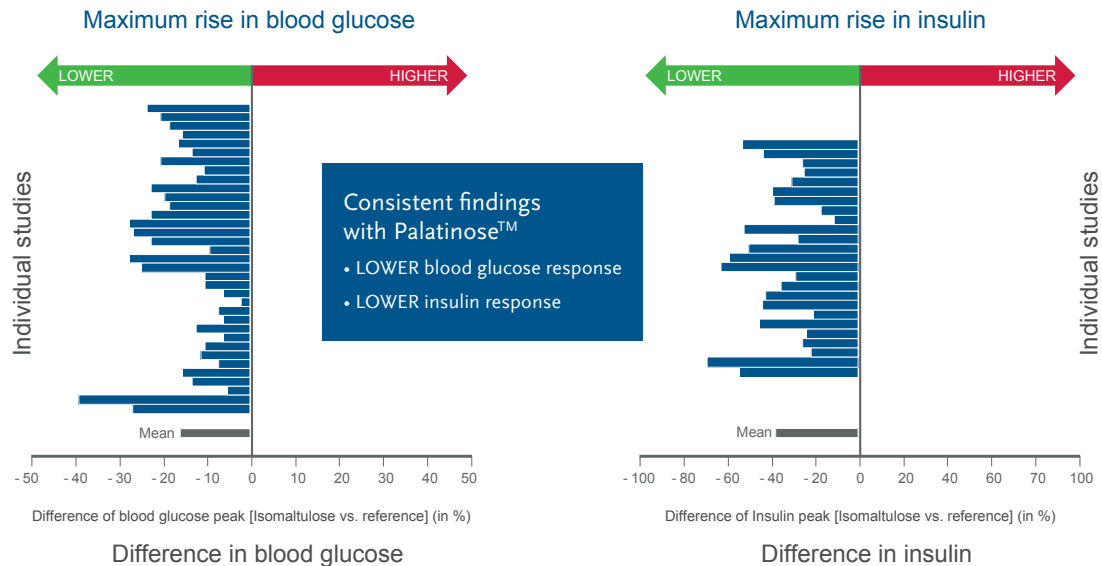


Glycemic index (GI) compares the blood glucose response associated with various carbohydrate foods to the response of a 50 g carbohydrate load of either glucose or white bread. Palatinose™ has a **GI of 32**, in the low glycemic range, compared to a moderate GI of 68 for sucrose and a high GI of 86 for maltodextrin.<sup>8</sup>



The totality of data from over 30 blood glucose response trials<sup>3,8,10-15</sup> consistently finds a lower blood glucose response to low GI Palatinose™ as compared to sucrose, maltodextrin or other reference carbohydrates. The lower rise in blood glucose levels is associated with lower insulin levels (Figure 3). A claim for a lower rise in blood sugar levels has been laid down in EU legislation following the publication of a positive EFSA opinion.<sup>40</sup>

Figure 3. Lower blood glucose and insulin response for Palatinose™ (isomaltulose) vs. reference confirmed in over 30 human trials



Palatinose™ is a tool to help manage blood glucose response. It has been shown to provide a **lower and sustained blood glucose response** in healthy adults<sup>3,8-11,14</sup>, in those with overweight and obesity or impaired glucose tolerance<sup>13,16</sup>, as well as in individuals with type 1<sup>17,18</sup> and non-insulin dependent type 2 diabetes<sup>4,5,12</sup>.

One study compared the effects of Palatinose™ to sucrose on postprandial glucose metabolism in 11 adults with type 2 diabetes in a randomized, double-blind, cross-over design using stable isotope technique.<sup>4</sup> **It confirmed prolonged intestinal glucose absorption of Palatinose™, a lower postprandial glucose rise, and lower insulin release compared to sucrose.** The incretin pattern associated with Palatinose™ contributed to improved glucose flux.

Pfeiffer and his team from the German Institute of Human Nutrition provided 10 adults with type 2 diabetes with 50 g of either Palatinose™ (isomaltulose) or sucrose in water following an overnight fast in a cross-over design. Compared to sucrose, Palatinose™ positively impacted blood glucose, insulin, and incretin responses.<sup>5</sup> A similar trial of the same research team in healthy adults has been published in a review on the metabolic role of incretins.<sup>18</sup>

Providing carbohydrate energy in a slower, more balanced and sustained way helps to keep blood sugar levels stable, with benefits beyond those for people with diabetes. New insights show that early life nutrition sets the foundation with outreach to metabolic health and disease later in life. Keeping blood sugar levels low matters from the very beginning, during pregnancy and early childhood as well as later in life, supporting a healthy development and aging. Beyond that, sustained glucose supply from Palatinose™ has shown benefits to maintain memory performance better over the morning and to improve mood in school-age children<sup>20</sup> and adults<sup>21</sup>.

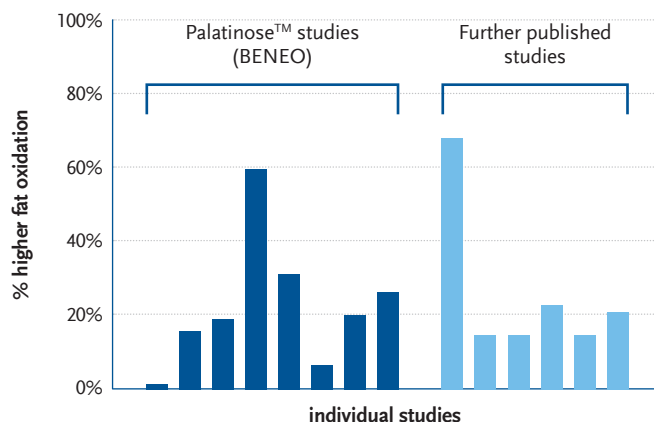
## Improved metabolic profile through higher level of fat burning.

The body metabolizes both fat and carbohydrate to produce energy. Excess energy that is not immediately metabolized is stored as the glucose polysaccharide glycogen and/or as fat. The proportions of ingested fat and carbohydrate that are utilized for energy depend on the needs of the body, its metabolic state and physical activity, as well as on the type of food consumed and the subsequent insulin response in the body.

The hormone insulin plays a key role in postprandial metabolic regulation. Most sugars and other high glycemic carbohydrates produce a high blood glucose response, and that stimulates high insulin release which drives glucose into cells and stimulates glucose storage in the liver as glycogen. High insulin levels also suppress cellular fatty acid oxidation in adipose tissue and promote hepatic fatty acid synthesis.

Palatinose™ offers the advantage of **slower and steadier glucose release into the bloodstream and thus lower insulin release, allowing the body to burn more fat than conventional high glycemic carbohydrates.** Human intervention studies demonstrate these effects in healthy weight, overweight, and obese adults, as well as sedentary or physically active adults (Figure 4). Maresch and colleagues have published a scientific review of clinical trials that confirmed an improved fat oxidation with Palatinose™.<sup>22</sup> A randomized, double-blind, controlled, cross-over study with continuous glucose monitoring for up to 42 hours and an indirect calorimetry measurement over 10 hours by Henry et al. examined the effects of a low versus high glycemic diet on blood glucose response and substrate metabolism.<sup>23</sup> The study showed a lower blood glucose response over 24 hours, a significantly lower glycemic variability, and higher fat oxidation after low glycemic index meals with Palatinose™, as compared to a higher glycemic diet with sucrose. These results are notable for the duration of effects over a full day rather than up to 3 hours, suggesting that small dietary changes such as replacing high glycemic carbohydrates with lower glycemic options such as Palatinose™ can have a lasting impact on blood glucose response.

**Figure 4. Higher fat oxidation with Palatinose™**





**The ability of Palatinose™ to promote fat oxidation is unique.** Traditional sugars and carbohydrates are either high glycemic or induce higher carbohydrate oxidation rates for other reasons, for example, fructose content. **The steady energy release of Palatinose™ creates a metabolic profile that supports both physical activity and weight management.**

### Palatinose™ offers unique benefits for physical activity.

Carbohydrate consumption is particularly important to support all levels of physical activity. Carbohydrates that are quickly digested and absorbed, like common sugars and maltodextrin, provide fast energy from glucose as the primary fuel; fat oxidation is largely suppressed. In contrast, Palatinose™ breaks down more slowly, steadily releasing energy, allowing the body to also use body fat as a fuel, and preserving the body's own carbohydrate reserves to support activities of longer endurance.

Studies at the Institute of Sport and Sport Science at the University of Freiburg (Germany)<sup>13,24,25</sup>, as well as other laboratories<sup>17,26</sup>, observed that higher fat oxidation rates in various types of sports and physical activity result from Palatinose™ consumption rather than higher glycemic index carbohydrates like maltodextrin or sucrose. In a randomized controlled trial, 20 endurance athletes had more stable and sustained blood glucose profiles and higher fat oxidation rates during exercise after consuming Palatinose™ in comparison with maltodextrin.<sup>22</sup> In a subsequent time trial, the athletes performed better after Palatinose™ intake, finishing the time trial faster and with a higher power output. This suggests that Palatinose™ has the **potential to enhance endurance performance by sparing glycogen sources.**

Maintaining acceptable blood glucose levels during physical activity poses particular challenges for people with type 1 diabetes. Research from the Swansea University (UK) showed that feeding Palatinose™ compared to dextrose before exercise **improves glycemic control, protects against hypoglycemia and maintains running performance** among individuals with type 1 diabetes.<sup>17,18,27,28</sup> Investigators also found that a low glycemic meal after exercise and a Palatinose™-containing bedtime snack improved overnight glycemic control and reduced risk for hypoglycemic episodes.<sup>28,29</sup>



fat  
oxidation

## Effective and long-term weight management benefits with Palatinose™.

An alarming number of people are impacted by overweight and obesity in today's society. Positive energy balance, where calorie intake exceeds expenditure, plays a role; frequent consumption of high glycemic carbohydrates may contribute to the incidence of obesity as well. High blood glucose levels trigger high insulin release, promoting the use of carbohydrates instead of fat for energy. This suppresses fat mobilization and promotes the storage of fat in adipose and non-adipose tissue. Furthermore, fat oxidation may be suppressed in obese individuals.<sup>30</sup> While it is not clear yet whether this is causal or a consequence of a higher body fat mass, it has been shown that obese individuals who oxidize fat more slowly tend to continue gradually gaining weight.<sup>30</sup> Therefore, **impaired fat oxidation appears to be an important contributor to long-term weight gain, independent of other factors, and increasing fat oxidation can benefit weight management and body composition.**

Sugar replacement with Palatinose™ has been shown to improve metabolic response and increase fat oxidation rates in healthy adults, independent of body weight, as well as in adults with normal or impaired glucose tolerance.<sup>13,15,16,31,32</sup>

One study compared the effects of Palatinose™ to a high glycemic reference on metabolic regulation and fat oxidation in overweight to obese adults with impaired glucose tolerance.<sup>13</sup> Consumption of meals with Palatinose™ instead of traditional high glycemic sugars was associated with lower blood glucose and insulin levels and an increase in fat oxidation by up to 18%. Energy expenditure during the 7-hour test period tended to be greater with Palatinose™, a difference of about 50 kcal, which was attributed to increased fat burning.

Over a longer period of time, the effects of Palatinose™ on fat oxidation may translate into **beneficial effects on body fat accumulation, energy expenditure and body weight**, based on findings from animal<sup>33-36</sup> and human intervention studies<sup>37-39</sup>. In a 12-week weight loss study, overweight to obese men who successfully lost weight as a result of a negative energy balance achieved an even greater weight loss and fat loss around the trunk when sucrose was replaced with Palatinose™.<sup>38</sup> This suggests that making a small diet change by substituting Palatinose™ for sucrose **may improve loss of both weight and body fat in a calorie-restricted diet.**

## Other benefits: Dental health.

Palatinose™ is no substrate for oral bacteria and therefore the first sugar that is kind to teeth. Its tooth-friendliness has been confirmed in pH telemetry studies. A corresponding claim has been accepted in the USA by FDA and implemented in the Code of Federal Regulations<sup>41</sup> as well as in the EU following the publication of a positive EFSA opinion<sup>40</sup>.



# Where can I find Palatinose™ (isomaltulose)?

Globally, Palatinose™ is used as an ingredient in a growing number of foods and drinks, including sports and fitness supplements, sports nutrition, instant beverages, functional dairy drinks, tea, cereal and energy bars, baked goods, meal replacement drinks, and specialized clinical nutrition products. It is half as sweet as sugar, has a natural sweet taste without any aftertaste, and does not contribute to dental caries.<sup>37</sup> Palatinose™ is listed as its generic name “isomaltulose” on the ingredient list.

Palatinose™ offers a unique alternative for high glycemic carbohydrates, with all the nutritional and physiological advantages of a fully digestible slow-release carbohydrate. It provides carbohydrate energy in a balanced way, with less blood glucose fluctuation and steadier insulin release, resulting in improved metabolism. In addition, it supports an active lifestyle as a valuable carbohydrate source in sports nutrition. Over time, use of Palatinose™ may help promote health and prevent common metabolic diseases such as type 2 diabetes and obesity.

## Key takeaways

Palatinose™ (isomaltulose) is a unique innovative carbohydrate:

- The only fully digestible and slow-release carbohydrate, providing standard carbohydrate energy (4 kcal/g)
- Balanced and sustained energy supply
- Low blood glucose and insulin response (glycemic index = 32)
- Improved metabolic profile, including lower GIP and higher GLP-1 release, to burn more body fat
- Gastrointestinal tolerance as good as sugar
- Natural, mild sweet taste
- Toothfriendly

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# BENEO-Institute – knowledge to connect nutrition and health.

The BENEO-Institute facilitates access to the latest scientific research and knowledge concerning physiology and legislation related to BENEO ingredients. With this, BENEO supports food and beverage manufacturers in innovations that are based on sound science, increase the nutritional benefits for consumers, and meet their expectations in terms of taste and natural origin.

## **BENEO-Institute – a network of minds.**

The BENEO-Institute brings together BENEO's expertise from Nutrition Science, Nutrition Communication, and Regulatory Affairs teams. It was founded and developed by experts having different scientific backgrounds such as bio-chemistry, chemistry, and nutritional science. This network of intelligence will continue to grow as scientists who already contribute to the BENEO-Institute consult their own scientific network to find solutions to the most challenging questions in the food industry.

## **Knowledgeable and active in the megatrends of nutrition.**

Consumers' health consciousness and expectations towards modern food products are under constant change – worldwide. The BENEO-Institute started early to focus on the global megatrends in nutrition science and food industry:

- Weight management
- Digestive health and its positive effects on overall health
- Blood sugar management and low glycemic concepts
- Bone health
- Dental health

## **Experienced in regulatory frameworks worldwide.**

The food and beverage industry is continuously experiencing regulatory changes. The BENEO-Institute takes an active role in monitoring and commenting on the regulatory framework on national and international levels. This relates to projects like the Codex Alimentarius' dietary fiber definition, the European Health Claim Regulation, and many more. In addition, the BENEO-Institute will continue its leadership in seeking and achieving regulatory approval for BENEO's ingredients on a global scale.



## BENEO-Institute – examples of work and benefits for BENEIO's partners.

Our in-depth knowledge of nutrition is one important part of what we offer to our customers and partners. With this we continue supporting product innovation based on scientific evidence to facilitate the launch of new products. We are interested in exchange, aiming to inspire partners, and be inspired to help increase the knowledge of how important healthy nutrition is and how good it can taste.

Examples of our work include:

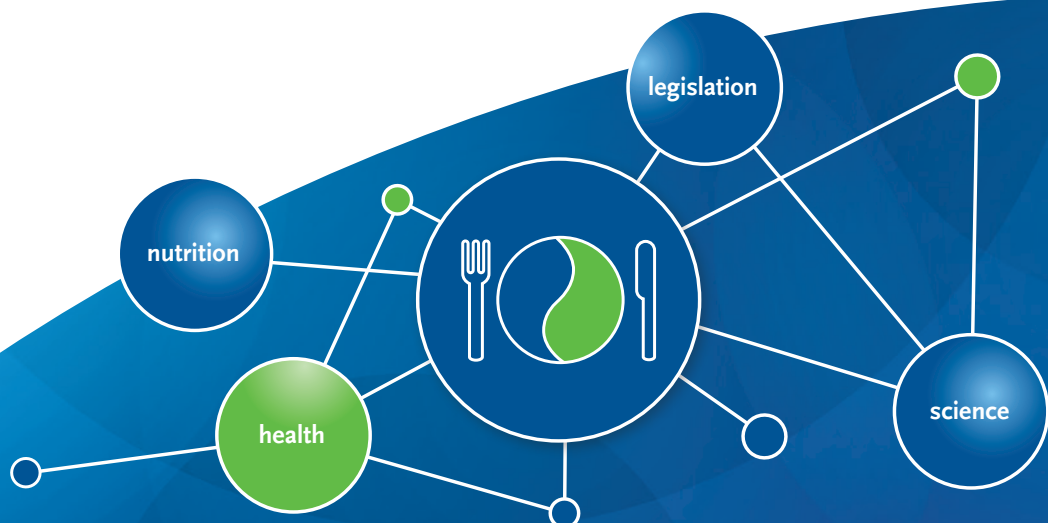
- Nutritional research and peer-reviewed articles
- Position papers on nutritional and regulatory topics
- International research conferences and workshops
- Consultancy with respect to regulations
- Support with product composition
- Participation in joint research projects

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It does not contain any warranty that the supply or use of the goods in any territory is not an infringement of the rights of third parties in industrial or intellectual property. It can also not be regarded as an encouragement to use our products in violation of existing patents or legal provisions in the matter of foodstuffs.

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## Want to know more?

We invite you to check out [www.beneo.com](http://www.beneo.com) for more information on Palatinose™ (isomaltulose).

If you have any questions, please contact us at [contact@beneo.com](mailto:contact@beneo.com).

We will be happy to assist you.

### **BENEO-Institute**

c/o BENEIO Inc.

6 Upper Pond Road #3A,  
Parsippany, NJ 07054 (USA)

Phone +1 973 867 2140

Fax +1 973 867 2141

An initiative of

### **BENEO GmbH**

Maximilianstraße 10  
68165 Mannheim (Germany)

Phone +49 621 421-150

Fax +49 621 421-160

[contact@beneo.com](mailto:contact@beneo.com)

[www.beneo.com](http://www.beneo.com)

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