Matching today's expectations.
Functional carbohydrates for better nutrition.

beneo
connecting nutrition and health

Matching today's expectations.

What are today's nutritional expectations?

Modern nutritional habits are often characterised by a fast pace of life, frequent snacking and reduced time to regularly prepare a wholesome meal from scratch. People tend to go for the fast and easy options. This often means high glycaemic diets combined with a disproportional daily calorie intake. When poor dietary habits are then combined with insufficient physical activity, this does not only drive the individual metabolism out of balance, but also has remarkable consequences on populations: The international societal result has been a tremendous rise in non-communicable diseases, such as obesity, type 2 diabetes, cardiovascular diseases and others.

The health relevance of lower glycaemic nutrition is strongly gaining traction among public health experts and informed consumers alike. Today consumers are starting to actively look for products that help them in keeping their blood glucose on a lower and more balanced level. In the USA, for example, almost half of the consumers have been found to be explicitly concerned about avoiding large peaks and drops in their blood glucose levels.

The growing public awareness extends to the amount of sugar and calorie intake. About half of the European and American population is looking for products that will lower their overall calorie intake, and almost two thirds of both populations also actively try to limit their sugar intake.

Ideal carbohydrate solutions for different needs.

Even more important than protein and fat, carbohydrates are the most essential nutrients that provide our body with the very energy it functions on. Following nutrition recommendations around the globe, more than 55 % of the daily energy intake should come from available carbohydrates. This means these carbohydrates have a strong influence on our body's metabolism. However, one has to distinguish between different kinds of carbohydrates – in terms of their digestibility, their speed of absorption, their influence on blood glucose levels and hormones like insulin as well as in terms of their potential effect on dental health.

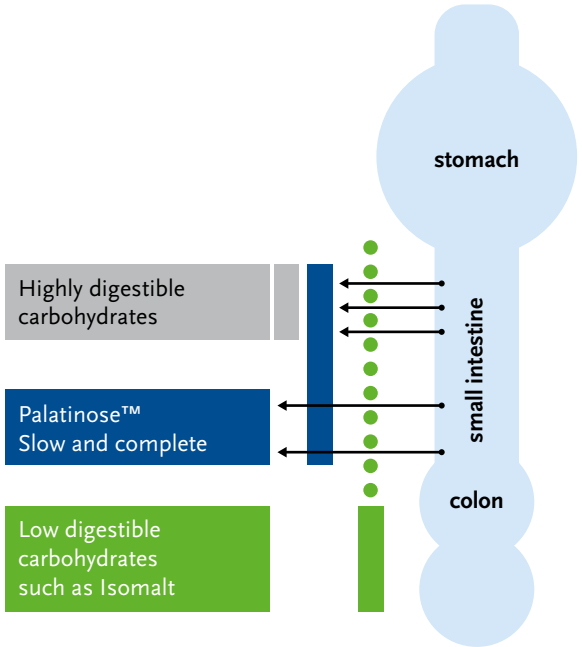
In today's diet, the vast majority of carbohydrates are quickly available, highly digestible starches and sugars. As a refreshingly different approach, BENEO offers two important alternatives: functional carbohydrates that drive the metabolism into more advantageous, healthy conditions.

One alternative to traditional sugars is Palatinose™, with the generic name isomaltulose. Palatinose™ is a fully available and digestible sugar that is taken up by the body in a slow and more balanced way. As such, it triggers lower blood glucose responses as well as lower insulin levels, offers a longer lasting energy effect and at the same time makes better use of fat storages for energy production.

The second BENEO functional carbohydrate is Isomalt, a polyol made from sugar. It replaces sugar cup by cup and is mainly known for its major role in sugar-free, calorie-reduced confectionery. Isomalt is a carbohydrate that is only available to the body to a very limited extent. It passes the small intestine almost entirely and reaches the large intestine where it then serves as food for the human gut microflora. Due to this digestion process, a blood glucose response hardly occurs and almost no carbohydrate energy is delivered.

Both Palatinose™ and Isomalt also have a few important benefits in common: unlike conventional carbohydrates, they both do not cause dental caries. At the same time, they convince manufacturers through their natural sugar-like taste and mouthfeel, easy applicability and excellent stability. **Upgrade your nutritional products with the next generation of healthy functional carbohydrates.**

Fig. 1: Absorption of different kinds of carbohydrates.



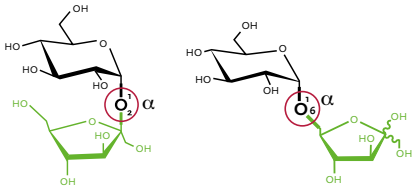
Discovering our functional carbohydrates.

All our functional carbohydrates are purely based on sucrose from the sugar beet. They are 100 % vegan, kosher, halal and non-GMO. In terms of their chemical structure, their applications and their nutritional benefits, Palatinose™ and Isomalt both have their own distinctive merits.

Palatinose™: The stable, smart carbohydrate.

Palatinose™, also generically known as isomaltulose, is derived from sugar beet. Just like sucrose, Palatinose™ consists of one glucose and one fructose unit. The difference lies in the bond between these parts. With its α-1.6-glucosidic bond, Palatinose™ is a more stable molecule compared to the α-1.2-glucosidic bond found in sucrose.This strong binding explains why Palatinose™ offers a more steady source of energy when compared to sucrose, for example. It can simply not be broken down as fast as sucrose.

Fig. 2: The chemical structures of sucrose & Palatinose™.



Sucrose Palatinose™

Range	PSD in mm	Application specific
Palatinose™ PST-N	< 0.71	various foods & beverages
Palatinose™ PST-PF	< 0.1	fine powder of various foods & beverages
Palatinose™ PST-PA	< 0.05	coated products and tablets

PSD: Particle size distribution; particle sizes apply for 90 % of the product

Areas of application for Palatinose™.

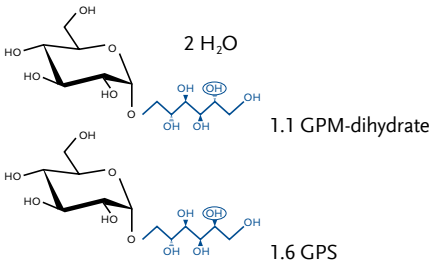
Although Palatinose™ has proven to work great in all kinds of beverages, it can also be used in a multitude of other applications:

- Baked goods
- Breakfast cereals & cereal bars
- Confectionery
- Dairy products
- Frozen desserts
- **Fruit juice beverages**
- **Malt beverages**
- **Near water**
- **Powder based drinks**
- Special and clinical nutrition
- **Sports beverages & energy drinks**

Isomalt: The sugar-free nutritive sweetener.

Isomalt is the only sugar-free nutritive sweetener derived exclusively from sucrose. It is produced by an enzymatic step followed by hydrogenation. The resulting principal components of Isomalt are 6-0-α-D-glucopyranosyl-D-sorbitol and 1-0-α-D-glucopyranosyl-D-mannitol dehydrate. This molecular structure explains why Isomalt provides a sweetening profile almost equal to sucrose – but only half the calories! This makes Isomalt work perfectly as a healthy sugar replacer for calorie-reduced and toothfriendly products.

Fig. 3: The chemical structure of Isomalt.



Range	PSD in mm	Application specific
Standard Isomalt crystalline (ST)		
Isomalt ST-M	0.5 – 3.5	hard candies
Isomalt ST-F	0.2 – 0.7	chocolate, powder drinks
Isomalt ST-PF	< 0.1	chocolate, low boilings, chewing gum, baked goods
Isomalt ST-PA	< 0.05	granulates
Isomalt crystalline with good solubility (GS)		
Isomalt GS	(unsieved)	coating
Isomalt GS-PF	< 0.1	coated products, fruit spreads
Isomalt GS-PA	< 0.05	baked goods, granulates
Low moisture Isomalt crystalline (LM)		
Isomalt LM-E	0.063 – 0.9	chocolate
Isomalt LM-PF	< 0.1	chocolate
Isomalt crystalline for direct compression (DC)		
Isomalt DC 101	0.1 – 0.8	direct compressed tablets (swallow)

PSD: Particle size distribution; particle sizes apply for 90 % of the product

In addition to these Isomalt varieties, BENEO also provides liquid variants that our expert sales force can personally inform you about at any time.

Areas of application for Isomalt.

Especially when it comes to hard candies, Isomalt is the number one sugar replacer worldwide. However, it is also utilised in a lot of other applications:

- Baked goods
- Breakfast cereals & cereal bars
- **Chewing gum**
- Chocolate
- **Coated products**
- **Compressed tablets**
- **Low-boiled candies**
- Frozen desserts
- Fruit spreads

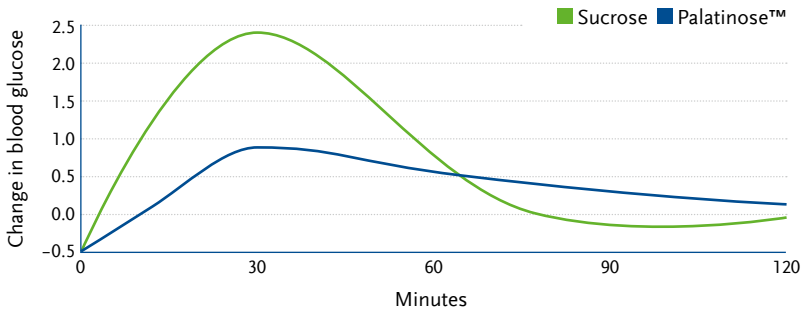
Tapping the full potential of low glycaemic power.

As a fully but slowly digestible carbohydrate, Palatinose™ provides the entire carbohydrate energy in a slower and more balanced way. Unlike high glycaemic carbohydrates that are already completely absorbed at the beginning of the small intestine, Palatinose™ is the only fully available carbohydrate that is absorbed more slowly – and throughout the entire small intestine. This results in a slower and overall lower rise in blood glucose as well as in an enhanced fat oxidation. In addition, this next generation carbohydrate is recognised as toothfriendly.

For sustained energy: Stretching the power curve.

Palatinose™ provides the body with the same amount of carbohydrate energy as sucrose does, with three important differences. First of all, the energy is released more slowly and not all at once. The blood glucose peak is therefore lower and the blood glucose curve is stretched, which leads to the second difference: a prolonged, more balanced energy supply for the body (see Fig. 4). Additionally, Palatinose™ supports fat oxidation to occur at a higher level. Ideally this allows for the body's own carbohydrate storage to be spared for higher levels of endurance. Therefore, Palatinose™ is the ideal carbohydrate for athletes and all others who count on mental or physical stamina.

Fig. 4: The blood glucose response of Palatinose™ in healthy adults.



For a healthy metabolism: Balancing blood glucose profiles.

Science increasingly makes reference to the health benefits of a carbohydrate-based low glycaemic diet, especially regarding the development of a number of non-communicable diseases. A low glycaemic diet may offer the following preventive effects:

- Safeguarding the body's sensitivity to insulin (contributes to preventing type II diabetes)
- Improving diabetes control
- Reducing the risk of heart disease
- Lowering blood cholesterol levels

The slow digestion of Palatinose™ smoothens peaks and drops in blood glucose levels that are known from sucrose intake situations, thus reducing the resulting insulin release. There is no "sugar rush" and blood glucose levels do not drop so early below the baseline as experienced with conventional carbohydrates (see Fig. 4). Thus the body is more steadily provided with energy in the form of glucose.

For healthy weight management: Promoting fat oxidation.

Insulin facilitates the transition of glucose from the blood into the cells so that a normal blood glucose level can be quickly achieved. At the same time, insulin is a so-called ‘storage hormone’ and as such it is responsible both for fat storage and the suppression of fat burning. As Palatinose™ induces a low blood glucose response, the body releases only a reduced amount of insulin, which has a positive effect on the entire metabolism. Fat can then be used and burned for energy supply.

In a study on overweight participants with insulin resistance, the consumption of meals containing Palatinose™ did not only prove to result in lower rises in blood glucose and a lower daily insulin level, but also showed an increase in fat burning by up to 18 %.

For a bright smile: Keeping teeth healthy.

Commonly known carbohydrates like sucrose or starches put teeth at risk by being cariogenic. As Palatinose™ can scarcely be fermented by oral micro-organisms, acid production hardly occurs and the pH does not drop to critical levels.

Up to now, the only toothfriendly alternatives have been sugar replacers (polyols). With Palatinose™, a fully digestible alternative is now available for the first time: A sugar that is kind to teeth! Palatinose™ can be used in toothfriendly chocolate and candy bars designed for those younger generations that can’t get enough of their sweet treats. Its toothfriendliness has been accepted by the U.S. Food and Drug Administration (FDA) with a corresponding health claim in the Code of Federal Regulations and is an approved health claim within the European Union. BENEO offers a range of specialty sugar grades to promote your toothfriendly products to consumers.

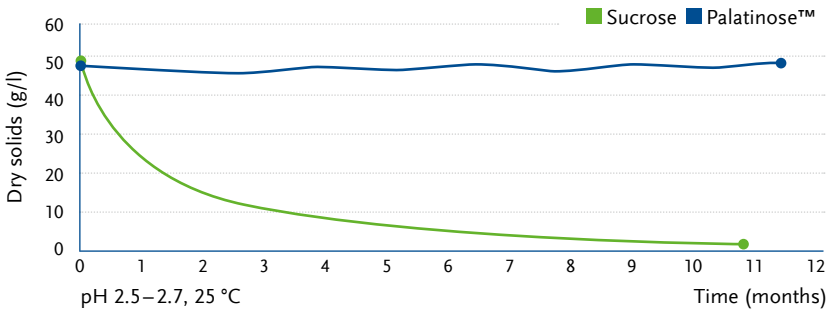
Enhancing your products with Palatinose™.

Next to its nutritional benefits, Palatinose™ also convinces through a whole range of technical benefits: The functional carbohydrate can be included in food and beverages without any changes in the production processes. Its acid and temperature stability result in a longer shelf life and more specifically it can support a better rehydration after exercise. Its low hygroscopicity prevents powder drinks from lumping and its taste and mouthfeel closely resemble the popular sweetness profile of sucrose, thus providing a natural, sugar-like taste and sweetness. At the same time, Palatinose™ displays a high stability against fermentation by most yeasts and cultures in yogurts, yogurt drinks, kefir and beer.

For a longer shelf life: Avoiding hydrolysis.

With an α-1.6-glucose-fructose bond, Palatinose™ has a much higher stability than sucrose, which only consists of an α-1.2 bond: Palatinose™ is not hydrolysed by acids as easily as sucrose (see Fig. 5). This characteristic is especially relevant for isotonic sports drinks which usually have a pH value of less than three. If these beverages contain sucrose, the latter will hydrolyse into glucose and fructose. This in turn increases the number of osmoactive particles and produces an imbalance of the isotonic osmolality, resulting in a lower rehydration functionality after exercise. Palatinose™ does not hydrolyse and therefore supports a longer shelf life with the full rehydration effect that an isotonic sports drink should offer.

Fig. 5: Palatinose™: Stable against hydrolysis in low pH beverages.



For a longer shelf life: Limiting water activity with bilayer products.

With bilayer products, such as glazed donuts, the dough underneath the donut glazing becomes harder over time. Shelf life can be extended when water migration between two layers is carefully controlled. When Palatinose™ is used in the glazing, water activity is balanced. Thus, the dough keeps its original softness and freshness, the shelf life is extended and logistics costs are minimised.

For free powder flow: Benefiting from low hygroscopicity.

At a temperature of 25 °C and relative humidities up to 85 %, Palatinose™ absorbs virtually no moisture. It is a very low hygroscopic free-flowing powder.

This characteristic makes it the perfect ingredient for all powder drinks and blends. As it reduces water absorption and therefore significantly minimises the risk of caking and lumping, Palatinose™ is the ideal carrier for baby food or special nutrition products. Even in blends with other sugars like sucrose or fructose, Palatinose™ can reduce the moisture uptake of the powder.

For a sugar-like taste and mouthfeel: Resembling the organoleptic profile of sucrose.

Palatinose™ is naturally derived from sucrose. Therefore it offers a very similar organoleptical profile with 50 % of the sweetness compared to sucrose. Density, specific volume and viscosity of Palatinose™ aqueous solutions are identical to sucrose solutions with the same concentration, thus delivering a very similar mouth-feel otherwise obtained from sucrose. Furthermore, Palatinose™ can also be combined with high intensity sweeteners in order to achieve any kind of sweetness profile – without producing any side- or aftertaste.

The functional carbohydrate additionally displays a high stability against fermentation by yeasts and bacteria. A benefit that makes it ideal for the use in malt beverages, beer specialties and fermented dairy products. The use of Palatinose™ results in an optimised palate fullness, body and true-to-type sensorial profile.

At a glance: The benefits of Palatinose™.

Nutritional benefits	Technical benefits
• Balancing blood glucose levels • Sustained energy thanks to a stretched power curve • Promoting fat burning • Preventing demineralisation of tooth enamel	• Free powder flow due to low hygroscopicity • Longer shelf life due to high stability at low pH and high temperatures • Shelf life extension due to excellent moisture barrier • Sugar-like taste and mouthfeel, improved palate fullness

Reducing sugar the healthy way.

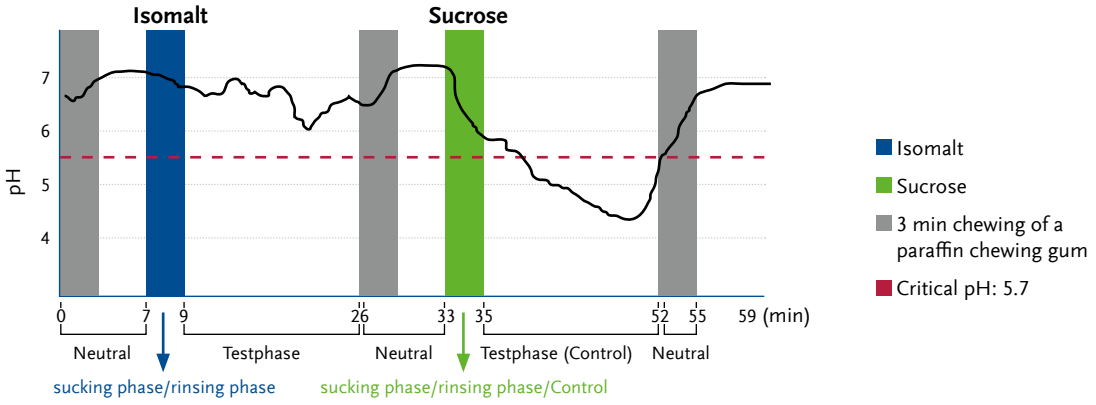
The functional carbohydrate Isomalt is a naturally-derived bulk sugar replacer. With only half the calories of sucrose, it is the number one sugar replacer for hard candies worldwide. Thanks to its physiological properties, this sugar-free, nutritive ingredient perfectly matches the consumer trends of dental health, weight management and keeping the body's metabolism healthy throughout life.

For dental health: Preventing tooth decay.

Dental cavities develop when bacteria convert fermentable carbohydrates into acids, which then attack the tooth enamel. As most micro-organisms occurring in the oral cavity are unable to feed on Isomalt, the pH-level always remains above the critical level of 5.7. This has been demonstrated in numerous clinical trials (see Fig. 6).

Furthermore, Isomalt reduces plaque formation as it cannot serve as a structural component of the plaque. By stimulating saliva production, it even has a remineralising effect which promotes the repair of incipient cavaties. Research also suggests that Isomalt enhances the positive effects of fluoride.

Fig. 6: pH-value after the consumption of Isomalt and sucrose.



For healthy weight management: Cutting down the calories.

Even small changes in calorie intake can have major impacts. It all depends on the overall calorie balance. Studies have shown that on average, women and men gain up to one kg each year, simply by eating as little as respectively four kcal and 13 kcal a day more than the amount of calories required.

A smart, low calorie sugar replacer such as Isomalt can counter these effects. As Isomalt is mainly fermented in the colon, the human body can only use less than 50 % of its energy. This explains its low caloric value of two kcal/g which is accepted for food labelling in Canada, the U.S.A. and other countries.

For a health-conscious lifestyle: Little effect on blood glucose levels.

Being a low digestible carbohydrate, Isomalt is only partially digested by the body's enzymes. Compared to rapidly absorbed, high glycaemic carbohydrates it has a very low effect on blood glucose levels. Studies have shown that both blood glucose and insulin levels rise only minimally after Isomalt consumption, compared with glucose. This is especially relevant when managing diabetes, overweight or cardiovascular diseases.

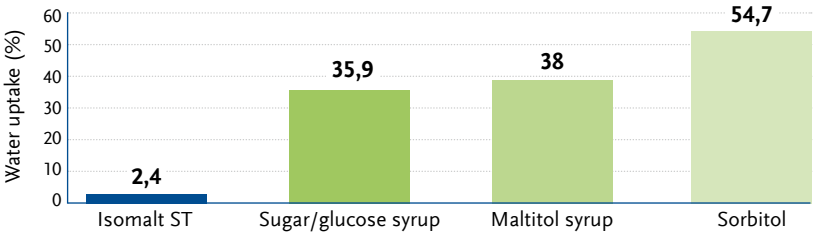
Enhancing your products with Isomalt.

Increasing shelf life stability, avoiding stickiness of hard boiled candy, enhancing colours and crunchiness of chewing gum coatings or optimising tastes – from menthol to fruity flavors: Isomalt does not only convince through easy processing due to its temperature stability. It also offers manufacturers a whole range of benefits considerably enhancing their low-calorie and sweet tasting products.

For longer shelf life and convenient packaging: Profiting from low hygroscopicity.

Isomalt's hygroscopicity is lower than that of most polyols and even sugar itself. Consequently, it virtually absorbs no moisture at room temperature and relatively high humidity. This makes Isomalt the ideal component to stabilise formulations with ingredients that are themselves highly sensitive to moisture absorption. In hard boiled candy, for example, Isomalt's low hygroscopicity does not only minimise stickiness during forming, cutting and wrapping. It also prevents the products from sticking afterwards, thus enabling unwrapped candy to be packed together while guaranteeing a longer shelf life.

Fig. 7: Low hygroscopic Isomalt: Increasing storage stability of high-boiled candies.



25 °C, 80 % r.h., 7 days

For brilliant colours and attractive coatings: Profiting from transparency.

While sugar has a white colour, Isomalt is translucent due to its unique chemical structure. Thus, it boosts the colour brilliance in the coatings of products such as chewing gum, jelly beans or colour coated chocolate lentils. This can even have a positive influence on the production processes: With chewing gum coatings and dragees, for example, any intense colour can be simply applied without having to change the coating process. Isomalt also enhances products where transparency plays an important role, such as high boiled candies and lollipops.

For easy processing: Providing stability when cooking and coating.

Isomalt remains stable even at high temperatures and is highly resistant to acids and enzymatic hydrolysis. If only Isomalt is used, no maillard reaction occurs during the cooking process. This can have a positive effect on the appearance of a sugar-reduced shortbread cookie, for example. These characteristics make Isomalt particularly easy to process – even easier than sugar itself. Manufacturers do not require any additional or different equipment. They do not even have to change the way of heating, making Isomalt the ideal raw material for sugar-free, toothfriendly and low-calorie products. Additionally, working with Isomalt for coating means just a single syrup process, short coating times and lower process temperatures. Beyond that, Isomalt offers excellent storage stability.

For process optimization: Higher product stability in chewing gum centre.

When Isomalt is used instead of mannitol, results show increasing starting firmness, providing a more stable chewing gum centre. As such, the shape of the gum is maintained and deformation during the coating process is avoided. Additionally, by using Isomalt in the chewing gum centre, conditioning times are reduced leading to optimised processing. Isomalt also promotes long-term firmness of gum centres to the same extent as mannitol, while maintaining chew-ability and texture.

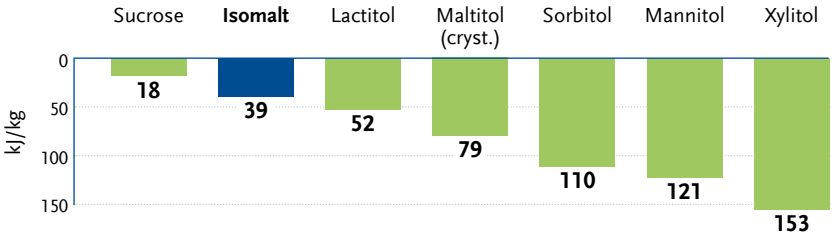
For an optimised taste and mouthfeel: Adding better flavour to sugar-free products.

As Isomalt's natural origin is sugar, it shows a very similar organoleptical profile – with 45 % to 60 % of the sweetness of sucrose. Where a strong classic sugar taste can overpower the more delicate fruit flavours, Isomalt's subtle sweetness brings about a better flavour release of those more gentle notes.

In applications such as sugar-free chewing gum or fruit-flavoured hard candies, this flavour-release-functionality is perfectly complemented with Isomalt's low solubility, which improves the sweetness retention. Isomalt virtually absorbs no moisture and can therefore maintain the crunchiness of coated applications. On top of this, it also ensures a smooth surface on candies and lollipops avoiding those sharp cracks that can compromise the indulgence.

With a negative heat of solution of only –39.4 kJ/kg, Isomalt also has a lower cooling effect than all other sugar replacers. This makes it the ideal low-calorie sweetener for chocolates, low-boiled candies and baked goods, for example. In combination with high intensity sweeteners, Isomalt can furthermore achieve any sweetness profile without producing any side- or aftertaste.

Fig. 8: Negative heat of solutions of sugar and sugar alcohols.



At a glance: The benefits of Isomalt.

Nutritional benefits	Technical benefits
• Preventing demineralisation of tooth enamel • Half the calories • Little effect on blood glucose levels	• Longer shelf life and reduced stickiness due to low hygroscopicity • Easy processing due to high process stability • Brilliant coloured coatings and highly transparent hard candy shell • Optimised taste and mouthfeel • Enhanced and prolonged flavour release

Convincing either way.

BENEO functional carbohydrates do not only make your food products healthier. They also add a whole range of application benefits – from better taste to longer shelf life.

Palatinose™ in a nutshell.
Palatinose™ is the only fully available, slowly digestible, toothfriendly sugar on the market. It offers a sustained energy supply, a lower impact on blood glucose levels as well as an increased fat oxidation. Beyond that Palatinose™ convinces through its excellent stability, its ability for shelf life extension, free powder flow and its sugar-like taste and mouthfeel.

Isomalt in a nutshell.
Isomalt, on the other hand, is a nutritive, toothfriendly sweetener with only half the caloric value of traditional sugar. Beyond its low effect on blood glucose, it serves as a calorie-reducing sugar replacer while providing a natural sugar-like taste. Apart from a longer shelf life and high process stability, Isomalt prevents stickiness and offers an optimised taste and mouthfeel.

To sum up, Palatinose™ and Isomalt can help you to produce food and beverages that will perfectly match today's expectations and tomorrow's markets. Each one in its own way. Together, we can contribute to better nutrition and health.

Always at your side: Profit from our interdisciplinary expertise.

Our experts comprise valuable insights. No matter if your question concerns physiology or process technology, if it is marketing related or if it is about legislation and regulations. With nutritionists, marketers, regulatory professionals, technical food engineers and a competent sales force throughout the world, there is always a BENEO expert that can help you. It's the combination of advanced ingredients and specialist knowledge intertwined with access to a global network of experts which makes BENEO a unique business partner.

Also interested in other ingredients? Discover our complete range now.

The BENEO range of ingredients also includes functional fibres, specialty rice ingredients and functional protein.
Learn more about the other BENEO ingredients online: **www.beneo.com**

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Sydney University's Glycaemic Index Research Service (SUGiRS). Glycemic Index of isomaltulose and Isomalt, published in the GI database at www.glycemicindex.com

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