

Figures. Facts. Benefits.

Palatinose™ – The next generation sugar



palatinose™

beneo
palatinit

Palatinose™ – Breaking the boundaries between sweeteners and functional carbohydrates

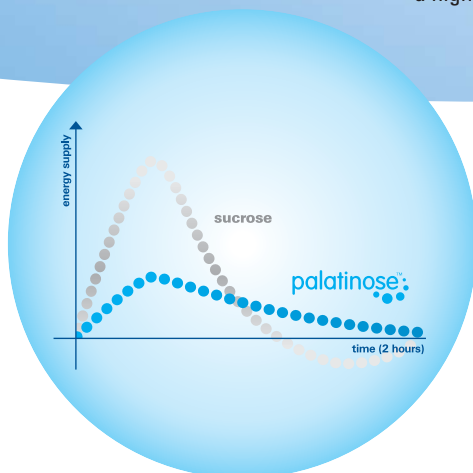
Palatinose™ is a pure, white crystalline carbohydrate derived from sucrose and occurring naturally in e.g. sugar cane juice or honey. The disaccharide produced by BENEÓ-Palatinin is kosher, halal and non-GMO. The generic name of this sucrose isomer is Isomaltulose. It is applied as a functional carbohydrate to capitalize on its distinctive nutritional and technological properties.

Why is Palatinose™ unique?

Due to its specific molecular bond Palatinose™ is fully absorbed but slower than commonly known sugars or carbohydrates. It therefore offers the full caloric value of carbohydrates (4 kcal/g) but in a balanced and longer lasting way.

Compared to sucrose it is however the combination of the following characteristics that allows Palatinose™ to be called the “next generation sugar”:

- Kind to teeth
- Completely available with a slower digestion and absorption in the small intestine resulting in a continuous bioavailability
- Direct but balanced and longer lasting source of glucose which is the most important energy providing nutrient for muscles and brain
- A low insulinemic and low glycemic index (GI: 32)
- In contrast to quickly absorbed carbohydrates Palatinose™ facilitates a higher level of fat oxidation during physical activity



Palatinose™ combines different physiologically favorable properties which otherwise are attributed to higher molecular non-sweet carbohydrates or less-digestible and not so well tolerated carbohydrates.

It is therefore the preferred choice to make your food and beverage application more healthy and to offer your consumers an optimized way of energy management for body and mind.

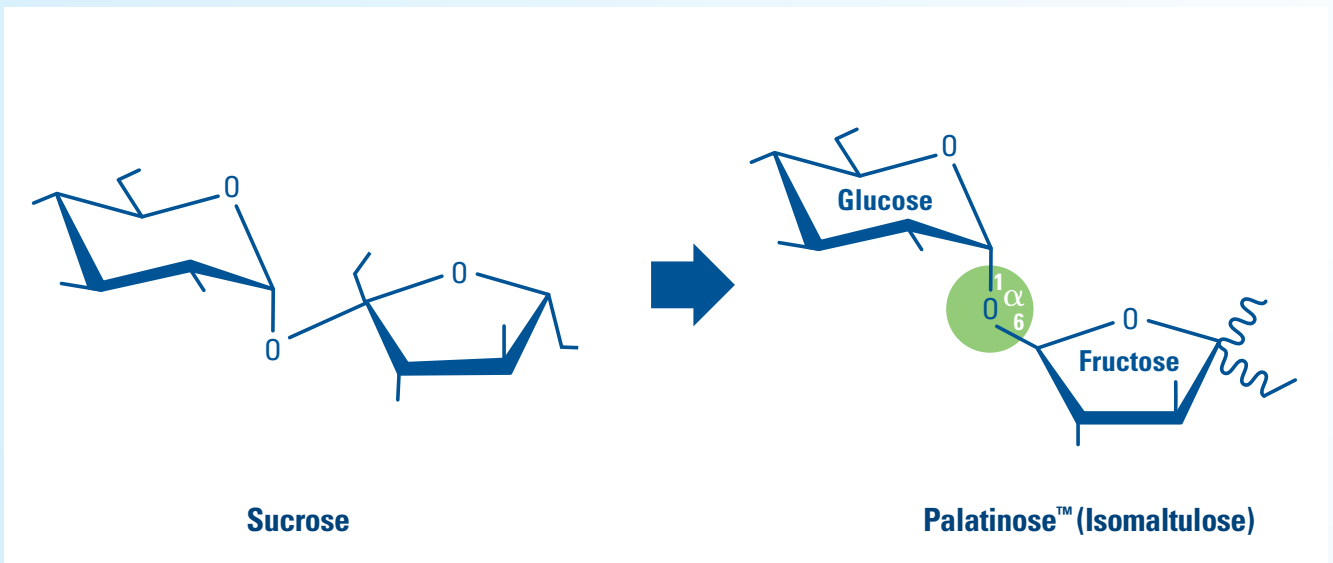


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Innovation in energy management – Derived from a natural source

Palatinose™ is commercially produced from food-grade sucrose by enzymatic rearrangement of the glycosidic linkage between glucose and fructose from an α -1,2 linkage of sucrose to an α -1,6 linkage in Palatinose™. The resulting new molecular linkage of Palatinose™ is much more stable compared to that of sucrose.



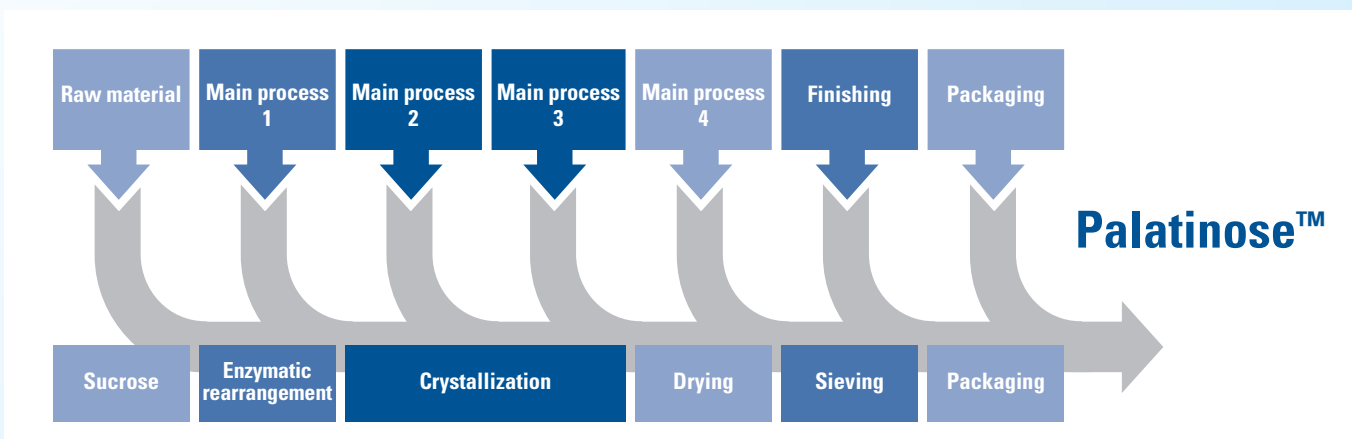
Production process: Chemical perspective

Palatinose™ is available in different qualities depending on the designated application it will be used in e.g.:

Palatinose™ PST-N	Crystalline: 90% < 0.7 mm	<ul style="list-style-type: none"> • Functional beverages • Sports nutrition • Dairy products • Beer & beer specialties • Meal replacement • Clinical & special nutrition • Chocolate, cereals & bars
Palatinose™ PST-PF Palatinose™ PST-PA	Powder: 90% < 0.1 mm Powder: 90% < 0.05 mm	<ul style="list-style-type: none"> • Powder drinks & blends • Coated products • Granulates & agglomerates
Palatinose™ PAP-N	Crystalline: 90% < 0.7 mm	<ul style="list-style-type: none"> • Toothfriendly products (chocolate, drinks, coating)

The shelf life of Palatinose™ is comparable to that of sucrose. It is best stored under dry conditions and at moderate temperatures.

Palatinose™ product family



Palatinose™ production process



Sweet functionality

The motivation to conduct product development with Palatinose™ on one hand comes from the fact that this functional ingredient allows to substantiate nutritional claims and innovative product positioning, on the other hand to profit from its technological benefits.

As important as functionality in all food and beverage is taste:

Palatinose™ comes along with a sucrose-like natural sweet perception without any aftertaste. Its sweetening power is about 50 % that of sucrose, possible to be adjusted by means of intense sweeteners (Stevia, Sucralose etc.) to any required sweetening level*.

Dependent on the application, a combination of Palatinose™ with other carbohydrates can also result in improved sweetness as well as taste and texture of the final product.

For example, Palatinose™-Acesulfame K mixtures showed a sweetness profile and perception matching closest to that of sucrose when compared with alternative combinations of intense and bulk sweeteners**.

In combination with functional ingredients like omega-3-fatty acids, EGCG and others Palatinose™ seems to mask off-taste and -odor.

In beer and alcohol free malt-based beverages Palatinose™ can improve taste and palate fullness (mouth-feeling) of the final product in addition to an improved nutritional value.

** Depending on the country-specific legislation, regulatory requirements for combination of high-intense sweetener and sugar should be taken into consideration.*

*** (Innovations in Food Technology, 11/2006)*





Exemplary sweetening concepts

Palatinose™ 99.97 %	Sucralose 0.03 %	<ul style="list-style-type: none"> • 10 % Palatinose™ solution and HIS to achieve an iso-sweetness of sucrose (10 % solution)
Palatinose™ 99.95 %	Stevia* 0.05 %	
Palatinose™ 99.986 %	Stevia* 0.014 %	<ul style="list-style-type: none"> • 6 % Palatinose™ solution and stevia to achieve an iso-sweetness of HFCS (6 % solution)
Palatinose™ 99.930 %	Stevia* 0.046 % Acesulfam K/Aspartam 0.024 % (1:1)	<ul style="list-style-type: none"> • 4 % Palatinose™ solution and HIS to achieve an iso-sweetness of sucrose (8 % solution)
Palatinose™ 99.915 %	Stevia* 0.059 % Acesulfam K/Aspartam 0.026 % (1:1)	<ul style="list-style-type: none"> • 3 % Palatinose™ solution and HIS to achieve an iso-sweetness of sucrose (8 % solution)

* Total Rebaudioside A content: 95 %

EGCG: Epigallocatechin-3-gallat (Polyphenole; Green Tea Extract)

HFCS: High fructose corn syrup

HIS: High intensity sweetener

Applications and technological basics with Palatinose™

Looking at the technological properties and considering its nutritional benefits, Palatinose™ allows the development and optimizes the composition of a wide array of food and drink products, such as:

LIQUIDS

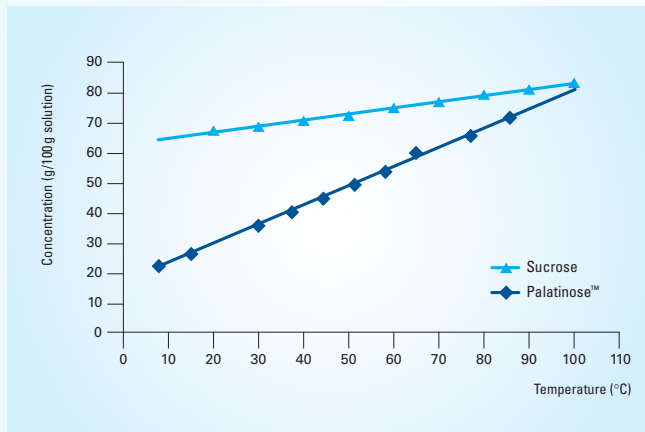
- Functional, sport and energy beverages
- Toothfriendly beverages
- Wellness drinks and ice tea
- Enhanced fruit juices and juice based drinks
- Enhanced water, near water and aqua plus concepts
- Milk mixed drinks, drink yogurts
- Whey-, soy- and rice-based beverages
- Beer, beer mix and malt beer varieties
- Special and clinical nutrition

SOLIDS

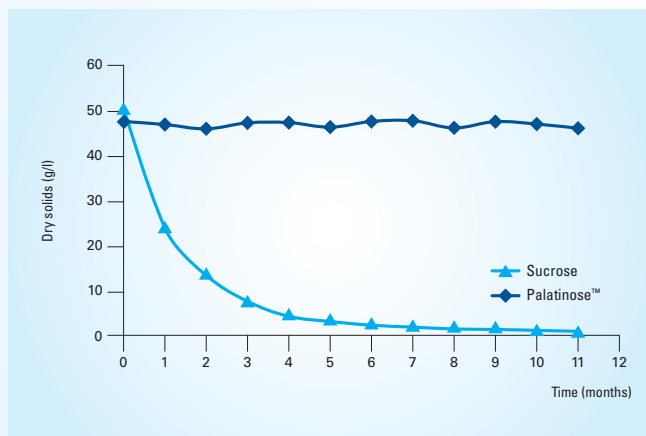
- Powders, instant and compressed products
- Food supplements and nutraceuticals
- Toothfriendly chocolate and sweets
- Nutritional and cereal bars and ice cream

Solubility and stability

Palatinose™ offers a good solubility (29 %; 20°C/aqueous solution) and a very high stability under acidic conditions even at high shelf temperatures:



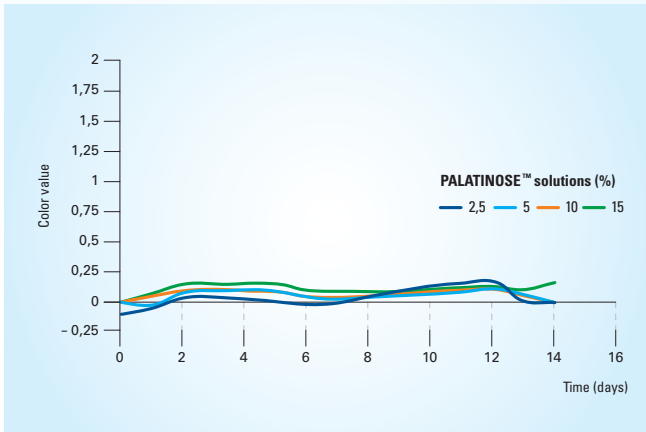
Palatinose™: Exhibits good solubility for RTD-Application



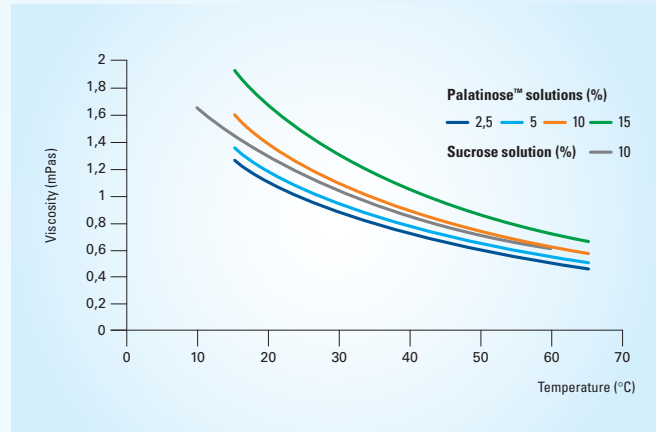
Palatinose™: Stable against hydrolyzation (25°C; pH, 2.5 - 2.7)

Density and viscosity

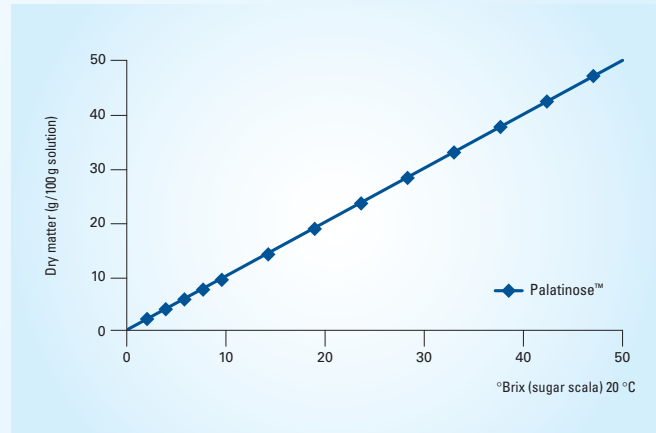
Density, specific volume and viscosity of Palatinose™ aqueous solutions are just the same as equal concentrated sucrose solutions.



Palatinose™: Stable against discoloration (40°C, pH2)



Palatinose™: Sucrose-like viscosity of solution



°Brix values of Palatinose™ solutions comparable to those of sucrose

Also the refractive index of Palatinose™ solution is identical to that of sucrose. Thus, refractometry can be easily applied for determination of Palatinose™ concentration in water.

Technological properties

Palatinose™ improves sports beverages: Hypotonic – isotonic – hypertonic

Many sports drinks with a pH value of ~ 3 currently on the market contain sucrose which in an acidic environment hydrolyzes into glucose and fructose. That means the number of osmoactive particles increases and the isotonic balance may be destroyed.

The Palatinose™ benefit:

Unlike sucrose Palatinose™ is not easily hydrolyzed by acids, thus it is ideal for iso- or even hypotonic beverage concepts, as it helps to maintain the osmolality of the product.



Hypertonic drink

Formulation

Ingredients	%
• Palatinose™ PST-N	4.02
• Fructose	3.01
• Water	92.57
• Citric acid (monohydrate)	0.30
• Pectin	0.10

Total 100.00

Flavoring and coloring corresponding to supplier's recommendations.

Product characteristics

• Density	1.028 kg/l
• Caloric value	31.7 kcal/100 ml
• Osmolarity	374 mOsmol/kg
• rel. sweetness	5.6 g (sacch)/100 g

Hypotonic rehydration drink

Formulation

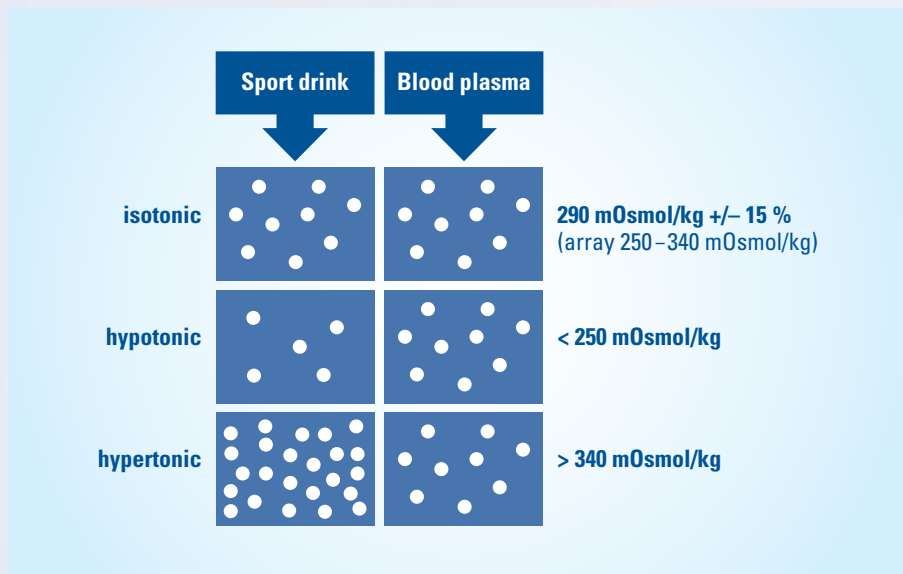
Ingredients	%
• Palatinose™ PST-N	3.935
• Water	95.598
• Citric acid (monohydrate)	0.401
• Pectin	0.050
• Aspartame	0.016
• Acesulfame K	0.009

Total 100.00

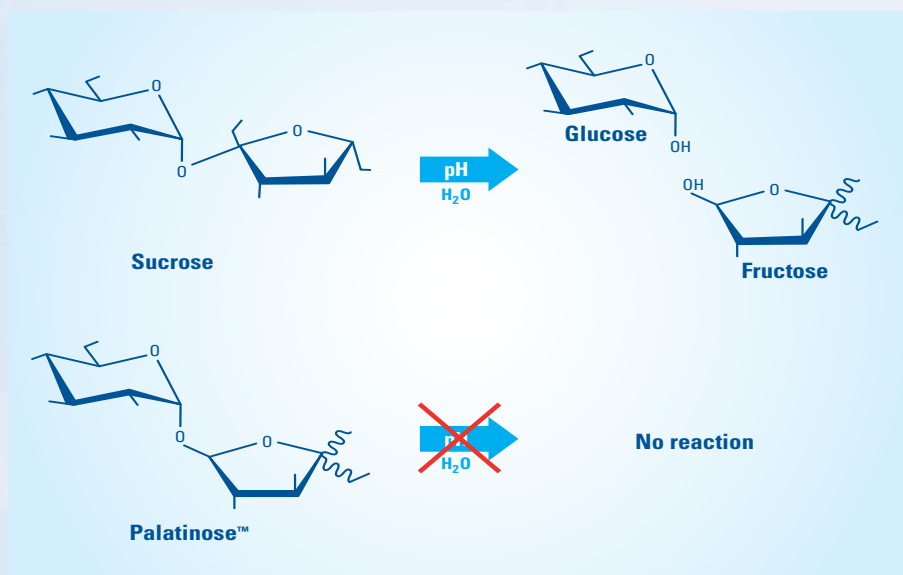
Flavoring and coloring corresponding to supplier's recommendations.

Product characteristics

• Density	1.016 kg/l
• Caloric value	18.9 kcal/100 ml
• Osmolarity	220 mOsmol/kg
• rel. sweetness	5.9 g (sacch)/100 g



Different osmolality in sports drinks



Palatinose™: Reduced hydrolysis in beverages with Palatinose™ compared to sucrose

Technological properties

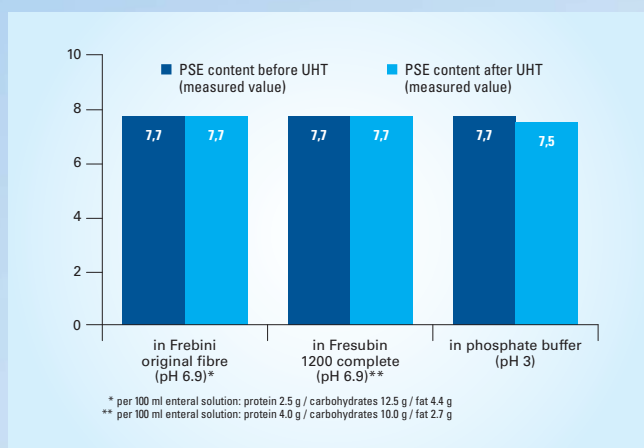
Palatinose™ brings stability into liquid applications containing proteins

Like lactose in milk or many other sugars Palatinose™ tends to undergo Maillard reactions. This might result in coloration at certain high temperatures and long heating periods. However, if Palatinose™ is added into e.g. milk or yogurt, this issue can be managed under certain conditions.

For sterilization of e.g. special and clinical nutrition products, UHT can effectively be used to avoid colorization. In general, shorter heating periods at higher temperatures are favored.

Conditions: 0.5 %, 1 %, 3 % and 6 % Palatinose™ added to milk, UHT (143°C/7–8 sec), stored at 38°C/1 week.

Pasteurization of a Palatinose™ containing protein solution for 10 minutes at 90°C also results in a stable product without colorization.



Palatinose™: Stable under UHT treatment; 2 seconds at 143°C

Yogurt drink

Formulation

Ingredients	%
• Palatinose™ PST-N	9.00
• Full cream milk (3.5 % fat)	80.81
• Water	9.48
• Pectin ¹⁾	0.50
• Yogurt culture solution ²⁾	0.20
• Sucralose	0.0056

Total **100.00**

¹⁾ Pectin classic CM203, Herbstreith Fox/DE

²⁾ YF-3331 (Lactobacillus bulgaricus and Streptococcus thermophilus), CHR Hansen/DK

Process

1. Defrost the cultures and make a solution of 10 % in full cream milk.
2. Store at 45°C until used.
3. Make a solution of 3.5 % of the pectin in water at 60°C.
4. Store at room temperature until used.
5. Add Palatinose™ and sucralose to the milk and heat to 95°C.
6. Hold this temperature for 5 minutes.
7. Cool down to 50°C and add the yogurt culture solution (0.2 %).
8. Incubate at 45°C until a pH of 4.5 (+/- 4 hours).
9. Add the pectin solution (14.3 %) and homogenize at 150 bar.
10. Store refrigerated.

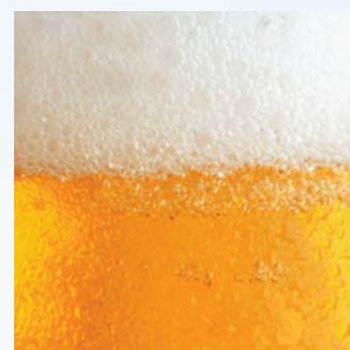
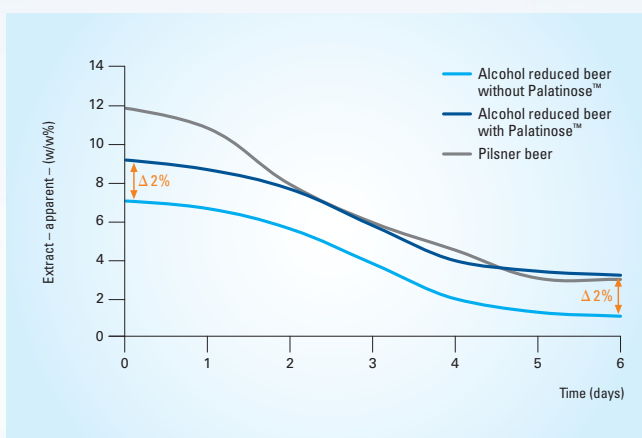
Product characteristics

• Dry substance	20.20 %
• Caloric value	95 kcal/100 ml
• Fat	2.70 %
• Lactose	3.70 %
• GI category	low glycaemic (< 55)

Profit from Palatinose™ in beverages derived via fermentation

Palatinose™ displays a high stability against fermentation by most yeasts and bacteria.

This can effectively be used for the production of e.g. probiotic yogurts to increase sweetness level with a non-fermentable functional bulk sweetener or in beer products to increase final extract, resulting in increased palate fullness, body and an optimized true-to-type sensorial profile.



Palatinose™ survives fermentation during beer brewing process, resulting in a final extract similar to traditional pilsner type beer (dosage of Palatinose™ = 2%; alcohol content of alcohol reduced beer: 2.9% vol; alcohol reduced beer was also pilsner type).

Alcohol reduced pilsner type beer (with Palatinose™)

Formulation

Ingredients

• Pilsner malt	21.00 kg
• Main casting	90.00 l
• Second casting	160.00 l

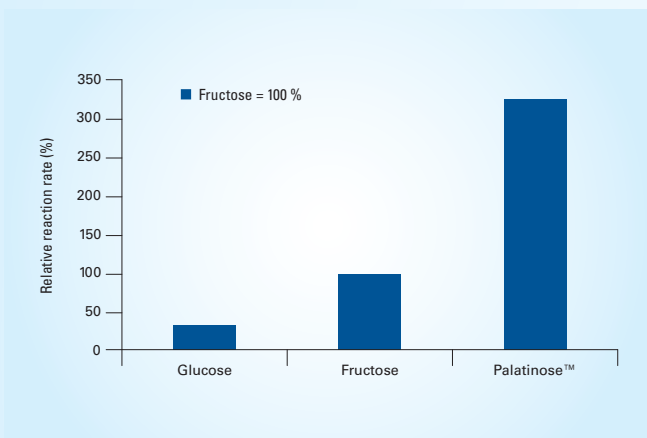
Process

1. Mashing-in (temp. 62°C, time 5 min.)
 2. Heating up to 66°C (duration 1°C per min), rest for 30 min.
 3. Heating up to 72°C (duration 1°C per min), rest for 20 min.
 4. Mashing-out temperature 78°C, lauter to cattle full 6% gravity/after boiling 7%, boiling time 60 min.
 5. Hop dosage aim at 25 – 27 bitter units.
- Add 2% of Palatinose™ add to the cattle 5 minutes before end of boiling to reach a final extract of 12%.
 - Ferment with *Saccharomyces Cerevisiae*, 20 x 10⁶ cells/ml at 11°C for 12 hours.
 - Filter after storage and bottle.
Alcohol content: < 3% vol.

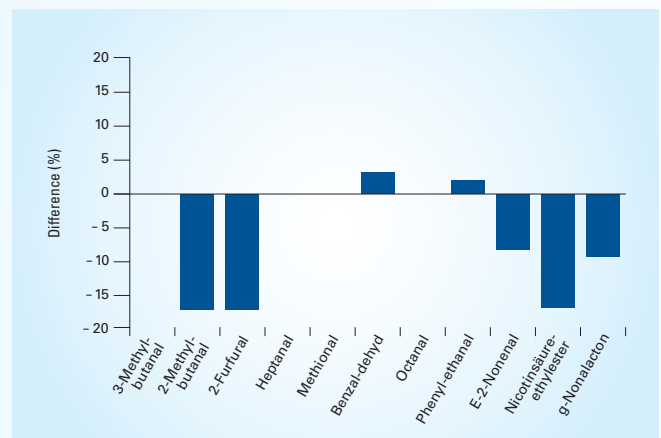
Technological properties

Antioxidant properties of Palatinose™ optimizing your product stability

In addition to its functional characteristics, Palatinose™ can be used to enhance the stability of food products which are sensitive to oxygen. This complies with the findings in different solid and liquid matrixes, e.g. beer, where Palatinose™ decreases the formation of aging products like E-2-Nonenal significantly.



Reducing power (antioxidative effect) of Palatinose™ compared to other sugars (methylene blue discoloration kinetics). The reaction rate is calculated based on the time measured until total discoloration.



Development of substances contributing to the aging taste of beer/beer with plus 2% Palatinose™ compared to normal beer after 2 weeks of enhanced aging (28°C).

Palatinose™ benefits in beer and beer specialties:

Enhanced microbiological stability of beer-mix products

- Cannot be converted by most yeasts and bacteria

Optimized sensorial profile and taste

- Increases body and mouth-feel
- Enhances the long-term stability
- Reduces the development of fermentation by-products

New product concepts

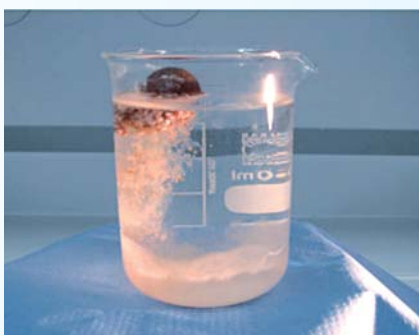
- Light malt beer with a true pilsener note and the best of nature's ingredients
- Alcohol reduced beer with increased body and palatfulness



Palatinose™ featuring self disintegrating instant powder tabs

Palatinose™ can be used to increase the disintegration of instant drink tabs. With the help of the established sugar cube technology or combined with a vacuum drying step these products can be produced either as “swimmers” or “drowners”. In addition to its nutritional properties this technology can be used to come up with new dosage forms offering a “twist of convenience and adventure/play”.

Beverage tabs (swimmers) made by vacuum drying. Disintegration without agitation in approx. 60 sec.



“Healthy Crystals” for instant products and compressed tabs

Energy chocolate drink

Binding agent

Ingredients	%
• Water	13.05
• Lecithin ¹⁾	0.65
• Sodium chloride	0.04
• Vanillin ²⁾	0.04
• Sucralose	0.02

Total **13.80**

¹⁾ Metarin P IP, Degussa/DE

²⁾ Art.-no. 1.08510, Merck/DE

Formulation

Ingredients	%
• Palatinose™ PST-N	68.80
• Cocoa powder (low fat, dark) ³⁾	17.40
• Binding agent	13.80

Total **100.00**

³⁾ GT 150, Gerken/DE

Process

1. Premix Palatinose™ and cocoa powder.
2. Transfer the premix to the fluid bed agglomerator.
3. Prepare the binding agent by dissolving lecithin, sodium chloride, vanillin and sucralose in water.
4. Agglomerate the premix by injecting the binding agent by means of a peristaltic pump.
Pump capacity: approx 230 g/min.
Temperature ingoing air: 60°C
Atomizer pressure: 2.5 bar
5. Inject 1000g water to rinse the pump.
6. Dry the agglomerate at 80°C ingoing air temperature until 62°C outgoing air temperature is reached.
(duration approx. 30 min.).
7. Sieve the dried agglomerate to desired particle size (< 1.0 mm).

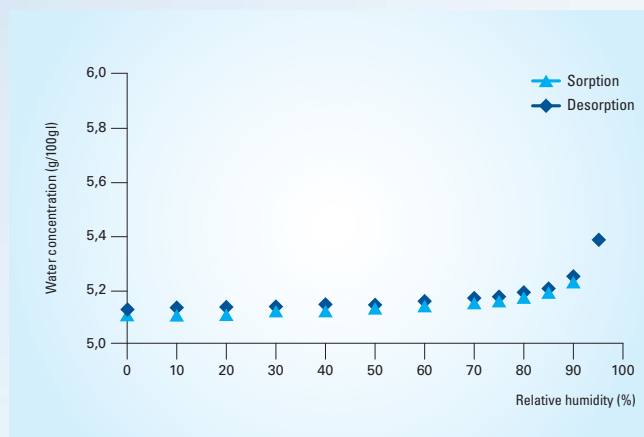
Preparation

- Mix 100 g of the blend with 1 litre of milk.

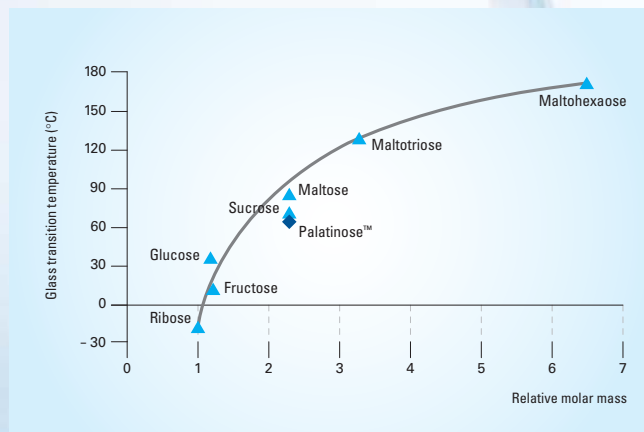
Remark

- Fluid bed agglomerator Aeromat STEA3, Aeromatic/CH

Palatinose™ is a very low hygroscopic free-flowing powder hardly forming lumps. It therefore is an ideal ingredient for powder instant beverages or agglomerates and it significantly reduces the water absorption in blends with e.g. fructose minimizing the risk of caking and lumping.



Sorption- and desorption isotherms of Palatinose™ powder at 25°C



Glass transition temperature (Tg) of Palatinose™ in comparison with other sugars



Glass transition temperature (tg) of Palatinose™ is 62°C and compared to fructose (10°C) and glucose (35°C) it proves to be favorable during spraying or mechanical treatment as carbohydrates often may develop amorphous parts in this process. Increased amorphous parts anyhow lead to an increased hygroscopicity affecting the product stability. Palatinose™ develops less amorphous parts so that agglomerated Palatinose™ powder will therefore combine a very low hygroscopicity with an excellent flowability. Water activity of Palatinose™ and sucrose are equal (23°C).

How instant products capitalize from distinct nutritional advantages:

- Position your instant product towards innovative energy management based on Palatinose™
- Use Palatinose™ as a healthy carrier for products enriched with other functional ingredients to support added nutritional benefits (e.g. green tea extract, phytosterols, vitamins, minerals, ω-3 fatty acids)



“T-Shape”

(Instant formula for a fat burning wellness drink with green tea extract*)

Formulation

Ingredients	%
• Palatinose™ PST-N	60.78
• Citric acid, anhydrous powder ¹⁾	8.00
• Tri-sodium-citrate, dihydrate powder ¹⁾	1.44
• TWINSWEET ²⁾	0.33
• Flavor ³⁾	1.10
• TEAVIGO™ ¹⁾	0.38
• Caffeine ¹⁾	0.40
• CustoMix BE-P ¹⁾	0.10
• Grapefruit 250-L powder ⁴⁾	27.50

Total 100.00

¹⁾ DSM Nutritional Products/CH

²⁾ HSC/NL

³⁾ Grapefruit Givarom Permaseal 60750-51, Givaudan/CH

⁴⁾ Obipektin/CH

Process

1. Blend all ingredients.
2. If required, transfer the pre-blend to the fluid bed agglomerator, e. g. fluid bed agglomerator Aeromat STEA3, Aeromatic/CH.

Preparation

- Mix 100 g of the blend with 1 litre of water.

* TEAVIGO™, in cooperation with DSM

More applications

An intrinsic technological opportunity – Toothfriendly products



Palatinose™ is a reducing sugar which is kind to teeth and offers a clearly defined and exceptional hard crystal structure. This intrinsic properties can be used to generate new and innovative product developments:

Creating new markets with toothfriendly beverages and toothfriendly confectionery

A unique product position is now available with Palatinose™ – kind to teeth but still fully digestible. Innovations in e.g. chocolate products, chewy and gummy candies, ice tea, etc. offer a unique potential for differentiation, functionality and great taste. Of course this also applies to chewing gum and coated confectionery.



Toothfriendly ice tea

Formulation

Ingredients	%
• Palatinose™ PST-N	3.30
• Water	95.20
• Intense Sweetener	0.25
• Citric acid	adjust to pH \geq 5.5
• Black tea extract	optional
• Flavor	optional

Total 100.00

Benefits

- Toothfriendly
- Sugar reduced ¹⁾
- Calorie reduced ¹⁾
- Prolonged energy release ²⁾
- **GI category: low glycemic (< 55)**

¹⁾ In comparison with conventional ice tea sweetened with sucrose

²⁾ Serving size: 500 ml



Opening new opportunities with Palatinose™



Palatinose™ in chewing gum

- Coating
- Center
- Coating and center



Palatinose™ in toothfriendly chocolate

- The world's first toothfriendly, fully digestible chocolate, that really tastes good
- A unique and beneficial way to provide prolonged energy to the human body
- No sucrose
- For balanced glucose and insulin levels
- For full cocoa flavor experience with sugar-like, mild sweetness



Palatinose™ in sugar confectionery

- Jelly beans
- Marshmallows (stones)
- Chewies
- Coatings

Business opportunities:

- Does not promote tooth decay
- No laxative warning, no disclaimer necessary
- Longer energy, prolonged energy, low GI
- Sugar-like crunch (when coated)
- "Sugar reduced" claim (if center with polyols)

More applications

... nutritional bars, cereals, bakery, ice cream, chocolate and chewing gum

Palatinose™ offers a very stable crystal structure and can be perfectly applied as dry matter in e.g. cereal & nutritional bars, breakfast cookies as well as in glazed or frosted cereals, ice cream or chewing gum.

Due to its extremely stable bound crystal water, Palatinose™ can further be applied in conching for chocolate production without any adaption of a normal chocolate production process.

Palatinose™ is also ideal for pan coating and dragées production as it combines a low hygroscopicity with a sufficient solubility for cost effective coating.

In all these applications, Palatinose™ basically behaves like sugar and can replace sugar one by one. Depending on the nutritional property intended the overall recipe needs to be adapted.





BENEO-Palatinit – Close to you worldwide

Regulatory status

Palatinose™ is a food or food ingredient (like sugar, starch or maltodextrin). In more than 40 countries, the food status of Palatinose™ has been confirmed by the authorities. It has been approved for use as novel food/novel food ingredient in Europe and Australia for example. In the U.S., Palatinose™ has FDA notified GRAS status (the GRAS notification #184 has been accepted by FDA with a letter of no objection in March 2006). In Japan it has been marketed already since 1985. Furthermore, BENE0-Palatinit is heavily involved in the regulatory framework and the EU claim regulation.



BENE0-Palatinit – Markets served

Based in Mannheim, Germany, BENE0-Palatinit was founded in 1979 and is part of the Functional Food Group BENE0. The Group, formed in autumn 2007, also includes the leading food companies BENE0-Orafti as well as BENE0-Remy. It is part of the Südzucker AG – Europe's largest sugar producer. Under the mission 'Connecting nutrition and health' the BENE0-Group and its companies are constantly striving to improve today's food products and beverages for a healthy and tasteful future.

BENE0-Palatinit's service package

- Development of product concepts
- Technical consulting
- Nutritional science
- Regulatory support for dealing with food legislation or obtaining product approval
- Research on international markets and consumer trends
- Marketing communication

BENE0-Palatinit has developed and is No 1 in the market with the unique sugar replacer ISOMALT and the functional carbohydrate Palatinose™. BENE0-Palatinit produces Palatinose™ routinely on industrial scale. State-of-the-art production facilities are located at Offstein in south-west Germany. With its subsidiaries in North America (New Jersey/US) and in Asia (Singapore) as well as a global network of sales agencies in more than 40 countries, BENE0-Palatinit supplies its ingredients to food and pharmaceutical markets all around the globe.

Furthermore, the company offers comprehensive service and consultancy to customers, including production technology, formulation development and product optimization as well as regulatory advice, market research and marketing support.

Patent situation

As a benefit for us and our clients BENE0-Palatinit and the members of Südzucker/BENE0-Group can rely on a strong patent position concerning Palatinose™ and its uses. We own or have licensed several essential patents in all relevant fields of application.



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