



海藻糖

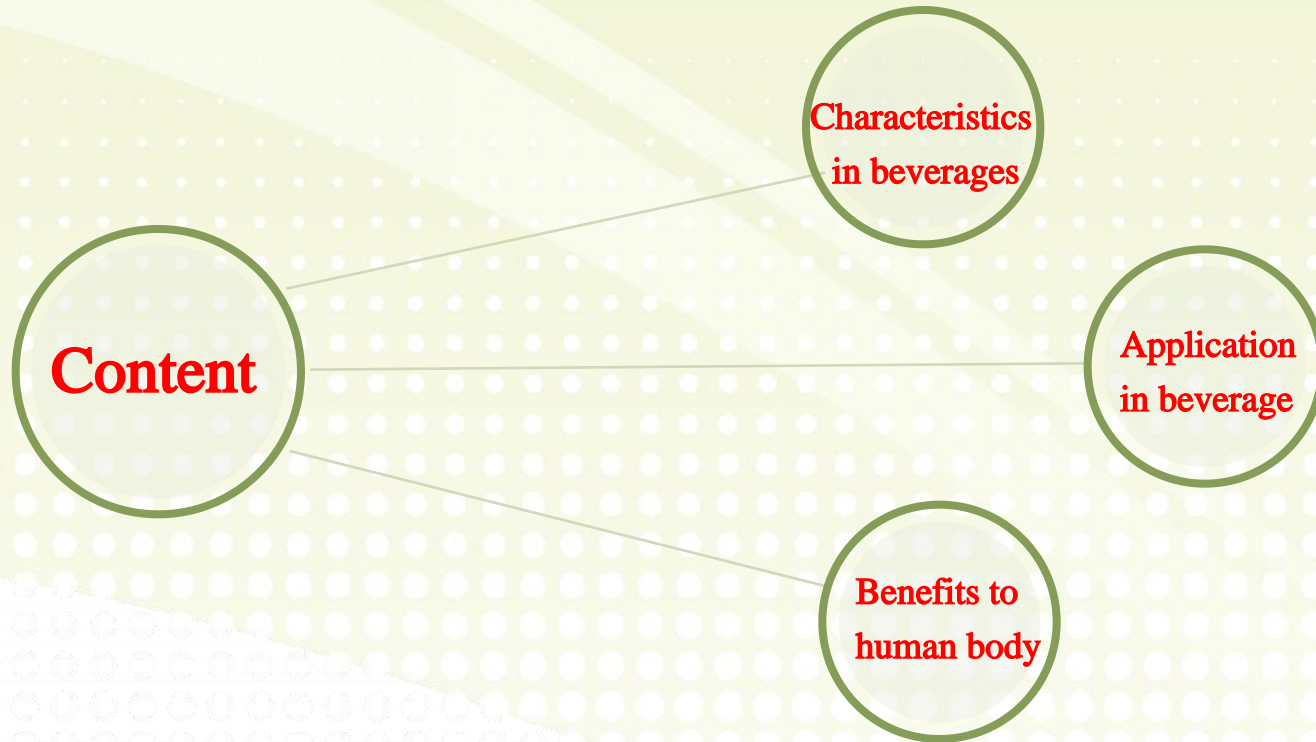
The Application Prospect of Trehalose — Beverage



INTRODUCTION

- Trehalose is a kind of non reducing disaccharide which is composed of two glucose molecules through glycosidic bond. Because of its magical protective effect on organisms, trehalose is known as "sugar of life".
- In July 2000, the international authoritative journal Nature published a special article on the evaluation of trehalose, which pointed out that "for many living organisms, the presence or absence of trehalose means life or death".
- Our company produces and sells food grade crystal trehalose. According to its excellent processing performance, customer feedback and our good production process and strong application technical support, we share the application performance of trehalose in beverages and its benefits to human body.



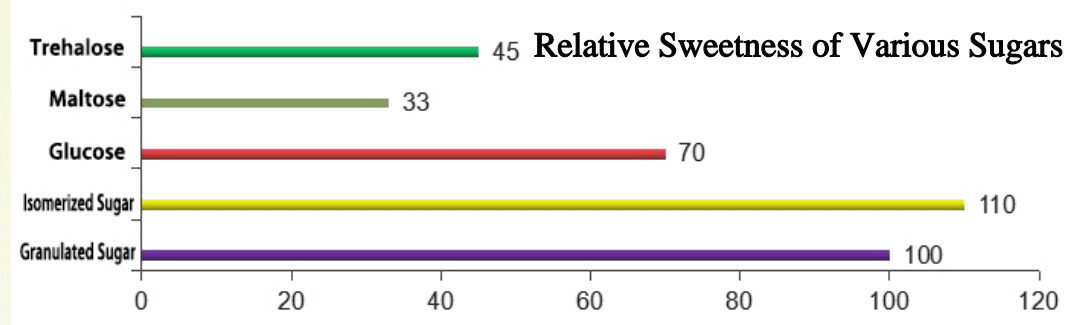




1, Characteristics in Beverages --- Low Sweetness

The results showed that when the concentration of trehalose was 22.2%, the sweetness of trehalose was about 45% of that of granulated sugar. Compared with granulated sugar, the sweetness of trehalose can permeate quickly without aftertaste. Trehalose is "sweet but not greasy, sweet and refreshing".

Trehalose has the function of not causing dental caries. It does not decompose and produce acid in the oral cavity after eating. The pH value in the oral cavity is only slightly reduced. It will not produce insoluble glucan that leads to dental caries. It can also inhibit the attachment of insoluble glucan produced by granulated sugar. It can be said that trehalose is a kind of "tooth benefiting" sugar. The osmotic pressure of trehalose is equal to that of granulated sugar. Trehalose can replace part or all of granulated sugar (granulated sugar) in food to avoid the sweet taste of granulated sugar.



Trehalose has the characteristics of low sweetness. It can be combined with granulated sugar or other sweeteners to optimize its sweetness and taste the original flavor of beverage products.

In China, beverages are divided into alcoholic beverages and non-alcoholic beverages, and non-alcoholic beverages are usually called soft drinks (soft drinks include basically the same types as cool drinks in Japan, which generally refer to carbonated drinks such as soft drinks and cola, drinks added with fruit juice, coffee drinks, oolong tea, black tea, lactic acid bacteria drinks, mineral water and fruit juice, etc.), But excluding milk and dairy products). In the production of beverages, most need to add sugar and other sugar substances, among which carbonated drinks, coffee drinks, sports drinks and drinks added with fruit juice are the most used sugar substances. Trehalose is widely used in beverages because of its excellent properties, which not only plays the role of sweetness, but also meets people's pursuit of new functions such as low calorie.



1, Characteristics in Beverages --- ② Stability

In the process of beverage production, sugar substances need to be added, but because the raw materials, sugar concentration and pH value of various beverages are different, the sterilization conditions are different. The stability of 6 kinds of disaccharides including sugar is shown in the table.

Decomposition rate of 30% disaccharide solution /%

experimental condition			Name of sugar					
Temp. °C	pH	Time/min.	Trehalose	Maltitol	Maltose	Isomaltulose	Isomaltitol	Granulated Sugar
100	2	180	2.5	14.4	9.6	7.6	2.9	100
121	3	30	0.4	2.5	1.6	4.7	0.8	100
121	2	30	7.8	33.2	30.3	18.6	8.9	100

As we all know, granulated sugar is a kind of sugar that is easy to decompose at low pH value. Maltose will decompose 10% after 180 min at 100 °C and pH 2, but trehalose will decompose less (2.5%) under the above conditions. Trehalose still remains more than 99% undecomposed after heating at 100 °C for 24 h at pH 3.5 High temperature heating processing conditions can maintain good stability.

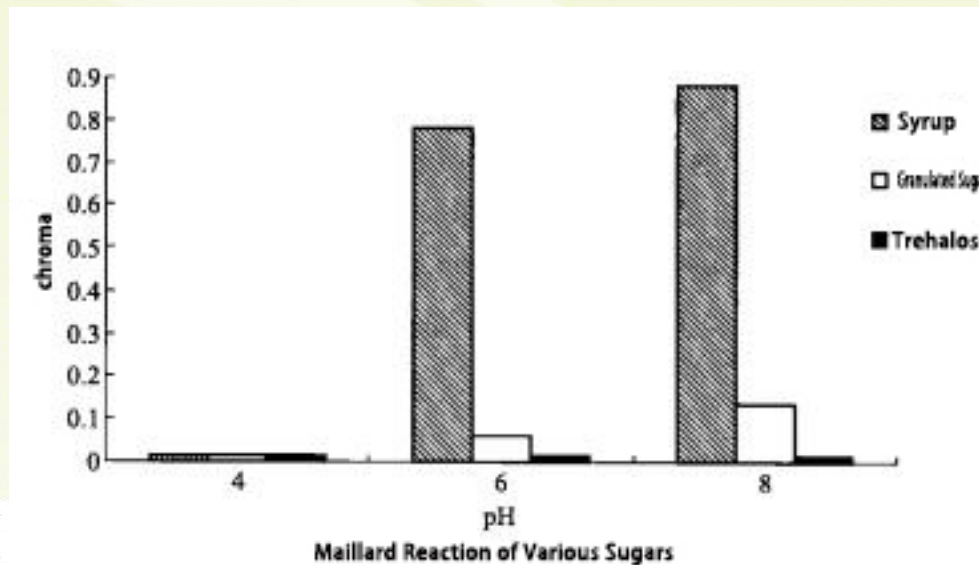
1, Characteristics in Beverages ---

Prevent Browning



The reasons for browning of beverages are enzymatic browning and nonenzymatic browning (Maillard reaction or amino acid carbonyl reaction), and the Maillard reaction is related to sugars. The so-called Maillard reaction is the reaction of coloring and aroma produced by heating when sugars and proteins or amino acids coexist.

Experiment 1:



However, the strength of Maillard reaction is related to the type of sugar, such as the concentration of 12.5% sugar, granulated sugar and trehalose, adding 0.5% glycine respectively, pH value of 4, 6 and 8, heating at 120 for 6 minutes.

The results showed that the browning of sugar was significant due to Maillard reaction, followed by granulated sugar, while the color of trehalose solution had almost no change.



1, Characteristics in Beverages --- Prevent Browning

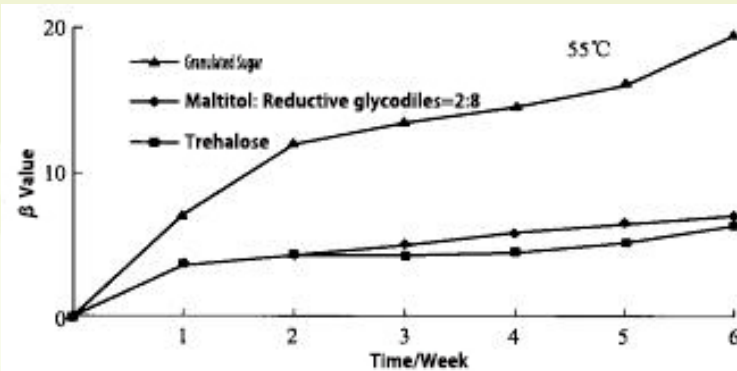
Experiment 2:

The browning reaction of 5% lemon juice beverage prepared with various sugars during storage at 55 °C was also significantly different.

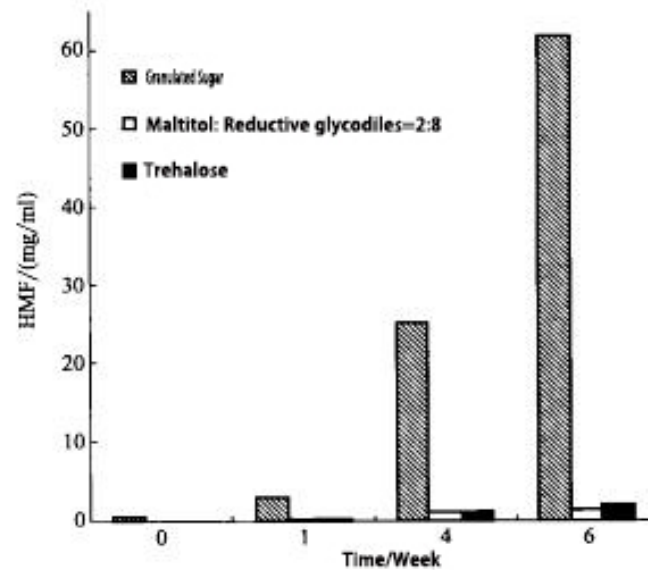
Result:

With the increase of storage time, the b value (yellow value) and HMF value (amount of hydroxymethylfuraldehyde) of lemon juice beverage with granulated sugar increased, and the browning became more and more serious;

However, with the increase of storage time, the b value of lemon juice drinks with trehalose or sugar alcohol increased little, the HMF value did not increase, and the coloring was very slight.



Inhibitory effect of various sugars on Browning (β value) of lemon juice drinks



Inhibitory effect of various sugars on Browning (HMF value) of lemon juice drinks

1, Characteristics in Beverages ---

Prevent Browning



Experiment 3:

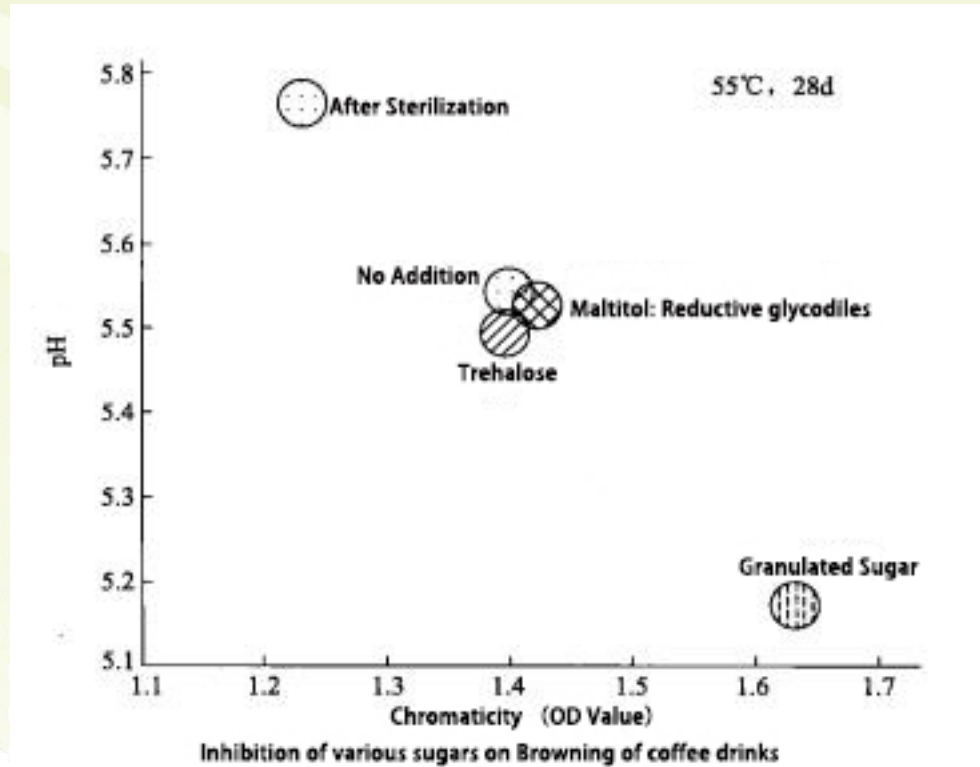
Add the same kinds of sugars into the commercially available sugar free coffee, and then autoclave them again. After 28 days storage at 55°C, the results of coloration degree are shown in the figure below.

Results:

Like lemon juice, the pH value of coffee drinks added with granulated sugar decreased more and the coloring value was higher;

The color value and pH value of coffee added with trehalose or glycol are exactly the same as those of sugar free coffee.

This indicated that trehalose and sugar alcohol did not affect the coloring of coffee drinks and did not cause the decrease of pH value.



1, Characteristics in Beverages --- The Purgative Effect is Small



Sorbitol, maltitol and other sugar alcohols and oligosaccharides are often added in the production of beverages. If the human body ingests too many of these indigestible sugar alcohols and oligosaccharides at one time, diarrhea will occur (Note: the amount of diarrhea is also related to the temperature and quantity of beverages and individual differences).

Trehalose is a kind of digestible carbohydrate. There is a trehalase enzyme on the small intestinal mucosa of animals and people, which can hydrolyze trehalose into glucose and absorb it. Therefore, in the development of beverage products, we must fully consider the amount of sugar, and reasonably use the indigestible oligosaccharides such as maltooligosaccharides, soybean oligosaccharides and lactulooligosaccharides, and reasonably mix them with sugars such as trehalose and erythritol, which have less diarrhea effect.

sugar type	Maximum dose without purgative effect (g / kg body weight)	
	male	female
Trehalose	---	0.65
Erythritol	0.66	0.8
Sorbitol	0.15	0.3
Maltitol	0.3	0.3
Isomaltitol	0.3	---
Lactulose	---	0.26
Fructose oligosaccharide	0.3	0.4
Persimmon sugar	0.6	0.6
Soybean oligosaccharides	0.64	0.96
4-galactooligosaccharide	0.28	0.14
6-galactooligosaccharide	0.3	0.3
Xylooligosaccharides	0.12, or 7.5/d	---
Isomaltooligosaccharides	> 1.5	---
Mixed sugar	---	0.3

1, Characteristics in Beverages --- High Utilization Rate of Lactic Acid Bacteria



In the production of fermented beverage with lactic acid bacteria, the difference of utilization rate of sugars by microorganisms is closely related to the development of fermented beverage.

Experiment:

Sugars	lactobacillus		保加利亚乳杆菌 (<i>L. bulgaricus</i>)		干酪乳杆菌 (<i>L. casei</i>)		嗜酸乳杆菌 (<i>L. acidophilus</i>)		粪链球菌 (<i>S. faecalis</i>)	
	utilization rate	reproductive	utilization rate	reproductive	utilization rate	reproductive	utilization rate	reproductive	utilization rate	reproductive
Blank (No Sugar)	0	—	0	—	0	—	0	—	0	—
Glucose	32	+	78	++	43	+	38	+		
Maltose	44	—	38	+	13	—	43	+		
Trehalose	40	++	58	++	29	±	12	±		
Lactulose oligosaccharides	26	±	15	+	34	+	32	+		
panose	16	+	57	++	50	+	34	+		
Mixed sugar	1	—	29	+	28	+	27	+		
Malt tetrasaccharide glycogen	0	—	47	++	14	—	22	+		
Malt pentasaccharide glycogen	5	—	26	++	19	—	36	+		
Reducing sugar syrup	0	—	0	—	0	—	0	—		

Note: 1. The culture condition is Mrs medium added with 2% sugar, then inoculated with 1% inoculum of lactic acid bacteria, cultured at 35 °C for 24h.

2. Utilization rate (%) = (sugar consumption / total sugar) x 100

3. Reproduction was compared with the blank (without sugar).

"—" is the same "±" It is slightly better, "+" is better and "++" is very good

Result:

The utilization rate of glucose by four kinds of lactic acid bacteria was very high; The utilization rate of trehalose and maltose was high; However, the utilization rate of maltooligosaccharide is very low. Because the utilization rate of lactic acid bacteria to various sugars is very different, it is necessary to study the utilization rate of added sugars and select appropriate sugars when using sugars to make lactic acid bacteria beverage.



1, Characteristics in Beverages ---

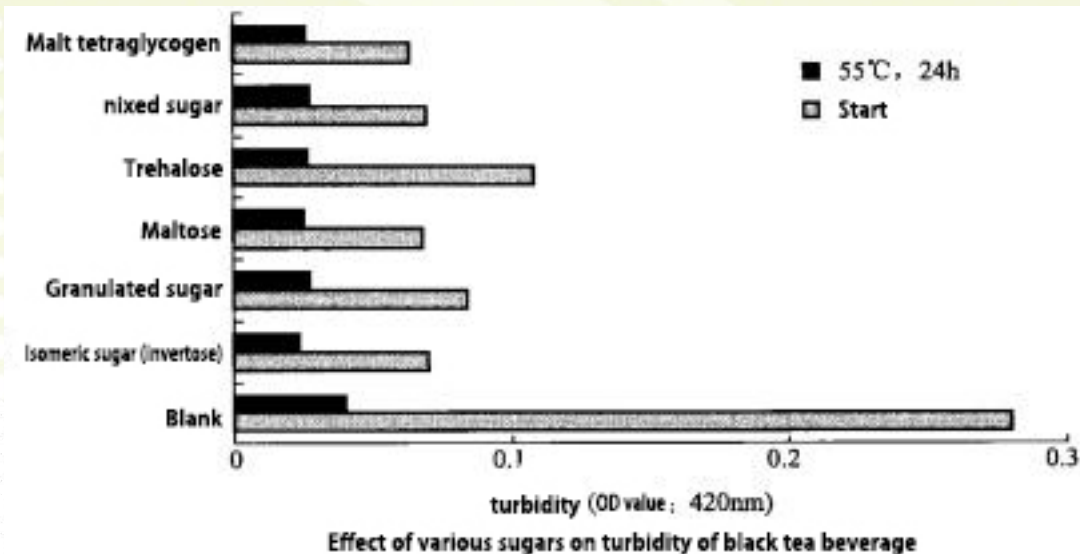
⑥ Prevent Turbid Sediment

Nowadays, heated drinks are often sold on the market. When the drinks are stored at about 55 °C, the pH value of the drinks will decrease and the color of the drinks will change.

The decrease of pH value will not only make the taste worse, but also make the milk protein agglutinate and precipitate in the milk and coffee drinks. If trehalose is added to the hot drinks on the market, the stability of the drinks will be greatly improved.

It is well known that the beverage diluted with milk or fruit juice will also precipitate, and the interaction between caffeine and tannin in coffee and black tea drinks and protein will become turbid.

Experiment:



Result:

Compared with the samples without sugar, sugar has better effect on inhibiting the turbidity of black tea drinks; The effect of cyclodextrin is better all the time, while malttetrasaccharide is similar to trehalose, mixed sugar, maltose, transformed sugar, sugar and so on.

1, Characteristics in Beverages --- Prevent mineral deposits



Background:

In recent years, with the changes of people's diet and life, insufficient intake of calcium, iron and other minerals has become a serious problem. Therefore, there are many nutritious foods on the market, including drinks and foods used to supplement minerals. However, there are still some problems in the dissolution of minerals and the reaction between minerals and other substances, which restrict the development of this kind of food.

Example:

Calcium is dissolved in water as an ion in aqueous solution, but when there is phosphate in water, it will form insoluble calcium phosphate and precipitate. If the precipitation of calcium ion can be prevented, it will be beneficial to the absorption and utilization of calcium in calcium containing beverages.

Solution:

The addition of trehalose to water can reduce the occurrence of precipitation and extract the retention of soluble calcium ion. With the increase of trehalose addition, the effect of inhibiting precipitation is more significant (after analyzing the mixed solution of trehalose and calcium chloride by NMR, it is found that the 2-and 4-hydroxyl groups in trehalose molecules are combined with calcium ion, This combination prevents the formation of insoluble phosphates. Compared with trehalose, adding sugar and other sugars has no such effect.

Similarly, trehalose also interacts with minerals such as iron, copper and magnesium to avoid insoluble salt precipitation. In addition, the interaction between trehalose and minerals is conducive to the stability of vitamin C and other substances in beverages. For example, vitamin C is easy to decompose and color in beverages with iron ions and copper ions, but trehalose can inhibit its decomposition and color. This is because trehalose is easy to combine with iron ions and steel ions, which reduces the use of these ions as reaction catalysts for vitamin C oxidative decomposition.

1, Characteristics in Beverages ---⑧Improvement of Flavor

Many foods have special bitterness and irritating odor. If these foods are not allowed to have sweet taste, cyclodextrin was used to cover up their odor. Recently, trehalose has been widely used in beverage and other food industries as a special additive to cover up bitterness, astringency and other bad odor (taste).



2, Application in Beverage

(1) Black Tea

Raw Material Formula

Black Tea	1 cup	Trehalose	2g
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Making Method:

In a cup of black tea, adding about 2G trehalose can eliminate its astringency. In addition, if combined with granulated sugar, it can have a refreshing sweet taste.

Characteristic:

Trehalose can soften and lighten the bitterness of black tea, and has good compatibility with lemon tea, making the sweet taste of black tea more refreshing and delicious.

(2) Soybean Milk

Raw Material Formula

Soybean Milk	200ml	Trehalose	5g
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Modulation:

Add 5g trehalose into 200ml soybean milk and mix well.

Characteristic:

It can reduce the peculiar beany smell of soymilk and taste better.



2, Application in Beverage

(3) Juice Soymilk

Raw Material Formula

Soymilk (Solid content 8%)	27.5%	Sodium Citrate	0.2%
Juice (Solid content 3.8%)	10%	Pectin	0.3%
Granulated Sugar	8%	Food Flavor	appropriate amount
Trehalose	0.5%-2%	Water	Add till 100%
Citric Acid	0.5%-0.8%		

Making Method:

Mix pectin, granulated sugar, trehalose and sodium citrate evenly, then add 60 °C warm water to fully dissolve and cool to 5-10 °C; Then pour the mixture into soybean milk at 5-10 °C and continue to stir for 5-7min; Adjust pH 3.8-3.9 with citric acid, then add pectin into soybean milk; After heating to 70 °C, homogenize with homogenizer and package after sterilization.

Characteristic:

When soybean protein is added into fruit juice, it will precipitate below pH 5. The processing stability of this formula is excellent. When pH drops to 5-3.6, there will be no separation or precipitation. In soybean milk products, 0.5% - 2% trehalose can cover up the beany and bitter taste, and improve the non colorability and processing stability.



2, Application in Beverage

(4) Fruit wine (plum wine)

Raw Material Formula

ciruela	1kg	Trehalose	60g
Rock sugar	540g	Spirit	1. 8L

Making Method:

Clean the plum fruit, remove the fruit base with toothpick, and dry the plum fruit with cloth.

Put half of the plum fruit into a bottle and spread half of the sugar on top of it.

Put the rest of the plum fruit on the rock sugar, and then put the rest of the rock sugar and trehalose on the plum fruit.

Add Shaojiu and store in a cool place away from light.

After about three months, you can drink this wine, and plum fruit can also be eaten. The wine should be removed after about one year. If the wine is not removed, the wine will be turbid.



2, Application in Beverage

(5) Energy sports drink

In the course of exercise, the appearance of fatigue and the decline of sports level are closely related to the decrease of the effectiveness of sugar in the body. Especially in endurance sports, the supply of human carbohydrate energy is the limiting factor for the improvement of performance. As the main energy source in sports, such as glucose, fructose, sugar and other sugars, the glucose will rise immediately due to the fast absorption after ingestion, which can cause the secretion of insulin to increase immediately and decrease the blood sugar; When blood sugar returns to normal value, insulin still plays a role, which causes the blood sugar to continue to decline, forming physiological hypoglycemia, and affecting the exercise ability. Therefore, glucose supplementation was not improved but decreased in 15-45min before exercise. Trehalose absorption is slow, can provide a long-term energy supply, and insulin response is stable, does not form physiological rebound of blood glucose value, more suitable for the production of endurance, energy sports drinks than other sugars.

Energy Drinks Formula : Tre

halose	90g	Calcium	0.35g
Soybean polypeptide	40g	Vitamin B1	0.008g
Octanol	0.04g	Vitamin B2	0.004g
Sodium	1.8g	Vitamin Bt (L-carnitine)	0.0135g
Potassium	0.55g	Vitamin C	0.15g
Magnesium	0.18g	Water	950ml

Potassium, sodium, calcium, magnesium and other elements in the above substances can be selected from sulfate, hydrochloride or phosphate. The production method is to dissolve the above substances in purified water or distilled water, remove insoluble substances, bottle, sterilize and package. Each time drinking 30-5 OML can maintain blood glucose at a high level, and stabilize serum insulin, magnesium, potassium and lactic acid.



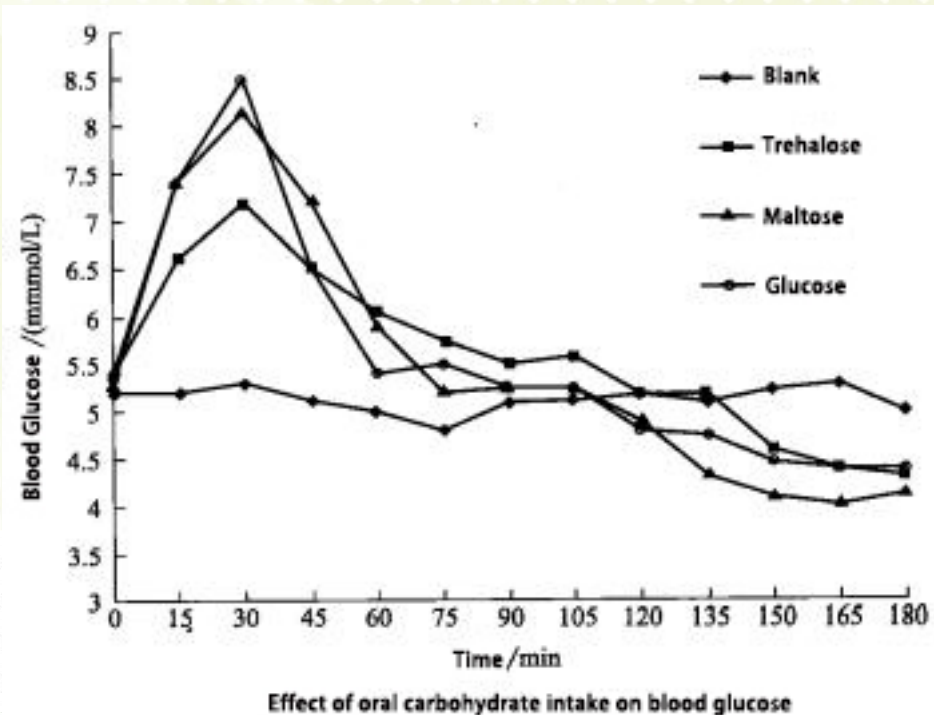
3, Benefits to Human Body

(1) A stable energy source

When the human body ingests sugars and other nutrients, the enzymes secreted on the surface of human intestinal epithelial cells will digest and absorb the sugars that enter the intestine together with food or drink through hydrolysis. For example, granulated sugar is decomposed into glucose and fructose by granulase, while maltose is decomposed into glucose and absorbed by maltase. Trehalose is also digested into glucose by trehalase in intestine. But the type of digestion and absorption of trehalose is different from glucose, maltose or granulated sugar.

Experiment :

British Sugar Company conducted a study on absorption and metabolism of trehalose, maltose and glucose in 12 subjects. After taking 75g of sugar orally, the changes of blood glucose value, insulin and some endocrine related hormones were observed. The results showed that after the human body ingested glucose, sugar or maltose, the blood sugar would rise sharply, reached the peak in 30min, and then decreased sharply. However, after the trehalose intake, the blood sugar increased slowly, the peak value was lower, and then decreased slowly.

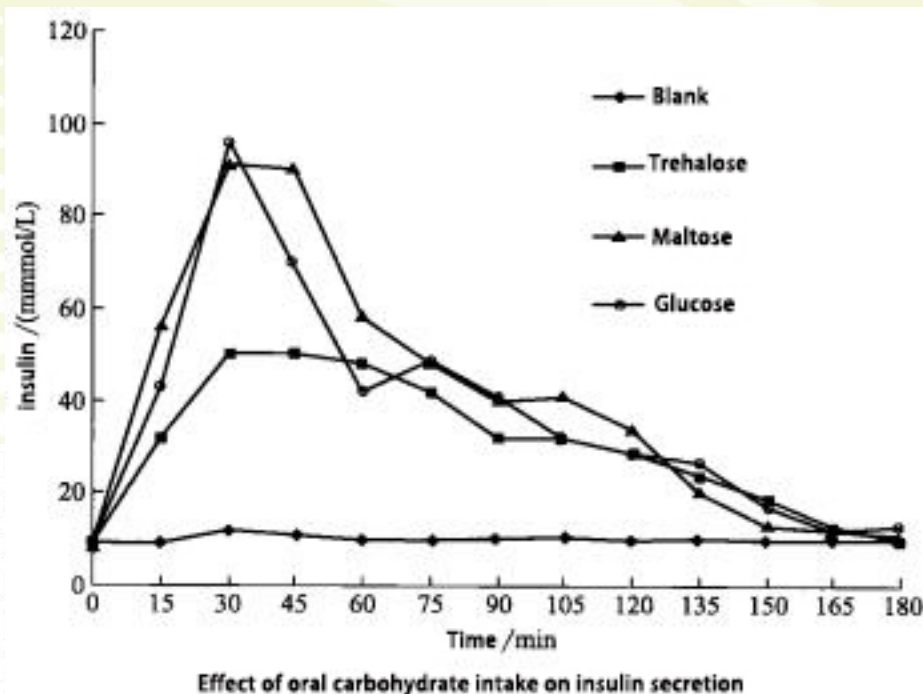




3, Benefits to Human Body

(1) A stable energy source

In addition, the secretion of insulin after trehalose intake was not significantly higher than that of glucose and maltose intake.



Because trehalose does not cause rapid changes in blood glucose and insulin, it is also beneficial to the human body. It may be used to develop food for diabetics. Of course, in view of the deficiencies of glucose metabolism in diabetic patients, further studies should be carried out on whether or not trehalose can be used as a food for diabetics. However, trehalose can provide a continuous source of energy without causing dramatic changes in blood glucose and insulin, which is completely suitable for the development of new energy sports nutrition food or drink.



Thanks

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From Huiyang, To The World