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СРАВНИТЕЛЬНЫЙ АНАЛИЗ РАЗЛИЧНЫХ САХАРОЗАМЕНИТЕЛЕЙ С ТОЧКИ ЗРЕНИЯ ВОЗДЕЙСТВИЯ НА ОРГАНИЗМ ЧЕЛОВЕКА

COMPARATIVE ANALYSIS OF VARIOUS SWEETENERS IN TERMS OF THEIR EFFECTS ON THE HUMAN BODY

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Аннотация

В данной статье рассмотрены наиболее распространенные сахарозаменители с точки зрения воздействия на организм человека. Актуальность данной темы заключается в том, что современное человечество находится в постоянном поиске средств борьбы с такими заболеваниями как сахарный диабет, ожирение, атеросклероз, кариес зубов, которые связаны с избыточным потреблением сахара. Тысячелетиями человечество питалось естественными продуктами, содержащими сложные углеводы. В настоящее

время структура рациона изменилась - люди стали потреблять очищенные рафинированные углеводы, проще говоря, обычный сахар. Ежедневное потребление сахара во всем мире приближается к 500 ккал в день, тогда как рекомендуемая суточная доза сахара для человека с нормальным весом составляет около 25 г или 96 ккал в день. Доступность разнообразных пищевых продуктов, содержащих большое количество сахара, в условиях современной гиподинамии является одной из причин роста ожирения и связанных с ним многих осложнений, таких как гиперинсулинемия, инсулинорезистентность и гиперлипидемия, предрасполагающие к непереносимости глюкозы и сахарному диабету. Важнейшим эффективным терапевтическим средством для профилактики и лечения диабета и его осложнений является замена потребления рафинированных углеводов сахарозаменителями, обладающими сладким вкусом, но не содержащих калорий и в значительно меньшей степени стимулирующих секрецию инсулина. Серьезной проблемой современного человека являются и заболевания ротовой полости. Поэтому с этой точки зрения применение сахарозаменителей также актуально. В данной статье проведен сравнительный анализ природных и синтетических сахароподобных веществ (ксилита, мальтита, сорбита, эритрита, сукралозы, тагатозы, экстракта архата, аллюлозы, инулина, стевии) по органолептическим и физико-химическим свойствам, уровню сладости, калорийности, воздействию на желудочно-кишечный тракт и эмаль зубов. Рассмотренные вещества сопоставимы по вкусу с сахаром, но не обладают пищевой энергией, не содержат в своем составе глюкозу и гораздо медленнее усваиваются. Они не наносят вреда здоровью и могут применяться как компонент лечебного диетического питания больных сахарным диабетом и людей с избыточной массой тела.

Ключевые слова: сахарозаменители, уровень сладости, калорийность, желудочно-кишечный тракт, эмаль зубов.

Abstract

This article discusses the most common sweeteners from the point of view of the impact on the human body. The relevance of this topic lies in the fact that modern humanity is constantly searching for ways to combat such diseases as diabetes, obesity, atherosclerosis, dental caries, which are associated with excessive sugar consumption.

For thousands of years, humanity has been eating natural foods containing complex carbohydrates. Currently, the structure of the diet has changed - people began to consume refined refined carbohydrates, in other words, ordinary sugar. The daily sugar intake worldwide is close to 500 kcal per day, whereas the recommended daily sugar intake for a person of normal weight is about 25 g or 96 kcal per day. The availability of a variety of foods containing a large amount of sugar in the conditions of modern inactivity is one of the reasons for the growth of obesity and many related complications, such as hyperinsulinemia, insulin resistance and hyperlipidemia, predisposing to glucose intolerance and diabetes mellitus.

The most important effective therapeutic tool for the prevention and treatment of diabetes and its complications is to replace the consumption of refined carbohydrates with sugar substitutes that have a sweet taste, but do not contain calories and to a much lesser extent stimulate the secretion of insulin. Diseases of the oral cavity are also a serious problem of modern man. Therefore, from this point of view, the use of sweeteners is also relevant.

This article presents a comparative analysis of natural and synthetic sugar-like substances (xylitol, maltitol, sorbitol, erythritol, sucralose, tagatose, arhat extract, allulose, inulin, stevia) according to their organoleptic and physico-chemical properties, sweetness, caloric content, and effects on the gastrointestinal tract and tooth enamel. The substances considered are comparable in taste to sugar, but do not have nutritional energy, do not contain glucose in their composition and are much slower to digest. They do not cause harm to health and can be used as a component of therapeutic dietary nutrition for patients with diabetes and people with excess body weight.

Key words: sweeteners, sweetness level, calorie content, gastrointestinal tract, tooth enamel.

Introduction

The diet of a modern person includes a large number of foods containing sugar. Their tempting tastes make them an essential part of your daily diet. But few people know that unlimited access to sweets poses a direct threat to health.

Sugar is a high-calorie, quickly digestible product with a high glycemic index. It also increases appetite by encouraging overeating. This leads to a number of health problems including diabetes, obesity, and tooth decay. That is why experts from the World Health Organization are urging to study the information on product packaging more carefully for the content of sucrose.

However, even an informed person can find it difficult to change their eating habits and completely give up sweets. A compromise solution to this dilemma is the transition to sugar substitutes, which are comparable in taste to sugar, but do not contain sucrose in their composition. They can be classified into several groups: sugar alcohols (polyols), natural (natural) sweeteners, artificial (intensive) sweeteners. The group of sugar alcohols includes: xylitol, maltitol, sorbitol, erythritol. The second group of sweeteners is divided into oligosaccharides (allulose, tagatose, inulin) and glycosidic sweeteners of plant origin (stevia, monk fruit extract). Artificial sweeteners include sucralose.

Materials, methods, results and discussions

Let's carry out a comparative analysis of some sugar substitutes from the point of view of their effect on the human body.

E967 Xylitol (Xylitol, 1,2,3,4,5-pentahydroxypentane)

Xylitol is a five-carbon sugar alcohol. Chemical formula: $C_5H_{12}O_5$ (Fig. 1).

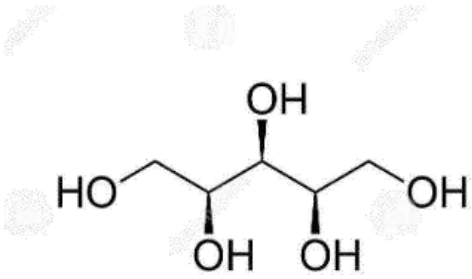

Fig.1. Structural formula of xylitol

Xylitol is an odorless, white crystalline powder. It has a strong "refreshing" effect and is highly soluble in water. Sweetness coefficient - 0.95 [1]. Energy value - 2.5 kcal / g [2].

This substance is slowly absorbed in the small intestine by 25-50% (depending on the dose), the rest undergoes enzymatic degradation in the large intestine with the formation of low molecular weight fatty acids and gases [3]. It is well tolerated, but large doses (more than 50 g per day) can cause temporary gastrointestinal upset: bloating, flatulence, diarrhea.

Xylitol is characterized by a low glycemic response, exhibits probiotic properties, which makes it possible to use it in the diet of patients with diabetes mellitus. Thus, in a study conducted on a Spraque-Dawley rat model with type 2 diabetes who consumed a 10% xylitol solution for 5 weeks, a significant decrease in blood glucose, serum fructosamine, and most serum lipids was found [4].

The use of xylitol as a food supplement has an impact on the amount of food consumed, which is very important for obese people. For example, 25 g of xylitol, taken with yogurt 1 hour

before lunch, stimulated the feeling of satiety and contributed to a decrease in calories from food by 10-20% compared to sucrose [3].

It is also used as a preventive measure for dental caries, in the treatment of ENT diseases, inflammatory processes, and also as an additional therapy for malignant neoplasms.

A study conducted among children aged 8 years, found that long-term use (39 months) of chewing gum with xylitol not only reduces, but also slows down the growth of *Streptoccocus mutans* in saliva and plaque [5].

It has been scientifically proven that the use of xylitol solution for irrigation of the nasal sinuses of patients after endonasal endoscopic surgery gives an analgesic and anti-inflammatory effect [6].

In 2020, Japanese scientists obtained positive results in the study of the effect of xylitol on cancer cells. It was noted that daily intravenous injections of xylitol solution (2.0 g / kg) in mice with melanoma reduce the protective capacity of cancer cells and increase their sensitivity to chemotherapeutic drugs [7].

E965 Maltitol (α-D-Glucopyranosyl-1,4-glucite, hydrogenated maltose)

Maltitol is a disaccharide polyol. Chemical formula: $C_{12}H_{24}O_{11}$ (Fig. 2).

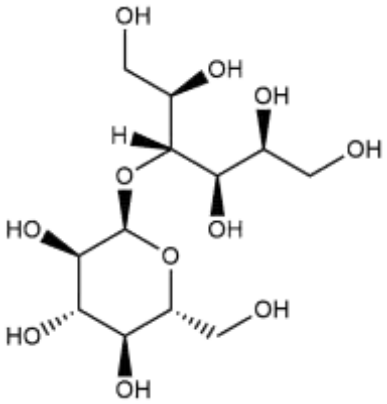

Fig. 2. Structural formula of maltitol

Maltite is a white crystalline powder, odorless, readily soluble in water. Has a weak "refreshing" effect. Sweetness coefficient - 0.95 [1]. Energy value - 2.7 kcal / g [2].

A smaller part of the substance is slowly absorbed in the small intestine, most of it undergoes enzymatic degradation in the large intestine with the formation of low molecular weight fatty acids and gases. Since maltitol is fermented by bacteria in the lower gastrointestinal tract, discomfort such as flatulence or diarrhea may occur during digestion.

Maltitol has no significant effect on blood sugar, so it can be used in the diet of patients with diabetes mellitus. It was noted that when a solution of maltitol was administered at doses of 0.8 g / kg of body weight to 20 physically healthy people and 6 patients with diabetes, the concentration of glucose and insulin in the blood serum of the participants of the experiment did not change [8].

This substance has high anti-cariogenic properties. A study conducted among adults, whose average age was 41 years, who took 4 tablets of 5 g of sweetener daily for a long time, proved that plaque does not form during maltitol metabolism [9].

E420 Sorbitol (sorbitol)

Sorbitol is a sugar alcohol called d-glucitol. Chemical formula: $C_6H_{14}O_6$ (Fig. 3).

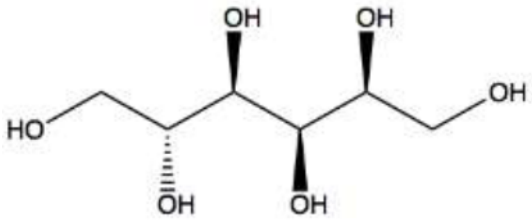

Fig. 3. Structural formula of sorbitol

Crystals of sorbitol are grayish-white in color with a "cooling" sweet taste, readily soluble in water and alcohol. Sweetness coefficient - 0.6 [3]. Energy value - 2.5 kcal / g [2].

Like all sugar alcohols, sorbitol is slowly absorbed (from 25% to 80%) in the intestine due to facilitated diffusion, and then metabolized in the liver [10]. The unabsorbed part moves to the large intestine, where it is fermented by the microbiota. Like xylitol, sorbitol is well tolerated, however, taking more than 50 g per day can cause side effects such as flatulence and / or diarrhea.

Sorbitol plays an important role in solving the problem of obesity in humans. Thus, in an experimental experiment of 16-day feeding of healthy rats and Wistar rats subjected to cystectomy, a diet supplemented with 7% sorbitol, a decrease in body fat was noted, as well as a decrease in liver obesity in all types of experimental animals [11].

Sorbitol has potential prebiotic effects. An experiment on a male Wistar rat model, which was added to water 10% sorbitol, showed that its consumption significantly increases the levels of butyrate of the colon and cecum, therefore, it is able to alter the activity of the intestinal microbiota [12].

Sorbitol does not raise blood glucose levels. When examining the blood of 40 Holstein calves under the age of 24 hours, which, when fed for 28 days, included sorbitol (0, 10, 20, and 40 g) in a liquid diet, no differences in glucose concentrations were observed [13].

Generally, sorbitol is not absorbed by the bacteria in the mouth. This prevents tooth decay and erosion of tooth enamel. In a study of 547 Hungarian schoolchildren who took part in a 2-year sorbitol-based chewing gum program, there was a significantly lower incidence of caries compared with children who did not participate in the experiment [14].

E968 Erythritol (Erythritol, 1,2,3,4-tetraoxybutane, 1,2,3,4-butantetraol)

Erythritol is a four - carbon polyol. Chemical formula: $C_4H_{10}O_4$ (Fig. 4).

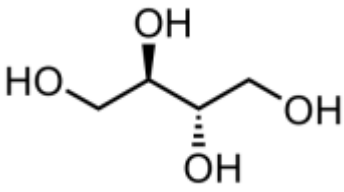

Fig. 4. Structural formula of erythritol

It is a white powder of moderately sweet taste, without aftertaste and odor. Sweetness coefficient 0.7 [3]. Energy value - 0.2 kcal / g [2].

Erythritol is rapidly absorbed (60-90%) in the small intestine and, without fermentation, is excreted in the urine within 24 hours [10]. The rest of the substance enters the large intestine and is excreted unchanged in feces. It is well tolerated when consumed and does not cause side effects.

According to clinical studies, erythritol is safe for both healthy people and diabetic patients, since it does not affect the rise in glucose and insulin in the blood. It was noted that when erythritol was administered to rats with streptozotocin diabetes at doses of 100, 200, and 400 mg / kg of body weight for 10 days, they experienced a significant decrease in the concentration of glucose in the blood, liver and kidneys [15].

Erythritol is considered one of the best anti-cariogenic sugar substitutes. Thus, when examining the oral cavity of children aged 7-8 years who consumed erythritol-containing candies (7.5 g daily) for 3 years, there was a decrease in the number of *Streptococcus mutans* compared to the level of *Streptococcus mutans* in the oral cavity of children who consumed lozenges with xylitol or sorbitol [16].

E963 Tagatose (D-tagatose)

Tagatose is a monosaccharide . Chemical formula: $C_6H_{12}O_6$ (Fig. 5).

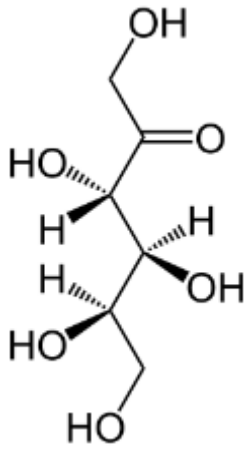

Fig. 5. Structural formula of tagatose

It is a white crystalline powder similar to sucrose. Its sweetness is 92% of that of sucrose. Energy value - 1.5 kcal / g [3].

Only 20% of the consumed tagatose is absorbed in the small intestine. Most of it is completely fermented by the colon microbiota with the formation of low molecular weight fatty acids. Since tagatose is not completely metabolized, it can cause flatulence and a mild laxative effect.

Tagatose has a prebiotic effect. It promotes the growth of lactobacilli and lactic acid bacteria, which support the normal functioning of the intestinal microbiota, prevent the growth of pathogenic microorganisms and have a stimulating effect on the immune system. This is confirmed by the results of an experiment aimed at studying the influence of tagatose on the processes of digestion and fermentation. During the study, volunteers donated fecal samples twice: before and after 14 days of consumption of tagatose (10 g daily). The result of analysis of stool samples showed that the concentration of low molecular weight fatty acids in stool after consumption of tagatose is 3 times higher than in stool before it was taken. In addition, the number of lactic acid bacteria in the feces of those consuming tagatose increased significantly, while the BGKP decreased (compared to the data at the beginning of consuming tagatose) [3].

Tagatose is characterized by low glycemic and insulin responses, as evidenced by data from several clinical trials conducted on people with type 2 diabetes at major research institutes in the United States and India. In the experiment, 356 people with type 2 diabetes took 15 g of tagatose or

1.5 g of placebo, dissolved in water, 3 times a day with food for 12 months. As a result, tagatose reduced blood glucose levels by about 0.2% [17].

As a low-calorie carbohydrate sweetener, this substance is slowly fermented by microorganisms in the oral cavity, thereby reducing the risk of tooth decay. This has been proven thanks to testing carried out at the Dental Institute of the University of Zurich. The test results showed that the pH of saliva after rinsing with a tagatose solution is much lower than the pH of saliva after rinsing with a sucrose solution [3].

Allulose (pseudo-fructose, psicose)

Allulose, a rare sugar, is a D-3 epimer of fructose . Chemical formula: $C_6H_{12}O_6$ (Fig. 6).

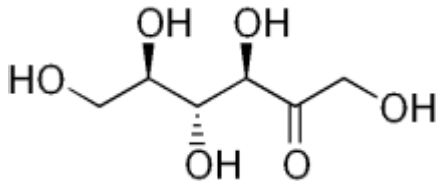

Fig. 6. Structural formula of allulose

It is a white, odorless powder, with a pure taste without a "cool" aftertaste, easily soluble in water. Its sweetness is 70% of that of sucrose [18]. Energy value - 0.2 kcal / g [2].

When ingested, about 70% of the allulose is absorbed and excreted in the urine. The rest is excreted in the feces, since it does not undergo fermentation in the large intestine [19]. Since allulose is the newest sugar substitute, its effect on the human body has not been studied enough.

This substance is positioned as a unique regulator of glucose and lipid metabolism and is estimated as a promising agent for the treatment of type 2 diabetes mellitus. This is confirmed by an experimental study on rats, during which, after 13 weeks of feeding rats with 5% allulose solution, no increase in body weight and abdominal fat mass was observed in rodents. An oral glucose tolerance test (OGTT) showed a decrease in blood glucose and insulin levels, indicating an improvement in insulin resistance in rats [20].

Allulose is believed to be a sweetener that can help control body weight. The result of a study of 13 healthy patients who took 5 g of allulose 30 minutes before meals showed that taking it at this dose increases fat oxidation and reduces carbohydrate oxidation in healthy people. Therefore, allulose can be used in the treatment of obesity [21].

There is no evidence of the effect of allulose on tooth enamel. However, it is known that Japanese scientists are developing a new anti-cariogenic sweetener, which contains allulose. It is expected that the created drug will be effective in combating bacteria that cause diseases of the oral cavity.

Inulin

Inulin is a plant polysaccharide of the fructan type. Chemical formula: $(C_6H_{10}O_5)_n$ (Fig. 7).

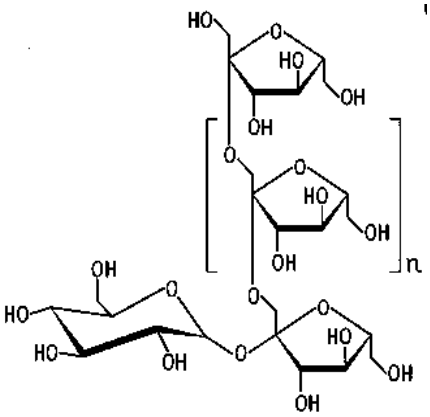

Fig.7. Structural formula of inulin

It got its name from the tall elecampane plant (*Inula helenium L.*). Inulin is a white powder, has a sweet taste, slightly soluble in cold water and ethanol, well in hot water. The sweetness level of inulin is about 10% of the sweetness of sucrose. Energy value - 1.5 kcal / g [22].

Since the inulinase enzyme is absent in the human digestive tract, the decomposition of inulin takes place partially with the help of the enzymatic systems of microorganisms in the colon, therefore it is excreted in the feces in a slightly modified form. However, some people experience irritation of the colon and increased peristalsis.

Body weight, insulin sensitivity, and glucose metabolism are known to be associated with the fermentation of dietary fiber into short chain fatty acids by the gut microbiota. Increasing the concentration of short-chain fatty acids in the colon and blood plasma can be used as a strategy for the prevention and treatment of obesity and insulin resistance caused by overweight. In a study of 14 healthy normoglycemic men aged 20-50 years who took a milk shake with a high fat content and inulin (24 g), it was found that the level of free fatty acids in the blood plasma of the subjects was significantly reduced [23].

Another study on this topic was carried out on 64 Sprague Dawley rats at the age of 7 weeks. At the end of the 4-week experiment, it was noted that in the inulin-fed rats, the average weight was comparable to the weight of the rodents fed the inulin-free diet. In addition, the results of analyzes of feces from rats demonstrated that the inulin diet is effective in maintaining the growth of intestinal bacteria, especially *Lactobacillus spp.* [24].

As a low-calorie sugar substitute, inulin is slowly fermented by microorganisms in the oral cavity, thereby reducing the risk of dental caries.

Monk fruit extract

Monk fruit extract is a natural sweetener obtained from the fruit of the evergreen climbing plant *Siraitia grosvenorii* , which grows in southern China in the Guangxi province. Its fruits are known as Luo-Han-Guo or "Buddha fruits".

It is a white or light yellow powder, has a pleasant aroma, 250-300 times sweeter than sucrose [25]. Energy value - 0.0 kcal / g [2]. The sweetness of the extract is due to the highly stable triterpene glycosides known as mogrosides. Chemical formula: $C_{60}H_{102}O_{29}$ (Fig. 8).

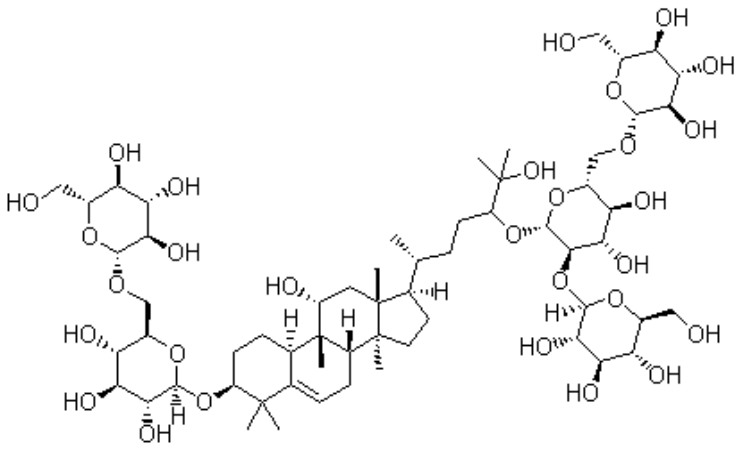

Fig. 8. Structural formula of mogroside

After ingestion of monk fruit extract, mogrosides undergo minimal systemic absorption, hydrolysis by digestive enzymes and intestinal flora, after which they are excreted from the body in the form of mogrol and its mono- and diglucosides.

Monk fruit extract has hypoglycemic properties, which allows it to be used in the diet of diabetics. Thus, the administration of a solution of monk fruit extract to diabetic Goto-Kakizaki rats for 13 weeks improved the insulin response, decreased blood glucose levels, and decreased urine volume and urine albumin [26].

The non-nutritive sweetening properties of *Siraitia grosvenorii* make it indispensable in the prevention of obesity. Thus, the introduction of monk fruit extract into the diet of male and female Wistar rats at concentrations of 0%, 0.04%, 0.2%, 1% and 5% for 13 weeks did not affect body weight and the amount of food and water consumed [27].

In traditional Chinese medicine, monk fruit extract has been widely used as a medicine for over 300 years, since the triterpenoids, flavonoids, and amino acids contained in the plant have various biological activities, including antioxidant, immunological, antitussive, hepatoprotective, and antimicrobial. In addition, *Siraitia grosvenorii* is used for oncological diseases of the nasopharynx, larynx and lungs.

Since monk fruit extract is a rare sugar, there is no evidence of its effect on teeth.

Stevia (honey herb)

Stevia *Stevia rebaudiana Bertoni* is a perennial plant from the Asteraceae family. It is famous for its sweetness, which is due to the presence of steviol glycosides, among which stevioside (E960) is the most widely used . Chemical formula: $C_{38}H_{60}O_{18}$ (Fig. 9).

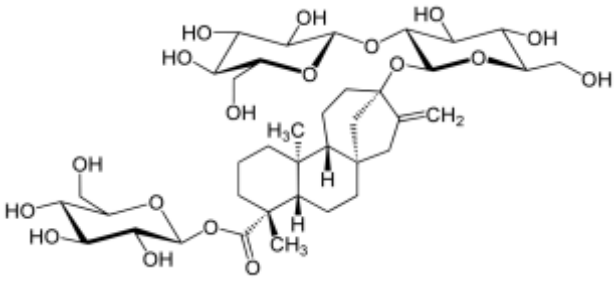

Fig. 9. Structural formula of stevioside

The extract of the stevia plant is a sweetener of the latest generation, is a white crystalline powder, odorless, well soluble in ethanol, poorly - in water, 300 times sweeter than sucrose [3]. Energy value - 0.0 kcal / g [2].

After oral administration of the drug, stevioside is broken down by the intestinal microbiota into glucose, steviolbioside and steviol, which is further excreted unchanged from the body with feces.

A large number of clinical trials conducted for therapeutic purposes have shown that stevia has hypoglycemic, hypotensive, antifungal, anti-inflammatory properties and can be used to treat cancer, diabetes mellitus, obesity, and hypertension.

It was found that the introduction of an aqueous extract of stevia at various concentrations (200, 300, 400, 500 mg / kg of body weight per day) for 8 weeks in albino rats showed a decrease in blood glucose levels and a decrease in body weight compared to the control group [28].

In another study, testing found that steviol, found in stevia leaves, successfully suppressed the viability of cancer cells in the human gastrointestinal tract. At a dosage of 100-200 µg / ml, steviol demonstrated the same inhibition efficiency as 5-fluorouracil, and at 250 µg / ml it had even stronger inhibition [29].

An important evidence that stevia and its secondary metabolites (stevioside, steviol, etc.) play a positive role in the prevention of dental caries is a study demonstrating their protective effect against microorganisms *Streptoccocus mutans, Streptoccocus aureus, Escherichia coli* and *Bacillus subtilis* grown on agar environment [30].

E955 Sucralose (4,1 ', 6'-trichlorogalactosucrose, TGS)

Sucralose is a substituted disaccharide. Chemical formula: $C_{12}H_{19}O_8Cl_3$ (Fig. 10).

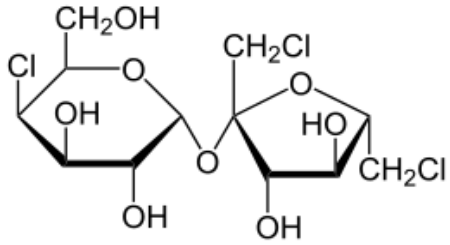

Fig. 10. Structural formula of sucralose

It is a crystalline powder, odorless, readily soluble in water and alcohol, has a pronounced sweet taste without a metallic aftertaste and bitter aftertaste. Sweetness coefficient - 600 [1]. Energy value - 0.0 kcal / g [2].

Most of the consumed sucralose (85%) is excreted unchanged in feces, and the remaining 15% is absorbed in the gastrointestinal tract and enters the system of circulation of body fluids, from where, without accumulating in any tissues and organs, it is excreted in the urine [3]. Since sucralose is not a substrate for the microflora of the gastrointestinal tract, it is not affected by intestinal fermentation products and does not cause discomfort (flatulence, bloating, diarrhea).

Sucralose is an ideal food for diabetics. It has no discernible effect on blood sugar. This is confirmed by a study conducted on 48 healthy volunteers, some of whom received sucralose in the amount of 13.2 mg / kg of body weight per day for 12 weeks, and the other received placebo. The study evaluated the indicators of glucose and insulin homeostasis both on an empty stomach and after a meal. After summing up the results of the experiment, it was noted that there were no statistically significant differences in laboratory screening values of glucose and insulin in the blood between the two groups of volunteers from the initial level [31].

Regular consumption of sucralose curbs the detrimental effects of a high-carb diet on body weight. The experiment was carried out on mice. The control group had access to a normal diet (ND) and water, the other three ate a high fat (HF) diet with access to either water, 10% sucrose solution, or 0.017% sucralose solution. Mice fed the HF diet and sucralose had less weight gain compared to the other HF groups. The obesity index and subcutaneous fat were also reduced in this group [32].

Sucralose is a sweetener with a high sweetness index, but does not damage tooth enamel. An experiment on rats proved that in the presence of sucralose *Streptococcus mutans* do not multiply, that is, sucralose is not cariogenic [3].

Results.

This article compares ten of the most famous sugar substitutes (Table 1).

Table 1

Generalized information on sweeteners

Sugar substitute	Coeffi-citation of sweetness relative to sucrose	Energy value, kcal / g	Metabolism and side effects on the gastrointestinal tract	Anti-diabetic activity	Caries genicity	Other positive properties
one	2	3	4	5	6	7
Xylitol (E967)	0.95	2.5	breaks down to low molecular weight acids and gases, in case of an overdose, flatulence and diarrhea may occur	+	-	treatment of ENT and oncological diseases, inflammatory processes
Maltit (E965)	0.95	2.7	breaks down to low molecular weight acids and gases, in case of an overdose, flatulence and diarrhea may occur	+	-	
Sorbitol (E420)	0.6	2.5	breaks down to low molecular weight acids and gases, in case of an overdose, flatulence and diarrhea may occur	+	-	prebiotic, laxative effect
Erythritol (E968)	0.7	0.2	quickly absorbed, well tolerated	+	-	
Tagatose (E963)	92%	1.5	decomposes to low molecular weight acids, possibly gassing and laxative effect	+	-	prebiotic action

Continuation of table 1

1	2	3	4	5	6	7
Allulose	70%	0.2	not metabolized, the effect on the body has not been studied enough	+	no information available	
Inulin	10 %	1.5	partially breaks down, irritation of	+	-	prebiotic action

			the colon and increased peristalsis are possible			
Monk fruit extract	250-300	0	degrades to mogrol and its mono- and diglucosides	+	no information available	immunostimulating, antimicrobial, expectorant effect
Stevia	300	0	breaks down into glucose, steviolbizide, steviol	+	-	anti-inflammatory, antifungal action, treatment of cancer
Sucralose (E955)	600	0	does not undergo splitting, does not cause side effects	+	-	

Along with the general characteristics inherent in all the substances considered, they have significant differences. So erythritol, inulin, stevia, tagatose, monk fruit extract, allulose are natural sweeteners, sucralose, maltitol, sorbitol, xylitol are synthetic.

The highest degree of sweetness is found in sucralose (sweetness coefficient - 600), the lowest - in inulin (10% of the sweetness of sucrose) and sorbitol (sweetness coefficient - 0.6). The most "high-calorie" sweeteners are maltitol (2.7 kcal / g), xylitol (2.5 kcal / g), sorbitol (2.5 kcal / g), and sucralose, stevia, monk fruit extract are calorie-free (0.0 kcal /G).

Conclusion

Sweeteners have different effects on metabolism. So taking xylitol, maltitol, sorbitol, tagatose, inulin can cause side effects in the form of flatulence, increased peristalsis, diarrhea. In contrast, erythritol, sucralose, monk fruit extract, allulose, and stevia do not cause side effects.

Scientific research has revealed promising benefits of sweeteners in the fight against obesity, which is the cause of many metabolic diseases such as diabetes, high blood pressure, coronary heart disease and stroke. The sugar substitutes presented in this article have a low glycemic index and can be included in the diet of patients with diabetes mellitus. In addition, sucralose, monk fruit extract, allulose, inulin prevent obesity and can be included in the diet of people who maintain an optimal weight.

Various studies have confirmed that sweeteners are non-cariogenic and can be used to prevent dental caries. Erythritol stands out especially among them, since it not only reduces the number of *Streptococcus mutans* , but also helps to reduce plaque compared to xylitol and sorbitol.

Having considered the most common sugar substitutes from the point of view of their effect on the human body , we can conclude that their use is necessary and advisable for diseases of the endocrine system and for building the right eating habits of people leading a healthy lifestyle.

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