Comparative characteristics of instant creams with sugar and isomaltulose

R D Hadjikinova
University of Food Technologies of Plovdiv, Bulgaria
Faculty of Technology, Department of tobacco, sugar, vegetable and essential oils
e-mail: raina.h@abv.bg

Abstract. In recent years, there has been a trend to replace sugar (sucrose) in the composition of foods with sweet taste, with its alternatives that have a beneficial effect on some of the functions of the human body. One of the newest alternatives to sucrose is isomaltulose, which differs from other sugars by its low glycemic index and its non-cariogenicity. The aim of the present study was to establish the influence of isomaltulose, as a substitute for sucrose in the composition of instant starch creams, on their main physicochemical parameters and properties. Based on a comparative analysis, the main physicochemical parameters and the rheological behavior of instant starch creams obtained with sucrose and isomaltulose were determined. It was found that differences between the samples exist in the indicator content of reducing substances and the values of glycemic indicator. No differences were observed in the rheological behavior of the creams, similar to the cream with sugar, the cream with isomaltulose refers to non-Newtonian liquids.

1. Introduction
Starch creams are widely used in the food industry both alone and in the form of fillings for various products. They have properties that allow them to be used for filling and garnishing. When used as semi-finished products, they have a significant impact on the products of confectionery industry, as they give them a specific flavour, color and taste [1]. They are prepared by heat treatment (cooking) or by fast (instant) method. One of the main ingredients in the composition of this type of cream is sugar. From the group of carbohydrates, sucrose, better known as "sugar", has the largest quantitative production and application worldwide [2]. It has been found that excessive consumption of foods high in sucrose is one of the reasons for the so-called "Diseases of civilization" [3, 4]. For this reason, the interest of producers, nutritionists and consumers in sucrose alternatives is understandable. In this respect, isomaltulose is a carbohydrate (isomer of sucrose) that has been gaining popularity in recent years as an alternative to sucrose. Isomaltulose is a reducing disaccharide that occurs naturally in honey and sugar beet juice [5]. The chemical name of this sugar is 6-O-α-D-glucopyranosyl-D-fructofuranose. It consists of fructose and glucose linked by an α-(1→6) bond compared to sucrose, where the bond is α-(1→2) [6]. Isomaltulose is defined as a "slow" but completely degradable carbohydrate [7]. It is completely broken down in the small intestine, although its breakdown process is slower than that of sucrose [8]. It thus causes attenuated blood glucose and insulin response, a property which may be particularly favourable for diabetics. Isomaltulose is known under the trade name "Palatinose™". Isomaltulose has about 50% less sweet taste than sucrose [9, 10, 11]. The glycemic index of isomaltulose was determined according to an internationally recognized standard methodology with a score of GI = 32.8 [12]. For comparison,
the glycemic indices of sucrose and glucose are 68 and 100, respectively [9]. It has been found that isomaltulose does not cause the development of dental caries [7, 10, 11]. The non-cariogenic characterization of isomaltulose is approved as a health claim by the US Food and Drug Administration (FDA) [13].

Isomaltulose was "recognized as safe" (GRAS) by the US Food and Drug Administration (FDA) and approved as "Novel Food" in 2005 by the European Union [9, 14, 15].

Isomaltulose is currently used as an alternative to other sugars in foods and beverages, including sports drinks, energy drinks and clinical nutrition foods, dairy products, chocolate products, jellies and others [10, 11].

Given the influence of composition on the quality characteristics of food, the aim of the present study is to determine the influence of isomaltulose, as an alternative to sucrose, in the composition of instant dry mixtures for starch creams, on the main physicochemical parameters and properties of finished products.

2. Materials and methods

Isomaltulose from “Beneo” under the trade name Palatinose™ was used for the study. Based on the basic composition of the company "Dafa" Ltd., a manufacturer of dry instant mixtures for dessert creams, a composition of an instant powder mixture with the participation of isomaltulose has been developed. The composition of the instant mixtures used for the preparation of dessert creams is shown in table 1, the individual samples being designated as follows: the sample with sugar S, a sample with an equivalent amount of isomaltulose - Is.

| Components, % | Sample S | Sample Is |
|---------------|----------|-----------|
| Sugar         | 56.2     | -         |
| Isomaltulose  | -        | 56.2      |
| Starch        | 32.2     | 32.2      |
| Powdered milk | 4.0      | 4.0       |
| Powdered milk whey | 6.0 | 6.0 |
| Other additives | 1.6 | 1.6 |
| Total         | 100      | 100       |

Starch creams are prepared in the laboratory (without heating), using a mixer "Planetary Mixer B5", with the addition of 3 parts by mass of water to 1 part of dry instant mixture.

The values of the main physicochemical parameters of the finished creams, such as dry matter content, total sugar, reducing substances and titratable acidity, were determined by methods according to [16].

The pH values of the 10% sample solutions were determined using a „Bante“ pH meter. The syneresis of the samples was determined. Quantitative assessment of syneresis was performed on the basis of the secreted fluid, expressed as a percentage, relative to the initial mass. Syneresis was determined by storing the samples at room temperature and at a temperature of 8 °C. The viscosity of the samples was determined with a rheoviscometer "Rheotest 2" at a temperature of 35 °C. The glycemic indicator is calculated by methodology [17].
3. Results and discussions
In order to determine the effect of isomaltulose on the basic indicators, in comparison with those of the cream with sucrose, their basic physicochemical indicators are determined, reflected in Table 2.

Table 2. Physicochemical parameters of creams.

| Indicators                                      | Sample S          | Sample Is         |
|------------------------------------------------|-------------------|-------------------|
| Dry matter content, %                          | 25.7±0.4          | 26.1±0.6          |
| Total sugar content, % (as invert sugar), on dry matter | 48.4±0.5          | 45.9±0.2          |
| Reducing substances, % (as invert sugar), on dry matter | 2.6±0.2           | 31.4±0.3          |
| Titratable acidity                              | 3.0±0.3           | 3.1±0.2           |
| pH                                             | 7.6±0.2           | 7.4±0.1           |
| Density, g/cm³                                  | 1.1               | 1.1               |
| Glycemic indicator (on dry matter)              | 15.2              | 10.1              |

The data in the table 2 show that significant differences between the samples are observed in the values of reducing substances and glycemic indicator. The lower value of the glycemic indicator of sample Is is due to the lower value of the glycemic index of isomaltulose compared to that of sucrose. Differences are also observed in terms of the content of reducing substances. Sample Is has about 12 times higher content of reducing substances than sample S. There are no significant differences with respect to the other indicators.

The storage behavior of the samples was determined by syneresis (Figure 1 and Figure 2). The results of the analysis show that storage conditions affect syneresis.

Figure 1. Syneresis when stored at room temperature. Type of sample: □-S and ●-Is.
The data in the figures show that the two samples behaved similarly with respect to syneresis. Both at room temperature and at 8 °C, the cream obtained with isomaltulose, although to a small extent, shows less pronounced syneresis.

As a dessert food, also as a semi-finished product, which participates in the composition of various groups of sweet foods, their rheological properties are also important for the quality of the creams. The viscosity of starch creams is defined as the main rheological indicator. It is defined in the range of change of the speed gradient from 4.5 to 72.9 s⁻¹ - figure 3.

From the graphically expressed dependence it is evident that with increasing share rate the viscosity decreases, which confirms the non-Newtonian rheological behavior of the creams. At values of the share rate above 20 s⁻¹ the values of the viscosity of the samples are relatively close.

4. Conclusion
It was found that the finished cream, obtained with the participation of isomaltulose, has higher values of the indicator reducing substances in comparison with the cream with sugar. There are also differences in the glycemic indicator of the samples, as the cream with isomaltulose has a lower value. The viscosities of the samples have relatively similar values at high values of share rate and are rheologically defined by a non-Newtonian type of behavior. The results obtained show that isomaltulose is a suitable alternative to sucrose in the composition of starch creams.
Acknowledgements
The author acknowledge the support by the National program „Young scientists and postdoctoral“.

References
[1] Nikovska K, Petrova I, Merdjanov P, Stoyanova A and Damyanova S 2013 Sensory profile of sweet emulsion products with chokeberry pressed flour (Aronia melanocarpa (Michx.) Elliott.), Scientific Papers of University of Ruse 52 pp 153-158
[2] Spillane W 2006 Optimising Sweet Taste in Foods, Woodhead Publishing p 448
[3] Rusu M 2009 The Functional Foods: Development and opportunities Sectiunea Genetica si Biologie Moleculara 10 pp 93-98
[4] Hu F and Malik V 2010 Sugar-sweetened beverages and risk of obesity and type 2 diabetes: Epidemiologic evidence, Physiology & Behavior 100 pp 47-54
[5] Bárez J, Villanova R, García S, Palá T, Páramas A, Sánchez J 2000 Geographical discrimination of honeys through the employment of sugar patterns and common chemical quality parameters European Food Research and Technology 210 pp. 437-444
[6] Lina B, Jonker D, Kozianowski G 2002 Isomaltulose (Palatinose): a review of biological and toxicological studies Food and Chemical Toxicology 40 pp 1375–1381
[7] Maresch C, Petry S, Theis S, Westphal A, Linn T 2017 Low Glycemic Index Prototype Isomaltulose-Update of Clinical Trials Nutrients 9(4) pp 381
[8] Grembecka M. 2015 Sugar alcohols—their role in the modern world of sweeteners: A Review European Food Research Technology 241 pp 1–14
[9] Holub I, Gostner A, Theis S, Nosek L, Kudlich T, Melcher R and Scheppach W 2010 Novel findings on the metabolic effects of the low glycaemic carbohydrate isomaltulose (palatinose™), British Journal of Nutrition 103 pp 1730–1737
[10] Sawale D, Shendurse M, Mohan S, Patil R, 2017 Isomaltulose (palatinose) - An emerging carbohydrate Food Bioscience 18 pp 46–52
[11] Shyam S, Ramadas A and Chang S 2018 Isomaltulose: recent evidence for health benefits Functional Foods 48 pp 173–178
[12] Atkinson F, Foster-Powell S, Brand-Miller C 2008 International tables of glycemic index and glycemic load values Diabetes Care 31 pp 2281–2283
[13] Godshall M 2007 The expanding world of nutritive and non-nutritive sweeteners Sugar Journal 69 pp 12–20
[14] FDA. 2006. US GRAS Notification no 0184 on isomaltulose
[15] EU Commission Decision 2005/581/EC of 25th July 2005 authorising the placing on the market of isomaltulose as a novel food or novel food ingredient under Regulation (EC) no 258/97 of the European Parliament and of the Council. Official Journal of the European Union of 29.7.2007, L199/90–L199/91
[16] Lurie S, Skokan E, Tsitovich A. 2003 Technical and microbiological control in the confectionery industry, Kolos, Moscow (in Russian).
[17] Patent 40623 Ukraine, IPC A 23 L 1/10, Method for determining the glycemic index of a food product, Dorokhovych A., V. Kovbas, M. Gulich, V. Dorokhovych, O. Yaremenko, application. 10.07.2008, publ. 27.04.2009