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DETERMINATION OF SELECTED ELEMENTS OF THE NUTRITIONAL VALUE AND BIOACTIVE COMPOUNDS CONTENT IN ORGANIC SUGAR SYRUPS

Summary

The growing consumers' awareness in the nutrition area, the desire to look for alternatives to white sugar and the trend to live healthily have led to an increase in the supply of sugar syrups on the organic market. Insufficient number of studies on the health attributes of these syrups does not allow to state clearly that they are a good substitute for saccharose. The aim of the work was to identify and determine the content of biologically active compounds and sugars content of natural sugar syrups from organic production. Purchased products have been examined to indicate the content of individual sugars and polyphenol compounds. The type of sugar syrup had an impact on the nutritional value, the content of dry matter, sugar and the content of bioactive compounds such as polyphenols. The obtained results showed that sugar beet as well as date syrup due to high content of bioactive compounds are nutritionally beneficial.
***Key words**: sugar syrups, organic syrups, sugars, polyphenols content, HPLC*

OZNACZENIE WYBRANYCH ELEMENTÓW WARTOŚCI ODŻYWCZEJ I ZAWARTOŚCI ZWIĄZKÓW BIOLOGICZNIE CZYNNYCH W EKOLOGICZNYCH SYROPACH CUKROWYCH

Streszczenie

Rosnąca świadomość żywieniowa konsumentów, chęć poszukiwania alternatyw dla białego cukru oraz trend zdrowego trybu życia spowodowały wzrost podaży roślinnych syropów cukrowych na rynku żywności ekologicznej. Niedostateczna ilość badań nad walorami zdrowotnymi tych syropów nie pozwala jednoznacznie stwierdzić, że stanowią dobry substytut sacharozy. Celem niniejszej pracy była identyfikacja i określenie zawartości związków biologicznie czynnych oraz wartości odżywczej rynkowych syropów słodzących z produkcji ekologicznej. W zakupionych produktach oznaczono zawartości poszczególnych cukrów oraz związków polifenolowych. Rodzaj syropu cukrowego miał wpływ na wartość odżywczą, zawartość suchej masy, cukrów i związków bioaktywnych, takich jak polifenole. Na podstawie uzyskanych wyników stwierdzono, że syropy buraczany i daktylowy z uwagi na wysoką zawartość związków bioaktywnych są korzystne pod względem żywieniowym.
***Słowa kluczowe**: syropy cukrowe, syropy ekologiczne, cukry, zawartość polifenoli, HPLC*

1. Introduction

The growing consumers' awareness in the nutrition area, the desire to look for alternatives to white sugar and the trend to live healthily have led to an increase in the supply of sugar syrups on the organic market. Both synthetic and natural products are available on the market as an alternative to sucrose. Among the modern consumers, the trend of a healthy lifestyle is dominating more and more, and thus the selection of food products that have a positive effect on health. Synthetic sweeteners arise much controversy and the consumer is trying to choose natural products, which leads to a steady increase in the supply of organic products [7, 13]. The market offers a wide range of organic sweet syrups, an alternative to the notorious white sugar. Consumers willingly reach for natural sweet syrups, encouraged by positive opinions in social media, especially on the Internet, and ecological label. However, sweetening organic syrups are relatively new products and there are few studies available to confirm their beneficial effects on health. This paper discusses the content of individual sugars and some biologically active compounds in sugar syrups from organic production [5, 9].

The biologically active substances present in sugar syrups include polyphenolic compounds. Polyphenols are organic compounds from the group of phenols, which are secondary plant metabolites characterized by a very diverse structure as well as physicochemical and biological properties. Polyphenolic compounds, being the largest group of natural antioxidants, are commonly found in plants and are not synthesized by animal organisms. Polyphenolic compounds are valuable and desirable chemical components due to the antioxidant properties that result from the presence of a large number of hydroxyl groups in their molecules. Eating foods with a high polyphenols content contributes to increasing the body's antioxidant capacity. Antioxidant activity of polyphenols is based on inhibition of enzymes involved in the reactions of free radical formation and metal chelation, which reduces the formation of reactive oxygen species [2, 12].

The aim of this study was to identify and determine the content of biologically active compounds and the nutritional value of market-based natural sweeteners from organic production.

2. Material and methods

The research material included organic sugar syrups: sugar beet syrup, agave syrup, coconut flower syrup, rice syrup, tapioca syrup, maple syrup, date syrup. Syrups were purchased in organic shops. In plant syrups, the dry matter

content was determined by scale method. The content of phenolic acids, flavonoids and sugars was determined by HPLC method. The obtained results were statistically elaborated with post-hoc Tukey test (p=0,05).

3. Results

Dry matter content and sugar content in various types of sugar syrups are shown in Table 1.

Dry matter content. The highest content of dry matter was found in date syrup. High content of dry matter was also observed in rice syrup, tapioca syrup and maple syrup. The lowest content of dry matter was recorded for agave and sugar beet syrups.

Sugar content. Based on the conducted studies, it was observed that the total sugar content was similar in all tested syrups. Date syrup contained the highest content of total sugar in all types of sugar syrups, but the difference was not statistically significant. The highest content of saccharose was observed in sugar beet syrup, tapioca syrup, maple syrup and date syrup. In contrast, the highest content of glucose was found in rice syrup, but this syrup didn't contain any saccharose and fructose. Coconut syrup contained the most fructose. The content of polyphenols in examined sugar syrup is shown in Table 2.

Total polyphenols. The highest content of total polyphenols was observed in sugar beet syrup. Phenolic acids**.** The highest content of total phenolic acids, gallic acid, caffeic acid and p-coumaric acid was found in date syrup while sugar beet syrup and agave syrup contained the most ferulic acid. Sugar beet syrup was characterized by the highest content of total flavonoids, luteolin glycoside-3-O-quercetin and kaempferol. In contrast, the highest content of quercetin was found in rice syrup.

4. Disscusion

The research shows that the organic date syrup is a very good source of polyphenolic compounds compared to other syrups. A study conducted by Taleb et al. [12] confirms that the date syrup contained polyphenolic compounds in large quantities. The results of this study indicate that the syrup contained approximately 605 mg / 100 g total polyphenol product - thus almost three times more than in our own research. In addition, in both studies the presence of flavonoids in date syrups was identified. In our study, it was observed that the main source of flavonoids (10.12 mg / 100g) in the date syrup were quercetin and kempferol (flavanols) and a similar result was obtained in the Taleb et al. [12] study, where flavanols accounted for approx. 90% of identified flavonoids in the date syrup (flavonoid content - 40.5 mg / 100 g, including flavanols - 31.7 mg / 100 g).

A study done by Abbes et al. [1] was another one which also confirmed the presence of polyphenols in the date syrup. The results obtained at that time indicated the total polyphenol content in syrups (depending on the type of dates from which they were obtained) at the level of 409.85 to 529.28 mg / 100 g.

Table 1. The content of dry matter (g/100 g) and sugar (g/100 g) in examined sugar syrups
Tab. 1. Zawartość suchej masy (g/100 g) oraz cukrów (g/100 g) w badanych syropach cukrowych

Examined compounds	Type of sugar syrup						
	Sugar beet syrup	Agave syrup	Coconut flowers syrup	Rice syrup	Tapioca syrup	Maple syrup	Date syrup
Dry matter	75.46±0.23a	76.23±0.25a	80.02±0.45b	84.04±0.70c	83.15±0.20c	82.42±0.10c	87.51±2.32d
Total sugars	68.24±1.48a	69.09±4.68a	75.19±0.94a	70.08±2.52a	71.02±13.19a	68.08±6.63a	85.21±4.38a
Saccharose	64.23±1.21b	-	0.36±0.04a	-	60.54±13.12b	62.58±6.64b	46.19±3.50b
Glucose	3.10±1.11a	33.91±3.14c	31.20±0.11c	70.08±2.52d	10.07±0.11b	4.72±0.03ab	-
Fructose	0.90±0.03a	35.18±1.80b	43.63±1.08d	-	0.42±0.02a	0.78±0.00a	39.02±0.88c

*data are presented as the mean ± SD with ANOVA p-value;
** n.s.(statistically not significant); values labelled with the same letter are not significantly different (Tukay's honestly significant difference test. P=0.05)

Source: own work / Źródło: opracowanie własne

Table 2. The content of polyphenols (mg/100 g) in examined sugar syrups
Tab. 2. Zawartość związków polifenolowych (mg/100 g) w badanych syropach cukrowych

Examined compounds	Type of sugar syrup						
	Sugar beet syrup	Agave syrup	Coconut syrup	Rice syrup	Tapioca syrup	Maple syrup	Date syrup
Total polyphenols	312.14±32.51d	253.45±16.85 c	82.92±7.27b	75.31±1.69ab	37.56±0.42a	112.61±5.72b	264.81±40.03c
Total phenolic acids	166.85±13.64c	153.87±16.39 c	30.23±1.30a	27.92±0.63a	20.48±0.05a	86.60±6.05b	254.69±39.56d
Gallic	15.47±0.68c	14.86±0.57c	2.32±0.19a	8.86±0.07b	2.95±0.15a	2.40±0.43a	21.95±4.46d
Caffeic	37.58±1.95c	33.27±1.03c	6.23±1.13ab	2.69±0.20a	2.49±0.12a	29.70±3.31ab	126.42±29.91d
p-coumaric	57.14±9.89bc	50.30±6.52bc	13.16±0.33a	7.86±0.14a	7.44±0.23a	47.52±2.11b	61.17±6.39c
Ferulic	56.65±3.16c	55.44±10.99c	8.52±0.48a	8.51±0.52a	7.61±0.38a	6.98±0.22a	45.14±2.24b
Total flavonoids	145.29±18.87d	99.58±2.45c	52.69±7.58b	47.39±1.66b	17.08±0.47a	26.01±0.33a	10.12±0.52a
Luteolin	1.56±0.40c	3.71±0.10d	0.12±0.05a	0.55±0.19b	0.25±0.00ab	0.43±0.06ab	1.50±0.03c
Quercetin	9.84±0.31c	11.18±0.37d	3.40±0.01a	12.90±1.54e	3.12±0.01a	7.00±0.07b	3.46±0.09a
Glycoside-3-O-quercetin	50.03±16.28c	15.82±0.31b	3.31±0.43ab	14.03±0.96ab	1.56±0.74a	8.18±0.35ab	1.02±0.44a
Kaempferol	83.86±2.76e	68.88±2.28d	45.86±7.90c	19.92±0.68b	12.15±0.35ab	10.40±0.19ab	4.14±0.02a

*data are presented as the mean ± SD with ANOVA p-value;
** n.s.(statistically not significant); values labeled with the same letter are not significantly different (Tukay's honestly significant difference test. P=0.05)

Source: own work / Źródło: opracowanie własne

The total flavonoid content was 92.15 - 194.51 mg / 100g, and the compound that was present in the largest amounts in all syrups was coumaric acid.

The content of polyphenolic compounds in the date syrup may also be confirmed by studies in which antioxidant activity was determined. In two studies, similar results were obtained (2.636 mmol FRAP / 100 g and 3.273 mmol FRAP / 100g) indicating strong antioxidant activity of the date syrup. In addition, in one of these studies carried out by Grabek-Lejko and Tomczyk-Ulanowska [4] there was marked in date syrup the content of polyphenols calculated as gallic acid - 392.3 mg gallic acid / 100 g , which confirms the high antioxidant activity. In our own study of date syrup, the total polyphenol content was slightly lower - 264.82 mg / 100g. In the case of this study, small quantitative differences in results may be the result of different degrees of processing of date syrups.

In our study, phenolic acids were identified in ecological maple syrup, of which p-coumaric acid and caffeic acid were dominant. Slightly different results were obtained in the study of St-Pierre et al. [11]. At that time, in maple syrup, such phenolic acids as - hydroxyphenylacetic, vanilla and p-coumaric acid were identified in large quantities. The flavanols content is another qualitative difference in the results of both studies. In our own studies, maple syrup contained mainly kaempferol and, in slightly smaller amount, quercetin whereas in the 2014 study, maple syrup contained only quercetin, and kaempferol was not identified..

The organic sugar beet syrup in our own research was characterized by the highest total polyphenol content, including the highest content of flavonoids. The compounds that were identified in the highest amounts were: kaempferol 3-O-quercetin and ferulic acid. Other results were presented in a study by Chen et al. [3]. According to these studies, beetroot molasses are dominated by such bioactive compounds as gallic acid, glycoside-3-0-cyanidins and epicatechin. The results are completely different from those obtained in our own studies, according to which gallic acid was present in very small amounts, and the remaining compounds were not identified. The differences can result from different varieties of sugar beet and production systems, as well as growing conditions.

The research shows that the organic maple syrup contained the most saccharose (62.6%), next glucose (4.72%) and fructose (0.78%). The study conducted by Muhr et al. [8], confirmed that saccharose is the main sugar in maple syrup. In this study, saccharose proved to account for 80% of all sugars.

In our research it was observed that the organic agave syrup didn't contain saccharose, and fructose (35.18%) and glucose (33.91%) were the main sugars. Similar results were obtained by Mellado-Mojica and López [6], whose results suggest that fructose and glucose predominate in agave syrup, and saccharose is determined in trace amounts.

5. Conclusions

1. The type of sugar syrup has an impact on the nutritional value, the content of dry matter, sugar content and the content of bioactive compounds such as polyphenols in the examined sugar syrups.
2. The highest content of dry matter was found in date syrup.
3. It was observed that the total sugar content was similar in all tested syrups.
4. The highest content of saccharose was observed in sugar beet syrup, tapioca syrup, maple syrup and date syrup. In contrast, the highest content of glucose was found in rice syrup. coconut syrup contained the most fructose.
5. The highest content of total phenolic acids, gallic acid, caffeic acid and p-coumaric acid was found in date syrup.
6. Sugar beet syrup was characterized by the highest content of total flavonoids, luteolin glycoside-3-O-quercetin and kaempferol.

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