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Quantification of sugar in different brands of drinks

Simona DOBRINAS, Alina SOCEANU*, Gabriela STANCIU and Viorica POPESCU

Department of Chemistry and Chemical Engineering, Ovidius University of Constanta, 124 Mamaia Blvd, 900527 Constanta, Romania

Abstract The levels of invert sugar (glucose/fructose mixture resulting from inversion) were determined in different brands of orange, grapefruit, lemon, apricot and raspberry products. Samples of fresh juice, soft drink, syrup, nectar and compote were representative of the Romanian market. The invert sugar was quantified by Ofner's method (a titrimetric method) and the refractive and Brix indices were measured for the quantification of sucrose in studied samples. International Commission for Uniform Methods of Sugar Analysis accepts reading of sugar content based on the refractive properties of sucrose despite the fact that the sugar in analyzed juice sample is fructose, not sucrose. This usually does not result in significant error. There were significant differences among orange, grapefruit, lemon, apricot and raspberry products brands, in the levels of sugars.

Keywords: invert sugar, sucrose, Brix, soft drinks

1. Introduction

Soft drink is the name commonly given to a nonalcoholic beverage that is consumed cooled or chilled, as opposed to a hot beverage, like tea or coffee. Juices and nectars are beverages made mainly from natural fruit juices, the content of which is prescribed by local food law regulations. A fruit juice may be defined as the liquid obtained from the edible portion of a ripe fresh fruit or from a fruit kept in fresh condition by suitable means [1-3].

Sucrose is the major sugar used as sweetener in soft drink. Refractometry is the conventional method for measuring sucrose. In addition to the refractometric method, there are some other methods reported for determination of sucrose in beverages, including Fourier transform infrared (FTIR) spectrometry [4] with multivariate analysis [5], mass spectrometry [6], acoustic wave and enzymatic sensors [7-9]

Invert sugar is a mixture of equal parts of glucose and fructose resulting from the hydrolysis of sucrose. It is called invert sugar because the angle of the specific rotation of the plain polarized light changes from a positive to a negative value due to the presence of the optical isomers of the mixture of glucose and fructose sugars. It is found naturally in fruits and honey and produced artificially for use in the food industry.

One degree Brix (°B) is 1 gram of sucrose in 100 grams of solution and represents the strength of the solution as percentage by weight (% w/w). There are various tables Brix/density for sugar solutions that can be used in beverage industry [3].

The goal of this study was to determine the levels of invert sugar in different brands of drinks by Ofner's method. The refractive and Brix indices were measured for the quantification of sucrose in studied samples.

2. Experimental

2.1. Samples

The studied samples were different brands of orange, grapefruit, lemon, apricot and raspberry products (**Table 1**). Samples of fresh juice, soft drink, syrup, nectar and compote were representative of the Romanian market.

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Table 1. Analysed samples

Fruit	Sample number	Type of juice
Orange	1	Pulp juice
	2	CO_2 juice
	3	Natural juice
Red grapefruit	4	CO_2 juice
	5	Juice without CO_2
	6	Nectar
	7	Natural juice
Lemon	8	Lemon tea
	9	Juice with CO_2
	10	Natural juice
	11	Concentrate juice
Apricot	12	Compote
	13	Nectar
Raspberry	14	Syrup
	15	Tea
	16	Nectar

2.2. Sample analysis

The invert sugar was quantified by Ofner's method.

Ofner's method is the indirect determination of the amount of copper oxide by the action of the reducing sugars in the determination of copper sulfate remained unreacted in the Ofner solution used in excess. The Ofner solution is a mixture of copper sulfate, anhydrous sodium carbonate, Seignette salt, Na_2HPO_4 and distilled water. Excess of copper sulfate is treated with sulfuric acid and potassium iodine, and the amount of copper is titrated with 0.1 N sodium thiosulfate in the presence of starch as an indicator. The following reactions occur:

$$2CuSO_4 + 4KI \longrightarrow 2K_2SO_4 + 2CuI + I_2$$

$$I_2 + 2Na_2S_2O_3 \longrightarrow Na_2S_4O_6 + 2NaI$$

25 mL of test solution is placed in a conical flask and 25 mL Ofner solution was added with few pieces of pumice. The obtained solution was boiled for 4-5 minutes. It was immediately cooled by immersion in water for several minutes and 7.5 mL of sulfuric acid 1:1 and 7.5 mL of iodine 0.1N were added. The flask was covered and was allowed to stand leaves for 2-3 minutes stirring circular occasionally for the complete reaction of copper with iodine. A few drops of starch were added and the solution was titrated with sodium thiosulfate until the disappearance of blue coloration of the reaction medium.

The invert sugar was calculated using the formula:

$$\%\ \text{inverted sugar} = [(V \times F \times N)_{I_2} - (V \times F \times N)_{Na_2S_2O_3}] \times 100$$

were V, F and N were the values for volume, factor and concentration respectively, of I_2 solution and of sodium thiosulfate solution.

In refractometric method measurements were performed using an Abbe digital refractometer that works on the principle of light refraction. The angle of refraction will depend upon the concentration of sugar, which causes its density and therefore brix value, or index of refraction. Because the refractometric measurement depends on solution density, the reading is temperature dependent.

A drop of studied solution is placed between two glass prisms. After each reading glass prisms were washed with distilled water. The brix index and refractive index for each analyzed sample were registred.

3. Results and discussions

Table 2 summarizes the results of the invert sugar from studied samples determined by Ofner method.

Table 2. The content of invert sugar from the studied samples

Sample	Invert sugar %	Sample	Invert sugar %
1	24	9	9.8
2	1	10	0
3	7	11	5
4	5	12	24
5	15	13	30
6	28	14	2
7	4	15	12
8	5	16	28

The highest concentration of invert sugar (30%) was found in apricot nectar while the smallest quantity (1%) was found in orange juice with CO_2. In natural juice of lemon, no sugar residues have

been identified. The obtained data shows that generally nectars have a larger amount of sugar.

Taking into account the correlation between refractive index and sucrose content according to the literature [10] (**Table 3**) the results of Brix index and refractive index and their correlation with the amount of sucrose in analyzed drinks were obtained.

Table 3. The correlation between refractive index and sucrose content

Refractive index	Sucrose	Refractive index	Sucrose
1.33299	0	1.34957	11
1.33443	1	1.35093	12
1.33588	2	1.35250	13
1.33733	3	1.35408	14
1.33880	4	1.35567	15
1.34027	5	1.35728	16
1.34176	6	1.35890	17
1.34326	7	1.36056	18
1.34477	8	1.36218	19
1.34629	9	1.36384	20
1.34783	10	1.36551	21

Based on Table 3 data, the sucrose content of the studied samples was estimated. Results of Brix and refractive indices for studied samples are given in **Table 4.**

Table 4. Refractive and Brix indices and correlation with sucrose content (g/L)

Sample	Refractive index	Sucrose g/L	Brix Index (^oB)
1	1.349	11	11
2	1.333	0	0
3	1.346	9	9
4	1.346	9	9
5	1.348	10	10
6	1.356	15	15.5
7	1.342	6	6.5
8	1.343	7	7
9	1.349	11	10.5
10	1.329	0	0
11	1.338	4	3.5
12	1.356	15	15.5
13	1.357	6	16
14	1.334	1	1
15	1.342	6	6
16	1.355	15	14.5

The results of Brix index and refractive index show their correlation with the amount of sucrose in analyzed drinks. The highest value of sucrose was obtained for red grapefruit and raspberry nectars and apricot compote.

In literature [11] diet soft drinks have the lowest sucrose concentration, with an average value of 0.5 g/L, as compared to regular soft drinks (average sucrose concentration: 125 g/ L).

4. Conclusions

From experimental data it appears that most analyzed soft drinks have in their composition sugar.

Orange juice with CO_2 had the lowest concentration of invert sugar and the apricot nectar the highest quantity.

It should be noted that in natural juice of lemon, no sugar residues have been identified.

5. References

* E-mail address: asoceanu@univ-ovidius.ro

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