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Assessment of concentration changes of selected elements in birch sap, depending on collection day, using atomic absorption spectrometry

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ABSTRACT

Research on new products made of naturally occurring substances that possess regenerative and recuperative characteristics of benefit to humanity occurs continuously. In light of this, birch sap is receiving more and more attention. The aim of this work was an assessment of concentration changes of selected elements in birch sap depending on the day of collection. Herein, we utilized a ContrAA 700 high-resolution atomic absorption spectrometer with continuous light source (HR-CS-AAS) and we applied electro-thermal and flame techniques. Our results indicate that the concentration of the marked elements is variable and is connected with the date of collection. For most of elements, a downward trend can be observed. Only the amount of iron increased with time.

INTRODUCTION

New products that are beneficial for humanity, and which are made of naturally occurring substances with regenerative and recuperative characteristics are under continuous, world-wide research. One of the products that is gathering more and more appreciation is natural birch sap. Birch sap used to be formerly called 'oskoła' in Polish. It is a cooling and a medical beverage with a sweet flavor, popular in all Slavic countries. It is obtained as a result of a deep (but not deeper than 4 cm) cut in a trunk or a branch of a birch tree, and should be preserved in glass or enamel containers. Indeed, one can gather around 5 litres of sap daily from a trunk of around 15 cm diameter, and the amount from larger trees can reach even up to 15 litres [1]. The tradition of acquiring birch sap was once popular not only in Poland but also in Norway, Scotland, Slovakia, Russia and Hungary [4].

The sap contains inverted sugar syrup, organic acids such as citric and malic acids, mineral salts, amino acids and peptides. It is considered to be today's "health elixir", rich in ingredients such as vitamin C, flavonoids functioning as antioxidants, tannins, as well as calcium, phosphorus, iron, magnesium, copper and group B vitamins. Thanks to these ingredients, birch sap enhances immunity, prevents infections and helps with mineral element deficiency. Birch sap can also be used in treating diseases such as chronic urinary tract infections, cardiovascular system oedema, kidney stone disease and nephritis or gout. Fresh birch sap is acquired during the beginning of spring and it is believed that it provides a large amount of vital energy, cleans liver, helps hair growth, improves blood circulation and skin flexibility. Moreover, it is thought useful in treating acne and skin eczema [3,9]. Other research indicates that it enhances kidney function – an accelerated diuresis causes faster toxin cleansing. It also supports the liver in cleansing blood from redundant metabolism products, alcohol and other detrimental elements supplied with food. Birch sap can be drunk for the whole year. However, only fresh and non-processed birch sap has the most nutritious value. It should not be heated as high temperature destroys its beneficial properties [2].

Birch sap contains three substances with positive influence on the human organism. The first of these is methyl salicylate. It has similar characteristics to aspirin and reduces the sensation of pain. Betulin, the second ingredient, improves insulin sensitivity and reduces cholesterol levels. Chlorogenic acid, the third substance decreases the feeling of hunger and expedites the metabolism of carbohydrates, which, in return, contributes to weight loss [5,7]. Birch sap also contains glucose (around 1%) and fructose (over 1%) [6,8].

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The aim of this work was an assessment of concentration changes of selected elements in birch sap – depending on collection day, using atomic absorption spectrometry.

MATERIALS AND METHODS

The research was conducted on birch sap from silver birch (*Betula Pendula* Ehrh) growing in a forest near the town of Niwiska (Niwiska municipality in Kolbuszowa county, Podkarpackie voivodeship, Poland). For study purposes, 15 test samples were taken between the 28th of February and the 15th of March 2015. In so-doing, a small V-shaped incision was made in the southern side of the tree. Next, a small tube of 12 cm of length and 2 cm of diameter was placed therein. A sterile 50 ml container was then placed under the pipe. After collecting the sap, the container was immediately closed. The test samples were numbered from 1 to 15 and then frozen until the time of laboratory studies.

Table 1. Test sample collection data

Sap collection date	Sample number
28.02.2015	1
01.03.2015	2
02.03.2015	3
03.03.2015	4
04.03.2015	5
05.03.2015	6
06.03.2015	7
07.03.2015	8
08.03.2015	9
09.03.2015	10
10.03.2015	11
11.03.2015	12
12.03.2015	13
13.03.2015	14
15.03.2015	15

The research was conducted using a ContrAA 700 atomic absorption spectrometer with continuous light source, as well as flame atomization (F-AAS) and graphite furnace (GF-AAS) (Analytik Jena, Germany). In the electro-thermal technique, the examined solution was dispensed directly on the graphite furnace platform in 25 µl volumes. Zinc, magnesium, manganese, copper, potassium, sodium, calcium and iron contents were assessed. The test samples were determined directly, without mineralization because of the character of the research material, its density and stickiness. The measurement of absorbance was performed 7 times for each sample. A mean content was then calculated.

In order to draw the calibration curve (range given in Table 2), standard solutions with 1000 ppm concentration of the analyzed elements were used (Merck, Germany). Exemplary calibration graphs are presented in Figures 1 and 2.

Table 2. Concentration range

Electro-thermal method	
Element	Graph scope (ppb)
Cu	0-10
Fe	0-30
Flame method	
Element	Graph Scope (ppm)
Zn	0-1
Mg	0-0.5
Mn	0-1.5
K	0-1
Na	0-0.5
Ca	0-7

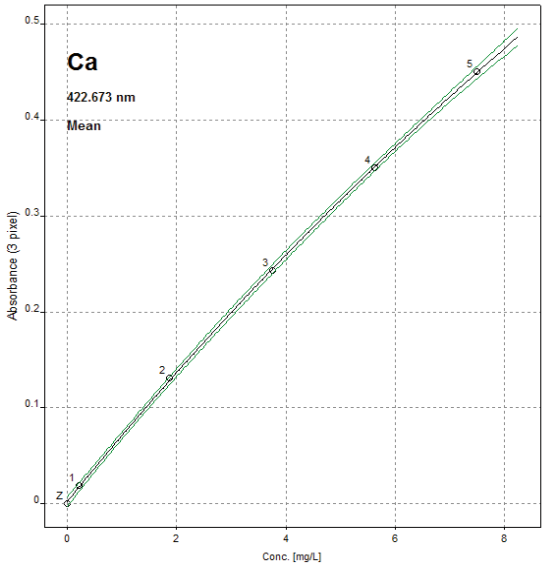

Figure 1. Dependence between absorbance and calcium concentration chart

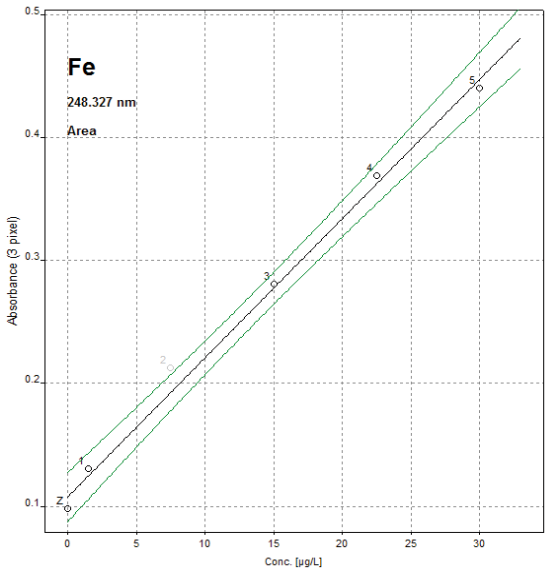

Figure 2. Dependence between absorbance and iron concentration chart

The measurements were performed using two atomization methods: electro-thermal, where copper and iron were analyzed, and flame for the remaining elements. The referential solution consisted of 0.5% HNO_3 and the 20% KCl ionizing buffer (the amount of the buffer used was selected so that its concentration in the examined solution was 0.1%). When sodium and potassium were analyze, the standard solution did not contain the ionizing buffer. The flame technique was used for zinc, magnesium, potassium, sodium and calcium determination. Copper and iron were assessed using the electro-thermal technique. Herein, $Pd/Mg(NO_3)_2$ solution was used as a matrix modifier.

Table 3. Analysis parameters of the F-AAS technique

Parameter/ tested element	Zn	Mg	Mn	K	Na	Ca
Wave length (nm)	213.857	285.212	279.482	766.491	588.995	422.673
Flame	C_2H_2-air: 50 L/h	C_2H_2-air: 70 L/h	C_2H_2-air: 80 L/h	C_2H_2-air: 80 L/h	C_2H_2-air: 90 L/h	C_2H_2-air: 50 L/h
Burner head lenght (mm)	5	6	6	8	6	5
Nebulizer flow (ml/min)	2	2	2	2	2	2

Table 4. Analysis parameters of the GF-AAS technique

No.	Process	Temperature [°C]	Temperature growth [°C/s]	Time of parameter sustaining [s]
1	Drying	80	6	20
2	Drying	90	3	20
3	Drying	110	5	10
4	Pyrolysis	350	50	20
5	Pyrolysis	1100	300	10
6	Gas adaptation	1100	0	5
7	Atomization	2000	1500	4
8	Cleaning	2450	500	4

Correctness of analytical procedure parameter was confirmed using certified material (Certified Reference Material INCT-SBF-4 Soya Bean Flour, Institute of Nuclear Chemistry and Technology, Warsaw, Poland) by way of which the contents of randomly chosen elements analyzed in the researched material were identified (Table 5).

Table 5. Compilation of results achieved for the certified material

Element	Certified value [ppm]	Measured value [ppm]
Cu	14.30 ± 0.46	14.05
Fe	90.80 ± 4.00	93.00
Mn	32.30 ± 1.10	31.70
Zn	52.30 ± 1.30	51.50

RESULTS

The results are presented in Tables 6 and 7 and Figure 3. The birch sap mainly contains potassium (sap no. 1 – 120 mg/l) and calcium (sap no. 1 – 79.97 mg/l) and lower amounts of iron (maximal value in sap no. 10 – 26.82 µg/l), copper (maximal value in sap no. 3 to 5.65 µg/l and sodium (maximal value in sap no. 3) – 0.39 mg/l.

Changes in concentration of the analyzed elements were also observed depending on the day of collection. Potassium and calcium concentration in sap collected at the break of February and March was higher than that in the middle of March. With the passing of time, the concentration of these elements decreased. The iron content was, however, increased – the amount of iron in sap collected on the 9th of March was 4.5 higher than that on the 28th of February.

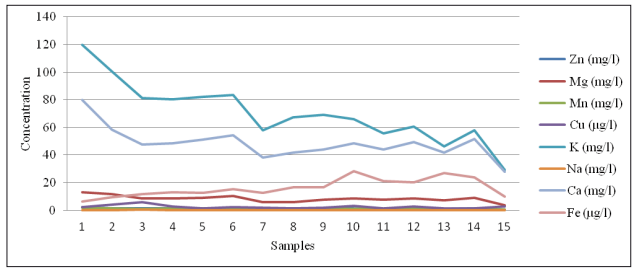

Figure 3. Concentration of examined elements in individual test samples

Table 6. Mean of element content in birch sap as obtained using the F-AAS technique (mg/l)

Sample number	Zn	Mg	Mn	K	Na	Ca
1	2.12	13.04	1.64	120.00	0.20	79.97
2	1.60	11.56	1.35	100.30	0.19	58.41
3	1.32	8.42	1.15	81.31	0.39	47.66
4	1.38	8.64	1.17	80.30	0.25	48.66
5	1.46	8.96	1.21	81.92	0.17	51.39
6	1.58	10.19	1.28	83.31	0.08	54.17
7	1.02	5.90	0.83	58.11	0.14	37.97
8	1.07	6.03	0.82	67.18	0.25	41.75
9	1.17	7.63	0.94	69.27	0.08	44.03
10	1.23	8.55	0.95	65.98	0.15	48.27
11	1.13	7.76	0.85	55.85	0.09	43.85
12	1.25	8.78	0.98	60.56	0.18	49.23
13	1.02	7.12	0.37	46.34	0.09	41.74
14	1.23	9.14	0.94	57.97	0.19	51.80
15	0.60	3.84	0.48	29.08	0.20	27.96

Table 7. Mean of element content in birch sap as obtained using the GF-AAS technique (µg/l)

Sample number	Cu	Fe
1	2.40	6.21
2	4.13	9.32
3	5.66	11.50
4	2.57	13.07
5	1.32	12.49
6	2.50	15.26
7	1.93	12.54
8	1,60	16.74
9	1.71	16.65
10	3.32	28.22
11	1.21	20.97
12	2.72	20.38
13	1.34	26.82
14	1.30	23.88
15	2.83	9.78

CONCLUSIONS

Birch sap is rich in many mineral ingredients, the presence of which was demonstrated in our research. However, the concentration of the elements is variable and is connected with the date of collection. For most of elements, a downward trend of concentration for micro and macro elements can be observed. Only the amount of iron increased.

REFERENCES

1. Strzelecka H. Encyklopedia zielarstwa i ziołolecznictwa. Warszawa: Wydawnictwo Naukowe PWN;2000:72-73.
2. Gertig H, Przysławski J. Bromatologia, zarys nauki o żywności i żywieniu. Warszawa: PZWL;2006:177-237.
3. Bilek M, Natłok N, Kaniuczak J, Gorzelany J. Sugar and inorganic anions content in mineral and spring water-based beverages. Rocz Państw Zakł Hig. 2014;65(3):193-197.
4. Ostrowska A, Gawliński S, Szczubiałka Z. Metody Analizy i oceny właściwości gleb i roślin. Warszawa: Instytut Ochrony Środowiska;1991:36.
5. Łuczaj Ł, Bilek M, Stawarczyk K. Sugar content in the sap of birches, hornbeams and maples in southeastern Poland. Cent Eur J Biol. 2014;9(4):410-416.
6. Bilek M, Stawarczyk K, Łuczaj Ł, Cieślik E. Zawartość wybranych składników mineralnych i anionów nieorganicznych w sokach drzewnych z terenu podkarpacia. Żywność. Nauka. Technologia. Jakość. 2015;3(100):138-147.
7. Bilek M, Siembida A, Stawarczyk K, Cieślik E. Aktywność przeciwrodnikowa soków drzewnych z terenu Podkarpacia. Żywność. Nauka. Technologia. Jakość. 2015;4(101):151-161.
8. Bilek M, Stawarczyk K, Siembida A, Strzemski M, Olszewski M, Cieślik E. Zawartość cukrów w sokach drzewnych z terenu Podkarpacia. Żywność. Nauka. Technologia. Jakość. 2015;6(103):53-63.
9. Svanberg I, Soukand R, Łuczaj Ł, Kalle R, Zyryanova O, Denes A, et al. Uses of tree saps in northern and eastern parts of Europe. Acta Societatis Botanicorum Poloniae. 2012;81(4):343-357.