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EDITORIAL

This is the XXVIIth volume of the Journal of Food Physics, and as You know the first one was published in 1988. Let me stress, that this issue is after so many years the first only electronical version, becausse of some reasons – mainly finacial ones – we can not publish the hard copies, as well. Anyway, I do hope, that this issue gives again the possibility for the readers to find interesting and really useful articles about special fields of food physics, including recently some topics of the 2014 ISFP meeting in Plovdiv. E.g. the importance of physical knowledge for food engineers, electrical conductivity of honey, rheological properties of honey, viscosity of different sugar solutions, colour measurement of beer, thermodynamical and technological properties of some foodstuffs and agricultural products.

I would like to emphasize that in June 2014 we had an excellent conference in Bulgaria – after 2008 again in Plovdiv – good oral lectures, interesting posters, very good organization, visit to a meat factory – we are really grateful to the local organizing committee, to Maria Marudova-Zsivanovits and Gabor Zsivanovits. Thanks a lot, they did their best. In this volume, in the 2014 issue of our JPF You will find the program of the Plovid meeting, and some information about the activity of a food manufacturer, FORNETTI.

I do hope that we can continue also in the next years our activity concerning the publication of Journal of Food Physics, and management of the organization of International Society of Food Physicists (ISFP) conferences and the tasks of the Food Physics Public Utility Foundation. However, we need badly the help and donations for existence and further work! So, please, do not hesitate to support the Food Physics Public Utility Foundation!

Andras S. Szabo
editor-in-chief

http://www.foodphysics.net

Obituaries

Let us mention some our former colleagues, members of editorial board of JFP who passed away in the last years:

Jozsef Farkas, 1933-2014, chemical engineer, member of HAS, research field: microbiology, radiation techniques, food technology and safety

Karoly Kaffka, 1927-2014, electrical engineer, PhD, research field: measurement technique, NIR- technique, food physics

Pal Tolnay, 1966-2014, food engineer, research field: food chemistry and analysis, nutrition science

Andras Fekete, 1936-2013, mechanical engineer, DSc, research field: measurement technique, automation, process control

Denes Berenyi, 1928-2012, physicist, member of HAS, research field: radiation techniques, nuclear spectroscopy

Jozsef Simon, 1927-2007, agricultural engineer, PhD, research field: radiation techniques in agrofood sector

Gabor Foldiak, 1929-2001, chemical engineer, DSC, research field: radiation technique, isotope technique, nuclear technique

Dezso Kiss, 1929-2001, physicist, member of HAS, research field: nucler physics, particle physics

Gabor Ember, 1928-1999, electrical engineer, research field: food technology, R+D in the food industry

Janos Nagy, 1922-1995, physicist, PhD, research field: agrophysics, biophysics, nuclear physics

We will remember your activities.

Editorial board of JFP

International Conference of food physicist

XI[th] INTERNATIONAL CONFERENCE OF FOOD PHYSICISTS
FOOD PHYSICS AND INNOVATIVE TECHNOLOGIES
10-12 June 2014, Plovdiv, BULGARIA

http://icfp.uni-plovdiv.net/en/home

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Kispeter-book

Book-review
FROM JUNIOR TO SENIOR
J-. Kispeter, PR-Innovation Ltd, Budapest, 2014.

This hungarian written book –Ifjan – eretten – oregen is the original title – is the life of the 80 years old author from 1934 till 2014 (8 decades) in the form of 80 questions and 80 answers. The book – well illustrated with nice photos – is the product of a professor from Szeged, who had been working long years as a scientist of food physics, technical editor of JFP and member of the Food Physics Public Utility Foundation.

Best wishes for the next years!

A. S. Szabo, P. Laszlo

Significance of physical knowledge during education of food technologists and food engineers

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Keywords:
BSc, food engineer, food science, MSc, physics, technology, university education

Abstract. The paper deals with the following topics:

- importance of food physics
- physical methods in instrumental food analysis
- physical techniques in modern food processing
- main topics in BSc level education, concerning basic physics, general and inorganic chemistry, electrotechnics, measurement technique and automation
- main topics in MSc level education, concerning instrumental food analysis, food physics, process control, measurement theory, research planning

Conclusion: without high level of knowledge in physics the food engineers can not fulfil the expectations of modern food processing technologies.

INTRODUCTION

It is a well known (and widely accepted) fact, that people are different, countries and states are different, education systems are different, expectations and knowledge-levels are different. However, there is no question about the importance of physics – as a basic subject - in education of food technologists and food engineers (1)(2)(3). They need to learn food science (a lot of subfields, like food chemistry, food microbiology, food technology, food analysis, food machinery, unit operations in food processing), but without appropriate knowledge in physics - dominantly food physics – there is no chance to be a well-educated engineer, a good specialist of food industry (4)(5). The BSc and MSc programs are based on many subjects, belonging to physics. The proper education (build up) of a food engineer is rather similar to house building: we need strong fundament (e.g. physics), walls (e.g. unit operation) and roof (technology). However without correctly made fundament and walls where to put the roofs?

IMPORTANCE OF FOOD PHYSICS

The meaning of the word physics (in greek) is nature, and physics is the mother and fundament of other natural and technical sciences, like chemistry, geology, unit operations, machinery, automation, measurement technique, architecture, electronics, nuclear technique, astronomy even robot-technique. Of course it is clear, that the background to physics is mathematics, and the next steps of the system (in teaching, as well) are the following: the fundament to chemistry is physics, and the fundament to biology is chemistry. It is evident that today – in consequence of differentiation and integrations – there are many subsciences, and interdisciplinary sciences (6). Food physics - as a rather new, but rapidly and efficiently developing subscience – is a typical interdisciplinary science, a real and stable bridge between food science and applied physics (7) (8) (9). Without high level of knowledge in physics the food engineers can not fulfill the expectations of modern food processing technologies (10)(11)(12).

PHYSICAL METHODS IN INSTRUMENTAL FOOD ANALYSIS

Classical chemical methods for food analysis are today used mainly only for preparation of the samples, however many diffrerent instrumental methods were developed and applied for the measurements. The classification of the methods is the following:

- optical methods
- separation techniques
- magnetic techniques
- radioanalytical methods
- electroanalytical techniques
- rheological methods
- thermical techniques

In these mentioned groups there are many physical techniques, giving the opportunity to perform nondestructive measurements – eventually „in vivo" measurements, or non-invasive techniques, as well – so to get the data about the composition, physical and chemical parameters of the foodstuffs without chemical treatment. Let us mention e.g. the following techniques: dielectrometry, oscillometry, infrared spectroscopy (like NIR-NIT method), calorimetry, DSC, PAS, ESR, NMR, XRF, PIXE, INAA, penetrometry, plastometry, viscosimetry.

PHYSICAL TECHNIQUES IN MODERN FOOD PROCESSING

The technology hill – the methods, applied in the past, present and techniques of the future for food processing – is a figure, beginning with the oldest systems (e.g. smoking, dehydration) and as a function of time (via e.g. freezing, irradiation, microwave treatments) we are at the door of application of the newest techniques (e.g. pulsed technology, high pressure technology, application of powerful electrical and magnetic fields) in the food industry (13). Obviously the food technologists and food engineers have to be able to apply these techniques and even take part in the development of the processing methods. And this innovation is not possible without good knowledge in physics.

TOPICS OF THE EDUCATION PROGRAM AT BSC LEVEL

Let us mention some important topics of the Faculty of Food Science at

University of Budapest in the subjects of Basic Physics, General and Inorganic Chemistry, Electrotechnics, Measurement Technique and Automation:
mechanics, statics, dynamics, hydraulics, rheology, rheological models, optics, colour measurements, spectral image processing, physical and chemical properties, states of matter, structure of atom, radiations, electromagnetic spectrum, microwave, electricity, currant, potential, charge, resistance, impedance, capacitor, inductor, conductivity, electric motors, generators, transformers, accumulators.

TOPICS OF THE EDUCATION PROGRAM AT MSC LEVEL

Let us mention some useful and necessary topics of the Faculty of Food Science in the subjects of Instrumental Food Analysis, Food physics, Process Control, Measurement Theory, Research Planning:

different analytical (optical, electro-analytical, thermal, separation, magnetic, rheological, radioanalytical) techniques for composition determination, mechanical, optical, electrical, thermal properties of foodstuffs, infrared spectroscopy, heat and mass transport, conductivity, permittivity, impedance spectroscopy, light emission, reflection, CIELAB system, modern measurement techniques, computer aided systems, computer aided design, error of measurement, data evaluation, statistics, validation, experiment planning, pneumatic, hydraulic, electrohydraulic, electropneumatic, hydropneumatic systems, TTL and PLC systems, control and regulation, control of food processing technologies

CONCLUSION

Physics is a basic subject, fundament to understand food science, unit operations, food technology, measurement technique, automation. It is evident, that without high level of knowledge in physics the food technologists and engineers can not fulfill the expectations of modern food processing. In other words: without this knowlege they can not take part successfully innovation, R+D activities, creation of new technological lines, even in the everyday processing of food products using up-to-date technologies.

REFERENCES

1. N. N. Mohsenin: Physical properties of plant and animal materials. Gordon and Breach Science Publishers, New York, 1986.
2. N. N. Mohsenin: Electromagnetic radiation properties of foods and agricultural products, Gordon and Breach Publishers, New York, 1984.
3. K. Gasztonyi (1992): The significance of physical principles in the education of food analysis. Journal of Food Physics, 95-98, Publ. University of Horticulture and Food Industry, Vol. LVI.
4. A. S. Szabo, P. Laszlo (2010): Food physics and food safety – some aspects in food processing and food quality control. Journal of Life Sciences, USA, 4(7), 58-60.
5. A. S. Szabo, P. Laszlo, P. Tolnay (2012): Importance of food physics, food safety and nutrition requirements in production and processing of food products. Application of physical research in engineering. Scientific monograph, ed.:

M. Bozikova, Z. Hlavacova, P. Hlavac, Slovak University of Agriculture, Nitra, p. 153-166.

6. A. S. Szabo, P. Tolnay: Differentiation and integration in sciences, role of interdisciplinary sport science. Hungarian Review of Sport Science, 15 (57), 75-80, 2014(1).

7. A. S. Szabo (1999): Food physics as an important part of food science and applied physics. Int. Agrophysics, 13, 407-409.

8. L. O.Figura, A. A. Teixeira: Food Physics, Springer, 2007.

9. V. Vozarova (2008): Study of foodstuffs physical properties during thermal treatment. 8th ICFP, 24-26 Sept. 2008, Plovidv, Bulgaria, book of abstracts, p. 45-46, Univ. Paisii Hilendarski.

10. A. S. Szabo, P. Laszlo, J. Simon (2006): The growing importance of aspects of food safety and food physics in the industrial food production. 7th Int. Conf. Food Physicists, Senta, 30. June-01. July, 2006, Serbia.

11. A. S. Szabo 2008): Food physics and food safety – aspects in food processing and quality control. 8th ICFP, 24-26 Sept. 2008, Plovidv, Bulgaria, book of abstracts, p. 5, Univ. Paisii Hilendarski.

12. A. S. Szabo, P. Laszlo, P. Tolnay (2013): Importance of food physics to fulfill the expectations of modern food technologies. Journal of Food Science and Engineering, 3(4), 169-175.

13. A. S. Szabo: Food science, food physics, radiation science. Proc. 2nd Int. Conf. Food Phys. 21-23 May, 1996, Bucharest, Romania, Journal of Food Physics, supplement, 14-21, 1996.

Electrical conductivity of hungarian honeys

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Abstract. The aims of this present study were the determination of electrical conductivity and mineral content of different honey types and the examination of the relation among the floral origin, electrical conductivity and element content. Electrical conductivity and 13 elements (K, Ca, Mg, Na, P, S, Al, B, Ba, Cu, Fe, Mn and Zn) were determined with digital conductivity meter and ICP-OES) in seven honey types (acacia, lime, silk grass, sunflower, rape, chestnut and forest). The values of the electrical conductivity ranged between 0.101 and 1.036 mS/cm. The lowest values were measured in the acacia, silk grass and rape honey samples and the chestnut and forest honey samples showed the highest values. The electrical conductivity showed strong correlation with K, Mg and S (r = 0.975, 0.856 and 0.802). It was possible to determine the botanical origin of the case of the lime and sunflower honey types was able to determine by measuring their electrical conductivity.

Keywords:
electrical conductivity,
honey,
botanical origin

INTRODUCTION

The honey production in the European Union (EU) was 191,119 tons in 2012. The greatest producers were Spain (29,735 tons) and Romania (23,062 tons). Hungary was the third most important honey producer in the EU with 17,000 tons in 2012 (FAO). About 80% of total amount of Hungarian honey is exported to abroad, to the different countries of the world.

Honey plays an important role in the human nourishment. This food contains many important constituents such as sugars, acids, proteins, vitamins, enzymes, micro and macro elements. The honey is not only a food but it is a very good environmental indicator. Honey can provide environmental data from the collecting area that is about 7 km^2 (Pisani et al., 2008).

Electrical conductivity is a very important property of a honey because it is used to distinguish between floral and honeydew honeys (Kaškonienė et al., 2010). The electrical conductivity is closely related to the mineral salts, organic acids and proteins (Terrab et al., 2004). According to many authors the measurement of electrical conductivity instead of the time-consuming gravimetric method is an indirect technique to the determination of mineral content in some food (Acquerone et al., 2007).

The aims of this present study were: (i) determination of electrical conductivity and micro and macro element content of different honey types (acacia, rape, lime, sunflower, silk grass, chestnut and forest); (ii) examination of the connection among the botanical origin, electrical conductivity and mineral content.

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MATERIALS AND METHODS

Samples

Fifty honey samples were examined in this study. All samples were collected from Hungarian beekeepers. The collecting areas were different counties of Hungary. The samples were not heated or treated. The botanical origin was verified with pollen analysis that were: acacia *(Robinia pseudoacacia)* (18 samples); lime *(Tilia sp.)* (7 samples); rape *(Brassica napus)* (8 samples); sunflower *Helianthus annuus)* (7 samples); silk grass *(Asclepias sp.)* (3 samples); chestnut *(Aesculus hippocastanum)* (3 samples) and honeydew (4 samples). The samples were stored at room temperature in dark.

Methods

Electrical conductivity (EC)

The determination of EC was carried out with Bogdanov et al. (1997) method, in 20% (v/w) honey solution at 20°C, using a digital electrical conductivity meter (Mettler Toledo Five Easy^{TM} FE30, Switzerland) with an electrode (Mettler Toledo LE703). Ultrapure water produced by Milli-Q water purification system (Millipore SAS, Molsheim, France) was used for the preparation of solutions. The results were expressed in millisiemens per centimetre (mS/cm).

Element content

The determination of aluminium (Al), boron (B), barium (Ba), calcium (Ca), copper (Cu), iron (Fe), potassium (K), magnesium (Mg), manganese (Mn), sodium (Na), phosphorous (P), sulphur (S) and zinc (Zn) was carried out with an inductively coupled plasma optical emission spectrometer (ICP-OES) (Thermo Scientific iCAP 6300, Cambridge, UK). The used reagents to the digestion were high-purity concentrated nitric acid (VWR® International BVBA, Belgium) and hydrogen-peroxide (VWR® International S.A.S., France) based on method of Kovács et al. (1996). The standard solutions were prepared from monoelemental standard solutions (1000 mg/dm^3, Sharlau Chemie, Spain).

Statistics

All examination was carried out in triplicate. The applied statistical program was the SPSS version 13.0 for Windows. Applied statistical methods were the general statistics (mean, standard deviation, minimum and maximum values), and Pearson correlation. The hierarchical cluster analysis and linear discriminant analysis (LDA) were applied to categorize the honey types.

RESULTS AND DISCUSSION

Results of the determination of electrical conductivity and element content

According to the floral origin the electrical conductivity showed great variability (Table 1). The values of this parameter ranged between 0.101 and 1.036 mS/cm. The measured values were corresponding to the Codex Alimentarius Hungaricus. In floral origin honey samples (except the chestnut honey) the electrical conductivity was lower than 0.800 mS/cm. The acacia, rape and silk grass honeys showed very similar results (0.140±0.026, 0.220±0.070 and 0.196±0.029 mS/cm). In the sunflower honeys the measured values were higher (0.396±0.065 mS/cm). The lime honeys showed the highest results (0.604±0.060 mS/cm) among the floral origin honeys (except the chestnut honey). The electrical conductivity of chestnut and forest honey samples was higher than 0.800 mS/cm. The measured values were similar (0.935±0.076 and 0.965±0.063 mS/cm).

Table 1: The analysis of electrical conductivity and macro elements

Honey types	Statistics	EC (mS/cm)	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)
Acacia	range	0.101-0.185	100-255	17.6-59.6	1.90-15.9
	mean±std	0.140±0.026	164±54.2	20.9±16.7	6.57±3.96
Lime	range	0.519-0.680	1027-1883	15.2-67.4	19.8-30.2
	mean±std	0.604±0.060	1374±291	50.2±19.6	24.2±3.67
Rape	range	0.143-0.301	103-288	23.7-60.4	13.5-27.6
	mean±std	0.220±0.070	209±63.9	38.6±12.3	18.3±4.78
Sunflower	range	0.311-0.470	245-552	58.2-153	10.2-36.6
	mean±std	0.396±0.065	412±120	93.1±32.2	22.3±9.71
Silk grass	range	0.168-0.225	149-165	17.2-35.8	3.00-11.3
	mean±std	0.196±0.029	157±8.00	28.0±9.67	7.87±4.33
Chestnut	range	0.850-0.998	2136-2281	51.6-59.7	25.4-31.7
	mean±std	0.935±0.076	2197±75.2	55.5±4.06	27.6±3.58
Forest	range	0.901-1.036	2155-2391	55.8-78.8	34.7-43.6
	mean±std	0.965±0.063	2259±108	66.7±9.44	39.9±3.96
Total	range	0.101-1.036	100-2391	17.6-153	1.90-43.6
	mean±std	0.370±0.289	664±767	44.1±30.3	17.1±11.4

Honey types	Statistics	Na (mg/kg)	P (mg/kg)	S (mg/kg)
Acacia	range	1.60-11.5	27.7-92.3	6.92-30.4
	mean±std	5.23±3.53	49.9±20.4	17.6±8.76
Lime	range	5.12-7.43	23.0-42.4	31.4-39.3
	mean±std	6.03±0.76	30.7±7.83	35.5±3.08
Rape	range	6.27-16.9	50.9-71.1	20.3-43.0
	mean±std	11.2±4.19	63.7±10.5	33.2±8.22
Sunflower	range	4.66-24.5	59.8-144	17.3-35.9
	mean±std	9.18±5.72	81.7±30.6	26.9±7.96
Silk grass	range	3.49-11.6	27.1-74.7	11.5-32.7
	mean±std	7.94±4.10	45.2±25.7	23.2±10.8
Chestnut	range	10.8-18.3	66.4-84.7	38.6-44.9
	mean±std	13.7±4.00	77.8±9.95	42.3±3.36
Forest	range	12.0-19.4	115-156	85.8-89.8
	mean±std	15.9±3.57	129±19.4	87.4±1.86
Total	range	1.60-21.5	23.0-156	6.92-89.8
	mean±std	8.38±5.02	61.6±31.4	31.3±19.9

The macro and micro element content in the examined honey types was very various (Table 1 and Table 2). In each samples the potassium showed the highest concentration. Similarly to the electrical conductivity the lowest potassium concentrations were measured in acacia, rape and silk grass (164±54.2, 209±63.9 and 157±8.00 mS/cm) honeys following by sunflower (412±120 mS/cm), lime (1374±291 mS/cm), chestnut (2197±75.2 mS/cm) and forest (2259±108 mS/cm) honeys.

Table 2: The analysis of micro element contents

Honey types	Statistics	Al (mg/kg)	B (mg/kg)	Ba (mg/kg)	Cu (mg/kg)
Acacia	range	0.083-1.14	2.43-8.57	<LD-0.193	0.009-0.282
	mean±std	0.481±0.307	4.89±1.96	0.052±0.064	0.146±0.090
Lime	range	0.126-1.720	3.36-5.70	<LD-0.170	0.080-0.340
	mean±std	0.762±0.578	4.92±0.96	0.072±0.059	0.216±0.097
Rape	range	0.279-1.960	5.05-15.7	<LD-0.086	0.050-0.642
	mean±std	0.717±0.579	10.0±3.89	0.030±0.034	0.251±0.192
Sunflower	range	0.103-1.540	4.46-9.88	0.007-0.238	0.098-0.457
	mean±std	0.565±0.510	6.36±2.37	0.081±0.080	0.292±0.142
Silk grass	range	0.590-0.814	3.65-5.74	<LD-0.061	0.259-0.269
	mean±std	0.696±0.112	4.92±1.12	0.039±0.034	0.265±0.006
Chestnut	range	1.06-1.56	2.86-4.08	0.335-0.551	0.304-0.384
	mean±std	1.37±0.274	3.40±0.619	0.429±0.110	0.352±0.042
Forest	range	1.77-2.56	1.70-6.71	0.078-0.995	0.649-1.030
	mean±std	2.29±0.36	4.95±2.24	0.384±0.413	0.839±0.161
Total	range	0.083-2.559	1.70-15.7	<LD-0.995	0.009-1.030
	mean±std	0.781±0.642	5.83±2.91	0.104-0.171	0.268±0.215

Honey types	Statistics	Fe (mg/kg)	Mn (mg/kg)	Zn (mg/kg)
Acacia	range	0.033-1.78	<LD-0.470	0.234-6.661
	mean±std	0.679±0.432	0.134±0.149	1.82±1.71
Lime	range	0.389-1.16	0.075-1.521	1.58-2.79
	mean±std	0.736±0.247	0.610±0.603	2.15±0.541
Rape	range	0.473-3.35	<LD-0.343	0.271-5.603
	mean±std	1.62±1.09	0.142±0.137	2.39±1.84
Sunflower	range	0.123-2.45	<LD-0.183	0.379-4.690
	mean±std	0.968±0.750	0.073±0.074	2.43±1.65
Silk grass	range	0.896-1.320	<LD-0.298	1.16-7.67
	mean±std	1.07±0.22	0.164±0.151	3.52±3.60
Chestnut	range	1.17-1.71	14.5-16.1	0.637-0.918
	mean±std	1.45±.0.27	15.4±0.58	0.798±0.145
Forest	range	2.93-3.78	2.72-21.9	0.776-1.929
	mean±std	3.37±0.38	8.27±9.11	1.42±0.54
Total	range	0.033-3.795	<LD-21.9	0.234-7.67
	mean±std	1.16±0.94	1.76±4.70	2.06±1.65

The forest honeys showed the highest calcium, magnesium, phosphorus, sulphur, aluminium, copper and iron concentrations. The lowest sodium and phosphorus content was determined in the lime honeys and the lowest magnesium content was measured in the acacia and silk grass honeys.

Evaluation of the Pearson correlation

The electrical conductivity is closely related to the mineral content. The correlation values is indicated in Table 3 (that were highest than 0.600). These correlations were significant at the 0.01 level. The highest correlation value was determined between the electrical conductivity and potassium content (r=0.975). This value was also high in the case of magnesium (r=0.856) and sulphur (r=0.802).

Table 3: Results of the Pearson correlation ("r" values)

	EC	Al	B	Ba	Ca	Cu	Fe
EC		0.654		0.60		0.656	
Al	0.654					0.851	0.831
B							
Ba	0.603						
Ca							
Cu	0.656	0.851					0.803
Fe		0.831				0.803	
K	0.975	0.632		0.628		0.616	
Mg	0.856	0.632			0.624	0.741	
Mn	0.671			0.901			
Na						0.603	
P		0.606				0.730	0.614
S	0.802	0.732				0.830	0.682
Zn							

	K	Mg	Mn	Na	P	S	Zn
EC	0.975	0.856	0.671			0.802	
Al	0.632	0.632			0.606	0.732	
B							
Ba	0.628		0.901				
Ca		0.624					
Cu	0.616	0.741		0.603	0.730	0.830	
Fe					0.614	0.682	
K		0.786	0.697			0.779	
Mg	0.786			0.636		0.861	
Mn	0.697						
Na		0.636				0.605	
P						0.703	
S	0.779	0.861		0.605	0.703		
Zn							

Therefore these elements had strong influence to the electrical conductivity. Other element such as aluminium, barium, copper and manganese had also important effect to this parameter. Very strong correlation (r>0.800) was determined between aluminium and copper; aluminium and iron; barium and manganese; copper and iron; sulphur and copper; sulphur and magnesium.

Evaluation of the Linear Discriminant Analysis (LDA)

First, the electrical conductivity and potassium content were used to the LDA (Figure 1.a.). The values of Wilks' Lambda were 0.29 (EC) and 0.25 (K), so the values of independent variables were similarly assisted to the function (both were significant). The first function explained the 97.6% of the variance of the independent variable and this value was 71.0% in the case of second function. The value of group centroid of acacia honeys had low values in both dimension. The values of group centroids of rape and silk grass honeys had similarly low values in the first dimension but their other values were higher. Therefore these three honey types were not separated based on these two parameters. In the case of chestnut and forest honey types the results of the LDA were similar.

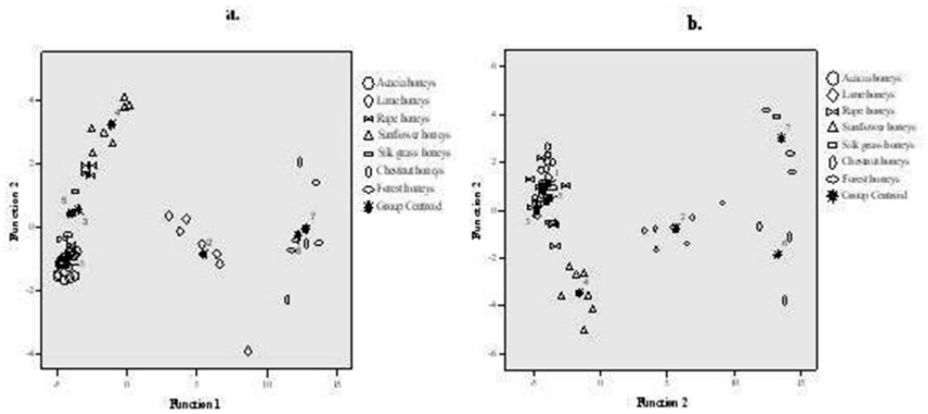

Figure 1
The results of the LDA

These two groups could not be discriminated but these honey types were squarely separated from the other honey types. The sunflower and the lime honeys were absolutely separated from the other honey types. Taking the sulphur and magnesium into the LDA analysis the sunflower and lime honeys were squarely separated; the forest and chestnut honeys divorced from each although these samples showed similar group centroid values in the first dimension (Figure 1.b).

CONCLUSIONS

The electrical conductivity is important parameter of a honey. Due to the various botanical origins the examined samples showed different element content. The electrical conductivity was strong relation to the potassium, magnesium and sulphur content but other elements, such as aluminium, barium, copper and manganese were influence to this parameter. The determination of mineral content is a very expensive method however the measure of electrical conductivity may be enough to the verification of the botanical origin.

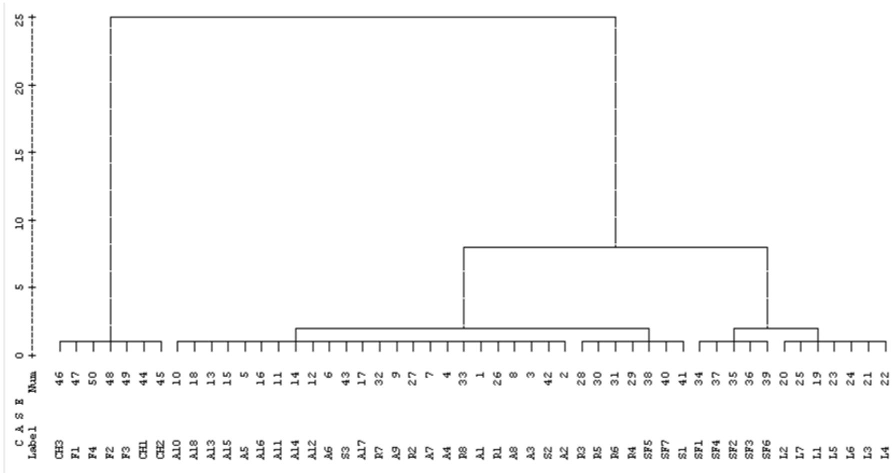

Figure 2
Result of the Cluster analysis

Based on the electrical conductivity the lime and the sunflower honeys could be differentiated from the other honey types. The forest and chestnut honeys showed one separated groups from the other types but this parameter did not allow to the discrimination of this two types. The electrical conductivity values of this two honey types were very similar to each other and the very high values (> 0.800 mS/cm) showed the botanical origin of these two honey types.

The acacia, rape and silk grass honeys did not showed difference but studying together the electrical conductivity, colour and consistence of these honeys the authentication of botanical origin is possible. The rape honeys are crystallized (because of the ratio of fructose and glucose) but the acacia and silk grass honeys are not crystallized. The rape honeys are white or jonquil (it depends on the clarity of honey), the acacia honeys are greenish and the silk grass honeys are yellow.

The examination of great number samples may permit of the determination of minimum and maximum electrical conductivity limit values in the case of each honey types. The knowledge of the electrical conductivity and appearance of different honeys types may be enough to the determination the botanical origin.

REFERENCES

Acquerone, C., Buera, P. & Elizalde, B. (2007). Pattern of pH and electrical conductivity upon honey dilution as a complementary tool for discriminating geographical origin of honeys. *Food Chemistry*, 101:695-703.

Bogdanov, S., Lüllman, C., martin, P. (1997). Harmonized method of the European Honey Commission. *Apidologie extra issue,* 1-59.

Codex Alimentarius Hungaricus. (2001). 1-3-2001/2010. Honey.

FAOSTAT. (2014). http://faostat.fao.org/site/569/DesktopDefault.aspx?PageID=569#ancor

Kaškonienė, V., Venskutonis, P.R. & Čeksterytė, V. (2010). Carbohydrate composition an electrical conductivity of different origin honeys from Lithuania. *LWT – Food Science and Technology*, 43:801-807.

Kovács, B., Győri, Z., Prokisch, J., Loch, J. and Dániel, P. (1996). A study of plant sample preparation and inductively coupled plasma emission spectrometry parameters. *Communications in soil science and plant analysis*, 27(5-8):1177-1198.

Pisani, A., Protano, G. & Riccobono, F. (2008). Minor and trace elements in different honey type produced in Siena County (Italy). *Food Chemistry*, 10:1553-1560.

Terrab, A., Recamales, A.F., Hernanz, D. & Heredia, F.J. (2004). Characterization of Spanish thyme honeys by their physicochemical characteristics and mineral content. *Food Chemistry*, 88:537-542.

Influence of selected factors on rheological properties of forest honey

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Keywords:

forest honey, rheological properties on temperature, dynamic and kinematic viscosity, viscometer Anton Paar

Abstract. According to Codex Alimentarius (2004) honey is a natural sweet substance, produced by honeybees from the nectar of plants or from secretions of living parts of plants, or excretions of plant-sucking insects on the living parts of plants, which the bees collect, transform by combining with specific substances of their own, deposit, dehydrate, store and leave in honeycombs to ripen and mature. Physical properties of honey are influenced by many factors and most important of them are temperature, time of storage, honey composition, mixture of flowers visited by bees producing the honey and it differs with locations, terms and particular colony of bees. In our research we focused on influence of temperature and time of storage to rheologic properties of forest honey.

INTRODUCTION

Honey is the primary product of bees and belongs among natural sweeteners; it is also known for its health promoting effects. The main parts of honey are nectar and honeydew. Nectar is the secretion of the plant organs and it consists of concentrated solution of sugars (glucose, fructose, sucrose, and maltose). Honeydew is plant juice, which passed through the part of the bee digestive tract. Its main ingredients are also sugars, but in more varied composition. Honey is a mixture of sugars, water, and other components. The specific composition of a honey depends mostly on the mixture of flowers visited by bees producing the honey and it is different in relation to locations, terms and particular colony of bees. Honey in general consists of fructose (approximately 38 %), glucose (about 31 %), sucrose (around 1 %), other sugars (about 9 %), water (approximately 17 %), ash (around 0.17 %), and other substances (Hlaváč – Božiková, 2012).

Some rheologic properties of honey are mentioned in literature. Bhandari et al. (1999) examined rheologic properties of Australian honeys. They found that rheologic properties of honey depend on the composition of individual sugars, and the amounts and types of colloids present in honey. Zaitoun et al. (2000) examined rheologic properties of selected light-coloured Jordanian honeys. They found that the viscosity of honey decreases with the water content. The water content is the major factor that influences the keeping quality or storability of honey. White et al. (1964) examined the effect of storage and processing temperature on the honey quality. In their investigation they found that dark-coloured types of honey tend to be affected by heat faster than the light-coloured types. It is natural for many types of honey to granulate or crystallise upon storage. Since the retail honey market largely favors liquid honey, some types of processing are necessary to maintain the liquid state. This is most commonly done by straining, heating, or filtration (White, 1999). Generally, physical properties of honey are influenced by various factors such as: the type of flowers, way of processing and most of all area of origin, etc.

MATERIALS AND METHODS

This article deals with the rheologic properties of forest honey made in Slovakia. Two series of rheologic parameters measurements were done. Firstly the sample of fresh honey was measured at the beginning of storage and then the same sample of honey was measured again after one week of storage. The measurements of dynamic viscosity were done by the viscometer Anton Paar (DV-3P) and the principle of measuring is based on the dependence of the sample resistance on the probe rotation. Density of honey sample was determined according to definition. Other rheologic parameters as kinematic viscosity (dynamic viscosity divided by density of sample at the same temperature) and fluidity (reciprocal value of dynamic viscosity), were also determined.

All honey parameters were measured during temperature stabilisation in the temperature interval from 20 °C to 43 °C. The effect of temperature on viscosity can be described by an Arrhenius type equation with decreasing exponential shape.

$$\eta = \eta_0 \, e^{-\frac{E_A}{RT}} \qquad (1)$$

where η_0 is reference value of dynamic viscosity, E_A is activation energy, R is gas constant and T is absolute temperature (Figura and Teixeira, 2007).

Temperature dependencies of dynamic and kinematic viscosity can be described by decreasing exponential functions (2, 3) and temperature dependency of fluidity by increasing exponential function (4).

$$\eta = A\, e^{-B\left(\frac{t}{t_o}\right)} \qquad (2)$$

$$\nu = C\, e^{-D\left(\frac{t}{t_o}\right)} \qquad (3)$$

$$\varphi = E\, e^{F\left(\frac{t}{t_o}\right)} \qquad (4)$$

where t is temperature, t_o is 1 °C, A, B, C, D, E, F are constants dependent on kind of material, and on ways of processing and storing. It is important to know the influence of temperature on physical properties not only for food materials, but also for technical materials (Kumbár – Dostál, 2014).

RESULTS AND DISCUSSION

Results are presented as graphic relations of rheologic properties on temperature. Temperature dependencies of dynamic and kinematic viscosity are shown on Fig. 1 and Fig. 2 and temperature dependencies of fluidity are on Fig. 3.

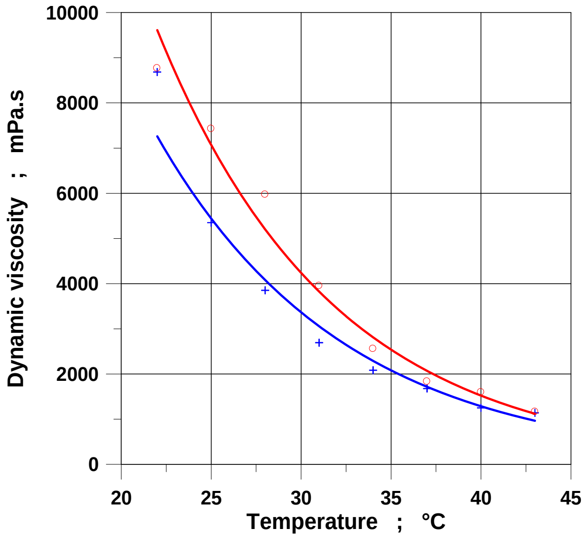

Figure 1
Temperature dependencies of forest honey dynamic viscosity
(first measurement +, after one week of storing ○)

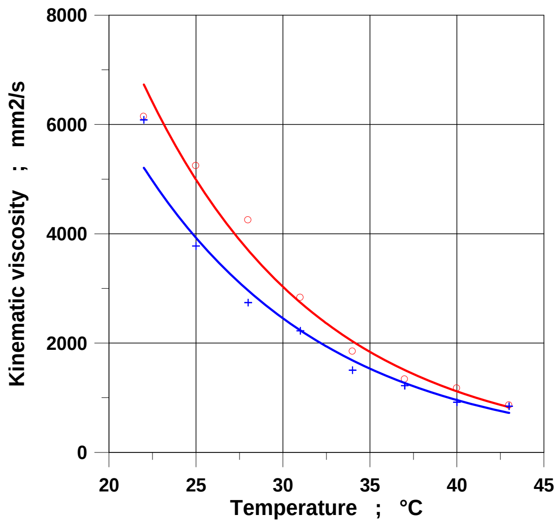

Figure 2
Temperature dependencies of forest honey kinematic viscosity
(first measurement +, after one week of storing ○)

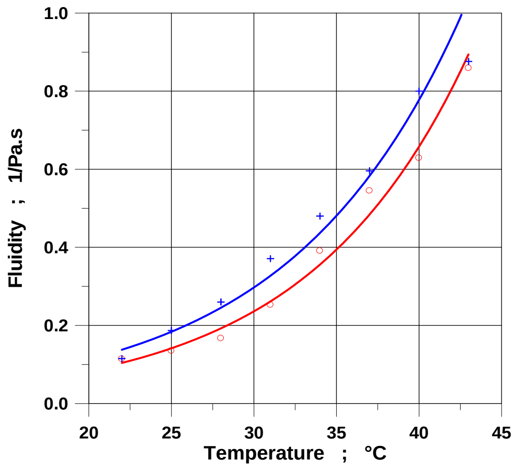

Figure 3
Temperature dependencies of forest honey fluidity
(first measurement +, after one week of storing ○)

Table 1: Coefficients A, B, C, D, E, F of regression equations (2, 3, 4) and coefficients of determinations (R^2)

	Regression equations (2, 3, 4)		
	Coefficients		
Forest honey	**A [mPa.s]**	**B [1]**	**R^2**
First measurement	60 147.9	0.096 11	0.974 692
Next measurement	91 376.4	0.102 37	0.984 745
Forest honey	**C [$mm^2.s^{-1}$]**	**D [1]**	**R^2**
First measurement	41 287.8	0.094 12	0.978 836
Next measurement	60 520.7	0.099 83	0.984 745
Forest honey	**E [$Pa^{-1}.s^{-1}$]**	**F [1]**	**R^2**
First measurement	0.016 612	0.096 14	0.974 640
Next measurement	0.010 924	0.102 44	0.985 470

It can be seen from Fig. 1 that dynamic viscosity of forest honey in both measurements is decreasing with temperature. The progress can be described by decreasing exponential function, which is in accordance with Arrhenius equation (1). Kinematic viscosity of forest honey is decreasing exponentially with temperature (Fig. 2). Dependency of forest honey fluidity on temperature is on Fig. 3. It is evident that fluidity of sample is increasing exponentially with temperature. All regression coefficients and coefficients of determination are shown in Tab.1. In all cases were the coefficients of determination very high.

From presented results is clear that dynamic and kinematic viscosity values were a bit higher after storing due to loosening of the water during storage. Values of fluidity were a bit smaller after storing, which is caused by loosening of the water respectively by crystallization during the storage.

CONCLUSION

Rheological properties of forest honey at the beginning of storage and after one week of storing were compared in this paper. Also the influence of temperature on rheological properties of honey was analyzed. Exponential functions were obtained for temperature dependencies of rheological parameters. In case of dynamic and kinematic viscosity it has decreasing shape which is in accordance with Arrhenius equation. In case of fluidity was used increasing exponential function. Similar results were obtained for other types of honey (Hlaváč – Božiková, 2012; Bhandari et al., 1999; White et al., 1964).From the presented results is clear that viscosity values were a bit higher after storage due to the loosening of water during the storage. The values of fluidity were a bit smaller after storage, which was caused by the loosening of water respectively by crystallization during the storage. Similar results were obtained by authors Sahin and Sumnu (2006), Figura and Teixeira (2007), and Cohen and Weihs (2010). Results showed that temperature has significant influence on thermal and rheologic parameters. Knowledge about physical properties of food products can be used at determination of their quality.

ACKNOWLEDGEMENT

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REFERENCES

BHANDARI, B. – D'ARCY, B. – CHOW, S. 1999. Rheology of selected Australian honeys. Journal of Food Engineering, 41, p. 65–68.

Codex Alimentarius of the Slovak Republic, 2004. Decree No. 1188/2004-100 of Ministry of Agriculture and Ministry of Health of the Slovak republic, 3rd part, head IX relating to honey. Vestník Ministerstva pôdohospodárstva Slovenskej republiky, 15, p. 43–48.

COHEN, I. – WEIHS, D. 2010. Rheology and microrheology of natural and reduced-calorie Israeli honeys as a model for high-viscosity Newtonian liquids. Journal of Food Engineering, 100, p. 366–371.

FIGURA, L.O. – TEIXEIRA, A.A. 2007. Food Physics, Physical Properties – Measurement and Applications. New York, Springer, 550p.

HLAVÁČ, P. – BOŽIKOVÁ, M. 2012. Influence of temperature and storing time on flower honey rheologic and thermophysical properties. Journal on processing and energy in agriculture, 16(2), p. 52–56.

KUMBÁR, V. – DOSTÁL, P. 2014. Temperature dependence density and kinematic viscosity of petrol, bioethanol and their blends. Pakistan Journal of Agricultural Sciences, 51(1), p. 175 – 179.

SAHIN, S. – SUMNU, S. G. 2006. Physical properties of foods, Springer, USA, 257p.

WHITE, J.W. – KUSHNIR, I. – SUBERS, M.H. 1964. Effect of storage and processing temperatures on honey quality. Food Technology, 18, p. 153–156.

WHITE, J.W. 1999. Honey - The Hive and the Honey Bee. Hamilton, Dandant & Sons, p. 491–530.

ZAITOUN, S. – GHZAWI, A. – AL MALAH, K. – ABU JDAYIL, B. 2000. Rheological properties of selected light colored Jordanian honey. International Journal of Food Properties, 4, p. 139–148.

The viscosity of supersaturated aqueous glucose, fructose and glucose-fructose solutions

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Keywords:

supersaturation, glucose, fructose, viscosity

Abstract. The viscosity of supersaturated aqueous glucose-fructose solutions has been measured, using flow curves on an Anton Paar RheolabQC rotating viscometer. Three different concentration (85%, 83%, 81%) and five different glucose:fructose ratios (60:40, 55:45, 50:50, 45:55, 40:60) has been selected in a similar composition to honey. Measurements were taken at temperatures ranging from +10 to +50 °C.

All systems exhibited Newtonian behaviour, meaning that the viscosity is independent of the shear rate. The viscosity of the supersaturated solutions was decreasing with increasing temperature and increasing with increasing the concentration. Aqueous solutions of fructose are somewhat more viscous than glucose solutions. For aqueous glucose-fructose solutions, the increase of fructose concentration increases the solutions viscosity.

INTRODUCTION

Viscosity is widely acknowledged as a key physical property in understanding the flow of raw materials, processing intermediates and final products (Ferry, 1980). Aqueous solutions of glucose and fructose at different temperatures and concentrations are found in several food processes and basis to formulation of a number of food products or ingredients in the bakery, ice cream, and confectionary industries (Telis et al., 2007). The confectionary products as well as honey contain high amount of sugar and knowing the flow properties of supersaturated sugar solutions are important in designing industrial processes like pumping, filtration, mixing and packaging.

There have been several studies looking at viscosities of aqueous sugar solutions. The viscosity-temperature relationship in aqueous sugar amorphous phases in partially frozen systems has been evaluated by Maltini & Anese (1995) and in liquid supercooled pure sugar systems has been evaluated by Kerr & Reid (1994). Several studies have been performed with solutions of sucrose, glucose and/or fructose in a range of temperatures and concentrations with objective of comparing different models (Arrhenius, Williams-Landel-Ferry (WLF), Vogel-Taumman-Fulcher (VTF), and power law) to fit experimental data (Recondo, et al., 2006; Quintas et al., 2006; Telis et al., 2007). All the models can be employed quite satisfactorily to describe the experimental behaviour. However, the Arrhenius model predicts the lower temperature dependence, while the WLF predicts the higher temperature dependence close to the Tg value (Telis et al., 2007).

There is a lack of data on supersaturated aqueous sugar systems similar to honey. The aim of the present work was to determine experimental values of viscosities for supersaturated aqueous glucose-fructose solutions as a function of temperature and concentration.

MATERIALS AND METHODS

Supersaturated solutions of glucose, fructose and glucose-fructose were prepared by appropriate amounts of glucose (Cargill) and fructose (Cargill), up to complete dissolution in distilled water at 95 °C. Three different concentration (85%, 83%, 81% w/w) and five different glucose (G):fructose (F) ratios (60:40, 55:45, 50:50, 45:55, 40:60) has been selected in a similar composition to honey.

Flow properties of samples at temperatures in the range of 10 – 50 °C at 10 °C intervals were measured with a RheolabQC rotating viscometer (Anton Paar, Germany) fitted with CC27 system, with temperature controlled water bath. The apparent viscosity η was measured as a function of shear rate $\dot{\gamma}$ (1 – 100 s^{-1}). Moreover, the apparent viscosity was measured as a function of shear time (2 minutes), while keeping the shear rate constant (50 s^{-1}). Samples were allowed to rest for about ten minutes before to measuring their rheological properties. All determinations were performed in triplicate.

RESULTS AND DISCUSSION

All systems exhibited Newtonian time independent behaviour in the whole domain of temperature, meaning that the viscosity is independent of the shear rate. This is according to other published works, sugar solutions as well as honey are reported to be Newtonian fluids (Recondo et al., 2006; Telis et al., 2007; Lazaridou et al., 2004).

The supersaturated 83% glucose solution showed the low viscosity 2.14 ± 0.30 Pa*s at 20 °C compared to other tested solutions. The supersaturated 83% fructose solution had viscosity 9.27 ± 0.23 Pa*s and 83% glucose-fructose solutions had slightly higher viscosity values than fructose solutions, ranging from 11.0 ± 0.3 Pa*s (G50:F50) to 13.15 ± 1.32 Pa*s (G40:F60) at 20 °C. The viscosity of supersaturated 83% glucose-fructose solutions increased with an increase in fructose content (Figure 1). This is in agreement with Sopade et al. (2004) work. Glucose and fructose are chemically different. Fructose is a ketose sugar, while glucose is an aldose sugar, and the positions of the hydroxyl groups in these sugars can influence hydrogen bonding with water.

The viscosity of the supersaturated solutions was decreasing with increasing temperature (Figure 2a). As temperature increases, viscosity falls, due to less molecular friction and reduced hydrodynamic forces (Mossel et al., 2000). The value of viscosity had a dramatic decrease in the low range of temperature. Similar results have been obtained in different studies (Recondo et al., 2006; Sopade et al., 2004; Telis et al., 2007). Generally, at a low temperature, the viscosity of materials is usually very high as they tend towards the glassy state (Rahman, 1995).

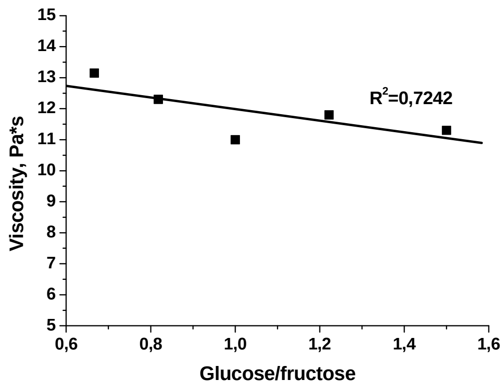

Figure 1
Viscosity of supersaturated 83% glucose-fructose solution as a function of glucose-fructose ratio at 20 °C

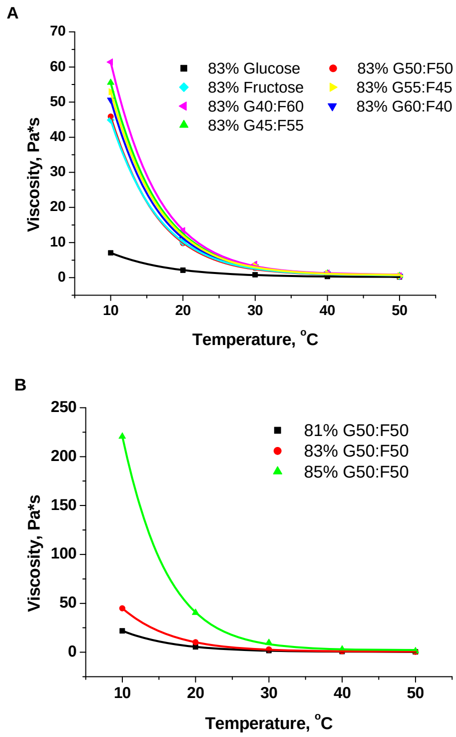

Figure 2
Viscosity of sugar solutions as a function of temperature (a) and solid content (b) at shear rate 50 s^{-1}.

Increase in moisture content (decrease in solids) (Figure 2b) exponentially reduce the viscosity of aqueous supersaturated glucose/fructose solutions. This is in accordance with published studies on honeys and other foods (Munro, 1943; Sopade et al., 2004). The temperature have more effect on more concentrated solutions.

CONCLUSIONS

Supersaturated aqueous glucose, fructose and glucose-fructose solutions showed Newtonian time independent behaviour. The glucose solution showed the low viscosity compared to other tested solutions. Increases in moisture, glucose and temperature reduced the viscosity while the increase in fructose content increased the viscosity of supersaturated glucose-fructose solutions.

ACKNOWLEDGEMENTS

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REFERENCES

Ferry, J.D. (1980). *Viscoelastic Properties of Polymers.* New York: John Wiley & Sons.

Kerr, W.L., & Reid, D.S. (1994). Temperature dependence of the viscosity of sugars and maltodextrins in coexistence with ice. *Lebensmittel-Wissenchaft und – Technologie,* 27:225-231.

Lazaridou, A., Biliaderis, C.G., Bacandritsos, N., & Sabatini, A.G. (2004). Composition, thermal and rheological behaviour of selected Greek honeys. *Journal of Food Engineering,* 64:9-21.

Maltini, E., & Anese, M. (1995). Evaluation of viscosities of amorphous phases in partially frozen systems by WLF kinetics and glass transition temperatures. *Food Research International,* 28:367-372.

Mossel, B., Bhandari, B., D'Arcy, B., & Caffin, N. (2000). Use of an Arrhenius model to predict rheological behaviour in some Australian honeys. *Food Science and Technology,* 33:545-552.

Munro, J.A. (1943). The viscosity and thixotropy of honey. *Journal of Entomology*, 36:769-777.

Quintas, M., Barandao, T.R.S., Silva, C.L.M., & Cunha, R.L. (2006). Rheology of supersaturated sucrose solutions. *Journal of Food Engineering*, 77:844-852.

Rahman, S. (1995). *Food Properties Handbook*. Boca Raton: CRC Press.

Recondo, M.P., Elizalde, B.E., & Buera, M.P. (2006). Modelling temperature dependence of honey viscosity and of related supersaturated model carbohydrate systems. *Journal of Food Engineering,* 77:126-134

Sopade, P.A., Halley, P.J., D'Arcy, B.R., Bhandari, B., & Caffin, N. (2004). Dynamic and steady-state rheology of Australian honeys at subzero temperatures. *Journal of Food Process Engineering*, 27:284-309.

Telis, V.R.N., Telis-Romero, J., Mazzotti, H.B., & Gabas, A.L. (2007). Viscosity of aqueous carbohydrate solutions at different temperatures and concentrations. *International Journal of Food Properties*, 10:185-195.

Colours of beers

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Abstract. Beer is a well-known fermented beverage, which is a complex mixture of more than 800 compounds. Thanks to the raw materials, beer is an excellent source of different valuable components such as polyphenols, which influence the colours of beers. In our research the colour values and total polyphenol contents of our self-brewed beers were determined and the results were compared with the colours of commercial beers. Based on our result it can be stated that there is moderately correlation between the polyphenol content and colour value.

Keywords:

beer, colour,
total polyphenol content,
correlation

INTRODUCTION

Beer is a well-known alcoholic beverage, which is consumed from the beginning of civilization (Piendl, 2005; Eßlinger, 2009). It had an important role in the ancient cultures, it was used even for medication (Eßlinger, 2009). Nowadays, we pay more attention to the quality of our foods and drinks and to their effect on our bodies, because of the more and more popular health-conscious nutrition (O'Brien G. & Davies, 2007). Therefore we pay more attention to the beer, because it contains more valuable components such as polyphenols, which influence the colours of beers (Cortacero & Ramírez et al., 2003; Jaskura-Goiris et al., 2010).

The colours of beers

The colour determines the type of beers. There are light beers, brown beers and provisional colour beers. The colour depends on the grain used as raw material, and also on the processes in what the grain undergo during the brewing. Colour components are produced partly in the Maillard reaction, partly by the oxidative processes of polyphenols derived from barley husk (Shellhammer, 2009; Narziss, 1981).

Roasted malts or caramel malts are added to brew coloured beer. On the higher temperature roasted malt causes tone up in the beer, because of its higher polyphenol and anticarcinogenic compounds content (Narziss, 1981).

In the past, to determine the beer colour it was compared with colour standards. Joseph Lovibond used the solutions of potassium chromate as reference standard. It became possible to compare measurements from different Lovibond Tintometers. These standardized comparator were accepted by the European Brewing Convention in 1951 (Hughes & Baxter, 2001). So when the colours of beers are determined, it refers to colour values in degrees Lovibond (Strien & Drost, 1979).

Table 1: Raw materials of beer samples

		Water	***Malt***	***Caramell malt***	***Colouring malt***
1	Light beer 1	water	**Pilsner 3 EBC[1]**	**Cara-hell 20 EBC[1]**	-
2	Light beer 3	water	**Pilsner 3 EBC[1]**	**Carabelge 30 EBC[2]**	-
3	Light beer from stream water	stream	**Pilsner 3 EBC[1]**	**Carabelge 30 EBC[2]**	-
4	Light beer from mineral water	mineral	**Pilsner 3 EBC[1]**	**Carabelge 30 EBC[2]**	-
5	Ligth beer from distilled water 2	distilled water	**Vienna 7 EBC[1]**	**Abbey 40 EBC[2]**	-
6	Brown beer 1	water	**Pilsner 3 EBC[1]**	**Cara-hell 20 EBC[1]**	**Carafa Type1 800 EBC[2]**
7	Brown beer 2	water	**Pilsner 3 EBC[1]**	**Carabelge 30 EBC[2]**	**Carafa Type1 800 EBC[2]**

		Bitter hops pelletts	***Aroma hops pellets***	***Beer yeast***
1	Light beer 1	Aurora[2]	Spalt Select[3]	Safbrew T-58[4]
2	Light beer 3	Aurora[2]	Spalt Select[3]	Brewferm Lager[5]
3	Light beer from stream water	Spalt Select[3]	Saphir[2]	Brewferm Lager[5]
4	Light beer from mineral water	Spalt Select[3]	Saphir[2]	Brewferm Lager[5]
5	Ligth beer from distilled water 2	Spalt Select[3]	Saaz[2]	Brewferm Lager[5]
6	Brown beer 1	Aurora[2]	Spalt Select[3]	SafLager[4]
7	Brown beer 2	Aurora[2]	Spalt Select[3]	Brewferm Lager[5]

Distributor: [1]Weyermann-Deutschland, [2]No dates, [3]Hallertauer-Deutschland, [4]Fermentis, [5]Brouwland

MATERIAL AND METHOD

Our aims were to determine the colour values and the total polyphenol contents of self-brewed beers and to compare it with the colour values of the commercial beers.

Our self-brewed beers were produced by Zip's Micro Brewery Equipment in the laboratory of the Institute of Food Science at the University of Debrecen, using the recipe of the equipment.

Tap water was used for 1-2. samples, and for the brown beers, for the light beer from stream water was taken from Kecső stream in Slovakia, and for the light beer from mineral water was used the water of the deep-fount of mineral water company, Debrecen. Distilled water was used for the brewing of 5th beer.

Slovak Pilsner malt was used for all the beers with one exception. We brewed the light beer from distilled water from Vienna malt. Colouring malt was added to get the expected dark colour of the brown beers. The components of the beers are shown in Table 1.

Different hops were used. Our beers were fermented by lager yeast with one exception. Light beer 1 was fermented by ale yeast. Samples were taken from one brewing process.

Different commercial beers were also analysed, which were bought in Hungary. This beers were: Becks (light beer, from Borsodi Brewery); Heineken (light beer), Soproni Fekete Démon (brown beer), Soproni Szűz (light beer) (from Heineken Brewery); Carlsberg (light beer), Holsten (light beer) (from Carlsberg Brewery); Kanizsai (light beer), Pilsner Urquell (light beer) (from Dreher Brewery).

We determined the colour values of beers by the method of European Brewery Convention Analytica in a ten times dilution. EBC colour values and absorbancies were determined (Analytica-EBC, 1999). Total polyphenols were quantified by Folin-Ciocalteu colorimetric method (760 nm), results were given in gallic-acid equivalent value (Kalušević et al., 2011). Chemical analysis were performed in triplicate.

Data were subjected to correlation and variance analysis (sd=0,05).

RESULTS AND DISSCUSIONS

Colour values of beers are presented in Figure 1. As it shows, the highest value belonged to the light beer with mineral water, while the light beer 3 has produced the lowest value. However virtually the brown beers were the darkest, but they had fewer colour values than the light beer from mineral water.

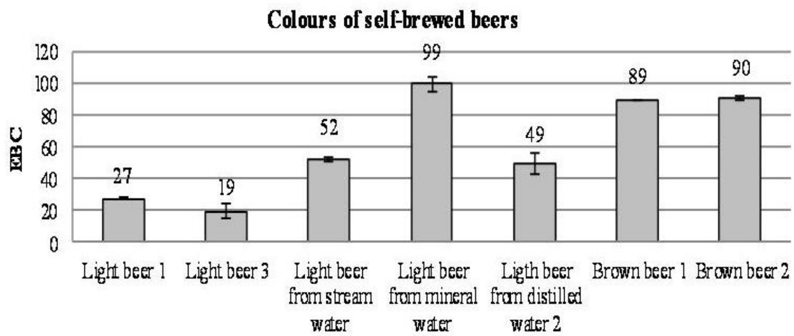

Figure 1
Colour of beer samples

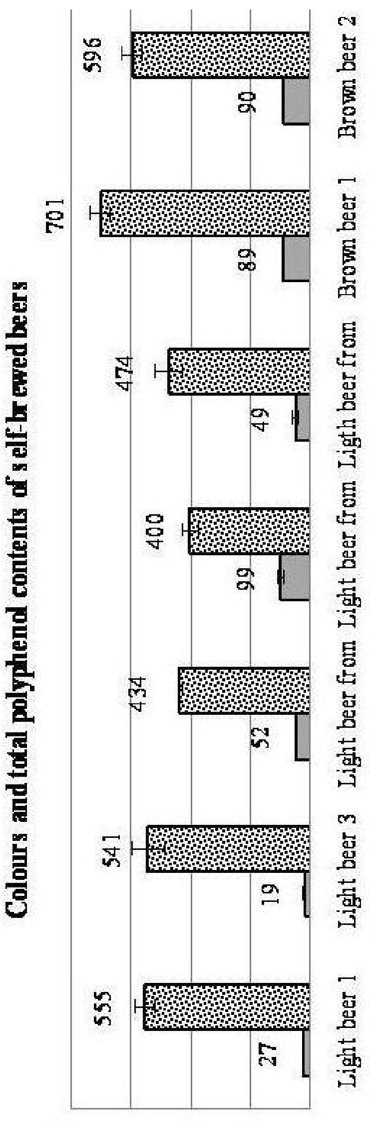

Figure 2

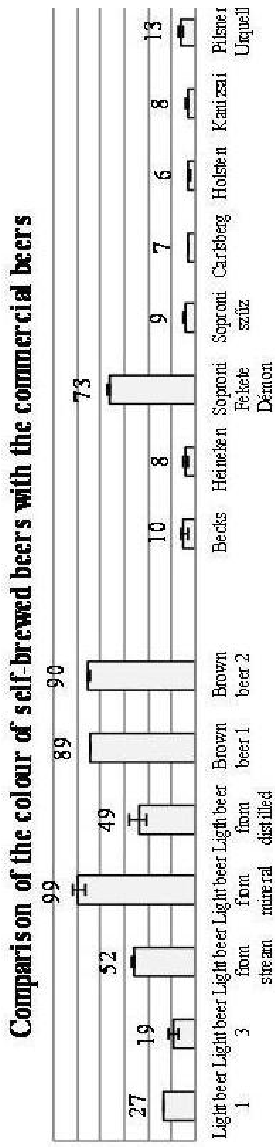

Figure 3

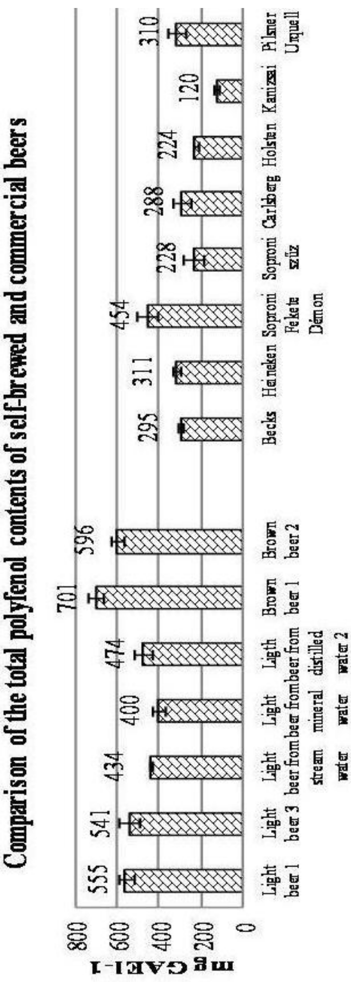

Figure 4

RESULTS AND DISSCUSIONS

Colour values of beers are presented in Figure 1. As it shows, the highest value belonged to the light beer with mineral water, while the light beer 3 has produced the lowest value. However virtually the brown beers were the darkest, but they had fewer colour values than the light beer from mineral water.

When we compared (Figure 2) the colours and total polyphenol contents of self-brewed beers, we could establish that the light beer from mineral water had the highest colour value but the lowest polyphenol content. Brown beer 1 had the highest polyphenol content, and light beer 3 had the lowest colour value.

We compared the colour of the self-brewed beers with the colour values of some commercial beers (*Figure 3*), and we could establish, that our self-brewed beers had higher colour values than the commercial beers, but Soproni Fekete Démon had as high color value as the brewed beers.

Antioxidant contents of the produced and commercial beers were represented in *Figure 4.* Brown beer 1 contained the highest amount of polyphenols, while the light beer from mineral water was the poorest in antioxidants. The commercial beers contained fewer polyphenols than the brewed beers with one exception. There were more polyphenol components in the Soproni Fekete Démon than the light beer from mineral, and stream water.

Evaluating the results it can be established that there is moderately strong correlation between the total polyphenol contents and the colours of the beers. The correlation coefficient was 0,69. The correlation between the inconstants was significant. In case of light beer brewed with mineral water the highest colour value was found together with the lowest polyphenol content. In brown beers we measured higher polyphenol content than in light beers, but the colour values were lower than in the light beer from mineral water. In the light beer brewed with tap water low colour value and higher polyphenol content was found. The commercial beers usually had lower colour values and lower polyphenol contents.

CONCLUSIONS

Our study showed that the light beer from mineral water had higher colour value than the brown beers but the polyphenol contents were in higher level in the brown beers. We could establish that the commercial beers had the lowest colour values. There was an exception, because the Soproni Fekete Démon had high colour value. To compare the polyphenol contents of brewed beers with the polyphenol contents of commercial beers we could establish that the self-brewed beers contained more polyphenols.

Summarizing the results, there are significant differences between the self-brewed beers and the commercial beers. Comparing the measured parameters it was found that there was moderately strong correlation between the colours and the total polyphenol contents of the beers.

REFERENCES

Analytica-EBC (1999). Method 9.24.2. Verlag Hans Carl Getranke-Fachverlag, Nürnberg.

Cortacero-Ramírez S., Hernáinz-Bermúdez de Castro M., Segura-Carretero A., Cruces-Blanco C., Fernández-Gutiérrez A. (2003) Analysis of beer components by capillary electrophoretic methods, *Trends in Analytical Chemistry Vol.* 22: Nos. 7+8, 440-455.

Eßlinger H. M. (Eds). (2009). Handbook of Brewing. Processes, Technology, Markets. Wiley-VCH, 778.

Hughes , P. S. & Baxter , E. D. (2001). Beer: Quality, safety and nutritional aspects. *Royal Society of Chemistry : Cambridge, UK.*

Jaskura-Goiris B., Aerts G., De Cooman L. (2010) Hop α-acids isomerisation and utilisation: an experimental review, *Cerevisia* 35:57-70.

Kalušević A., Uzelac G., Veljović M., Despotović S., Milutinović M., Leskošek-Čukalović I., Nedović V. (Eds). (2011). The antioxidant properties of honey beer, in Food Process Engineering a Changing World, *Proceedings of the 11th International Congress on Engineering and Food (ICEF11) VOLUME III*: 2057-2058.

Narziss L. (1981). A sörgyártás. Mezőgazdasági Kiadó, Budapest.

O'Brien, G., Davies, M. (2007). Nutrition knowledge and body mass index, *Health Education Research* 22:571–575.

Piendl, A. (1989). Über den Stellenwert des Biers in der heutigen Ernährung. *Brauwelt* 14:546-552.

Shellhammer T.H. (2009). Beer color, (ed). In. Charles W. Bamforth, Inge Russell and Graham Stewart. (2009). Beer A Quality Perspective A volume in Handbook of Alcoholic Beverages, 213-227,

Strien , J. V. & Drost , B. W. (1979). Photometric determination of beer and wort color .
Journal of the American Society of Brewing Chemists, 37 (2):84 – 88.

The Fornetti brand name and the Fornetti products are well-known and popular not only in Hungary, from where Fornetti started, but in all countries where it is present. In the period of the dynamic network building, on each market, where it had appeared, it became the market leader in the food sector in a short time. Its products are consumed by nearly 2 million people daily.

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The continually rising demands have always required the installation of state-of-the-art automated production lines and automated packaging machines with several measuring cells in Fornetti plants. The technological developments initiated in the past few years are aimed at the replacement of semi-automated production lines in Fornetti plants with automated ones.

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