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CONTENTS

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EDITORIAL

This is the XXIV- XXV Volume of the Journal of Food Physics, and as You know the first issue was published in 1988, almost a quarter of century ago. This is a relatively long period of existence. Many thanks for your kind help, cooperation, collaboration, support and understanding. Anyway, this issue is a new format, proving the excellent work of Prof. Peter Laszlo, the managing and technical editor of our JFP and the founder of the Food Physics Public Utility Foundation.

This issue gives again the opportunity for the readers to get interesting and useful information about some special questions of food physics. The topics of the 7 scientific articles in this issue cover the following fields:

- Chernobyl disaster 25 years ago
- rheological and thermal properties of whisky and beer
- electric properties of blueberry
- chips products investigation
- sensory evaluation of bread
- lycopene content of tomato
- dielectric impedance monitoring of apple

Let me say a few words about the 2012 ISFP conference, which was the 10th meeting of our society. As You probably know or remember the first conference we organized in Budapest, Hungary, 1994, followed by the second one in Bucharest, Romania, 1996. The place of the third meeting was Poland, Lublin, 1998, and in 2000 we met in Turkey, Istanbul. Later we decided to organize the conference in Brno, Czech Republic, 2002, and 2 years later, in 2004 we came back again to Hungary, but the place was Pecs. The 2006 meeting we had in Serbia, in a beautiful small town, Senta, and the next one in Plovdiv, Bulgaria, 2008. The place of the 9-th conference was Nitra, Slovakia, 2010. And the last one – see also a special short report about the meeting in this issue – in 2012 we had again in Hungary, in Budapest. The participants declared that it is necessary to continue the history of the ISFP conferences, and – special thanks to our bulgarian colleagues – may I inform You that in 2014 we will have the 11th ISFP conference in Bulgaria.

In this issue of JFP You can find also some other information (Food Physics Public Utility Foundation, Conference report about PRAE 2011, Szegedi Paprika Spice and Canned Food Producing Co, which is our sponsor, invitation to the next Agrophysics Conference in 2013, Poland, information for the authors).

Read and enjoy this issue! And please, do not hesitate to support the Food Physcs Public Utility Foundation! We need badly the help and donations for existence.

Andras S. SZABO
editor-in-chief

Quater of century has passed away after the chernobyl disaster

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Keywords:
disaster,
natural radioactivity,
radiometric measurements,
contamination of food and agricultural products,

ABSTRACT. The disaster has happened in 1986 in the former Soviet Union, on the territory of northern Ukraine. In consequence of the nuclear plant accident a huge territory of Europe has been contaminated, including also Hungary. The contamination level of foodstuffs in Hungary within a few weeks after the disaster (dominantly 131-I) was significantly higher than the natural radioactivity (e.g. 40-K). Later the pollution level decreased and from 1990 the results of radiometric measurements have been proved that there is no significant difference in contamination (e.g. 137-Cs) of food and agricultural products before and after the nuclear disaster. The total radiation burden (partly from foodstuffs) of hungarian population (living appr. 1000 kilometres from the place of the accident) has been much less than the natural radiation load, so no increase of health risk has been determined in the 25 years period after the disaster.

INTRODUCTION

From the beginning of the publication of Journal of Food Physics (1988) a lot of papers were published concerning the radioactivity (natural and man-made one) of the food chain and contamination level, radiation burden, measurement techniques of radionuclides. A special attention was paid to the questions of the Chernobyl disaster, giving detailed information about the radiocontamination level of foodstuffs in Hungary (Tarjan, Kis-Benedek, 1991) (Szabo, 1991, 1996, 2000-2003).

The disaster at Chernobyl is often called the worst nuclear accident of the XX. century. This accident is the most serious one of the nuclear industry, partly through consuming contaminated food and drinking water or breathing with radionuclides contaminated air. Huge territory of the earth was contaminated by rainfall and the radioactive isotopes entered into the food chain through plants and animals. The impact of the Chernobyl disaster on health of population, living in the affected regions of Ukraine and Belorussia was significant because of radiation exposure (UN report, 2006).

A total of up to 4000 people could eventually die of radiation exposure from the Chernobyl nuclear power plant (NPP) accident in 1986, an international team of more than 100 scientists has concluded. However, fewer than 50 deaths had been directly attributed to radiation from the disaster, almost all being highly exposed rescue workers, many who died within weeks or months of the accident but others who died much later.

The report, "Chernobyl's Legacy: Health, Environmental and Socio-Economic Impacts," was released by the Chernobyl Forum. The three-volume, 600-page report, incorporating the work of hundreds of scientists, economists and

health experts, assesses the impact of the largest nuclear accident in history. The Forum is made up of 8 UN specialized agencies, including the International Atomic Energy Agency (IAEA), World Health Organization (WHO), United Nations Development Programme (UNDP), Food and Agriculture Organization (FAO), United Nations Environment Programme (UNEP), United Nations Office for the Coordination of Humanitarian Affairs (UN-OCHA), United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), and the World Bank, as well as the governments of Belarus, the Russian Federation and Ukraine.

This compilation (report) of the latest research can help to settle the outstanding questions about how much death, disease and economic fallout really resulted from the Chernobyl accident. The governments of the three most-affected countries have realized that they need to find a clear way forward, and that progress must be based on a consensus about environmental, health and economic consequences and some good advice and support from the international community. Unfortunately this was a very serious accident with major health consequences, especially for thousands of workers exposed in the early days after the disaster.

Let us see shortly the situation today (2011) in Hungary, after 25 years of the Chernobyl NPP accident. Of course it seems to be necessary to mention that 25 years later the Chernobyl accident the nuclear industry had another serious disaster in Japan at the Fukushima NPP in 2011, contaminating with radionuclides the environment. But – because of the huge distance between Hungary and Japan – the effect of the japanese accident is perfectly negligible in Hungary, the food chain was absolutely not contaminated (Szabo, 2011).

RADIOACTIVE CONTAMINATION OF THE FOODSTUFFS

In Hungary during a few weeks after the disaster the contamination of milk and fresh vegetables was rather high (mainly 131-I, 137-Cs, 134-Cs) in comparison with the natural radioactivity level, but the contamination decreased fast. In 1987 the pollution was based dominantly on the 137-Cs activity (physical half-life 30 years). In 1990 the contamination level of foodstuffs of plant and animal origin was similar to the level before the accident. And in the following 20 years after this 1990 year the contamination level (man-made radioactivity) of the foodstuffs and agricultural products, produced in Hungary was practically negligible in comparison with the natural radioactivity (e.g. 40-K). Till today a lot of measurements were carried out to get data about the contamination level of different foodstuffs, but no case about high level of radioactivity in the food samples.

RADIATION BURDEN AND HEALTH RISK

Because of the accident a huge amount of radioactive materials (e.g. volatile noble gases, cesium, iodine isotopes) were emitted into the atmosphere and later into the food chain (soil, surface water, plants, animals, men), contaminating mainly many countries of the continent, but also some other countries (e.g. Turkey). Hungary is appr. 1000 kilometres from the place of the Chernobyl NPP, so the indirect contamination – depending mainly on meteorological conditions – was a few orders of magnitude less, than the pollution level in the surrounding territories of the NPP in Chernobyl. Even there were some areas in Hungary – Great Plain – where the contamination level was really very low. But even in case of people, living on

territories of the country with higher contamination (e.g. Budapest region) the total dose burden from the accident should be less than 1.0 mSv. The natural radiation load per year is appr. 2.4 mSv. This is the reason that we do not have to expect or calculate the increase of the irregular growth of babies and cancer cases of the hungarian population.

We know that the probability of occurrence of leucemia and disease of thyroid gland for children increased significantly on the territories of high radioactive contamination (mainly southern part of Belorussia). But in Hungary there was no indication of increase of disorders of new-born children, or cancer illness, tumour mortality and leucemia for adult and young population. With other words: no increase of health risk has been evaluated.

CONCLUSION

Today in Hungary the impact of the Chernobyl NPP accident in 1986 is not significant, concerning the contamination level of foodstuffs or health risk of the population. But we have to take into account that the Chernobyl NPP accident was not the first and not the last one of the history of nuclear industry. Therefore – to my mind – it would be necessary to have a significant change in the energy program development of the world, paying more attention to the renewable energy sources and the construction of fusion reactors. The fusion reactor – this is the energy source of the Sun – produces no fission products, so there is no harmful risk on the environment. No carbon-dioxide, no radioactive waste materials, no global warm-up, but sustainable environment.

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Chosen temperature dependencies of whisky rheologic and thermal properties

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Keywords:
whisky, temperature, rheologic properties, thermophysical properties, relation,

Abstract. Information about physical properties of whisky is almost impossible to find. That is why this paper is concerned with some physical properties of chosen types of whisky. Our research was focused on rheologic and thermal parameters. Temperature can be included between the most significant parameters that influence physical properties of food. And that is the reason why this article deals with chosen temperature dependencies of whisky rheologic and thermal properties. Temperature dependencies of whisky dynamic and kinematic viscosity can be described by decreasing exponential function and temperature dependency of whisky fluidity has increasing exponential character. Dependencies of thermal conductivity, diffusivity and volume specific heat on temperature are characterized by increasing linear function.

INTRODUCTION

Whisky is an alcohol drink. Origins of the whisky are in Scotland and Ireland (Jackson, 2002), but nowadays its production is spread on several continents. Whisky is usually produced from these three basic ingredients: grains, water and yeasts. Different types of grains could be used, for example wheat, barley, corn and rye (Hoffmann, 2009). Malt is made out of grains and yeast assists in transformation of sugars to alcohol.

Particular sort of whisky depends mostly on the ingredients used during the production, on the used production method, and way and time of maturing in special containers (most frequently wood barrels). There are several types of whisky as single malt whisky, grain whisky, mixed malt whisky, blended whisky, etc. (Gasnier, 2005).

Colour, odour and taste could be included between basic properties of whisky (Soole, 2010).

Physical properties of whiskies are not known and research of these properties is very important. Because of liquid character of whisky, are very significant rheologic properties, which can determine the quality of whisky. During the manipulation with whisky we can observe temperature changes, so the second type of very important physical properties is thermal.

MATERIALS AND METHODS

Our research was oriented on measuring of thermophysical and rheologic characteristics of whisky. There were measured two types of whisky – Grant's and Jim Beam from two different producers. During the experiments were measured thermal characteristics as: thermal conductivity, thermal diffusivity and volume specific heat. The second part

of experiments was focused on measuring of rheologic parameters as: dynamic viscosity, kinematic viscosity and fluidity. Measuring of dynamic viscosity was performed by digital rotational viscometer Anton Paar DV–3P, and the principle of measurement is based on sample resistance against the probe rotation. Other rheologic parameters were calculated according to equations mentioned in Božiková – Hlaváč (2010). Measuring of thermal parameters was performed by instrument Isomet 2104. Measurement by Isomet is based on analysis of the temperature response of the measured sample to heat flow impulses (Božiková – Hlaváč, 2010).

Selected rheologic and thermal parameters were measured during the temperature stabilisation in temperature range (-5 – 27) °C. The temperature effect on viscosity can be described by an Arrhenius type equation:

$$\eta = \eta_0 \, e^{-\frac{E_A}{RT}} \tag{1}$$

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). Temperature dependencies of thermal conductivity, diffusivity and volume specific heat can be described by increasing linear functions (5, 6 and 7).

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

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

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

$$\lambda = G + H\left(\frac{t}{t_0}\right) \tag{5}$$

$$a = I + J\left(\frac{t}{t_0}\right) \tag{6}$$

$$c\rho = K + L\left(\frac{t}{t_0}\right) \tag{7}$$

where t is temperature, t_o is 1 °C, A, B, C, D, E, F, G, H, I, J, K, L are constants dependent on kind of material, and on ways of processing and storing.

RESULTS AND DISCUSSION

Results are presented as graphic relations of rheologic and thermal 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.

It can be seen from Fig. 1 that dynamic viscosity of both whisky samples is decreasing with temperature. The progress can be described by decreasing exponential function, which is in accordance with Arrhenius equation (1). From Fig. 1 can be also seen that dynamic viscosity of both whisky samples were approximately same and that can be caused by same amount of alcohol content. Kinematic viscosity of whisky samples is decreasing exponentially with temperature (Fig. 2). Dependency of whisky fluidity on temperature is on Fig. 3. It is evident that fluidity of both whisky samples 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.

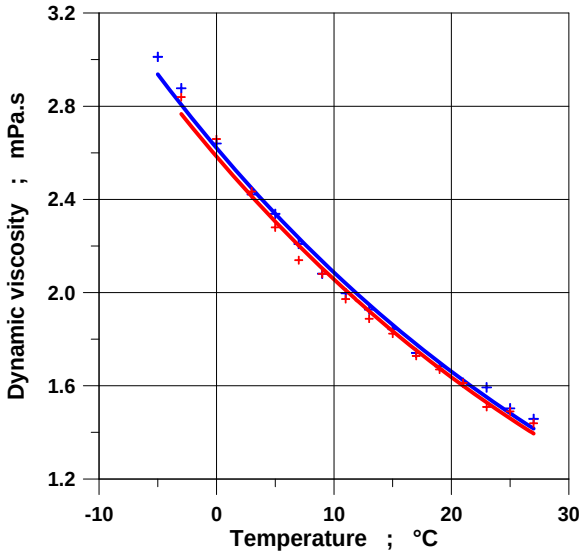

Figure 1
Temperature dependencies of whisky dynamic viscosity (Grant´s +, Jim Beam ○)

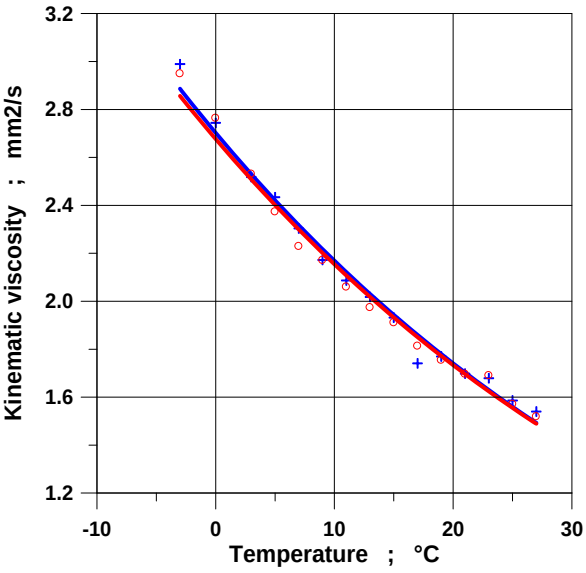

Figure 2
Temperature dependencies of whisky kinematic viscosity (Grant´s +, Jim Beam ○)

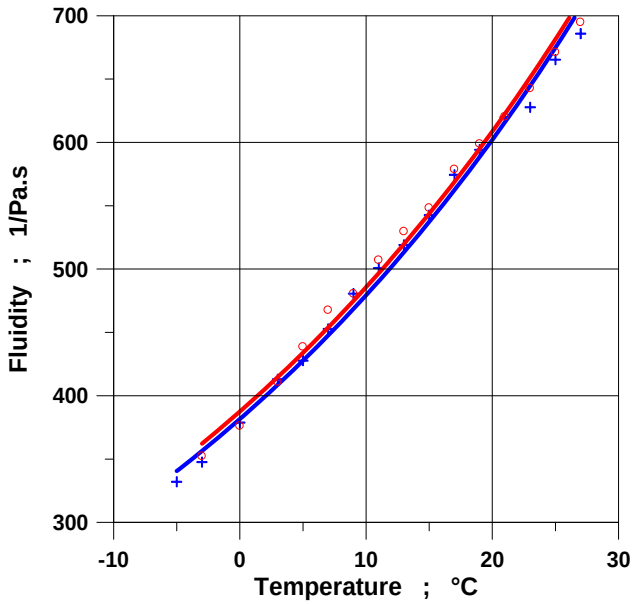

Figure 3
Temperature dependencies of whisky fluidity (Grant´s +, Jim Beam ○)

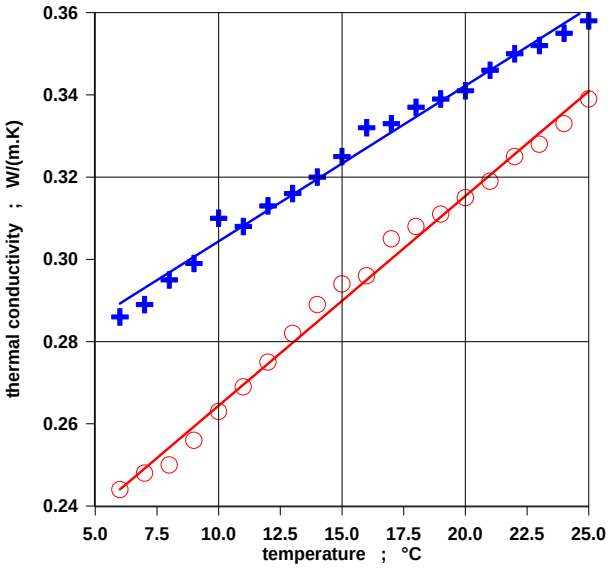

Figure 4
Temperature dependencies of whisky thermal conductivity (Grant´s +, Jim Beam ○)

Table 1. Coefficients A, B, C, D, E, F, G, H, I, J, K, L of regression equations (2, 3, 4, 5, 6, 7) and coefficients of determinations (R^2)

	Regression equations (2, 3, 4)			**Regression equations (5, 6, 7)**		
	Coefficients			**Coefficients**		
Whisky Sample	**A [mPa.s]**	**B [1]**	**R^2**	**G [W.m^{-1}.K^{-1}]**	**H [W.m^{-1}.K^{-1}]**	**R^2**
Grant's	2.6206	0.0228	0.9934	0.2134	0.0051	0.9927
Jim Beam	2.5838	0.0228	0.9919	0.2665	0.0038	0.9873
Whisky Sample	**C [mm^2.s^{-1}]**	**D [1]**	**R^2**	**I [mm^2.s^{-1}]**	**J [mm^2.s^{-1}]**	**R^2**
Grant's	2.7022	0.0220	0.9851	0.6052	0.0034	0.9469
Jim Beam	2.6766	0.0217	0.9876	0.6237	0.0038	0.9958
Whisky Sample	**E [Pa^{-1}.s^{-1}]**	**F [1]**	**R^2**	**K [MJ.m^{-3}.K^{-1}]**	**L [MJ.m^{-3}.K^{-1}]**	**R^2**
Grant's	381.585	0.0228	0.9934	0.4305	0.0029	0.9395
Jim Beam	387.529	0.0226	0.9917	0.3583	0.0055	0.9856

Temperature dependencies of thermal conductivity and diffusivity are shown on Fig. 4 and Fig. 5 and temperature dependencies of volume specific heat are on Fig. 6.

It can be seen from Fig. 4 that thermal conductivity of both whisky samples is increasing with temperature linearly. From Fig. 4 can be also seen that thermal conductivity of whisky Grant's is higher than values for whisky Jim Beam. Thermal diffusivity of whisky samples is increasing linearly with temperature (Fig. 5). Also in this case are values of thermal diffusivity of whisky Grant's higher than for whisky Jim Beam. Dependency of whisky volume specific heat on temperature is on Fig. 6. It is evident that volume specific heat of whisky samples is increasing linearly with temperature. Higher values of volume specific heat had whisky Grant's. Position of the curves in Fig. 4 – 6 could be caused by different quality of basic whisky ingredients, which influence final thermal parameters of whisky. All regression coefficients and coefficients of determination are shown in Tab. 1. In all cases were the coefficients of determination higher than 0.94 approximately.

CONCLUSIONS

Rheologic and thermal properties of two types of whisky were compared in this paper. Both types of whisky (Grant's and Jim Beam) have very similar rheologic properties. It can be seen on temperature dependencies of dynamic, kinematic viscosity and fluidity (Fig. 1 – 3), where increasing (respectively decreasing) exponential functions were applied and it is in accordance with Arrhenius equation. In all relations of thermal properties was used linear increasing function. It can be seen on Fig. 4 – 6 that whisky Grant's had higher values of thermal conductivity, diffusivity and volume specific heat than whisky Jim Beam. This proportion was caused by different types of basic ingredients or by small differences during the production. 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.

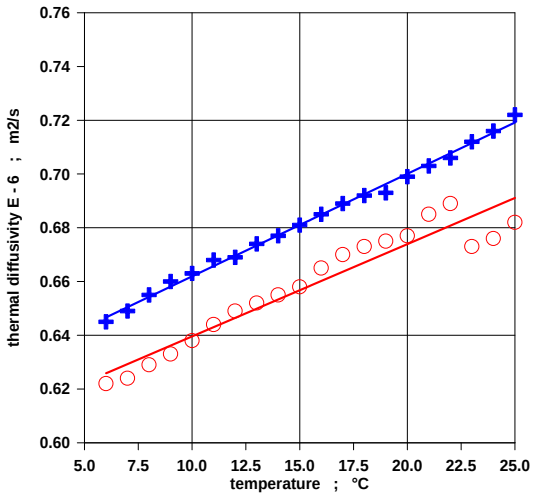

Figure 5
Temperature dependencies of whisky thermal diffusivity (Grant´s +, Jim Beam ○)

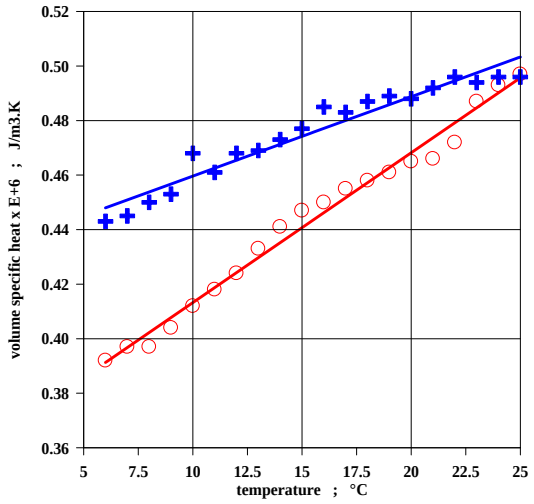

Figure 6
Temperature dependencies of whisky volume specific heat (Grant´s +, Jim Beam ○)

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Comparison of rheologic and thermal properties of beer (pilsner urquell®) with different wort content

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Abstract. This article deals with thermophysical and rheologic properties which are very complicated characteristics of materials. For quality evaluation of food material is necessary to identify their physical properties. During processing of food materials we need to check their status step by step, in different parts of processing. For detection of food material status we could analyze chemical and physical properties. Chemical analyses usually take a longer time intervals than study of physical properties. In modern physical research there are often used dynamic methods of measurements, which are quicker than static methods. By using dynamic methods we can get characteristics of material in the short time. This fact is very important for the practice. Results of measurements are shown as graphical relations of rheologic and thermal properties to the temperature. Relations of dynamic and kinematic viscosity to the temperature are described by decreasing exponential function and dependency of beer fluidity on temperature has increasing exponential character. Dependencies of thermal conductivity and thermal diffusivity on temperature are characterized by increasing linear function.

Keywords:
beer, wort content,
alcohol content,
thermal parameters,
rheologic parameters,

INTRODUCTION

Beer is an alcoholic drink which is made by alcoholic fermentation generally from barley malt, hop and water. It is a colloid system from several extract components in dispersive surroundings that is created by slightly alcoholic water solution. At lower fermented beers the pH value moves in the range (4.4 – 4.6). Temperature has disadvantageous influence on the colloid stability, because it accelerates all the accompanying reaction of the colloid ageing process. Ageing process of the beer colloid system is directly connected to physical – chemical or colloid durability of beer. At beers is also required the biological durability (it commutes to reproduction of some sorts of microorganism) (Tóth and Opáth, 2006).

MATERIALS AND METHODS

Our research was oriented on measuring of rheologic and thermophysical characteristics of beer Pilsner Urquell®. There were measured two types of beer with different wort content. During the experiments were measured rheologic parameters as: dynamic viscosity, kinematic viscosity and fluidity. The

second part of experiments was focused on measuring of thermal characteristics as: thermal conductivity and thermal diffusivity.

The thermal conductivity is derived from the resulting change in temperature over a known time interval. The ideal analytical model assumes an ideal – infinitely thin and infinitely long line heat source (hot wire), operating in an infinite, homogenous and isotropic material with uniform initial temperature T_0. If the hot wire is heated for the time $t = 0$ with constant heat flux q per unit wire length, the radial heat flow around the wire will occur. The temperature rise $\Delta T(r,t)$ in any distance r from the wire as a function of time is described by the simplified equation (1) (Carslaw and Jeager, 1959).

$$\Delta(r,t) = \frac{q}{4\pi\lambda} \ln \frac{4at}{r^2 C} \qquad (1)$$

where: λ – the thermal conductivity, a – thermal diffusivity, $C = \exp(\gamma)$ where γ is the Euler's constant. The thermal conductivity and is calculated from equation (1). Thermal diffusivity a is defined as ratio between thermal conductivity and $c\rho$ - volume specific heat. Measurement is based on analysis of the temperature response of the analyzed material to heat flow impulses (Božiková – Hlaváč, 2010).

Viscosity as one of the most important rheologic parameters is defined as the resistance of a fluid to flow. The unit of dynamic viscosity in SI units is Pa.s. Viscosity changes with temperature. Viscosity of most of the liquids decreases with increasing temperature. The temperature effect on viscosity can be described by an Arrhenius type equation (2)

$$\eta = \eta_0 e^{-\frac{E_A}{RT}} \qquad (2)$$

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). Kinematic viscosity is defined as a ratio between dynamic viscosity and density of measured sample at the same temperature and the unit is $m^2.s^{-1}$. Reciprocal value of dynamic viscosity is fluidity and unit is $Pa^{-1}.s^{-1}$. Measuring of dynamic viscosity was performed by digital rotational viscometer Anton Paar DV–3P, and the principle of measurement is based on sample resistance against the probe rotation (Božiková – Hlaváč, 2010).

All measured samples were stored in special cool box with internal temperature (3 – 5) °C. There were measured relations of dynamic and kinematic viscosity, fluidity, thermal conductivity and diffusivity to the temperature during the temperature stabilisation. Measurements of beer samples were performed in the temperature range (6 – 26) °C.

Temperature dependencies of thermal conductivity and diffusivity can be described by increasing linear functions (3, 4). Temperature dependencies of dynamic and kinematic viscosity can be described by decreasing exponential functions (5, 6) and temperature dependency of fluidity by increasing exponential function (7).

$$\lambda = A + B\left(\frac{t}{t_0}\right) \qquad (3)$$

$$a = C + D\left(\frac{t}{t_0}\right) \qquad (4)$$

$$\eta = E\, e^{-F\left(\frac{t}{t_o}\right)} \quad (5)$$

$$\nu = G\, e^{-H\left(\frac{t}{t_o}\right)} \quad (6)$$

$$\varphi = I\, e^{J\left(\frac{t}{t_o}\right)} \quad (7)$$

where t is temperature, t_o is 1 °C, A, B, C, D, E, F, G, H, I, J are constants dependent on kind of material, and on ways of processing and storing.

RESULTS AND DISCUSSION

Selected results for beer Pilsner Urquell® with different wort content in temperature range (6 – 26) °C are shown on Fig.1 – 5. On Fig. (1 – 2) are shown relations of thermophysical parameters such as thermal conductivity and thermal diffusivity to the temperature. In both cases was applied linear increasing function (3, 4). It can also be seen that beer with higher wort content (respectively alcohol content) had higher values of thermal conductivity and thermal diffusivity.

On Fig. (3 – 5) are shown temperature dependencies of rheologic parameters such as dynamic viscosity, kinematic viscosity and fluidity. It is possible to observe from Fig. 3 that dynamic viscosity of beers is decreasing with increasing of temperature. The progress can be described by decreasing exponential function (5), which is in accordance with Arrhenius equation (2). Relations of kinematic viscosity to temperature are on Fig. 4, where decreasing exponential functions (6) were applied.

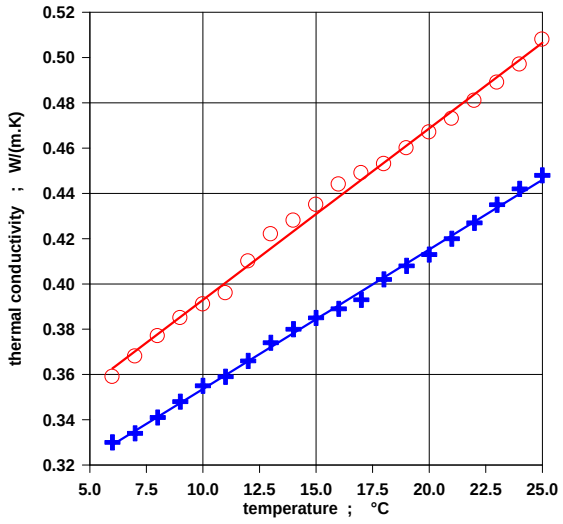

Figure 1
Temperature dependencies of beer thermal conductivity
(Pilsner Urquell® 10% +, Pilsner Urquell® 12% ○)

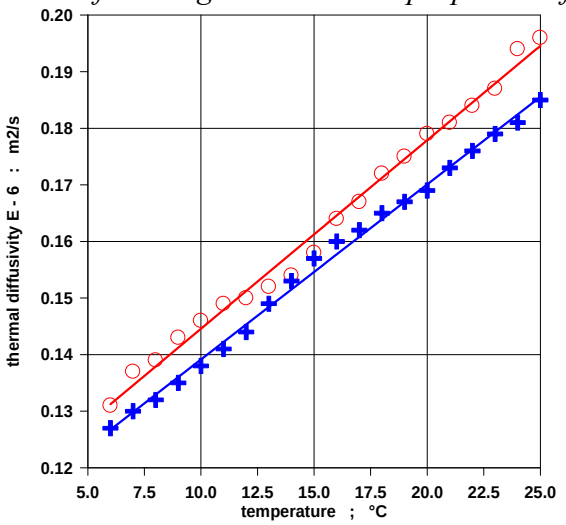

Figure 2
Temperature dependencies of beer thermal diffusivity
(Pilsner Urquell® 10% +, Pilsner Urquell® 12% ○)

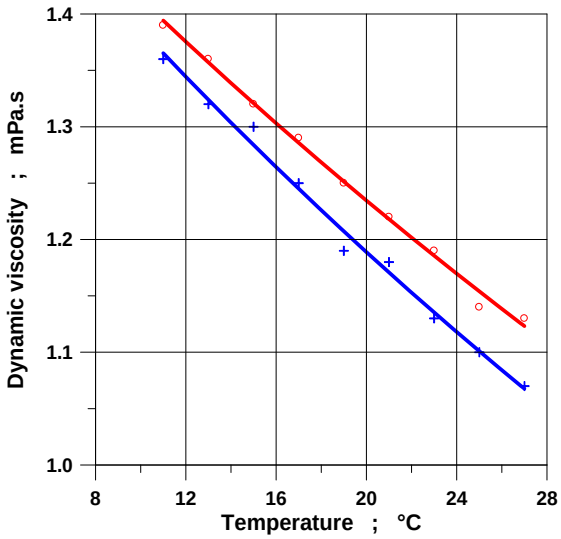

Figure 3
Temperature dependencies of beer dynamic viscosity
(Pilsner Urquell® 10% +, Pilsner Urquell® 12% ○)

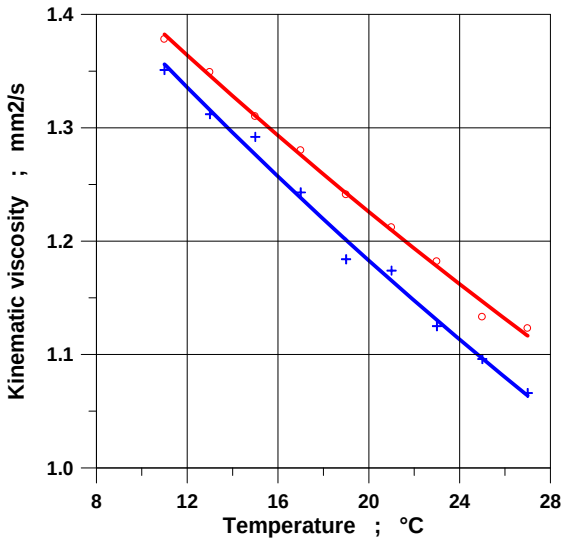

Figure 4
Temperature dependencies of beer kinematic viscosity
(Pilsner Urquell® 10% +, Pilsner Urquell® 12% ○)

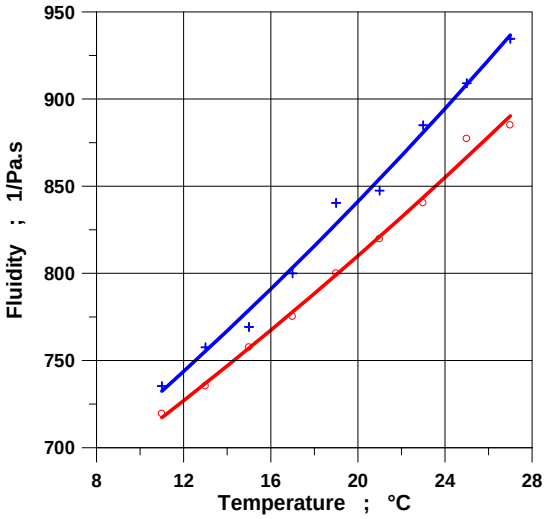

Figure 5
Temperature dependencies of beer fluidity
(Pilsner Urquell® 10% +, Pilsner Urquell® 12% ○)

Table 1. Coefficients A, B, C, D, E, F, G, H, I, J of regression equations (3, 4, 5, 6, 7) and coefficients of determinations (R^2)

	Regression equations (3, 4)			Regression equations (5, 6)		
	Coefficients			Coefficients		
Beer Sample	**A [W.m^{-1}.K^{-1}]**	**B [W.m^{-1}.K^{-1}]**	**R^2**	**E [mPa.s]**	**F [1]**	**R^2**
Pilsner Urquell® 10%	**0.2920**	**0.0062**	**0.9981**	**1.6167**	**0.0154**	**0.9914**
Pilsner Urquell® 12%	**0.3172**	**0.0075**	**0.9947**	**1.6175**	**0.0135**	**0.9948**
Beer Sample	**C [mm^2.s^{-1}]**	**D [mm^2.s^{-1}]**	**R^2**	**G [mm^2.s^{-1}]**	**H [1]**	**R^2**
Pilsner Urquell® 10%	**0.1082**	**0.0031**	**0.9958**	**1.6025**	**0.0152**	**0.9915**
Pilsner Urquell® 12%	**0.1113**	**0.0033**	**0.9918**	**1.6011**	**0.0134**	**0.9948**

Beer Sample	**Regression equation (7)**		
	Coefficients		
	I [Pa^{-1}.s^{-1}]	**J [1]**	**R^2**
Pilsner Urquell® 10%	**618.560**	**0.0154**	**0.9914**
Pilsner Urquell® 12%	**618.234**	**0.0135**	**0.9948**

It can be seen on Fig. 3 and Fig. 4 that the higher the wort content (respectively alcohol content) is the higher the values of dynamic and kinematic viscosity are. Increasing exponential function (7) was used for temperature dependencies of fluidity (Fig. 5). All regression coefficients and coefficients of determination are shown in Tab.1. In all cases were the coefficients of determination very high.

CONCLUSIONS

Rheologic and thermal properties of two beers Pilsner Urquell® with different wort content were compared in this paper. First sample of beer had 10 % of original wort and 4.3 % of alcohol content, while the second sample had 12 % of original wort and 5.0 % of alcohol content. These differences are visible in all graphs (Fig. 1 – 5). Sample of beer with higher wort content (respectively alcohol content) had higher values of thermal conductivity and diffusivity, dynamic and kinematic viscosity. Situation was different only in case of fluidity, which arises from definition of this rheologic parameter. In both temperature relations of thermal parameters was used linear increasing function, while the temperature dependencies of rheologic parameters were characterized by decreasing (respectively increasing) exponential functions which is in accordance with Arrhenius equation.
Analyse of food products physical properties can be used at determination, improvement and protection of food products quality.

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Conference report about PRAE 2011

The Slovak University of Agriculture in Nitra (Faculty of Engineering, Department of Physics) organized the PRAE (Physics – Research - Applications – Education) 2011 Conference in Nitra, 13-14 October, 2011. This was the seventh conference in Nitra concerning this topic.

The participants and conference speakers represented not only the local country, but came from Bulgaria, Czech Republic, Hungary, Poland, Serbia and even Indonesia, as well. The conference was organized perfectly, 2 days compact, but really interesting scientific program with good accommodation, excellent food, friendly atmosphere and useful excursions to the agricultural museum and biogas pilot plant in Nitra.

Let me mention some interesting topics of lectures:

mechanical and physical properties of soybean seeds

rheological properties of gummy confections

changes of physical properties of quince during osmotic drying

importance of food physics in processing of safe food

hybrid technology in solar energy utilization

application of agrophysics in modern agriculture

needle electrodes for measurement of DC and AC conductivity of potato

activities of engineering doctoral school at the Szent Istvan University, Gödöllő

The participants got the book of abstracts and later (in 2012) a big issue of Scientific Monograph, (part 1 and part 2) which was prepared with the following title: Applications of Physical Research in Engineering.

Many thanks for the very good organization of the conference to the staff of the Department of Physics, to Vlasta Vozarova, Zuzana Hlavacova, Monika Bozikova and other colleagues.

Andras S. Szabo

J. Food Physics, 2011/2012, Vol.24-25, pp.13.-19.

Electric properties utilization at quality of blueberry evaluation

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Abstract. Blueberries have become a product of interest in recent years due to their nutritional and health benefits. Electrical properties are important when processing foods involving electrical fields, electric current conduction, or heating through electromagnetic waves. These properties are also useful in the detection of processing conditions or quality of foods. Good correlations were obtained between dielectric properties measurements and human sensory analysis at the temperature 15 °C for the capacity range 640.98 nF to 1048.78 nF. The correlations, between human sensory and dielectric properties evaluation, show that in this range of capacity will be accepted as in the best quality by consumers.

Keywords:
blueberries, capacity, sensory analysis, quality,

INTRODUCTION

Interest in electrical properties of agricultural products for useful purposes dates back more than 80 years (Bauchot et al. 2000, Harker et al. 1994, Varlan et al. 1996). There are two main electrical properties in food engineering: electrical conductivity and electrical permittivity. These properties are also useful in the detection of processing conditions or quality of foods (Nelson, 1994). Other electric properties are: electric conductance, electric resistivity, impedance, admittance, relative permittivity, complex permittivity with the components – real part that is equal to permittivity and imaginary part characterizing dielectric losses in material, further we can mention dielectric loss angle, loss tangent, Maxwell relaxation constant (Hlaváčová, 2011).

Dielectric properties are primarily determined by their chemical composition (presence of mobile ions and permanent dipole moments associated with water and other molecules) and too much lesser extent, by their physical structure.

Nelson et al. (1994) measured the permittivity of twenty three kinds of fresh fruits and vegetables at 23 °C. A few samples of fresh fruits and vegetables were selected to study the variation of permittivity with temperature and frequency in the range from 10 MHz to 1.8 GHz. They included apple, orange, grape, banana, potato, cucumber, carrot, cantaloupe, and avocado, Dielectric properties of a commercial apple juice product were also measured over the 200 MHz to 20 GHz frequency range (Nelson, Bartley, 2002).

MATERIALS AND METHODS

Electrical properties

The measurements were done with 15 cultivars of *Vaccinium corymbosum* L. The samples were from Research Institute of Grassed Growth and the Mountain Agriculture in Krivá on Orava. Electrical capacity was measured by LCR Good Will

821 at frequency from 50 Hz to 200 kHz, which is connected to personal computer. The parallel plate capacitor which was used during the measurement is created by two parallel electrodes. The each sample (blueberries with the same dimensions) was pouring into the parallel plate capacitor and connected by electrodes on LCR meter. Samples with different temperatures were measured at the frequency (0.05 kHz, 0.1 kHz, 0.2 kHz, 0.5 kHz, 1 kHz, 3 kHz, 10 kHz, 50 kHz, 100 kHz, 200 kHz).

Sensory analyses

Each panellist (5) evaluated all fifteen samples with the fifteen cultivars serving as a complete block in the statistical design. They were given a questionnaire that included a rating scale for several sensory characteristics.

RESULTS AND DISCUSSION

New data were obtained on the dielectric properties of the blueberries in the frequency between 0.05 kHz and 200 kHz with using LCR meter. Correlations were studied between the dielectric properties and human sensory analysis as a quality factor of interest of blueberries.

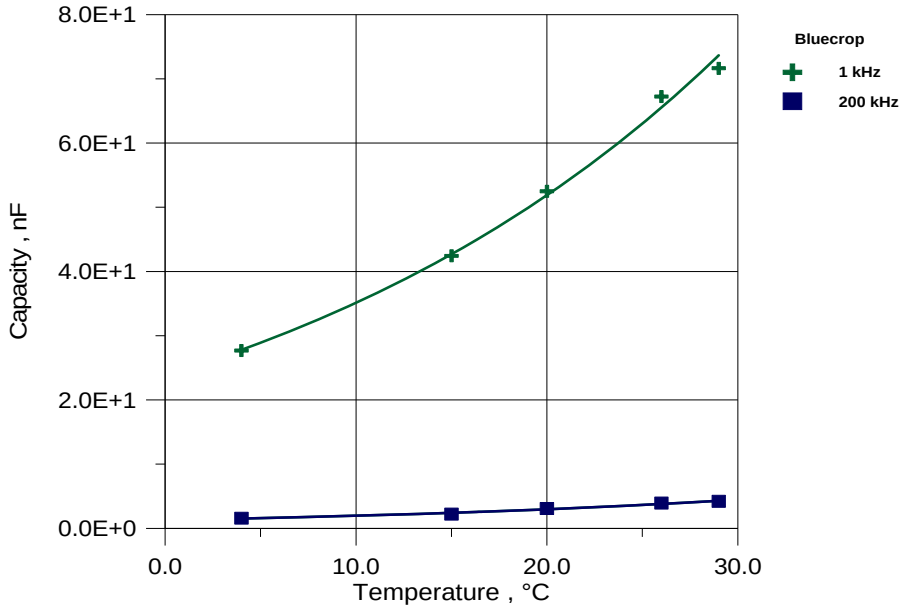

Figure 1
Shows temperature and frequency dependencies of capacity for cultivar Bluecrop at two frequencies

The temperature dependence of capacity, are shown at two frequencies, over the temperature range from 4 °C to 29 °C for cultivars Bluecrop (Fig. 1). The value of capacity had the increasing dependence with increasing temperature and decreasing dependence with increasing frequency. The highest values of capacity were obtained at the highest temperature

(29 °C), and the lowest values of capacity are at the lowest temperature (4 °C).

The follow Fig. 2 shows the frequency and temperature dependencies of capacity for cultivar Nelson. As we already mentioned, we can see that the capacity is increasing with increasing temperature and decreasing with decreasing frequency.

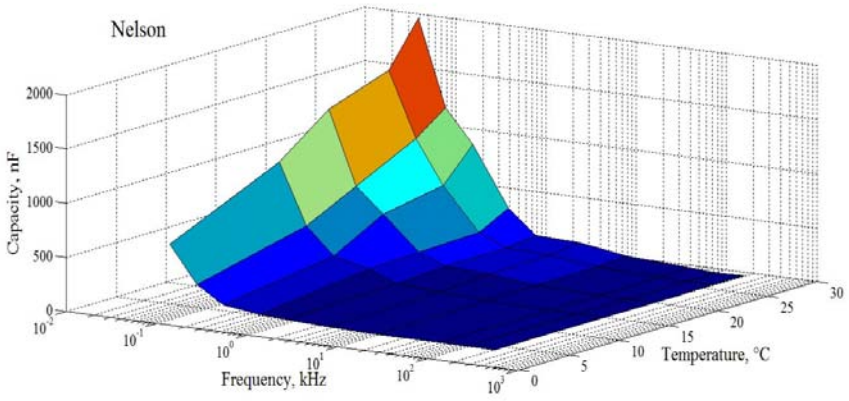

Figure 2
Frequency and temperature dependencies of capacity for cultivar Nelson

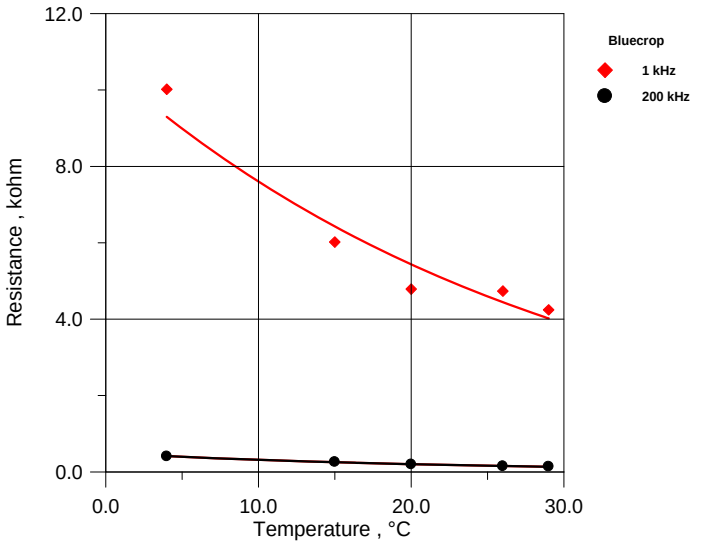

Figure 3
Temperature and frequency dependencies of resistance for cultivar Bluecrop at two frequencies

Resistance seems to decrease exponentialy with increasing temperature. Resistance values had decreasing tendency with increasing frequency. Resisatnce at 1 kHz is decreasing more rapidly like at frequency 200 kHz (Fig. 3).

In Fig. 4 we can see the differences between temperatures, frequency dependencies for cultivar Bluecrop at 1 kHz and 200 kHz for both years (2009, 2010). In comparison of both years we can see the similar capacity increase with increasing temperature and decrease with decreasing frequency. As we can see the differences are not very big. At frequency 200 kHz we can see that in 2009 the capacity values were a bit lower that in 2010. At 1 kHz it was quite similar. For capacity there are not visible differences.

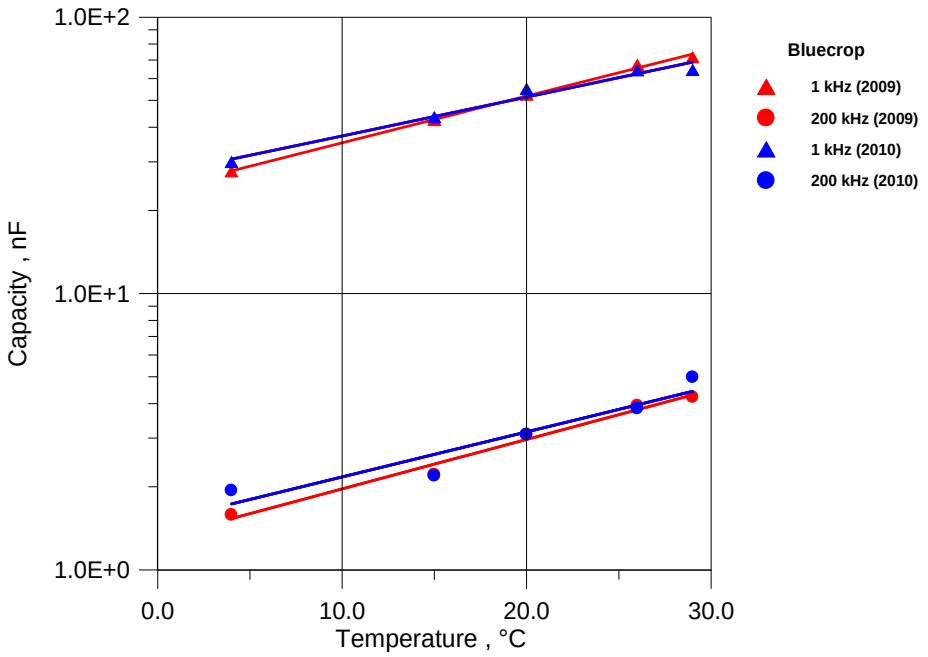

Figure 4
Temperature and frequency dependence of capacity for both years (2009, 2010)

The maximum score was 45 point for each evaluated descriptor and maximum score for all evaluated cultivar was 360 points. The panellists evaluated descriptor of appearances acceptability of blueberries cultivars using 9-point hedonic scale in follow order Tab. The best score (40) for descriptor of appearances acceptability had cultivar Duke. The descriptor of skin colour the highest score had cultivar Sierra (44). The descriptor skin toughness was evaluated with high score for 3 cultivars Pemberton, Polaris and Sierra, which had the same score 34. Cultivar Sunrise had the highest score for evaluated descriptor

flavour (36). For taste were scored high (27) cultivars Bluecrop and Nelson.

Table 1. Sensory panel scores of visual quality, textural quality and eating quality characteristics for blueberry fruit from 15 cultivars

Cultivar	Acceptability of appearance	Colour of skin	Skin toughness	Flavour	Taste	Fruit size	Size uniformity of berries	Texture quality during eating
Berkeley	**37**	**42**	**32**	**30**	**23**	**34**	**35**	**35**
Bluecrop	**40**	**42**	**32**	**33**	**27**	**38**	**36**	**39**
Bluejay	**35**	**40**	**28**	**25**	**20**	**36**	**34**	**34**
Blueray	**38**	**43**	**30**	**30**	**24**	**38**	**39**	**36**
Duke	**41**	**42**	**33**	**30**	**25**	**38**	**38**	**31**
Goldtraube 23	**32**	**41**	**32**	**27**	**21**	**29**	**33**	**31**
Chippewa	**35**	**32**	**31**	**25**	**22**	**37**	**36**	**36**
Nelson	**39**	**43**	**33**	**33**	**27**	**39**	**41**	**39**
Patriot	**36**	**42**	**33**	**30**	**22**	**40**	**37**	**34**
Pemberton	**39**	**43**	**34**	**31**	**24**	**37**	**39**	**35**
Polaris	**39**	**41**	**34**	**33**	**20**	**38**	**34**	**31**
Puru	**32**	**40**	**31**	**25**	**22**	**28**	**33**	**30**
Sierra	**35**	**44**	**34**	**30**	**25**	**39**	**40**	**32**
Spartan	**37**	**42**	**33**	**30**	**23**	**34**	**35**	**35**
Sunrise	**39**	**41**	**32**	**36**	**23**	**37**	**38**	**35**

CONCLUSION

We found out decreasing tendency of capacity in whole measured frequency range for each from 15 monitored cultivars of blueberries. We can notice that differences between the dependencies are occurred till frequency of 3 kHz (Fig.1). At the higher frequencies are the differences very small. The values of capacity are decreasing more rapidly at 4 °C. The values of the capacity lowest than ones for cultivar Puru are in this order (0.05 kHz, 200kHz): Goldtraube 23, Bluejay, Spartan, Polaris, Patriot, Duke, Blueray, Sierra, Sunrise, Bluecrop, Pemberton, Nelson, Chippewa, Berkeley at each temperatures. The decreasing order of resistance is from cultivar Berkeley to cultivar Puru, through this order: Chippewa, Nelson, Pemberton, Bluecrop, Sunrise, Sierra, Blueray, Duke, Patriot, Polaris, Spartan, Bluejay and Goldtraube 23 at each temperature.

Capacity is the good value for indication the correlation between human sensory analysis and physical properties. For all evaluated 15 blueberries cultivars, sensory scores for intensity and acceptability of visual quality characteristics (acceptability of appearance, colour of skin, fruit size, size and fruit uniformity) were acceptable (scores of 20 – 30) good (scores of 30 – 40) to excellent (scores > 40) (Tab. 1.) The intensity and acceptability of visual quality charac-

teristics were generally in the score of 30 – 40 in 2009, but with relatively low scores for some exceptions like cultivars Godltraube 23 and Puru for more of descriptors. Except the acceptability of appearance and colour of skin, in which more of cultivars were in the scores > 40, these descriptors showed the excellent quality.

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Conference report about ICFP 2012

With help of the International Society of Food Physicists (ISFP) the Department of Physics and Control (Faculty of Food Science, Corvinus University of Budapest)) organized the 10th International Conference on Food Physics, June 4-5, 2012, Budapest. The conference was organized in 4 oral sessions, plus one poster session and laboratory visits.

The participants and conference lecturers represented not only different hungarian universities in Budapest, Gödöllő, Debrecen, Mosonmagyaróvár and Szeged, but came from Bulgaria and Slovakia, as well.

Let us mention some interesting topics of lectures and posters:

heat mass transfer in food products

influence of fat content on the thermal properties

sensory evaluation and electronic tongue measurement

food physics – a helping hand for nutrition science

rheological properties of hydrogels

physical characteristics of whisky

amilograph properties of wheat flours

photoacoustic spectroscopy for quantification of cocoa content

The participants got the book of abstracts and some papers will be published in the 2013 issue of Journal of Food Physics, as well. A special thank to the local organizing committee members, to J. Felföldi, L. Baranyai and V. Zsom-Muha for their work, giving forum for discussions of currant ideas of food physics.

Eszter Vozary Andras S. Szabo

10th International Conference on Agrophysics
http://ica.ipan.lublin.pl/

It is a great pleasure for us to inform you that the Institute of Agrophysics Polish Academy of Sciences in Lublin organizes the 10th International Conference on Agrophysics which will be held in Lublin from 5th till 7th June 2013.
The scope of the Conference is focused on agrophysics as an interdisciplinary field of science dealing with the broad spectrum of research areas including, among others:

environmental science,
agronomy,
soil physics,
food science.

The conference is commonly organized by the Institute of Agrophysics PAS and Lublin Branch of Polish Academy of Sciences.
The conference language will be English.
The regular Conference fee is 200 EUR, but PhD students pay 100 EUR.
The deadline for registration is: 31st March 2013.
The deadline for abstract upload is: 31st March 2013
The deadline for fee payment is: 31st March 2013.
Abstracts of conference presentations will be published as a book of abstracts.
The fee includes:

Book of abstracts,
Social evening, dinners,
Excursion to the Old Town in Lublin,
Lunch breaks.

Conference fee does not include accommodation expenses. Conference participants will pay for the hotel themselves. Organizers will book the room in a hotel for participant after conference registration and fee payment.
Fee may be paid by bank money transfer to:
Bank:
BGK o/Lublin
Account No.:
PL 30 1130 1206 0028 9107 8920 0004
Swift/Bic Code:
GOSKPLPW
The conference will be held in the Institute of Agrophysics PAS (Doświadczalna Str. 4, Lublin) according to the **agenda**.

Programme of the ICA 2013 Conference

Wednesday 5th June 2013

08:30 – 09:30 Registration
09:45 – 10:00 Opening ceremony
10:00 – 11:00 Ceremony of unveiling of the commemorative plate dedicated to Prof. Ryszard Walczak
11:00 – 11:30 Coffee break
11:30 – 13:00 Plenary lectures
13:00 – 14:30 Lunch
14:30 – 16:30 Panel sessions
16:30 – 17:00 Coffee break
17:00 – 19:00 Panel sessions
19:00 Dinner

J. Food Physics, 2011/2012, Vol.24-25, pp.26.-27.

Thursday 6th June 2013

08:30 – 10:30 Panel sessions
10:30 – 11:00 Coffee break
11:00 – 13:00 Panel sessions
13:00 – 14:30 Lunch
14:30 – 19:00 Excursion to the Old Town in Lublin
19:00 Dinner

Friday 7th June 2013

08:30 – 10:30 Poster session
10:30 – 11:00 Coffee break
11:00 – 12:15 Poster session
12:15 – 13:00 Final discussion and conclusions
13:00 – 14:30 Lunch

Institute of Agrophysics
(PAS, Polish Academy of Science in Lublin)
Homepage: http://www.ipan.lublin.pl/en/about_us/index.html

The Institute of Agrophysics, Polish Academy of Sciences, was established in 1968 on the initiative of Professor Bohdan Dobrzański, member of the Polish Academy of Sciences, who was also its first Head (1968-1979). Originally with the rank of a basic research institution, in 1986 it was elevated to the full rank of an Institute in the PAS structure. In 1990 the Institute was named after its creator – Professor Bohdan Dobrzański. In 1989 the Institute was awarded the right to confer the degree of PhD, and in 1992 the degree of DSc in the field of agronomy-agrophysics. In 1998 the Institute became a legal entity and was entered in the Register of Institutes of the Polish Academy of Sciences.

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The Lublin region

The Lublin region is one of the most beautiful and ecologically clean areas in Europe. It is still undiscovered and full of valuable and unique spots. The scenery enchants with numerous forest complexes, fabulous ravines, lakes hidden in greenery and mysterious marshlands. Here, on nature paths, one can observe birds and rare species of plants.

The intellectual thought of Lublin has its roots in the past. The first higher educational institution, Studium Generale by the Dominican Priory, was established already in the 17th century. At the time when Jewish Community was flourishing in Lublin, a well known yeshiva was established. The first university in Lublin, the Catholic University of Lublin, was opened in 1918. Also other institutions, like, for example, the Talmudic "Yeshivat Chachmei Lublin" made Lublin an important academic center already in the interwar period.

J. Food Physics, 2011/2012, Vol.24-25, pp.26.-27.

Investigation of chio chips products

Part II.

Composition evaluation of investigated chio chips products

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Abstract. A lot of different measurements - sensory, analytical and other ones – were carried out for investigation of Chio chips products. In this part of the article information is given about the results of various analytical measurements (composition) of products. The following parameters were determined: dry material, carbohydrate, fat, protein, salt and fibre content. Based on the average chip consumption data in Hungary, and the measured composition results – in comparison with other food products – the conclusion is the following: moderate eating of high quality and energy reach Chio chips products does not have any unhealthy impact on the body of human consumers.

Keywords:
Chio chips,
analytical measurements,
dry material, carbohydrate, fat,
protein, salt and fibre content,
consumption data

INTRODUCTION

In the last few years practically all over the world a lot of rather unfair information has been given in the media – concerning the need of healthy nutrition, as well – about the consumption of chips products, proposing that these products are unhealthy. This opinion is based on different statements: e.g. too high energy and fat content and presence of toxic or unhealthy components (salt, acrylamide, glycidamide, trans fatty acids) in the chips products.

Based on the commission of Chio Hungary Ltd. numerous measurements were carried out at the Department of Food Chemistry and Nutrition of Corvinus University – in cooperation with other departments and research institutes - concerning the sensory, packaging, analytical and microbiological parameters and storability of different Chio products(1). In the first part(2) of the paper information was given about the comparative sensory evaluation of 2 Chio products (salted chips and flavoured with onion and sour cream ones). All samples were evaluated as products with very good sensory properties.

In this part we try to give objective information about composition (macro-components) measurements, but also about the healthy status of chips products, based on the measurements for the composition. Anyway, let us mention that the Chio Chips products are produced using high level of technology and excellent quality

regulation and control systems (ISF, HACCP) during processing(3). Before processing the raw materials of the chips products are appr. in the following ratios: potato: 70 %, vegetable (palm and sunflower) oil: 25 %, salt and spices and flavouring materials: 5 %

RESULTS

The measurements were carried out using usual analytical equipments, like drying oven, aching oven, polarimeter and methods, like Kjeldahl-method for protein, Soxhlet extraction method for fat, Mohr-method for salt, Wendee-method for fibre determinations.

Table 1 shows the results of measurements for 2 different products (chips flavoured with onion and sour cream and salted chips) with nominal filling quantity 90 g.

Table 1. Results of mesurements of chio chips products

parameter	unit of measurement	chips with onion and sour cream	salted chips
filling quantity	g	91.4	90.3
	SD	1.0	0.6
water	m/m %	1.70	1.83
	SD	0.05	0.006
ash	m/m %	3.08	3.22
	SD	0.08	0.09
salt	m/m %	2.29	2.42
	SD	0.07	0.06
fat	m/m %	33.72	33.45
	SD	0.17	0.22
protein	m/m %	6.05	5.96
	SD	0.09	0.08
carbohydrate	m/m %	49.27	50.54
	SD	0.32	0.29
fiber	m/m %	1.96	1.87
	SD	0.07	0.07

DISCUSSION

The statements, based on the data of table 1 are the following:

1. The filling quantity is appropriate, the low SD values prove the discipline of controlled technology
2. The water content (and the water activity) is very low, this is the fundament of good microbiological state and safe storability
3. The ash content is rather high, so there are a lot of essential elements in significant concentration
4. The salt content is similar to the one in bakery products, so chips products are

not typical products with high salt content

5. Although the fat content is high (appr. 1/3 ratio), but the fat is vegetable oil, which has no cholesterol, but the MUFA and PUFA content is high. This is a great advantage from point of view of healthy nutrition
6. The chips product contain of course mainly carbohydrates and fats, but the protein content is also not negligible. Consumption of 1 portion (90 g) would cover appr. 10 % of the protein requirement of human being per day
7. The carbohydrate content of the products is appr. 50 %, rather high. But the dominant part of carbohydrate is starch, which is favourable, because to eat starch (complex carbohydrate) and not sugar type carbohydrates is an important proposition of healthy nourishment regulation
8. The fibre content is also not negligible, and this fact seems to be necessary to mention, taking into account that significant part of hungarian population eats less fibre (animal products do not contain dietary fibre) than the real physiological need

CONCLUSION

We would like to mention that the average chips consumption in Hungary is only 0.4-0.5 kg/year/capita – based on the food consumption structure of hungarian population. So moderate eating of high quality and energy reach Chio chips products – with excellent sensory properties and appropriate composition – does not have any unhealthy impact on the body of consumers.

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Sensory evaluation of bread enriched in fibres and minerals designed to elderly

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Abstract. The effect of fibres and minerals on the quality of enriched bread was studied by means of consumer test for acceptance by elderly. Additionally rheological test was performed to determine the degree of elasticity of the enriched dough. The sensory and physical characteristics were established and evaluated.

Keywords:
flour, dough, bread, fibres, minerals, consumer test degree of elasticity

INTRODUCTION

The demographic estimations show that the population over 80 years of age will increase with 30 % over the next 50 years, due to the increase of life expectancy in context of continue technological development and improved medical-social conditions. The functional concept ”healthy aging” mentioned in the European documents and recommend-ations in the field concerns the prevention of specific pathology along with early detection, before the clinical manifestation, medical recovery and social re-orientation/re-insertion of the elderly. The factors that directly and decisively influence the achievement of these goals are: eating-style and food product quality, whose scientific documentation guarantees allow the building of a specific market as well as the elaboration of certain educational and specific political strategies. The main objective of these strategies is to improve the health status of elderly as group of population with proven bioactive deficiency. Basically, this is achieved by modifying the composition of foods to enrich them and consequently improve the situation by providing critical nutrients. Hence adopted new processing protocol of enriched bread to meet the needs of elderly consumers would be a step further in nutrients deficiencies prevention for over aged.

Proper nutrition is an important prerequisite for quality of life, health and welfare. During the life, each person develops their own way of eating, which includes diet, food choices and menu designs. Aging is accompanied by physiological changes, emotional, social and environmental unrecognizable.

Because of the high incidence of disorders in the elderly that interfere with

iron absorption efficiency as: post-atrophic gastritis, syndrome gastroectomic, some elderly people have iron available in small quantity. Blood loss associated with hiatal hernia, peptic ulcer, haemorrhoids and cancer non-steroidal as well as the use of anti-inflammatory drugs is common in older people. Zinc influences the health of tissues, especially the skin and is important in immunity. Zinc provides general protection against aging, functioning as an antioxidant (*Gariballa and Sinclair, 1998*).

Inulin is used increasingly for obtaining new foods as bakery products, milk, cereal snacks and beverages due to various reasons: it is a soluble fibre with health benefits as prebiotic, it has low caloric value, it can be used as a substitute for sugar or fat, it is appropriate because diabetics use low GI. Inulin promotes high absorption of minerals, especially calcium (*Kim and others, 2004*) and magnesium; the increase in bone mineral density, reduces the quantities of lymph lipids (e.g. cholesterol and triglycerides) favouring a good heart activity.

Being indigestible carbohydrate, inulin fits well with the current dietary fibre concept. By increasing faecal biomass and high water content removed, it can enhance the functionality intestines. In addition, inulin is classified as prebiotic; prebiotic effect was defined as the ability to selectively stimulate the development and activity of the gut bacterial species (*bifidobacteria* and *lactobacilli* in general) with health benefits (*Meyer and Wolf, 2008). Marteau and colleagues* (2011) demonstrated that supplementation with 15 g inulin improves constipation and quality of life in an elderly population with constipation.

Comparison between the sensory and rheological – texture – parameters have always been a part of the quality surveys for the breads (Jiang *and others*, 2005; Mahmoud Abu-Ghoush *and others*, 2008; Amita R. Shah *and others*, 2006; Lanqin Xia *and others*, 2008; Nyuk L Chin *and others*, 2005). These resources demonstrate similar compression test for different type of sliced breads.

The aim of this work was to develop cereal-based products (bread types and roll types) for elderly and test the acceptance and the texture parameters of the obtained products.

MATERIALS AND METHODS

Materials

Materials for obtaining bread rolls improved in soluble fibres (inulin from chicory) (Figure 1)

- Wheat flour (white flour: 13.8 % humidity, 26 % gluten content, 1.5 mm deformation index; 0.65 % d.w. ash content, brown flour: 14.0 % humidity, 24% gluten content, 1.5 mm deformation index; 1.25 % d.w. ash content, whole wheat flour: 15 % humidity, 23 % gluten content, 2.0 deformation index; 1.75 % d.w. ash content),
- Yoghurt (1.5 % fat content),
- Soluble fibre – inulin (product Fibruline Instant) was purchased from S.C. Enzymes and Derivates S.A. and added to flour in concentrations of 8 %,
- Compressed yeast "Pakmaya" from the market,
- Cooking salt,
- Margarine (commercially available),
- Gluten (1.5 % reporting to the wheat flour amount) and
- Vinegar was used to prepare three types of bread rolls samples.

Materials for obtaining bread enriched with iron and zinc (Figure 2)

- Wheat white flour with ash content 0.42%, moisture 13.8%, water absorption capacity 60.5% (up to 500 B.U. consistency to the dough),
- Lipids 0.07 % dry weight,
- Proteins 11.9 % dry weight,
- Cooking salt,
- Compressed yeast "Gist-Brocades",
- Drinking water,
- Sunflower oil,
- Crystal sugar and
- Na-stearoil-2-lactylat.
- Minerals: Chemically pure and toxicologically safe mineral salts with purity above 99.0% were used: FeSO4*7H2O and ZnCl2 in amounts corresponding to 10% enrichment level to compliment the daily intake (RDI).

Bread markers in that paper

A – white wheat flour enriched with inulin;
B – brown wheat flour enriched with inulin;
C – whole wheat flour enriched with inulin, and second day
D – white wheat flour enriched with $FeS0_4*7H_20$;
E – white wheat flour enriched with $ZnCl_2$ and
F – white wheat flour enriched with the combination of the two salts type

Methods

1. Obtaining the bread rolls improved in soluble fibres.

The bread rolls improved in soluble fibres were obtained using a direct manufacturing procedures follows: white wheat flour/ brown wheat flour/whole wheat flour 100 g, water $40.0x10^{-3}$ m^3; cooking salt 1.5 g, yeast 3.0 g, yogurt 10 g, margarine 1 g, vinegar $0,7 \times 10^{-3}$ m^3, inulin 8 g. Gluten 1.5 g was added to brown/whole wheat flour. The parameters of bread making procedure are shown in Table 1. The fibres were added into the dough during the kneading process. Dough rolls samples were weighed in grams of around 140 g so the finished products reached about 100 g each. Laboratory baking tests for obtaining the bread rolls enriched in inulin were done in the pilot plant of IBA Bucharest (Romania).

Figure 1
Bread rolls enriched in fibres (samples 1-A, 2-B and 3-C)

Figure 2
Bread loaves enriched in minerals (samples D, E and F)

2. Obtaining bread enriched in iron and zinc.

The protocol for dough preparation was as follows: flour 100 g; water 54.4×10^{-3} m^3; cooking salt 1.2 g; yeast 3.5 g; sunflower oil 0.4×10^{-3} m^3; crystal sugar 2 g; Na-stearoil-2-lactylat 0.2 g. The level of enrichment with mineral salts is shown in Table 2. The minerals were added into the dough during the kneading process. The parameters of bread making procedure are shown in Table 1. Crusty bread weight yield was 135 g in amounts designated to both of the samples in accord with recommended daily intake (RDI). Laboratory baking tests for obtaining the bread enriched in minerals were done according to modified method used in the Department of technology of cereals, forage, bread and confectionery products, University of Food Technology, Plovdiv (Bulgaria) (Table 1).

3. Sensory evaluation.

Consumer test for acceptance (Resurreccion, 1998; Peryam, DR and Pilgrim PJ., 1957) was performed at the Consumer & Sensory Analyses Lab in the Food Research and Development Institute (FRDI) in Plovdiv, Bulgaria. The enriched bread samples with minerals were baked one day before the test and in the test day were delivered to the sensory lab kitchen where the loaf of breads were sliced to 3 mm thickness, coded with three digit random numbers and presented in a balanced sequential monadic order.

The bread rolls enriched in fibres, obtained in the pilot plant of the institute in Romania, were tasted after 48 hours, due to

the transportation reasons from Romania to Bulgaria. They were packed in plastic bags and maintained in a cold and dry place. The three types of rolls were presented to the consumers in their round shape.

Consumers over age of 62 (n=15) were picked up among the ex-employees currently retired from the FRDI with no allergies towards bread, gluten, yeast, minerals, inulin and yogurt and must consume bread at least once a day. Overall 5 samples of enriched bread were evaluated in two consecutive days with two replications (first day – three types of bread with added fibres and second day – three types of bread with minerals). Consumers used 9-point hedonic scale (1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much, and 9 = like extremely), using pens and paper ballots to rate overall acceptance, appearance, odour, texture, flavour and aftertaste, and sweetness and acidity for the samples with fibres.

Table 1: Parameters of bread making procedure

Stages	Time, min	Temperature, °C
Bread rolls improved in soluble fibres		
Dough mixing	10-12 (two speeds)	34.5±0.5
Dough fermentation under controlled conditions	30.0	30.0±0.5
Dough forming in small portions around 140 g	3.0	30.0±0.5
Proofing	50.0	30.0±0.5
Baking	20.0	230
Bread enriched with iron and zinc.		
Dough mixing	6.0 (two speeds)	40.6±0.5
Dough fermentation under controlled conditions	30.0	33.0±0.5
Dough forming in small portions around 150g	3.0	-
Proofing	40.0	37.5±0.5
Baking	20	230

Table 2: Levels of enrichment with minerals

Minerals, salts	RDI, g	E, g/100 g flour
$FeSO_4*7H_2O$	0.012	0.006
$ZnCl_2$	0.010	0.004

E – Level of enrichment corresponding to 10% enrichment level to compliment the daily intake (RDI) (the quantities of salts are calculated in compliance with the real content as ion)

4. Volume test.

The volume of the bread loaves was compared based on photos of half breads.

5. Texture test.

To compare the texture of the breads quasi non-destructive hysteresis tests were performed with Stable Micro Systems TAXT2 instrument equipped by a cylinder (d=25 mm), in uniaxial compression mode up to 35 % strain of the 10 mm slices with slow deformation speed (0.1 mm*s^{-1}).
The degree of elasticity was calculated based on the curves:

$$Degree\ of\ elasticity = \frac{\int_{F_{max}}^{0N} F(D)\cdot d(D)}{\int_{D=0}^{F_{max}} F(D)\cdot d(D)} \qquad (1)$$

6. Physico-chemical analysis of bread rolls enriched in fibres.

The obtained bread rolls enriched in fibres were analysed for their physico-chemical characteristics (in accordance with Romanian standard STAS 91: 2007 for baked products analyses): humidity (%), acidity (grades), lipids (% d.w.), protein content (% d.w.), ash content (% d.w.), data shown in Table. 4.

7. Statistics.

The data were statistically analysed using STATISTICA software (STATISTICA 7, 2005) to determine the means, standard deviation and significant differences between bread samples for each given attribute. T-test was performed to determine which sample means were significantly different (α=0.05).

RESULTS AND DISCUSSION

1. Consumer acceptance test (Table 3).

The mean consumer ratings for appearance, odour, mouthfeel/texture, flavour/taste and aftertaste for all the bread samples, and sweetness and acidity for samples enriched with fibres along with significant differences of the hedonic ratings for the sensory attributes of the bread samples are presented in Table 3. Bread enriched with mineral salts had the highest mean ratings for all attributes evaluated in the consumer acceptance test.

Overall acceptance.

All the mean ratings for overall acceptance were above 6.0 (like slightly), indicating that all of the bread samples were liked by the consumers. Samples D, E and F rated highest in overall acceptance compared to all other samples. Its mean rating was 8.1, 7.8 and 7.8 compared to samples A, B and C which had ratings of 7.5, 6.8 and 6.7, respectively (Figure 3).

Appearance.

The bread sample D (x=8.2) was significantly highest in appearance compared to all other samples while sample C rated significantly lower (x=7.1). Samples A, B, E and F had mean ratings of 7.9, 7.4, 7.8 and 7.9, respectively, were liked moderately. There were no significant differences among the samples A, E and sample B and F was rated significantly lower.

Odour.

The ratings for odour for all the bread samples were similar but sample D was significantly higher (x=7.6) Samples A, B,

E and F had mean ratings of 7.3, 7.1, 7.1 and 7.4 respectively, and were liked moderately and sample C was liked slightly (x=6.7). There were no significant differences among the A, B, C, E and F.

Table 3: Means of hedonic ratings of sensory attributes of bread enriched with fibres and minerals

Samples	Appearance	Odour	Mouthfeel/ texture	Flavour/ Taste
A	$7.9^{a}\pm0.74$	$7.3^{a}\pm0.42$	$7.6^{a}\pm0.70$	$7.3^{a}\pm0.82$
B	$7.4^{ab}\pm0.52$	$7.1^{a}\pm1.29$	$7.0^{a}\pm1.15$	$6.5^{a}\pm0.71$
C	$7.1^{b}\pm1.29$	$6.7^{a}\pm1.06$	$7.0^{a}\pm0.33$	$6.6^{a}\pm1.26$
D	$8.2^{ac}\pm0.42$	$7.6^{ab}\pm1.35$	$8.0^{ab}\pm0.67$	$8.1^{b}\pm0.74$
E	$7.8^{a}\pm0.42$	$7.1^{a}\pm1.20$	$7.6^{a}\pm0.70$	$7.4^{a}\pm0.97$
F	$7.9^{a}\pm0.70$	$7.4^{a}\pm0.42$	$7.7^{a}\pm0.70$	$7.5^{a}\pm0.82$

Samples	Aftertaste	Sweetness	Acidity
A	$7.5^{a}\pm0.71$	$7.3^{a}\pm0.67$	$6.5^{b}\pm1.18$
B	$5.7^{c}\pm1.21$	$6.5^{ab}\pm0.43$	$6.0^{b}\pm0.56$
C	$5.8^{c}\pm1.10$	$6.2^{b}\pm0.75$	$6.1^{b}\pm0.60$
D	$7.9^{ab}\pm0.57$	n.a.	n.a.
E	$7.4^{a}\pm1.35$	n.a.	n.a.
F	$7.6^{a}\pm0.71$	n.a.	n.a.

Means in the same column not followed by the same letter are significantly different at p=0.05 as determined by t-paired means test

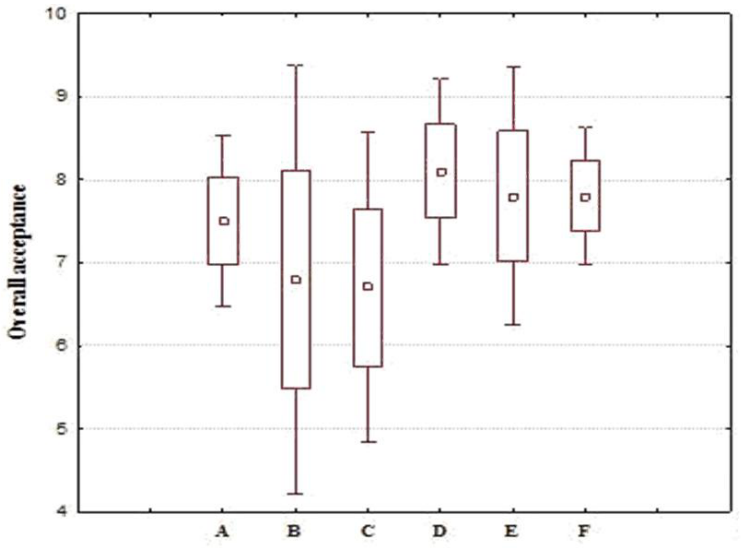

Figure 3
Overall acceptance of breads enriched with fibres and minerals

Mouthfeel/Texture.

All the mean ratings for mouthfeel/texture were rated above 7.0 (like moderately), indicating that all of the bread samples were liked by the consumers. The mouthfeel/texture of the sample D with mean rating of 8.0 was significantly different from the rest of the samples. Samples A, B, C, E and F which had mean ratings of 7.6, 7.0, 7.0, 7.6 and 7.7, respectively, showed no significant difference from one another.

Flavour/Taste.

The flavour of all the bread samples were rated above 6.0 (like slightly), except for samples A, E and F which were rated higher (x=7.3, x=7.4 and x=7.5) (like moderately). Sample D was liked very much (x=8.1) and had a rating significantly higher than the rest of the samples.

Aftertaste.

The aftertaste of all the bread samples were rated above 7.0 (like moderately), except for the samples B and C, which were rated 5.7 and 5.8, respectively (neither liked nor disliked). The Sample D (x=7.9) was significantly higher than the samples A, E and F which had ratings of 7.5, 7.4 and 7.6, respectively.

Sweetness.

The sample A (x=7.3) was significantly highest in sweetness compared to all other samples enriched with fibres. The samples B and C were liked slightly (x=6.5 and 6.2) with no significant differences between them.

Acidity.

All the mean ratings for acidity were rated above 6.0 (like slightly), indicating that all of the bread samples were liked by the consumers. The acidity ratings for all the bread samples enriched with fibres were similar with mean ratings of 6.5, 6.0 and 6.1 and rated not significantly.

2. Volume test.

Based on the comparison between the photos the bread enriched with the mixture of minerals had the biggest volume and the smallest one was for the Zn^{2+} enriched bread. The Fe^{2+} gave a loose structure of the bread which is visible from the bigger porosity of the product. The product enriched with zinc showed a compact structure. The mixture of these minerals gave bread, with moderate structure, and high volume. (Figure 4)

3. Texture tests.

The highest degree of elasticity was shown by the bread enriched with mixture of minerals but with no significant differences with the zinc enriched bread. Iron enriched bread was significantly different by degree of elasticity (Figure 5.).

4. Physico-chemical parameters.

The physico-chemical indices of the bread rolls enriched in fibres shows (Table 4) that the samples had similar humidity but some differences in acidity, lipids, protein and ash content due to the differences in the quality of the flour used for their preparation.

Figure 4
Volume of the loaves of breads enriched with minerals

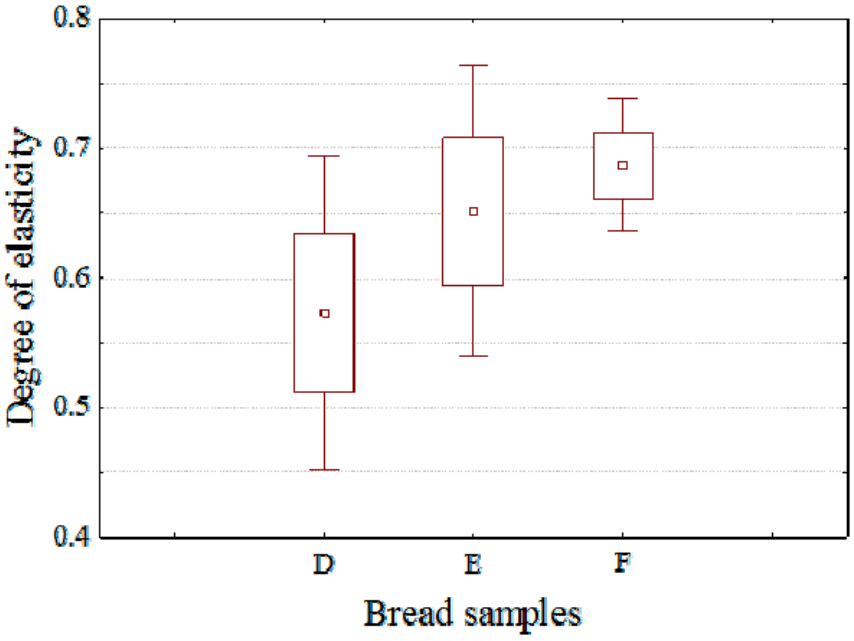

Figure 5
Degree of elasticity of the bread slices enriched with minerals

Table 4: Physico-chemical characteristics of the obtained bread rolls enriched in fibres

Samples	A (White bread rolls)	B (Brown bread rolls)	C (Whole meal bread rolls)
Humidity, %	45.89	42.36	42.21
Acidity, grades	1.00	1.20	1.60
Lipids, % d.w.	0.79	0.86	1.05
Proteins, % d.w.	12.15	14.32	16.81
Ash, % d.w.	1.20	1.52	1.71

CONCLUSIONS

The evaluators appreciated more the samples of bread from white flour enriched in minerals and less the samples in the form of rolls. This can be explained by the fact that samples of bread were sliced and presented to the panellists in slices, while rolls of 100 g were presented as such and evaluators had to break them. analyse them for the outside aspect and then for the inside aspect, also, the rolls had 48 hours from the baking time and the bread with minerals only 24 hours from the baking time.

However, from the three types of rolls, the most appreciated was the sample of rolls from white wheat flour with added inulin, than the rolls from brown wheat flour and the last preferred sample was the roll from whole wheat with added inulin. This demonstrates once again that consumers are more familiar with white flour products and less familiar with whole wheat products.

The consumer panel rated white wheat bread enriched with Fe^{2+} as the best product. White wheat bread treatment enriched with combination of minerals rated second followed closely by Zn^{2+} bread and white wheat bread sample enriched with inulin.

Main differences were observed in appearance and aftertaste for whole wheat bread treatment enriched with inulin and brown wheat bread enriched with inulin.

Whole wheat bread enriched with inulin was the least preferred sample.

Based on the volume and texture experiments the iron loosened the structure of the bread and the zinc strengthened it (made it more compact).

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The traditional activity of the Szegedi Paprika Spice and Canned Food Producing Co. is the production and distribution of spice paprika grounds. We strive to reach and to maintain the satisfaction and trust of our customers besides the steady good quality of the spice paprika ground by a wide variety of canned food and ready-made dishes, furthermore by serving the demand for healthy nutrition. Pastes are not only delicious, but those are healthy too. Those are excellent sources of calcium for everyone.

The uniqueness of our products is given by their special tastes as well as their modern and practical packing. Those rise above the conventional pastes with their high values of the contained ingredients. Our goose and duck liver products are premium preparations. These products with their superb tastes are getting more and more popular and known in nowadays culinary culture.

We guarantee the steady quality of our products already marketed and acknowledged by our customers by the food safety management systems ISO 22 000:2005 and by the HACCP system.

Our goal is to create such eating alternatives by continuous marketing and development engineering, which assure the satisfaction of diverse diets. During our developments we introduce new products corresponding to the customers' requirements and so we continuously increase both the customer satisfaction and the sales volume.

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Content of lycopene and visible reflectance in case of conventional and elevated lycopene tomato cultivars.

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Keywords:
tomato, lycopene, (all-E)-(9Z)-(13Z)-lycopene isomers, irrigation

Abstract. This study examined the feasibility of using non destructive, spectrophotometrical method to predict one of the most valuable internal quality indices, lycopene in individual tomato fruits. An open field experiment was conducted to study the effect of irrigation and potassium supplement on the yield and lycopene content of processing tomato fruit. Three different treatments (regularly irrigated *RI*, irrigation cut-off 30 days before harvest *CO*, and rainfed *RF* unirrigated control) and two different K fertilisations (P) were applied. Regular irrigation significantly decreased the lycopene content of tomato fruits. The *CO* treatment resulted in the highest total lycopene without additional potassium supplement. Potassium supplement given at the time before fruit maturity significantly increased the lycopene concentration of cultivar Brigade, independently of irrigation. The closest correlation was at 700nm R^2=0.39 and R^2=0.50, between reflectance and the (all-E)-lycopene and the (9Z)+(13Z)-lycopene isomers respectively.

INTRODUCTION

Tomato fruit is an important dietary source of antioxidants, like ascorbic acid, β-carotene, lycopene and polyphenols (Helyes et al., 2007). Ecological conditions have great effect on carotenoid and antioxidants of tomato (Abushita et al., 2000). Colour is one of the most important quality components of tomato fruits. Amount of predominant carotenoid lycopene, which causes the red coloration of fruits, is well characterized by surface reflectance. Lycopene is accumulated mainly in deep red stage and colour is an indicator of lycopene level (Brandt et al., 2006; Helyes et al., 2006c).

Synthesis of lycopene is easily detectable by nondestructive method of colour measuring of fruit surface (Helyes et al., 2006b), also affected by varietal and ecological factors (Dumas et al., 2003; Tomlekova et al., 2007). Chlorophyll breaks down and carotenoids, mostly lycopene, accumulate during ripening (Biacs and Daood, 2006).

Lycopene occurs in various geometrical isomers. In most raw fruits, the (all-E)-isomer is quantitatively the most important, and within the relatively small proportion of (Z)-isomers, (5Z)-, (9Z)- and (13Z)-lycopene are usually predominant (Schierle et al., 1997). The present work eludicated the isomeric ratio of fresh tomato fruits, additionally the (all-E)/(9Z),(13Z)-isomer ratio influenced by technological traits.

MATERIALS AND METHODS

Samples

Open field experiment was carried out in the test sites of Szent István University, Gödöllő in 2008 and 2009. A determined conventional tomato variety Brigade F_1 and high lycopene cultivars, Triple Red F_1, and UG Red F_1 were investigated in the present study. The experimental field, which was 300 m^2, is brown forest soil, with mechanical composition are sand, sandy-clay and the subsoil water is below 5 m, therefore it cannot influence the water turnover.

Area of the experiment was 300 m^2 and the area of one plot was 25 m^2. Seeds were sown on the 7th of April 2008 and 2nd of April 2009 in greenhouse and transplanted on the 12th of May 2008 and on the 14th of May 2009 respectively. Tomato seedlings were planted out in twin rows, 0.4 m spacing inside the raw and 1.2 m between adjacent twin rows, the space between the plants in the row was 0.4 m. There were regularly irrigated (RI), irrigation cutoff (CO) plant stands and the rainfed (RF) control and two different K fertilisations (P). Drip irrigated water was given out according to potential evapotranspiration. National Meteorological Institute forecasts were used to calculate with the probable evapotranspiration.

Basic nutrition supply was given out when plants were transplanted with Agroblen 18-8-16 (nitrogene-phosphorus-potassium). Additionally more potassium fertiliser was applied with KNO_3 at fruit set, resulting a different potassium supply of 555 (+ K) kg ha^{-1}. Five harvested fruits in three replicates were chosen for preliminary spectrophotometric analysis. The spectrophotometric measurements were carried out using a Minolta spectrophotometer. Minolta chroma meter CM-512m3 is a multi-angle spectrophotometer, which uses geometry with D65/10˚ in both years.

Lycopene analysis in 2009

Lycopene contents were established from five fruits in three replicates of which lycopene content of fruits were analysed in the National Institute for Food and Nutrition Science in 2008. Lycopene was extracted from the tomato juice with a mixture of n-hexane, methanol and acetone (2:1:1) containing BHT. Optical density of the hexane extract was measured at 502 nm by a Perkin Elmer Lambda 3B UV Spectrophotometer (Perkin Elmer Co., Norwalk, USA) (Sadler et al., 1990). Lycopene concentrations were calculated by applying the molecular extinction coefficient of 158500 (Merck and Co., 1989). All parameters measured are referred to fresh weight of fruits. Lycopene contents were established from five fruits in three replicates of which lycopene content of fruits were analysed in the Central Food Research Institute in 2009. Five grams of fresh fruits were weighed and crushed in a crucible mortar in presence of quartz sand with gradual addition of 20 ml of methanol and then was let stand for 5 minutes. The supernatant was decanted carefully into a 100ml Erlenmeyer flask. The residues were further crushed and 50 ml of a 20:60 methanol-1,2-dichloroethan were gradually added. The whole mixture was quantitatively transferred to the Erlenmeyer flask by rinsing twice with 10 ml of the mixture of methanol-1,2-dichloromethan. After gentle hand shaking few drops of double-distilled water were added to enhance separation of polar (aqueous) and less-polar (solvent) phases. The solvent layer was separated in a separating funnel and dried over anhydrous Na_2SO_4.and then evaporated under vacuum at not higher than 40°C. The residues were re-dissolved in 5 ml of HPLC grade acetone and filtered

through a Teflon PETF 0,45µm syringe filter before injection onto HPLC column.

HPLC instrument and conditions

Instrument: A Waters HPLC chromatograph consisting of a model 2695 separation module and 2696 photodiode-array detector was used for the analysis of carotenoids. The operation and data processing was performed by Empower software.

Column: Nucleodur ISIS C18, 3 µm, 150x4.6 mm was used

Mobile phase: The following gradient elution was applied:

		Solvents	
Time	Flow	%water	%acetone
0,01	0,7	20	80
3	0,7	20	80
8	0,7	12	88
12	0,7	12	88
20	0,7	5	95
25	0,7	5	95
28	0,7	20	80
30	0,7	20	80

Detection: Photodiode-array between 190 and 700 nm. For quantification, chromatogram was integrated at maximum wavelength for each peak using manual integration.

Calibration: Stock solutions for lycopene were prepared by dissolving 1 mg of standard materials (Sigma, St. Lo. USA) in 10 ml of petroleum ether using brown-coloured volumetric flask. Working solutions between 0 and100µg/ml were then prepared by dilution with HPLC acetone and injected onto the HPLC system. The recorded peak areas of standard solutions was Plotted versus concentrations to get the calibration curve using Microsoft xls 2007 program.

Identification: The peaks were identified by comparing their spectral characteristics and retention times with those of standard materials and with literature data when available (Bauernfeind, 1981).

Statistical analysis

The results were expressed as the average plus/minus significant differences at P=0.05. The statistical analysis was carried out by the t-student test, and the statistical analysis was made using the Statistica 9 software.

RESULTS AND DISCUSSION

CIELab colour parameters are the most commonly used parameters to indicate the development of red coloration of ripening tomato fruit. We established correlation coefficients of linear regression among a*, a*/b*, chroma and hue and fruit surface reflectance between 400-700 nm in 2008. The closest correlation between chroma and reflectance was at 630 nm (r^2=0.967; data not shown), so we used this frequency parameter to evaluate fruit surface colour. Table 1 shows the average lycopene content and surface reflectance at 630 nm of three hybrids tomato fruits. Regular irrigation significantly decreased the lycopene content of tomato fruits. Lycopene content is fundamentally determined by the genetic factors, but our results show contradictions. High lycopene hybrids (Triple Red F_1) with irrigation and (Ug Red F_1) without irrigation did not exceed lycopene content of normal lycopene hybrid (Brigade F_1). Reflectance data showed the same pattern, so we calculated linear regression between lycopene content and reflectance.

Table 1. Average lycopene content and reflectance at 630 nm of tomato fruits in 2008. (n=3; ±SD).

	Lycopene content (mg 100g^{-1})		Reflectance at 630 nm (%)	
Variety	RF	RI	RF	RI
Brigade F_1	17.5±0.5^{a}	15.5±2.4^{ab}	28.5±1.6^{ab}	27.3±1.8^{a}
Triple Red F_1	22.5±1.8^{b}	15.0±0.7^{a}	29.6±0.8^{a}	27.7±1.6^{ab}
Ug Red F_1	14.9±1.7^{a}	19.2±1.9^{b}	25.0±1.9^{b}	29.8±1.3^{b}

Data in the same column bearing the same superscript letter are not significant at P=0.05

Correlations are presented in Figure 1. The more lycopene content of fruits there was the higher reflectance values were reached at 630 nm. High lycopene hybrids resulted in more lycopene in tomato fruits. Triple Red F_1 reached the highest lycopene content (24.3 mg 100g^{-1}), but not the highest reflectance (UG Red, 31.1%).

In 2009 we used the same three cultivars in the experiments, as in the previous years, supplementing the measurements with the determination of (all-E)-lycopene and (9Z)+(13Z)-lycopene isomer concentrations. The results are shown in Table 2.

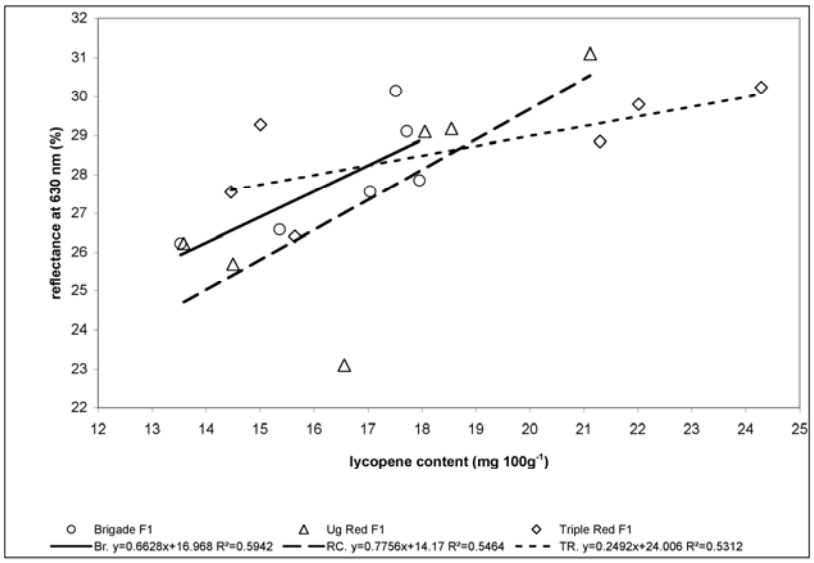

Figure 1.
Correlation between lycopene content and reflectance at 630 nm of tomato fruits, with function and correlation coefficient of linear regressions (n=6).

Table 2. Average carotenoid component of different types of tomatoes with different irrigation and potassium fertilization regime in 2009 (n=3).

	(all-E)-lycopene (mg 100g^{-1})	(9Z)+(13Z)-lycopene (mg 100g^{-1})	(all-E)+(9Z)+(13Z) lycopene (mg 100g^{-1})	(all-E)-lycopene (%)	(9Z)+(13Z) -lycopene (%)
Brigade RF	7.42±0.13^{d}	1.70±0.12^{d}	9.12±0.16^{d}	81.4%	18.6%
Brigade RF P	8.47±0.10^{e}	1.82±0.11^{de}	10.29±0.12^{e}	82.3%	17.7%
Brigade RI	4.04±0.10^{a}	0.71±0.11^{a}	4.75±0.01^{a}	85.0%	15.0%
Brigade RI P	5.74±0.25^{c}	1.15±0.11^{c}	6.89±0.21^{c}	83.3%	16.7%
Brigade CO	8.11±0.41^{e}	1.93±0.15^{e}	10.05±0.47^{e}	80.7%	19.3%
Triple Red RF	4.28±0.01^{b}	0.97±0.11^{b}	5.25±0.10^{b}	81.6%	18.4%
Triple Red RI	5.78±0.11^{c}	1.07±0.06^{bc}	6.84±0.08^{c}	84.4%	15.6%
UG Red RF	4.34±0.08^{b}	1.13±0.13^{bc}	5.47±0.21^{b}	79.5%	20.5%
UG Red RI	4.14±0.27^{ab}	0.94±0.08^{b}	5.09±0.35^{ab}	81.5%	18.5%

Data in the same column bearing the same superscript letter are not significant at P=0.05

In year 2009 the cultivars contained less lycopene at harvest than in 2008. This can be explained by the difference in weather conditions. In 2009 the temperature was higher on average and there was less precipitation at fruit maturity than in 2008 (data not shown). Among the cultivars Triple Red produced significantly higher total lycopene content than Brigade and UG Red.

The irrigation generally decreased the total lycopene content of fruits, except in cultivar Triple Red, where it caused significantly higher lycopene concentration. The CO treatment resulted in the highest total lycopene without additional potassium supplement. Potassium supplement given at the time before fruit maturity significantly increased the lycopene concentration of cultivar Brigade, independently of irrigation. The greatest effect of irrigation on lycopene could be measured in cultivar Brigade, where it reduced the concentration almost by 50%.

The major part of lycopene content is constituted by (all-E)-lycopene, changed between 79.5 and 85%, while the ratio of (9Z)+(13Z)-lycopene isomers ranged between 15.6 és 20.5%. Irrigation reduced (all-E)-lycopene, in cultivars Brigade and UG Red, while in the case of cultivar Triple Red the opposite effect could be measured. Irrigation only caused a significant reduction of (9Z)+(13Z)-lycopene isomers in the case of cultivar Brigade. Potassium increased all lycopene isomers, under unirrigated conditions it increased (all-E)-lycopene to the greatest extent, while under irrigated conditions (9Z)+(13Z)-lycopene.

In 2009 we also performed the correlation analysis between the spectral reflectance of fruits and their lycopene content. In the analysis we did not include the RF treatments of high lycopene hybrids. The results are shown on Fig 2. The measured reflectance values (400-700nm) showed a positive

correlation at 630-700nm with the lycopene components, among which the closest was at 700nm R^2=0.39 and R^2=0.50, thus the (all-E)-lycopene and the (9Z)+(13Z)-lycopene isomers respectively.

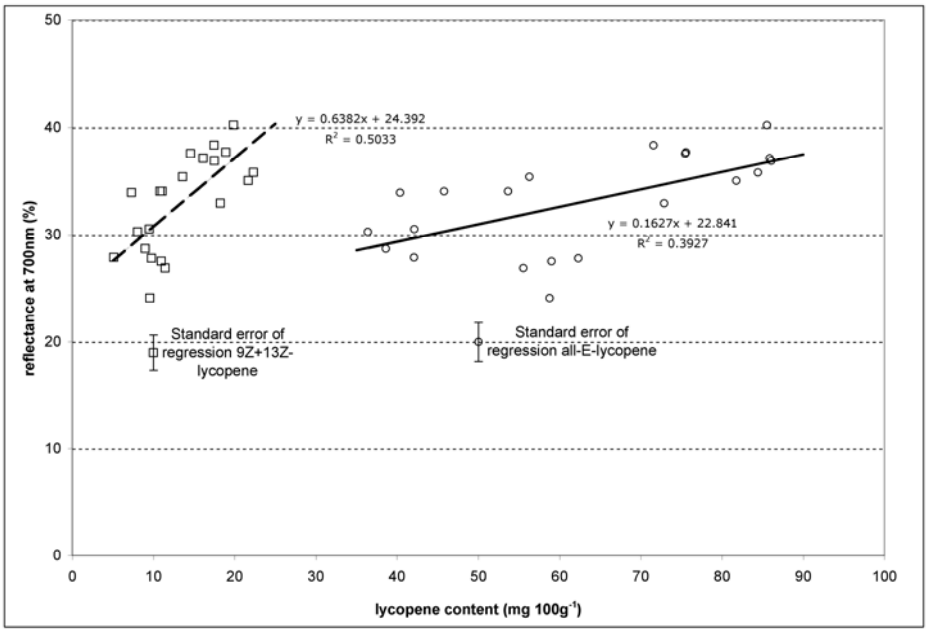

Figure 2.
Correlation between (all-E)-lycopene and (9Z)+(13Z)-lycopene content and reflectance at 700 nm of tomato fruits, with function and correlation coefficient of linear regressions in 2009 (n=21).

Conclusion

We managed to prove the quantitative and qualitative changes in lycopene content of raw tomato fruit samples as a result of irrigation and potassium supplement treatments. In the two consecutive years the lycopene content of fruits differed in all three examined cultivars, which was possibly a result of the difference in weather conditions. The lycopene content of high lycopene hybrids was higher under irrigated conditions, than that of the traditional cultivars. We have shown that irrigation cutoff which is an old technological trait used to speed up the rate of maturation, how effectively increases the lycopene content of raw fruits. In the case of (9Z)+(13Z)-lycopene isomers more beneficial to human health, a significant increase was caused by irrigation in high lycopene hybrids, compared to traditional cultivars.

Reflectance values measured in the visible range gave closer positive correlation with lycopene content above the 600nm range in both years. Based on the results of 2009 it can be concluded that the reflectance of lycopene isomers is possibly different. Besides this the correlations are

not so close, so that the lycopene content of fruits could not be determined more accurately by the reflectance of fruit surface. Further spectrophotometrical experiments are required, to fine-tune a nondestructive method of lycopene isomer determination.

Acknowledgements

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Dielectric impedance monitoring of heat pump drying of apple slices

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Abstract. Heat pumps have been known to be energy efficient when used in conjunction with drying operations. The principal advantages of heat pump dryers (HPD) emerged from the ability of heat pumps to recover energy from the exhaust as well as their ability to control the drying gas temperature and humidity. It is a low temperature (40-45°C) drying system, which can preserve the nutrition parameters of the raw material, but can produce a dried product, with high level of microbiological and shelf-life stability and safety. The apple slices were dried for five hours, till equilibrium dry content. The received product has low moisture (about 85 % dry base) which is good for longer shelf-life. Dielectric parameters (between 20Hz and 10MHz), volume and weight of the dried apple slices were investigated in every hour. The aim of the experiment series was to see, if the method of dielectric spectroscopy is useful to follow the drying process. To analyse the data in function of drying time non-linear (sigmoid) regression was used and linear correlation matrix was created between the measured parameters. The highest correlations are marked in the tables.

Keywords:
impedance parameters,
non-linear regression,
drying trends,
correlation matrix,
gentle drying,

INTRODUCTION

A tendency in the food industry is the attempt for reducing the cost of water and energy to the development of processes that use significantly less of these resources and generate smaller amount of waste (Lee and Okos, 2011). The application of heat pump technology allows the production of high quality products based on better heat and energy efficiency, without damage to the environment, reduce the production cost and power consumption (Pereira and Vicente, 2010). With appropriate choice of temperature-time variation, it is possible to reduce the overall colour change while maintaining high drying rates (Chua and others 2000a, b). The endpoint of the drying is the "equilibrium moisture content". The moisture content remaining in a dry material, when the drying rate drops to zero at specified conditions of the drying medium is called the equilibrium moisture content. It is in equilibrium with the vapour contained in the drying gas and its magnitude is a function of the structure and type of the subject food and of the prevailing drying conditions. The equilibrium moisture values predicted by static and dynamic moisture sorption do not always agree over the whole range of relative humidity of the drying air. The drying of the fruits requires energy for removing of free water (evaporation or

sublimation) and for removing of water associated with the food matrix (bound water).

Dielectric spectroscopy in a wide range of frequencies has been used earlier for monitoring the changing of the electric impedance of fruits and vegetables during drying (Zsivanovits, G. and E. Vozáry, 2011) and during long or short time controlled storage of apples and other fruits. The correlations between dielectric parameters and quality of melons were also analyzed by Wen-chuan Guo and others (2007). They reported relationships between fruit ingredients and dielectric parameters in high frequency range (from 10 MHz to 1.8 GHz). However, the prediction of soluble solid content by the dielectric properties was not as high as expected. Measurement of dielectric properties of agricultural material is essential for understanding their electrical behaviour (Nelson, 2008) level of mechanical damage (Al-Mahasneh and others, 2007) and also for the development of indirect nondestructive methods for determining their physical characteristics, including moisture content and bulk density. Venkatesh and others, (2004) found that corn samples chopped to different degrees showed a difference in dielectric response at similar bulk densities and moisture contents which indicated that some of the response was due to the chopping or size reduction. The dielectric properties of a food depend upon its composition. It is beneficial to conduct dielectric properties measurements for each product that is to undergo a dielectric heating process. Dielectric properties are with primary importance to evaluate the suitability and efficiency of heat pump drying of the products.

MATERIALS AND METHODS

Materials

Apples were washed with running water, peeled and cut into sticks 7*7*30 mm. The sticks were washed again and strained off.

Methods

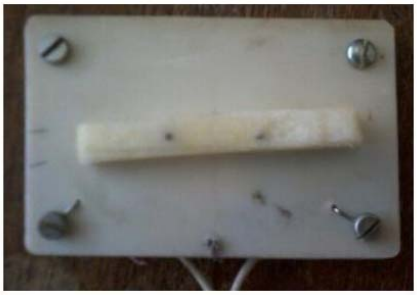
Drying was applied by highly energy-efficient and environmental protective heat pump drying (HPD). The applied drier was developed by FRDI – Plovdiv (Figure 1). The process was carried out at 45 ± 2°C and low relative humidity (average 10%) of the circulating air. The mass of apple sticks was measured during drying at every half an hour. The drying was finished when the mass was not changed already. The actual dry content was calculated based on the mass changes and original dry content of raw material, which was measured from samples at the beginning of the drying by standard methods.

Dielectric parameters of apple sticks (20 samples) were investigated in every hour. The stick samples were measured for volume changes by calliper, photographed by computer supported image analyzer system and weighed.

The impedance was measured by GW INSTEK 8110G precision LCR meter (Figure 2) in frequency range between 20 Hz – 10 MHz with stainless steel pin electrodes (gap 15 mm). Similar method and calculations were used earlier for monitoring the changing of the impedance during drying by Zsivanovits, G. and E. Vozáry (2011).

Figure 1
HPD configuration

GW INSTEK 8110G precision LCR meter



pin electrodes (gap 15 mm)

Figure 2
The applied instrument and stainless steel electrodes with an apple stick sample

Dielectric impedance and phase angle (θ_m) were used for the calculations in that experimental series. The real part (R_m), and imaginary part (X_m) of the measured impedance were calculated for monitoring the changing during the storage period:
If Z_m is a complex number, where:

$$Z_m = R_m + jX_m, \qquad (1)$$

and R_m is the real part of Z_m and:

$$R_m = |Z_m| \cdot \cos\theta_m , \qquad (2)$$

and X_m is the imaginary part of Z_m and:

$$X_m = |Z_m| \cdot |\sin\theta_m| \qquad (3)$$

The experimental values ($|Z_m|$ and θ_m) were averaged over measurements of twenty

sticks in every hour (Vozary and others, 2002).

Based on the calculations the Nyqist plots (Liu, 2006) were drawn (Figure 3). The virtual R_m intercepts (left and right) with the frequency coordinates of them, and the max(X_m) points with the R_m and frequency coordinate of them were used to follow the changes during the drying. The received parameters may have connection with the dry content changes during the drying. The received data were processed statistically by non-linear (iteratively fitted sigmoid curve) regression in function of drying time. For the calculations Table Curve software was used. The used approximation formula was:

$$y=a+b/(1+\exp(-(x-c)/d)) \qquad (4)$$

The trend functions may useful to follow the drying process and to mark the endpoint (equilibrium water content) of it.

Linear correlation matrix was created between the received dimensional and dielectric data by Excel.

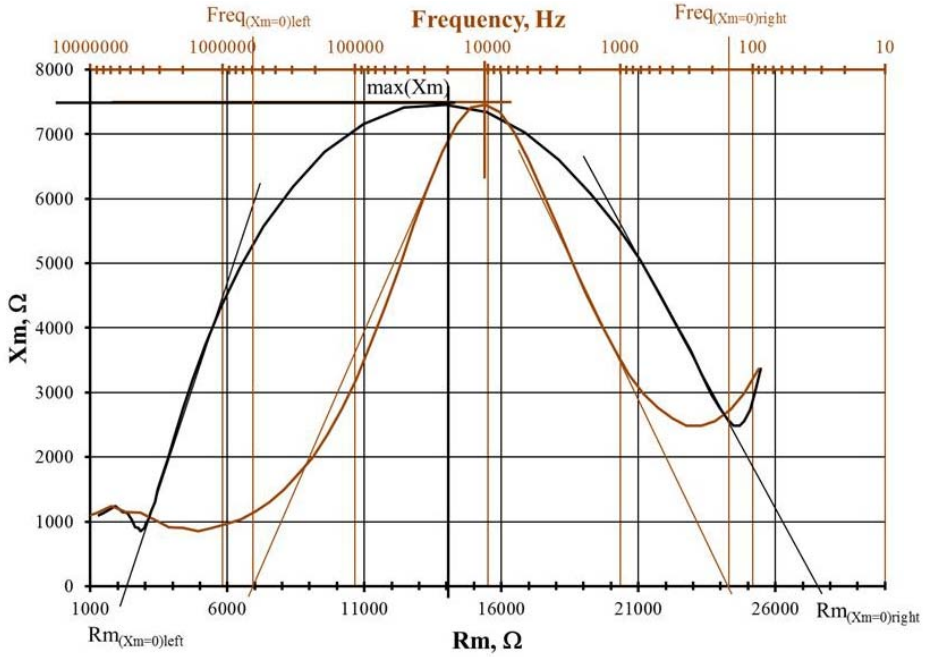


Figure 3
Nyqist plot of apple sticks before drying

RESULTS AND DISCUSSION

Results of mass volume and density investigation

During the drying time the mass and external dimensions of apple sticks were controlled in every hour. For further process of colour changes the sticks were pictured by computer supported digital image analysis system (Figure 4). The dimension changes can be followed by decreasing sigmoid functions (Figure 5 and

Table 1). That means, at the beginning of the drying the changes are faster, but later become slower and at the end of the process the parameters became near constant, after infinite time the calculated "a" constant should be the theoretical value. These near constant parts show the endpoint (equilibrium dry content) of that process method. Dryer product cannot received, from heat pump drying without increase the temperature. If the drying temperature increased, the quality of dried product and the energy efficiency of the process become worse. Based on the sigmoid trend all of the parameters had high correlation, parameters of density showed the highest correlation (r^2=0.9996), but it has the highest standard deviations for all of the points.

Table 1. Constants of non-linear (sigmoid) regression dimensional parameters and dry content

Parameters	Mass, g	Volume, mm^3	Density, kg/m^3	Dry content, %
A	0.228	786.74	294.44	0.12
B	3.834	45175.03	678.47	0.69
C	-0.734	-7.66	1.09	2.18
D	-1.026	-1.96	-0.62	0.68
r^2	0.9991	0.9713	0.9996	0.9971

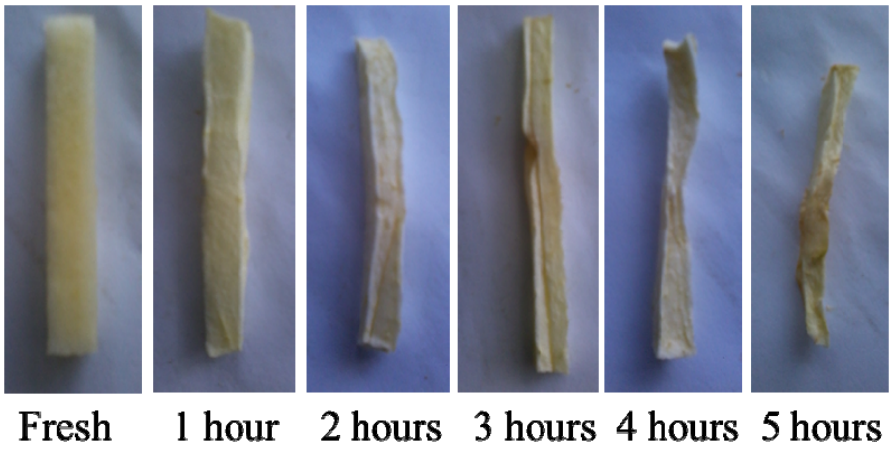


Figure 4.
Apple sticks during drying

Based on the standard methods the refractometric dry content was 13.5 % and 14.25 % from gravimetric method. Based on the mass changes of the full dried item and the mass changes of the selected samples (20 sticks in every hour for the dielectric measurements), the dry content was calculated during the drying for every

hour. The calculated dry content was changed up to 78-85 % during the drying. The received dry content values were also used for sigmoid trend calculations (Figure 5 and Table 1). The antioxidant activity (AOAC, 1990) was 15173.24 ± 1357.70 µmol/kgTE. These values were investigated just before drying.

Dielectric parameters

To analyse the parameters of the Nyqist plot nonlinear (sigmoid) regression calculations were used in function of drying time (Table 2). At the end of the drying the R_m values show slower increasing or near constant values. Maybe it is the result of the slower dimension changes. There are high correlations between the impedance parameters and drying time. The highest one is with R_m left ($r^2 = 0.9980$) (Figure 6).

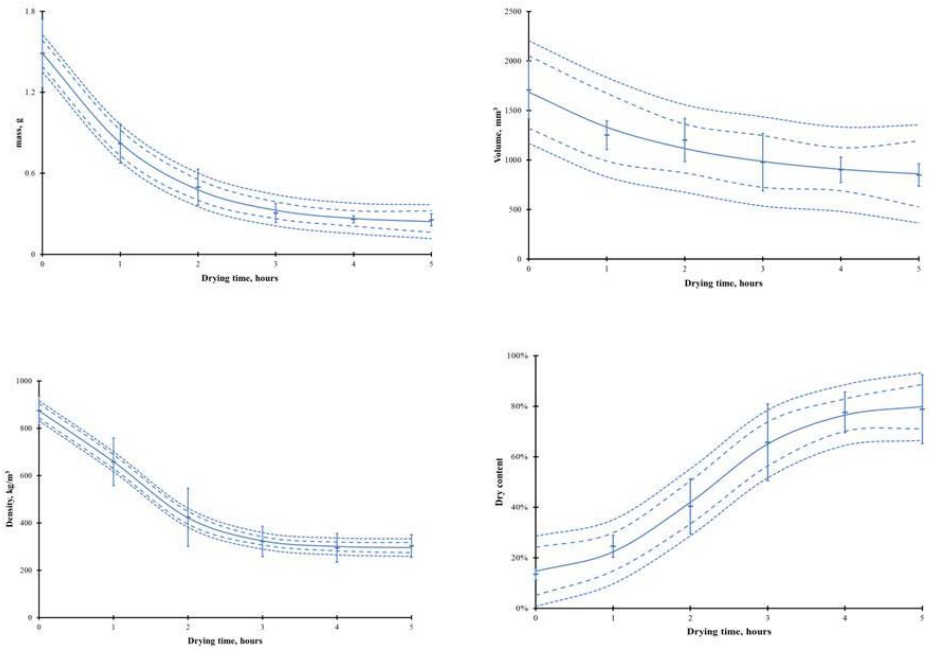


Figure 5.
Changes of external dimensions during the drying time
(mass, volume, density and dry content) with sigmoid trends

Table 2 Constants of non-linear (sigmoid) regression dielectric parameters

Parameters	R_m left kΩ	R_m Right kΩ	R_m max kΩ	Max(X_m) kΩ
a	3.83	51.41	17.83	-27.10
b	25.36	304.56	58.23	1328.36
c	3.36	3.39	2.68	4.73
d	0.37	0.66	0.90	1.17
r^2	0.9980	0.9880	0.9769	0.9907

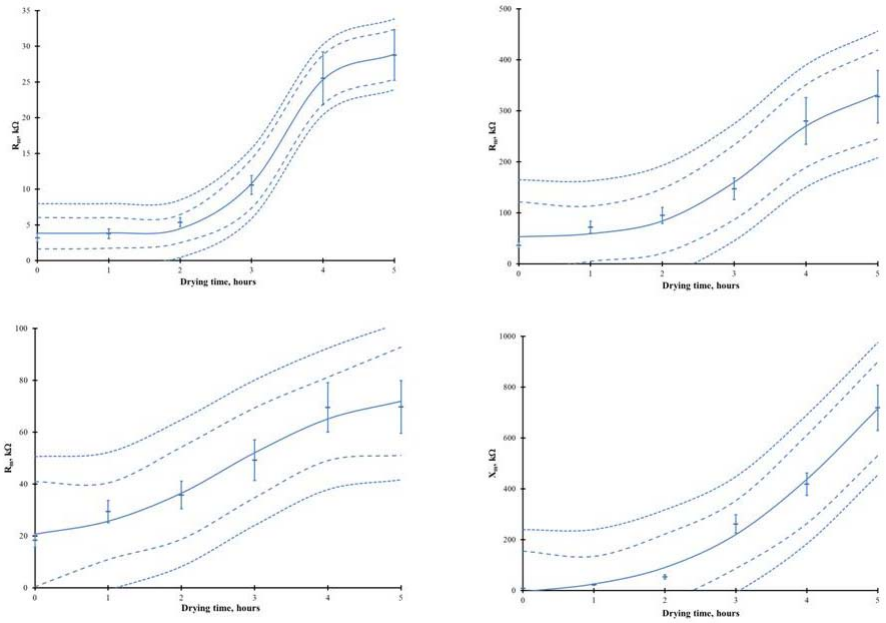


Figure 6
Dielectric impedance parameters in function of drying time with sigmoid trends

Table 3 Correlation matrix between the measured parameters

	Drying time, h	Mass, g	Volume, mm^3	Density kg/m^3	LeftR_m0 kΩ	MaxX_m kΩ	R_m at MaxX_m kΩ	RightR_m0 kΩ	Highest corr.
Mass	**-0.8884**	**1**							
Volume	**-0.9356**	**0.9769**	**1**						**Mass**
Density	**-0.9129**	**0.9871**	**0.9588**	**1**					**Mass**
LeftR_m0	***0.9292***	**-0.6866**	**-0.7852**	**-0.7256**	**1**				**Drying time**
MaxX_m	***0.9384***	**-0.6849**	**-0.7879**	**-0.7207**	**0.9604**	**1**			**Drying time**
R_m at MaxX_m	**-0.9716**	**0.9642**	**0.9699**	***0.9833***	**-0.8324**	**-0.8341**	**1**		**Density**
RightR_m0	***0.9636***	**-0.7595**	**-0.8469**	**-0.7887**	**0.9930**	**0.9681**	**-0.8837**	**1**	**Drying time**
Highest corr.	**RightR_m0**	**Density**	**R_m at MaxX_m**	**R_m at MaxX_m**	**RightR_m0**	**RightR_m0**			**Drying time**

To analyze the connections of measured dimensional and calculated dielectric parameters linear correlation matrix was created (Table 3). The correlation matrix shows high correlations between the dimensional changes and

dielectric parameters. The highest correlations are marked in the table. The overall highest correlation was found between density and R_m at Maximum(X_m) (r=0.9833). This parameter has the highest correlation with all of the dimensional parameters as well.

CONCLUSIONS

As it is shown in the tables and on the figures the dielectric parameters are useful for monitoring the drying process. The high correlations between the dimensional and dielectrical parameters show the impedance parameters give information about the progress of drying.

FUTURE WORK

Next time we should repeat the work on more apples and with the examination of physico-chemical parameters during the drying process. The target of new experiments should be to look for connections between the quality parameters of dried products and the impedance parameters.

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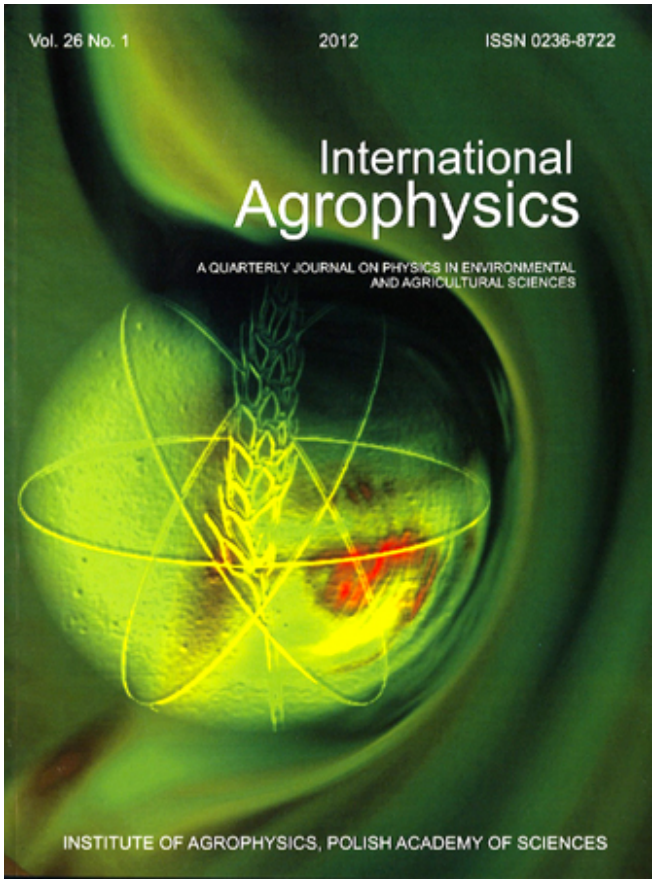

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