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USEFULNESS OF THE SELECTED APPLE CULTIVARS FOR PRESSING IN FARM CONDITIONS

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ABSTRACT

The paper presents the research results concerning the impact of varietal properties of apples on the efficiency of pressing juice. The research was carried out on eight apple cultivars from the crop of 2011 and 2012 after three month storing in a cold store with controlled atmosphere. Pressing was carried out in one cycle with the use of a laboratory bucket press. It was reported that varietal properties significantly influence the pressing efficiency. The highest efficiency was obtained in case of Idared cultivar and the lowest for Elise and Boiken variety. Moreover, it was proved that the content of essence, pH value of juice, dynamic viscosity and the juice thickness depend on the varietal properties of apples. The obtained juice was characterised with the content of essence exceeding Brix 10°, which indicated usefulness of all the investigated cultivars for production of cloudy juices.

Introduction

Apples are a source of many valuable phenolic compounds having antioxidant, antibacterial, antiviral, anti-inflammatory, antiallergic, or even expected to have anti-cancer properties (Kalinowska, 2012). Poland is one of the largest producers of apples in the European Union. The assessment for polish farmers suggested the production of apples at 3.2 million tons in 2013. Modern techniques, used in Poland concerning apples storing in controlled atmosphere guarantee the availability of high-quality fruit almost throughout the year. On 1 December 2012, according to the WAPA, stocks of apples in Poland amounted to about 1.18 million tons, while in the first day of February 2013 – 819 thousand tons and was 2% higher compared to the same period in the previous year (AgroTydzień 2013). Successful harvesting and large inventory of fruits contributes to difficulties with sale, as well as reduction of their prices. According to the data of IERiGŻ [Institute of Agriculturla and Food Economics] presented in January 2013, the average price of dessert apples in the national procurement was 14% lower compared to January 2012. The procurement prices of apples for export in the same period fell by an average of 5% to PLN 1.09·kg^{-1} (E-sadownictwo, 2013). The low price of the fruit may cause the interest of orchard farmers to produce fresh juices in ta farm. In Western Europe, the market share of fresh juices

ranges from several to several dozens of percent, while in Poland does not exceed 2%. They are often cloudy juices and juices produced from organic farms, and thus they have pro-health properties. The heat treatment has negative influence on the antioxidant properties and the content of bioactive compounds in cloudy apple juice (Rembiałkowska et al., 2006). In some countries (Austria, Germany) orchard farms are equipped with a complete line of pressing and gentle juices preservation. Lately the development of a service using the mobile pressing is observed. This fact justifies the need for investigation of national apple cultivars to assess their suitability for production of fresh juices. In the industry for juice extraction from fruits and vegetables basket presses are commonly used (Nadulski et al., 2006; Lewicki et al., 1989; Lewicki et al., 1984), while less frequently layer presses are used. For basket presses, two designs are used: presses with a perforated basket or a solid basket, where the juice flows out through drainage hoses. Under laboratory conditions for research on the pressing process, basket presses with perforated elements (Nadulski, 2012; Guillermin et al., 2006; Grochowicz and Kusińska, 1980) and layer presses (Gerard and Roberts 2004) are most often used.

Objective and scope of the work

The objective of the study was to evaluate selected national apples cultivar after storage in ULO conditions (ultra low oxygen), for their suitability to produce fresh juices by pressing. Pressing was performed in a single cycle using a laboratory basket press. The scope of work included determining the efficiency of pressing and quality of apple juice, such as extract content (^{o}Brix), acidity (pH), dynamic viscosity and density.

Materials and Methods

The study was conducted in the Department of Food Engineering and Machinery in Lublin on eight apple cultivars: Golden Delicious, Gloster, Ligol, Jonagored, Idared, Boiken, Elise and Pinova harvested in 2011 and 2012. Apples came from specialized farm orchard Witków located in the Lublin region. Fresh juices are naturally cloudy and should be produced from apples of maturity close to the consumer quality (ie. not containing starch) (Gasik et al., 2012). Maturity of fruit was determined by the starch test. The tests were performed on the material after three months of storage at refrigerated controlled atmosphere (temperature 1,6-2,2^{o}C, oxygen content of 1.6%, 2.2% carbon dioxide and 96.2% nitrogen). The raw material was ground using a shredding machine MKJ250 (Spomasz, Nakło, Poland) with the use of a standard shredding disc with a hole with a diameter of 8 mm. The shredding disc speed was 170 rpm · min^{-1}. Pressing was carried out in a laboratory basket press of own construction with a diameter of 120 mm and a working chamber volume of approximately 150 cm^3 (Fig. 1). The ground material with a weight of 500 g was placed in special bags, which were inserted into the press cylinder and then loaded with the piston. After obtaining the value of the loading force of 40 ± 1 kN pressing process was stopped. Each measurement was performed in six replications.

Figure 1. A laboratory bucket press

After each procedure the amount of juice obtained (mass and volume) was determined, as well as its density, extract °Brix (PN-90 / A-75101/02), pH (according to BS EN 1132: 1999) and the dynamic viscosity. To determine the amount of juice extract refractometer, PAL-1 (Atago, Tokyo, Japan) was used; to determine the pH of the juice, a CP-411 pH meter (Elmetron, Zabrze, Poland) was used; and to determine dynamic viscosity, an LVDV-II + PRO machine (Brookfield Engineering Laboratories, Middleboro, MA, USA) was used. The dynamic viscosity of the juice was measured using a ULA spindle at a rotational speed of 20 rpm at 20±0.5ºC, controlled by a thermostat. Rheocalc V3.1 software (Brookfield Engineering Laboratories) was used to record the data and control the viscosity meter.

Efficiency of pressing was determined by the following formula:

$$W_j = \frac{M}{M_p}$$

where:

W_j – is the efficiency of pressing, (%)

M – is the mass of juice after pressing, kg (kg),

M_p – is the mass of input material, (kg)

Statistical analysis of results of tests carried out using factorial ANOVA. The significance of differences was tested using Fisher test

Results

Statistical analysis of the results showed the impact of the cultivar characteristics on the juice extraction process and showed differences in the physical properties of the juices obtained from different cultivars. Juice yield of the tested cultivar is from 38.67 to 52.33%. The obtained yield is less than the values obtained in industrial conditions, i.e. 72-83% (Kowalczyk, 2004). Under the conditions of the experiment only one pressing cycle have been used and the enzyme preparations have not been used. The highest yield was obtained in the case of Idared and the lowest in the case of a Boiken and Elise cultivars (fig. 2). Statistical analysis confirmed the significance differences in the yield of pressing for pulp obtained from different apple cultivars (table 1).

Table 1.
Significance of difference between amount obtained for particular cultivars (Fisher's test)

Variety	Significance of difference				
	Efficiency W	Extract °Brix	Acidity pH	Dynamic viscosity η	Dencity ρ
Jonagored	bc	d	a	a	a
Golden D.	b	a	b	b	a
Boiken	a	c	c	c	a
Idared	d	c	d	d	b
Pinova	bc	a	e	e	ab
Elise	a	a	f	f	a
Gloster	d	b	g	a	b
Ligol	c	b	h	g	d

a, b, c – average values marked with the same letter are not statistically significantly different (p>0.05)

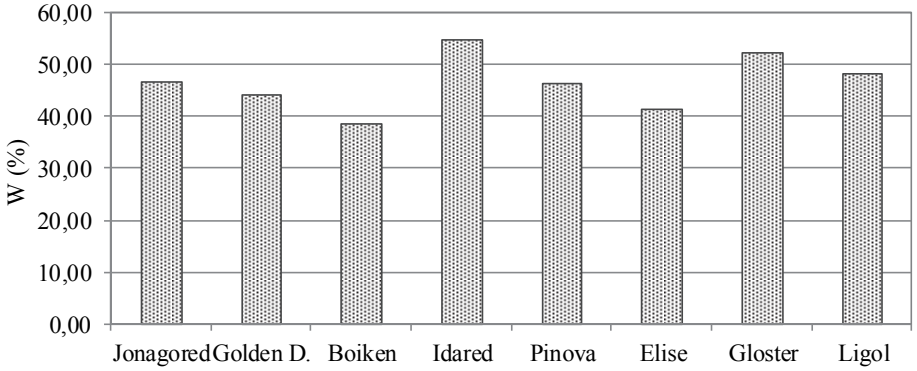

Figure 2. Pressing efficiency W (%) in relation to cultivar

Extract content in apples depends on the conditions during the growing season, harvest date and time of cool storage (Błaszczak, 2006). In the investigated apple juice, the extract content ranged from 10.5 to 13.5 of °Brix and depended on the cultivars from which juice was extracted (Fig. 3). Extract had the highest content of juice obtained from Idared and the lowest from a Boiken cultivar. The extract content in apple juice pressed in the fruit and vegetable industry is at the level of 11.0-12.4 of °Brix (Kowalczyk, 2004).

Considerably statistically significant differences in the acidity of apple juice were presented (table 1). The lowest pH value of 2.51 was obtained for Boiken cultivar juice, and the highest value of 3.58 in the case of Ligol cultivar juice (fig. 4).

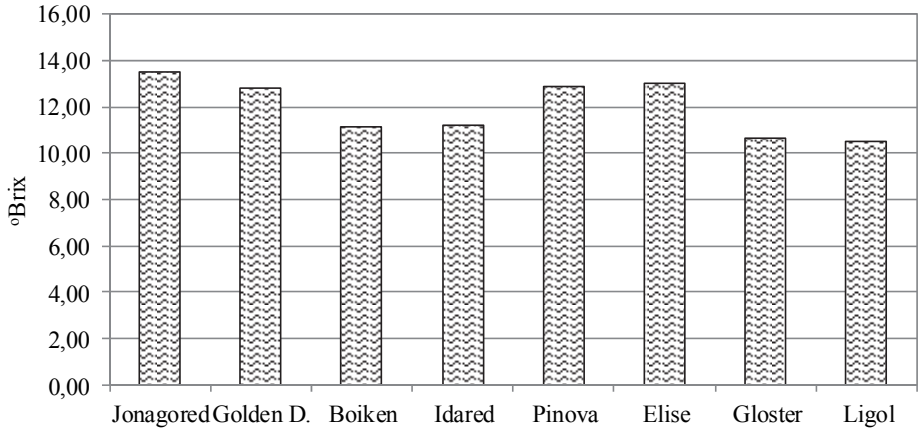

Figure 3. Extract content (°Brix) in apple juice depending on cultivar

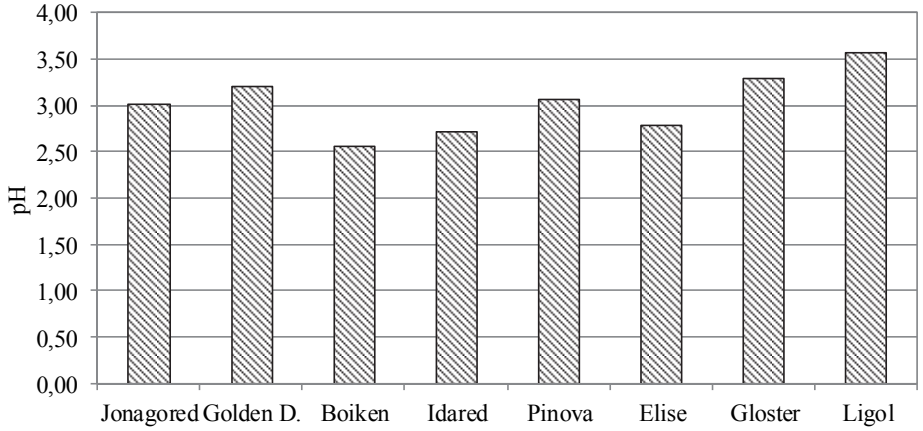

Figure 4. Acidity (pH) of apple juice depending on cultivar

Studies have shown clear differences in the dynamic viscosity of obtained apple juice (fig. 5). Dynamic viscosity of tested juices ranged from 4.3 m·Pa·s to 15.1 m·Pa·s. The highest value of dynamic viscosity was obtained in the case of apple juice from Boiken cultivar, whereas the lowest value in the case of juice from Idared and Pinova cultivars. Difference of dynamic viscosity is related to the fact that the tests were carried out on fresh cloudy juice. Particles included in the juice pulp may affect the dynamic viscosity of the obtained values. In contrast, apple juice is Newtonian fluid and has a lower dynamic viscosity value. The density of apple juice obtained from different cultivars is presented in

figure 6. It was found that juice density is in the range of 1.028 to 1.052 kg·m^{-3}. No statistically significant difference was found between the Jonagored, Golden Delicious, Boiken, Pinova and Elise cultivars.

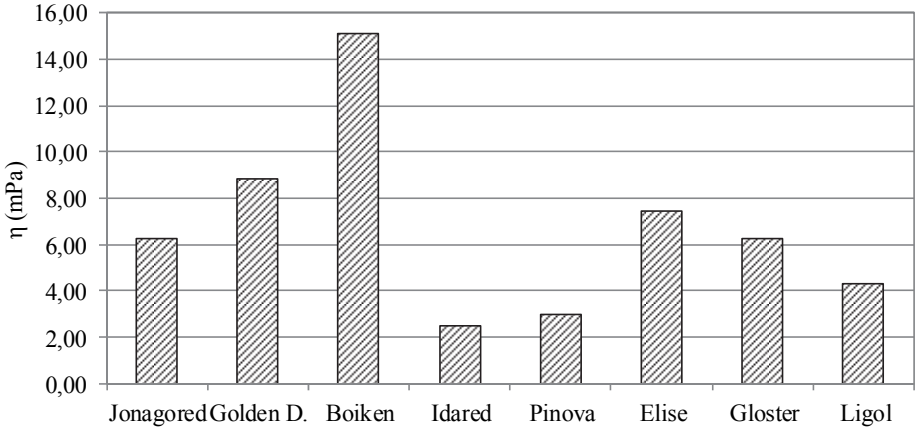

Figure 5. Dynamic viscosity η (m·Pa·s) of apple juice in relation to cultivar

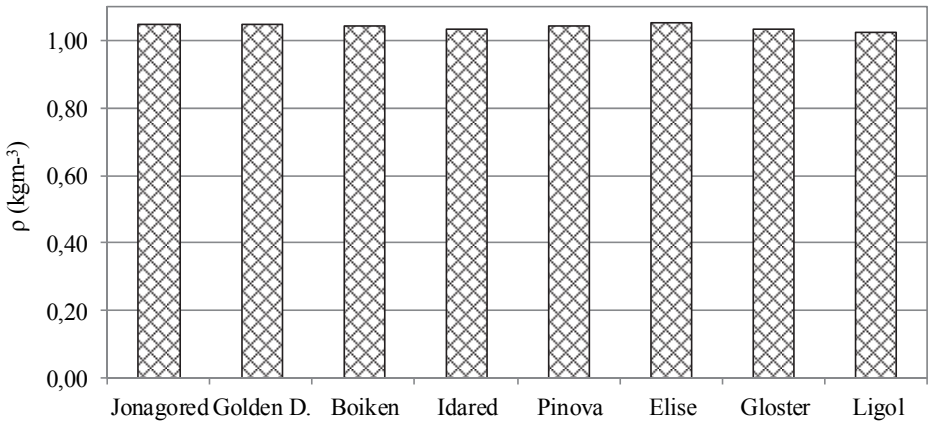

Figure 6. Density ρ (kg·m^{-3}) of apple juice in relation to cultivar

Research has indicated different yield of apple juice, depending on cultivars, the quality of juice depends on the cultivar, from which it is obtained. Obtained apple juices were characterized by the content of the extract above 10^{o}Brix, indicating the usefulness of all the examined cultivars for production of cloudy juices (Gasik et al., 2012).

Conclusions

The study allows formulation of the following conclusions:

1. The highest juice yield, during single pressing, was obtained for apple pulp from Idared cultivar whereas the lowest from Boiken cultivar.
2. Juice obtained from Gloster and Ligol cultivars characterized by the lowest content of the extract, whereas the highest obtained from Jonagored cultivar.
3. Taking into account the content of extract (10ºBrix) in juice all investigated cultivars of apples are suitable for the production of cloudy juices.
4. The highest acidity of juice obtained from Boiken cultivar, and the lowest from Ligol cultivar.
5. Dynamic viscosity of apple juice is highly diverse, the highest value obtained in the case of Boiken cultivar and the lowest in the case of Idared variety.
6. Minor, but in some cases substantial, statistically significant differences were recorded during measurement of density of the obtained juices.

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PRZYDATNOŚCI WYBRANYCH ODMIAN JABŁEK DO TŁOCZENIA W WARUNKACH GOSPODARSKICH

Streszczenie. W pracy przedstawiono wyniki badań dotyczące wpływu cech odmianowych jabłek na wydajność tłoczenia soku. Badania wykonano na ośmiu odmianach jabłek ze zbioru w 2011 i 2012 roku po trzymiesięcznym przechowywaniu w chłodni z kontrolowaną atmosferą. Tłoczenie prowadzono w jednym cyklu przy użyciu laboratoryjnej prasy koszowej. Stwierdzono, że cechy odmianowe owoców mają istotny wpływ na wydajność tłoczenia. Najwyższą wydajność uzyskano w przypadku odmiany Idared a najniższą odmian Elise i Boiken. Ponadto wykazano, że zawartość ekstraktu, wartość pH soku, lepkość dynamiczna i gęstość soku zależą od cech odmianowych jabłek. Otrzymane soki charakteryzowały się zawartością ekstraktu powyżej 10oBrix'a, co wskazuje na przydatność wszystkich badanych odmian do produkcji soków mętnych.

Słowa kluczowe: sok jabłkowy, odmiany jabłek, wydajność tłoczenia