

COMPARISON OF SOME CHEMICAL COMPONENTS IN APPLES 'SZAMPION' VARIETY PRODUCED IN THE LUBLIN PROVINCE

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Abstract. Apples of 'Szampion' variety produced in the homestead orchards showed the highest concentration of nutrients in dry mass with, however, slight differences in mineral component contents. The highest level of fructose (24.304 g/100 g d.m.), glucose (5.207 g/100 g d.m.) and sucrose (19.015 g/100 g d.m.) was recorded in the apples harvested in Wola Sernicka, Łęczna and Puławy, respectively. The apples produced in the commercial orchard in Lublin proved the highest content of vitamin C available.

Key words: chemical composition, mineral components, sugars, vitamin C, apple, 'Szampion'

INTRODUCTION

Fruit consumption in Poland has increased substantially not only due to their rich flavour and the dietetic qualities but also wholesome values. The studies report that the substances they contain, like dietary fibre, sugars, vitamins or mineral compounds can prevent the development of numerous civilization – related diseases. They include, among others, atheromatosis, cardiovascular system diseases, diabetes and cancer [Anderson et al. 1994, Nicolle et al. 2004, Szponar and Ciok 2002].

The greatest vogue have domestic fruits, including apples. A statistical Pole consumes about 20 kg per year, that makes over 50% of all the fruits eaten. One of the most favourable varieties in demand is Szampion, whose contribution to the total domestic production reaches 15%. At the market one can find fruits from both big commercial orchards and small homestead ones. A different level of agrotechnics applied in an orchard can exert a significant impact on the chemical composition as well as nutritional, dietetic and medicinal value of the apples produced [Makosz 2000, Volz et al. 1994].

Therefore, the objective of the present work was determination and comparison of the basic chemical composition of dry matter, crude ash, crude protein, ether extract,

dietary fiber and calculated content of nitrogen-free extract, a content of the following macro-elements: P, K, Ca, Mg and microelements: B, Mn as well as sugars: fructose, glucose, sucrose and vitamin C in the apples 'Szampion' variety produced in the Lublin province orchards differentiated in respect of agrotechnical practices level.

MATERIAL AND METHODS

The investigations were carried out on apples cv. 'Szampion' gathered in 2003. There were chosen six orchards situated in the Lublin province and differentiated in respect of the area size and method of the agrotechnical management practices. The orchards in Łęczna and Wola Sernicka are located at the allotment area, their size is under 2 ha and are managed with minimal plant protection. The orchards in Góry Markuszowskie and Stryjno occupy the area from 5 to 10 ha, whereas those situated in Lublin and Puławy over 10 ha. All the orchards of the area over 5 ha are of a commercial character and come within the protection according to the Orchard Protection Agenda.

In the material under study the basic chemical composition: dry matter, crude ash, crude protein, ether extract and dietary fiber was determined after the analytic procedures defined in Rozporządzenie... [2004]. The content of easily hydrolyzed sugars determined in the fraction of nitrogen-free extract (NFE) was calculated from the basic chemical content. A content of mineral components K, Ca, Mg, Mn was fixed by the absorption atomic spectrophotometry with ASA apparatus. The colorimetric methods were applied to determine contents of P (PN-76/R-64781) and B (PN-91/R – 04014, PN-93/R-04018). A content of vitamin C was established after the pulsatory differential polarography method; voltammetrical trace analysis VA 746. Sugar content was fixed with HPLC model 422 fitted with column APEX I RP 5um and refractometric detector – model 475.

The results were analyzed statistically to establish the mean value, standard deviation and differences between the means (one-factor variance analysis). The calculations were performed with a computer statistical program STATISTICA 5.1.M.

RESULTS

The highest concentration of nutrients had the apples harvested from the orchards of 5-10 ha area: in Stryjno 19.639% d.m. and Góry Markuszowskie – 17.942% d.m. (Table 1). In the rest of the studied material, even up to 25% less dry matter was determined compared to the highest values recorded. The stated differences proved to be significant statistically.

The significant differences were also reported in the crude ash content. The highest level of mineral compounds, nearly twice as large as against the other apples, was recorded for the fruits coming from the orchard in Wola Sernicka (0.511% d.m.).

As regards crude protein content, the best turned out to be the apples produced in the orchards in Góry Markuszowskie (0.524% d.m.) and Stryjno (0.541% d.m.). A significantly lower content of this nutrient was detected in the other fruits.

Table 1. The chemical composition of apples variety 'Szampion', % d.m.
Tabela 1. Skład chemiczny jabłek odmiany 'Szampion', % s.m.

Town Miejscowość	Area of orchards Powierzchnia sadów ha	Dry matter Sucha masa	Crude ash Popiół surowy	Crude protein Białko ogólne	Ether extract Tłuszcz surowy	Crude fiber Błonnik pokarmowy	NFE* BAW*
Łęczna	to 2 do	14.535 ^e ±0.038	0.285 ^b ±0.004	0.385 ^{bc} ±0.049	0.397 ^b ±0.002	6.902 ^a ±0.045	6.566 ^{cd} ±0.023
Wola Sernicka	to 2 do	16.094 ^c ±0.040	0.511 ^a ±0.002	0.432 ^b ±0.002	0.599 ^a ±0.005	7.597 ^a ±0.065	6.955 ^{cd} ±0.123
Góry Markuszowskie	5-10	17.942 ^b ±0.046	0.233 ^c ±0.026	0.524 ^a ±0.004	0.568 ^a ±0.008	6.167 ^b ±0.056	10.450 ^b ±0.103
Stryjno	5-10	19.639 ^a ±0.002	0.306 ^b ±0.005	0.541 ^a ±0.005	0.574 ^a ±0.012	6.752 ^b ±0.066	11.466 ^a ±0.067
Lublin	above 10 około	15.132 ^d ±0.043	0.301 ^b ±0.023	0.415 ^b ±0.031	0.402 ^b ±0.006	6.510 ^b ±0.023	7.504 ^c ±0.056
Puławy	above 10 około	14.532 ^e ±0.056	0.300 ^b ±0.003	0.369 ^c ±0.021	0.404 ^b ±0.003	7.169 ^a ±0.061	6.287 ^d ±0.098

a,b,c,... – significant differences between the content of nutrition contents in apples gathered in different orchards, $p \leq 0.01$.

*NFE – nitrogen free extract.

a,b,c,... – różnice statystyczne między zawartością składników pokarmowych w jabłkach pochodzących z różnych sadów, $p \leq 0,01$.

*BAW – związki bezazotowe wyciągowe.

A significantly higher content of ether extract was noted in apples obtained from the orchards of small area (Wola Sernicka – 0.599% d.m.) and medium (Góry Markuszowskie – 0.568% d.m. and Stryjno – 0.574% d.m.). This fraction content determined in these fruits was higher by around 30% compared to those gathered in other orchards.

Significant differentiation of results was also observed in crude fiber content. In the fruits produced in the orchards situated in Łęczna, Wola Sernicka and Puławy, this fraction content ranged 6.902-7.597% d.m. In the other apples analyzed, crude fibre content was determined at the level 6.167-6.510% d.m. (obtained from the orchards in Góry Markuszowskie and Lublin, respectively).

The depicted changes in the chemical composition affected the calculated content of non-nitrogen extract compounds. The significantly highest content of this fraction was noted in the apples obtained from the orchards in Stryjno and Góry Markuszowskie (11.466 and 10.45% d.m., respectively) and the lowest in the fruits from Puławy (nearly 6.3% d.m.).

Some differences were reported in macroelement content (Table 2).

Greater variability of results was noted in the case of phosphorus and potassium content. The significantly highest phosphorus content had the apples from the orchards in Stryjno (0.059% d.m.) and in Lublin (0.055% d.m.). The significantly lowest content of this element was established in the fruits from the orchard in Puławy (0.038% d.m.).

Table 2. The content of mineral elements in apples variety 'Szampion'
Tabela 2. Zawartość związków mineralnych w jabłkach odmiany 'Szampion'

Town Miejscowość	Area of orchards Powierzchnia sadu ha	Macroelements % d.m. Makroelementy % s.m.				Microelements mg/kg d.m Mikroelementy mg/kg s.m	
		P	K	Ca	Mg	B	Mn
Łeczna	to 2	0.048 ^c	0.550 ^b	0.068 ^{abc}	0.030 ^{ns}	11.925 ^a	3.342 ^a
	do	±0.001	±0.014	±0.002	±0.001	±0.275	±0.094
Wola Sernicka	to 2	0.052 ^{bc}	0.560 ^b	0.069 ^a	0.030 ^{ns}	9.725 ^c	2.575 ^b
	do	±0.002	±0.016	±0.001	±0.001	±0.095	±0.170
Góry Markuszowskie	5-10	0.047 ^c	0.552 ^b	0.062 ^{bc}	0.029 ^{ns}	11.875 ^a	2.600 ^b
		±0.02	±0.009	±0.004	±0.005	±0.095	±0.163
Stryjno	5-10	0.059 ^a	0.620 ^a	0.061 ^c	0.030 ^{ns}	9.850 ^c	3.250 ^a
		±0.002	±0.018	±0.002	±0.002	±0.288	±0.351
Lublin	above 10	0.055 ^{ab}	0.537 ^b	0.066 ^{abc}	0.028 ^{ns}	10.975 ^b	2.975 ^{ab}
	około	±0.004	±0.022	±0.003	±0.001	±0.170	±0.170
Puławy	above 10	0.038 ^d	0.612 ^a	0.068 ^{ab}	0.029 ^{ns}	10.700 ^b	2.750 ^b
	około	±0.002	±0.009	±0.002	±0.001	±0.182	±0.129

a,b,c,... – significant differences between the content of mineral elements in apples gathered in different orchards, $p \leq 0.01$.

ns – no significant differences.

a,b,c,... – różnice statystyczne między zawartością związków mineralnych w jabłkach pochodzących z różnych sadów, $p \leq 0,01$.

ns – nieistotne statystycznie.

As for potassium content, the best apples proved to be those gathered from the orchards in Stryjno (0.620% d.m.) and Puławy (0.612% d.m.). In the other apples studied a similar content of this element at the level 0.55% d.m. was detected.

The highest content of Ca was observed in the fruits produced in the Wola Sernicka, Łeczna and Puławy orchards (mean – 0.068% d.m.). The lowest amount of Ca, however, was noted in the apples gathered in orchards in Stryjno and Góry Markuszowskie (0.061 and 0.062% d.m., respectively). All the differences observed were significant statistically.

In the investigated material similar amount of Mg was determined – average 0.03% d.m. The noted differences were not significant statistically.

Some major variability of results was observed in microelement content. As regards a boron content, its significantly highest quantity was detected in the apples from the orchards in Łeczna and Góry Markuszowskie (11.925 and 11.875 mg/kg d.m.). However, its lower level by about 1 mg/kg dm was observed in the fruits harvested in large commercial orchards. The significantly lowest boron amount was determined in the apples produced in the orchards in Wola Sernicka and Stryjno (9.725 and 89.850 mg/kg d.m., respectively).

The significantly highest content of Mn was reported in the fruits gathered in the orchards in Łeczna (3.342 mg/kg d.m.), Stryjno (3.250 mg/kg d.m.) and Lublin

(2.975 mg/kg d.m.) In the other apples analyzed a significantly lower manganese content – at the average level 2.7 mg/kg d.m. was established.

Some significant differences were also reported in vitamin C content (Table 3). The highest content of this vitamin was detected in the apples from the orchard in Lublin (31.055 mg/100 g d.m.) whereas the lowest in those from the orchard in Góry Markuszowskie (14.935 mg/100 g d.m.). All the results stated varied and proved to be significant.

Great variability of the results was also observed in sugar content (Table 3). Significantly highest amount of fructose was fixed in the fruits from the orchard in Wola Sernicka (39.935 g/100 g d.m.). A similar level of fructose content was determined in the apples gathered from the orchards occupying the area from 5 to 10 ha. (Góry Markuszowskie – 31.97 g/100 g d.m. and Stryjno – 30.842 g/100 g d.m.). In the other apples its content was reported at significantly lower level – over 25.5 g/100 g d.m.

Table 3. The content of vitamin C and the chosen sugars in apples variety 'Szampion'
Tabela 3. Zawartość witaminy C i wybranych cukrów w jabłkach odmiany 'Szampion'

Town Miejscowość	Area of orchards Powierzchnia sadu ha	Vitamin C mg/100 g d.m. Witamina C mg/100 g s.m.	Sugars, g/100 g d.m. Cukry, g/100 g s.m.		
			Fructose Fruktoza	Glucose Glukoza	Sucrose Sacharozza
Łeczna	to 2	23.897 ^e	24.307 ^e	5.207 ^a	15.980 ^e
	do	±0.346	±0.290	±0.276	±0.091
Wola Sernicka	to 2	26.185 ^b	39.935 ^a	3.495 ^b	11.700 ^d
	do	±0.427	±0.278	±0.202	±0.241
Góry Markuszowskie	5-10	14.932 ^f	31.970 ^b	3.525 ^b	15.030 ^c
		±0.260	±0.296	±0.218	±0.168
Stryjno	5-10	16.317 ^e	30.842 ^{cb}	2.060 ^e	16.707 ^b
		±0.315	±1.206	±0.111	±0.232
Lublin	above 10 około	31.055 ^a	30.387 ^c	3.047 ^c	16.615 ^b
		±0.798	±0.463	±0.059	±0.249
Puławy	above 10 około	18.320 ^d	27.130 ^d	2.505 ^d	19.015 ^a
		±0.363	±0.541	±0.215	±0.186

a,b,c,... – significant differences between the content of vitamin C and sugars in apples gathered in different orchards, $p \leq 0.01$.

a,b,c,... – różnice statystyczne między zawartością witaminy C i cukrów w jabłkach pochodzących z różnych sadów, $p \leq 0,01$.

Similar differences were noted in glucose content. Its significantly higher amount was shown in the apples from the orchard in Łeczna (5.207 g/100 g d.m.), while in the fruits from the orchards in Stryjno and Puławy about 50% less glucose was stated (2.060 and 2.505 g/100 g d.m., respectively). In the rest research material this sugar content maintained at the average level, it ranged from 3.0-3.5 g/100 g d.m. All the differences noted were significant statistically.

Some significant differences were recorded in sucrose content. The highest amount, i.e. 19.015 g/100 g d.m., was determined in the apples produced in the orchard in Puławy.

However, the significantly lowest content was recorded in the fruits obtained from Wola Sernicka. In the other apples, a similar content of this sugar, on average 16.5 g/100 g d.m., was recorded.

DISCUSSION

The nutritional values, dietetic or medicinal quality of apples are conditioned by their chemical composition. Each nutrient content of fresh fruits can vary substantially. It is affected by an apple variety, its ripeness level, fertilization, soil properties and composition and the climatic factors [Makosz 2000]. In the present authors' own investigations the highest nutrient concentration was recorded in the apples obtained from the commercial orchards of area from 5 to 10 ha (Góry Markuszowskie, Stryjno).

Among the basic nutrients there was a major variability in crude ash content. Nearly twice as large as in other fruits there was determined crude ash content in the apples produced at a small homestead orchard in Wola Sernicka. A high concentration of crude ash in dry mass implies fruit micro and macroelement availability. Literature points out that apples cv. 'Szampion' are more ample with microelements like, magnesium, iron, copper, zinc and manganese [Makosz 2000]. The present authors' investigations made on 'Jonica' variety confirm this hypothesis. In the apples 'Szampion' variety there was determined from 5 to 10% of crude ash more than in Jonica cv. fruits. Such differences, however, were not reported in the content of P, K, Ca, Mg and B, Mn [Kiczorowska and Kiczorowski 2005].

Among the macroelements occurring in apples the key role is played by potassium, sodium and calcium. They participate in many metabolic processes in human organism. Special attention should be paid to potassium contained in apples as it contributes to the reduction of harmful effect of sodium excess in organism [Block et al. 1992, Kuchanowicz et al. 2004, Wolfe and Liu 2003]. The most phosphorus and potassium available proved to be in the apples obtained from the big and medium-sized orchards (Lublin and Stryjno). Low lability, however, was recorded for calcium and magnesium content. Similar amount of them was noted in the whole research material, irrespective of the production place, agrotechnical practices, climatic factors or soil properties.

Literature confirms that apples are rich in microelements, they may contain as many as 28 of such elements [Lipecki and Libik 2003, Makosz 2000, Volz et al. 1994]. Boron and manganese are of great importance for consumer's health. Appropriate boron quantity in the diet assists the assimilation of bone minerals. However, dietary manganese conditions the proper functioning of enzymes in organism [Kuchanowicz et al. 2004, Oberbeil 1997, Wolfe and Liu 2003]. The results of the present authors' investigations point to great differentiation of these elements accumulation. The highest boron concentration was recorded in the apples obtained from a homestead orchard in Łęczna and in one of 5-10 ha area in Góry Markuszowskie. The most valuable source of manganese appeared to be the apples produced in Łęczna as well as the fruits from the medium-sized orchard in Stryjno.

Apples alike most fruits contain slight amount of protein and fat. Crude protein content in apple may be to some degree conditioned by its capacity for the nitrogen uptake and accumulation. This is connected with reasonable fertilization of trees in an orchard. Fat, however, is collected mainly as a wax protective layer of the cuticle on the apple

surface [Makosz 2000]. The highest concentration of these nutrients in dry matter was shown in the apples gathered in the orchards of 5-10 ha area.

Dietary fibre is one of the most valuable nutrients in apple. This fraction comprises polysaccharides included into cell wall composition. In apples they are mainly located in the skin and seed chambers. These polysaccharides are of primary importance in organism as they regulate the peristaltic movements of intestines, binding cholesterol toxins and heavy metals. They also prevent numerous civilization-related diseases, among others malignant [Aprikian et al. 2001, Block et al. 1992, Car et al. 1993, Nicolle et al. 2004]. Among the investigated apples, the highest dietary fibre content was recorded in the apples obtained from the homestead orchards. It was probably connected with percentage share of skin and seed chambers in whole fruits. The apples produced in the orchards managed amateurishly demonstrated a thicker skin compared to those from the commercial ones.

On the grounds of the determined chemical composition there was computed a content of non-nitrogen extract compounds for all the apples examined. This fraction comprises the readily hydrolyzing sugars, like monosaccharides, disaccharides and polysaccharides. The content of this fraction was quite differentiated in the research material, its highest amount was detected in the apples obtained from the orchards of 5-10 ha area.

Among the monosaccharides, fructose, glucose and sucrose have a great nutritional value. They balance sugar level in blood, which is crucial for the diabetics [Block et al. 1992, Gallaher and Scheneenman 2001]. However, these compounds content in apples is very differentiated. It depends on many factors that cause differences in sugar content in apples coming even from the same tree. They include among others, the insulation of leaves adjacent to the ripening fruits, their regular distribution as well as yielding size. Too high crop results in a lower sugar content in fruits [Makosz 2000, Volz et al. 1994].

Although, there were examined the fruits from the central part of the tree crown, a different stand of a tree in an orchard could also affect a varied content of these compounds in the fruits under study. The highest fructose content had the apples produced in the homestead orchard in Wola Sernicka, whereas the glucose content proved the highest in the fruits from a similar orchard in Łęczna. As regards sucrose content, the apples produced in a commercial orchard in Puławy were the most valuable.

Alike, in the case of vitamin C there were observed great differences, even up to 200%. The highest content of this vitamin was determined in the fruits coming from a commercial orchard in Lublin. The size of the vitamin C synthesis is influenced by the similar factors as in the case of sugars. Literature reports that apples can contain 7-3 mg/100 g f.m., that is most of all the seedy fruits [Lipecki and Libik 2003, Makosz 2000]. Vitamin C is of vital physiological significance. It participates in the synthesis of the biologically active compounds, contributes to the neutralization of drugs and toxins as well as inhibits the malignant disease development [Steinmetz and Potter 1991].

The results of the presented investigation show how different the chemical composition of apples of the same variety can be subject to different soil and agrotechnical conditions. The fruits obtained from the homestead orchards do not yield in the nutritional value but on the contrary, in many cases they were superior to the apples obtained in the commercial orchards. However, the fruits from the orchards of a low agrotechnical level were not equal in respect of the appearance as the apples produced in the commercial orchards were very attractive. They were of higher weight, fine colour and a smooth

shiny skin. These qualities really affect the customers' choice at the apple market or shop, but they not always ensure the best chemical composition or nutritional value.

RESULTS

1. Apples produced in the orchards in Góry Markuszowskie and Stryjno were characterized by the highest dry mass concentration and a fraction of readily hydrolyzing sugars contained there.

2. The highest content of crude ash, ether extract and dietary fibre in dry matter was determined in the apples obtained from the homestead orchard in Wola Sernicka.

3. There were not recorded any serious changes in an Mg content in the examined apples. The highest concentrations of P and K were noted in the apples produced from the orchard in Stryjno, while Ca in the apples gathered in the orchards in Łęczna and Puławy.

4. Among the microelements, the most B available had the apples produced in the orchards in Łęczna and Góry Markuszowskie, while Mn – in Łęczna and Stryjno.

5. The greatest differences were recorded in vitamin C content, its highest content was determined in the apples obtained in the commercial orchard in Lublin. The fruits harvested in the orchards of 5-10 ha area contained nearly twice less of this vitamin.

6. The apples coming from the homestead orchards also had the highest fructose (Wola Sernicka) and glucose (Łęczna) content. While the highest sucrose content was recorded in the fruits produced in the commercial orchard in Puławy.

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PORÓWNANIE WYBRANYCH SKŁADNIKÓW CHEMICZNYCH W JABŁKACH ODMIANY 'SZAMPION' WYPRODUKOWANYCH W SADACH WOJEWÓDZTWA LUBELSKIEGO

Streszczenie. Jabłka odmiany 'Szampion', wyprodukowane w sadach przydomowych, charakteryzowały się największą koncentracją składników pokarmowych w suchej masie. Niewielkie różnice notowano natomiast w zawartości składników mineralnych. Najwyższy poziom fruktozy (24,304 g/100 g s.m.), glukozy (5,207 g/100 g s.m.) i sacharozy (19,015 g/100 g s.m.) oznaczono w jabłkach zebranych w sadach: Woli Sernickiej, Łęcznej i Puław. Najzasobniejsze w witaminę C okazały się natomiast jabłka wyprodukowane w wielkotowarowym sadzie w Lublinie.

Słowa kluczowe: skład chemiczny, związki mineralne, cukry, witamina C, jabłko, 'Szampion'

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