

CHEMICAL AND POMOLOGICAL CHARACTERISTICS OF FRUIT OF SOME COMMERCIAL PEAR CULTIVARS GROWN IN CONDITIONS OF BJELO POLJE

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Abstract

This study described some chemical and pomological traits of fruits in 14 commercial pear cultivars in the ecological conditions of Bjelo Polje (Montenegro) in period 2010 to 2012. The study focused on few segments. Very first one included recording of the chemical traits - dry matter, total soluble solids, pH, and total acidity. The other segment comprised pomological traits [fruit weight (g), fruit size (mm), fruit length (mm),] petiole length (mm)].

Dry matters was determined by drying at 105 °C. Total soluble solids was determined by refractometer. The acidity was measured by titration with 0.1 N NaOH [AOAC, [1]]. Fruit mass were determined by measuring by the electric scale Metler 1200. The result is shown in grams with the accuracy of 0.01g. Fruit dimensions - length and width were measured by Vernier scale.

The values for fruit dry mater ranged from 16.6% ± 0.39 to 18.08% ± 0.32, total soluble solid contents ranged from 11.99% ± 0.25 to 15.66% ± 0.42, titrable acid contents ranged from 0.31 to 0.55 %. The values for fruit weights ranged from 67.76 ± 3.26 g to 251.76 ± 6.36 g, fruit length ranged from 52.72 ± 1.07 mm to 110.2 ± 1.05 mm, fruit widths ranged from 47.75 ± 0.42 mm to 79.23 ± 0.63 mm, and petiole length ranged from 16.87 ± 2.05 mm to 40.33 ± 2.09 mm. Fruit size and contents of major chemical fruit components were compared with the results of other authors who investigated the same properties.

The differences found were slight and occurred due to differing climatic characteristics of the localities in which the studies were conducted.

Key words: Pear, Cultivar, Chemical characteristics, Pomological characteristics.

1. Introduction

Pear, after the apple, represents one of the most important cultivars of pome fruits grown in the moderate climate zone (Hussain *et al.*, [2]). The fruits of the most common commercial cultivars of pear are highly valued by consumers thanks to low amount of calories and high nutritional value, as well as the pleasant taste (Senser *et al.*, [3]). In addition to fresh consumption, pear fruits are used as raw materials for different types of processing.

The pear (*Pyrus spp.*) genus is variously said to consist of from 20 to over 70 wild or domesticated species (Terpo [4]; Oliveira *et al.*, [5]; Potter *et al.*, [6] and Rehder, A., [7]). It is relatively difficult to give an accurate number of pear species, because they easily cross-pollinate and the obtained crosses have ambiguous taxonomic status. The existence of a very large number of cultivars, species, subspecies, hybrids and clones reinforces the need for genetic characterization and verification. The wild pear is the only species of pears that grows naturally in the region of Central Europe.

The capacity of *Rosaceae* species for interspecific hybridization, even beyond genus borders, has been exploited in breeding programmes to incorporate desirable traits of wild populations into breeding gene pools. Hybridization between fruit crops and their wild relatives has probably also occurred 'spontaneously' and individuals with intermediate phenotypes are known to occur throughout the European landscape. The importance of (anthropogenic induced) hybridization processes has been underestimated by conservation biologists until recently (Allendorf *et al.*, [8]). However, it is becoming more and more apparent that hybridization has led to the extinction of many populations and species and represents a severe threat especially to rare species that come into contact with other, more abundant species (Rhymer and Simberloff, [9]).

Pear is the most important temperate fruit crop and has been cultivated in Europe and Asia from antiquity (Janick, [10]). The pear tree cultivating has a long tradition in Montenegro. According to statistical data for Montenegro, the number of trees in the year of 2011 was 234.720, out of which 201.724 trees were yielding trees (Monstat, [11]).

The pear represents one of the most significant fruit cultivar in the territory of Bijelo Polje municipality. The structure of the pear assortment, apart from autochthonous varieties, includes commercially important cultivars, which are characterized with much larger fruits and better quality of the fruit flesh (mesocarp) in comparison to autochthonous pear varieties. The aim of this paper is to obtain data by researching the most important chemical and morphological fruit traits of 14 commercial pear cultivars in agroecological conditions in the territory of Bijelo Polje. The research results should show very important data for fruit production and processing.

2. Materials and Methods

Bijelo Polje is situated between 43° and 43°5' north latitude and 19°40' and 19°50' east longitude. The municipality of Bijelo Polje is situated at the altitude from 520 m (estuary of the River Kanjska to River Lim) to 2017 m (Komovi Mountain). The terrain of Bijelo Polje municipality is following the direction of River Lim flow, i.e. the north and northwest direction. Larger and better-quality agricultural land is located on the near proximity of the River Lim, and its tributaries (Šebek, [12]).

The municipality of Bijelo Polje has average annual temperature of 8.9 °C. The warmest period is during the months of June, July and August, with an average temperature from 16.3 °C to 18.1 °C. The coldest period is during the months of December and January, with an average temperature from 0.1 °C to -1.6 °C. The lowest daily temperatures on annual level are around -3 °C. The winter period is characterized with intense negative temperatures, which can reach up to -27.6 °C. The spring period is characterized with low temperatures, which can be more than critical when it comes to fruit production (late spring frosts). Namely, the month of April was recorded in some years with the lowest temperature of up to -8 °C. The average minimal temperature during April is -2.8 °C for the Bijelo Polje territory.

The annual precipitation level in Bijelo Polje municipality is 893.7 mm/m². The maximum precipitation is occurring during the period of October - December, while the period with the lowest precipitation is from June - August. The dominance of the cold and rainy period over the warm and dry one is expressed in relation of 54% vs. 46%.

During the three year period (2010 - 2012) the characteristics of 14 commercial pear cultivars were researched. Those cultivars are the following: 'Coscia precoce', 'Grand champion', 'Starkrimson', 'Santa Maria', 'Bella di Giugno', 'Starking delicious', 'Conference', 'Passe Crassane', 'Junsko zlato', 'William's bovey', 'Patten', 'Pachams's Triumph', 'Bonne louise d' avranches', 'Alexandre Lucas'.

These researches were conducted on a larger number of private production orchards, which are in near proximity one from another and are all situated within the territory of Bijelo Polje. All cultivars were grafted on the generative rootstock of wild pear (*Pyrus communis* L.), and their tree shape was formed according to the system of an improved pyramidal crown. The orchards were of mixed type, and the trees of researched cultivars were with average age of 7 - 10 years, and were in the fruiting period. When it comes to agro-technical measures, winter cutting and winter spraying were applied.

The study focused on few segments. Very first one included recording of the chemical traits - dry matter, total soluble solids (TSS), pH, and total acidity. The other segment comprised pomological traits [fruit weight (g), fruit size (mm), fruit length (mm) and petiole length (mm)].

Dry mater was determined by drying at 105 °C. Total soluble solids were determined by refractometer. The acidity was measured by titration with 0.1 N NaOH. Fruit weight was determined by measuring by the electric scale Metler 1200. Analyses of the fruit were done on an average sample of 30 fruits per cultivar. The result are shown in grams with the accuracy of 0.01 g. Fruit dimensions - length and width were measured by Vernier scale. Gained results were analysed by LSD test.

3. Results and Discussion

The results of chemical and morphological characteristics of fruits of pear cultivars are shown in Tables 1 and 2. Fruit dry mater, total soluble solids, pH and titrable acidity content of fourteen pear cultivars are shown in Table 1.

The values for fruit dry mater ranged from 16.6% ± 0.39 (Cv. 'Passe Crassane') to 18.08% ± 0.32 (Cv. 'Grand champion'); total soluble solid contents ranged from 11.99% ± 0.25 (Cv. 'Santa Maria') to 15.66% ± 0.42 (Cv. 'Bonne louise d' avranches'); pH ranged from 3.37 ± 0.47 (Cv. 'Grand champion') to 4.65 ± 0.47 (Cv. 'Conference'); titrable acid contents ranged from 0.23% ± 0.1 (Cv. 'Bella di Giugno') to 0.55 % ± 0.2 (Cv. 'Passe Crassane').

The results of our research, related to the parameter of dry matter drying, with cultivars 'Passe Crassane' and 'Conference' are approximate values in relation to data Juhasa and Bardić, [13], Vujanić - Varga and Grbić, [14]

and Stančević *et al.*, [15]. Every tested cultivar contains different percentage of total soluble solids (TSS). The high content of TSS (> 15%) was found in the varieties 'Bonne louise d'avranches' and 'Patten' ($15.66\% \pm 0.42$ and $15.16\% \pm 0.40$ respectively).

The cultivars 'Junsko zlato' and 'Santa Maria' have under 12.1% of total soluble solids. Data for total soluble solids, according to previously cited authors, for cultivars 'Passe Crassane', 'Conference' and 'Stark Delicious' are similar to the results of our research. The exceptions are the results of Stančević *et al.*, [15] for the cultivar 'Passe Crassane', where the total soluble solids amount is 17.17%, and the results of our research show 14% which is significantly lower. The cultivars which contain high content of TSS can be used for the production of brandy, for drying and other procession processes.

Previous similar researches show that the total soluble solids (TSS), titrable acidity (TA) and pH values of pear fruits grown in different agro climatic regions of Turkey are between 6 - 18%; 0.21 - 0.56% and 3.84 - 4.54, respectively (Karadeniz and Sen, [16]; Edizer and Gunes, [17]; Guleryuz and Ercisli, [18] and Ozturk *et al.*, [19]). Our findings regarding total soluble solids (TSS), titrable acidity (TA) and pH values showed results that were similar to these studies. The recorded variations of total soluble solids, titrable acidity and pH in pear fruits could be the result of different cultivars and the effect of the different agro ecological conditions, where the cultivars are grown. The researches of some chemical and physic-mechanical properties of the cultivar 'Santa Maria', in Turkey, show following characteristics: total soluble solids ($12.5\% \pm 1.46$); pH (3.94 ± 0.55)

and titrable acidity ($0.48\% \pm 0.04$), (Ozturk *et al.*, [19]). Research of some chemical and physic-mechanical properties for the cultivar 'Santa Maria', in Bosnia and Herzegovina, show following characteristics: total soluble solids (10%); pH (3.53) and titrable acidity (0.35%), Kulina *et al.*, [20]). Our research for the cultivar 'Santa Maria', in Montenegro, show following characteristics: total soluble solids ($11.99\% \pm 0.25$); pH (3.75 ± 0.50) and titrable acidity ($0.54\% \pm 0.2$). Therefore, the level of researched chemical parameters (TSS and TA) for the 'Santa Maria' cultivar is the highest in Turkey. Then, Montenegro results come in second place, while the lowest values are recorded by researches conducted in Bosnia and Herzegovina.

If we want to compare the TSS content in the fruits of commercial pear cultivars with the TSS content in the fruits of autochthonous pear cultivars, we will emphasize the following literature data:

- For the fruits of autochthonous pear cultivars in the territory of Bosnia and Herzegovina, the variation interval of the TSS content is from 13.51% - 19.72%. (Đurić *et al.*, [21]).
- For the fruits of autochthonous pear cultivars in the territory of Pakistan, the variation interval of the TSS content is on a slightly lower level (11.03 - 14.42%). (Hussain *et al.*, [22]).
- For the fruits of autochthonous pear cultivars in the territory of Gornje Polimlje (Bijelo Polje), the variation interval of the TSS content is 11.68% ('Pečanka') to 22.17% ('Vidovača'). The high TSS content (> 15%) was determined for the following cultivars: 'Begar',

Table 1. Chemical characteristics of fruit of some commercial pear cultivars

Cultivar	Fruit dry mater (%) mean \pm SD	Total soluble solids (%) (TSS) mean \pm SD	pH (0 -14) mean \pm SD	Total acidity (%) (TA) mean \pm SD
Coscia precoce	16.63 \pm 0.24	13.28 \pm 0.32	4.16 \pm 0.55	0.41 \pm 0.16
Grand champion	18.08 \pm 0.32	13.66 \pm 0.35	3.37 \pm 0.47	0.36 \pm 0.15
Starkrimson	17.15 \pm 0.31	12.76 \pm 0.28	4.35 \pm 0.62	0.50 \pm 0.18
Santa Maria	16.66 \pm 0.25	11.99 \pm 0.25	3.75 \pm 0.50	0.54 \pm 0.20
Bella di Giugno	17.05 \pm 0.40	13.80 \pm 0.38	4.30 \pm 0.60	0.23 \pm 0.10
Starking delicious	17.55 \pm 0.33	13.33 \pm 0.33	3.75 \pm 0.51	0.57 \pm 0.22
Conference	16.80 \pm 0.26	14.30 \pm 0.40	4.65 \pm 0.47	0.28 \pm 0.12
Passe Crassane	16.60 \pm 0.39	14.00 \pm 0.37	3.88 \pm 0.52	0.55 \pm 0.20
Junsko zlato	17.34 \pm 0.36	12.09 \pm 0.25	4.16 \pm 0.56	0.37 \pm 0.15
William's bovey	16.75 \pm 0.44	13.66 \pm 0.34	4.07 \pm 0.55	0.36 \pm 0.13
Patten	17.08 \pm 0.25	15.16 \pm 0.40	4.45 \pm 0.63	0.30 \pm 0.13
Pachams's Triumph	16.80 \pm 0.30	14.11 \pm 0.37	4.00 \pm 0.54	0.31 \pm 0.13
Bonne louise d'avranches	16.64 \pm 0.28	15.66 \pm 0.42	3.70 \pm 0.48	0.40 \pm 0.16
Alexandre Lucas	17.58 \pm 0.29	13.66 \pm 0.33	3.68 \pm 0.45	0.36 \pm 0.15
LSD 0.05	1.33	1.12	0.28	0.08
LSD 0.01	2.09	1.48	0.37	0.1

'Ječmenka', 'Jeribasma', 'Krivodrška', 'Samoraska', 'Sijerak', 'Vidovača' and 'Zelenika'. The highest level of TSS content was recorded in fruits of 'Begar', 'Zelenika' and 'Vidovača' (18.5%, 19% and 22.17%, respectively). (Jačimović *et al.*, [23]).

Wide variation in chemical and morphological characteristics of fruit were recorded among cultivars of different fruit species, such as apple (Đurović *et al.*, [24]; Šebek, [25]), medlar (*Hacisferogullaria et al.*, [26]) and cherry (Trajković, [27]).

Fruit weight, length, width and petiole length are given in Table 2.

The results of our research, as show in Table 2, indicate that the values for fruit weights ranged from 57.76 ± 2.26 g (Cv. 'Bella di Giugno') to 251.76 ± 6.36 g (Cv. 'Passe Crassane'), fruit length ranged from 52.72 ± 1.07 mm (Cv. 'Junsko Zlato') to 110.2 ± 1.05 mm (Cv. 'Conference'), fruit widths ranged from 43.75 ± 0.42 mm (Cv. 'Bella di Giugno') to 79.23 ± 0.63 mm (Cv. 'Passe Crassane'), and petiole length ranged from 16.87 ± 2.05 mm (Cv. 'Junsko Zlato') to 40.33 ± 2.09 mm (Cv. 'Patten').

The great variability in terms of fruit weight and dimensions is evident among different cultivars researched in our paper. The fruit weight of cultivar 'Passe Crassane', which is placed under the group of cultivars with largest fruits, is statistically significantly different from other cultivars. Likewise, the fruit weight of cultivar 'Bella di Giugno' (the group of cultivars with smallest fruits), is statistically significantly different comparing to other cultivars. As Table 2 shows, six cultivars have the average weight above 200 g ('Grand champion', 'Starking delicious', 'Conference', 'Passe Crassane', 'Bonne louise

d' avranches' and 'Alexandre Lucas'); three cultivars are with the fruit weight from 150 to 200 g ('Starkrimson', 'Santa Maria' and 'Patten'); two cultivars are with the fruit weight from 100 to 150 g ('William's bovey' and 'Pachams's Triumph'), while two cultivars are with the fruit weight under 100 g ('Bella di Giugno' and 'Junsko zlato').

Fruit weight, length and width are given in Table 2 and fruit weight of researched commercial pear cultivars varied within a wide range from 57.76 ± 2.26 g to 251.76 ± 6.36 g (Table 2). LSD test showed that there were statistically significant differences between varieties in terms of fruit weight for the following cultivars: 'Grand champion', 'Starking delicious', 'Conference', 'Passe Crassane', 'Bonne louise d' avranches' and 'Alexandre Lucas'. These cultivars were placed under the first group with the highest fruit weight level, which significantly differed from all other varieties. 'Bella di Giugno' and 'Junsko zlato' cultivars, which belong to the last group, were with smallest fruits in terms of its weight. Other cultivars are ranked between the first and the last group, based on their fruit weigh level.

Some studies previously conducted on pear cultivars in Turkey revealed that fruit weight, fruit length and fruit width ranged from 50 to 368 g; 61 to 91 mm and 59 to 78 mm, respectively. (Karadeniz and Sen, [28]). In Montenegro, our fruit weight, fruit length and fruit width results were similar to these studies. The variation of fruit weight, fruit length and fruit width of pear could be due to different cultivars and rootstocks researched, as well as different agro-pomotechnical conditions of orchards.

Table 2. Morphological characteristics of fruit of some commercial pear cultivars

Cultivar	Fruit weight (g) mean \pm SD	Fruit length (mm) mean \pm SD	Fruit widths (mm) mean \pm SD	Petiole length (mm) mean \pm SD
Coscia precoce	67.76 \pm 3.25	65.64 \pm 1.08	47.75 \pm 0.52	31.35 \pm 2.05
Grand champion	220.60 \pm 5.95	87.42 \pm 1.95	73.05 \pm 0.58	20.05 \pm 2.02
Starkrimson	187.50 \pm 4.35	84.91 \pm 1.55	69.78 \pm 0.58	30.42 \pm 2.05
Santa Maria	174.76 \pm 4.28	86.81 \pm 1.65	67.70 \pm 0.45	26.74 \pm 2.02
Bella di Giugno	57.76 \pm 2.26	72.05 \pm 1.84	43.75 \pm 0.42	37.22 \pm 2.09
Starking delicious	210.88 \pm 5.88	71.95 \pm 1.75	71.52 \pm 0.41	23.40 \pm 2.04
Conference	231.56 \pm 6.25	110.20 \pm 1.05	70.40 \pm 0.45	25.47 \pm 2.04
Passe Crassane	251.76 \pm 6.36	77.72 \pm 1.21	79.23 \pm 0.63	29.85 \pm 2.05
Junsko zlato	61.76 \pm 3.26	52.72 \pm 1.07	48.20 \pm 0.35	16.87 \pm 2.05
William's bovey	129.20 \pm 3.85	91.05 \pm 1.14	78.77 \pm 0.41	26.42 \pm 2.05
Patten	152.65 \pm 4.05	89.90 \pm 1.85	70.45 \pm 0.33	40.33 \pm 2.09
Pachams's Triumph	118.70 \pm 3.55	91.25 \pm 1.02	74.25 \pm 0.42	31.42 \pm 2.05
Bonne louise d' avranches	222.44 \pm 6.02	80.95 \pm 1.25	62.10 \pm 0.45	26.51 \pm 2.04
Alexandre Lucas	238.15 \pm 6.20	79.26 \pm 1.05	78.25 \pm 0.62	23.98 \pm 2.02
LSD 0.05	2.78	0.85	0.82	2.48
LSD 0.01	3.69	1.13	1.09	3.29

Selamovska *et al.*, [29] examined the local pear varieties in West Macedonia, which showed the variation of fruit weight in the range of 13.8 g to 214.1 g.

Fruit length was in the range of 52.72 ± 1.07 mm (Cv. 'Junsko Zlato') to 110.2 ± 1.05 mm (Cv. 'Conference'), and width from 43.75 ± 0.42 mm (Cv. 'Bella di Giugno') to 79.23 ± 0.63 mm (Cv. 'Passe Crassane') (Table 2). Comparing our data with other authors, it can be concluded that the dimensions of the fruit are in approximate range (Stančević, [30]; Milošević, [31]; Nenadović - Mratinić *et al.*, [32]) indicating that similar fruit weight causes similar dimensions, because there is positive correlation between these characteristics. This can be explained with the fact that the fruit weight is more influenced by environmental factors than the dimensions (Šebek, [33]).

4. Conclusions

Based on the obtained results on morphological and chemical characteristics of researched pear cultivars ('Coscia precoce', 'Grand champion', 'Starkrimson', 'Santa Maria', 'Bella di Giugno', 'Starking delicious', 'Conference', 'Passe Crassane', 'Junsko zlato', 'William's bovey', 'Patten', 'Pachams's Triumph', 'Bonne louise d' avranches' and 'Alexandre Lucas'), the following conclusions can be made:

- The values for fruit dry mater ranged from $16.6\% \pm 0.39$ (Cv. 'Passe Crassane') to $18.08\% \pm 0.32$ (Cv. 'Grand champion'); total soluble solid contents ranged from $11.99\% \pm 0.25$ (Cv. 'Santa Maria') to $15.66\% \pm 0.42$ (Cv. 'Bonne louise d' avranches'); pH ranged from 3.37 to 0.47 (Cv. 'Grand champion') to 4.65 ± 0.47 (Cv. Conference); titrable acid contents ranged from $0.23\% \pm 0.1$ (Cv. 'Bella di Giugno') to $0.55\% \pm 0.2$ (Cv. 'Passe Crassane').

- The results of our research, are indicating that the values for fruit weights ranged from 57.76 ± 2.26 g (Cv. 'Bella di Giugno') to 251.76 ± 6.36 g (Cv. 'Passe Crassane'), fruit length ranged from 52.72 ± 1.07 mm (Cv. 'Junsko Zlato') to 110.2 ± 1.05 mm (Cv. 'Conference'), fruit widths ranged from 43.75 ± 0.42 mm (Cv. 'Bella di Giugno') to 79.23 ± 0.63 mm (Cv. 'Passe Crassane'), and petiole length ranged from 16.87 ± 2.05 mm (Cv. 'Junsko Zlato') to 40.33 ± 2.09 mm (Cv. 'Patten').

- At the end of these studies, one general conclusion can be made, as an answer to set goals and the very task of our research: agro-ecological conditions of Bijelo Polje and its surrounding environment fully correlate to the intensive pear production, hence the agro-biological characteristics of researched cultivars can be demonstrated in an economically justified manner.

5. References

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