

Fruit quality assessment of some Romanian pear cultivars

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Abstract

Similar to apple, pear is one of the most important horticultural crops with high nutritional and economical value. The biological and economic traits of the specie, as well as the fruits quality, make the pear growing much appreciated and to be given an increasing importance. Five pear cultivars ('Paramis', 'Paradox', 'Paradise', 'Isadora', 'Pandora') registered in the last period by Research Institute for Fruit Growing Pitesti, Romania and one selection 'SP06C2P5' ('Packham's Triumph' x 'Monica') were investigated regarding their physical-chemical parameters. Fruits quality attributes were determined by the external (weight, size, skin lightness) and internal (firmness, total soluble solids, acidity, pH). Observations and determinations were made in the season of 2019, 2020 and 2021, in field trial planted in 2016. For this study, comparisons were made with 'Monica', the most spread bred Romanian cultivar. Significant differences were encountered among the different cultivars for most of the quantitative characters, such as fruit weight, caliber, lightness, total soluble solids (TSS) and acidity. Based on these results, 'Pandora' cv. had the highest annual average of weight (243.17g), 'Isadora' cv. the highest amount of TSS (14.63%), 'SP06C2P5' the highest amount of malic (0.74%), citric (0.71%) and tartaric acid (0.80%). The data referring to the external and internal fruit quality traits of new bred Romanian pear cultivars are useful for growers, but also to enrich germplasm collection and to select proper parents for breeding.

Keywords: *Pyrus*, size, firmness, lightness, soluble solids content, acidity.

INTRODUCTION

As a member of the *Rosaceae* family, pear has a wide range of germplasm resources and an ancient cultivation history. There are at least 22 known *Pyrus* species, with over 5,000 accessions that are either cataloged or maintained around the world. Of all the species of the genus *Pyrus*, the species *Pyrus communis* is the most widespread, together with its countless forms is a very valuable genetic material for creating new cultivars, with superior characteristics. China is a major producer of pear, accounting for 71.40% of world pear production, and supplies approximately 17.60% of the export pear market (Jiaming et al., 2022). The total European pear production is rather stable and has ranged during the last four years at around 2 million ton. Netherlands, Spain and Belgium are the most important pear producing countries and account for 57% of the total European production. In Romania, according to the FAO Statistics, pear production at the level of the 2020 year was about 46,000 tons, which represent 3% of total Romanian fruit production and only 0.20% of the world's pear production (FAO Stat Data Base, 2022).

Regarding the assortment, even if there are a very large number of cultivars (over 6000), the world pear production (including the one in Romania) is based on a small number of cultivars, such as 'Conference', 'Williams', 'Beurre Bosc', 'Passe Crassane', 'Beurre Hardy',

'Abate Fetel', some of them being sensitive to diseases and pests, with mediocre quality and with low storage capacity (Militaru *et al.*, 2010).

Therefore, it is necessary to continue the pear breeding program. Thus, countries such as US, France, Italy, England, Russia, Bulgaria, Greece, Slovenia, Republic of Moldova and Romania carry out extensive breeding programs. The main breeding objectives are resistance to fire blight, scab and *Psylla*, fruit quality, productivity, etc. (Militaru *et al.*, 2013).

In Romania, the pear breeding program developed at Research Institute for Fruit Growing Pitesti has the main objective to release new cultivars with tolerance to the main pest and diseases such as *Erwinia amylovora* (Burill) Winslow *et al.*, *Venturia pirina* (Aderhold), *Cacopsylla pyri* (L.), with crisp, juicy and flavor flesh, a long shelf life after cold storage (Budan *et al.*, 2009; Militaru *et al.*, 2010, Budan *et al.*, 2012, Braniste *et al.*, 2013, Militaru *et al.*, 2013). The breeding strategy involves the intercrossing of European (*P. communis*) and Asian, Japanese and Chinese (*P. pyrifolia* Nakai, *P. bretschneideri* Rheder) pear types. However, obtaining new cultivars depends on the natural conditions in which their culture occurs and the economic factors that differ from one area to another (Militaru *et al.*, 2010). It is recognized that there are no ideal cultivars for all regions and for all purposes. There are many cultivars that have excellent quality, but they are sensitive to diseases and pests, others give small productions, are sensitive to transport and storage, etc.

The objective of this study was to evaluate under Maracineni climatic conditions the performance of new pear cultivars, registered in the last time at Research Institute for Fruit Growing Pitesti, that have fruit quality suitable for local and regional markets.

MATERIALS AND METHODS

Field trial and climatic conditions

The pear field trial, establish in spring 2016, was planted in a randomized complete block design with five single-tree replicates per cultivar in a conventionally orchard. The trees, grafted on franc pear rootstock, were spaced at 3.5 m between rows and 3 m between trees. The climate neighboring RIFG Pitesti is favorable for growing deciduous fruit species (including the pear). The average multi-annual temperature is 10.0°C, the maximum temperature is 38.8°C, whereas the minimum temperature is -24.4°C; total annual rainfalls recorded is 678 mm. The early autumn frosts usually occur at the end of October and the latest about mid-April (Figure 1).

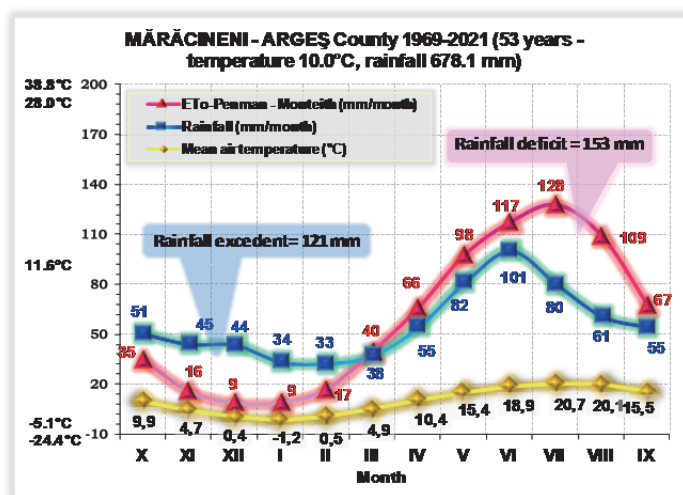


Figure 1. The values of the main meteorological parameters in the Maracineni area, between 1969-2021

Plant material

Five pear cultivars ('Paramis', 'Paradox', 'Paradise', 'Isadora', 'Pandora') and one selection ('SP06C2P5') registered by Research Institute for Fruit Growing Pitesti were compared with 'Monica', the standard in terms of fruit quality, appearance and good storage capacity (Table 1).

Table 1. Origin of Romanian pear genotypes studied

Cultivar	Reported parentage	Year released
Paramis	Monica x Passe Crassane	2008
Paradox	Monica x Pastravioare	2010
Paradise	H 26-67-73P x Pastravioare	2010
Isadora	Haydeea x Tse Li	2012
Pandora	Euras x Tse Li	2019
SP06C2P5	Packham's Triumph x Monica	-
Monica (Ct)	Santa Maria x Principe Di Gonzaga	1994

Measurement

The following biometrical and the biochemical indicators regarding the fruits quality were determined: weight, caliber, lightness, pH, acidity and soluble solids content.

Fruit quality data were collected immediately after harvest for three consecutive years (2019, 2020 and 2021), on a number of three fruits per each genotype in three replications. The fruit weight was measured using an electronic weighing balance (OAP-6-MA, Universal Enterprise) having the least unit of 0.001 g.

The fruit caliber (mm) was measured using a calibrator.

Skin colour was measured on two opposite sites using a Konica Minolta chroma meter CR-400, based on light transmittance. The colour values were expressed on the CIE colour system with L*, a* and b* axis representing lightness (change from black to white), green-red and blue-yellow, respectively. The values of a* and b* axis converted to hue angle (H°), which represents the tonality, varying between red (0°), yellow (90°) and green (180°).

The fruit firmness was determined with a digital penetrometer (Bareiss Qualitest HPE-II-FFF, Germany, at two distant places on each side of pear, and average values were reported. For measurement of total solids content (TSS), the total acidity (malic, citric and tartaric acid) and pH, the juice of the pear was extracted using a domestic juice extractor and was filtered through a cotton cloth.

The total soluble solids (TSS) was determined with the Hanna HI 96801 portable refractometer, in °Brix of juice.

The total acidity and pH were determined by using Hanna HI 84532 minititrator.

Statistical analysis. The data in this study were included in an Excel database and were statistically interpreted within the SPSS 14.0 program. The level of significance was defined as $P \leq 0.05$. Correlation analysis was performed in order to determine the relationships among fruit quality parameters.

RESULTS AND DISCUSSIONS

The concept of quality of European pear fruit at the time of consumption is different from that of the quality of fruit during or after storage. In the latter case the absence of defects, disorders and diseases is sufficient to describe a good quality fruit, while for eating quality an appropriate texture is needed, with balanced sweet and sour taste, and full development of typical pear flavor (Eccher Zerbini, 2002).

Fruit weight, determined on three fruits for each genotype in 3 replications, ranged from 152.4 g/fruit on 'Paradise' cv. to 230.68 g/fruit on 'Paramis' cv., between genotypes being very

significant differences. All genotypes studied, except 'Paradise' cv., have larger fruits than the control 'Monica', which has 174.02 g. Of the six new genotypes were noted with very large fruits 'Paramis' cv. with 230.68 g and 'Pandora' cv. with 243.17 g, the other genotypes having values of the fruits weight significantly lower, in varying degrees (Table 2).

The results regarding the fruits weight are in accordance with those reported by the Butac and Militaru in 2017 for 'Isadora' and 'Monica' cvs. On the 'Paramis' and 'Paradise' cvs. the fruits weight was greater than the results reported by the same authors in 2017, which can be explained by the fact that the climatic conditions and the technology were better during in the our study period.

Other authors, such as Braniste *et al.* (2013) and Budan *et al.* (2010, 2012) reports data on the fruits weight 'Paramis', 'Paradox' and 'Paradise' cvs. similar to those obtained by us.

Regarding the 'Isadora' cv., Budan *et al.* (2012) reports an average fruit weight of 120 g and our results show an average fruits weight larger (178.50 g).

Fruit caliber. The data on the fruit caliber (mm) showed that the values of the 'Paradise' and 'SP06C2P5' genotypes were significantly lower than the values of the control 'Monica'. In contrast, the other 4 Romanian cultivars had the fruits caliber significantly larger than of the control 'Monica' (Table 2).

A differentiation of the genotypes studied in terms of fruits caliber can be done taking into account the classification made by Iglesias (2008) who showed that from a commercial point of view, the minimum fruit sizes establish for early cultivars were > 50 mm and for late cultivars > 60 mm, respectively. In our study, all pear cultivars showed fruit sizes > 64 mm.

Table 2. External quality characteristics of Romanian pear genotypes studied (2019-2021)

Cultivar	Harvested time (month)	Fruit weight (g)	Caliber (mm)	Skin colour	
				L*	H ⁰
Paramis	IX	230.68 ^a	81.19 ^a	67.50 ^a	-79.77
Paradox	XI	184.91 ^b	71.67 ^b	69.25 ^a	85.10
Paradise	XI	152.40 ^c	64.31 ^c	53.87 ^d	58.64
Isadora	XI	178.50 ^{bc}	73.00 ^b	59.92 ^c	-69.21
Pandora	XI	243.17 ^a	79.89 ^a	66.92 ^{ab}	-81.20
SP06C2P5	VIII-IX	182.24 ^b	68.52 ^{bc}	54.31 ^d	-85.87
Monica (Ct)	IX	174.02 ^{bc}	68.84 ^{bc}	62.80 ^{bc}	76.60

Duncan multiple ranges test. Mean values followed by the same letter within a column are not significantly different (P≤0.05).

Skin colour. Colour is also an important quality parameter that directly affects appearance and consumer acceptability (Predieri and Gatti, 2008). Color intensity depends on the cultivar due to pigments content, like anthocyanins. According to the CIELAB color scale it is noted that, there are significant differences between cultivars influenced by the genetic factor. The lightness (L) is ranging from 54.31 on 'SP06C2P5' to 66.92 on 'Pandora'. The values of hue angle (H⁰) are ranging from 58.64 on 'Paradise' cv. to -85.87 on 'SP06C2P5'. Thus, compared to the values of the lightness and hue angle recorded at the control Monica' (L=62.80; H⁰=76.60), three of the studied cultivars ('Paramis', 'Paradox', 'Pandora' cvs.) were registered significantly higher values, and in the other three ('Paradise', 'Isadora' and 'SP06C2P5' genotypes) were significantly lower values. The average values of lightness and hue angle indicate that the most cultivars studied had the yellow color like 'Monica' cv., except for the 'Paradise' cv. which had the red color and the selection 'SP06C2P5' which had a rust color (Table 2).

Total soluble solids (TSS). Sugar, but also, acids and volatile substances are involved in taste and flavour of pears. Many seedlings, in the first generation cross, between European

and Asian pears had unpleasant flavours including unpleasant aromatics, alcoholic flavours, bitterness, grassiness and high acidity levels, but a few with European pear flavor and crisp or firm texture were identified (Brewer *et al.*, 2006, 2008).

The soluble solids content of fruits varied between 11.16° Brix on 'Paramis' cv. and 14.33% Brix on 'Isadora' cv., between genotypes being very significant differences. Compared to the value of 12.38% Brix registered on the Monica cv., three of the cultivars were registered significantly lower values, and in the other genotypes significantly higher. Comparing the values of the TSS recorded on the six genotypes, a grouping can be made in: genotypes with high values (13.76-14.63% Brix) and genotypes with lower values (between 11.16-12.10% Brix) significantly differentiated (Table 3).

The results regarding the soluble solids content of fruits are in accordance with those reported by the Butac and Militaru in 2017 only for 'Isadora'. On the 'Paramis', 'Paradise' and 'Monica' cvs. the fruits soluble solids content was smaller than the results reported by the same authors in 2017.

Fruit firmness. Texture is especially difficult to obtain, because it depends on many factors: time of harvesting, conditions and duration of storage, conditions of post-storage ripening. If storage is too short or too long, pears can soften with a dry, coarse texture. Also, if all conditions are met to obtain a buttery and juicy texture, it may be difficult to obtain it at the right time for consumption. The texture of fruit conditions the possibility that other compounds contained in the cell (sugars, acids, volatile substances) can be extracted from the cell with mastication and so can be perceived by the consumer (Eccher Zerbini, 2002). All pear study cultivars demonstrated good fruit firmness (more than 75 HPE units), two of the genotypes ('Paradox' and 'SP06C2P5') were registered significantly higher values, and in the other four ('Paramis', 'Paradise', 'Isadora', 'Pandora' cvs.) were significantly lower values than 'Monica' cv. (Table 3).

The results regarding the fruits firmness are similar to those obtained by Butac and Militaru in 2017.

Acidity. Regarding acidity, the highest values for malic, citric and tartaric acids were recorded for new selection 'SP06C2P5', which had a lowest total soluble solid content, the other cultivars studied having a lower acidity than the 'Monica' cv. (Table 3).

pH. It can be seen from table 3 that for pH value statistically significant differences among cultivars were found. 'Pandora' cv. had higher pH value (4.97) compared to control Monica while 'Paradise' cv. had lower one (4.05) (Table 3).

Regarding the fruits acidity, expressed by pH and the malic, citric, tartaric acid, the results obtained in the period 2019-2021 show a lower content in acids compared to the results obtained by Butac and Militaru in 2017.

Table 3. Internal quality characteristics of Romanian pear cultivars studied (2019-2021)

Cultivar	TSS (°Brix)	Firmness (HPE units)	Acidity			pH
			Malic acid	Citric acid	Tartric acid	
Paramis	11.16 ^c	75.38 ^b	0.203 ^d	0.192 ^d	0.230 ^d	4.29 ^{cde}
Paradox	13.76 ^a	79.95 ^a	0.214 ^d	0.201 ^d	0.241 ^d	4.56 ^{bc}
Paradise	12.10 ^{bc}	76.25 ^{ab}	0.258 ^d	0.247 ^d	0.288 ^d	4.05 ^e
Isadora	14.63 ^a	75.94 ^{ab}	0.322 ^c	0.314 ^c	0.353 ^c	4.73 ^{ab}
Pandora	14.53 ^a	75.57 ^b	0.214 ^d	0.204 ^d	0.240 ^d	4.97 ^a
SP06C2P5	11.81 ^{bc}	78.71 ^{ab}	0.741 ^a	0.718 ^a	0.802 ^a	4.43 ^{bcd}
Monica (Ct)	12.38 ^b	76.37 ^{ab}	0.408 ^b	0.382 ^b	0.455 ^b	4.23 ^{de}

*Duncan multiple ranges test. Mean values followed by the same letter within a column are not significantly different ($P \leq 0.05$).

There are distinctly significant correlations between:

- caliber and fruit weight ($r=0.815$) (Figure 2);
- fruit weight and lightness ($r=0.404$) (Figure 3);
- fruit weight and pH ($r=0.263$) (Figure 4);
- caliber and pH ($r=0.351$) (Figure 5);
- caliber and lightness ($r=0.563$) (Figure 6);
- lightness and acid malic ($r=-0.493$) (Figure 7);
- fruit soluble solids content and pH ($r=0.438$) (Figure 8);
- fruit soluble solids content and malic acid ($r=-0.295$) (Figure 9).

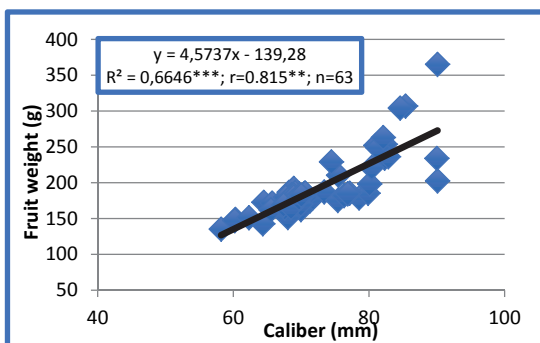


Figure 2. Significant correlation between caliber (mm) and fruit weight (g)

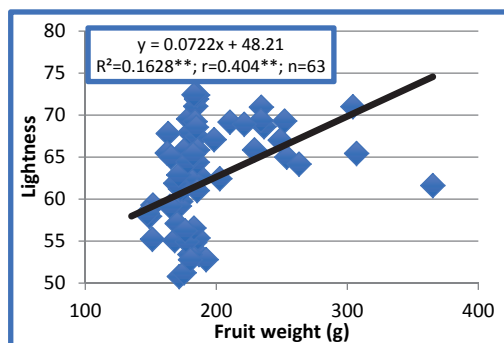


Figure 3. Significant correlation between fruit weight (g) and lightness

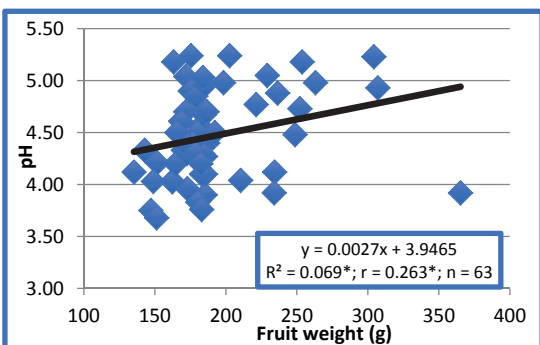


Figure 4. Significant correlation between fruit weight (g) and pH

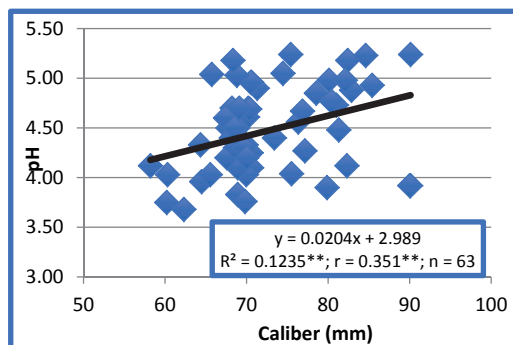


Figure 5. Significant correlation between caliber (mm) and pH

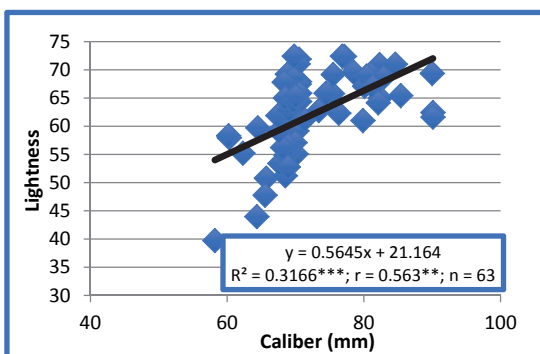


Figure 6. Significant correlation between caliber (mm) and lightness

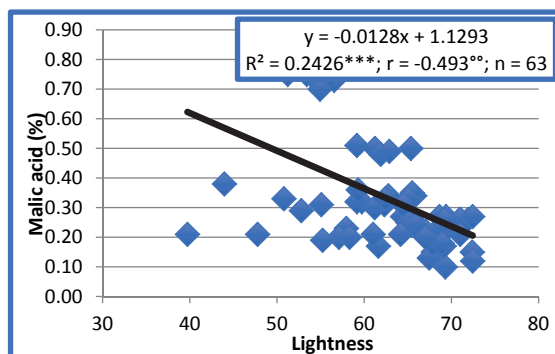


Figure 7. Significant correlation between fruit lightness and malic acid (%)

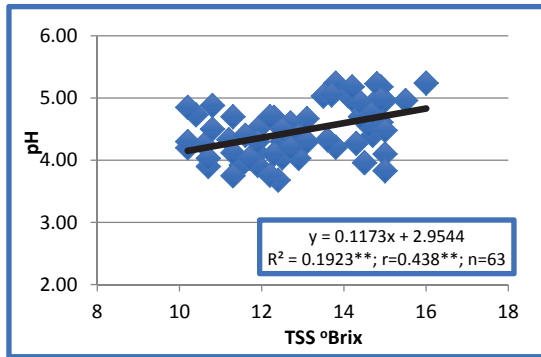


Figure 8. Significant correlation between fruit soluble solids content (°Brix) and pH

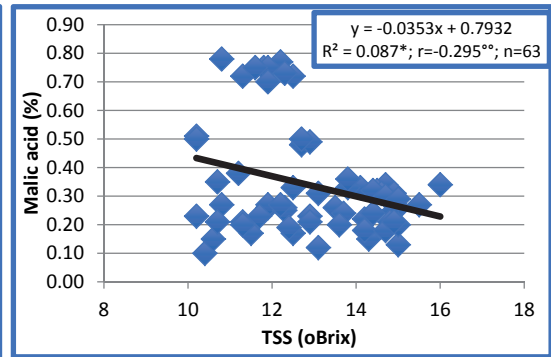


Figure 9. Significant correlation between fruit soluble solids content (°Brix) and malic acid (%)

It is known that climatic factors can influence the fruits quality parameters, such as size, color and content in sugar and acids. The results obtained show that between quality parameters and climatic factors are not significant correlations. In this case, the frequency of obtaining such results in the Maracineni area, has not been calculated.



Figure 10. Pear cvs. studied: a - 'Paramis', b - 'Isadora', c - 'Paradox', d - 'Paradise'

CONCLUSIONS

The data referring to the external and internal fruit quality traits of new bred Romanian pear cultivars are useful for growers, but also for researchers to enrich germplasm collection and to select proper parents for breeding.

Even if the genotypes taken in the study do not ripe in the same period, comparative observations and determinations have been performed in order to completing the assortment on different maturation stage. Thus, the 'Paramis' and 'SP06C2P5' genotypes can complete the autumn assortment, and the 'Paradox', 'Paradise', 'Isadora' and 'Pandora' cultivars can complete the winter assortment. These last cultivars seem to be interesting for the extension in the commercial culture in our country and abroad.

Also 'Isadora' and 'Pandora' cvs. offers important agronomical performances as size, taste and long storage, even if the standard 'Monica' proved a better general appearance. Both 'Paradise' cv. for nice red skin colour and 'Paradox' cv. for taste and flavor will be used in further works.

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