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COMERCIAL AND BIOCHEMICAL QUALITY OF ROMANIAN PEAR GENOTYPES

Eugenia GHERGHINA (MAREȘI)[1, 2], Mihaela PARASCHIV[2], Mădălina MILITARU[2], Dorel HOZA[1]

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăsti Blvd, District 1, Bucharest, Romania
[2]Research – Development Institute for Fruit Growing Pitești - Mărăcineni, 402 Mărului Street, Pitești, Argeș, Romania

Corresponding author email: mihaela1mail@yahoo.ca

Abstract

The present study was carried out to evaluate the quality of different pear genotypes used in the breeding programs at Genetic and Breeding Department of Research Institute for Fruit Growing Pitești, Romania. Thirteen new pear genotypes harvested at the commercial maturity stage: 'Argessis', 'Carpica', 'Cristal', 'Daciana', 'Haydeea', 'Isadora', 'Paradox', 'Paramis', 'Romcor', 'P20R41P30', 'SP06C2P', 'Triumph' and 'Tudor' were compared with internationally recognized varieties: 'Monica' (Romanian cultivar), 'Xenia' and 'Williams'. In this study we analyzed the commercial parameters (weight, firmness, color) and the biochemical indicators (total dry mater content, soluble dry matter, titratable acidity, the soluble dry matter/ titratable acidity ratio, vitamin C, and polyphenols). The obtained data leads to the conclusion that 'Isadora' and 'SP06C2P5P' fruits have the biggest chance to fulfill consumer expectations, due to their commercial qualities, then the reference variety 'Williams' cultivar. Also, the 'Isadora' variety had the content of polyphenols and the total dry substance superior to the three control cultivars.

Key words*: breeding program, fruit quality, polyphenols, Pyrus communis (L).*

INTRODUCTION

Pyrus communis L. is a typical crop of temperate climates and its fruit has numerous health benefits (Piluzza et al., 2023). It is an important and valuable fruit tree species, due to the agrobiological characteristics of the trees, the taste quality of the fruits, their nutritional and therapeutic properties, representing one of the main fruit crops of temperate climate (Sestraș, 2004).

Pear is cultivated on all continents, both in the Northern and Southern hemispheres, at the level of 2022, totaling a production over 26 million tons (FAOSTAT 2024). It gives the best results in regions with a temperate climate, but also succeeds well in subtropical regions.

Fruit quality is the main objective of all fruit breeding programs and encompasses a wide range of characteristics. A good quality fruit for the consumer an appropriate texture is needed, with balanced sweet and sour taste, and full development of typical pear flavor. In general, pears with external appearance of a whole fruit are used as an indicator of ripeness, although it can be a misleading one (Shewfelt, 2000). For consumers, the external appearance is very important, which refers to the size, shape, firmness and color of the fruit. Besides the commercial aspect, a major role is played by the taste and the other intrinsic characteristics of the fruit (aroma, juiciness, consistency, lack of sclereids). This set of quality elements is given, on the one hand, by the genetic structure of each variety, and on the other hand by the environmental conditions and the culture technology applied. Pear (*Pyrus communis* L.) fruit is rich in health promoting antioxidant compounds such as phenolic compounds (Ceccarelli et al., 2021; Wang et al., 2021). The composition of organic acids in pears is more variable than that of sugars. Generally, the most abundant is malic acid in all cultivars, but Drake and Eisele (1999) found very high proportion of citric acid in 'Bartlett' pears. Malic and shikimic acid decreased during ripening. Ripening is a key factor for fruit quality.

Branişte and Rădulescu (1994) showed as possible sources of genes for improving the quality of pears, the varieties 'Highland', 'Beierschmidt', 'Delbarexquise d'hiver', 'Graslin', 'Napoca', 'Untoasa de Geoagiu', 'Argessis' (for good taste), 'Triomphe de Jodoigne', 'President Heron', 'Beurre d'Anjou', 'Bergamotte Esperen', 'Notair Lepin', 'Grand Champion' (for high sugar content), 'Alexandre Lucas', 'Thompson', 'President Drouard', 'Matya', 'Moonglow', (for high vitamin C content).

The objective of this study was to evaluate different pears cultivars used in the breeding programs at Genetic and Breeding Department of Research Institute for Fruit Growing Pitești - Maracineni, Romania.

MATERIALS AND METHODS

Field trial and plant material

The study was carried out at Research Institute for Fruit Growing Pitesti - Maracineni, Genetic and Breeding Department, during harvest season 2023. Change in fruit quality parameters at different origin pears cultivars: 'Argessis', 'Carpica', 'Cristal', 'Daciana', 'Haydeea', 'Isadora', 'Paradox', 'Paramis', 'Romcor', 'P20R41P30', 'SP06C2P5', 'Triumf', 'Tudor, 'Monica' from Romania, 'Xenia' from Republic of Moldova and 'Williams' from UK, were evaluated by point of view commercial and biochemical quality of fruits. As control, the commercial variety 'Monica' (Ct1), 'Xenia' (Ct2) and 'Wiliams' (Ct3) were used. The trees grafted on M9, were planted in spring 2009, at 3.5 meters between rows and 2 m between trees. The optimal harvest time for picking each cultivar was constructed on the basis of reports in the pomological literature and for internal quality of fruits (Table 1).

Soil Description

The most favorable conditions for pear are found on soils with medium texture (clay-sandy and clay-argued), which provides optimal retention, transfer and movement regime in the soil, of retention and transfer of nutrients, optimal cationic exchange capacity.

The experimental plots are located on the third terrace of the Arges river, the type of soil being clear cambic (formerly brown eumezobasic), with sandy-clay texture up to 80 cm in-depth. The main agrochemical indicators that characterize the soil are the following: the pH in the water is included 6.16-6.36 (moderately acid), slightly under the requirements of the species compared to this aspect; The humus reserve has values between 0.86 and 2.11%; the nitrogen index has very low values (0.04-0.10%) the soil falling into the category of those with poor nitrogen supply.

Climatic conditions

The studied area has a humid temperature continental climate, climatic conditions of Maracineni, Arges are characterized by the average annual temperature of 12.3°C, the average annual rainfall of 663.3 mm and the relative humidity of the air wanted the value of 79.6%.

For the pear, the vegetation period is longer, between 180 and 270 days, compared to only 170 - 210 at the apple (Coman et al, 2014).

Measurements

To assess external fruit quality at harvest, ten representative pear fruits of each cultivar were used for physical and chemical analysis by standard methods:

- Fruit weight was determined by weighing a sample of ten fruits (g/fruit);
- The firmness of the fruit was determined with a HPE non-destructive penetrometer with a 0.5 cm^2 measuring device, expressed in HPE units (from 0 - without firmness - to 100 - very hard), the measurement was performed on the two parts of the fruits according to ECPGR, Pear (*Pyrus communis*) recommendations, 2022;
- The fruit content of the acids (malic, citric and tartaric acid), expressed in g / 100 g of fresh pulp or in percent, was determined by the Mini Titrator -Hanna Instrument 84532;
- The color of fresh fruits is one of the most important sensory quality attributes. The color of food surface is the first quality parameter evaluated by consumers, and it is critical to product acceptance. Fruits appearance determined mostly by surface color is the first sensation that the consumer perceives and uses as a tool to either accept or reject food (Leon et al., 2006).

Table 1. Background information of pear cultivars studied

Cultivar	Reported parentage	Institution	Tree	Fruit	Production	Harvesting time
Argessis	Napoca x Butira precoce Morettini	Research Institute for Fruit Growing Pitesti, Romania	Medium vigor	Medium size (125 g), pyriform, regular shape	Yields are constant	August
Carpica	Napoca x Butira precoce Morettini	Research Institute for Fruit Growing Pitesti, Romania	Medium - strong vigor	Medium-sized, on average 140 g, pyriform	High productivity	August
Cristal	[(Rosior pietros x Doyenné du Comice)xDoyenné du Comice]x Beurré Hardy	Research Station for Fruit Growing Voinesti, Romania	Medium vigor	Medium-large size, on 200 g average, the conical shape	High yielding potential	October-November
Daciana	Napoca x Butira precoce Morettini	Research Institute for Fruit Growing Pitesti, Romania	Medium vigor	Medium sized (150g), pyriform shape	High productivity	July
Haydeea	Beurré Hardy x Beurré Six	Research Station for Fruit Growing Cluj, Romania	Medium growth vigour	Medium-large size, on 180 - 220 g	High productivity (over 40-50 t/ha)	September
Isadora	Haydeea x Tse Li	Research Institute for Fruit Growing Pitesti, Romania	Medium –strong vigor	Medium sized, 115g	High productivity	October
Paradox	Monica x Pastravioare	Research Institute for Fruit Growing Pitesti, Romania	Medium vigor	Medium to large size, 150-170 g	Yields are constant	October
Paramis	Monica x Passe Crassane	Research Institute for Fruit Growing Pitesti, Romania	Medium vigor	Large, on average 180 g	Good productivity	September
Romcor	[Passe Crassane x (*Pyrus serotina* x Olivier de Seres)] x Doyenné du Comice	Research Station for Fruit Growing Voinesti, Romania	Medium - strong	Medium to large size, 200 g on average	Good productivity	October
SP06C2P5	Packham's Triumph x Monica	Research Institute for Fruit Growing Pitesti, Romania	Medium –strong vigor	Medium to large size	High yielding potential	September
P20R41P30	unknown	Research Institute for Fruit Growing Pitesti, Romania	Medium vigor	Medium to large size	Good productivity	October
Triumf	Napoca x Beurré Giffard	Research Institute for Fruit Growing Pitesti, Romania	Small to medium vigor	Medium (120g), pyriform shape	Good productivity	July
Tudor	[(*Pyrus serotina* x Doyenné du Comice) x Passe Crassane] x 30-44 Angers	Research Institute for Fruit Growing Pitesti, Romania	Medium - strong vigor	Large (200-250 g)	High yield potential	September-October
Monica (Ct_1)	Santa Maria x Principe di Gonzaga	Research Institute for Fruit Growing Pitesti, Romania	Medium vigor	Medium to large size, between 160-180 g	High productivity	September-October
Xenia (Ct_2)	Triomphe Vienne x Doynné Krier	Scientific-Practical Institute of Horticulture and Food Technologies Chisinau, MD	Medium vigor	Large (300-250 g)	High yield potential	October
Williams (Ct_3)	unknown	Aldermaston, UK	Medium vigor	Medium to large size (150-250 g)	Good productivity	September

The fruit skin color was visually evaluated and also with the Konica Minolta CR 400 colorimeter in the system (La*b*). The CIE (Commision Internationale de L'Eclairage)

LAB color range is an approximately uniform color scale in which the color space is organized in the shape of a cube. The L* axis is executed from top to bottom, representing a measure of brightness, on a scale from 100 (completely transparent) to zero (completely opaque). Axes a* and b* do not have specific numerical limits. Positive values to a* show red color and negative values show green color. The positive values for b* show the yellow color, and the negative values for the blue color (Chivu et. al, 2018).

pH-indicates the acidity or alkalinity of a substance, is a crucial metric for assessing the quality and ripeness of fruits, including pears(Taghinezhad et.al, 2023).These vary depending on the varieties, the pedoclimatic conditions and agrotechnics apply in orchards.

Total soluble solids content (TSS) was measured with Atago Palette PR32 digital refractometer (0-32°Brix).

The fruit content of the acids (malic, citric and tartaric acid), expressed in g / 100 g of fresh pulp or in percent, was determined by the Mini Titrator -Hanna Instrument 84532.

Total content in dry weight (DW) % was determined by the gravimetric method, by keeping the fruit tissue at 105°C until constant weight (AOAC, 2002).

Total polyphenolic content (mg GAE/100g FW) was assessed spectrophotometrically by measuring the optical density of the alcoholic fruit extract complexes with the Folin-Ciocalteu reagent (Singleton et al., 1999). The determinations were compared with a standard solution of gallic acid and the results were expressed in mg GAE/kg fresh fruit (Escribano – Bailon & Santos – Buelga, 2003).

Vitamin C content (mg/100 g FW) was determined according to the method based on the oxidation of L-ascorbic acid to dehydro-ascorbic acid in acidic medium (PN-A-04019, 1998). The vitamin C content (mg/100 g FW) is considered to be a very important quality indicator, because ascorbic acid is a bioactive compound with antioxidant properties.

Statistical analysis

The experiment was conducted in each sample and the data are expressed as mean ± standard deviation (SD). All data was normally distributed and respected homogeneity of variance. Results were processed by Excel (Microsoft Office 2010) and SPSS Trial Version 14.0. Data were subjected to analysis of variance (One-way ANOVA; $p \leq 0.05$), and Duncan's Multiple Range Test (DMRT) post hoc tests were used to measure specific differences between sample means.

RESULTS AND DISCUSSIONS

From the study of the results, it turned out that the limits of the variability of the main biochemical components that define the quality are very wide, from double to triple and even more.

Thus, in the varieties with the maturation time in the summer months, the analyzed components oscillate within: 89.33-159.33 g weight; 51.9-65,21 mm caliber; 49.03-84.97 HPE units firmness; 11.53-16.37% SSC; 3.31-3.65 pH; 0.18-0.33% malic acid; 0.17-0.28% citric acid; 0.20-0.36% tartaric acid; 1879.71-3114.49 mg GAE/kg FW polyphenols; 83.51-85.79% water content; 14.21-16.49% DW; 3.49-9.25mg/100g FW vitamin C; 42.04-63.43 L; -16.17-7.43 a*; 15.3-29.53 b*.

At the varieties with harvesting in the autumn months the analyzed components oscillatedwithinthe limits: 152.67-385.33 g weight; 63.14-91.45 mm caliber; 49.03-81.58 HPE units firmness; 12.53-15.83% SSC; 3.32-4.37 pH; 0.19-0.50% malic acid; 0.16-0.50% citric acid; 0.19-0.59% tartaric acid; 1010.15-4027.53 mgGAE/kg FW polyphenols; 79.49-85.35% water content; 14.24-20.51% DW; 4.46-10.3125 mg/100 g FW vitamin C; 45.59-66.9 L; -12.41-14.62 a*; 19.12-33.62 b*.

Fruit weight

Regarding the fruit weight, that could be taken as an indicator of potential consumer appreciation of the fruit at the market. From a genetic point of view, the weight of the pears is a polygenic character, whose manifestation is strongly influenced by the environmental conditions (Sestraș, 2004). Thus, following the statistical analysis of the data, it was observed that the varieties studied were in homogeneous classes, the average fruit

weight ranging between 89.33 g in the 'Triumf' variety to 385.33 g in the 'Paramis' variety. The varieties 'Paramis' and 'Tudor' overcoming control cultivars taken in study: 'Monica' (214 g), 'Williams' (253.33 g) and 'Xenia' (206.00 g) (Table 2).

Caliber

The limits between which the fruits of the new varieties must be located, to that optimal size, are between 150-250 g (but as uniform, without variability inside the variety), which corresponds to a diameter of 6-7.5 cm (Sestraș, 2004). The studied varieties were within this limit, except 'Paramis' cv. (92.92 mm), 'Tudor' cv. (91.45 mm) and 'Triumf' cv. (51.9 mm) (Table 2).

Table 2. Fruit characteristic of the pear genotypes

Genotype	Weight (g)*	Caliber (mm)*	Firmness (HPE units)*
Argessis	126.67±20.43^{cf}	60.5±4.30^{e}	84.97±1.06^{a}
Carpica	159.33±6.43^{cdef}	65.21±2.52^{cde}	83.17±2.49^{a}
Cristal	152.67±11.02^{def}	66.18±2.04^{cde}	71.6±1.39^{cdef}
Daciana	153.33±9.02^{def}	61.42±3.6d^{e}	83.07±1.55^{a}
Haydeea	193.33±4.16^{bcde}	67.26±1.26^{cde}	75.2±6.60^{abcde}
Isadora	228.67±108.71^{bc}	69.62±9.87^{de}	77.32±4.32^{bcdef}
Monica (Ct_1)	214.00±22.54^{bcd}	66.9±3.32^{bcd}	50.8±0.92^{abcd}
P20R41P30	172.00±20.3^{cde}	63.14±2.12^{bc}	72.62±12.55^{g}
Paradox	176.67±7.02^{cde}	67.76±1.92^{cde}	65.3±7.34^{f}
Paramis	385.33±68.71^{a}	92.92±9.67^{bcde}	76.1±1.49^{abcde}
Romcor	201.33±14.47^{bcd}	73.12±3.89^{a}	66.93±2.80^{ef}
SP06C2P5	223.67±24.01^{bcd}	74.08±1.96^{bc}	80.4±3.61^{abc}
Triumf	89.33±2.52^{f}	51.9±6.50^{f}	49.03±0.94^{g}
Tudor	375.33±64.79^{a}	91.45±3.93^{a}	69.98±0.97^{def}
Williams (Ct_3)	253.33±21.20^{bc}	76.47±3.85^{a}	25.8±10.71^{h}
Xenia (Ct_2)	206.00±7.21^{bcd}	70.42±1.74^{bcd}	81.58±1.55^{ab}

*Values followed by the same letter are not statistically different according to DMRT (P<0.05).

Firmness measurements

Fruit firmness is an important criterion for fruit quality pear (De-Ell et al., 2001) and the loss of fruit firmness is a serious problem in postharvest handling pear fruits (Kov & Felf, 2003), because it resulted in soft and mealy fruit with poor consumers acceptance. Firmness is a main quality indicator of the pear flesh and is commercially used to predict the optimal harvest date of pear (Hic et al., 2023; Wang, 2015). Torregrosa in 2019 showed that consumers most appreciated pears of the 'Conference' variety, which showed firmness value in the range of 10-30 N. The maximum average of flesh firmness (84.97 HPE units) was registered at 'Argessis' cv., follow by 'Carpica' with 83.17 HPE units. The smallest value of the firm of firmness was at the 'Williams' (25.8 HPE units) variety used as at control. 'Isadora' cv., traits inherited from the species *Pyrus serotina*, one of the parents of this cultivar belonging to this species (Militaru et al., 2010) also had high firmness (Table 2).

Total soluble solids content (TSS)

Sugar, but also, acids and volatile substances are involved in taste and flavor of pears (Maresi et al, 2022). The summer cultivars generally had much lower soluble solids content than the late season ones, what confirms our study. The soluble solids content of fruits varied between 11.16% Brix and 16.37% Brix.

Table 3. The chemical properties of the fruit in the pear genotypes studied

Genotype	TSS (%Brix)*	pH*	Titratable acidity (%)		
			Malic acid*	Citric acid*	Tartaric acid*
Argessis	13.57± 0.85de	3.62± 0.02^{ef}	0.20± 0.02^{jk}	0.19± 0.02^{ij}	0.23± 0.02^{i}
Carpica	13.2± 0.36^{def}	3.54± 0.09^{efg}	0.33± 0.03^{f}	0.30± 0.02^{f}	0.36± 0.03^{f}
Cristal	13.87± 0.32^{cde}	3.78± 0.12^{de}	0.28± 0.00^{h}	0.27± 0.00^{g}	0.31± 0.00^{g}
Daciana	11.53± 0.25^{f}	3.31± 0.12^{fg}	0.29± 0,02^{h}	0.28± 0.02^{g}	0.32± 0.02^{g}
Haydeea	15.83± 2.83^{ab}	4.13± 0.29^{abc}	0.21± 0.00^{j}	0.20± 0.00^{j}	0.23± 0.00^{i}
Isadora	15.53± 0.90^{abc}	4.43± 0.11^{a}	0.17± 0.00^{i}	0.16± 0.00^{m}	0.19± 0.00^{k}
Monica (Ct_1)	15.5± 0.30^{abc}	3.63± 0.20^{ef}	0.30± 0.01^{m}	0.29± 0.01^{f}	0.34± 0.01^{f}
P20R41P30	12.63± 0.60^{def}	3.75± 0.19^{de}	0.25± 0.00^{g}	0.24± 0.00^{h}	0.28± 0.00^{h}
Paradox	12.9± 1.31^{def}	4.03± 0.11^{cd}	0.35± 0.00^{e}	0.33± 0.00^{e}	0.39± 0.00^{e}
Paramis	12.53± 0.15^{ef}	3.60± 0.38^{ef}	0.40± 0.00^{d}	0.39± 0.00^{d}	0.45± 0.00^{d}
Romcor	14.5± 0.36^{bcd}	3.25± 0.2^{1g}	0.5± 0.01^{b}	0.47± 0.01^{b}	0.55± 0.01^{b}
SP06C2P5	13.23± 1.20^{def}	4.06± 0.16^{bcd}	0.53± 0.00^{a}	0.5± 0.00^{a}	0.59± 0.00^{a}
Triumf	16.37± 0.15^{a}	3.65± 0.24^{ef}	0.18± 0.02^{lm}	0.17± 0.02^{km}	0.2± 0.02^{jk}
Tudor	13.1± 1.14^{def}	4.21± 0.16^{abc}	0.19± 0.00^{kl}	0.18± 0.00^{jk}	0.21± 0.00^{j}
Williams (Ct_3)	13.73± 0.61^{cde}	3.32± 0.15^{fg}	0.45± 0.0^{c}	0.43± 0.01^{c}	0.5± 0.00^{c}
Xenia (Ct_2)	13.9± 0.2^{cde}	4.37± 0.15^{ab}	0.17± 0.00^{m}	0.16± 0.00^{m}	0.19± 0.00^{k}

*Values followed by the same letter are not statistically different according to DMRT (P<0.05).

The highest average of TSS was registered at 'Triumf' cv. with 6.37% Brix, followed by 'Haydeea' cv. with 15.83% Brix. Making a comparison between the values of the soluble solid content, it should be mentioned that the following genotypes studied had a lower content in the soluble solid than the control

cultivars: 'P20R41P30', 'Paradox', 'Paramis', 'SP06C2P5', 'Tudor', 'Daciana' (Table 3).

pH

Regarding pH, the results showed homogeneity is high enough and varying within a 3.25 and 4.43. Compared to the control varieties, 'Isadora' and 'Tudor' cvs. recorded the highest pH values (Table 3).

Titratable acidity

Organic acids together with sugars are the main soluble components of ripe fruits and have a major effect on taste, being responsible for acidity and aroma, at the same time, acidity is one of the main maturation indices that determine the date of harvesting of the fruits used either for direct consumption or for industrial processing (Neri et al., 2003; Crucirescu, 2022). With the approximation of the seeds of maturity, the fruit begins to ripen, and the concentration of acids decreases (Walker, 2011; Moscatello, 2012).

The most represented acid in the pear is malic acid, has the highest values at 'SP06C2P5' (0.53 %), 'Romcor' (0.50%). Of the analyzed varieties, 'Xenia' control cultivar had the lowest malic acid value 0.17%, the other control varieties had the content in malic acid 'Williams' (0.45 %) and (0.30%). In 2017, Butac & Militaru found values of malic acid for 'Monica' cv. of 0.25% and 0.30% for 'Isadora' cv. (Table 3).

Total polyphenols content

The content of phenolic compounds in fruits depends on intrinsic and extrinsic factors, such as the cultivar, part of fruit, agronomic practices, environmental conditions, maturity stage, and harvesting, in juices it also depends on the method of processing (Teixeira et al., 2023).

The polyphenolic content in pears is similar to that in apples (1654.8-5314.1 mg/kg DW) and quince (2609.50 mg/100 g DW) (Kolniak-Ostek et al., 2020; Górna´s et al., 2015; Teleszko et al., 2015). The results indicated that the varieties coming from *Pyrus serotina*, namely 'Isadora' and 'Tudor' have the highest content in polyphenols, respectively 4027.53 mg GAE/kg FW and 4000.00 mg GAE/kg FW, far exceeding the varieties taken as control (Table 4). Large values of the polyphenols content recorded at the following varieties: 'Triumf' (3114.49 mg GAE/kg FW), 'Paradox' (2788.41 mg GAE/kg FW), 'Cristal' (2679071 mg GAE/kg FW). On the contrary, the genotypes 'Paramis' and 'P20R41P30' showed lower contents, respectively 1167.27 mg GAE/kg FW and 1010.15 mg GAE/kg FW.

DW (%)

The fruit pears contain on average 79.19-87.23 % water, the rest is dry weight (DW). It consists of carbohydrates, proteins, lipids, minerals, organic acids, vitamins, phenolic compounds.

Table 4. The chemical properties of the fruit in the pear genotypes studied

Genotype	Total polyphenols content (mg GAE/kg FW)*	Water content (%)*	DW (%)*	Vitamin C (mg/100 g FW)*
Argessis	2178.26± 15.67^{ef}	84.76± 0.25^{ab}	15.24± 0.25^{ef}	7.79± 0.20^{bc}
Carpica	1879.71± 33.21^{fgh}	83.51± 0.09^{bcde}	16.49± 0.09^{cde}	9.25± 0.47^{a}
Cristal	2679.71± 488.63^{d}	83.97± 0.25^{bcd}	16.03± 0.25^{cde}	7.55± 1.33^{bc}
Daciana	2034.78± 4.35^{fg}	85.79± 1.01^{a}	14.21± 1.01^{f}	3.49± 1.06^{h}
Haydeea	2446.38± 354.19^{de}	84.21± 0.73^{bc}	15.45± 0.38e^{f}	7.11± 0.60^{bcd}
Isadora	4027.53± 33.21^{a}	79.49± 0.25^{f}	20.51± 0.25^{a}	5.25± 0.14^{fg}
Monica (Ct_1)	2820.29± 395.78^{cd}	83.48± 0.40^{bcde}	16.52± 0.40^{cde}	10.31± 0.44^{a}
P20R41P30	1010.15± 100.50^{i}	85.76± 0.36^{a}	14.24± 0.36^{f}	8.05± 0.69^{b}
Paradox	2788.41± 200.01^{cd}	80.63± 0.08^{f}	19.37± 0.08^{a}	7.83± 0.94^{bc}
Paramis	1167.27± 19.95^{i}	82.21± 0.30^{e}	17.79± 0.30^{b}	6.22± 0.27^{def}
Romcor	3315.94± 149.12^{b}	82.72± 0.07^{de}	17.28± 0.07^{bc}	4.79± 0.34^{g}
SP06C2P5	1594.2± 319.86^{h}	84.23± 0.26^{bc}	15.77± 0.26^{de}	7.74± 0.38^{bc}
Triumf	3114.49± 18.10^{bc}	85.78± 2.39^{a}	14.22± 2.39^{f}	6.65± 0.36^{cde}
Tudor	4000± 69.97^{a}	84.12± 0.08^{bc}	15.88± 0.08^{de}	4.46± 0.27^{gh}
Williams (Ct_3)	2475.36± 246.77^{de}	83.00± 0.25^{cde}	17.00± 0.25^{bcd}	5.6± 1.34^{efg}
Xenia (Ct_2)	1708.69± 23.01^{gh}	83.51± 0.19^{bcde}	16.49± 0.19^{cde}	5.19± 0.32^{fg}

*Values followed by the same letter are not statistically different according to DMRT (P<0.05).

Essentially, total dry matter reflects the quality of the fruit at harvest (Kader, 2002; Paraschiv & Nicola, 2023), the most relevant components being starch and soluble dry matter (Travers, 2013).

Highly significant differences, statistically assured by Duncan's multiple comparisons test, regarding DW were obtained between cultivars. This quality parameter was significantly higher in 'Isadora' and 'Paradox'

varieties (20.51% and 19.37%, respectively). For the ˈDacianaˈ and ˈTriumfˈ varieties, the average recorded value of this indicator was only 14.21 % and 14.22 %, respectively (Table 4).

Vitamin C (mg/100 g FW)

A very important element of the quality of the pears is vitamin C. The content in vitamin C on pears is very low compared to apple. The results of vitamin C content of pears genotypes investigated in this study are presented in Table 4. These results show that there are statistically significant differences between the pear genotypes. ˈMonicaˈ control cv. gave the highest results in vitamin C content (10.31 mg/100 FW), followed by ˈCarpicaˈ (9.25 mg/100 FW). At the other varieties the value of the vitamin C content was between 4.46-8.05 mg/100 FW. The smallest value was registered with the ˈDacianaˈ variety, 3.49 mg/100 FW. According to Radulescu (1994) the contents of pears in vitamin C is between 2.31mg/100 FW on the ˈMeskiˈ cv. and 16.4 mg/100 FW at the ˈSanta Mariaˈ cv., which partially confirms our study (Table 4).

The color

The CieLa*b* color space is organized in the form of a cube. Axis L is executed from top to bottom. The maximum for L is 100, which represents the white color, and the minimum for L is zero, which represents black. Axes a* and b* have no specific numerical limits. The positive values to show the color red and the negative values show the green color. Positive values for b* show yellow color, and negative values blue color (Butac et al., 2012).

The color of the fruits is a quality commercial element, the colored fruits usually having a higher success on the market. The color of the fruits is a quality commercial element, the colored fruits usually having a higher success on the market. The pear peel contains chlorophyll (green) or carotenoid (yellow) pigments that give the color of the fruits. The ratio between these pigments influences the color, and can vary from dark green to yellow. Compared to apples where the heredity of the color is polygenic, in the background color it is determined monogenic, the allele for the yellow color is dominant to the alley for the green color. The red color is given by the anthocyanin pigment, the allele that determines this pigment is recessive to the allele that determines its lack, which is why many varieties have no color (Sestraș, 2004).

There were significant differences between cultivars influenced by the genetic factor. The lightness L* is ranging from 42.04 on ˈArgessisˈ to 66.91 on ˈTudorˈ. Compared to the values of the lightness at the control 'Williams' (L=62.24), three of the studied cultivars ('P20R41P30', 'Romcor' and 'Daciana' cvs.) were registered significantly higher values, the other two cultivar varieties 'Monica' and 'Xenia' were significantly lower values. As for axis a*, five of them have positive values 'Argessis', 'Carpica', 'Haydeea' and 'Triumf' which indicates the red color of the fruits. Regarding the axis b* the results obtained show that the genotypes obtained are yellow (Table 5).

Table 5. Color of the fruit pear-measured with the Konica Minolta colorimeter (Lab)

Genotype	L*	a*	b*
Argessis	42.04±4.13^{d}	7.43±5.41^{ab}	16.36±2.95^{de}
Carpica	50.62±4.91^{abcd}	0.56±3.45^{bcd}	15.3±11.4^{e}
Cristal	55.97±7.54^{abcd}	-10.34±4.51^{ef}	24.95±3.33^{abcd}
Daciana	63.43±3.24^{ab}	-16.17±1.29^{f}	29.53±0.71^{ab}
Haydeea	45.85±6.54^{cd}	14.62±7.04^{a}	19.12±3.96^{cde}
Isadora	60.23±6.81^{abc}	-12.41±2.63^{ef}	28.76±3.26^{ab}
Monica (Ct_1)	59.82±14.74^{abc}	-1.79±2.08^{bcde}	25.95±6.7^{abc}
P20R41P30	65.44±0.99^{ab}	-3.51±4.52^{cde}	26.7±2.11^{abc}
Paradox	61.71±1.42^{abc}	-9.01±1.61^{def}	27.39±1.27^{abc}
Paramis	60.34±4.93^{abc}	-9.01±4.85^{def}	27.17±0.61^{abc}
Romcor	63.15±3.05^{abc}	-10.00±3.16^{def}	28.75±0.89^{ab}
SP06C2P5	49.28±2.18^{bcd}	-2.2±2.2^{bcde}	23.47±0.58^{bcde}
Triumf	50.24±21.39^{abcd}	2.15±17.00^{bc}	27.11±10.36^{abc}
Tudor	66.91±6.19^{a}	-1.96±3.77^{bcde}	33.62±2.48^{a}
Williams (Ct_3)	62.24±2.58^{abc}	-3.11±1.12^{bcde}	29.07±0.77^{ab}
Xenia (Ct_2)	54.49±17.4^{abcd}	-8.96±2.33^{def}	22.9±5.72^{bcde}

*Values followed by the same letter are not statistically different according to DMRT (P<0.05).

CONCLUSIONS

At the genotypes of Romanian pears in most cases, higher results have been obtained than in the foreign varieties taken as control.

Of the studied genotypes were noted: 'Paramis' and 'Tudor' cvs. for weight and caliber; 'Argessis', 'Carpica', 'Daciana' cvs. for firmness; 'Haydeea', 'Isadora', 'Triumf' cvs. for soluble solids content (% Brix); 'Isadora' and 'Tudor' cvs. for pH and total polyphenols content (mg GAE/kg FW); 'Daciana' and

'Triumf' for water content (%); 'Isadora' and 'Paradox' for DW (%); 'Monica', 'Carpica', 'P20R41P30' for vitamin C (mg/100 g FW).
It takes a continuous concern to complete the germplasm fund and find better gene quality sources.
For the characters taken in the study there is a great variability of gene sources, offering the breeders numerous choices for hybridization.

REFERENCES

Branişte, N., Rădulescu, M. (1994). Părul. In: Fondul de germoplasmă la speciile pomicole existente în România, ICPP Pitești-Mărăcineni (In Romanian).

Butac, M., Militaru M. (2017). Quality of some Romanian cultivars in correlation with consumer preferences. *Fruit Growing Research, Vol. XXXIII*.

Butac, M., Militaru, M., Budan, S. (2012). Criteria for harvesting plums at the optimum maturity for Romanian varieties of the fresh fruit market. *Fruit Growing Research, Vol. XXVIII*.

Ceccarelli, D., Antonucci, F., Talento, C., &Ciccoritti, R. (2021). Chemical characterization in the selection of Italian autochthonous genotypes of plum. *Scientia Horticulturae, 281*, 109922.

Chivu, M., Butac, M., Militaru, M. (2018). Research regarding fruits quality of some sour cherry genotypes from national collection. *Fruit Growing Research, Vol. XXXIV*, DOI 10.33045/fgr.v34.2018.03.

Coman, M., Chitu, E. (2014). Zonarea speciilor pomicole în functie de conditiile pedoclimatice și socio-economice ale României. Bucharest, RO: Invel Multimedia Publishing House, (In Romanian).

De-Ell, J.R., Khanizadeh, S., Saad, F. and Ferree, D.C. (2001). Factors affecting apple fruit firmness-a review.

Drake, S.R. and Eisele, T.A. (1999). Carbohydrate and acid contents of 'Gala' apples and 'Bartlett' pears from regular and controlled atmosphere storage. *Journal Agricultural and Food Chemistry, 47*(8), 3181-3184.

Drake, S. R., &Eisele, T. A. (1999). Carbohydrate and acid contents of Gala apples and Bartlett pears from regular and controlled atmosphere storage. *Journal of Agricultural and Food Chemistry, 47*(8), 3181-3184.

Escribano – Bailon M.T. & Santos – Buelga C. (2003). *Phenol extraction from food*, Ed. C. Santos-Buelgaand Williamson G., Royal Society of Chemistry, Great Britain, 1-16.

Famiani, F., Casulli, V., Baldicchi, A., Battistelli, A., Moscatello, S., & Walker, R. P. (2012). Development and metabolism of the fruit and seed of the Japanese plum Ozark Premier (*Rosaceae*). *Journal of Plant Physiology, 169*(6), 551-560.

Górna´s, P., Mišina, I., Olšteine, A., Krasnova, I., Pugajeva, I., Lacis, G., Siger, A., Michalak, M., Soliven, A., Seglina, D. (2015). Phenolic compounds in different fruit parts of crab apple: Dihydrochalcones as promising quality markers of industrial apple pomacee by-products. *Ind. Crop. Prod. 74*, 607–612.

Híc, P., Kožíšková, J., Omastová, P., Balík, J.,Goliáš, J., Horák, M. (2023). Physiochemical Changes of European Pear cv. Conference and Asian Pear cv. Yali during Cold Storage. *Horticulturae, 9*, 378. https://doi.org/10.3390/horticulturae9030378.

Kader, A.A. (2002). Methods of gas mixing, sampling and analysis. *Postharvest technology of horticultural crops 3*, 145-148.

Kolniak-Ostek, J, Kłopotowska, D, Rutkowski, KP, Skorupińska, A, Kruczyńska, DE. (2020). Bioactive Compounds and Health-Promoting Properties of Pear (*Pyrus communis* L.) *Fruits. Molecules, 25*(19), 4444. doi: 10.3390/molecules25194444. PMID: 32992651; PMCID: PMC7582546.

Kov, E. and Felf, E. (2003). Investigating the firmness of stored apples by non-destructive method. *Acta Hort. 59*, 257-260.

Lateur, M., Szalatnay, D., Höfer, M., Bergamaschi, M., Guyader, A., Hjalmarsson, I., Militaru, M., Miranda Jiménez, C., Osterc, G., Rondia, A., Sotiropoulos, T., Zeljković, M.K., Ordidge, M., (2022). ECPGR Characterization and Evaluation Descriptors for Pear Genetic Resources Pear (*Pyrus communis*).

Leon, K., Mery, D., Pedreschi, F., & Leon, J. (2006). Color measurement in L∗ a∗ b∗ units from RGB digital images. *Food research international*, *39*(10), 1084-1091.

Mareşi, E., Militaru, M., Butac, M., Stan, A. (2022). Fruit quality assessment of some Romanian pear cultivars. *RJH Vol. III*, 147-154. DOI 10.51258/RJH.2022.17.

Militaru, M., Branişte N., Sestraş A., Andrieş N. (2010). *Ameliorarea soiurilor de pere – realizări şi perspective*. Pitești, RO: Universitatea din Pitești Publishing House, 93 pp (In Romanian).

Neri, F., Pratella, G. C., & Brigati, S. (2003). Gliindici di maturazione per ottimizzare la qualità organolettica della frutta. *Rivista di Frutticoltura e di Ortofloricoltura, 5*, 20-29.

Paraschiv, M., Nicola, C. (2023). Dynamics of biochemical indicators of highbush blueberries during postharvest storage, *Fruit Growing Research, Vol. XXXIX*, DOI10.33045/fgr.v39.2023.20, https://publications.icdp.ro/index.php.

Piluzza, G., Campesi, G., D'hallewin, G.; Molinu, M.G.; Re, G.A.; Sanna, F.; Sulas, L. (2023). Antioxidants in Fruit Fractions of Mediterranean Ancient Pear Cultivars. *Molecules, 28*, 3559. https://doi.org/10.3390/molecules28083559.

Sestraș, R., (2004). Ameliorarea Speciilor Horticole, Cluj-Napoca, RO: AcademicPres Publishing House, 128 (In Romanian).

Shewfelt, R.L. (2000). Fruit & vegetable quality. In R.L. Shewfelt & B. Brückner (Eds.), *Fruit & vegetable quality: an integrated view,* pp. 144–157. Lancaster: Technomic Press.

Singleton V.L., Orthofer R., Lamuela-Raventós R.M. (1999). Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteure agent. In *Methods in enzymology*, *Vol. 299*, 152-178. Academic press.

Taghinezhad, E., Sharabiani, V.R., Shahiri, M., Moinfar, A., Szumny, A. (2023). Predicting Quality Properties of Pears during Storage Using Hyper Spectral Imaging System. *Agriculture, 13*, 1913. https://doi.org/10.3390/agriculture13101913.

Teixeira, J.C., Ribeiro, C., Simões, R., Alegria, M.J., Mateus, N., de Freitas, V., Pérez-Gregorio, R., Soares, S. (2023). Characterization of the Effect of a Novel Production Technique for 'Not from Concentrate' Pear and Apple Juices on the Composition of Phenolic Compounds. *Plants 12*, 3397. https://doi.org/10.3390/plants12193397.

Teleszko, M., Wojdyło, A.,(2015). Comparison of phenolic compounds and antioxidant potential between selected edible fruits and their leaves. J. *Funct. Foods, 14*, 736–746.

Torregrosa, L., Echeverria, G., Illa, J., Giné-Bordonaba, J. (2019). Ripening behaviour and consumer acceptance of 'Conference' pears during shelf life after long term DCA-storage. *Postharvest Biol. Technol., 155*, 94–101.

Travers, S. (2013). Dry matter and fruit quality: manipulation in the field and evaluation with NIR spectroscopy. *Department of Food and Technology*, 28-35.

Walker, R.P., Battistelli, A., Moscatello, S., Chen, Z. H., Leegood, R.C., &Famiani, F. (2011). Phosphoenol pyruvate carboxykinase in cherry (*Prunus avium* L.) fruit during development. *Journal of Experimental Botany, 62*(15), 5357-65. 22.

Wang, Z., Barrow, C.J., , F.R. Suleria, H.A.R. (2021). A Comparative Investigation on Phenolic Composition, Characterization and Antioxidant Potentials of Five Different Australian Grown Pear Varieties. *Antioxidants (Basel), 10*(2), 151. doi: 10.3390/antiox10020151. PMID: 33498549; PMCID: PMC7909527.

Wang, Y., Sugar, D. (2015). 1-MCP efficacy in extending storage life of 'Bartlett' pears is affected by harvest maturity, production elevation, and holding temperature during treatment delay. *Postharvest Biol. Technol. 103*, 1–8.

AOAC International (2002). Official methods of analysis (OMA) of AOAC International 17th Edition, USA. Method number: 920.15. Available at: http://www.eoma.aoac. org/.

PN-A-04019, (1998). Produktyspożywcze – Oznaczaniezawartościwitaminy C (Food products – Determination of vitamin C content).

https://www.ecpgr.cgiar.org/resources/ecpgr-publications/publication/ecpgr-characterization-and-evaluation-descriptors-for-pear-genetic-resources-2022.

https://www.fao.org/faostat/en/#data/QCL/visualize.