

Evaluation of qualitative traits in some pear cultivars and local populations grown in west part of Romania

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Abstract

The assessment of variability in fruit quality traits among pear genotypes is essential for the characterization of genetic resources and for supporting breeding strategies aimed at improving fruit quality. This study evaluated several morphological and qualitative parameters, including fruit weight, soluble sugar content, and pulp firmness, in a set of pear cultivars and local populations cultivated in western Romania. The results indicated significant differences among genotypes. Fruit weight ranged from 149.52 g ('Williams', used as control) to 288.84 g ('Santa Maria'), while soluble sugar content varied between 12.77 °Brix and 17.30 °Brix, with 'Fizești' and 'Margaret' genotypes exhibiting the highest sugar levels. Fruit firmness values ranged from 3.43 N ('Fizești') to 5.53 N ('Williams'). The observed variability highlights a substantial genetic diversity within the analysed material, offering valuable perspectives for future selection and breeding programs targeting pear cultivars with superior qualitative attributes.

Keywords: cultivars, pears, qualitative traits, local population

Introduction

The pear (*Pyrus communis* L.) is a fruit species of great importance, cultivated for thousands of years in the temperate regions of the globe [16]. Pear trees are cultivated in all the temperate zone regions which constitutes more than 50 countries [3,4]. Native to the southeastern areas of Europe and western Asia, it has gradually spread to all continents, being appreciated for its aromatic fruits, valuable from a nutritional and economic point of view. The dietary value of pears derives from their chemical composition and the presence of easily assimilated nutritional elements. Pears are indispensable in a balanced human diet and have diverse uses, including fresh consumption, dehydration, and processing into products such as compotes, marmalades, cider, and distillates. Pear cider—commonly known as perry—is particularly appreciated and widely consumed in several Western European countries [4]. Due to their superior flavour compared to many other fruits, pears serve as an excellent source of carbohydrates, offering an optimal balance of natural sugars and dietary fibre [8]. From a nutritional point of view, pears are rich in fibre, vitamins (C, K), antioxidants and minerals, being recognized for their benefits on the cardiovascular, digestive and immune systems. In addition to its nutritional value, pear contributes to the protection of the environment, the maintenance of biodiversity and the improvement of the urban and rural landscape. The genetic diversity within the genus *Pyrus* is essential for the breeding of varieties, especially in the context of climate change and market demands. Also, pear culture has a traditional and cultural value, being present in customs and gastronomy in many regions of the world. Pear fruit quality is determined by a combination of physical attributes, such as colour, size, texture, taste, and aroma, as well as by chemical parameters including sugars, organic acids, vitamins, and minerals [7]. Pears represent an important source of sugars, minerals, and various biologically active compounds, particularly phenolic compounds known for their antioxidant properties. In pears, the most significant sugar is fructose, followed by glucose, sorbitol, and sucrose [1,11,14,17,18]. In the context of modern consumer preferences, there is an increasing demand for fruits that not only exhibit distinctive sensory qualities but also ensure nutritional value and safety for human health.

Material and Methods

Measurements were performed on nine pear genotypes and local population (Williams, Galați, Fizești, Kiffer, Santa Maria, Conference, Nădăștie, Santa Maria Buteir, and Margaret) to investigate the variability of quality traits in *P. domestica* L. The plant material used consisted of fruits harvested at maturity. Measurements on the biological material included fruit weight, size index, sugar content, and pulp firmness [12].

Average fruit weight (g): 25 fruits were individually weighed, and the average, minimum, and maximum values were determined.

Size index (mm) – determined based on the average of measurements of the large diameter D, the small diameter d, and height H. The mean value was calculated on 25 fruit samples.

Formula: $I_{mm} = (D + d + H)/3$

Sugar content was determined on juice obtained by pressing the pulp using a refractometer. The recorded values were corrected using standard tables depending on the temperature. Sugars are the main component of dry fruit matter (approximately 90%). Monosaccharides (glucose and fructose), disaccharides (sucrose), and polysaccharides (cellulose, starch, and pectin) are the most common. Fruit sugars, especially simple ones, are readily assimilated by the human body, entering directly into the bloodstream without requiring energy-consuming transformations.

Pulp consistency (firmness) is an important characteristic for assessing the transport and quality of fresh fruits and apples. From a consumer standpoint, apples should have a firm, crisp, but not excessively hard texture to avoid harming the oral cavity. Pulp firmness was measured using a penetrometer.

Statistical and mathematical methods were used for data analysis and interpretation.

To determine the significance of differences among cultivars for each trait, the experimental data were processed using analysis of variance and the t-test for bifactorial experiments (year—main factor; cultivar—secondary factor). Significance levels were expressed using symbols (*, **, ***, 0; 00; 000), and differences among variants marked with different letters were considered significant. [10].

Results and Discussion

Studying the variability of quality traits in the analysed genotypes is an essential element in the characterization of genetic resources and the support of breeding programs. In this context, a series of morphological and qualitative parameters, such as fruit weight, soluble sugar content, and pulp firmness, as well as other relevant characteristics for evaluating the potential of the studied genotypes, were evaluated.

The weight of the fruits in the analysed genotypes ranged from 149.52 g/fruit, recorded in the control variety “Williams,” to 287.77 g/fruit, determined in the genotype “Santa Maria,” with statistically significant differences between the genotypes. All tested genotypes had higher fruit weight values than the control variety “Williams” (149.52 g/fruit). The “Kiffer” (276.39 g) and “Santa Maria” (287.77 g) genotypes stood out for their very high fruit weights, while the remaining genotypes recorded significantly higher values than the control, differentiated according to the genetic potential of each genotype (Table 1). The results regarding the fruits weight are in accordance with those reported by the Butac and Militaru in 2017 for 'Isadora' and 'Monica' cvs.

Table 1. Results regarding fruit weight in the experimental years

Genotypes	2023				2024			
	Mean (g)	Relative value%	Difference	Signification	Mean (g)	Relative value%	Difference	Signification
Williams	149.52	100.00	0.00		156.52	100.00	0.00	
Galați	150.48	100.64	0.96		154.14	98.48	-2.38	
Fizești	192.22	128.56	42.70		193.55	123.66	37.03	
Kiffer	276.39	184.85	126.87	***	277.38	177.22	120.86	***
Santa Maria	287.77	192.46	138.25	***	288.84	184.54	132.32	***
Conference	252.20	168.67	102.68	***	255.20	163.05	98.68	***
Nădăștie	186.03	124.42	36.51		186.69	119.28	30.17	
Santa Maria Buteir	216.82	145.01	67.30	**	221.16	141.30	64.64	**
Margaret	202.54	135.46	53.02	*	203.54	130.04	47.02	*
			LSD5%	45.10			LSD5%	44.00
			LSD1%	62.11			LSD1%	60.60
			LSD0.1%	85.51			LSD0.1%	83.43

Considering the weight of fruits in 2024 (Table 1), fruits from the analysed genotypes generally fall into the category of medium-sized fruits. The average weight values ranged from 154.14 g/fruit in the “Galați” population to 288.84 g/fruit in the “Santa Maria” genotype. Compared with the control variety “Williams,” the genotypes “Kiefer,” “Santa Maria,” and “Conference” showed very significant positive differences, highlighting a higher fruit size potential. Additionally, the genotypes “Santa Maria Buteir” and “Margaret” were distinguished by significantly higher average weights than the control, thus reinforcing the importance of these genotypes for use in breeding programs. In 2023, the fruit size index values were between 58.48 and 98.72 (mm). The highest value was recorded in the “Galați” population, with an index of 98.72, which was significantly different from that of the control variety. In addition, most of the genotypes analyzed showed significantly positive values compared with the control, indicating a higher fruit size potential. These results confirm the existing genetic variability and the relevance of the genotypes studied for improving fruit size in breeding programs. The data on fruit size (mm), presented in Table 2, showed in 2024 that all genotypes analyzed in 2024 recorded higher values than the control “Williams.” The “Galați” population and the “Santa Maria” genotype had the highest fruit size 98.05 and 85.02 mm, respectively. Other authors, such as Braniste et al. (2013) and Budan et al. (2010, 2012) report data on the fruits weight “Paramis”, “Paradox” and “Paradise” cvs. similar to those obtained by us. The differences from the control were statistically significant, confirming the potential of these genotypes to improve fruit size in breeding programs.

Table 2. Pear size index results in experimental years

Genotypes	2023				2024			
	Mean (mm)	Relative value%	Difference	Signification	Mean (mm)	Relative value%	Difference	Signification
Williams	58.480	100.000	0.000		59.160	100.000	0.000	
Galati	98.724	168.817	40.244	***	98.058	165.750	38.898	***
Fizești	71.701	122.608	13.221	***	71.651	121.114	12.491	***
Kiffer	75.588	129.254	17.108	***	75.191	127.098	16.031	***
Santa Maria	85.413	146.056	26.933	***	85.027	143.723	25.867	***
Conference	76.771	131.278	18.291	***	76.471	129.262	17.311	***
Nădăștie	63.763	109.034	5.283		63.553	107.426	4.393	
Santa Maria Buteir	75.174	128.547	16.694	***	74.508	125.943	15.348	***
Margaret	66.190	113.184	7.710	**	65.980	111.528	6.820	**
			LSD5%	5.394			LSD5%	4.654
			LSD1%	7.429			LSD1%	6.410
			LSD0.1%	10.228			LSD0.1%	8.824

Differentiation of the genotypes studied according to fruit size can be made taking into account the classification carried out by [15], which showed that the minimum fruit sizes established for early varieties were >50 mm and >60 mm for late varieties from a commercial point of view. All pear varieties in our study had fruit sizes of >60 mm. Soluble sugar content is one of the main determinants of the taste quality of fruits, directly influencing consumer preferences. Understanding the genetic basis and molecular regulatory mechanisms underlying variations in sugar content between different pear varieties is crucial for improving fruit sweetness and overall quality. In the experiment, the variability of this parameter in the pear genotypes studied was analyzed under agroclimatic conditions specific to 2023. The values of total soluble sugars (expressed in °Brix) varied significantly between genotypes. The range of determined values was between 12,60 °Brix in the “Williams” genotype and 17,60 °Brix in the “Fizești” population (Table 3). In most cases, the differences recorded were significant or very statistically significant, confirming the existence of a high genetic variability in terms of this quality character. Several genotypes showed higher sugar content than the control variety “Williams,” highlighting the “Fizești,” “Conference,” “Santa Maria Buteir,” and “Margaret” genotypes. These results indicate that these genotypes have valuable potential for improving taste quality. Table 3 shows that the soluble sugar content values in the genotypes studied in 2024 ranged between 12,77 °Brix and 17,30 °Brix. The highest values of sugar content were recorded in the “Fizești” and “Margaret” genotypes, and the results obtained were statistically significant compared to the control “Williams.” The control variety “Williams” showed lower sugar content, confirming the superiority of the “Fizești” and “Margaret” genotypes in taste quality. This significant differentiation highlights the importance of these genotypes for selection in breeding varieties with high fruit sweetness potential. In conclusion, the high variability in sugar content observed among the analysed

genotypes is a strong argument for the use of “Fizești” and “Margaret” genotypes in breeding programs aimed at improving the organoleptic qualities of pears.

Table 3. Results on the sugar content of pears in experimental years

Genotypes	2023				2024			
	Mean (°Brix)	Relative value%	Difference	Signification	Mean (°Brix)	Relative value%	Difference	Signification
Williams	12.60	100.00	0.00		12.77	100.00	0.00	
Galati	13.20	104.76	0.60	**	13.20	103.39	0.43	
Fizești	17.60	139.68	5.00	***	17.60	137.86	4.83	***
Kiffer	13.20	104.76	0.60	**	13.20	103.39	0.43	
Santa Maria	12.80	101.59	0.20		12.80	100.26	0.03	
Conference	13.40	106.35	0.80	***	13.73	107.57	0.97	**
Nădăștie	12.83	101.85	0.23		13.27	103.92	0.50	
Santa Maria Buteir	13.47	106.88	0.87	***	13.40	104.96	0.63	*
Margaret	15.90	126.19	3.30	***	16.23	127.15	3.47	***
			LSD5%	0.37			LSD5%	0.69
			LSD1%	0.51			LSD1%	0.95
			LSD0.1%	0.70			LSD0.1%	1.30

The variability identified in this study highlights the essential role of genetic background in determining sugar content, alongside pedoclimatic influences. In this context, genotypes with high sugar levels may be regarded as valuable genetic resources for future pear breeding programs.

Pulp firmness is a major characteristic in fruit quality assessment, playing a crucial role in determining storage capacity and resistance to handling and transport. Fruits with optimal firmness benefit from increased durability throughout the distribution chain, maintaining their commercial appearance and structural integrity. At the same time, it is important to note that excessive firmness is not always positively perceived by consumers. Fruits with very hard pulp may be considered unpleasant to eat and may, in some cases, cause discomfort or even injury to the oral cavity. Therefore, to obtain fruits that are competitive on the market, it is necessary to achieve a balance between optimal firmness for handling and storage and acceptable organoleptic quality for consumption. In terms of pulp firmness, the analysed genotypes exhibited values ranging from 3.56 N, recorded for the “Fizești” population, to 5.33 N, measured for the reference cultivar “Williams”. Compared to the control, none of the studied genotypes displayed higher values. These results indicate that, although some genotypes show advantages with respect to other quality traits, from the perspective of pulp firmness they do not surpass the performance of the reference cultivar “Williams”, known for its high fruit firmness (Table 4).

Table 4. Results on fruit firmness in pears in experimental years

Genotypes	2023				2024			
	Mean (N)	Relative value%	Difference	Signification	Mean (N)	Relative value%	Difference	Signification
Williams	5.333	100	0		5.533	100.000	0.000	
Galati	4.333	81.25	-1	oo	4.000	72.289	-1.533	ooo
Fizești	3.567	66.875	-1.767	ooo	3.433	62.048	-2.100	ooo
Kiffer	4.567	85.625	-0.767		4.433	80.120	-1.100	oo
Santa Maria	4.300	80.625	-1.033	oo	4.500	81.325	-1.033	oo
Conference	4.333	81.25	-1.000	oo	3.900	70.482	-1.633	oo
Nădăștie	4.767	89.375	-0.567		4.400	79.518	-1.133	oo
Santa Maria Buteir	4.533	85	-0.800		4.413	79.759	-1.120	oo
Margaret	4.933	92.5	-0.400		4.850	87.651	-0.683	
			LSD5%	0.591			LSD5%	0.630
			LSD1%	0.814			LSD1%	0.868
			LSD0.1%	1.120			LSD0.1%	1.196

The statistical analysis of the data revealed the existence of significant variability among genotypes for most of the assessed traits, reflecting a valuable potential for selection and breeding. The obtained results allow the identification of genotypes with superior performance in terms of fruit quality and provide a scientific basis for their use in future breeding programs.

Conclusions

Following the research carried out on the variability of quality traits in the analyzed pear genotypes, the following conclusions can be drawn:

Fruit weight showed significant variability, with values ranging from 149.52 g (“Williams” – the control of the experiment) to 288.84 g “Santa Maria”. All tested genotypes exceeded the control, recording highly significant statistical differences. The genotypes “Santa Maria”, “Kiffer”, and “Conference” stood out due to their high fruit weight, representing valuable potential for the improvement of this trait.

The fruit size index ranged between 58.48 and 98.72. The “Galați” population exhibited the highest value, significantly exceeding the control. Most genotypes recorded highly significant positive differences, confirming a high genetic variability with regard to fruit size.

The soluble sugar content varied between 12.77 °Brix and 17.30 °Brix. The genotypes “Fizești” and “Margaret” distinguished themselves by their high sugar content, with differences that were highly significant compared with the control. These results highlight their potential for improving flavour-related qualities.

Fruit firmness ranged from 3.43 N (“Fizești”) to 5.53 N (“Williams”). None of the tested genotypes surpassed the control in terms of firmness, confirming the superiority of the ‘Williams’ cultivar for this trait, which is relevant for storage capacity and resistance to handling.

Overall, the obtained results confirm the existence of significant genetic variability among the analyzed genotypes, offering valuable perspectives for the selection and breeding of pear cultivars aimed at obtaining fruits with superior quality traits.

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