

STUDIUL PRIVIND INDICI DE CALITATE ȘI RANDAMENTUL LA EXTRAȚIA SUCULUI UNOR SOIURI DE MĂR CULTIVATE ÎN SUD-ESTUL ROMÂNIEI STUDY REGARD SOME QUALITY INDICES AND YIELD ON JUICE EXTRACTION OF THREE APPLE VARIETIES GROWN IN SOUTHEAST ROMANIA

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Abstract

The apple (*Malus domestica*) is a species commonly found in temperate climates, leading both in cultivated area and fruit production. Apple consumption is recommended throughout the year. To ensure the presence of this fruit in the market for a long and continuous period, it is necessary for the harvest to be stored under optimal and specific conditions. The success of apple storage largely depends on the correct harvesting and timing appropriate for each variety. The composition of phenols and the antioxidant capacity of apple juice play an essential role in defining its quality and contribute significantly to its potential health benefits, acting in synergy with other components. The research was conducted in 2023 and analysed the behaviour of several apple varieties ('Florina', 'Golden spur', 'Jonagored') and their suitability for apple juice extraction. The experiment took place at the Moara Domneasca Experimental Base, which belongs to the Research and Development Station for Fruit Growing Baneasa-Bucharest. The experiment was organized into three variants based on the mentioned varieties, each with three repetitions per variant. Several quality indicators were monitored, such as fruit weight, firmness, main chemical components (total dry matter, soluble dry matter, titratable acidity) as well as the suitability for processing the apples. Additionally, organoleptic testing of the fruits was conducted to assess their sensory quality. Determinations were made on a total of 25 fruits for each variant, with the average used for data processing. It was found that the 'Florina' and 'Golden spur' cultivars have a similar average weight (123.30 g and 121.00 g), while 'Jonagored' has a significantly larger fruit (138.50 g). In terms of firmness, the 'Jonagored' and 'Golden spur' cultivars have similar firmness values (4.45 kgf/cm² and 4.50 kgf/cm²), while the 'Florina' cultivar shows a significantly higher firmness compared to the other two (5.19 kgf/cm²). Based on the obtained results, we can conclude that after processing, the 'Florina' cultivar had the highest yield in terms of juice volume extracted from the pulp (638.0 ml/kg) and from whole fruits (551.0 ml/kg), followed by the 'Jonagored' cultivar (601.0 ml/kg) and the 'Golden spur' cultivar (538.0 ml/kg).

Cuvinte cheie: *Malus*, fermitate, randament, extracție, soi.

Key words: *Malus*, firmness, yield, extraction, variety.

1. Introduction

Fruit, rich in easily assimilable sugars (glucose and fructose), organic acids, minerals and trace elements, is an essential component of a healthy diet. Regular fruit consumption throughout the year is essential for a balanced diet. For this reason, preserving fruit over winter is an important action, ensuring access to valuable nutrients throughout the year and increasing crop profitability by reducing market overcrowding during the harvest season (Oltenacu and Lascăr, 2015).

Apples are a good example of a fruit that has caught the attention of researchers for several reasons. Apart from being very affordable, versatile and inexpensive, apples have a high nutritional value and contain a wide variety of bioactive components, making them a fruit of interest. A study based on data from the 2013-2016 National Health and Nutrition Examination Health and Nutrition Examination Survey reported that the consumed of apple juice had a 10% higher 2015 Healthy Eating Index score compared to non-consumers, as well as higher intakes of a variety of nutrients such as vitamins C and D, calcium, magnesium, potassium, and energy (Marcotte et al., 2022).

The dominant sensory attributes of apples are the taste sensation of sweetness and acidity, caused by sugars (glucose, fructose and sucrose) and malic acid, respectively, which are the main components of the apple, along with water. Apples contain dietary fiber in their skin and core. Apples also contain vitamins and minerals. The flavor of the apple results from the subtle mixtures of the 250 volatile esters, alcohols, aldehydes and essential oils present. The fruit's color comes from trace chemicals such as chlorophyll, carotenoids and anthocyanins. The rest of the apple consists of water (Karakasova et al., 2009).

According to Table 1, the total area planted with fruit trees is small, in 2020 it is about 138 thousand ha, representing only 1% of the country's agricultural area, with apple plantations occupying an area of 57,100 ha, of which a large part is in decline (Vlad et al., 2022).

The process of preserving fruit must be carried out carefully, maintaining its optimal organoleptic qualities until the moment of consumption. Well-preserved fruit retains its freshness, turgidity and specific characteristics, minimizing weight loss during storage. Successful storage depends largely on the quality of the fruit at the time of harvest. Their natural characteristics, defined by the totality of their physical, biochemical and organoleptic characteristics, have a significant influence on the duration and efficiency of storage.

The area of fruit tree plantations under fruit tree plantations and fruit production 2021-2022 in Romania was over 136 thousand ha and the production recorded an amount of 930 thousand tons in 2021 followed by a significant decrease to 716 thousand tons in 2022 (Table 1).

Romania ranks 5th in Europe in apple production (www.forbes.ro). In the Bucharest-Ilfov region, the region to which the SCDP Băneasa Experimental Base belongs, apple production was between 24-29 kg/tree (Table 2).

Approximately 77% of apples are used as fresh fruit, while 23% are processed for natural juice, nectar, syrup, jam, marmalade, canned fruit, candies, ice cream, frozen fruit, dried fruit, etc. (Popescu, 2016).

2. Material and methods

The present study focused on three apple (*Malus domestica*) cultivars grown at the Moara Domnească Experimental Station, part of the Băneasa - București Research and Development Station for Fruit Growing. The study was conducted during 2023.

The study area is dominated by soils of the Luvisols class, with reddish preluvosols as the predominant soil type. Reddish luvisols and stagnosols are also found in the depressional areas and in the crovs. On the slopes of the Pasărea valley, eroded reddish Preluvosols can be found 2.46% humus content in the Ap horizon and 2.17 % in the Bt horizon, data presented in Table 3. The amount of precipitation recorded in 2023 was not sufficient, being below the average value of the last 10 years, 376.9 mm, excluding December (Fig. 1).

The experiment included three apple varieties 'Florina', 'Golden spur' and 'Jonagored'. All varieties were planted in 2020, on an area of 0.4 ha.

'Florina' is a variety that is almost immune to rapeseed, tolerant to floury, early and extremely productive. It does not need much spraying and the fruit can keep well until March-April. It ripens in October, with an aromatic, sweet and slightly acidic taste. The flesh is yellow, crisp and juicy. It is a variety obtained in Angers, France, and the fruit can reach a weight of about 150-200 g.

The 'Golden spur' variety is susceptible to rapeseed and has a good consistency and high sugar content which induces storage for 6-8 months after harvest. Native to the U.S., the fruit develops to 100-150 g. Ripening between September-October, the flavor is aromatic, moderately acid-sweet, the flesh is yellowish in color, crisp and aromatic.

The 'Jonagored' variety, harvested in the first half of October is ripe in December and has good frost resistance (www.pepinieramoara.ro). The fruit is medium to large (150-210 g) and was obtained in the United States in 1953 in Geneva, New York, by the New York State Agricultural Experiment Station of Cornell University's College of Agriculture and Life". 'Jonagored' is a mutant of 'Jonagold', which is a controlled cross of 'Jonathan' with 'Golden Delicious' (Rocha and Morais, 2001).

The experiments were single-factor, organized in 3 variants, based on the mentioned varieties, with 3 replicates per variant (Table 3).

Within 5 days of harvesting, physico-chemical analyses were carried out to determine the apples' suitability for processing, consisting of: determination of the average mass, using the Precisa XT620M scale to measure their weight (g), the structural and textural firmness of the apples, determination of the juice content in the fruit pulp, organoleptic testing of the fruit to assess their sensory quality, consisting of comparative tastings including 3 criteria (appearance, firmness, taste), values presented in Table 4.

In order to accurately assess the properties of each apple variety, 25 fruits were taken as an average sample. Careful selection was made, choosing representative apples in terms of size, ripeness and color. Structure-texture firmness was determined using an Effe-gi hand-held penetrometer (kgf/cm²) with an 11 mm plunger. Four penetrations were carried out in the equatorial area of each apple, after local removal of the epidermis in these areas. This method allowed an accurate evaluation of the pulp's resistance to pressure, providing important information about the stage of ripeness and texture of the apples.

A total of 25 fruits were used to evaluate the amount of juice extracted from each apple variety. The juice extraction was carried out using a laboratory centrifugal juicer, ensuring high accuracy of the

measurements. The amount of juice obtained was related to the mass of fruit introduced in the extraction process, giving a clear picture of the yield of each variety (Table 5).

In addition to the determination of the quantity of juice, detailed observations on the color and degree of sedimentation of the extracted juice were also made, as shown in Table 6. These observations allowed a more in-depth analysis of the organoleptic characteristics of the juice, providing additional clues about the quality and composition of the apples.

A 100-point rating scale was used to assess the sensory quality of the apples. Each of the three evaluation criteria - appearance, firmness and taste - received a specific weight in the overall scoring, reflecting its importance. Appearance contributed 15% to the final score, firmness 35% and taste 50%. Based on the score obtained, the apples were classified into quality classes, according to the results presented in Table 7. This classification gives a clear picture of the overall organoleptic quality of apples, allowing the identification of the varieties with the best taste and visual characteristics.

Table 7 details the ranking of the fruits according to the scores obtained in the quality assessments. Each variety was evaluated according to standardized criteria.

'Florina' obtained the maximum score in the evaluation, falling in the 'very good' category (80-100 points), which reflects the superior quality of the fruit, both in terms of appearance and organoleptic and physico-chemical characteristics.

'Golden spur', with a score between 60 and 79, falls into the 'good' category, indicating satisfactory quality but inferior to 'Florina'. This score suggests an average subjective quality depending on the judge's taste, but the fruits remain competitive on the market.

'Jonagored' scored between 40 and 59 and is classified as "acceptable". This reflects the presence of quality characteristics below expectations, either in terms of size, consistency or other commercially and qualitative important characteristics.

These results highlight the small qualitative differences between the varieties and provide a scientific basis for recommending them in practice, either for consumption or for further cultivation.

3. Results and discussions

Following the experiment, the 'Florina' variety proved to be the most valuable organoleptic and physico-chemical variety, with the best properties for consumption and industrial processing. It obtained excellent scores in all the categories analysed, being superior to the other varieties.

'Golden Spur' showed satisfactory quality but needs more attention in terms of plant protection and long-term storage. Table 4 shows that the 'Jonagored' variety, although a large and attractive fruiting variety, had inferior firmness results. The highest firmness was measured in 'Florina', 5.19 kgf/cm.

These aspects suggest that 'Florina' deserves to be promoted as a favourite variety for production, due to its excellent adaptability and outstanding organoleptic characteristics, but also due to its high firmness which makes it resistant to handling and storage, while 'Golden spur' and 'Jonagored' can be grown according to market demand.

Physical characteristics of the fruit

'Florina' and 'Golden spur' varieties had a similar average mass (123.3 g and 121 g), while 'Jonagored' had a significantly bigger fruit (138.50 g), exceeding the average weight of the three varieties, 127.6 g. 'Florina' variety had a high firmness (5.19 kgf/cm²) exceeding the average of all three varieties (4.71 kgf/cm²). The 'Golden spur' variety had a firmness value of (4.5 kgf/cm²), which is close in value with the 'Jonagored' variety (4.45 kgf/cm²).

Biochemical characteristics of the fruit

All 3 varieties had a similar juice content, with values above 600 ml/kg (pulp) and 500 ml/kg (fruit). 'Florina' and 'Golden spur' varieties had similar juice extract values, over 650 g/kg (pulp) and 570 g/kg (fruit), slightly higher than 'Jonagored' (652 g/kg pulp, 574 g/kg fruit). On average, 'Florina' had the highest juice content (638 ml/kg pulp, 551 ml/kg fruit; 658 g/kg pulp, 575 g/kg fruit), followed by 'Jonagored' (601 ml/kg pulp, 538 ml/kg fruit; 652 g/kg pulp, 574 g/kg fruit) and finally 'Golden spur' (600 ml/kg pulp, 535 ml/kg fruit; 650 g/kg pulp, 572 g/kg fruit) (Table 5).

The apple juice extracted from 'Golden spur' and 'Jonagored' varieties had a significantly lower degree of sedimentation (15.40% and 23.10%) compared to 'Florina' (31.0%), indicating better stability and lower turbidity (Table 6).

4. Conclusions

Of all analysed varieties ('Florina', 'Golden spur' and 'Jonagored'), 'Florina' was best suited for juice extraction because it had the highest juice yield, both from pulp (638 ml/kg) and fruit (551 ml/kg), which is essential for juice producers as it allows a greater quantity of juice to be obtained from the same quantity of fruits. It had the highest concentration of juice mass from both pulp (658 g/kg) and fruit (575 g/kg), giving the juice a richer taste and more intense flavor.

Although 'Golden spur' and 'Jonagored' have certain advantageous characteristics (higher soluble sugar content, better appearance and sedimentation of the juice) 'Florina' stood out for an optimal balance of all the factors analysed, making it the ideal variety for the extraction of an aromatic juice with superior quantity content, preferred by consumers.

No differences in juice content between the apple varieties under analysis, regardless of whether the pulp ratio or the whole fruit ratio was considered. This result proves that all the three varieties analysed are suitable for apple juice extraction, each having an added value either in terms of sugar content, acidity (tartness) or flavor. This makes it possible to cover the market and consumer preferences with juices to suit every taste.

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Tables and figures

Table 1. Area of fruit tree plantations under fruit trees and fruit production 2021-2022 in Romania
 (Source: statistici.insse.ro)

	Surface		Total production		Differences (±)	
	- thousand ha-		- thousand tons-		compared to 2021	
	2021	2022	2021	2022	thousand ha	thousand tons
Fruit orchards	138	136	930	716	-2	-214

Table 2. Average apple production in the Bucharest Ilfov region
 (Source: statistici.insse.ro)

Fruit categories	Forms of ownership	Macro-regions, development regions and counties	Year		
			2021	2022	2023
			Kg/ tree		
Apples	Total	Bucharest - Ilfov county	29	25	24
	Private sector	Bucharest - Ilfov county	12	10	10
	Individual agricultural holdings	Bucharest - Ilfov county	17	15	14

Table 3. Chemical properties of the soil from Moara Domneasă 2019

Horizon	Depth (cm)	pH soil	Total content			
			Humus %	N-NO ₃ %	P ₂ O ₅ %	K ₂ O %
Ap	0-20	5.27	2.46	0.135	0.159	1.65
A/B	20-45	5.20	2.30	0.120	0.130	1.05
Bt	45-150	5.10	2.17	0.100	0.108	0.99
Cca	150-200	5.35	1.85	0.070	0.115	1.23

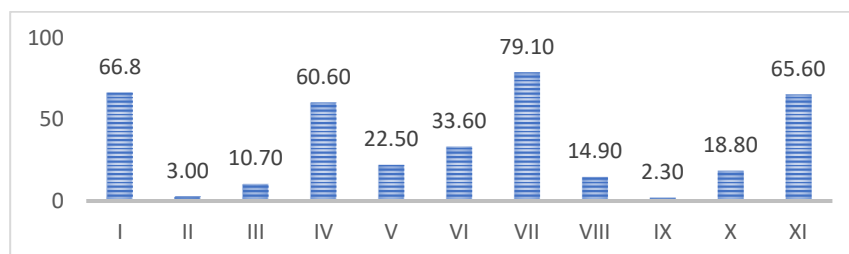


Fig. 1. Average monthly precipitation (mm) (2023), excluding the month of December.
Source: Moara Domneasă Weather Station

Table 4. Average weight and textural firmness of apples

Variant	Variety	Average weight (g)	Firmness (kgf/cm ²)
V1	Florina	123.30	5.19
V2	Golden Spur	121.00	4.50
V3	Jonagored	138.50	4.45
	Average	127.60	4.71

Table 5. Juice content resulting from extraction in apples

Variant	Variety	Juice content			
		Reported to the pulp		Reported to whole fruits	
		Volume (ml/kg)	Weight (g/kg)	Volume (ml/kg)	Weight (g/kg)
V1	Florina	638	658	551	575
V2	Golden Spur	600	650	535	572
V3	Jonagored	601	652	538	574
	Average	613	653.3	541.3	573.7

Table 6. Appearance and degree of sedimentation of apple juice

Variant	Variety	Appearance		Sedimentation rate after 24 hours (%)
		Color	Clarity	
V1	Florina	yellowish-brown	turbid	31.00
V2	Golden Spur	yellowish-brown	semi-turbid	15.40
V3	Jonagored	yellowish-brown	turbid	23.10

Table 7. Classification of fruits based on the achieved score

Qualification (quality classes)	Score	Variety
very good	80-100	Florina
good	60-79	Golden Spur
acceptable	40-59	Jonagored
mediocre	20-39	-
unsatisfactory	0-19	-