PHYSIOLOGICAL PARAMETERS OF SOME POMOLOGICAL SPECIES, FOR THE INITIAL MOMENT BEFORE STORAGE PERIOD - PRELIMINARY DATA

PARAMETRII FIZIOLOGICI A UNOR SPECII POMICOLE PENTRU MOMENTUL INTRODUCERII ACESTORA ÎN SPAȚIU DE DEPOZITARE – DATE PARȚIALE

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Abstract. *Due to the high perishability of the fruits, new ways of decreasing the physiological processes rates during the storage period are tested. Depending on the pomological characteristics of the fruits, the water and soluble solids contents are influenced by the respiratory intensity and transpiration rate. The aim of this study was to establish the values of the physiological parameters of organic fruits in view of subsequent correlations with the parameters determined during storage. The species chosen for this research were strawberries, blueberries, chokeberries, plums and apples. The respiration and transpiration rate are correlated with water content and soluble solids of the fruits. The differences obtained are explained by the different levels of maturation process and the fruit's large variability. The differences between the climacteric and non-climacteric fruits were pointed out in order to choose the best storage conditions for these.*

Key words: organic fruits, respiratory intensity, transpiration rate, water content

Rezumat. *Datorită perisabilității ridicate a fructelor, sunt testate noi modalități de scădere a intensității proceselor fiziologice în perioada de păstrare. În funcție de caracteristicile pomologice ale fructelor, conținutul de apă şi de glucide sunt influențate de intensitatea respirației şi transpirației. Scopul acestui studiu a fost de a stabili valorile parametrilor fiziologici ai fructelor ecologice, având în vedere corelațiile ulterioare cu parametrii determinați în timpul depozitării. Speciile alese pentru această cercetare au fost căpşunile, afinele, aronia, prunele şi merele. Intensitatea respirației şi transpirației sunt corelate cu conținutul de apă şi de glucide al fructelor. Diferențele obținute sunt explicate de nivelurile diferite ale procesului de maturare şi de variabilitatea mare a fructului. Diferențele dintre fructele climaterice şi cele neclimaterice au fost evidențiate pentru a alege cele mai bune condiții de păstrare pentru acestea.*

Cuvinte cheie: continutul de apă, fructe ecologice, intensitatea respirației, intensitatea transpirației

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INTRODUCTION

In Romania, the total organic area is 258.471 ha (fully converted and under conversion), in 2017 (Eurostat, 2019). In Romania, 87% of 121 thousand hectares of fruit trees are plum and apples orchards (Raport INS, 2017). Sumedrea (2014) shows that the fruit orchards contribute to a real progress by economic growth and reduction of rural poverty. Also, the most known and cultivated cash crops are berries, with 80% of the total area being occupied by blueberries industrial cultivation in the sub-mountainous regions of Romania (Asanica *et al*., 2018).

Fruits and vegetables are living organisms (Oltenacu *et al*., 2015), with mass loss due to physiological processes that continue from harvest to consumption (Lufu *et al*, 2019). For different postharvest technologies, like modified atmosphere packaging (MAP), one of the most important parameter is the respiration rate (Mahajan *et al*., 2016) which can be determined with a closed system which measures the CO_2 production (Fonseca *et al*., 2002). In this way, the metabolic activity in the fruits tissues is determined.

The demand for organic food continued to grow, due to EU consumers need for healthy and high quality products, with their restriction over chemical fertilizers and pesticides (Popa *et al.,* 2019). Also, Moggia (2016) showed that a major change in blueberries firmness during postharvest storage is the modifications of the cell walls produced by mass loss which is determined by transpiration rate (Lofu *et al*, 2019). Depending of the morphological and anatomical characteristics, like the presence of the cuticular wax, of the fruits (Xanthopulos *et al.*, 2017), it is observable that the quality parameters are influenced by the physiological processes in high CO_2 levels and lower O_2 levels (Fante *et al*. 2014).

Most common and used storage conditions are with controlled atmosphere (CA) which influence the variation of the physiological parameters in fruits (Priss *et al*,. 2017), by maintaining the quality of the fruits and increase their shelf-life (Xanthopoulos *et al*., 2017).

The objective of this study is to determine the intensity of the physiological parameters of some climacteric and non-climacteric fruit like: some berries, plums, and apples in order to choose the best storage conditions.

MATERIAL AND METHOD

For this study there were chosen climacteric and non-climacteric organic fruits like: strawberries (Regina cv.), blueberries (Legacy cv. and Blue Gold cv.), chokeberries (Melrom cv.), plums (Centenar cv., Tita cv., Stanley cv. and Jojo cv.) and apples (Rubinola cv., Topaz cv., Gemini cv.and Renoir cv.). For these samples the analyses like: respiratory intensity, transpiration rate, water and soluble solids content were made in triplicate, at room's temperature, to choose the optimal parameters of storage under controlled atmosphere conditions for each species separately. All analyses were performed in the Postharvest Technologies laboratory from the Research Center for Studies of Food Quality and Agricultural Products - University of Agronomic Sciences and Veterinary Medicine of Bucharest. The fruits from the same species, were chosen for analyzes, having the same ripening stage, with uniform size and colour.

For berries and plums the respiratory intensity was measured for 10 minutes and for apples for 30 minutes, in containers with hermetic closure with a volume of 280 mL (for berries) and 1180 mL (for plums and apples). Respiratory intensity was measured with Lambda T NDIR Monitor, ADC BioScientific LTd., and the results obtained were expressed in mg CO_2/kg/hour (Popa *et al.,* 2019). The transpiration rate was measured by gravimetric measurement (Fante, 2014), after 10 minutes for strawberries, after 20 minutes for blueberries and 30 minutes for chokeberries, plums and apples and the results obtained were expressed in g water/100g fresh weight/hour.

The water content of the samples were determined by oven drying for 24 hours at 105^{o}C using a UN110 Memmert oven, method used also by Corollaro (2014), Delian (2011), Mureşan (2014), Skupień (2006), Ticha (2015). Soluble solids were determined from 5 to 10 fruits, with refractive device Kruss DR301-95 (% Brix). Statistical analyses were performed using Excel, for the samples results like: mean, standard deviation, correlations, T Test and ANOVA single factor (Pomohaci, 2017).

RESULTS AND DISCUSSIONS

For blueberries, water content was estimated at 80.1-87.7% by Skupień (2006) and by Gherghi (2001) at 79-86%, values similar obtained for Legacy cv. (84.82%) and for Blue Gold cv. (86.26%). Also, Skupień (2006) estimated values between 10-19% for blueberries soluble solids content, similar with the values obtained for Legacy cv. (13.23%) and Blue Gold cv. (12.73%).

For strawberries, water content was estimated at 86-92% by Chira (2008), value similar obtained for Regina cv., with 90.9%±0,1 (tab. 1), and Gherghi (2001) estimated values between 6.4-15.3% for strawberries soluble solids content, similar with the values obtained for Regina cv. (9.49%). For chokeberries (Table 1), similar values for water content (74 to 82.1%) and soluble solids content (12.4-18.3% Brix) were found by Tolić (2015) for juices from different cultivars.

For plums, water content was estimated at 72-88% by Gherghi (2001), values similar obtained: for Stanley cv. (83.71%) and for Jojo cv. (83.17%). For soluble solids content, Gherghi (2001) estimated values between 7.2 - 14.9% , values similar to Centenar cv. (14.22%), Tita cv. (13.68%), and Stanley cv. (14.68%). Stefanova (2010) registered values between 15.5-25.5% for soluble solids content for Jojo cv., similar values showed in table 1 (17.567%).

Table 1

Variation of water and soluble solids content for the initial moment for berries, plums and apples

	Sample	Water content (%)		Soluble Solids (Brix %)	
		Mean	± St.Dev.	Mean	± St.Dev.
Strawberries	**Regina**	90.943	0.102	9.492	1.885
Blueberries	**Legacy**	84.822	0.308	13.233	1.021
	Blue Gold	86.256	0.609	12.733	0.058
Chokeberries	**Melrom**	74.775	2.105	17.850	1.098
Plums	**Centenar**	90.522	4.008	14.220	0.904
	Tita	91.871	1.466	13.680	1.385
	Stanley	83.707	0.62	14.680	0.816
	Jojo	83.170	0.425	17.567	1.303
Apples	**Rubinola**	83.977	0.846	14.410	1.174
	Topaz	84.618	0.900	13.230	1.503
	Gemini	87.245	0.947	11.960	0.938
	Renoir	79.520	1.724	17.490	1.600

For apples, water content was estimated at 83-89% by Chira (2008), values similar obtained: for Rubinola cv. (83.98%), for Topaz cv. (84.62%) and for Gemini cv. (87.25%). Also, Gherghi (2001) estimated values between 6.0-16.7% for apples soluble solids content, similar with the values obtained for Rubinola cv. (14.41%), for Topaz cv. (13.23%) and Gemini cv. (11.96%) (Leis *et al.,* 2013). Leis (2013) estimated a value about 15.5 % Brix for soluble solids content, at picking time, for Renoir cv., a value lower than that obtained in the present experiment (17.49 % Brix).

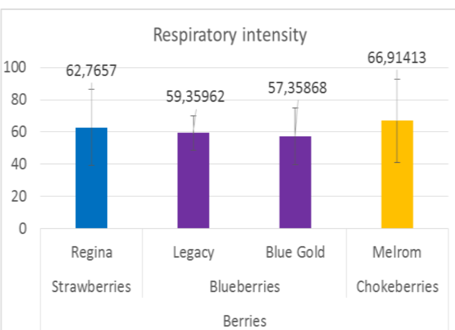

Fig. 1 Variation of respiratory intensity in berries

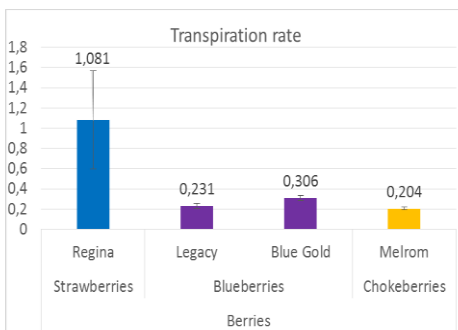

Fig. 2 Variation of transpiration rate in berries

For strawberries (fig. 1), respiratory intensity was estimated by Gherghi (2001) at 50.2-100 mg/ CO_2/kg/hour, values similar obtained for Regina cv. (62.77 mg CO_2/kg/hour). For all berries, between respiratory intensity (fig. 1) and soluble solids content (tab. 1), it has been registered positive correlation (R^2 = 0.266), with linear regression equation: y = 0.6276x + 53.236. For blueberries and chokeberries, between respiratory intensity (Fig. 1) and soluble solids content (tab. 1), it has been registered a very strong significant positive correlation (R^2 = 0.9877), with linear regression equation: y = 1.7754x + 35.281.

The values for respiratory intensity of the berries (fig. 1) are between 57.36 mg CO_2/kg/hour (Blue Gold cv.) and 66.91 mg CO_2/kg/hour (Melrom cv.). The values of blueberries transpiration rate were between 0.231 and 0.306 g water/100g fresh weight/hour and 0.204 g water/100g fresh weight/hour for chokeberries (fig. 2), have positive correlations (R^2 = 0.6105), with linear regression equation: y = 0.0066x – 0.2939, with water content (tab. 1). For strawberries, between transpiration rate (Figure 2) and water content (Table 1), a negative correlation with R^2 = 0.7791 has been registered, with linear regression equation: y = -4.2058x + 383.57. Comparing Legacy and Blue Gold blueberries cultivars, respiratory intensity has no significant differences ($p>0.05$, Anova and T test), but significant differences ($p<0.05$) were registered at transpiration rate.

For plums (fig. 3), respiratory intensity was estimated by Gherghi (2001) at 26.8-40.2 mg CO_2/kg/hour, values similar obtained for Jojo cv. (39.6 mg CO_2/kg/hour). For plums, between respiratory intensity (fig. 3) and soluble solids content (tab. 1), it has been registered very strong significant negative correlation R^2 = 0.8962, with linear regression equation: y = -8.0104x + 179.6) and for apples, between respiratory intensity (fig. 5) and soluble solids content (tab. 1), a negative correlation with R^2 = 0.0009 has been registered, with linear regression equation: y = -0.0839x + 23.501.

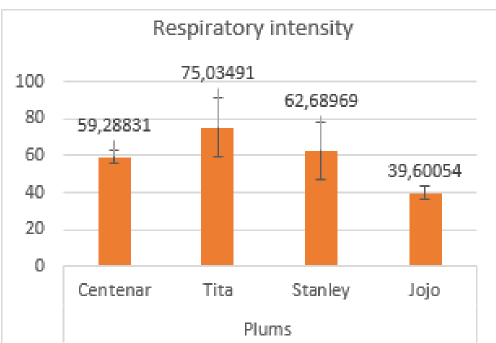

Fig. 3 Variation of respiratory intensity in plums

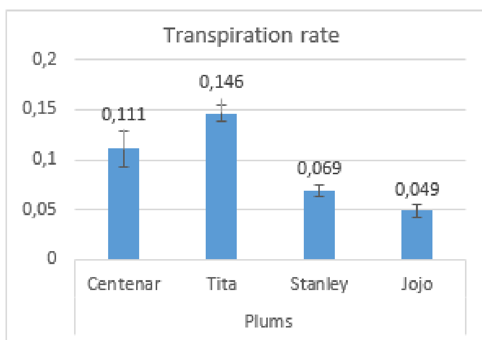

Fig. 4 Variation of transpiration rate in plums

The values for respiratory intensity of plums (fig. 3) are between 39,60 mg CO_2/kg/hour (for Jojo cv.) and 75, 03 mg CO_2/kg/hour (for Tita cv.). The values of plums transpiration rate were between 0,049 g water/100g fresh weight/hour (Jojo cv.) and 0,146 g water/100g fresh weight/hour (Tita cv.) (fig. 4), have very strong significant positive correlations $R^2 = 0.9341$, with linear regression equation $y = 0.0093x – 0.7163$, with water content (Table 1). Also the values of transpiration rate have positive correlations with there respiratory intensity $R^2 = 0.7184$, with linear regression equation $y = 0.0025x – 0.0543$. Comparing Centenar and Jojo cultivars, significant differences ($p<0.05$) at respiratory intensity were registered. For transpiration rate of plums, significant differences ($p<0.05$) were registered between the four varieties (fig. 4).

For apples (Figure 5), respiratory intensity was estimated by Gherghi (2001) at 24.2-42.3 mg/ CO_2/kg/hour, values similar obtained: for Gemini cv. (29.28 mg CO_2/kg/hour) and for Renoir cv. (23.98 mg CO_2/kg/hour).

Respiratory intensity of the apples (fig. 5) registered values between 13.38 mg CO2/kg/hour (Topaz cv.) and 29.28 mg CO2/kg/hour (Gemini cv.). Transpiration rate varied between 0.014 g water/100g fresh weight/hour (Topaz cv.) and 0.042 g water/100g fresh weight/hour (Renoir cv.) (fig. 6).

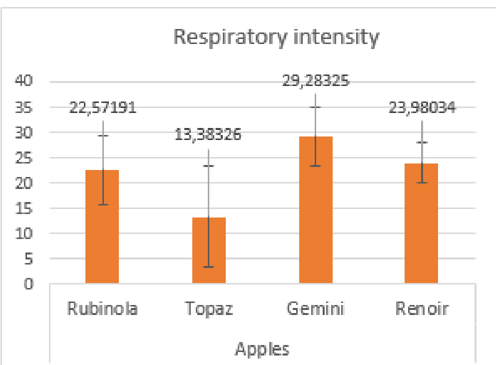

Fig. 5 Variation of respiratory intensity in apples

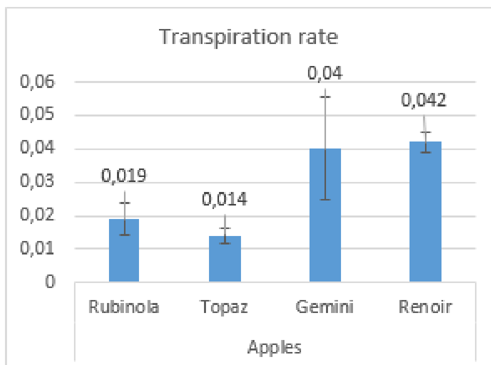

Fig. 6 Variation of transpiration rate in apples

Positive significant correlations ($R^2 = 0.6543$), with linear regression equation $y = 0.0018x – 0.0103$, were registered between respiratory intensity and transpiration rate. Negative significant correlation ($R^2 = 0.0531$) with linear regression equation $y = -0.001x + 0.1149$ were noticed between transpiration rate (fig. 6) and water content (tab. 1).

Comparing the four apple cultivars, significant differences ($p<0.05$) at respiratory intensity and at transpiration rate were registered (Anova and T test).

CONCLUSIONS

1. The respiratory intensity is correlated with soluble solids and transpiration rate is correlated with water content of the fruits. The differences obtained are explained by the different levels of maturation process and the fruit's large variability (for plums and apples).
2. The differences between the climacteric and non-climacteric fruits were pointed out in order to choose the best storage conditions for these.
3. The difference between strawberries and the others berries, in respiratory intensity and transpiration rate, shows the importance of cuticular wax on blueberries and chokeberries, which slows down the metabolic processes.

Future research is required in order to understand the physiological processes in fruits such as: strawberries, blueberries, chokeberries, plums, and apples.

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