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REZULTATE PRELIMINARE PRIVIND DESHIDRATAREA PRUNELOR ECOLOGICE

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ABSTRACT

The aim of this study was to determine the behaviour of five varieties of plums to the convective dehydration. The research summarizes the results of last two years. The plum trees cultivation has followed the rules and regulations of Organic Farming in the E. U. In order to find out the differences between the fruits organically cultivated and the fruits conventionally cultivated, as concern the dehydration process, two varieties of plums from both organic and conventional cultivation were analysed. Pitted plums have been convectively dehydrated, at the temperature of 50°C, as entire fruits or divided into half. Various comparisons have been made, as regard the type of cultivation and year of production, varieties, kind of division, time of dehydration, level of humidity, tissue structure, main bio-chemical indicators (dry matter, carbohydrates, acidity, vitamin C and total phenolics). Notable differences have been observed, highlighting the changes at the level of the appearance (colour & texture) and as regard the energy saving and health benefits, as well.

REZUMAT

Acest studiu și-a propus să determine comportarea a cinci cultivaruri de prune la deshidratarea convectivă. Cercetarea de față sintetizează rezultatele obținute în ultimii doi ani. Cultura prunilor a respectat regulile și reglementările Agriculturii Ecologice în cadrul U.E. Pentru a detecta diferențele dintre fructele cultivate ecologic și cele cultivate convențional, în ceea ce privește procesul de deshidratare, au fost analizate două cultivaruri de prune provenite atât din cultura ecologică, cât și din cea convențională. Prunele (fără sâmburi) au fost deshidratate convectiv la temperatura de 50°C, sub formă de fructe întregi sau jumătăți. S-au realizat analize comparative referitoare la tipul de cultură și anul producției, cultivaruri, tipul de divizare, gradul de umiditate, structura țesuturilor, principalii indicatori bio-chimici (substanța uscată, zaharuri totale, aciditate, conținutul de vitamina C și de fenoli totali). S-au observat diferențe notabile ce au evidențiat modificările apărute la nivelul aspectului vizual (culoare & textură), precum și în privința economisirii de energie și a beneficiilor aduse sănătății.

INTRODUCTION

The plum tree cultivation is the second in Romania, after apple cultivation, and the fourth - internationally, after apples, citric fruits and peaches, as concern the orchard surface and the market demand (Cepoiu, 2012). The plums are very nutritious fruits, rich in minerals & vitamins (including vitamin A, B, C, K and P), carbohydrates, fibres, proteins, enzymes and so on, making this fruit a valuable option for an intelligent nutrition (https://www.healthline.com/nutrition/benefits-of-plums-prunes). Can be consumed as fresh fruits or processed (e.g. jam, jellies, alcoholic drinking). Among the drying techniques, the most commonly used in the food industry is the traditional air-drying method, done by convective dehydration. This method has a long-time performance, extending the shelf-life of the dried fruits. Fruit dehydration is the technological process to reduce water content to a certain level in order to prevent or slow down the activity of microorganisms, without destroying fruit tissues or depreciating their nutritional value (Petkovic et al., 2019). Excess of water to be removed by dehydration varies depending upon the nature of the raw material, as well as the capitalization direction. Dehydrated fruits must follow the parameters of the nutritional components and the appearance of the fresh fruits. Consumption of dehydrated fruits offers great effects to our body, such as: tonic (mineralization); laxative & diuretic (detoxification); alkaline blood reaction.

MATERIALS AND METHODS

Five plum varieties (Figure 1) have been analysed at the Institute of Research - Development for Processing and Marketing of Horticultural Products - "Horting", Bucharest, as follows: *Anna Späth (analysed in 2019), Centenar (2020), Jojo (2019), Stanley (2019 & 2020) and Tita (2020).* The organic fruits have been supplied by the Institute of Research - Development for Fruit Cultivation, Mărăcineni Pitesti Arges.

Fig. 1. -Plum varieties analysed in the study

After reception (Figure 2), the plums were sorted, weighted (Figure 3), washed and spread on the dryer trays (Figure 4).

Fig.2. Plums reception

Fig. 3. Weighting plums

Fig. 4. Fresh plums on tray

For plums dehydration the Professional Dryer B. Master (https://www.taurodryers. com/en/b-master-line/b-master), as appears in Figures 5 and 6 has been used. Inside dryer, the temperature has varied inversely proportional with the humidity (Figure 7).

Fig. 5. Entire and halved plums on the dryer's trays

Fig. 6. B Master Professional Master

Fruit dehydration is an ancient method of fruit preservation by heat which retards cell oxidation and inhibits the natural ageing and discoloration that can occur during food preparation, such as the enzymatic browning reaction *(Yadav and Singh, 2014)* which appears after cutting different kinds of fruits. In case of organic fruits, especially those with light colour of pulp, the browning phenomenon requests a specific attention.

Enzymatic browning is also caused by the presence of phenolic compounds, especially tannins, tyrosine and chlorogenic acid (e.g. freshly cut fruit oxidizes under the action of polyphenol oxidase), but to inactivate the enzymes is hard to control. The browning phenomenon could be limited by the judicious management of the parameters of the drying process. Of them, the main parameter is represented by the drying temperature which can be set at maximum 50°C for the organic fruits. Le Maguer (1988) and Ponting et al. (1966) have however reported enzymatic browning and flavour deterioration above 49° C.

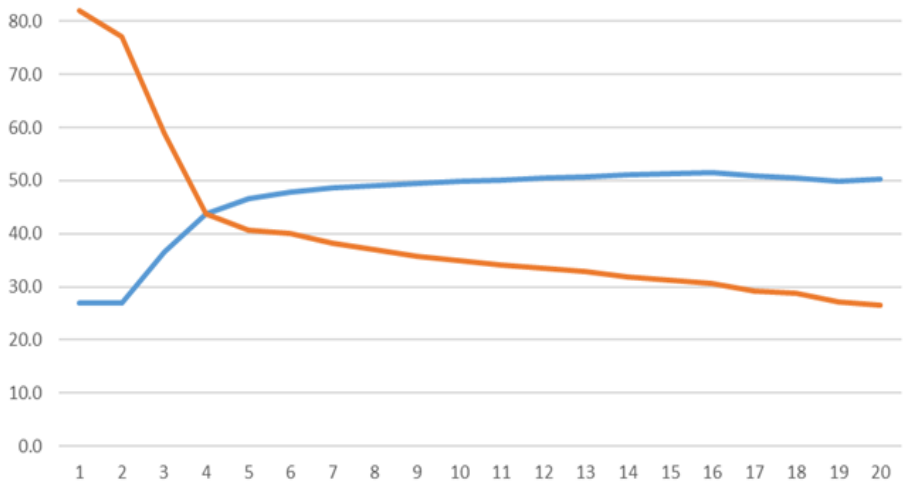


Fig. 7. Variation of temperature & humidity inside dryer in the first 20 hours of plums dehydration
Legend: blue line: temperature (T°); red line: humidity (U°)

Fresh fruits contain about 70-90% water, while the maximum moisture of the finished product is about 10-25%, determined by its destination. The water must be partially and gradually removed, not suddenly, because, this case, will appear irreversible qualitative degradations. The usual agent used to dehydrate the fruit is the hot air which serves both for the transfer of heat from the heating source to the product and for the circulation of evaporated water.

The tissues structure of the dehydrated plums was observed at the microscope with camera adapter. The main factors influencing the drying process are: raw material, shape and crushing degree of the raw material, drying methods, dehydration time, temperature, humidity, speed, air distribution & circulation.

The nature of the raw material and the mode of division (cubes, slices, noodles, halves or slices, etc.), particularly influence the drying rate and, therefore, the time of this operation. The dried or convectively dehydrated plums are called prunes. The main bio-chemical indicators (Table 1) analysed in 2019 and 2020 of all five varieties of organic plums were: dry matter, acidity, sugars, vitamin C and phenolic compounds (last indicator only to Anna Späth, Jojo and Stanley).

Table 1

Main bio-chemical indicators of organic plums – at the initial stage (fresh fruit)

Varieties / Year	Dry matter [°BRIX]	Acidity [%malic acid]	Sugars [%]	Vitamin C [mg/100g]	Phenolic compounds [mg GAE/100g]
Anna Spath - 2019	16.50	0.55	10.63	8.86	67.24
Jojo- 2019	17.40	0.62	9.18	9.61	66.98
Stanley - 2019	14.50	0.49	7.20	8.67	68.12
Centenar -2020	12.3	0.94	7.20	10.82	-
Stanley - 2020	17.3	0.65	9.79	11.42	-
Tita - 2020	15.75	1.13	9.05	4.84	-

RESULTS

In 2019 have been dehydrated both entire and halved plums (Figures 8 and 9). Drying of uncrushed fruit will keep a higher level of antioxidant bio-active components then drying the crushed fruits (*Oszmianski & Lachowicz, 2016).*

Fig. 8. Halved plums on trays

Fig. 9. Entire pitted plums on trays

In 2020, comparative analyses were performed at Centenar, Stanley and Tita cultivars, analysing the values obtained to the organic farming plums with those of conventional cultivation system (Tables 2-3).

Table 2.

Main bio - chemical indicators of fresh plums (in 2020)

Plum variety	Cultivation system	Dry matter [°BRIX]	Acidity [% malic acid]	Sugars [%]	Vitamin C [mg/100g]
Centenar	Organic	12.3	0.94	7.20	10.82
	Conventional	12.6	0.96	7.67	11.64
Stanley	Organic	17.3	0.65	9.79	11.42
	Conventional	15.0	0.60	8.62	8.94
Tita	Organic	15.75	1.13	9.05	4.84
	Conventional	14.4	1.09	8.66	9.23
Average	**Organic**	**15.11**	**0.90**	**8.68**	**9.02**
Average	**Conventional**	**14.0**	**0.88**	**8.31**	**9.93**

The study noticed that the values of final humidity depended mainly on the fruit division type (Table 4). The dehydration characteristics related to the plum varieties used in the study are presented in the Tables 5 -7 and Figure 10.

Observations:

1**.** Whole dehydrated plums (pitted) had a higher moisture content than halved fruits. The halved plums required shorter drying time, due to the fact that water distance in the fruit, to reach the evaporation surface is shorter.

Table 3.

Dehydration differences between organic and conventional plums (in 2020)

Plum variety	Cultivation system	Type of division	Dehydration time (50°C)
Centenar	Organic	half fruit	50 h
	Conventional	half fruit	60 h
Stanley	Organic	half fruit	50 h
	Conventional	half fruit	54 h
Tita	Organic	half fruit	53 h
	Conventional	half fruit	77 h
Average	**Organic**	**half fruit**	**51 h**
Average	**Conventional**	**half fruit**	**63.77 h**

Table 4.

Organic prunes humidity varying with the division type

Plum variety	Division type of fruit	Humidity after dehydration (50°C)
Anna Späth (2019)	entire	20.13 %
	half	13.31 %
Jojo (2019)	entire	22.49 %
	half	13.11 %
Stanley (2019)	entire	24.87 %
	half	19.47 %
Centenar (2020)	half	19.47 %
Stanley (2020)	half	17.4 %
Tita (2020)	half	15.04 %
Average	**entire fruit**	22.5 %
Average	**halved fruit**	**16.3 %**
AVERAGE	**entire & halved fruits**	**19.4 %**

Table 5.

Dehydration characteristics of the organic plums

Variety	Year	Type of division	Dehydration time (50°C)
Anna Späth	2019	entire fruit	55 h
Jojo	2019	entire fruit	47 h
Stanley	2019	entire fruit	40 h
Anna Späth	2019	half fruit	47 h
Jojo	2019	half fruit	40 h
Stanley	2019	half fruit	33 h
Centenar	2020	half fruit	50 h
Stanley	2020	half fruit	50 h
Tita	2020	half fruit	77 h

Table 6.

Plums weight reduction in the dehydration process)

Plum variety	Cultivation system	Plums mass (before dehydration)	Prunes mass (after dehydration)
Centenar	Organic	21.37 kg	2.83 kg
	Conventional	21.94 kg	3.05 kg
Stanley	Organic	10.00 kg	1.52 kg
	Conventional	11.20 kg	2.05 kg
Tita	Organic	21.00 kg	3.26 kg
	Conventional	24.23 kg	3.89 kg
Average organic		**17.45 kg**	**2.53 kg**
Average conventional		**19.12 kg**	**2.99 kg**

Table 7.

Plums water loss in the dehydration process

Plum variety	Cultivation system	Water loss after dehydration
Centenar	Organic	86.76 %
	Conventional	86.10 %
Stanley	Organic	84.80 %
	Conventional	81.70 %
Tita	Organic	84.48 %
	Conventional	83.95 %
Average organic		**85.35 %**
Average conventional		**83.91 %**

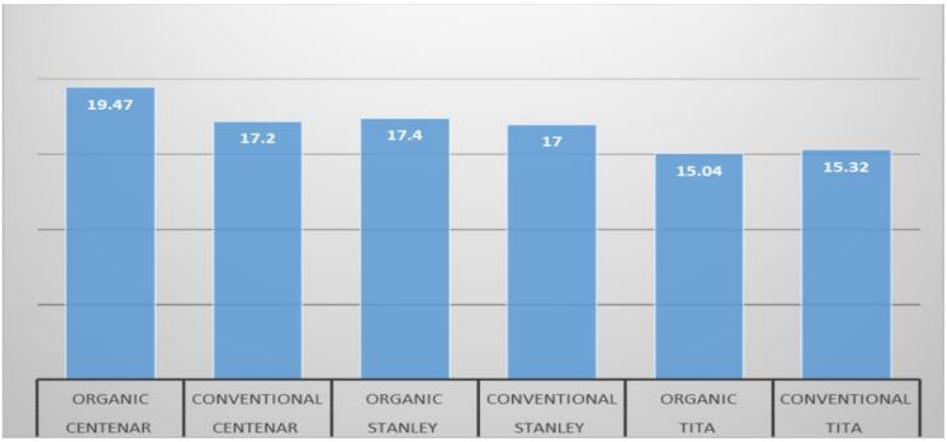


Fig. 10. Prunes humidity upon the cultivation system

2. The organic plums needed less time of dehydration comparing to the conventional plums (see the Tables 3-5). Oppositely, after same number of hours inside dryer at the constant temperature of 50º C, the organic plums obtained lower levels of humidity.

3. At Centenar variety, a comparison was made between organically and conventionally cultivated plums.Drying the same quantity of fruits (5 kg of fresh plums, near 1 kg/ tray) at the constant temperature of 50° C, after 50 hours in the professional dryer B. Master, the organic plums were faster dehydrated than conventionally ones.

Thus, after same number of hours inside dryer, 710 g of prunes were *obtained from the sample of organic plums, while 340 g of prunes were obtained from the sample of conventional plums, less than half compared to the first ones. In order to dehydrate all the fruits from the conventional sample, the dehydration was extended with other 10 hours. In conclusion, the organic plums required 50 h of dehydration and reached a humidity of 19.47%, while the plums from the conventional sample needed 60 h, reaching a humidity of 17.20%*.

In essence, the process of dehydration is faster to the organic plums, with advantages on the dried fruits quality, since the most valuable bio-compounds do not suffer undesirable changes. A medium drying temperature and a shorter time of dehydration offer a chemical stability to the bio-compounds. This is an important aspect concerning the health benefits and the saving of energy.

The main modifications observed after dehydration were: shrinkage of cells, plasmolysis and folding of the cell wall. The convective dehydration has increased elongation and decreased roundness and compactness (Mayor et al. 2011), as appear in the Figures 11 and 12.

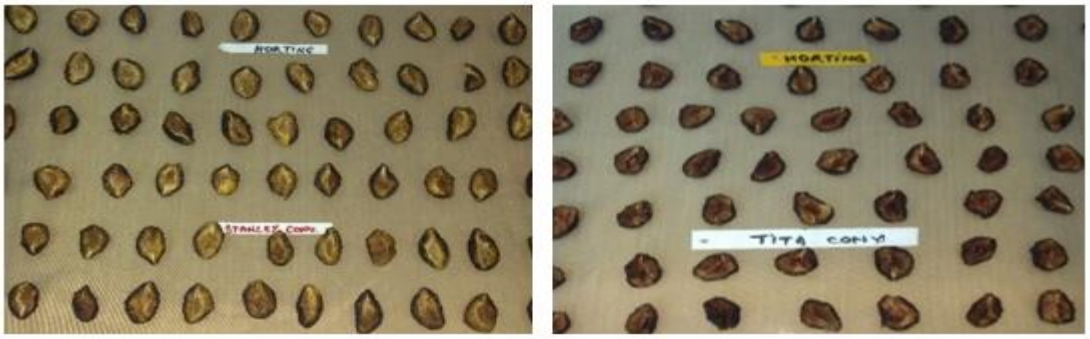
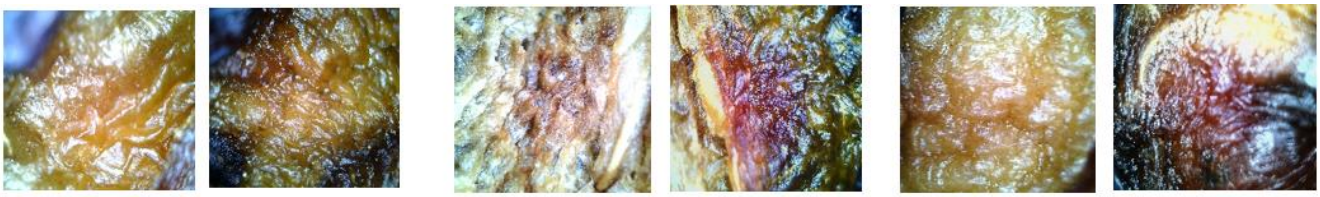


Fig. 11. Prunes on trays

Fig. 12. Organic prunes whole

Observations

An interesting and notable aspect is represented by the differences between the organic prunes and conventional ones, concerning their appearance (colour and texture). From a visual point of view, after the convective dehydration, the plums belonging to the conventional cultivation had glossy & caramelized sugar aspect, relatively fibrous & quite sticky texture and darker shade than organically grown plums. The texture of organic prunes was smoother, maintaining tissue elasticity. The comparison refers to the same number of drying hours at the temperature of 50° C. Visually, their appearance is significantly different, as the Figure 13 shows.



Centenar **Stanley** **Tita**

a.organic prune b.conventional prune a.organic prune b.conventional prune a.organic prune b.conventional prune

All these differences are due to the physic-chemical processes occurring inside plum tissues and are based on the intake of chemical pesticides and fertilizers found in the fruits of conventional cultivation system. After dehydration the prunes have been packed, choosing organic polythene in case of organic fruits.

CONCLUSIONS

The values of final humidity depended mainly on the fruit division type. Whole dehydrated plums gained a higher level of humidity than halved prunes, after same number of hours inside dryer, at the constant temperature of 50° C. The organic plums needed less time of dehydration comparing to the conventional plums. After same number of hours inside dryer at the constant temperature of 50º C, the organic plums obtained lower level of humidity.

In essence, the process of dehydration is faster to the organic plums, with advantages on the dried fruits quality. Medium drying temperature and a shorter time of dehydration offer a chemical stability to the bio-compounds. This is an important aspect concerning the health benefits and the saving of energy.

The main modifications observed after dehydration were: shrinkage of cells, plasmolysis and folding of the cell wall. The convective dehydration has increased elongation and decreased roundness and compactness.

Concerning the appearance, the conventional prunes had glossy & caramelized sugar aspect, relatively fibrous & quite sticky texture and darker shade than organic prunes. The texture of organic prunes was smoother, maintaining tissue elasticity. The comparison refers to the same conditions of dehydration.

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