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RESEARCHES ON THE INFLUENCE OF TECHNOLOGICAL PRODUCTION AND VALORIZATION FACTORS ON THE COMMERCIAL QUALITY OF CARDINAL PEACHES CULTIVAR

Constanța ALEXE[1], M. VINTILĂ[1], Simona POPESCU[1], Liana-Melania DUMITRU[2], Gh. LAMURANU[2], Lenuța CHIRA[3]

[1]Research and Development Institute for Processing and Marketing of the Horticultural Products - Bucharest, No. 1A, Intrarea Binelui street, District 4, 042159, Bucharest, Romania, Phone 40214610706, fax 0214600725, E-mail: tantialexe@yahoo.com
[2]Research Station for Fruit Growing Constanta, No.1, Pepinierei Street, 907300, Commune Valu lui Traian, Romania, Phone/Fax.+4024123187, E-mail: scpp_constanta@hotmail.com
[3]University of Agricultural Sciences and Veterinary Medicine Bucharest, No. 59, Mărăști Blvd, District 1, 011464, Bucharest, Romania Phone: +40 21 318 25 64/232, Fax: + 40 21318 28 88 E-mail: lenutachira@yahoo.com

Corresponding author email: tantialexe@yahoo.com

Abstract

Peaches are perishable fruits, with a high level of water, which present a pronounced sensitivity both to the action of environmental factors in orchard as well as after harvesting, at handling and storage. They may not be preserved for more then 3-4 weeks, according to the culture technology, cultivar, preserving conditions, because the quality may be affected . The quality represents one of the most important aspects of the produce, both during trading and on reaching the consumer or final buyer. Starting from this aspects, this paper will analyse the influence of some production (fertiliser regime) and valorisation (preserving conditions) factors upon the quality and its maintaining capacity during the preserving of peaches. The fruits' firmness, organoleptic appreciation, biochemical composition, quantitative and qualitative losses were determinated. The peaches - Cardinal cultivar (American cultivar, created in 1941, introduced in our country in 1962, appreciated throughout the world up to now) provided from experimental plots of the Research Station for Fruit Growing Constanta, fertilized in different manners, with organic and chemical fertilizers, applied on soil and foliar. The peaches were stored at ICDIMPH-Bucharest in three variants: in the ambient temperature (26-28^{0}C), in cold conditions (T = 2-4°C) and cold + modified atmosphere conditions, for 7; 28 and 35 days, respectively. The best results were obtained in the case of the fertilisation with chemical fertilisers applied on soil + foliar, which induce the best quality and their maintaining during storage. The results also indicate the superiority of fruit storage in modified atmosphere conditions in comparison with the others methods.

Keywords: *chemical analysis, fertilizer, firmness, storage*

INTRODUCTION

Due to their special characteristics in terms of taste, appearance and flavour and their importance in nutrition, peaches play an important role in consumption, both fresh and processed. Their superior dietary qualities are determined by their content of vitamins, minerals, cellulose, acids and peptic substances.
Peaches have the following properties: they are energizing, seizures, diuretic, slightly laxative, being indicated in treating dyspepsia, haematuria, urinary lithiasis [7].
Achieving and maintaining fruit quality depends on a complex of factors occurring in all the links of the culture and valorisation technology, from the choice of cultivar, crop maintenance, until harvesting, conditioning and shipping [4].
Since peaches are highly perishable fruit, maintaining their quality after harvesting is an important issue for their valorisation sector, given their importance within all fruit species.
Storage capacity depends on the quality of the raw material for preserving and on the conditions of storage. The chemical composition of peaches, which determines the biochemical processes during storage and thus, the storage capacity, is strongly influenced by the fertilization regime. Based on research results, it was proven that the dosage in which organic or mineral fertilizers are applied affects

the chemical composition of fruit, with effect on the storage capacity [5, 9].
The manner in which technology factors manifest themselves during storage (temperature, humidity, air composition, etc.) exerts a great influence on the storage life of peaches and the recorded losses [4].
The intensity of the metabolic processes, as well as the intensity of respiration are the most important factors determining the maintenance quality of horticultural products during post-harvest [3].
Peach varieties have different particularities regarding their preservation and recovery during a longer period of time. Extra early and early varieties with white pulp have the shortest duration of storage of only a few days. In contrast, cultivars with yellow pulp, which become ripen in the middle and late age, better withstand cold storage, thus allowing a recovery when market demands require it [7].
The valorisation technologies recommend storage application of technological processes (low temperatures, changing the gaseous composition of air, etc.) to determine the inhibition of physiological and biochemical processes of the fruit, leading to the maintaining of their commercial value for a longer period [1,2,8].
The purpose of this paper is to evaluate the achieving and maintaining of the quality of the Cardinal cultivar (American cultivar created in 1941, introduced in our country in 1962, appreciated throughout the world even today), depending on the fertility regime of the culture and the storage conditions after harvest.

MATERIAL AND METHOD

The peaches of the Cardinal cultivar were harvested from the experimental culture of SCDP Constanta and the research was conducted between 2008 and 2010. In specialized literature [6] this cultivar is described as follows: Cardinal (Photo 1) - early, with the period of maturation in the first and the 2nd decade of July, has medium to large fruit, weighting 120-160g, globular shape, flattened at the top and the bottom, slightly asymmetrical. The epidermis is thin, finely pubescent, yellow, 70-90% of surface covered in bright red, "Cardinal" in the form of patches and strips of varying sizes. The pulp is golden yellow, with fine iridescent red, medium hard, consistency, fondant, sweet, nice acid and aromatic, adherence to stone.

Photo 1. Cardinal cultivar

Stone is medium in size, oval, with sharp tip, asymmetric, gray-opened and features carvings in the form of recesses and grooves.
The Cardinal cultivar is early and yields economically beginning with the third year after cultivation. Its production is medium-large (about 28-32 kg / tree). Fruits are suitable for both fresh consumption and for processing (jam, stewed fruit, nectar, etc.)
For this experiment, fruits were harvested when they reached the mature stage - "first fruits".
Trees have benefited, in culture, from four different variants of fertilization:
V1 - control (unfertilized)
V2 - organic fertilization (fermented manure)
V3 - ground chemical fertilization (NPK complex fertilizers in relation to: 15:15:15.)
V4 - ground + foliar chemical fertilization (ground with NPK complex fertilizers 15:15:15 and foliar feeding with Murtonik 20:20:20 + micronutrients: Mn, Fe, Cu, Zn, Bo, in the form of chelation).
At the Research and Development Institute for Processing and Marketing of the Horticultural Products, fruits were stored in three storage options:

- ambient temperature (T = 26-28^{o}C, RH = 65-70%) in 1 kg packages - *keep warm*;
- refrigeration room (T = 2-4°C, RH = 83-87%), in packs of 1 kg covered with perforated polyethylene film - *cold storage*;
- refrigeration room (T = 2-4°C, RH = 92-96%), in 1 kg hermetic packages, so that the composition of the atmosphere inside has

modified, by the reducing of the O_2 content and the increasing the CO_2 content and also of air relative humidity - storage in modified atmosphere - *MA*.

The storage period (days) varied depending on the variant of storage technology, as follows:

- warm conditions: 7
- cold conditions: 28
- AM conditions: 35

Immediately after harvest, before placing in storage and at the end of storage, observations were made concerning fruit firmness, as well as organoleptic measurements and biochemical analyses of the main components (soluble dry matter, soluble carbohydrates, titratable acidity). Also, weight losses (quantitative) and depreciation (qualitative) suffered by the fruit during storage were quantified.

The determination of the fruit firmness was performed by means of a mass penetrometer OFD, the measurement being in penetrometer units (1UP = 0.1 mm) of the depth of the conical needle penetration (length = 24mm, diameter at base = 4 mm) in the pulp. Measurements were performed on a total of 25 fruit / variant, each fruit being penetrated in four points in the equatorial zone.

Organoleptic quality assessment was done by performing a sensory testing, by means of a method of assessing the fruit with a scoring scale of 1 to 100. Tasting ships were used which comprise three criteria for the assessment (appearance, texture, taste). Each of the three criteria of evaluation has a different weight in the general scoring, according to their importance: "aspect" is 15%, "texture" 35% and "taste" 50%. Depending on the obtained score, there are five different classes, as follows:

Grade(quality level)	**Score**
Very Good	80-100
Good	60-79
Acceptable	40-59
Mediocre	20-39
Unsuitable	0-19

The methods for determining biochemical components were:

- refractometry, using an ABBE refractometer to determine the soluble substance;
- the Bertrand titrimetric method for determination of soluble carbohydrates;
- the titrimetric method for the determination of the titratable acidity;

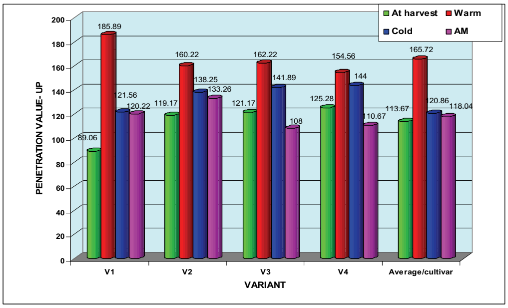
During preservation, the thermo-hydric factors in the cold room were checked daily, in order to ensure the compliance of the optimal conditions for maintaining quality. Also, the ability to maintain fruit quality was assessed, including the emergence and development of deposits of various diseases.

RESULTS AND DISCUSSIONS

1. Firmness

Firmness values at harvesting vary between 89.06 and 125.28 UP, the fruit in variant V1 having the highest firmness (Fig. 1). During preservation in warm conditions peaches easily lose their firmness through rapid ripening. When the fruits are stored in cold conditions, the intensity of the maturity processes reduce and so the structural and textural firmness is maintained for a longer period of time (28 days). By enriching the atmosphere in the space of storage in carbon dioxide, the metabolic processes are slower and the firmness of the peaches is preserved longer (35 days).

Fig. 1. Peach firmness at harvest and after storage



Firmness loss occurs in different rhythm during storage, depending on the variant of fertilization and storage conditions (Table 1).

Table 1. Firmness evolution of peaches during storage

Variant	**Extent of reduction in fruit firmness in storage-%**		
	warm	**cold**	**AM**
V1	208.72	136.49	134.98
V2	134.44	116.01	111.82
V3	133.87	117.09	89.13
V4	123.45	114.94	88.33
Average/ cultivar	**150.12**	**121.13**	**106.06**

It was noticed that, although at harvest peaches in variant V1 were the firmest, during storage the intensity of its reduction is the most pronounced. The peaches in the V4 variant are best at retaining their firmness during storage in various conditions.

2. Organoleptic quality

The results of the organoleptic testing (Table 2) reveals that, in the moment of the harvest, peaches got high marks because of their attractive appearance, firmness and taste which are “good” (93.20 points) and "very good" qualifying.

Table 2. Organoleptic assessment of peaches at harvest and after storage

Time determination - the indicator	Organoleptic assessment - score
At harvest: - Total	93.20
- Aspect	14.25
- Firmness	33.95
- Taste	45.00
- Qualifying	very good
After warm storage - Total	85.00
- Aspect	10.50
- Firmness	29.50
- Taste	45.00
- Qualifying	very good
Alter cold storage - Total	83.37
- Aspect	14.25
- Firmness	30.00
- Taste	39.12
- Qualifying	very good
Alter AM storage - Total	78.75
- Aspect	11.20
- Firmness	30.55
- Taste	37.00
- Qualifying	good

After storing peaches in warm conditions for seven days, the total score obtained in organoleptic test dropped to 85.00, which is still quite high and is due to the taste that has remained unchanged (45 points), so the qualifying remained "very good".

Storage in refrigerated conditions for 28 days also allowed for the maintaining of a high enough score and a "very good" qualifying. It should be taken into account that the fruit preserved a beautiful aspect. Because of the maturation during storage, they achieved the colour specific to the cultivar, but, at the same time, there was a decrease in the taste and firmness structural values.

After storage in modified atmosphere conditions for 35 days peaches were damaged in terms of appearance and especially in terms of taste and obtained a "good" qualifying. In some cases, the skin of the peaches began peeling off.

3. Biochemical composition

The data presented in Table 3 reveals the fact that the values of the biochemical indicators of the fruit vary according to the fertilization method used in the peach culture. Thus, the content of soluble dry matter ranges between 9.65°R in variant V1 (control) and 11.12°R in variant V4 (root and foliar chemical fertilizer). Variant V2 (organic fertilization) ranks second in terms of the content of soluble dry matter of the fruit, this being the only difference from variant 0.14°R V4, which ranked first. The third place was occupied by variant V3 (root chemical fertilization), with a content of soluble dry matter of 10.62°R.

The V1 variant also ranks last in terms of soluble carbohydrate content (6.80%), there being a big difference from other versions, whose contents have very similar values: 8.42% - V2 (the 1st place), 8.01% -V3 and 8.17% - V4. The content of organic acids has values between 1.03% to variant V1 (the 1st place) and 0.78% for variants V3 and V4.

During storage in warm conditions for 7 days, soluble dry matter content of peaches increased, while soluble carbohydrate content and malic acid decreased, a process observed in all four variants of fertilization.

Table 3. The main chemical components of peaches at harvest and after storage

Biochemical indicator	Variant				
	V1	V2	V3	V4	Avera-ge
At harvest: - soluble dry matter (°R)	9.65	0.98	10.62	1.12	10.59
-soluble carbohydrates (%)	6.80	8.42	8.01	8.17	7.85
- acidity (malic acid /100g)	1.03	0.78	0.81	0.78	0.85
After warm storage: -soluble dry matter (°R)	12.27	12.61	11.41	12.07	12.09
-soluble carbohydrates (%)	5.55	6.41	6,94	6.66	6.39
- acidity (malic acid /100g)	0.89	0.73	0.76	0.74	0.78
Alter cold storage: -soluble dry matter (°R)	11.60	11.37	11.26	11.30	11.38
-soluble carbohydrates (%)	6.52	8.10	7.86	7.96	7.61
- acidity (malic acid /100g)	0.98	0.76	0.79	0.72	0.81
- Alter AM storage: soluble dry matter (°R)	10.96	11.13	10.95	10.87	10.97
-soluble carbohydrates (%)	6.36	7.93	7.81	7.66	7.44
- acidity (malic acid /100g)	0.97	0.77	0.77	0.72	0.81

During cold preservation for 28 days, the value of the indicator soluble dry matter also increased, whereas the values of soluble carbohydrate content and titratable acidity were lower, but with a lower intensity.
Putting fruits in the modified atmosphere reduced the intensity of biochemical transformations, which, however, took place in the same direction, meaning in the increasing of the content of soluble dry matter and the reducing of soluble carbohydrate content and malic acid.

4. Quantitative and qualitative losses
The research shows that the fertilization variant of the peach crop – Cardinal cultivar, with the best results in terms of losses during storage, in all 3 technological methods is V4, followed by V2 variant, while the poor results were obtained by the variant V1 (Fig. 2).

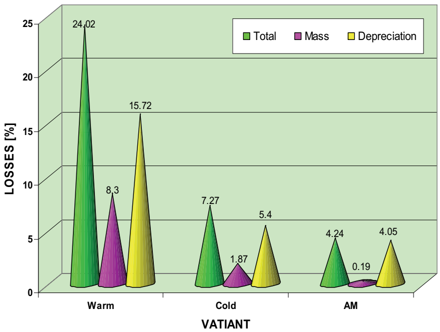


Fig. 2. Losses occurred during the preservation of peaches in different technological conditions

The impairment of the fruit is due to late infections caused by fungi Monilinia laxa and M. fructigena before harvesting, when they are barely visible. After harvesting, during transport and storage, their attack is rapidly evolving (depending on temperature) and the entire fruit rots. Moreover, during storage, it can lead to the rotting of the healthy, surrounding fruit, the mycelium penetrating directly or through almost invisible lesions. Also, fruit can be infected through wounds, blows or compression produced during harvesting and handling, by the molds Botrytis cinerea and Rhizopus stolonifera.
Of the three methods of storage (at ambient temperature, the cold room and the cold room + modified atmosphere), the best results were obtained in the case of the third method, because these fruit recorded the lowest losses during storage. Very good results were obtained through the option of cold storage, in which case losses during preservation for 28 days were much lower compared to storage at room temperature for 7 days.

CONCLUSIONS

In terms of firmness, the best results were obtained by peaches from cultures fertilized with foliar fertilizers. It was found that the rate of the metabolising of pectic substances in peaches and the reducing of their firmness differs according to the fertilization regime and especially to the temperature of the air and the composition of the storage space. In cold conditions and By enriching the atmosphere in the space of storage in carbon dioxide, the metabolic processes become slower and the firmness of the peaches is preserved for a longer period (35 days).
The peaches of the Cardinal are appreciated from an organoleptic point of view. The evolution of the quality during preservation depends on the environmental conditions of storage and especially on the temperature and gas composition. The storage method that gave the best results in terms of organoleptic assessment is the cold storage, taking into account the storage period and the score obtained at the end of it.
The content of main biochemical indicators (soluble dry matter, soluble carbohydrate, organic acids) varies depending on the fertilization system of the culture. From a biochemical point of view, the peaches from the culture fertilized with organic fertilizers and those from the culture fertilized with fertilizer incorporated into the soil plus foliar fertilization gave the best results.
The ability to maintain the fruit quality of the peaches varies according to the fertilization system and the storage conditions of the environment and especially to the temperature and gas composition of the air. Among the variants of fertilization, variant V4 (ground + foliar chemical fertilization) induces the best storage capacity. Foliar fertilizers provide, in addition to an intake of macro-and micronutrients and other organic substances

that stimulate the metabolism of chlorophyll assimilation, energy efficiency and, finally, the quality of the fruit Organic fertilizers contribute through their presence to the supplying of the plants with all the necessary minerals, ensuring the achievement of high quality fruit production and a high storage capacity.

Of the three methods of storage (at ambient temperature, the cold room and the cold room + modified atmosphere), the best results were obtained in the case of the third method, in which case the lowest losses during storage were recorded. Cold storage can be used successfully if there is not the possibility of changing the gaseous composition of the air in the storage space.

Low temperatures inhibit or slow down the growth of fungi and molds specific to each species of fruit and reduce the pace of the biochemical processes during their storage, so that impairment losses are greatly reduced.

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