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CHANGES IN EPIPHYTIC MICROFLORA OF CHERRY FRUIT STORED AT NON-CHILLING AND CHILLING TEMPERATURES

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Abstract

The choosing of the best storage condition of the sweet cherry play a very important role in reduction of the postharvest losses. The aim of this study was to evaluate the effect of non-chilling and chilling temperatures on changes in microbial population of cherry varieties with early and middle ripening time.

The batches of early ripen varieties: Bigarreau Burlat, Nalina, and Kosara, and middle ripen varieties: Rozalina, Vega, and Raynier were stored as non-chilled (climatic conditions) and chilled at 2-3 ^{0}C, relative humidity (RH) 86 - 90% during 3 and 9 days. Total aerobic plate count, coliforms, yeasts and molds followed by standard quantitative methods. Weight losses measured by weighing relative to initial weight. The relative weight losses and microbiological parameter were correlated with the storage time by regression analysis.

The losses relative to the initial weight and the total aerobic plate count, coliforms, yeasts and molds for each sample cherries during storage, regardless of the temperature, increased linear. The Pearson test of the correlations shows, resistance to microbial spoilage was affected by the decreasing temperature, but was also related to the difference in the varieties.

In conclusion the storage temperature could not be prioritized one or the other method and they should be implemented in practice.

Key words: *Sweet cherries, Postharvest storage, Microbiological indexes.*

1. Introduction

Storage of fruit, including cherries is a period of viability after their separation from the plant [1, 2]. Maximum allowable duration of this period is the biological characteristics of the type and variety. It is determined by numerous factors - physiological stage at harvest; method of cultivation; harvest; transport and handling; physiological and biochemical processes intensity in the fruit; chemical composition; phytosanitary condition; and resistance degree to pathogens and unfavorable environmental conditions [3, 4].

Quantitative measure of keeping quality is the time after harvesting, during which, under certain conditions, the fruit retains its stable structure and physiological functions [5]. Economic measure of keeping quality is the size and value of the quantitative losses - respiration and spoilage [6]. Microbial spoilage losses could be determined by standard methods for the epiphytic microflora analysis or visual and weighted [7]. But, a more comprehensive study concerning the effectiveness of the methods and also if they can be interchangeably is needed.

The aim of the study was by monitoring the microbiological changes to establish is there a correlation between technological parameters microbial spoilage losses determined by the cited methods on non-chilled and chilled cherries.

2. Materials and Methods

The study was conducted with Bulgarian cherry varieties from which early are Bigaro Burlat, Nalina, Kosara, and middle Rozalina, Vega, Rainier. Harvesting and handling before storage of all cherry varieties was carried out in one day to ensure homogeneous state of the fruit. The cherries of each variety in two layers were placed in twelve crates and were randomly distributed into two groups. The net weight of each crate was measured before storage.

2.1 Storage

The two groups' experimental batches were stored at non-chilled state, depending on the climatic conditions during harvest and storage, and chilled in experimental chambers with air cooling at 2 - 3 ^{0}C and a relative humidity of 86 - 90%.

2.2 Storage losses

Of each crate, of each variety cherries immediately postharvest and every day for non-chilled, and in three days for chilled were recorded:

- Microbial spoilage losses - measured weighted with a digital precision balance (±1 g) (PCE Instruments UK Ltd.) after complete fruit handling. Calculated cumulatively for the storage period as a percentage of the sample starting weight [7].

- Total mesophilic aerobic plate count, cfu x g^{-1} by BDS EN ISO 4833-2013.

- Coliforms, cfu x g^{-1} by ISO 4831-2006; ISO 4832-2006.

- Yeasts and molds, cfu x g^{-1} by BDS ISO 21527-2-2011.

- *Escherichia coli*, cfu x g^{-1} by ISO 16649-2:2014.

- *Salmonella* spp. (in 25g) by BDS EN ISO 6579-2017.

- *Listeria monocytogenes* (in 25g), BDS EN ISO 11290-1:2017.

2.3 Statistical analysis

The effects of storage time and temperature on individual microbiological indexes was studied by regression analysis. The correlation between tested methods was verified by Pearson index (Statistika 7.1, StatSoft, Inc., USA).

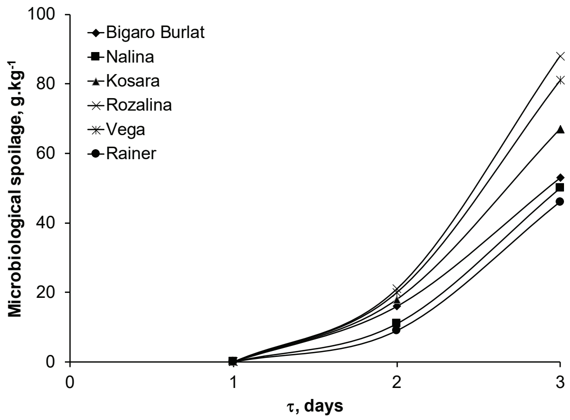

Figure 1. Microbial spoilage of non-chilled cherry fruit as a function of storage time

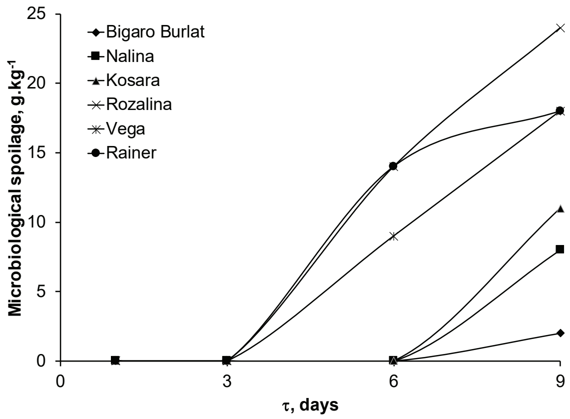

Figure 2. Microbial spoilage of chilled cherry fruit as a function of storage time

3. Results and Discussion

The results obtained for the microbial spoilage of chilled cherries indicate no apparent losses to third day for the middle varieties and to sixth day for the early ones (Figures 1 and 2). Initial greater sustainability of early varieties Bigaro Burlat, Nalina, Kosara is established. In contrary, with extension of the storage, recorded microbial spoilage in single fruit in subsequent periods cover a bigger percentage of test batches. Thus, in the final stage of storage, a percentage visible spoilage between the early and middle varieties is equalized. The results confirm reported in the literature influence of the variety, resistance degree to microorganisms, and phytosanitary condition on the keeping quality [3, 4, and 8].

Microbial spoilage data calculated for the non-chilled cherries show a higher rate of microbiological spoilage at an earlier stage proportional to the temperature increasing. Maintaining the differences between varieties under these conditions shows that the fruit physiological activity and storage depends on the variety characteristics. In this storage generally early varieties are more resistant. But for middle Rainier are calculated minimum losses in the same three-day period of storage. For them are recorded visibly decay, but without molds, whereas in other varieties both spoilages.

The increase in the losses relative to the starting weight of each sample cherries during storage, regardless of the temperature is linearly ($R^2 \geq 0.75$).

The tendency of difference between varieties associated with resistance to microbial spoilage is confirmed by analytical microbiological indexes. The comparative analysis shows that regarding the total plant count the middle cherries have a higher number of microorganisms per gram of fruit in comparison to the early cherries (Figures 3, 4, 5, and 6).

Figures 7, 8, 9 and 10 show that could not give preference to one of the two groups investigated cherries in regard to index molds and yeasts. On the other hand, the results of index coliforms for middle varieties cherries indicate that the number of coliforms decreased during storage (Figures 11, 12, 13, and 14).

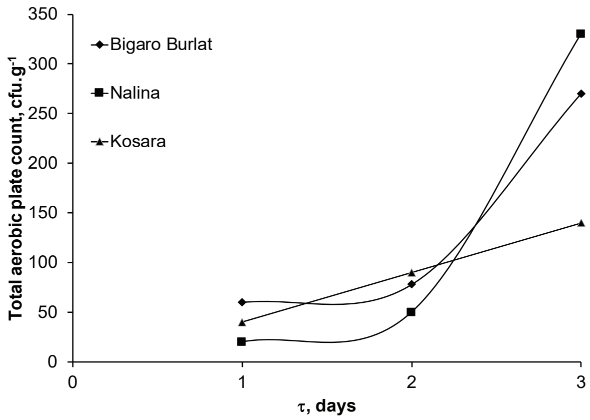

Figure 3. Total aerobic plate count of non-chilled early cherries as a function of storage time

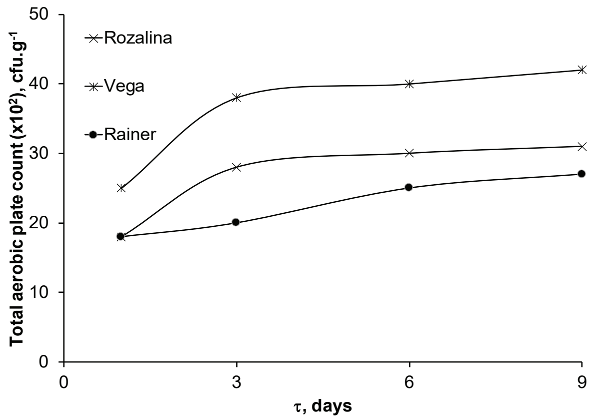

Figure 6. Total aerobic plate count of chilled middle cherries as a function of storage time

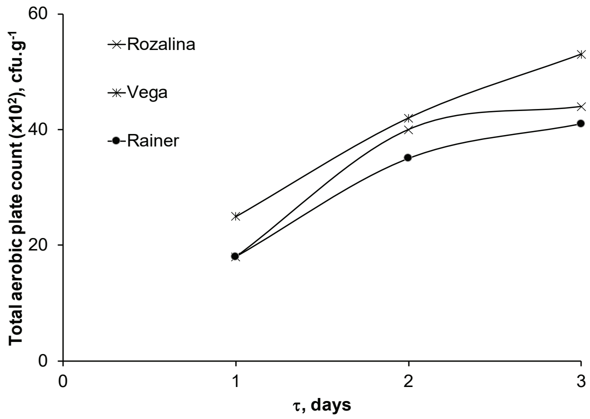

Figure 4. Total aerobic plate count of non-chilled middle cherries as a function of storage time

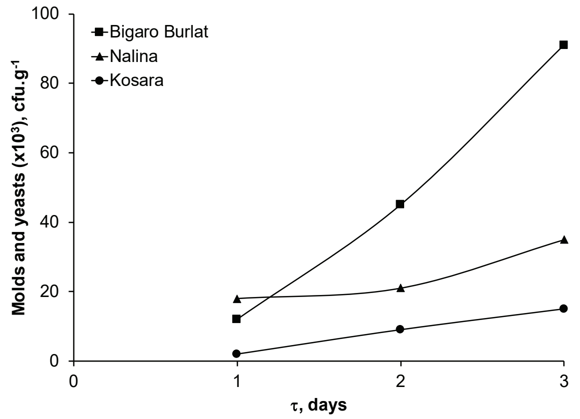

Figure 7. Molds and yeasts of non-chilled early cherries as a function of storage time

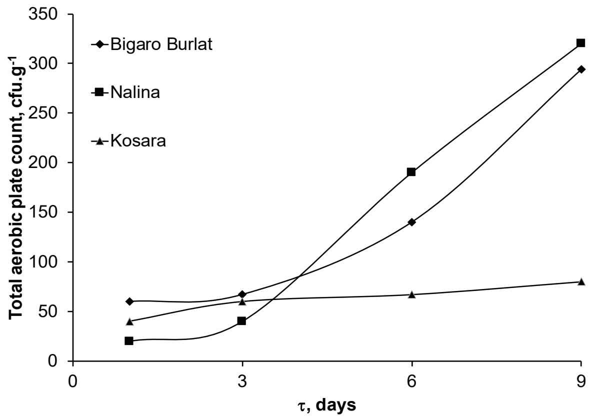

Figure 5. Total aerobic plate count of chilled early cherries as a function of storage time

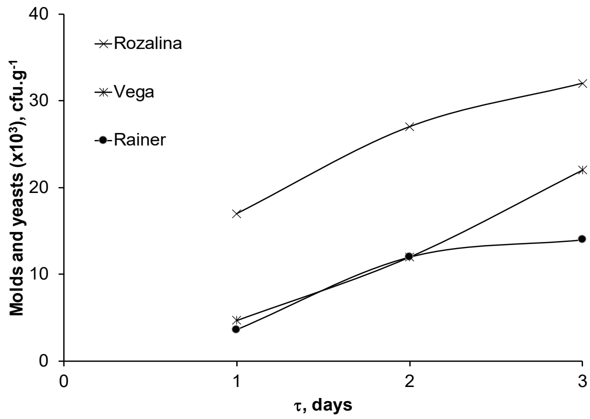

Figure 8. Molds and yeasts of non-chilled middle cherries as a function of storage time

Furthermore, the results show that the decreased temperature is effective to control the growth of mesophilic aerobic microorganisms, yeasts, molds and coliforms after nine days storage.

Positive linear correlation for both cherry varieties between total mesophilic aerobic plate count, and yeasts and molds with storage period at both controlled and uncontrolled temperatures is found. The obtained determination coefficients prove the observed effect of variety, since the period of storage of all samples is the same. Amount of mesophilic aerobic microorganisms, and yeasts and molds vary to a bigger extent in the early variety Bigaro Burlat and middle Rosalina and Rainier ($0.62 < R^2 < 0.70$). For other varieties determination coefficients are high (R^2

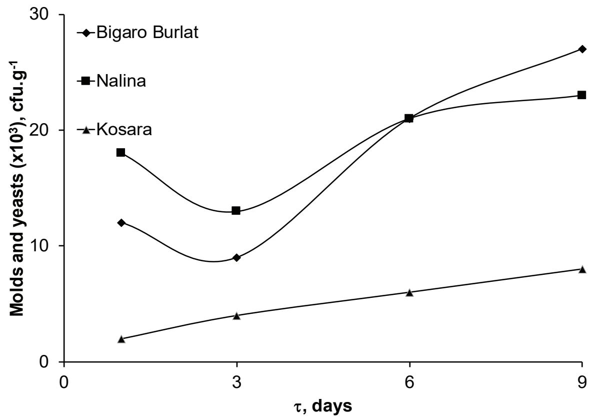

Figure 9. Molds and yeasts of chilled early cherries as a function of storage time

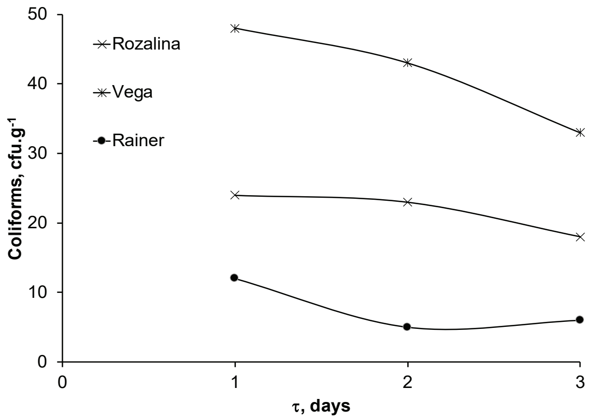

Figure 12. Coliforms of non-chilled middle cherries as a function of storage time

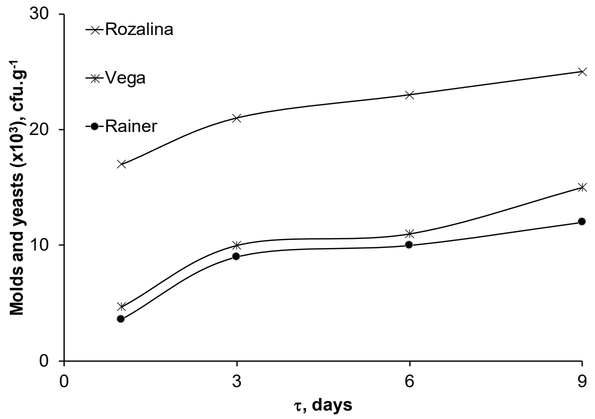

Figure 10. Molds and yeasts of chilled middle cherries as a function of storage time

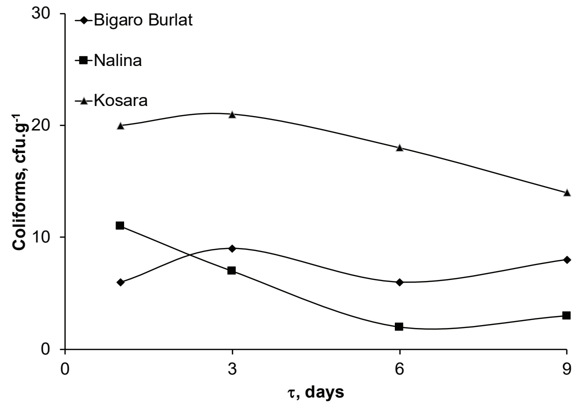

Figure 13. Coliforms of chilled early cherries as a function of storage time

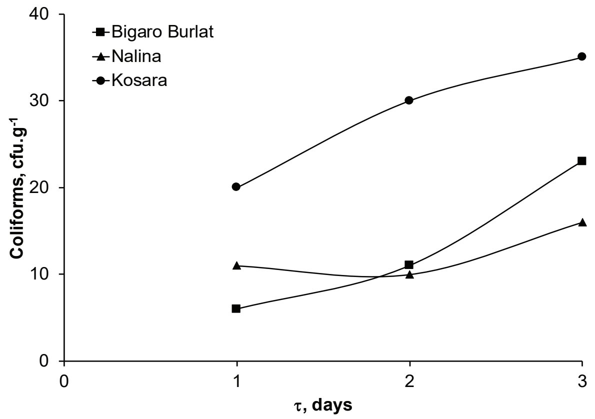

Figure 11. Coliforms of non-chilled early cherries as a function of storage time

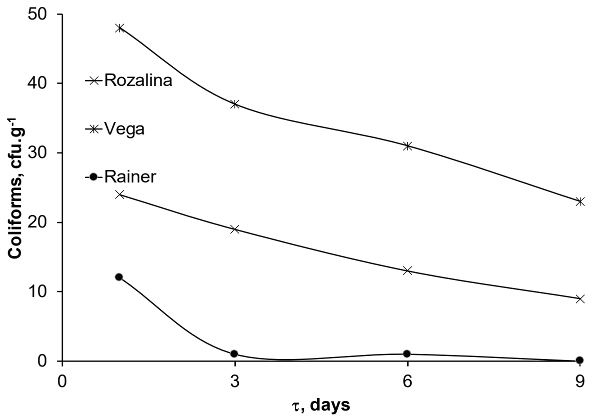

Figure 14. Coliforms of chilled middle cherries as a function of storage time

> 0.75). For all cherry varieties is established negative linear correlation of coliforms during storage, with more diversity ($R^2 = 0.66$) for variety Rainier.

The results of the analyzed pathogens in the first and third day of the storage for all tested cherry varieties show that not detected *E. coli*, *Salmonella* spp., and *Listeria monocytogenes*. Therefore, they are not involved in experimental design to analysis.

Correlations between microbial spoilage losses analyzed by standard methods, and visually and weighted are calculated. A positive, but varying degree of correlation between the total plate count, coliforms and the visual losses are found. There is a strong correlation between visual losses and coliforms in non-chilled cherries (Table 1), and between visual losses and total plate count in chilled (Table 2). Negative

Table 1. Correlation between microbial spoilage, total aerobic plate count, molds and yeasts, and coliforms of non-chilled cherry fruit

Parameters	Microbial spoilage, g x kg^{-1}	Total aerobic plate count, cfu x g^{-1}	Molds and yeasts, cfu x g^{-1}	Coliforms, cfu x g^{-1}
Microbial spoilage, g x kg^{-1}	*			
Total aerobic plate count, cfu x g^{-1}	0.534	*		
Molds and yeasts, cfu x g^{-1}	-0.125	-0.298	*	
Coliforms, cfu x g^{-1}	0.764	0.226	-0.418	*

Table 2. Correlation between microbial spoilage, total aerobic plate count, molds and yeasts, and coliforms of chilled cherry fruit

Parameters	Microbial spoilage, g x kg^{-1}	Total aerobic plate count, cfu x g^{-1}	Molds and yeasts, cfu x g^{-1}	Coliforms, cfu x g^{-1}
Microbial spoilage, g x kg^{-1}	*			
Total aerobic plate count, cfu x g^{-1}	0.820	*		
Molds and yeasts, cfu x g^{-1}	-0.236	-0.081	*	
Coliforms, cfu x g^{-1}	0.166	0.352	-0.245	*

weak correlation is found between molds and yeasts and visual losses in both storage temperatures.

Acknowledgements

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4. Conclusions

- The increase in the losses relative to the initial weight of each sample cherries during storage, regardless of the temperature is linearly. Their resistance to microbial spoilage is affected by the decrease in the temperature, but is also related to the difference in the varieties reaction. This dependence is confirmed by both visual and weight losses and microbiological indexes.

- The negative correlation between molds and yeasts determined by standard methods and the visual loss in both storage temperatures proves that you could not prioritize one or the other method and they should be implemented.

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