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THE EFFECT OF FOOD COATING TREATMENT ON THE CHANGE OF CHLOROGENIC AND CAFFEIC ACID CONTENT IN CHERRY FRUITS IN PERIOD OF STORAGE

SUMMARY

The article detected the effect of pre-treatment of cherry fruits with solutions of chitosan and salicylic acid on the content of chlorogenic and caffeic acid. The research have been conducted at the research station of pomology named after L.P. Symyrenko of the Institute of Horticulture of NAAS with cherry fruits of varieties 'Alpha' and 'Pamiat Artemenko'. For studies of 15 trees of each variety the day before harvest, sprayed with a solution of 1% chitosan; 1% chitosan with salicylic acid (100 mg L^{-1}). Fruits were removed at the consumer stage of ripeness from four different places of the crown from each tree of a certain variety and type of processing, placed in boxes weighing 5 kg for storage at a temperature of 1±0.5 °C and relative humidity of 95 ± 1%. Unprocessed cherry fruits were taken as a control. It was found that pre-treatment of cherry fruits with solutions of polysaccharide compositions contributed to the significant preservation of phenolic substances. Moreover, the most effective was the treatment of fruits with a solution of chitosan with salicylic acid, in which the loss of phenolic substances was 5.0−5.5%, including chlorogenic – 10.0−11.0% and caffeic acid – 36.8−40.1%.

Keywords: period of storage, coating treatment, phenolic substances, cherry fruits, chitosan

INTRODUCTION

Tart cherry is widely used in the food industry, and some are excellent for fresh consumption. The beneficial effects of fresh tart cherry consumption on health has also been proven. To increase the fresh consumption of cherry tart we need to provide longer availability of fresh fruit. Tart cherries are non-climatic fruits, therefore harvested fruit can be stored for a few days without significant decay. Appropriate storage, preserving nutritional value of fruits and inhibiting

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decay should be developed by using pre- and postharvest technologies. Chitosan has been found to be an effective preharvest treatment against decaying fungi in cherry. Different biofungicides effectively reduced the incidence of monilia-rot and other postharvest diseases. Several authors' research has shown that it is better to apply MAP with high (10%) CO_2 content during the storage of tart cherry than normal atmosphere. The not completely anaerobic conditions with increased CO_2 level in combination with cooling can slow the quality of deterioration of the fruit. There are few observations on pre- and postharvest technologies in the case of tart cherry, therefore, more research is necessary to develop successful storage technology methods that have been successfully applied to similar fruits. By achieving the most suitable storage technology, it would be possible to increase shelf-life, which would positively influence the increase in the consumption of fresh tart cherry (Mihaly *et al.*, 2019).

Shows the results of the research into marketability evaluation of sour cherry (*Prunus cerasus L.*) fruits, treated with chitosan solution. Fruits were treated with 0.5 % or 1 % chitosan solution, and stored at 5 °C. After 21 days of storage of sour cherry fruits the mass loss made up 4.6 % with 85.5 % output of marketable products (Vasylyshyna, 2018).

Polyphenols are a large group of secondary metabolites of the plant with a broad spectrum of biological action, exhibiting antioxidant activity. Studies have shown that the content of polyphenolic compounds and antioxidant activity of stone fruits depends on the characteristics of the variety (Goncalves *et al.*, 2004; Dziadek *et al.*, 2019).

The most important component of stone fruits, especially cherries, are phenolic substances, the content of which, depending on varietal characteristics and place of cultivation, varies significantly from 321 to 3370 mg / 100 g. - glucorutinoside, cyanidin-3-rutinoside and cyanidin-3-glucoside. Up to 40% of the amount of phenols is the content of flavan-3-oils and about 25% - flavonols and phenolic acids with the advantage of quercetin-3-rutinoside and chlorogenic acid, respectively (Wojdyło *et al.*, 2014; Yezhov *et al.*, 2019; Vasylyshyna, 2020).

In period of storage, the content of chlorogenic and caffeic acids changes. Thus, after six months of storage, the concentration of polyphenolic compounds of carrots of Nantes variety decreased caffeic acid by 64.6%, chlorogenic by 37.9% (Augqpole *et al.*, 2017).

The content of caffeic acid in the fruit due to its fungitoxic properties accelerates the process of suberinization, as well as helps to preserve them in period of transportation and storage.In response to damage to the fruit increases the content of chlorogenic acid. Which stimulates the formation of wound periderm. In contrast, caffeic acid inhibits these processes. Studies (Demyanets, *et al.*, 1974; Vasylyshyna, 2016) have shown that on the third day after injury there is a maximum accumulation of chlorogenic acid, after which its content decreases. In contrast, the maximum accumulation in the wound zone of caffeic acid occurs after 14 days.

Chlorogenic acid is thought to be a chemical barrier to the passage of microorganisms and provides reliable protection against damage. In addition, the appearance of darkening of the skin (tan) and pulp of the fruit is explained by the enzymatic oxidation of chlorogenic acid (Demyanets, *et al.*, 1974; Vasylyshyna, 2016).

There is an inverse correlation between the content of chlorogenic acid and the degree of browning of the fruit. More resistant to browning fruits are characterized by a high content of chlorogenic acid and its economical consumption (Vasylyshyna, 2016).

Protection of fruits from damage and economical consumption of chlorogenic and caffeic acid is possible only with proper organization of storage of fruits and vegetables. Polysaccharide-based preparations are now used for post-harvest ripening: chitosan, salicylic acid, and others (Rassa, *et al.*, 2013; Giméneza, *et al.*, 2016; Adiletta, *et al.*, 2019).

The purpose of the study was to study the effect of pretreatment with a solution of chitosan and salicylic acid on the change in the content of chlorogenic and caffeic acid in period of storage of sour cherry.

MATERIAL AND METHODS

Methods the research was conducted during 2018 year on the basis of the research station of pomology named after L.P. Symyrenko of the Institute of Horticulture of NAAS with cherry fruits of varieties Alpha and Pamiat Artemenko. For studies of 15 trees of each variety the day before harvest, sprayed with a solution of 1% chitosan; 1% chitosan with salicylic acid (100 mg L^{-1}). Fruits were removed at the consumer stage of ripeness from four different places of the crown from each tree of a certain variety and type of processing, placed in boxes weighing 5 kg for storage control fruits 15 days and experiment – 30 days at a temperature of 1±0.5 °C and relative humidity of 95±1%. Unprocessed cherry fruits were taken as a control. The experiment was repeated three times.

Phenolic compounds. The content of phenolic substances was determined by the Folin-Chocalteu method (Fruits, vegetables and products, 2006). Total phenolic content was determined spectrophotometrically KFK-2 (Russia), according to the Folin–Ciocalteu. Briefly, 1.0 mL of the sample was pipetted into a 10 mL volumetric flask containing 0.5 mL of Folin–Ciocalteu reagent (The Folin–Ciocalteu reagent be prepared by dissolving 100 g sodium tungstate (VI) dihydrate and 25 g sodium molybdate (VI) dihydrate with 700 ml distilled water, 100 ml concentrated hydrochloric acid, and 50 ml of 85% phosphoric acid to which is added 150 g of lithium sulphate hydrate), 5 mL of distilled water and 1.5 mL of Na_2CO_3 solution (w = 20 %), and the volume was made up with distilled water. After one hours, the absorbance of blue coloration was measured at λ = 670 nm against a blank sample. The measurements were compared to a standard curve of prepared rutin solutions (50, 100, 150, 250, 500 mg L^{-1}) and expressed as milligrams of rutin per 100 g ± SD. All measurements were performed in triplicate.

Chromatography. The content of chlorogenic and caffeic acid was determined by high performance liquid chromatography with diode matrix detector (chromatograms with absorption spectra) on a Waters 2998 instrument (USA) (Guidelines for methods of quality control, 2004). For research, an analytical column dimensions 250 mm × 4.6 mm filled with sorbent Diaspher-110-C18 (6 μm). Injection volume of a sample was 0.7-1.0 mL/minute. For the preparation of eluents used the mobile phase consisted of water, acetonitrile ("Cryochrome") and formic and orthophosphoric acid solution (1:1:0.1). The extracts were filtered and diluted with water (1: 5) before analysis. The relative content of chlorogenic and caffeic acid is defined as the ratio of the area of the chromatographic peak and the sum of the peak planes of all identified acids (*Guidelines for methods of quality control*: P 4.1.1672-03, 2004).

Statistical analysis. Data were expressed as mean ± stan-dard deviation; for mathematical data processing the value of $p<0.05$ was regarded as statistically significant. Two-way analysis of variance (ANOVA) was used to deter-mine the significance of differences. The statistical analyses were performed STATISTICA 6.

RESULTS AND DISCUSSION

The content of phenolic substances in fresh cherry fruits was significant and was at the level of 2270−2280 mg/100 g (Fig. 1). During storage, its content decreased by 5.9−6.1%. In the treated cherry fruits with chitosan solution, the losses decreased to the level of 5.6–5.7%, and they were the smallest when used for pre-treatment of a compatible solution of chitosan with salicylic acid - 5.0–5.5%.

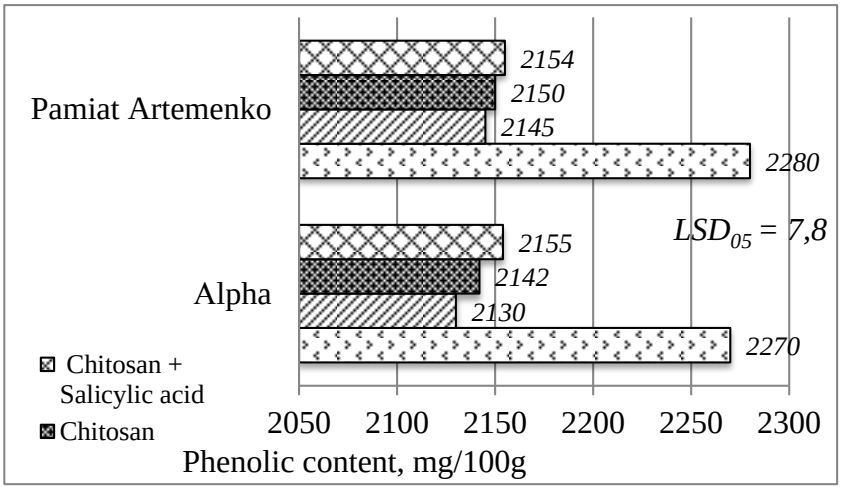

Figure 1. Change in the phenolic content of cherry fruits in period of storage

Their content chlorogenic acid in fresh cherries of the Pamiat Artemenko and Alpha varieties was at the level of 301 and 308 mg/100 g, respectively (Fig.

2). After storage, itscontent in the control version decreased by 1.5 times, and in pre-treated cherries, losses were lower and at the level of 13.6−14.9% in chitosan and 10.0−11.0% in chitosan and salicylic acid.

Similar to chlorogenic acid, there were changes in caffeic acid (Fig. 3). In particular, its content in fresh cherry fruits was at the level of 30.4−35.2 mg /100 g. During storage, it decreased by 1.9−2.0 times, and cherry fruits, pre-treated with polysaccharide compositions, had losses of caffeic acid at the level of 1.6−1.7 times.

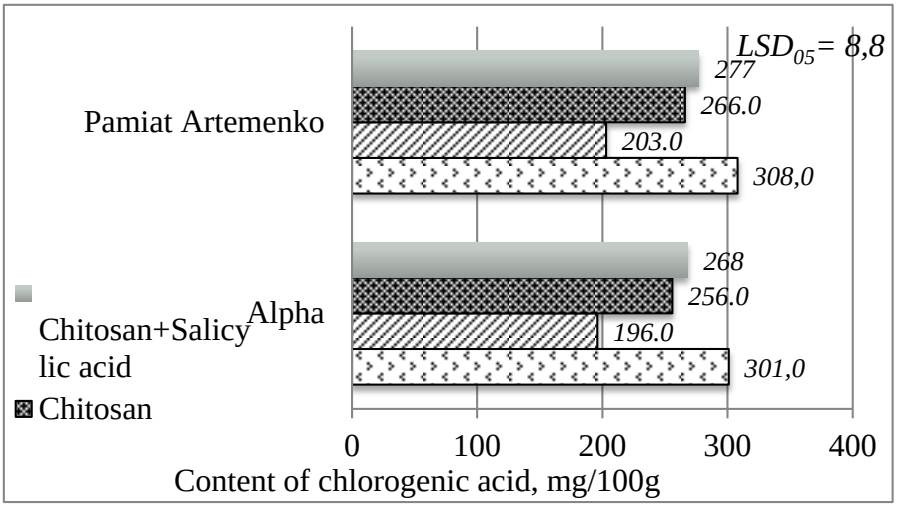

Figure 2. The content of chlorogenic acid in cherry fruits at the end of storage

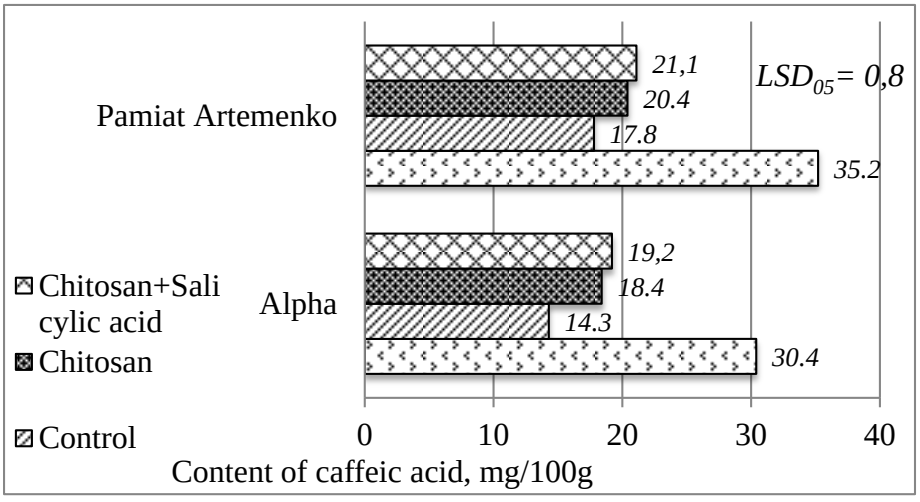

Figure 3. The content of caffeic acid in cherry fruits at the end of storage

As a result of the conducted researches the significant content of phenolic substances in cherry fruits was established - at the level of 2270−2280 mg /100 g,

of which 301−308 mg/100g are chlorogenic, and 30.4−35.2 mg/100 g - caffeic acid.

During fruit storage, the content of phenols decreased by 5.9−6.1%, including chlorogenic acid by 1.5 and caffeic acid by 1.9−2.0 times.

Strong correlations (r = 0.75–0.97) were found between the content of phenolic substances, chlorogenic and caffeic acids and the corresponding regression equations were derived (Fig. 4).

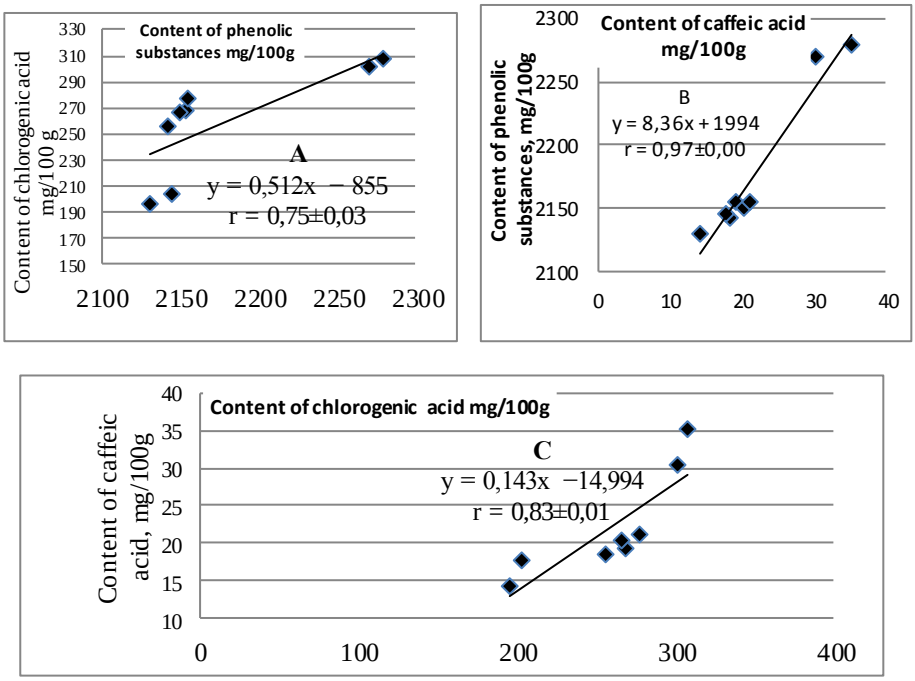

Figure 4. Correlation between the content of phenolic substances and chlorogenic acid (A); content caffeic acid and phenolic substances (B); content chlorogenic acid and caffeic acid (C) in cherry fruits

Were found between the content of phenolic substances, chlorogenic and caffeic acids strong correlations.

DISCUSSION

New storage technology, it would be possible to increase shelf-life, which would positively influence the increase in the consumption of fresh tart cherry (Mihaly *et al*., 2019). The results of the research Vasylyshyna (2018) into evaluation of sour cherry (Prunus cerasus L.) fruits, treated with chitosan solution, and stored at 5 °C after 21 days of storage of sour cherry fruits the mass loss made up 4.6 % and the quality of the chemical composition of cherry fruits changed.

Because sour cherries have unique anthocyanin content, and they are rich in phenolic compounds 2270−2280 mg/100 g. Our variability between sour cherry in total phenolics and anthocyanins confirming the results of Pedisic *et al*. (2010), Wojdylo *et al*. (2014), Stan *et al*. (2015). A significant part (25%) of the content of phenolic substances is accounted for by flavonols and phenolic acids with a predominance of chlorogenic acid (Yezhov *et al*, 2019). Phenolic acid contents generally decreased during storage by 5.9−6.1%, including chlorogenic acid by 1.5 and caffeic acid by 1.9−2.0 times. The data obtained by us are similar to the results of research performed Goncalves *et al*. (2007), Augqpole *et al*. (2017) on the reduction of chlorogenic and caffeic acid in period of storage of fruit.

And cherry fruits, pre-treated with polysaccharide compositions in chitosan and salicylic acid, had losses of caffeic acid at the level of 1.6−1.7 times of chlorogenic acid of 10.0−11.0%. According to research more resistant to browning fruits are characterized by a high content of chlorogenic and caffeic acid and its economical losses Demyanets, *et al*. (1974).

The obtained results are a consequence of the fact that the solutions used for fruit pretreatment form an additional barrier on the fruit surface, slowing down the intensity of transpiration processes and reducing the degradation of phenolic compounds (Krasniewska *et al.*, 2017).

CONCLUSIONS

Preservation of phenolic substances pretreatment of cherry fruits with solutions of polysaccharide compositions contributed. The most effective was the treatment of fruits with a solution of chitosan with salicylic acid in which the loss of phenolic substances was 5.0−5.5%, including chlorogenic - 10.0−11.0% and caffeic acid - 36.8−40.1%.

Therefore, in practice the content of chlorogenic and caffeic acids in the fruit during storage can determine the quality and suitability for fresh storage. To preserve the quality of cherry fruits before storage, they must be treated with a solution of 1% chitosan and 100 mg L^{-1} salicylic acid.

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