

The effect of aerosol spraying with calcium-containing preparations on basic grape quality indicators of CV. Shokoladnyi during long-term storage

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Abstract. In this work the effect of post-harvesting aerosol spraying with calcium-containing preparations Master Green Ca (1.75 g/l) and Brentax KCa (2.5 g/l) on changes in the indicators of commercial quality and natural weight loss of grape cv. Shokoladnyi in the dynamics of long-term storage was studied. The studies were carried out in 2019-2020. Experimental samples were collected on the 30th and 60th day of storage. It has been established that aerosol spraying contributed to a decrease in the natural loss of bunch weight by 5.7- 6.5%. The amount of total sugars in experimental samples decreased to the 60th day of storage by 15.3% and 10.2% compared to the control. The preparations positively impacted organoleptic indicators during the storage: the tasting assessment of experimental batches of grapes to the end of storage exceeded the control by 6.7-10.3%.

1 Introduction

In connection with prevailing conditions for reduction of imported products, modern commercial viticulture requires the improvement in long-term grape storage technology in order to meet the demands of population for valuable food products for a long period of time [1, 2]

It is impossible to solve this problem without modernization of storage technologies using innovative methods in order to keep quality of table grapes.

One way to extend storage period is aerosol spraying with edible grape coating, based on hydroxymethylpropyl cellulose, capa-carrageenan, glycerin, and cellulose nanofibers. This spraying has high waterproof properties. The grapes after spraying were characterized by the weight loss of less than 5% at the end of storage, the turgor level also remained high [3].

Grape spraying with film coating solutions based on potato starch, gelatin, glycerin, natamycin and chitosan, sodium alginate, glycerin, natamycin showed a decrease in natural weight loss. An increase in resistance to berry crushing at the end of storage from 4.8% to

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43.3% (starch/gelatin/glycerol/natamycin) and from 7.1% to 55.2% (chitosan/sodium alginate/glycerol/natamycin), compared to the control, was also observed [4].

One of the methods allowing increase preservation of commercial indicators of grape products at high level is the post-harvest aerosol spraying of grapes with biologically active calcium-containing preparations before laying for long-term storage [5-7].

Calcium is a member of the nucleus, mitochondria, ribosomes, plastids, cytoplasm, cell walls and other organelles. Besides, it is a part of membranes, necessary for their proper functioning. Calcium is an integral part of pectin substances. Cell membrane cannot be formed without it. It regulates the acid-based balance in the cell, changes the colloidal condition of cytoplasm, increases the viscosity and reduces the water content in the tissue. In plant body cells, it affects the osmotic activity and electrical polarization of anions, as well as membrane permeability and cell membrane potential [8-10].

In international practice, the use of calcium-containing preparations in agricultural sector has become widespread. For example, American and Iranian scientists studied the effect of pre-harvest spraying with calcium chloride (CaCl_2) on the commercial quality of table grapes *cv.* Asgari (*Vitis vinifera* L.). Spraying with calcium-containing preparations reduced berry shedding and infection with a rot complex. Such quality indicators as juice pH, content of soluble solids and titratable acids didn't change significantly, while the density, color and appearance of berries did. Scientists from Uruguay and Chile studied the effect of calcium propionate (5 g/l) in combination with heat treatment (60°C , 2 min.) on the quality of table grapes *cv.* Black Emerald, stored for 21 days at 5°C . The respiration rate of sprayed berries remained below control up to 17 days. The density of berries remained high up to 14 days of storage. The content of free and total calcium in berries was also higher relative to the control samples [11].

Our studies on the effect of spraying grapes with calcium-containing preparations showed the significant decrease in the loss of bunch weight to the end of storage by 45% and 34% relative to the control, while having remained high level of organoleptic indicators (7.8 and 7.6 points) [12, 13].

Kuzin A.I., Ilyinsky A.S. and Truniv Yu.V. studied the effect of spraying with calcium-containing preparations on the concentration of calcium and fruit quality of apple *cv.* Zhigulevskoe. Such sprayings contributed to an increase in the concentration of calcium and a decrease in weight loss. They also protected the pulp from development of vitreousness and decomposition [14].

Proceeding from the above, using of calcium-containing preparations in the post-harvest period is a high-potential method to preserve grape quality indicators during long-term storage.

The work is aimed at identifying the effectiveness of using various physiological preparations based on Ca^{2+} cations in aerosol sprayings during post-harvest period on quality characteristics of table grapes in the dynamics of long-term storage.

2 Materials and methods

2.1 Procedure and conditions of the experiment

CV. Shokoladniy ((Kata-Kurgan x Kirovabadsky Stoloviy) x Antey Magarachskiy) is a table grapevine cultivar of medium ripening. The bunch is big, cylindrical, usually winged, double clustered, of an average density. Berries are large, oval, elongated, dark red colored, with harmonious flavor. The pulp is fleshy and juicy, the skin is dense. Frost resistance is minus $22-23^\circ\text{C}$, weak sustainability to mildew and oidium, resistant to grey mold.

Experimental studies were carried out during 2019-2020 on the basis of Morskoye branch of commercial enterprise «Massandra», from the mountain-valley coastal viticultural region of the Republic of Crimea, and the Laboratory of Grape Storage of National Research Institute of Viticulture and Winemaking «Magarach», Yalta city.

Grape culture management system is open earthed. Planting scheme is 3.0m x 1.5m. Bush training is one-armed horizontal cordon on a middle trunk (from 60-80 cm).

2.2 Characteristics of preparations

The following preparations were used in aerosol sprayings:

1. Master Green Ca – a bioactivator, included lignin and polycarboxylic acids; the concentration of working solution was 1.75 g/l.
2. Brentax KCa – a bioactivator based on kations of K^+ and Ca^{+2} , the concentration of working solution was 2.5 g/l.

2.3 Scheme and methods of experimental study performance

Grape bunches were selected from the accounting bushes when the sugar content reached 20% or more. In the process of harvesting, bunches typical for the variety were weighed and the bunches were marked for further experiment to study a bunch weight loss. Selected bunches were placed in boxes. After forming the experimental grape batches, we placed the boxes in a chamber for spraying with calcium-containing preparation in aerosol form. The solution was supplied in mobile chamber equipped with a container installation platform and an electrically driven self-priming membrane pump for 20 seconds through nozzles with a pressure of 0.2 MPa. Control batches were not subjected to solution treatment.

Fresh grapes were stored at a temperature of $0\pm 2^\circ C$ and relative humidity of 90-95% for 60 days. Storage production technology in industrial freezer, as well as regular sulfur dioxide treatment were used in the control.

Sampling for research was carried out on in fresh grapes before storage, and on the 30th and 60th day during storage.

2.4 Analysis of industrial quality indicators and chemical composition of grape berries

For determining the total mass concentration of sugars (g/L) berries were crushed in a turbo blender (Moulinex – LM600E, France); juice suspension was centrifuged at 5000 rpm (Sigma 4K10 Braun, Germany) for 15 min; the juice was filtered through 0.45 μm pore size membrane filters. Total sugars were determined by using digital refractometer. [15].

The bunch weight loss was expressed as a bunch weight ratio after and before storage, multiplied by 100%. The organoleptic evaluation of grape samples was carried out using 10-point scale. It included the following parameters: visual appearance of bunch and berries, flavor and aroma, texture of berry skin and pulp. Studies were repeated three times.

2.5 Methods of mathematical processing of experimental results

To determine the significance of the effect of studied preparations on the natural loss values during long-term storage in the process of dispersion analysis, the obtained results were analyzed by the paired Student's t-test (at $t < 0.05$ "significant effect") in the SPSS Statistics 17.0 software program. The predetermined probability of an erroneous result (p) was less than 0.05. The error of the experiments, implemented in three replicates, did not exceed 10%.

3 Results and Discussion

3.1 The effect of spraying with calcium-containing preparations on changes in the conditional indicators of grapes during long-term storage

According to the results of two-year studies, an increase in the mass concentration of sugars in the control variant by 1.7% to the end of storage was noted. At the same time, in the experimental variants, a decrease in the mass concentration of sugars by an average of 9-13% was observed (Figure 1).

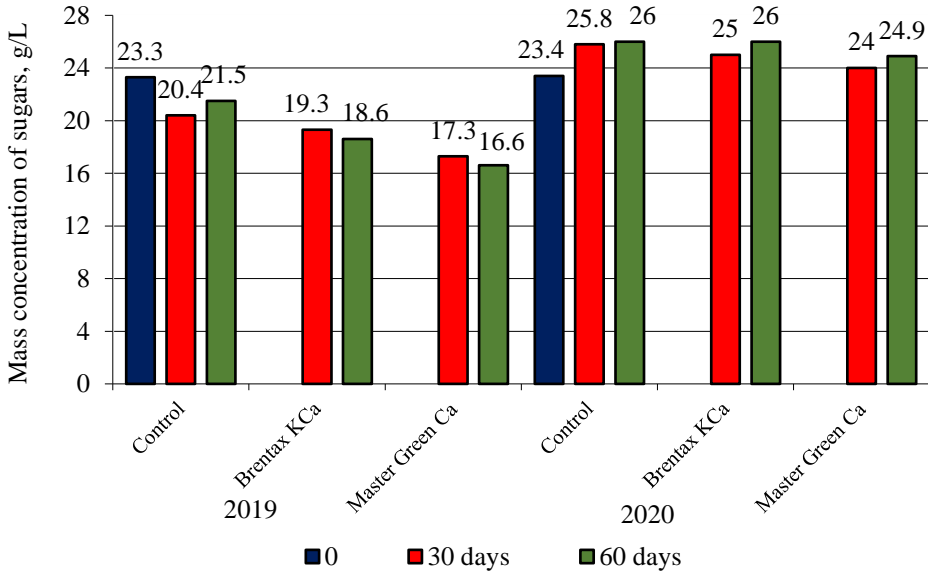


Fig. 1. Changes in the mass concentration of sugars during storage depending on the variant of spraying, 2019-2020.

3.2 The effect of spraying with calcium-containing preparations on the natural weight loss of grape CV. Shokoladnyi during long-term storage.

Using of aerosol spraying with physiologically active preparations allowed decrease the value of the natural weight loss, which, in its turn, contributed to the prolongation of grape storage period (Figure 2).

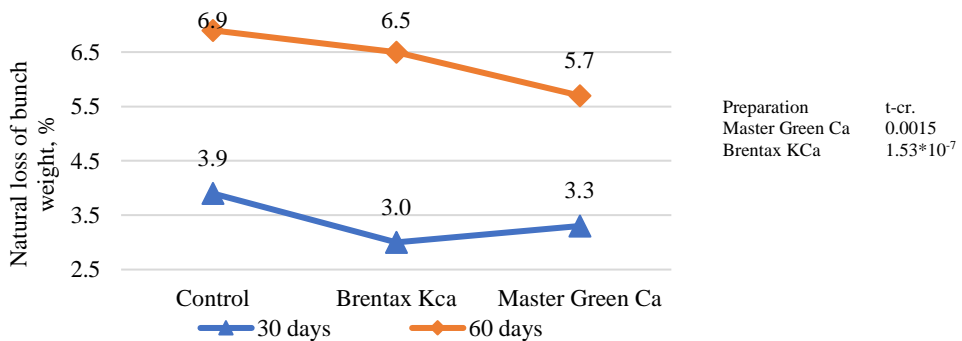


Fig. 2. The effect of spraying with calcium-containing preparations on the natural bunch weight loss of CV. Shokoladnyi during long-term storage.

A decrease in the natural weight loss by the 60th day of storage varied in the range from 17.4% (Master Green Ca) to 5.8% (Brentax KCa).

Statistically important difference in the effect of post-harvest spraying with Master Green Ca preparation ($t = 1.53 \cdot 10^{-7}$) and Brentax KCa ($t = 0.0015$) on the natural weight loss value was established, considering t-criterion much less than 0.05.

3.3 The effect of spraying with calcium-containing preparations on organoleptic indicators of grapes during long-term storage.

Using of aerosol spraying had a positive effect on bunch appearance, palatability traits, skin and pulp quality (Table 1).

Table 1. The effect of calcium-containing preparations on organoleptic indicators of grapes during long-term storage

Sample collection timing	Option	Appearance and smartness of bunch and berries	Aroma and flavor	Skin and pulp characteristics	Tasting assessment in total
Fresh	Control	1.76	4.34	2.60	8.7
After 30 days of storage	Control	1.53	3.80	2.27	7.6
	Master Green Ca	1.64	4.04	2.42	8.1
	Brentax KCa	1.70	4.19	2.51	8.4
	p<0.05	0.24	0.31	0.20	0.24
After 60 days of storage	Control	1.42	3.49	2.09	7.0
	Master Green Ca	1.52	3.73	2.25	7.5
	Brentax KCa	1.58	3.89	2.33	7.8
	p<0.05	0.27	0.33	0.24	0.26

The selected grape samples were characterized by the typical for the variety bunch size and uniform-sized berries (1.76 points). Ordinary and typical for the variety flavor was registered (4.34 points). The skin was easily crushed and barely feelable when eating (2.60 points). Total tasting assessment was 8.7 points. A uniform decrease in grape organoleptic indicators was observed in all experimental variants during storage. Aerosol spraying contributed to a higher stability of grape organoleptic indicators after 60 days of storage. Total tasting assessment after spraying was higher by 6.7% (Master Green Ca) and by 10.3% (Brentax KCa) in comparison with the control.

So, aerosol sprayings with calcium-containing preparations Master Green Ca and Brentax KCa have a positive effect on the conditional indicators of grapes: a decrease in the mass concentration of sugars in the dynamics of storage by 9%-13% indicates the ability of preparations to inhibit the processes of respiration and action of oxidative enzymes. At the same time, the parameter of natural loss of bunch weight significantly decreased by 6.7% (Master Green Ca) and 10.3% (Brentax KCa) relative to unprocessed grape batches, resulting in the prolongation of storage period.

4 Conclusion

The positive impact of aerosol spraying by Master Green Ca and Brentax KCa preparations on the crop quality indicators during long-term storage of Shokoladnyi grape cultivar has been established. Aerosol spraying contributed to decrease of the natural weight loss by 5.7

% (Master Green Ca) and by 6.5 % (Brentax KCa). Also, preparations positively impacted on organoleptic parameters during the storage, grape samples of experiment samples after the long-term storage were rated at 7.5 (Master Green Ca) and 7.8 (Brentax KCa) which is higher than control by 6.7% and 10.3% respectively. The data obtained make it possible to rationalize the system of long-term storage of grape *cv.* Shokoladnyi using aerosol sprayings with the preparation Master Green Ca.

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