

## INVESTIGATION OF THE RESPIRATION RATE DURING STORAGE OF FRUIT VEGETABLES UNDER THE INFLUENCE OF ABIOTIC FACTORS

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### Abstract

The aim of the work was to establish the influence of most important abiotic planting factors (temperature, precipitation quantity) on the respiratory rate of fruit vegetables at storage and also a possibility of correction of respiratory metabolism by post-harvest thermal processing by antioxidant compositions. Fruits of cucumbers of the hybrids Masha and Afina, bush pumpkins Kavili and Tamino, sweet pepper of the hybrids Nikita and Hercules, tomato of the varieties Novachok and Rio Grande Original were used for the studies. It was established, that the respiratory rate of pumpkin fruit vegetables is importantly influenced by the variety specificity. The respiratory level of pumpkin vegetables directly correlates with the sum of active temperatures of the period of fruits formation and reversibly – with precipitation and hydrothermal coefficient.

The influence of the variety specificity for nightshade vegetables is leveled, and among meteorological planting conditions the important intense influence on the respiratory rate is realized by the sum of active temperatures of the period of fruits formation and ripening. Precipitation and hydrothermal coefficient have the important influence only on pepper fruits.

It was established, that the use of post-harvest thermal processing by antioxidant compositions results in inhibition of respiratory processes in fruit vegetables at storage.

**Keywords:** respiratory rate, storage, fruit vegetables, post-harvest thermal processing by antioxidants, abiotic factors.

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### 1. Introduction

Quality characteristics of fruit vegetables vary widely by years. Even at planting fruits or vegetables of the same variety, their biomechanical composition, storage life and other technological properties change under the influence of changeable abiotic factors [1]. The problem of the influence of abiotic factors on the post-harvest quality of fruit and vegetable products, connected with climate global changes becomes more serious [2]. The most important physiological process in the post-harvest period for fruits and vegetables is respiratory metabolism [3]. Just the respiratory rate reflects a reaction of fruit tissues to stress abiotic factors at planting and storage. The speed of spoilage of fruit vegetable products at storage depends on the level of respiratory processes [3]. For shortening the respiratory activity in the post-harvest period, there were elaborated the series of arrangements: decrease of the storage temperature, preliminary thermal processing, use of ethylene inhibitors and other biologically active substances [4–6]. But the influence of abiotic factors of planting of fruit and vegetable products on physiological processes in the post-harvest period was not taken into account in these researches. So, for prognosticating and correcting storage life of fruit vegetables by the post-harvest thermal processing by antioxidant compositions, their respiratory rate depending on abiotic factors was studied.

### 2. Materials and Methods

The observations were realized during 2005...2012 years. 2 varieties of pumpkin vegetables and 2 varieties of nightshade vegetables were used in the researches. The subject of the research was fruits of cucumbers of the hybrids Masha F1 and Afina F1, bush pumpkins Kavili F1 and Tamino F1 (**Fig. 1**), sweet pepper Nikita F1 and Hercules F1, tomato Novachok and Rio Grande Original. Vegetables were planted at Southern Zaporizhia region, Ukraine. The region of planting is charac-

terized by the high heat supply: annual sum of temperatures higher than 10 °C is 3400...3600. And humidity is the least in Ukraine: the annual hydrothermal coefficient (HTC) is 0,5...0,7 units) [7]. So, at planting all fruit vegetables, drop irrigation was used. The spray norm within 30–90 m<sup>3</sup>/ha, in separate cases – 110–130 m<sup>3</sup>/ha was observed.



**Fig. 1.** Refrigeratory storage of bush pumpkins: *a* – Kavili F1; *b* – Tamino F1

Healthy fruits with a pedicle were laid for storage. The maturity degree of pumpkin fruits was determined by size characteristics and the one of nightshade fruits – by coloration. The size of cucumbers – 11–14 cm and of bush pumpkins – 16–21 cm. Tomatoes of the red maturity degree were selected, sweet pepper – at main coloration of no less than 80 % of the surface.

Cucumbers and bush pumpkins were submerged in solutions of antioxidant compositions with the temperature 42 °C for 10 min. They were stored at 8±0,5 °C and relative humidity 95±1 %.

Peppers and tomatoes were submerged in solutions of antioxidant compositions with the temperature 45 °C for 15 min. Tomatoes were stored at 2±1 °C, relative humidity of air 90±3 %. Peppers – at 7,0±0,5 °C at the relative humidity 95±1 % (**Fig. 2**).



**Fig. 2.** Refrigeratory storage of sweet pepper Nikita F1 and Hercules F1

Compositions included the following components: chlorophyllipt (Chl), water extract of horseradish (Hr), ionol (I) and lecithin (L) [8, 9]. The composition Chl+I+L that differed by concentrations of separate cases was used for cucumbers and bush pumpkins: for cucumbers 0.38 % Chl, 0.036 % I, 4 % L; for bush pumpkins – 0.75 % Chl, 0.048 % I, 4% L. The composition Chr+I+L was used for tomatoes and pepper. The water extract of horseradish was prepared in ratio of raw material and extractant 1:2. The composition included 4 % of L and 0.30 % of I for tomatoes and 0,024 % of I for pepper.

Non-processed fruits were used in control variants.

#### 4. 2. Research methods

According to annual data of the meteorological station of Melitopol city, there were calculated:

- the sum of active temperatures (SAT) higher than 10 °C of the vegetation period,
- SAT of the period of fruits formation (10 days before harvesting for pumpkins [10], 30 days for pepper [11] and 40 days for tomatoes [12]);
- Selyaninov hydrothermal coefficient (HTC).

According to the same data, there was determined the number of days of the vegetation period that didn't correspond to the biological minimum and maximum for fruit vegetables.

The respiratory rate (RR) in mg of CO<sub>2</sub>/kg×hour was determined by Tolmachev's method [13] (**Fig. 3**).



**Fig. 3.** Determination of vegetables respiratory rate by Tolmachev's method

This method was concluded in absorption of CO<sub>2</sub>, emitted at fruits respiration, by the alkali solution. The level of CO<sub>2</sub> was determined by titration by the solution of hydrochloric acid.

#### 3. Results

The veritable variety specification in the respiratory activity of pumpkin fruits was established during the researches (**Table 1**). Nightshade vegetables are characterized by specific differences of respiratory rate, but variety peculiarities are not expressed.

There were established essential fluctuations of levels of CO<sub>2</sub>, emitted by fruits, depending on a year of the research. Despite the variety specificity, such regularities were revealed between the respiratory rate and abiotic factors during vegetation. Most close dependencies are typical for SAT of the period of formation of fruits of both botanic families.

The thermal processing by antioxidants had the important inhibiting influence on respiratory activity in fruits of both pumpkin and nightshade vegetables (**Fig. 4**).

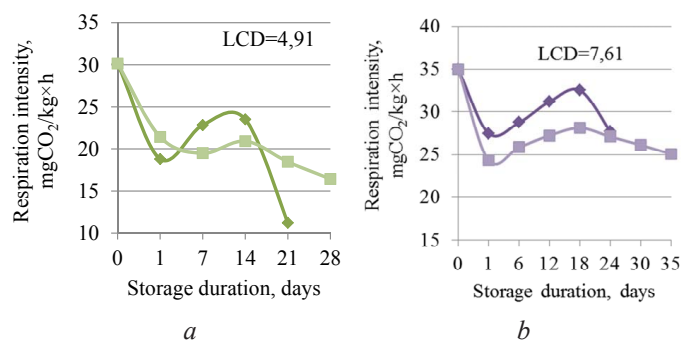


Fig. 4. Dynamics of respiratory rate: *a* – Afina cucumbers; *b* – Hercules pepper; —◆—, —◆— – control; —■—, —■— – thermal processing ChI+I+L

Table 1

Respiratory rate of nightshade vegetables before storage, mg of CO<sub>2</sub>/kg×hour, n=3

| Type         | Variety    | Respiratory rate, mg of CO <sub>2</sub> /kg×hour, n=3 | HIP <sub>0,95</sub> | V, %  | Sx, % |
|--------------|------------|---|---------------------|-------|-------|
| Cucumber     | Afina      | 31,73   | 2,35                | 27,51 | 2,44  |
|              | Masha      | 16,75   | 0,75                | 10,67 | 1,48  |
| Bush pumpkin | Kavili     | 38,68   | 1,72                | 36,40 | 1,46  |
|              | Tamino     | 58,38   | 1,78                | 16,59 | 1,00  |
| Pepper       | Hercules   | 41,49   | 3,03                | 37,64 | 2,40  |
|              | Nikita     | 46,21   | 3,90                | 37,11 | 2,78  |
| Tomato       | Rio Grande | 10,73   | 13,29               | 10,70 | 1,22  |
|              | Novachok   | 9,09  | 8,32                | 9,79  | 1,29  |

#### 4. Conclusions

The obtained results allow to state that the respiratory rate of pumpkin fruit vegetables is importantly influenced by the variety specificity. The respiratory level of pumpkin vegetables directly correlates with the sum of active temperatures of the period of fruits formation and reversibly – with precipitation and hydrothermal coefficient.

The influence of the variety specificity for nightshade vegetables is leveled, and among meteorological planting conditions the important intense influence on the respiratory rate is realized by the sum of active temperatures of the period of fruits formation and ripening. Precipitation and HTC have the important influence only on pepper fruits.

It was established, that the use of post-harvest thermal processing by antioxidant compositions results in inhibition of respiratory processes in fruit vegetables at storage.

The research results may be useful at making adequate decisions as to planning of arrangements on storage and post-harvest processing of products for decelerating respiratory metabolism. For the deeper understanding of the dependency of respiratory processes in the post-harvest period on abiotic factors, it is necessary to investigate the influence of such stressors as sun radiation, illumination intensity level and other.

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