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Evaluation of the Storage Dynamics of Tomatoes Treated with a 7% Edible Coating Based on an L-Leucine-Derived Pseudoprotein (PP)

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Abstract

During the storage of agricultural products, one of the major challenges is the rapid deterioration of fruit quality attributes, which is associated with moisture loss, respiratory activity, and the degradation of cellular structures. In contemporary research, particular attention is given to biodegradable edible coatings that reduce the intensity of metabolic processes and extend the shelf life of produce

The aim of the present study was to evaluate the storage dynamics of tomatoes treated with a 7% edible coating based on a pseudoprotein (PP) derived from the α-amino acid L-leucine. The study was conducted under conditions selected through preliminary optimization, at a temperature of 16°C, relative humidity of 70 ± 5%, and a storage period of 27 days. The dynamics of weight loss, total soluble solids (°Brix), and crude fiber content were assessed.

The obtained results demonstrated that the PP coating significantly reduced weight loss, slowed the decline in total soluble sugars, and ensured a relatively stable retention of crude fiber content compared to the control samples. It was established that the 7% pseudoprotein-based coating effectively limits dehydration and metabolic processes, thereby contributing to the preservation of the commercial and structural quality of tomatoes.

Keywords: tomato, pseudoprotein, edible coating, weight loss, soluble sugars, crude fiber.

Introduction

During the storage of agricultural products, one of the major challenges is the rapid alteration of their quality characteristics, which is associated with physiological and biochemical processes occurring within the fruit. During the storage period of fruits and vegetables, respiration, moisture evaporation, metabolic consumption of organic compounds, and degradation of cellular structures actively occur, ultimately leading to a reduction in the commercial quality and nutritional value of the product. [1].

Tomato (*Solanum lycopersicum L.*) is classified as a highly respiring agricultural product and is particularly sensitive to storage conditions. Under ambient or moderately low-temperature storage, major challenges include weight loss, reduction of sugar content, tissue softening, and the degradation of structural components of the cell wall.

In recent years, considerable attention has been devoted to the development and application of biodegradable edible coatings, which form a semipermeable protective layer on the fruit surface and reduce the intensity of water vapor and gas exchange. Of particular interest are pseudoproteins based on α-amino acids, which are characterized by biocompatibility, biodegradability, and favorable barrier properties. [2-6].

Within the framework of preliminary studies, the effect of a 7% pseudoprotein-based coating on biochemical parameters of tomatoes, including pH, titratable acidity, vitamin C content, and water-soluble dry matter, was evaluated. Based on the mathematical design of the experiment, the practically optimal conditions were determined to be a storage temperature of 16°C, a dipping time of 15 s, and a storage period of 27 days. [7,8].

The aim of the present study is to further evaluate the storage dynamics of tomatoes under these optimized conditions by assessing key quality parameters, including weight loss, total soluble solids (°Brix), and crude fiber content.

Methodology

The object of the study was red table tomatoes (*Solanum lycopersicum L.*) at the full-ripe stage, selected according to the principle of uniformity in size and maturity.

A 7% alcoholic solution of a pseudoprotein (PP) based on the α-amino acid L-leucine was used as the edible coating. The samples were coated by the dipping method for 15 seconds, after which the tomatoes were allowed to dry at room temperature. [9,10].

The storage conditions were selected based on the results of a preliminary optimization study, which established that a temperature of 16°C, a dipping time of 15 s, and a storage period of 27 days provided relatively stable preservation of the quality attributes of tomatoes.

The experiment was conducted in two variants: a control group without coating and an experimental group consisting of samples treated with a 7% PP coating.

Tomatoes were stored at a temperature of 16°C and a relative humidity of 70 ± 5% for a period of 27 days. Within the scope of the study, analyses were performed at 3-day intervals (days 0, 3, 6, 9, 12, 15, 18, 21, 24, and 27).

The following parameters were determined: weight loss (%) based on the difference between initial and current weight; total soluble solids (°Brix) using the refractometric method; and crude fiber content (%) according to the AOAC methodology. All determinations were performed in triplicate, and the results are presented as mean values. [11].

Results and Discussion

Based on the preliminary optimization study, it was established that the practically optimal storage regime for tomatoes treated with a 7% pseudoprotein (PP) edible coating consisted of a temperature of 16°C, a dipping time of 15 s, and a storage period of 27 days. Under these conditions, relatively stable values of key quality parameters, including °Brix, pH, titratable acidity, and vitamin C content, were obtained, providing the basis for the design of the present study. [8-9].

In the present study, the dynamics of additional key parameters during storage, including weight loss, total soluble solids (°Brix), and crude fiber content, were evaluated. These parameters provide important information regarding changes in the commercial, structural, and organoleptic quality of the fruit.

Table 1. Dynamics of Tomato Quality Parameters During Storage

Day	Weight Loss*, (%)		Total Soluble Solids (°Brix)		Crude Fiber, (%)	
	CTRL	Coated	CTRL	Coated	CTRL	Coated
0	0.0	0.0	5.8	5.8	1.18	1.18
3	1.1	0.7	5.92	5.88	1.19	1.19
6	2.3	1.4	6.05	5.96	1.18	1.19
9	3.6	2.2	5.85	5.92	1.15	1.18
12	5.0	3.1	5.55	5.82	1.11	1.16
15	6.5	4.1	5.20	5.65	1.06	1.13
18	8.2	5.3	4.82	5.35	1.00	1.09
21	10.1	6.6	4.45	5.05	0.94	1.05
24	12.0	7.9	4.12	4.72	0.86	1.00
27	13.8	9.0	3.82	4.52	0.81	0.95

A gradual increase in weight loss was observed in both treatments during storage; however, this process was significantly slower in the samples treated with the PP coating. By day 27, weight loss reached 13.8% in the control samples, whereas it was limited to 9.0% in the PP-coated samples. These results indicate that the pseudoprotein coating reduces the rate of moisture evaporation and partially restricts respiratory processes.

Analysis of changes in total soluble solids (°Brix) in both treatments showed that the slight increase observed during the initial stage of storage was associated with partial moisture loss and the consequent concentration of soluble constituents. During the subsequent storage period, a decline in °Brix values was recorded, which can be attributed to the utilization of sugars in respiration and other metabolic transformations. Nevertheless, the rate of decrease in total soluble solids was lower in the PP-coated samples. While the control samples exhibited a value of 3.82°Brix on day 27, the PP-coated samples maintained a higher value of 4.52°Brix. These findings are consistent with the results of the preliminary optimization study, in which relatively higher °Brix values were preserved under the optimized storage conditions.

During the initial stage of storage, no significant changes in crude fiber content were observed, which may be partially attributed to the concentration effect resulting from moisture loss. During the later stages of storage, however, a gradual decrease in crude fiber content was recorded, associated with the enzymatic degradation of structural polysaccharides in the cell wall and the consequent softening of tissues. This process was more pronounced in the control samples, where crude fiber content decreased to 0.81% by day 27. In contrast, the PP-coated samples maintained a crude fiber content of 0.95%, indicating a relatively better preservation of the fruit tissue structure.

The obtained results confirm that the 7% edible coating based on a pseudoprotein derived from the α-amino acid L-leucine effectively slows down dehydration and metabolic processes in tomatoes during storage. Particularly noteworthy is the fact that the application of the coating ensured a relatively stable preservation of both commercial quality and structural–biochemical characteristics throughout the 27-day storage period.

Conclusions

Under the conditions selected on the basis of the preliminary optimization study, namely a storage temperature of 16°C, an immersion time of 15 s, and a storage period of 27 days, the effect of a 7% edible coating based on a pseudoprotein derived from the α-amino acid L-leucine on the storage dynamics of tomatoes was evaluated.

The results of the study demonstrated that the application of the PP coating significantly reduced weight loss, slowed the decline in total soluble solids, and ensured better preservation of crude fiber content compared with the control samples.

It was established that the 7% pseudoprotein-based coating reduced the intensity of dehydration and metabolic processes, thereby contributing to the preservation of the commercial, structural, and organoleptic quality of tomatoes under prolonged storage conditions.

The obtained results complement the findings of the preliminary optimization study and confirm the potential of pseudoprotein-based edible coatings for application in agricultural product storage technologies.

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პომიდვრის შენახვის დინამიკის შეფასება α-ამინომჟავა L-ლეიცინზე დაფუძნებული ფსევდოპროტეინის (ფპ) 7%-იანი საკვები საფარით

სალომე ჭეიშვილი

ანოტაცია

აგროპროდუქტების შენახვის პროცესში ერთ-ერთ მნიშვნელოვან პრობლემას წარმოადგენს ნაყოფის ხარისხობრივი მაჩვენებლების სწრაფი გაუარესება, რაც დაკავშირებულია ტენის დაკარგვასთან, სუნთქვით პროცესებთან და უჯრედული სტრუქტურების დეგრადაციასთან. თანამედროვე კვლევებში განსაკუთრებული ყურადღება ეთმობა ბიოდეგრადირებად საკვებ საფარებს, რომლებიც ამცირებენ მეტაბოლური პროცესების ინტენსივობას და ახანგრძლივებენ პროდუქტის შენახვის ვადას.

წინამდებარე კვლევის მიზანს წარმოადგენდა პომიდვრის შენახვის დინამიკის შეფასება α-ამინომჟავა L-ლეიცინზე დაფუძნებული ფსევდოპროტეინის (ფპ) 7%-იანი საკვები საფარის გამოყენებით. კვლევა განხორციელდა წინასწარი ოპტიმიზაციის საფუძველზე შერჩეულ პირობებში 16°C ტემპერატურაზე, 70±5% ფარდობითი ტენიანობის პირობებში და 27-დღიანი შენახვის რეჟიმში. შეფასდა წონითი დანაკარგის, საერთო ხსნადი შაქრების (°Brix) და ნედლი უჯრედანას დინამიკა.

მიღებულმა შედეგებმა აჩვენა, რომ ფპ საფარი მნიშვნელოვნად ამცირებს წონით დანაკარგს, ანელებს შაქრების შემცირებას და უზრუნველყოფს ნედლი უჯრედანას შედარებით სტაბილურ შენარჩუნებას კონტროლის ნიმუშებთან შედარებით. დადგენილია, რომ 7%-იანი ფსევდოპროტეინული საფარი ეფექტურად ზღუდავს დეჰიდრატაციულ და მეტაბოლურ პროცესებს, რაც ხელს უწყობს პომიდვრის სასაქონლო და სტრუქტურული ხარისხის შენარჩუნებას.

საკვანძო სიტყვები: პომიდორი, ფსევდოპროტეინი, საკვები საფარი, წონითი დანაკარგი, შაქრები, ნედლი უჯრედანა.