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OPEN ACCESS

Received: 24.1.2023
Revised: 25.2.2023
Accepted: 13.3.2023
Published: 27.3.2023

Slovak Journal of Food Sciences

Potravinarstvo Slovak Journal of Food Sciences
vol. 17, 2023, p. 289-300
https:// doi.org/10.5219/1850
ISSN: 1337-0960 online
www.potravinarstvo.com

The effect of storage temperature on the quality of avocado fruits from different climatic zones

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ABSTRACT

Avocado is one of the most valuable products, as it is characterized by a high content of biologically active substances, including vitamins, mineral elements, fats, and dietary fibers. According to a complex of organoleptic and physicochemical indicators, the consumption properties of avocado fruits from different countries of origin, which are sold in Ukraine, have been investigated. Among the organoleptic indicators, the state of peel and pulp, taste, and smell has been determined according to the developed scoring scale. It has been established that the Haas type (Colombia) fruits have a light green pulp and a deep green peel that does not lag well behind the flesh, they are quite firm, the taste is watery, and there are no significant defects, the stem is not damaged. Haas (Israel) avocados had light green pulp and a brownish-black peel that separated from the flesh very well, with little evidence of pollination, a nice buttery flavour, and a nice texture. There is a slight peel defect (pollination mark) with an area of less than 4 cm^2, which does not affect the fruit's flesh, and the stem is not damaged. The fruit of the Fuerte type (Israel) had a light green pulp and a deep-green peel that did not lag well behind the flesh, a somewhat grassy taste, and a loose flesh texture. The fruit had a defect in the peel (lens) with an area of less than 6 cm^2, which does not affect the fruit's flesh, and the stem is not damaged. It has been found that the researched types of avocado fruits from different countries of origin differ in shape, size, and the ratio of peel, pulp, and stone. From the physicochemical parameters, the mass fraction of moisture, the content of dry soluble substances, active acidity, the content of ascorbic acid, and the fatty acid composition of lipids of avocado fruits have been determined.

Keywords: avocado, quality, consumption properties, fatty acid composition

INTRODUCTION

In most countries, the production of fruit and vegetable products increases annually due to the growing demand for them both on the national and global markets. According to the Healthy Nutrition Plate developed by experts from the Harvard School of Public Health, more than half of the daily diet shall consist of a variety of fruit and vegetable products, and the share of plant products, in general, can increase to 70-75% **[1]**. More than 400 types of avocados are known, among which the most popular for consumers are the fruits of Zutano, Big, Haas, Fuerte, Pinkerton, Ettinger, Bacon, Gwen, Reed, Puebla, and Cocktail varieties. The size, weight, peel color, and nutritional properties of avocados, including the mass fraction of lipids, vary and depend on the avocado type and the fruit's country of origin. The main suppliers of avocado fruits to the world market are RSA, Peru, Israel and Kenya, Mexico, Spain, and Chile. The main feature of avocado, distinguishing it from other fresh fruits, is a high mass fraction of lipids, which can vary depending on the type, country of origin, and harvest season, ranging from 3-30% and is 23.5% on average **[2]**. Unlike lipids of animal origin, avocado lipids are easier to digest and do not contain cholesterol. They are mainly represented by triglycerides (85%); the remaining 15% are mono- and diglycerides, phospholipids, and glycolipids. Free fatty acids are present in small amounts. The main fatty acids that make up glycerides are oleic (depending on the type, its share ranges from 49 to 73%), palmitic (15.7-30.8%), linoleic (0.3-15.8%), and palmitoleic (2.8-11.0%) **[3]**.

Basic information on the quality of avocados is presented in the UNECE standard FFV-42 **[4]**. Avocados' packaging and transportation is carried out per Code of Practice for Packaging and Transport of Fresh Fruit and Vegetables (CAC/RCP 44-1995) **[5]**. Relative humidity should be 90%. The optimal storage temperature depends on live on the variety and ripeness of the fruits. Considering the differences in the chemical composition of avocado fruits of different types and producing countries, suitability for storage, duration, conditions of transportation, and sale, the study of the consumption properties of avocado fruits, which are sold in Ukraine, is relevant.

Scientific hypothesis

The hypothesis of the scientific work is to establish the dependence of the consumption properties of avocado fruits of different types and countries of origin on the temperature conditions of storage to determine the optimal storage terms while preserving the marketable quality.

MATERIAL AND METHODOLOGY

Samples

The object of the research was avocado (*Persea americana*) fruits of three different types: Haas and Fuerte. The researched fruit samples were delivered to the laboratory for experimental research in compliance with the recommended temperature regimes along the entire logistical path.

Chemicals

Acetone, C_3H_6O (Torhovyi Dim Enerhostroiinvest, Ukraine; Sodium hydroxide, NaOH (Khimlaborreaktyv LLC, Ukraine), Ascorbic acid, vitamin C (Khimlaborreaktyv LLC, Ukraine), Metaphosphoric acid, HPO_3 (Khimlaborreaktyv LLC, Ukraine), Pyrocatechin, $C_6H_4(OH)_2$ (Khimlaborreaktyv LLC, Ukraine), Chloroform, $CHCl_3$ (CHEMICO GROUP, Great Britain), Methanol, CH_3OH (CAS, Netherlands), Hexane, C_6H_{14} (Hammerite, Netherlands).

Animals and Biological Materials

The following types of avocados were chosen for the study: Haas type, country of origin - Colombia, importer (Flamingoco); fruits of the Haas type, country of origin - Israel, importer (Nature's Pride); fruits of the Fuerte type, country of origin - Israel, importer (Nature's Pride).

Instruments

Drying cabinet SNOL 67/350 (Thermoengineering LLC, Ukraine), titration device (Labor-Technik LLC, Ukraine), analytical electronic balance KERN ABS 120-4 (Khimtex SE, Ukraine), refractometer IRF-454B2M (KOMZ JSC), pH meter ULAB MP 511 (ULAB, China), gas chromatograph Kristallux-4000M (Meta-Chrom Research and Production Company), refrigerator GGM Gastro (GGM Gastro, Germany).

Laboratory Methods

Experimental studies were carried out using modern standards, generally accepted, and special organoleptic and physicochemical methods. The mass fraction of moisture was determined by drying to a constant mass **[6]**; the content of dry soluble substances – by the refractometric method **[7]**; active acidity – by the potentiometric method **[8]**; the content of ascorbic acid – by the iodometric method **[9]**; fatty acid composition of lipids – by the chromatographic method.

Description of the Experiment

Sample preparation: after evaluating the organoleptic and physicochemical indicators of freshly purchased avocado samples, their quality was studied during 14 days of storage. Avocado samples were stored in a GGM Gastro refrigerator at a temperature of 3-5 °C and a room temperature of 15-18 °C. Fruit from the same batch was taken as a control sample.

Number of samples analyzed: 150.

Number of repeated analyses: 5.

Number of experiment replication: 3.

Design of the experiment: At the first stage of the study, the organoleptic indicators of the quality of avocado fruits were determined: the condition of the peel and pulp, taste, and smell. At the second stage of the study, physicochemical parameters were determined: mass fraction of moisture, the content of dry soluble substances, pH, the content of ascorbic acid, and fatty acid composition. In the last stage, we processed the obtained results, subjected them to statistical analysis, and checked the validity of our hypotheses.

Statistical Analysis

Origin 2021 software (OriginLab Corporation, Massachusetts, USA) was used for data analysis. All assays were repeated at least three times independently, and the experimental data were represented as mean ± standard deviation. The means were compared by Tukey's multiple range test at $p < 0.05$.

RESULTS AND DISCUSSION

The analysis of the scientific works of foreign scientists showed that sufficient attention is paid to the study of avocado quality. In particular, scientists **[10]** investigated changes in the quality of avocado fruits using two storage temperature regimes – T1 (+8 °C) and T2 (+17 °C) for 96 hours with the use of pretreatment of fruits with exogenous ethylene (C_2H_4) to speed up the process of their maturation. The issue of the development process of avocado fruits **[11]**, their ripening after harvesting **[12]**, the influence of different storage conditions on the control of black spot development **[13]**, and in work **[14]** are covered the causes of heterogeneous fruit ripening. The influence of cold shock on the shelf life of naturally ripened avocado fruits is covered in the publication of Jiao Chen, Xixia Liu, Fenfang Li, Yixing Li, and Debao Yuan **[15]**. The research showed that immersing avocado fruits in ice water for 30 minutes effectively slows their biochemical processes. The method proposed by scientists can be used to extend the shelf life of avocados. Alaika Kassim and Tilahun Seyoum Workneh investigated the effect of the combined processing of Hass avocado fruits after their harvest on changes in the fruits' physical, chemical and sensory properties during 28 days of cold storage **[16]**. It was determined that the proposed cold storage conditions (5.5 °C for two days, 5 °C for six days, and 4.5 °C for 20 days at 95% relative humidity) ensure the highest preservation of fruit quality. The combination of a wax coating, packaging made of low-density polyethylene, and the above-mentioned cold storage conditions helps delay avocado fruit ripening by about two weeks. Cold storage has been proven to be important for extending the shelf life and maintaining the quality of avocados during export. The scientists **[17]**, **[18]** substantiated the possibility of using bioactive films to preserve the quality of avocados and extend their shelf life under refrigeration conditions and at room temperature. In research confirmed the feasibility of using packaging with a modified environment to extend the shelf life of Hass avocado fruits **[19]**. In **[20]**, the effect of pre-treatment avocado fruits with 1-Methylcyclopropene (1-MCP) to extend their shelf life after harvest was investigated. Fruits treated with 1–MCP up to 14 days of storage showed similar peel firmness and color values as those treated at harvest. However, when 1–MCP pretreatment was applied in 21 days, the fruits showed signs of ripening similar to those not treated. These research data will help producers to choose the optimal time for applying 1-MCP in Hass avocados and contribute to a deeper understanding of the molecular mechanisms of the avocado ripening process **[21]**. The scientists **[22]**, **[23]** analyzed changes in the structure and composition of the avocado cell wall during softening. Cell wall pectins of Hass avocado fruits were studied during ripening at 20°C after harvest and after cold storage. The scientists **[24]** developed mathematical models that can be used to predict the ripening of a certain batch of Hass avocados in various logistics chains after harvest.

Amado D. with co-authors **[25]** and scientists **[26]** studied the nutritional and biological value of avocado peel and seeds and found that they can be used in the food, cosmetic **[27]**, and pharmaceutical industries **[28]**, **[29]**. It was determined that avocado seeds are rich in polysaccharides, proteins, lipids, vitamins, minerals, and other bioactive substances **[30]**. The work **[31]** summarises and analyses research on the main metabolites of avocado and its antioxidant and pharmacokinetic properties. In addition, the possibility of using avocados when developing new drugs to prevent and treat cancer, microbial, inflammatory diseases, diabetes, and cardiovascular diseases is emphasized. Chinese scientists **[32]** studied the physicochemical, functional, and emulsion properties of food protein made from defatted avocado flour and found that avocado protein contains all essential amino acids.

To develop an effective extraction of avocado oil in industrial processes, Normalina Arp and co-authors **[33]** studied the effect of pre-treated avocado on the properties of fruit pulp and extracted oil using hexane solvent extraction.

Tanweer Ahmad and Mohammed Danish proposed using avocado waste as a raw material to develop an effective adsorbent against various toxicants **[34]**.

It shall be noted that the results of studies on the consumption properties of avocados imported to Ukraine from different countries are practically absent in the domestic scientific literature. Comprehensive studies of avocado quality during storage were not conducted. Therefore, the paper's main purpose is to study the consumption properties of avocado fruits during storage according to a complex of organoleptic and physicochemical quality indicators.

The organoleptic evaluation of the quality of avocado fruits shall be carried out according to the UNECE standard FFV-42 2019 **[34]** and the developed 5-point scale. All examined samples met the requirements: undamaged, good-quality, clean, almost without insect pests or signs of pulp damage, without damage caused by low temperature, and without excessive external humidity and extraneous tastes/odours (Figures 1, 2, 3).

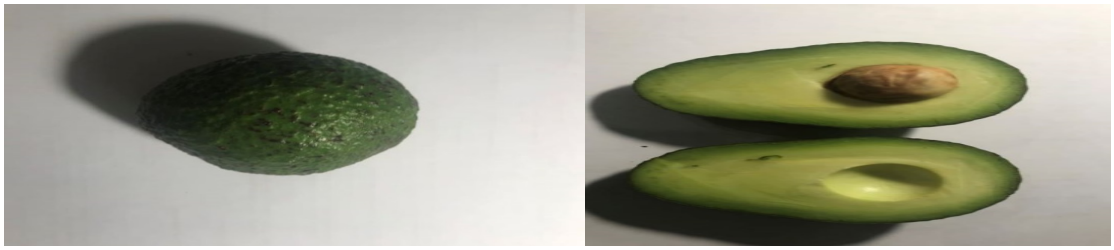

Figure 1 Study sample 1 – fruits of the Haas type, country of origin – Colombia, importer (Flamingoco).

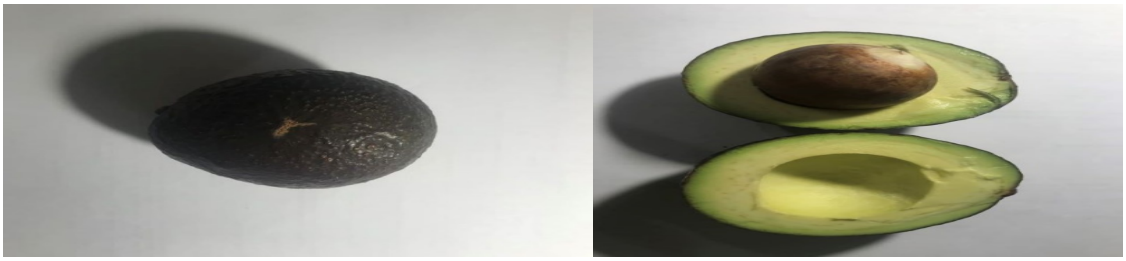

Figure 2 Study sample 2 – fruits of the Haas type, country of origin – Israel, importer (Nature's Pride).

Figure 3 Study sample 3 – fruits of the Fuerte type, country of origin – Israel, importer (Nature's Pride).

Table 1 Organoleptic evaluation of the quality of studied avocado samples.

Indicator	Experts	Researched avocado samples		
		Sample 1	Sample 2	Sample 3
Skin and flesh condition	I	5 ±0.25	4 ±0.20	3 ±0.15
	II	5 ±0.25	4 ±0.20	4 ±0.20
	III	5 ±0.25	4 ±0.20	4 ±0.20
	IV	5 ±0.25	4 ±0.20	3 ±0.15
	V	5 ±0.25	4 ±0.20	3 ±0.15
Aroma	I	3 ±0.15	5 ±0.25	2 ±0.10
	II	4 ±0.20	3 ±0.15	2 ±0.10
	III	3 ±0.15	5 ±0.25	3 ±0.15
	IV	3 ±0.15	4 ±0.20	3 ±0.15
	V	4 ±0.20	4 ±0.20	2 ±0.10
Taste	I	3 ±0.15	5 ±0.25	3 ±0.15
	II	3 ±0.15	5 ±0.25	4 ±0.20
	III	3 ±0.15	5 ±0.25	4 ±0.20
	IV	3 ±0.15	5 ±0.25	3 ±0.15
	V	4 ±0.20	5 ±0.25	4 ±0.20
Secondary ball		3.87	4.40	3.13

The results of the examination by experts (5 experts) of the organoleptic quality indicators of the studied samples of avocado fruits according to the developed 5-point scale are shown in Table 1.

According to the results of the organoleptic evaluation of the quality of the studied samples of avocado fruits, the experts noted that the studied sample 1 is quite firm, has light green flesh and a deep green peel that does not lag behind the flesh, watery taste, without significant defects, the stem is not damaged. Sample 2 has

light green flesh and brownish-black peel that separates very well from the flesh, has a nice buttery flavour and a nice texture, a minor peel defect (pollination mark) of less than 4 cm^2 does not affect the fruit flesh, the stem is not damaged. The studied sample 3 has light green pulp and deep green peel, which separates from the flesh badly, a mild grassy taste, and a loose structure of the fruit flesh. The sample has a defect in the peel (lens) with an area of less than 6 cm^2, which does not affect the fruit's flesh, and the stem is not damaged.

Since among non-oil crops, avocado is considered a fruit with relatively high-fat content. A study was conducted of avocado lipids' fatty acid composition (Table 2).

Table 2 Fatty acid composition of lipids of studied avocado samples.

Acid	Acid concentration in studied avocado samples, %		
	Sample 1	**Sample 2**	**Sample 3**
C 10 caprynova	-	0.0004	-
C 11:0 undecanova	-	0.0029	-
C 12:0 laurinova	0.0011	-	0.0025
C 13:0 triple decan	-	-	0.0025
C 14:0 miristinova	0.0136	0.0420	0.1081
C 14:1 myristoleinova	0.0091	-	0.0035
C 15:0 pentadecanoic	0.0180	0.0110	0.0512
C 15:1 cis-10-pentadecene	0.0136	0.0029	0.0194
C 16:0 palmitic	11.6000	10.5000	4.8390
C 16:1 palmitoleic	8.6870	15.8700	5.4130
C 17:0 heptadecane	0.1057	-	-
C 17:1 cis-10-heptadecene	0.0234	-	-
C 18:0 stearic	0.0832	3.9900	0.0522
C 18:1 oleinov	52.0800	62.4800	52.0000
C 18:2 linoleum	9.9690	2.5810	13.3800
C 18:3p6 gamma linolenic	0.9576	0.0912	0.6688
C 18:3p3 alpha-linolenic	0.0726	0.4177	0.0988
C 20:0 arachinova	0.0869	0.0082	0.0943
C 20:1 gondoinova	0.1296	-	0.1670
C 20:2 eicosadiene	0.0267	0.4440	0.0313
C 20:3p6 cis-8, 11, 14-eicosatriene	-	-	0.0062
C 20:3p3 cis-11,14,17-eicosatriene	0.0047	-	0.4253
C 20:4 arachidonic	0.0785	-	-
C 20:5p3 cis 05,8,11,14,17-eicosapentaenoic	0.0555	0.0183	0.0057
C 22:0 behenov	-	-	0.0100
C 22:1 erukova	0.0761	0.0106	0.4589
C 22:2 cis-13,16 docosadiene	0.0025	0.2639	0.0089
C 23:0 trikozanova	0.0975	0.0385	0.3648
Saturated fatty acids	12.0200	14.5900	5.5250
Unsaturated fatty acids	72.1800	82.1800	72.7500
The sum of saturated and unsaturated fatty acids	84.1919	96.7724	78.2112

The analysis of the fatty acid composition of the lipids of the studied samples of avocado fruits makes it possible to conclude that the main fatty acids are 16:0 palmitic acid, 16:1 palmitoleic, 18:1 oleic (omega-9) and 18:2 linoleic acids are predominant among unsaturated fatty acids. Oleic acid is one of the main useful fatty acids, without which proper metabolism in the human body is impossible. In turn, the linoleic most common omega-6 polyunsaturated fatty acid, which, according to research by the University of Eastern Finland, reduces the risk of premature death when the concentration in the human body increases **[35]**. Unlike oleic and linoleic acids, which have a positive effect on the human body, palmitic acid is not able to be fully metabolized and accumulates in the body causing fatty transformation of whole organs **[36]**, **[37]**.

The next stage of the complex study of avocado quality was to determine physicochemical parameters, the results of the studies are shown in Table 3. According to the results of the studies, it was found that the most

significantly studied avocado (6.6-13.4 mg/100 g) samples differ in ascorbic acid content. The lowest content was observed in sample 1 (6.6 mg/100 g).

Table 3 Physico-chemical indicators of the quality of the studied avocado samples.

Indicator	Researched avocado samples		
	Sample 1	Sample 2	Sample 3
Mass fraction of moisture, %	78.80 ±3.94	73.40 ±3.67	75.50 ±3.77
Content of dry soluble substances, %	7.5 ±0.37	7.8 ±0.39	8,2 ±0.41
pH, units	6.1 ±0.30	6.2 ±0.31	6.8 ±0.34
Ascorbic acid content, mg/100 g	6.6 ±0.33	13.4 ±0.67	11.45 ±0.57

Pomological types of avocado fruits differ in shape, size, and ratio of peel, pulp, and stone. According to the results of the conducted research, it was found that the largest mass of pulp had the avocado of sample 1 and was 85.42% of the total mass of the fruit. The smallest one had sample 3 (75.6%).

The next stage of the comprehensive evaluation of the quality of avocado fruits was the study of changes in their quality during 14 days of storage. The studied avocado samples had two storage modes: in a refrigerator at a temperature of 3-5 C and a room temperature of 15-18 C. Avocado fruits from the same batch, which were cut before the beginning of the study, were taken as control samples. The results of the studied samples are presented in Figures 4, 5, and 6.

Figure 4 Changes in the appearance of avocado fruits of sample 1 during 13 days of storage at temperatures of 3-5 °C (1-4), 15-18 °C (5-8). Note: 1 – at the beginning of storage; 2 – after 5 days of storage; 3 – after 9 days of storage; 4 – after 13 days of storage; 5 – the first day of storage; 6 – after 5 days of storage; 7 – after 9 days of storage; 8 – after 13 days of storage; 9 – section of the fruit after 14 days of storage.

At the beginning of storage, the studied samples of avocado fruits 1 (Figure 4) had a fresh appearance, dry peel, and dense flesh. During storage, the fruit, subjected to cold storage, almost did not change its colour but darkened on one side, and the peel became moistened. The fruit, which was stored at room temperature, became slightly moistened and darkened at the point of contact between the planes of the fruit and the cardboard substrate already on the third day, on the ninth day the fruit became very dark and softened almost over the entire area. It was found that the fruit pulp became loose and had an unpleasant smell, was inedible, and the process of rotting began. The color of the avocado also changed from dark green to brown. Compared to this, the fruit stored in the refrigerator retained all its organoleptic properties, taste, and smell without extraneous flavours and aromas. The fruit is hard; the peel is almost unchanged except for a spot on one side.

1 2 3 4 5

Figure 5 Changes in the appearance of avocado fruits of sample 2 during 13 days of storage at temperatures of 3-5 ºC (1-4). Note: 1 – at the beginning of storage; 2 – after 5 days of storage; 3 – after 9 days of storage; 4 – after 13 days of storage; 5 – section of the fruit after 14 days.

At the beginning of storage (Figure 5), the avocado fruit had a dry peel, was hard over the entire area, fresh in appearance with a minor defect that did not affect the appearance of the sample. On the seventh day, the fruit's peel became slightly moistened and soft near the stem. At the end of the study, the fruit became soft, the peel was wrinkled, near the stem and pollination mark, and the peel secreted juice when touched. The section shows that the fruit has started to rot near the stem and the pollination mark. This explains the softness in these areas that were observed earlier. The pulp has become looser than the control sample, and the peel comes off almost effortlessly. The smell and taste are unchanged, and signs of rotting make this fruit inedible.

1 2 3 4 5

Figure 6 Changes in the appearance of avocado fruits of sample 3 during 13 days of storage at temperatures of 3-5 º C (1-4). Note: 1 – at the beginning of storage; 2 – after 5 days of storage; 3 – after 9 days of storage; 4 – after 13 days of storage; 5 – section of the fruit after 14 days.

The fruit of the studied sample 3 (Figure 6) was firm and fresh at the beginning of storage, the defects (spots) did not affect the appearance of the sample, and the peel was dry. On the seventh day, the existing defects became more pronounced (the spots darkened), the peel became somewhat moistened, and the side on which the fruit lay became soft. At the end of the study, the fruit became soft, and the peel wrinkled. The section shows that the fruit has a physiological defect without signs of rotting. Compared to the control sample, the pulp became looser, and the peel became easier to separate, the smell and taste of the fruit did not change.

It was found that after 14 days of refrigerated storage, the studied sample 1 best preserved its quality, the worst – sample 2 after 14 days of refrigerated storage, and sample 1 after 14 days of storage without a refrigerator.

The main factors affecting the shelf life of fruits are the mass fraction of fruit moisture and storage conditions. Therefore, at the last stage of the comprehensive assessment of avocado quality, the dynamics of changes in the weight of the studied fruit samples during 14 days of storage were studied (Table 4).

The given research results make it possible to conclude that the preserved quality of avocados during storage is significantly influenced by the characteristics of types, the region of fruit cultivation, and their storage conditions. It was found that an increase in the storage temperature of the studied sample by 12 ºC is accompanied by an increase in the loss of fruit moisture by 3.78 times or by 378%.

Table 4 The dynamics of changes in the weight of the studied avocado samples during storage.

Storage period (day)	Investigated avocado samples/storage temperature			
	Sample 1.1 / t 3-5 °C	**Sample 1.2 / t 15-18 °C**	**Sample 2 / t 3-5 °C**	**Sample 3 / t 3-5 °C**
1	116.87 ±5.84	106.31 ±5.31	201.62 ±10.08	212.1 ±10.60
2	116.51 ±5.82	105.17 ±5.25	200.98 ±10.04	211.35 ±10.56
3	116.22 ±5.81	103,98 ±5.19	200.73 ±10.03	210.96 ±10.54
4	115.95 ±5.78	102.77 ±5.13	200.38 ±10.01	210.54 ±10.52
5	115.62 ±5.78	101.66 ±5.08	199.96 ±9.99	210.02 ±10.50
6	115.18 ±5.75	100.39 ±5.01	199.34 ±9.96	209.39 ±10.46
7	114.92 ±5.74	99.28 ±4.96	198.98 ±9.94	209.02 ±10.45
8	114.67 ±5.73	98.16 ±4.90	198.62 ±9.93	208.65 ±10.43
9	114.38 ±5.71	97.04 ±4.85	198.14 ±9.90	208.17 ±10.40
10	114.06 ±5.70	95.93 ±4.79	197.75 ±9.88	207.76 ±10.38
11	113.71 ±5.68	94.67 ±4.73	197.34 ±9.87	207.31 ±10.36
12	113.42 ±5.67	93.52 ±4.67	197.29 ±9.86	206.91 ±10.34
13	113.15 ±5.65	92.53 ±4.62	196.54 ±9.82	206.38 ±10.31
14	112.94 ±5.64	91.45 ±4.57	196.06 ±9.80	205.94 ±10.29
Loss of moisture, %	3.4 ±0.17	13.97 ±0.70	2.75 ±0.14	2.9 ±0.14

CONCLUSION

The nutritional properties of avocados vary depending on the type, country of origin, and other factors and may change significantly during storage. Pomological types of avocado fruits differ in shape, size, and ratio of peel, pulp, and stone. The analysis of the fatty acid composition of the lipids of the studied samples of avocado fruits makes it possible to conclude that the main fatty acids are 16:0 palmitic acid, 16:1 palmitoleic, 18:1 oleic (omega-9) and 18:2 linoleic acids are predominant among unsaturated fatty acids. Summarizing the findings of a study that examined how the quality of avocado fruits changed over 14 days of storage in two different environments (a refrigerator at 3-5 °C and a room temperature of 15-18 °C) it was determined that the consumption properties of avocado fruits changed during storage. It was found that sample 1 had the best quality preservation after 14 days of refrigeration, sample 2 had the worst quality preservation after 14 days of refrigeration, and sample 1 had the poorest quality preservation after 14 days of storage without a refrigerator. The main factors affecting the shelf life of fruits are the mass fraction of fruit moisture and storage conditions. We have found that a 12 °C rise in storage temperature was followed by a 3.78x or a 378% rise in fruit moisture loss. So, it can be concluded that when choosing storage conditions and regimes, the variety, country of origin and other factors of avocado fruits should be considered to preserve their quality as much as possible.

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Funds:

This study did not receive external funding.

Acknowledgments:

We would like to thank you, Dr. Natalia Orlova.

Conflict of Interest:

The authors have no conflicts of interest.

Ethical Statement:

This article does not contain any research that would require ethical statements.

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