ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE

ISSN: 2692-5206, Impact Factor: 12,23
American Academic publishers, volume 05, issue 05,2025

Journal: https://www.academicpublishers.org/journals/index.php/ijai

UDC;634.33

THE EFFECT OF DIFFERENT PACKAGING MATERIALS ON QUALITY AND LONG-TERM STORAGE OF FRUITS OF LEMON VARIETIES

Nortojiyev Bobosher Sheralievich

Associate Professor, Tashkent State Agrarian University, PhD

0009-0003-2380-9435

e-mail: nortojiyevbobosher80@gmail.com

Abstract: The scientific article shows that when using various packaging materials for the qualitative preservation of lemon fruits, the most optimal option is to store lemon fruits in polyethylene bags, which achieves high results in all indicators (natural shrinkage indicators%, output of unfit products%, rotten products% and output of marketable products%). When these indicators are compared between lemon varieties, experimental materials are presented that show that the fruits of Tashkent and Yubileiny varieties achieve higher results than other lemon varieties .

Key words: lemon, fruit, cold temperature, packaging material, parchment, polyethylene bag,

Introduction Lemons have unique characteristics compared to other citrus fruits, and the harvesting process is also somewhat different. Lemons are harvested gradually and in stages. Lemons are generally 75-80% ripe at one time and can be harvested. If lemons are not harvested on time, the degree of ripening increases and the shelf life is affected. Lemon harvest mainly falls on the 3rd decade of October and the 1st-2nd decade of December in our republic.

During the research, experiments were conducted to preserve the lemon harvest for as long as possible and with high quality, to deliver the product to the market, that is, to the population, using various methods and storage conditions in various storage structures, including controlled storage conditions in natural conditions, and to pack lemon fruits in various packaging materials.

Taking into account the above, in our experiments, studies were conducted to determine the level of storage tolerance of lemon fruits in the following storage conditions.

In this experiment, experiments were conducted on storing the products in a simple open state (in ordinary warehouses, packed in boxes, at a temperature of 8-14°C, relative humidity of 45-55%), as well as on storing the fruits of lemon varieties in an open state, wrapped in plain paper, parchment paper, and food film. During our experiment, 4 variants and 4 replicates were used. In this case, 10 kg in each replicate, 40 kg in each variant, 160 kg of each variety, and a total of 640 kg of lemon products were placed in various packaging materials for storage.

ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE

ISSN: 2692-5206, Impact Factor: 12,23
American Academic publishers, volume 05, issue 05,2025

Journal: https://www.academicpublishers.org/journals/index.php/ijai

Scientific research was conducted mainly on the preservation of fruits of the Meyer, Tashkent, Yubileiny and Chinese lemon varieties grown in our republic. The data was analyzed over a three-year period based on the above-mentioned experiments. Based on the analysis, the level of storage resistance of the varieties and the duration of qualitative storage, as well as the effect of various packaging materials on the natural decline of the product, were studied.

Fruit color, size and firmness are important quality indicators of lemon varieties. Therefore, in our research, these indicators of lemon fruit were stored and the aspects related to the coefficient of importance were studied depending on the duration and method of storage.

It is known that during the storage of lemon fruits, the antioxidant activity and the content of phenolic compounds in the product decrease, and as a result, the products deteriorate in a short time. At the same time, the conditions of their cultivation have a direct impact on the storage of lemon fruits. It should be noted that the geographical location of the region where the fruit is grown and the processes occurring in the plants also have an impact on the storage of fruits.

The basis of the vital activity of living organisms is the process of respiration, which produces the energy contained in organic matter and necessary for all other life processes.

Depending on the different parts of the fruit, respiration and physiological processes in lemons vary. During storage, the respiration process of lemons varies depending on the variety of lemons and their individual tissues. Some tissues have different respiration coefficients. Like all fruits, lemons undergo rapid respiration in the first days after harvest. This effect is due to the reaction of their separation from the plant, that is, when the lemon is plucked from the tree. When lemons come out of dormancy, increased respiration increases the consumption of nutrients.

During storage of lemons, moisture evaporates from the products, which disrupts the normal course of metabolic processes in them. As a result, a decrease in the water content of the peel tissues of lemons is observed, and the process of decomposition of organic substances accelerates, and energy metabolism is sharply disrupted. In this case, the resistance of lemons to pathogens decreases significantly. During storage of lemons, the temperature in the storage room has a significant effect on the quality of the product, and when it increases, the intensity of biochemical processes increases, i.e., the decomposition of complex organic substances, changes in the respiratory process , gas exchange, and anaerobic respiration of lemons occur.

During storage, the mass of lemons decreases mainly due to evaporation of moisture and the consumption of organic matter through respiration. This leads to an increase in the relative dry matter content of lemons. It is important to maintain a sufficiently high humidity in the storage room to protect the water content of lemons from loss.

During the storage period of lemon fruits, the products become more susceptible to pathogenic microorganisms. Our experiments have shown that this process is accelerated, especially if the product has been slightly mechanically damaged. It was found that when the temperature during storage of products is close to 8-12°C, despite a slight decrease in the vital activity of microorganisms, the resistance of the stored product to natural losses is significantly weakened. In addition, in some cases, it is necessary to store the products at

ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE

ISSN: 2692-5206, Impact Factor: 12,23
American Academic publishers, volume 05, issue 05,2025

Journal: https://www.academicpublishers.org/journals/index.php/ijai

slightly higher temperatures. This is due to the fact that lemon fruits of different ages use different organic substances for respiration.

During the storage period of lemon fruits, natural shrinkage and product deterioration were observed in our experiments, which varied between different varieties. In this case, experiments were mainly conducted on the storage of fruits of lemon varieties grown at the same time and in the same region. It should be noted that although the weight and size of lemon fruits did not differ significantly from each other, the degree of natural shrinkage during their storage varied depending on the packaging materials.

In our experiments, the changes in the duration of storage of the fruits of different lemon varieties were analyzed during the storage process of the fruits of lemon varieties placed in warehouses in an open state in cardboard boxes and packed in different packaging materials.

It should be noted that our experiments revealed that when lemon fruits were stored in a warehouse for 90 days at an air temperature of +5-12ºC and a relative humidity of 45-55%, the quality of the product and their natural shrinkage indicators varied between varieties and in different packaging materials.

Studies have shown that when lemon varieties are stored in ordinary warehouses at a temperature of +5-12ºC and a relative humidity of 45-55%, their natural shrinkage rates, percentage of unfit products, percentage of rotten products, and percentage of marketable products were compared between variants and varieties, depending on the lemon varieties and packaging materials.

It should be noted that in this experiment, the effect of packaging materials on various indicators of lemon fruits was studied. In our control variant, 40 kg of each lemon fruit was placed in polyethylene boxes of 10 kg each for 4 times and stored. In this control variant, the natural shrinkage of Meyer lemon fruits was 16.2%, the yield of unfit products was 7.4%, the yield of rotten products was 4.2%, and the yield of marketable products was 72.2%.

In this control variant, the natural decline of the Tashkent lemon variety was 15.9%, the output of products that did not meet the requirements was 7.2%, the output of rotten products was 3.5%, and the output of marketable products was 73.4% . The natural decline in the number of fruits of the varieties was 13.6%, the output of products that did not meet demand was 6.7%, the output of rotten products was 5.1%, and the output of marketable products was 74.6%.

In this control variant, the natural decline in the shelf life of lemon fruit imported from China was 15.7%, the output of products that did not meet the requirements was 7.3%, the output of rotten products was 3.9%, and the output of marketable products was 73.1%.

In our experiments, when lemon varieties were placed in separate paper bags and stored in polyethylene boxes with 10 kg of product, the natural fruit shrinkage of Meyer lemon varieties was 14.3%, the yield of substandard products was 6.5%, the yield of rotten products was 3.6%, and the yield of marketable products was 75.6%. (Table 1).

Table 1

ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE

ISSN: 2692-5206, Impact Factor: 12,23
American Academic publishers, volume 05, issue 05,2025

Journal: https://www.academicpublishers.org/journals/index.php/ijai

Effects of different packaging materials on the quality and long-term storage of lemon fruits in a simple warehouse (2023-2025).

T/p	Packaging materials options	Lemon varieties	Natural Decline %	% of product waste that does not meet demand	Perishable products %	Popular products %
1	When not wrapped in material (control)	Meyer	16.2 ±0.3	7.4 ±0.4	4.2 ±0.2	72.2 ±0.5
		Tashkent	15.9 ±0.3	7.2 ±0.4	3.5 ±0.2	73.4 ±0.5
		Anniversary	13.6 ±0.3	6.7 ±0.4	5.1 ±0.2	74.6 ±0.5
		Chinese lemon	15.7 ±0.3	7.3 ±0.4	3.9 ±0.2	73.1 ±0.5
2	Paper bags	Meyer	14.3 ±0.3	6.5 ±0.4	3.6 ±0.2	75.6 ±0.5
		Tashkent	13.8 ±0.3	6.6 ±0.4	3.5 ±0.2	76.1 ±0.5
		Anniversary	12.3 ±0.3	6.9 ±0.4	3.6 ±0.2	77.2 ±0.5
		Chinese lemon	13.7 ±0.3	6.7 ±0.4	3.5 ±0.2	76.1 ±0.5
3	Parchment paper bags	Meyer	12.8 ±0.3	5.1 ±0.4	2.9 ±0.2	79.2 ±0.5
		Tashkent	12.2 ±0.3	3.8 ±0.4	2.8 ±0.2	81.2 ±0.5
		Anniversary	11.4 ±0.3	3.6 ±0.4	2.9 ±0.2	82.1 ±0.5
		Chinese lemon	12.6 ±0.3	3.7 ±0.4	3.5 ±0.2	80.2 ±0.5
4	Polyethylene bags	Meyer	9.7 ±0.3	3.5 ±0.4	4.2 ±0.2	82.6 ±0.5
		Tashkent	8.9 ±0.3	3.4 ±0.4	3.1 ±0.2	84.6 ±0.5
		Anniversary	8.2 ±0.3	3.4 ±0.4	3.2 ±0.2	85.2 ±0.5
		Chinese lemon	8.8 ±0.3	3.3 ±0.4	4.2 ±0.2	83.7 ±0.5

Note* According to the information in this table, 10 kg in each return, 40 kg in each option, 160 kg of each variety, and a total of 640 kg of lemon products were packed in different packaging materials in the experimental block.

These indicators were similar to those for the Tashkent lemon variety. It was found that the natural decline of fruits was 13.8%, the output of products that did not meet demand was

ISSN: 2692-5206, Impact Factor: 12,23
American Academic publishers, volume 05, issue 05,2025
Journal: https://www.academicpublishers.org/journals/index.php/ijai

6.6%, the output of rotten products was 3.5%, and the output of marketable products was 76.1%.

The following happened with the Jubilee lemon variety. The natural decline of fruits was 12.3%, the output of substandard products was 6.9%, rotten products was 3.6%, and the output of marketable products was 77.2%. The natural decline of fruits during the storage period of the lemon variety imported from China was 13.7%, the output of substandard products was 6.7%, rotten products was 3.5%, and the output of marketable products was 76.1%.

During the conducted research, when lemon fruits were stored individually in parchment paper bags, the following results were achieved. In this experimental variant, the natural shrinkage of Meyer lemon fruits was 12.8%, the yield of substandard products was 5.1%, the yield of rotten products was 2.9%, and the yield of marketable products was 79.2%.

the Tashkent variety of lemon , this indicator was 12.2% natural decline in fruits, 3.8% unfit products, 2.8% rotten products, and 81.2% marketable product output, while in the Yubileiny variety of lemon, the natural decline in fruits was 11.4%, 3.6% unfit products, 2.9% rotten products, and 82.1% marketable product output.

in Chinese lemons, this indicator was a natural decrease of 12.6%, a loss of products that did not meet demand of 3.7%, a loss of rotten products of 3.5%, and a loss of marketable products of 80.2%.

During our research, the following results were observed when storing lemon fruits in polyethylene bags. In the experimental version, the natural shrinkage of Meyer lemon fruits was 9.7%, the yield of substandard products was 3.5%, the yield of rotten products was 4.2%, and the yield of marketable products was 82.6%.

the Tashkent variety of lemon , this indicator was observed, with a natural decrease in fruits of 8.9%, a loss of products that did not meet demand of 3.4%, rotten products of 3.1%, and a loss of marketable products of 84.6%. In the Yubileiny variety of lemon , a natural decrease in fruits of 8.2%, a loss of products that did not meet demand of 3.4%, rotten products of 3.2%, and a loss of marketable products of 85.2%.

In Chinese lemons, this indicator was found to have a natural decline rate of 8.8%, with the output of products that did not meet demand at 3.3%, rotten products at 4.2%, and the output of marketable products at 83.7%.

It should be noted that in our experiment, when we used various packaging materials for the qualitative preservation of lemon fruits, it was found that the most optimal option was to store lemon fruits in polyethylene bags, which achieved high results in all indicators (natural shrinkage indicators%, output of unfit products%, rotten products% and output of marketable products%). When these indicators were compared among lemon varieties, it was observed that the fruits of Tashkent and Yubileiny varieties achieved higher results than other lemon varieties.

ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE

ISSN: 2692-5206, Impact Factor: 12,23
American Academic publishers, volume 05, issue 05,2025

Journal: https://www.academicpublishers.org/journals/index.php/ijai

When analyzing the results of an experiment on storing lemon fruits in various packaging materials, the average indicators in the variants were compared with each other. In the process of comparing the experimental results, two cases were considered;

1) When comparing the averages of two independent samples, the results of the first sample observation are not related to the results of the second sample observation under any general conditions;

2) The results of the two samples were spatially and conditionally related. In the first case, the Student criterion (t) is used to evaluate the significance of the differences in means ($d=x_1-x_2$), in the second case, the significance of the mean difference ($d=d:n$). To analyze the data from the experiments on the storage of lemon fruits, the second condition, that is, the significance of the mean difference, was studied. During the storage of lemon fruits, various indicators of changes in the fruits were compared in terms of percentages, whether they were related or not. In the case of samples that were related to each other, the significance of the mean difference was calculated using the difference method. The essence of this method is that it is not the difference of means $d- x_1 - x_2$ that is evaluated , but the significance of the mean difference d^2 .

According to the arithmetic theory, these two indicators have a common value, and to find the mean difference in the Sd difference method, the difference between the pairs of observations was calculated as d, and the mean difference value $d:n$ was determined as d=.

In the calculation of the generalized description of the samples in terms of quality variability of preserved lemon fruits, they were placed in the order of distribution of initial observations by groups (classes). Determining the average value of the shares of the variants, the variability of the characters during the storage of lemon fruits, and the confidence interval, at the border of which the value of the share of the genius set is located, were determined in our experiments.

During our research, differences were observed in the shelf life and various quality indicators of products when fruits of lemon varieties were stored in various packaging materials, compared to the simple method, that is, when the fruits were stored without packaging in any material. It is not recommended to store lemon fruits together with other types of fruits, especially apples and similar fruits. Otherwise, various quality indicators of lemon fruits will decrease.

Conclusion: A positive result can be achieved by storing lemon fruits in ordinary warehouses. When storing lemon fruits in ordinary warehouses, it is necessary to avoid direct sunlight and ensure maximum darkness and cool temperature. In our experiments, when storing lemons in warehouses, lemons were placed in open cardboard boxes and bags were made from different packaging materials and placed in separate bags for storage.

List of used literature:

1. Рындин, А.В. Влияние регуляторов роста на физиологические показатели растений мандарина (CitrusReticulatavar. unshiutan.) в условиях влажных субтропиков России /А. В. Рындин, О. Г. Белоус, В. М. Горшков, Т. Н. Дорошенко, Л. Г. Рязанова, Аль-

ISSN: 2692-5206, Impact Factor: 12,23
American Academic publishers, volume 05, issue 05,2025
Journal: https://www.academicpublishers.org/journals/index.php/ijai

Хуссейни А. /Плодоводство и ягодоводство России: сб. науч. работ. - М.: ФГБНУ ВСТИСП, 2017. - Т. 51. - С. 92-100.

2. . Рындин, А. В. Некорневые подкормки калийными удобрениями как фактор формирования урожая и качества плодов мандарина в условиях Республики Абхазия / А. В. Рындин, Т. Н. Дорошенко, Л. Г. Рязпнова, Д. Д. Бакир-оглы, Д. А. Сабекия // Субтропическое и декоративное садоводство.-ФГБНУ ВНИИЦиСК. - Сочи, 2022. - Вып. 80 - С. 118- 126.
3. Садыкова Ф. В. Экологические аспекты выращивания лимонов в Уфимском лимонарии. - // Лесной вестник. - 2000. № 3. — С. 101-104.
4. Савин Е.З. Укоренение зеленқх черенков плодовқх культур в условиях
5. искусственноготумана под влиянием стимуляторов роста. - Куйбышев1980. – С. 5-6.
6. Сабекия, Д. А. Биологические основы увеличения продуктивности мандарина и улучшения состояния насаждении в Абхазии / Д.А. Сабекия, В.М. Горшков // Сохранение биоразнообразия растении растений в природе и при интродукции: матер.междунар. науч. конф. - Сухум: Институт ботаники Академии наук Абхазии. - 2006. - С. 547-548.
7. Нортожиев Б.Ш. “Лимон кўчатларини инновацион технологиялар асосида етиштириш” Агро илим 6-сон 2021 йил. Б. 25-28.
8. Нортожиев Б.Ш. “Лимон кўчатларини микроэлементлар билан баргидан озиқлантиришнинг ундаги вегетатив органлари ўсиши ва ривожланишига таъсири” Агро илим 2-сон 2022. – Б. 24-26.
9. Нортожиев Б.Ш. “Лимон кўчатларини очиқ майдонларда парваришлаш технологияси”. Қишлоқ ва сув хўжалиги журнали 2021. – Б. 35-36.