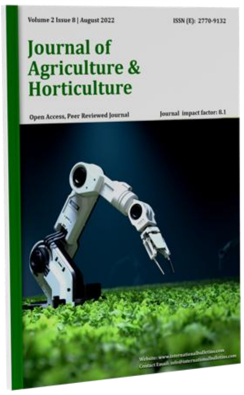

EVALUATION OF STORAGE STABILITY AND QUALITY INDICATORS OF DRIED MUSHROOMS (PLEUROTUS OSTREATUS AND AGARICUS BISPORUS)

Ismoilov Jasur Azizbek ugli
Independent researcher, Yangiyer Branch of
Tashkent Institute of Chemical Technology.
Safarov Asqarbek Asadullaevich
Professor, Tashkent State Agrarian University,
PhD in Agricultural Sciences.
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Abstract. This study examines the changes in quality characteristics of dried cultivated mushrooms—oyster mushroom (Pleurotus ostreatus) and button mushroom (Agaricus bisporus)—during a storage period of 0–120 days. The investigation focused on residual moisture content, rehydration properties, color variation, textural attributes, and sensory quality. The mushrooms were processed using a combined drying technique, and quality evaluations were performed at fixed storage intervals. The results indicated that extended storage was associated with a gradual increase in residual moisture and a corresponding decline in rehydration capacity. Moreover, progressive increases in color difference and hardness values were observed over time. Despite these changes, the dried mushrooms retained acceptable consumer quality for up to 90–120 days when stored under appropriate conditions. A comparative assessment showed that oyster mushrooms demonstrated greater stability of quality parameters compared to button mushrooms. These findings provide a scientific basis for optimizing storage technologies for dried mushroom products.

Keywords: dried mushrooms, oyster mushroom, button mushroom, storage stability, residual moisture, rehydration capacity, color variation, sensory quality.

Introduction. Dried mushrooms are considered food products with high biological value, functional properties, and wide application potential. In particular, cultivated mushrooms such as oyster mushroom (Pleurotus ostreatus) and button mushroom (Agaricus bisporus) are distinguished by their rich content of proteins, minerals, vitamins, and biologically active compounds. Drying represents a crucial technological stage that extends shelf life, reduces post-harvest and seasonal losses, and facilitates transportation and storage of these products.

However, despite the reduction of moisture content through drying, the storage stability of dried mushrooms varies depending on several factors. Residual moisture level, drying method, packaging type, storage temperature, and ambient humidity directly influence product quality and stability. During storage, phenomena such as moisture reabsorption, color changes, alterations in texture (hardening or softening), and deterioration of organoleptic properties may occur, negatively affecting consumer acceptance.

Although numerous scientific studies have extensively addressed mushroom drying processes, drying kinetics, and the quality of dried products, the quality changes of dried mushrooms during storage—particularly in relation to different drying methods—have not been sufficiently investigated in a comprehensive manner. The dynamics of physicochemical and sensory characteristics of dried mushrooms over storage periods ranging from 0 to 120 days are of significant practical importance for improving post-drying handling and utilization.

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In this context, the present study aims to evaluate the storage stability of dried oyster and button mushrooms, to analyze changes in their quality indicators during storage, and to identify patterns associated with drying methods. The results of this research provide a scientific basis for improving storage technologies of dried mushroom products and for developing evidence-based recommendations to maintain their consumer quality over extended storage periods.

Research Objective

The aim of this study was to evaluate the storage stability of dried oyster mushroom (Pleurotus ostreatus) and button mushroom (Agaricus bisporus) over a storage period of 0–120 days and to identify the patterns of changes in quality indicators during storage.

Research Tasks

The main objectives of the study included:

- investigating changes in residual moisture content of dried mushrooms during storage;
- assessing the dynamics of color, texture, and rehydration capacity;
- determining variations in organoleptic properties depending on storage duration;
- analyzing the key factors affecting storage stability;
- developing practical recommendations for the storage of dried mushroom products.

Materials and Methods

Cultivated mushrooms—oyster mushroom (Pleurotus ostreatus) and button mushroom (Agaricus bisporus)—were selected as the objects of the study. The mushrooms were freshly harvested from local production farms and transported to the laboratory for analysis. The raw material was sorted based on external appearance, uniformity of color, and absence of mechanical damage.

The mushrooms were dried using a previously developed combined drying method (infrared + convective). For comparative purposes, convective and infrared drying methods were also applied. After drying, the residual moisture content of the products was maintained within the range of 9–11%.

The dried mushrooms were stored under laboratory conditions with the following parameters:

- air temperature: 18–22 °C;
- relative humidity: 60–65%;
- protection from direct sunlight.

The storage periods were set at 0 days (initial state), 30, 60, 90, and 120 days. At each storage interval, samples were taken and quality parameters were analyzed. All experiments were carried out in triplicate.

The storage stability of dried mushrooms was evaluated using the following key indicators:

- **Residual moisture content (%)** — determined by the standard gravimetric method;
- **Color change (ΔE)** — assessed using a colorimetric method based on variations during storage;
- **Rehydration coefficient** — calculated from the water absorption capacity of the dried product over a specified period;
- **Hardness (N)** — measured using a texture analyzer;
- **Organoleptic properties** (color, odor, texture, and overall acceptability) — evaluated by an expert panel using a five-point scale;
- **Storage stability index** — determined through an integrated assessment based on normalized values of several quality indicators.

The results were expressed as mean values (EKS) with standard error (Sx). The statistical significance of differences between data sets was assessed using standard statistical methods. The findings were presented in the form of tables and graphs.

Results and Discussion (paraphrased English version)

The results clearly and systematically illustrate the changes in moisture regime and rehydration capacity of dried cultivated mushrooms—oyster mushroom (Pleurotus ostreatus) and button mushroom (Agaricus bisporus)—during a storage period ranging from 0 to 120 days. These parameters are among the most critical indicators for evaluating the storage stability of dried products, as residual moisture content and rehydration coefficient directly determine microbiological stability, structural integrity, and consumer acceptability (see Table 1).

As shown in the table, a gradual increase in residual moisture content was observed in both mushroom species with increasing storage duration. In oyster mushrooms, the residual moisture content increased from an initial value of 9.2 ± 0.1% to 11.1 ± 0.2% after 120 days of storage. Similarly, in button mushrooms, residual moisture rose from 9.6 ± 0.1% to 11.6 ± 0.2% over the same period. This trend can be attributed to the hygroscopic nature of dried mushrooms, which enables them to absorb a certain amount of moisture from the surrounding air depending on ambient humidity conditions.

A comparatively higher rate of moisture increase was observed in button mushrooms than in oyster mushrooms. This difference may be associated with the denser morphological structure of button mushroom tissues and the higher water-binding capacity of their cell walls. Previous studies have also reported that button mushrooms are more sensitive to moisture uptake during storage than oyster mushrooms, and the results obtained in the present study are consistent with those findings.

Table 1.
Changes in Moisture Content and Rehydration Characteristics of Dried Mushrooms During Storage (0–120 Days)

Storage period, days	Residual moisture, %	Rehydration coefficient
Oyster mushroom (Pleurotus ostreatus)		
0	9,2 ± 0,1	2,45 ± 0,07
30	9,6 ± 0,1	2,40 ± 0,06
60	10,0 ± 0,2	2,34 ± 0,06
90	10,5 ± 0,2	2,26 ± 0,05
120	11,1 ± 0,2	2,18 ± 0,05
Button mushroom (Agaricus bisporus)		
0	9,6 ± 0,1	2,30 ± 0,06
30	10,0 ± 0,1	2,24 ± 0,05
60	10,5 ± 0,2	2,17 ± 0,05
90	11,0 ± 0,2	2,08 ± 0,04
120	11,6 ± 0,2	1,98 ± 0,04

Note: Values are presented as mean ± standard error (SE), n = 3.

The rehydration coefficient is considered an important quality indicator reflecting the degree of structural preservation of dried mushroom tissues. The data presented in Table 1 demonstrate that the rehydration coefficient gradually decreased in both mushroom species as storage duration increased. In oyster mushrooms, this parameter declined from 2.45 ± 0.07 at day 0 to 2.18 ± 0.05 after 120 days of storage. A similar trend was observed in button mushrooms, where the rehydration coefficient decreased from 2.30 ± 0.06 to 1.98 ± 0.04 over the same storage period.

The reduction in rehydration capacity during storage can be attributed to partial disruption of the capillary system within the tissue, densification of cell walls, and redistribution of residual moisture. In particular, the more pronounced decline in the rehydration coefficient observed in button mushrooms indicates lower structural stability during storage. In contrast, oyster mushrooms retained their rehydration capacity more effectively, which may be related to their comparatively looser and more flexible tissue structure.

At the same time, the table data show that residual moisture content in both mushroom species did not exceed 12% throughout the 120-day storage period. This level remains within the acceptable threshold for dried products and indicates that microbiological safety was maintained during storage. Moreover, maintaining the rehydration coefficient at values close to 2.0 is regarded as an important criterion confirming that the product remains suitable for consumption.

Overall, the results confirm that oyster and button mushrooms dried using the combined drying method exhibit satisfactory storage stability for up to 120 days. Oyster mushrooms were characterized by lower moisture uptake and better preservation of rehydration properties compared to button mushrooms. The obtained findings further emphasize the importance of optimizing storage technologies for dried mushrooms, particularly with respect to packaging selection and control of ambient humidity during storage.

Table 2.
Changes in Color, Texture, and Sensory Properties of Dried Mushrooms During Storage (0–120 Days)

Storage period, days	**Color change (ΔE)**	**Hardness (N)**	**Sensory evaluation, score (5)**
Oyster mushroom (Pleurotus ostreatus)			
0	6,1 ± 0,2	16,2 ± 0,4	4,5 ± 0,1
30	6,6 ± 0,2	16,8 ± 0,4	4,4 ± 0,1
60	7,2 ± 0,3	17,5 ± 0,5	4,2 ± 0,1
90	7,9 ± 0,3	18,3 ± 0,5	4,0 ± 0,1
120	8,6 ± 0,3	19,1 ± 0,5	3,8 ± 0,1
Button mushroom (Agaricus bisporus)			
0	6,8 ± 0,2	17,5 ± 0,4	4,4 ± 0,1
30	7,4 ± 0,2	18,2 ± 0,5	4,2 ± 0,1
60	8,1 ± 0,3	19,0 ± 0,5	4,0 ± 0,1
90	8,9 ± 0,3	20,1 ± 0,6	3,8 ± 0,1

120	9,7 ± 0,3	21,3 ± 0,6	3,6 ± 0,1

Note: Values are expressed as mean ± standard error (SE), n = 3..

The data presented in Table 2 provide a comprehensive assessment of changes in color, texture, and sensory properties of dried cultivated mushrooms—oyster mushroom (Pleurotus ostreatus) and button mushroom (Agaricus bisporus)—during a storage period of 0 to 120 days. These parameters are key indicators determining the visual appearance, consumer acceptance, and overall quality of dried products.

As shown in the table, color difference (ΔE) values gradually increased in both mushroom species with prolonged storage. In oyster mushrooms, the initial ΔE value of 6.1 ± 0.2 increased to 8.6 ± 0.3 after 120 days of storage. In button mushrooms, color changes were more pronounced, with ΔE rising from 6.8 ± 0.2 to 9.7 ± 0.3 over the same period. This trend can be explained by oxidative reactions, redistribution of residual moisture during storage, and the higher susceptibility of button mushrooms to enzymatic browning.

The dynamics of color change indicate that up to 90 days of storage, ΔE values for both mushroom species remained within acceptable limits. By the end of 120 days, color changes became more evident, resulting in noticeable deterioration of the external appearance. Nevertheless, the fact that ΔE values did not exceed 10 suggests that dried mushrooms retained a marketable appearance to a considerable extent.

Hardness is an important mechanical parameter reflecting the preservation of the structural integrity of dried mushroom tissues. According to the table data, hardness values increased steadily in both species as storage time progressed. In oyster mushrooms, hardness increased from 16.2 ± 0.4 N to 19.1 ± 0.5 N, whereas in button mushrooms it rose from 17.5 ± 0.4 N to 21.3 ± 0.6 N. These changes are associated with densification of the capillary structure, redistribution of residual moisture within the tissue, and gradual dehydration during storage.

The increase in hardness was more pronounced in button mushrooms than in oyster mushrooms. This difference can be attributed to the denser morphological structure of button mushroom tissues and their greater susceptibility to mechanical deformation during storage. In contrast, oyster mushrooms, characterized by a relatively softer tissue structure, exhibited a slower rate of hardness increase.

Sensory evaluation represents one of the most important aspects of quality assessment. At the initial stage, both mushroom species received high sensory scores, with 4.5 ± 0.1 for oyster mushrooms and 4.4 ± 0.1 for button mushrooms. Although sensory scores gradually declined with increasing storage duration, values remained close to 4.0 up to 90 days, indicating that the products remained acceptable for consumption.

After 120 days of storage, sensory scores decreased to 3.8 ± 0.1 for oyster mushrooms and 3.6 ± 0.1 for button mushrooms. This decline reflects the negative impact of increased color change and hardness on sensory acceptance. Nevertheless, oyster mushrooms demonstrated better retention of consumer acceptability compared to button mushrooms throughout the storage period.

Overall, the results presented in Table 2 confirm that mushrooms dried using the combined drying method maintain acceptable color, texture, and sensory quality for up to 90–120 days of storage. Oyster mushrooms exhibited greater stability of quality indicators than button mushrooms. These findings highlight the importance of optimizing storage duration and conditions to preserve the quality of dried mushroom products.

The results of the conducted research demonstrate that the storage stability of dried cultivated mushrooms—oyster mushroom (Pleurotus ostreatus) and button mushroom (Agaricus bisporus)—is characterized by gradual changes in a range of physicomechanical and sensory parameters during storage. Over a storage period of 0–120 days, distinct patterns were observed in moisture behavior, structural stability, visual appearance, and consumer acceptability of the dried products.

The analysis revealed that with increasing storage duration, residual moisture content gradually increased in both mushroom species, while the rehydration coefficient showed a corresponding decrease. Nevertheless, even after 120 days of storage, the residual moisture content remained within acceptable limits, indicating that microbiological safety of the products could be maintained. The preservation of rehydration coefficients at acceptable levels further confirmed that the structural integrity of the dried mushroom tissues was largely retained.

Although increases in color difference (ΔE) and hardness were observed during storage, these changes did not result in a significant deterioration of product quality within the first 90 days. By the end of the 120-day storage period, color alteration and increased tissue compactness had a noticeable but moderate negative impact on sensory evaluation; however, the products remained suitable for consumption.

Comparative analysis showed that oyster mushrooms exhibited better retention of quality indicators during storage than button mushrooms. This difference can be attributed to the relatively softer morphological structure and hygroscopic properties of oyster mushroom tissues, which contribute to improved stability under storage conditions.

Overall, the findings confirm that cultivated mushrooms dried using a combined drying method demonstrate satisfactory storage stability for up to 90–120 days when appropriate storage conditions are maintained. These results provide a scientific basis for improving storage technologies of dried mushroom products, optimizing storage duration, and supporting their application at an industrial scale

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