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A Review Study on Effect of Temperature and Humidity on Onion in Storage

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ABSTRACT

Onions are an important vegetable, but storing them properly is a challenge. Temperature and humidity play a big role in keeping onions fresh. High temperatures cause moisture loss, shrinkage, and sprouting, while very low temperatures can damage their texture. If humidity is too high, onions can develop mold and bacterial infections. If it is too low, they dry out and become lightweight. This review explores how temperature and humidity affect onion storage. It also discusses methods to improve storage, such as controlled atmosphere storage, special packaging, drying, and fumigation. Using the right storage techniques can help reduce spoilage and keep onions fresh for a longer time. New technologies like AI-based monitoring and radiation treatment are also being studied to improve onion storage. By understanding the best storage conditions, farmers and traders can reduce losses and maintain onion quality. This review highlights solutions to improve onion storage and prevent wastage in the supply chain.

1. INTRODUCTION

Onion (*Allium cepa L.*) is an important vegetable grown and consumed worldwide. However, storing onions properly is a big challenge because factors like temperature and humidity affect their quality and shelf life. If not stored under the right conditions, onions can lose moisture, start sprouting, grow mold, or spoil due to bacteria, leading to major losses for farmers and sellers.

Temperature plays a key role in onion storage. If it is too high, onions lose water, shrink, and become soft. If it is too low, onions may get damaged and lose their firmness. Similarly, humidity (the amount of moisture in the air) is also important. If humidity is too high, onions can

develop mold and bacterial infections. If it is too low, they dry out and become lightweight. Keeping both temperature and humidity at the right levels is essential to maintaining onion freshness for a longer time.

Many studies have looked at how temperature and humidity affect onions during storage. Changes in these factors can affect the sugar content, acidity, and overall taste of onions. When stored in warm and humid conditions, onions are more likely to be attacked by harmful fungi and bacteria, which cause diseases like black mold and rot. Fusarium Bacterial soft rot, another common storage problem, spreads faster when humidity is too high.

To solve these problems, different storage techniques have been developed. Methods like controlled atmosphere storage, special packaging, drying, and fumigation help keep onions fresh for longer. Advanced storage technologies help control the air conditions around the onions, slowing down spoilage and improving shelf life.

This review focuses on how temperature and humidity affect onions during storage. It also discusses modern storage techniques that can help keep onions fresh, reduce wastage, and improve their quality. Understanding these factors will help farmers, traders, and food industries find better ways to store onions and reduce losses.

2. LITERATURE SURVEY

Islam et al. (2019) investigated the effects of temperature and relative humidity (RH) on onion quality during storage, concluding that fluctuations in these parameters accelerate moisture loss and biochemical degradation. Similarly, Tripathi and Lawande (2019) emphasized that onions stored in tropical climates face significant storage challenges, particularly due to high humidity, which promotes fungal infections and sprouting

Jolayemi et al. (2018) studied the chemical composition of onions during storage and found that temperature variations impact sugar content, acidity, and enzymatic activities, ultimately affecting flavor and texture. Additionally,

Tho et al. (2019) reported that bacterial infections in onions increase under high-temperature and high-humidity conditions, leading to significant postharvest losses. Storage temperature and humidity influence onion firmness, weight loss, and biochemical properties.

Shankar et al. (2023) analyzed the impact of on-farm storage structures on onion quality and found that well-ventilated storage significantly reduces weight loss and shrinkage.

Sasongko et al. (2020) further demonstrated that drying temperature affects the physicochemical properties of onions, with excessively high temperatures leading to textural degradation and discoloration. Moisture retention during storage plays a crucial role in preventing shrinkage.

Majid et al. (2019) investigated moisture sorption in onion powder and found that high humidity levels accelerate biochemical degradation, impacting sensory acceptability. Fungal and bacterial contamination is a major concern in onion storage.

Maude (2018) reviewed common storage diseases in onions, including Fusarium basal rot and black mold, and emphasized the importance of humidity control to prevent microbial proliferation.

Ji et al. (2018) explored the use of thymol fumigation in low-temperature storage and found that it effectively suppresses fungal growth.

Sharma et al. (2020) studied the application of γ-radiation to control microbial contamination and found that irradiation significantly reduces spoilage and extends onion shelf life under ambient conditions.

Ríos-González et al. (2018) reported that controlled atmosphere (CA) storage minimizes microbial growth by regulating oxygen and carbon dioxide levels. Several storage techniques have been explored to mitigate the effects of temperature and humidity on onions.

Lee and Robertson (2021) investigated the role of packaging films in extending the shelf life of dried vegetables, including onions, and found that moisture-resistant packaging significantly reduces spoilage.

NATUBHAI et al. (2018) studied different storage containers and found that ventilated containers improve onion seed quality and reduce microbial contamination. Modified atmosphere packaging (MAP) has also been explored for onion storage.

Wang et al. (2019) Analyzed the effects of VOC emissions on stored onions and found that proper packaging can help control gas exchange, thereby preserving onion freshness. Additionally, energy-efficient storage techniques such as solar-

powered cold storage and ventilated warehouses have been proposed.

Shankar et al. (2023) found that on-farm storage structures equipped with temperature and humidity regulation mechanisms improve onion storage stability Comparing onion storage techniques with other crops provides valuable insights into optimizing preservation methods.

Akan and Güneş (2021) studied garlic storage and found that methyl jasmonate application effectively delays sprouting and microbial growth, suggesting its potential application for onion storage.

Lestari et al. (2019) examined shallot storage and reported that controlled drying and packaging significantly enhance shelf life.

Bamba et al. (2020) compared different onion processing techniques and found that optimizing drying temperature and packaging improves the physicochemical and functional properties of onion powder. These findings indicate that integrating techniques from garlic and shallot storage can improve onion preservation methods.

Despite advancements in storage techniques, several challenges persist in onion preservation. High energy consumption in cold storage remains a significant barrier to widespread adoption.

Islam et al. (2019) developed predictive models for monitoring mass loss in onions and emphasized the need for automated, sensor-based storage management systems to optimize temperature and humidity control. Future research should focus on developing sustainable storage solutions such as biodegradable packaging, solar-powered storage units, and AI-driven monitoring systems to enhance onion preservation.

Tripathi and Lawande (2019) suggested that integrating postharvest treatments like fungicidal coatings and controlled humidity chambers can further improve onion storage efficiency.

3. Effect Of Temperature

Temperature plays a crucial role in the postharvest storage of onions, affecting their physical, biochemical, and microbial properties. Onions are highly susceptible to temperature fluctuations, which can lead to weight loss, sprouting, enzymatic degradation, and microbial contamination. The optimal storage temperature for onions depends on factors such as variety, intended storage duration, and environmental conditions.

Figure 1: Fresh Onion

A. *Impact of Temperature on Moisture Loss and Shrinkage*

Temperature variations significantly affect moisture content in stored onions. High temperatures accelerate moisture evaporation, leading to excessive weight loss and shrinkage. Studies have shown that onions stored at temperatures above 25°C experience rapid dehydration, resulting in reduced marketability and quality deterioration [1]. On-farm storage research has confirmed that controlled temperature conditions minimize weight loss, ensuring better shelf life [8].

B. Effect of Temperature on Sprouting and Dormancy

Onion bulbs have a natural dormancy period that prevents premature sprouting. However, improper temperature conditions can disrupt dormancy and promote early sprouting. Studies indicate that onions stored at temperatures between 5°C and 15°C are more likely to sprout prematurely due to increased metabolic activity. In contrast, cold storage at temperatures below 4°C helps extend the dormancy period but may lead to chilling injury if maintained for extended durations.

C. Influence of temperature on biochemical composition

Temperature also affects the biochemical stability of stored onions. Higher temperatures accelerate enzymatic reactions that cause changes in sugar content, acidity, and volatile compounds. Research on chemical composition changes in red and white onions has shown that temperature fluctuations alter flavor and texture due to shifts in sugar metabolism [4]. Additionally, studies on dried onions indicate that high drying

temperatures (above 70°C) lead to undesirable color changes and nutrient loss [3].

D. Microbial and fungal growth at different temperatures

Microbial contamination is a major concern in onion storage, especially in warm and humid environments. Studies indicate that fungal pathogens such as *Aspergillus niger* and *Fusarium oxysporum* proliferate at temperatures above 20°C, causing black mold and Fusarium rot [12].

Figure 2.: Microbial and Fungal Growth at Different Temperatures

Bacterial soft rot caused by *Pseudomonas* and *Erwinia* species is also more prevalent in onions stored at high temperatures with excessive moisture [5]. Postharvest disease control strategies, such as thymol fumigation, have been found to be effective in reducing fungal contamination during low-temperature storage [7].

E. Temperature Control Strategies for Onion Storage

Several storage techniques have been explored to mitigate the adverse effects of temperature on onions. Controlled atmosphere (CA) storage, which regulates oxygen and carbon dioxide levels, has been found to slow down respiration rates and microbial growth, improving onion storage life [6]. Additionally, radiation treatments such as γ-radiation have been investigated as a method to extend shelf life by eliminating microbial contaminants, with research confirming its effectiveness in preserving onion quality at ambient temperatures [10].

Figure 4: Temperature Control Strategies

Comparative studies with other perishable crops, such as garlic, suggest that methyl jasmonate application may help delay sprouting and microbial growth in onions [14]. Modified atmosphere packaging (MAP) has also been explored as a solution for temperature-sensitive storage, helping to control gas composition and maintain onion freshness [20].

EFFECT OF HUMIDITY

Humidity is a crucial factor influencing the postharvest storage of onions, affecting their moisture content, biochemical composition, and susceptibility to microbial contamination. Improper humidity levels can lead to excessive drying, sprouting, mold growth, and decay, making it essential to maintain optimal storage conditions for onions.

A. Impact of Humidity on Moisture Loss and Shrinkage

Humidity plays a significant role in determining the moisture balance of stored onions. Excessively low humidity levels result in rapid moisture loss, causing shrinkage and weight reduction. Studies have shown that onions stored under low humidity conditions (<50% RH) experience higher water loss, leading to quality deterioration and reduced market value [1]. Research on drying temperature and storage conditions also suggests that onions lose their firmness and become susceptible to cracking when stored in low-humidity environments [3].

On the other hand, high humidity levels promote excessive moisture retention, which can lead to condensation and microbial growth. Research indicates that humidity levels exceeding 85% contribute to the accumulation of surface moisture, creating favorable conditions for fungal infections and bacterial soft rot [5].

B. Influence of Humidity on Sprouting and Dormancy

Humidity is a key factor in regulating the dormancy period of onions. High relative humidity accelerates sprouting by activating metabolic processes within the bulb, reducing the storage duration [2]. Onions stored under uncontrolled high-humidity conditions tend to sprout prematurely, leading to quality loss and increased waste.

Figure 5: Sprouting on onions

Comparative studies on moisture sorption behaviour in onions indicate that humidity control is essential for preventing sprouting and preserving onion texture during storage [13]. Additionally, research on drying and storage techniques suggests that balancing humidity levels between 65% and 75% is optimal for preventing excessive moisture loss while minimizing sprouting [18].

C. Effect of Humidity on Biochemical and Textural Changes

Humidity levels directly impact the biochemical composition and texture of onions. Studies have found that onions stored in humid environments experience changes in sugar content, acidity, and volatile compound emissions, which can alter their flavor and sensory properties [4]. Research on onion powder storage also suggests that high humidity conditions accelerate biochemical degradation, reducing the functional and sensory acceptability of stored onions [9].

In addition to biochemical changes, high humidity storage conditions contribute to the softening of onion bulbs. Research on controlled atmosphere storage indicates that humidity fluctuations lead to variations in cell wall structure, reducing onion firmness and increasing susceptibility to microbial spoilage [6].

D. Microbial and Fungal Contamination at Different Humidity Levels

Humidity is a critical factor in the proliferation of microbial and fungal pathogens in stored onions. Studies have identified *Aspergillus niger* and *Fusarium oxysporum* as the primary fungal pathogens responsible for black mold and Fusarium rot in onions, with their growth significantly increasing under high humidity conditions [12].

Additionally, bacterial infections such as soft rot caused by *Pseudomonas* and *Erwinia* species thrive in humid environments where condensation occurs, leading to substantial postharvest losses [5]. Research on fumigation techniques suggests that thymol fumigation in low-humidity storage conditions can effectively prevent fungal contamination and prolong onion shelf life [7].

E. Humidity Control Strategies for Onion Storage

To mitigate the adverse effects of humidity on onion storage, several strategies have been explored. Modified atmosphere packaging (MAP) has been found to regulate humidity levels within storage containers, preventing excessive moisture accumulation and reducing spoilage risks [20]. Studies on moisture-resistant packaging films suggest that selecting the right packaging materials can help maintain optimal humidity conditions and extend onion storage life [16].

Additionally, controlled drying techniques have been proposed as an effective method to regulate humidity levels in stored onions. Research on onion drying and processing methods indicates that maintaining an appropriate drying temperature before storage significantly reduces the impact of high humidity conditions [19].

Further studies have suggested that storage structures with proper ventilation systems help in regulating humidity levels, minimizing fungal growth, and preserving onion quality [8]. Research on alternative preservation techniques such as γ-radiation has also shown promising results in reducing microbial contamination while maintaining onion quality in humid conditions [10].

4. COMBINED EFFECT OF TEMPERATURE AND HUMIDITY

Temperature and humidity are the two most critical environmental factors affecting onion

(*Allium cepa L.*) storage. Their combined influence determines onion weight loss, biochemical changes, microbial contamination, and overall shelf life. Improper storage conditions with fluctuating temperature and humidity lead to rapid deterioration, reducing the commercial value of onions. Maintaining an optimal balance between these two factors is essential for preserving onion quality and minimizing postharvest losses.

A. Influence on Moisture Retention and Shrinkage

The interaction between temperature and humidity plays a vital role in controlling moisture loss in stored onions. High temperatures accelerate moisture evaporation, and when combined with low humidity, this leads to excessive shrinkage and weight loss (*Islam et al.,* [1]. Studies on drying temperature and humidity effects confirm that onions stored in conditions with high temperatures (>30°C) and low humidity (<50% RH) suffer from rapid dehydration, resulting in compromised texture and marketability [3]. Conversely, excessively high humidity (>85% RH) in combination with high temperatures encourages condensation, leading to microbial growth and spoilage [5].

B. *Impact on Sprouting and Dormancy*

Temperature and humidity fluctuations significantly impact the dormancy period of onion bulbs. Storage at moderate temperatures (5–15°C) with controlled humidity (65–75% RH) is crucial for maintaining dormancy and preventing premature sprouting [2]. When onions are stored at high humidity and moderate temperatures, metabolic activity increases, leading to sprouting and reduced storage life 13]. In contrast, onions stored under extremely low temperatures with uncontrolled humidity can suffer from chilling injury, causing abnormal sprouting and loss of firmness [9].

C. Effect on Biochemical Composition and Volatile Emissions

The combined effect of temperature and humidity also influences the biochemical stability of onions. Higher storage temperatures accelerate enzymatic activity, altering sugar content, acidity, and volatile organic compound (VOC) emissions [4]. These biochemical changes result in modifications in flavor and aroma, affecting consumer preference and marketability [20]. Additionally, prolonged exposure to high humidity levels leads to cell wall breakdown, increasing susceptibility to microbial contamination [6].

D. Microbial and Fungal Growth at Different Temperature-Humidity Combinations

The interaction between temperature and humidity directly impacts microbial and fungal growth during onion storage. Studies have shown that fungi such as *Aspergillus niger* and *Fusarium oxysporum* thrive in high humidity environments, especially when temperatures exceed 20°C [12]. These conditions lead to black mold and Fusarium rot, which are major causes of onion spoilage. Additionally, bacterial soft rot caused by *Pseudomonas* and *Erwinia* species is more prevalent in high-temperature, high-humidity environments [5]. Controlled fumigation with thymol has been shown to effectively suppress fungal growth in low-temperature, low-humidity storage conditions [7].

E. Storage Techniques for Temperature and Humidity Management

To mitigate the negative effects of temperature and humidity fluctuations, various advanced storage techniques have been explored.

Figure 5: Storage Techniques

Controlled atmosphere (CA) storage, which regulates oxygen and carbon dioxide levels, has been found to improve onion storage life by reducing microbial activity and respiration rates [6]. Modified atmosphere packaging (MAP) helps maintain optimal humidity conditions within storage containers, preventing excessive moisture accumulation and minimizing spoilage [20]. Research on moisture-resistant packaging films suggests that proper selection of packaging materials helps regulate humidity levels,

preventing both dehydration and microbial contamination [16].

Additionally, alternative preservation techniques such as γ-radiation have shown promising results in controlling microbial contamination in onions stored under varying temperature-humidity conditions [10]. Studies on drying and processing methods indicate that pre-storage drying at controlled temperatures significantly improves onion stability by reducing sensitivity to humidity fluctuations [19].

CONCLUSION

Temperature and humidity play a major role in onion storage, affecting its quality, shelf life, and market value. High temperatures cause onions to lose moisture, sprout early, and spoil faster, while low temperatures can damage their texture. If humidity is too high, onions become prone to fungal and bacterial infections, while very low humidity makes them dry out and shrink.

To improve storage, methods like controlled atmosphere storage, special packaging, and fumigation are used to keep onions fresh for longer. Technologies like moisture-resistant packaging and automated monitoring systems help maintain the right storage conditions.

However, more research is needed to develop affordable and efficient storage solutions, especially for farmers in resource-limited areas. Using smart storage systems, eco-friendly packaging, and energy-saving techniques can help reduce onion waste, ensuring better quality onions and higher profits for farmers and traders.

REFERENCES

[1] Islam, Md Nahidul, et al. "Online measurement of temperature and relative humidity as marker tools for quality changes in onion bulbs during storage." *PloS one* 14.1 (2019): e0210577.

[2] Tripathi, P. C., and K. E. Lawande. "Onion storage in tropical region—a review." Current Horticulture 7.2 (2019): 15-27.

[3] Sasongko, Setia Budi, et al. "Effects of drying temperature and relative humidity on the quality of dried onion slice." Heliyon 6.7 (2020).

[4] Jolayemi, Olusola Samuel, et al. "Monitoring the changes in chemical properties of red and white onions (Allium cepa) during storage." *Journal of Stored Products and Postharvest Research* 9.7 (2018): 78-86.

[5] Tho, Kim E., et al. "Effects of temperature, relative humidity, and plant age on bacterial disease of onion plants." *Plant Health Progress* 20.4 (2019): 200-206.

[6] Ríos-González, Irving J., et al. "Effect of controlled atmospheres on the quality of white onion (Allium cepa L)." *Journal of food science and technology* 55 (2018): 3564-3574.

[7] Ji, Sang Hye, et al. "The major postharvest disease of onion and its control with thymol fumigation during low-temperature storage." *Mycobiology* 46.3 (2018): 242-253.

[8] Shankar, V. Siva, et al. "Effect of on-farm storage structure on physical and bio-chemical changes in aggregatum onion." *Materials Today: Proceedings* 72 (2023): 2417-2422.

[9] Seifu, Muhaba, et al. "Effect of variety and drying temperature on physicochemical quality, functional property, and sensory acceptability of dried onion powder." *Food science & nutrition* 6.6 (2018): 1641-1649.

[10] Sharma, Pallavi, et al. "Effect of γ-radiation on post-harvest storage life and quality of onion bulb under ambient condition." *Journal of Food Science and Technology* 57 (2020): 2534-2544.

[11] Islam, Md Nahidul, et al. "Analyzing quality and modelling mass loss of onions during drying and storage." *Computers and Electronics in Agriculture* 164 (2019): 104865.

[12] Maude, R. B. "Storage diseases of onions." *Onions and allied crops* (2018): 273-296.

[13] Majid, Ishrat, Shafat Hussain, and Vikas Nanda. "Moisture sorption isotherms and quality characteristics of onion powder during storage as affected by sprouting." *Journal of Food Measurement and Characterization* 13 (2019): 775-784.

[14] Akan, Selen, and NURDAN TUNA GÜNEŞ. "Potential effects of storage period, warehouse locations, and methyl jasmonate in long-term stored garlic bulbs." *Turkish Journal of Agriculture and Forestry* 45.1 (2021): 79-90.

[15] NATUBHAI, BALDANIYA, A. P. Karjule, and D. A. Patel. "Effect of containers and duration on seed quality of onion under ambient storage conditions." *Seed Research* 46.2 (2018): 164-167.

[16] Lee, Dong Sun, and Gordon L. Robertson. "Interactive influence of decision criteria, packaging film, storage temperature and humidity on shelf life of packaged dried vegetables." *Food Packaging and Shelf Life* 28 (2021): 100674.

[17] Madhu, Bogala, Vishvambhar D. Mudgal, and Padam S. Champawat. "Storage of garlic bulbs (Allium sativum L.): A review." *Journal of Food Process Engineering* 42.6 (2019): e13177.

[18] Lestari, Rohimah Handayani Sri, Endang Sulistyaningsih, and Aziz Purwantoro. "The effect of drying and storage on the quality of shallot (Allium cepa L. Aggregatum group) bulbs." *Ilmu Pertanian (Agricultural Science)* 3.3 (2019): 117.

[19] Bamba, Bio Sigui Bruno, et al. "Effects of onion bulb processing conditions on drying characteristics, physicochemical and functional properties profile of onion (Allium cepa L.) powder." *Journal of food science* 85.10 (2020): 3345-3354.

[20] Wang, Aimei, Alexandru Luca, and Merete Edelenbos. "Emission of volatile organic compounds from yellow onion (Allium cepa L.) bulbs during storage." *Journal of food science and technology* 56 (2019): 2940-2948