GreenariA
Go Green, Learn Green
An Agricultural Monthly e-Magazine

Volume 02, Issue 11, 2024
ISSN: 2584-153X
Article ID: G-24-1139

BIOLOGICAL AND ENVIRONMENTAL FACTORS CONTRIBUTING TO THE SHORT SHELF LIFE OF FRUITS AND VEGETABLES

Sharvesh S[1], Sharmila B[2*], Vigneswari G[1] and Sharmitha K[3]

[1]Research scholar, Department of Horticulture, Faculty of Agriculture, Annamalai University, Chidambaram

[2]Assistant Professor, AVS College of Technology, Salem

[3]Assistant Professor, Prist University, Thanjavur

**Corresponding Author Mail ID: samsherin98@gmail.com*

Introduction

Fruits and vegetables are highly perishable, which limits their storage life significantly. Unlike grains or pulses that can be stored for long periods, fruits and vegetables are prone to rapid deterioration due to their high moisture content, biological makeup and vulnerability to environmental conditions such as temperature and humidity.

In tropical regions, the challenges are even more pronounced, as high temperatures, humidity, insect pests and disease accelerate spoilage. Various pre-harvest and post-harvest factors contribute to the quality and longevity of produce, influencing both its storage life and market value.

This article delves into the scientific reasons behind why fruits and vegetables cannot be stored for long periods, focusing on the interplay of physiological, biochemical and environmental factors that hasten their decay. We will also explore potential solutions to extend their shelf life and mitigate post-harvest losses.

1. Physiological Characteristics

Fruits and vegetables are living tissues and even after being harvested, they continue to undergo metabolic processes like respiration, transpiration and ethylene production.

These processes play a significant role in limiting their storage life.

1.1. Respiration

Respiration is a metabolic process that converts sugars stored in the fruit or vegetable into energy, which is used to sustain cellular functions even after harvest. During respiration, oxygen is consumed and carbon dioxide, water vapor and heat are released. The rate of respiration is directly related to the perishability of the produce. Faster respiration leads to quicker degradation of sugars, proteins and lipids, resulting in the breakdown of tissues and spoilage.

Climacteric fruits, such as mangoes and bananas, exhibit a surge in respiration as they approach ripening, making them more susceptible to post-harvest deterioration. Non-climacteric fruits like citrus and grapes, on the other hand, show a steady decline in respiration without the ripening surge, giving them a relatively longer storage life.

1.2. Transpiration

Transpiration is the process of water loss from the surface of fruits and vegetables through evaporation. Since they consist largely of water (up to 90% in some vegetables), the loss of even a small amount can lead to visible wilting, shrivelling and a decline in marketability. Loss of water increases the concentration of solutes, disrupting the osmotic balance within the cells, which leads to cellular damage. Fruits and vegetables with high surface area, like leafy greens, tend to lose water rapidly compared to

those with thicker peels, such as melons or pumpkins.

1.3. Ethylene Production

Ethylene is a plant hormone that promotes ripening and senescence. Most fruits, especially climacteric fruits, produce ethylene in varying quantities. Even small concentrations of ethylene gas can accelerate ripening and spoilage in nearby produce. Ethylene production is stimulated by physical injuries, microbial infections and environmental stress, further shortening the storage life of fruits and vegetables. This is particularly detrimental in mixed storage settings, where ethylene-sensitive vegetables like lettuce are stored alongside ethylene-producing fruits like apples.

2. Environmental Factors

Environmental conditions play a critical role in determining the storage life of fruits and vegetables. Key factors include temperature, humidity and atmospheric composition.

2.1. Temperature

Temperature has a direct effect on the rate of respiration and other metabolic activities. Higher temperatures accelerate respiration, enzymatic activities and ethylene production, leading to faster spoilage. For instance, the respiration rate of many fruits doubles with every 10°C increase in temperature. However, low temperatures can also be harmful, especially for tropical and subtropical fruits that are susceptible to chilling injuries. For example, bananas and mangoes suffer from chilling injury when stored at temperatures below 13°C, resulting in browning and off-flavours

2.2. Humidity

Relative humidity is another crucial factor influencing water loss and decay. High humidity levels can reduce transpiration but may promote the growth of molds and bacteria, which cause decay. Conversely, low humidity accelerates moisture loss, leading to dehydration and shrivelling. For optimal storage, maintaining the right balance of humidity (usually 85-95% for most fruits and vegetables) is essential to slow down both water loss and microbial growth

2.3. Atmospheric Composition

The composition of gases around stored fruits and vegetables can significantly impact their shelf life. Reducing oxygen levels and increasing carbon dioxide concentrations can slow down respiration and delay ripening. Modified atmosphere packaging (MAP) and controlled atmosphere storage (CA) techniques exploit this principle by adjusting the gas composition within storage environments. However, improper regulation of these gases can lead to anaerobic respiration, resulting in off-flavors and spoilage.

3. Pre-Harvest Factors

Several factors related to the growth and development of fruits and vegetables also affect their post-harvest quality and storage potential.

3.1. Genetic/Varietal Factors

The choice of variety or cultivar has a significant influence on the storage life of horticultural produce. Some varieties are inherently more resistant to post-harvest diseases and physiological disorders, while others have traits like thicker skins, higher firmness, or lower respiration rates that contribute to longer storage life. For example, mango varieties like Alphonso and Ratna are better suited for longer storage and processing than other cultivars.

3.2. Environmental Conditions during Growth

Temperature, sunlight, humidity and soil conditions during the growing season influence the post-harvest behavior of fruits and vegetables. For instance, exposure to high temperatures during the growing phase can result in faster respiration rates and lower sugar content at harvest, reducing the storage potential of fruits. Similarly, excessive rainfall or humidity can make crops more susceptible to post-harvest diseases.

3.3. Cultural Practices

Pre-harvest cultural practices, such as irrigation, canopy management and nutrient application, also affect post-harvest quality. Water stress during the growing season can lead to irregular ripening and increased susceptibility to bruising and decay during storage. Proper nutrient management, particularly the application of calcium, can reduce the incidence of physiological disorders like bitter pit in apples and tip burn in lettuce.

4. Post-Harvest Handling and Processing

After harvesting, improper handling and storage techniques can further reduce the storage life of fruits and vegetables. Common issues include mechanical damage, poor packaging and inadequate temperature control.

4.1. Mechanical Damage

Fruits and vegetables are prone to bruising, cutting and crushing during harvesting, transportation and handling. Such injuries provide entry points for pathogens and accelerate water loss, respiration and ethylene production, hastening spoilage Careful handling practices, such as using padded containers and avoiding over-packing, can minimize mechanical injuries and extend shelf life.

4.2. Inadequate Packaging

Packaging plays a critical role in protecting produce from physical damage and controlling the micro-environment around the product. Loose or improperly packed produce is susceptible to vibration and impact damage during transportation, while overly tight packaging can cause crushing. The use of appropriate packaging materials, such as perforated polyethylene bags, can help maintain the right balance of oxygen and carbon dioxide levels, reducing spoilage.

4.3. Temperature and Humidity Control

Post-harvest cooling and temperature management are essential for slowing down respiration, transpiration and microbial growth. The use of refrigerated storage and cold chains can significantly extend the shelf life of fruits and vegetables. However, in many developing regions, the lack of proper infrastructure for refrigerated transportation and storage results in significant post-harvest losses.

5. Biological Factors

Microbial activity is a major cause of post-harvest losses. Fungi, bacteria and yeast can invade damaged or stressed tissues, leading to rot and decay. Common post-harvest diseases include anthracnose in mangoes, blue mold in citrus fruits and black rot in pineapples. Effective management of these diseases requires good sanitation practices, proper handling and, in some cases, the application of fungicides or biological control agents.

6. Intrinsic Factors

Fruits and vegetables are highly perishable due to their internal composition, which creates ideal conditions for microbial growth. One key factor is water activity (aw), as these food items contain high moisture levels, promoting the rapid growth of bacteria, molds and yeasts. Microorganisms need moisture to survive and when the water activity in food is high (above 0.95), microbial proliferation occurs quickly. Drying or freezing, which lowers the water activity, can help delay spoilage.

Additionally, the pH levels in fruits and vegetables contribute to their perishability. Many bacteria grow best in a neutral pH range (6.8–7.5), but yeasts and molds can thrive in more acidic environments, which are often found in fruits. This makes fruits especially prone to spoilage by yeast and mold, while vegetables are more susceptible to bacterial spoilage.

7. Extrinsic Factors

The external storage conditions also play a crucial role in determining how long fruits and vegetables can be stored. Temperature is the most important factor. Higher temperatures

accelerate the growth of spoilage microorganisms, while lower temperatures slow down microbial activity. However, refrigeration only inhibits microbial growth temporarily—it does not prevent spoilage altogether.

The relative humidity (RH) of the storage environment affects the moisture levels of the food. If the humidity is too high, fruits and vegetables may absorb additional moisture from the air, speeding up microbial activity and spoilage.

8. Lack of Natural Protective Structures

Once harvested, fruits and vegetables lose their biological barriers that protect them from external microbial invasion. Without these natural defences, they become more vulnerable to spoilage microorganisms, requiring proper handling, storage and preservation methods to extend their shelf life.

Conclusion

Fruits and vegetables are highly perishable due to their biological and physiological characteristics. Factors such as respiration, transpiration and ethylene production contribute to their rapid decay, while environmental conditions like temperature, humidity and gas composition further influence their storage life. Pre-harvest factors, including genetic variety, environmental conditions and cultural practices, also play a significant role in determining post-harvest behaviour.

Proper post-harvest handling techniques, such as careful harvesting, packaging and temperature management, are essential to extending the shelf life of these products. While technological solutions like modified atmosphere packaging and refrigerated storage offer promising avenues for extending storage life, their implementation remains a challenge, particularly in developing countries.