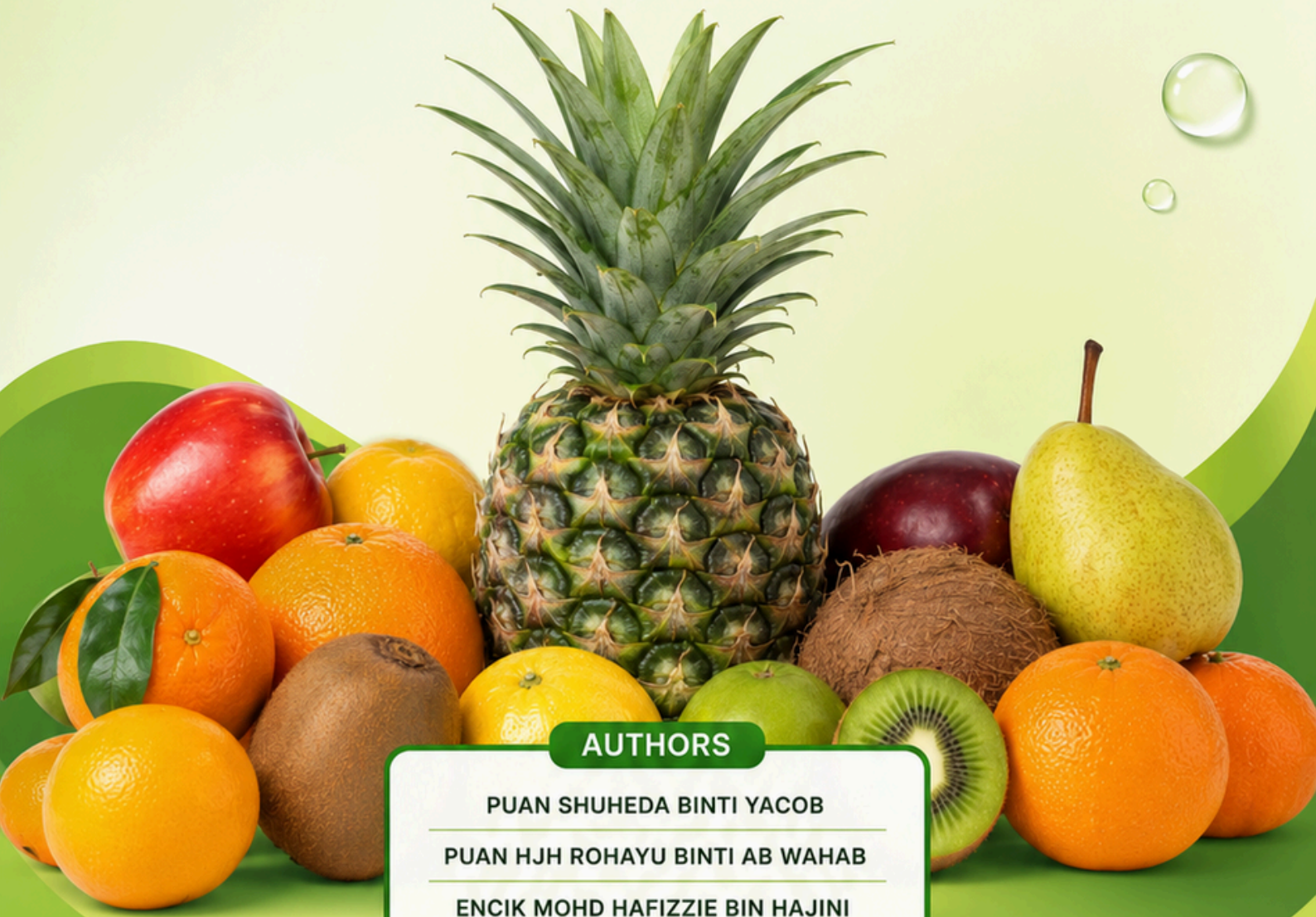
POLITEKNIK MALAYSIA
SANDAKAN

FRUIT PRESERVATION

Understanding Climacteric vs Non-Climacteric



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Fruit Preservation

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First Edition



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Preface

The preservation of fruits has long been a critical practice, enabling the continued availability of seasonal produce throughout the year. This practice not only ensures prolonged access to nutritious food but also contributes to reducing post-harvest losses. Whether one is a horticulturist, a food science practitioner, or an individual seeking to maintain the freshness of produce over extended periods, a clear understanding of various preservation methods is essential for enhancing product quality and sustainability.

This e-book examines two primary categories of fruits climacteric and non-climacteric and discusses the most effective preservation strategies applicable to each group. Beginning with an overview of the natural ripening process influenced by ethylene gas, the text further explores a range of techniques including freezing, drying, and modern packaging systems. Through this discussion, the e-book provides comprehensive insights into how both contemporary technologies and traditional practices can be utilised to extend the shelf life of fruits while preserving their nutritional attributes and sensory qualities.

FRUIT RIPENING

Fruit ripening is a natural process that involves various biological and chemical changes as the fruit matures. These changes are influenced by both internal and external factors, including enzymes, gases such as ethylene, and environmental conditions like temperature. Fruits can be grouped into two categories climacteric and non-climacteric based on how they ripen. This section explains the differences between these two groups, with particular attention to the role of ethylene and how it affects the ripening proces

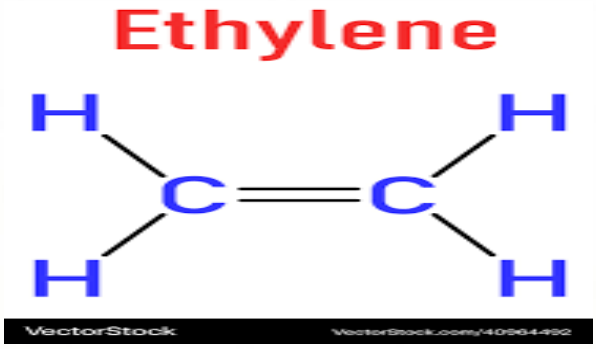


What is Ethylene?

Ethylene is a plant hormone that promotes the ripening of climacteric fruits. These fruits such as bananas, apples, and tomatoes produce increasing amounts of ethylene as they ripen, which then triggers a series of physiological changes.

How Ethylene Works:

- **Increased Respiration:** *Ethylene stimulates the fruit's respiration rate, thereby accelerating the ripening process.*
- **Softening:** *It facilitates the breakdown of the fruit's cell walls, resulting in a softer texture.*
- **Sugar Conversion:** *It promotes the conversion of starches into sugars, enhancing the fruit's sweetness.*
- **Colour Change:** *Ethylene degrades chlorophyll (the green pigment), allowing other pigments such as yellow, orange, or red to become visible, which alters the fruit's colour.*
- **Aroma**
  Ethylene plays a critical role in the development of the characteristic aroma of ripe fruits by stimulating the synthesis of volatile aromatic compounds.



CLIMACTERIC FRUIT

What is Climacteric Fruit?

Climacteric fruits continue to ripen even after being harvested. They produce ethylene, a natural hormone that accelerates ripening.

Examples: Banana, Mango, Papaya, Avocado

Did You Know? Bananas can ripen faster if placed near apples.



Climacteric fruits are fruits that continue to ripen after they are harvested. They produce a significant amount of ethylene gas, which triggers a rise in respiration, leading to the biochemical changes that result in ripening. These fruits undergo a rapid increase in their respiration rate and ethylene production as they ripen, which causes them to soften, sweeten, and change colour even after being picked.

Characteristics of Climacteric Fruits

Continued Ripening After Harvest:

They ripen further after being harvested. For example, bananas and avocados are often picked while still firm and ripen off the tree.

1. **Ethylene Production**:
   They produce ethylene, a natural plant hormone that accelerates the ripening process.

2. Changes During Ripening:

- *Softening: The fruit becomes softer due to the breakdown of cell walls.*
- *Sweetening: Starches in the fruit are converted into sugars.*
- *Color Change: The fruit changes color as chlorophyll breaks down and other pigments (like carotenoids or anthocyanins) become visible.*

BANANA



Bananas are rich in potassium and ripen quickly due to ethylene production. As bananas ripen, starches in the fruit convert to sugars, making the fruit sweeter and softer.



Storage Tips

- *Keep at room temperature to ripen.*
- *Refrigerate when yellow to slow further ripening.*

Did You Know?

- *Bananas can ripen faster if kept near apples or mango.*

PAPAYA



- *Papayas are tropical fruits that soften and sweeten after picking.*

Storage Tips

Keep at room temperature; refrigerate when fully ripe.



Did You Know?

Papaya leaves can also be used for tea with medicinal benefits.

MANGO



- *Mangoes are climacteric fruits that soften, change colour, and increase in sugar content after being harvested.*
- *Depending on the variety, they can be green, yellow, or red when ripe*



Storage Tips

Mangoes can be ripened at room temperature, away from direct sunlight.
To speed up the process, mangoes can be placed in a paper bag or with other climacteric fruits

Did You Know?

Mangoes are rich in fiber and contain enzymes like amylase, which help break down proteins and aid in digestion

AVOCADO



Avocados are harvested when they’re still hard, and they only ripen once they're off the tree. This makes them a unique climacteric fruit.

Storage Tips



Refrigerate ripe avocados *to slow down the ripening process and extend their freshness.*
This will keep them fresh for an additional 1–2 days.
Place the ripe avocado in the **crisper drawer** *of the refrigerator foroptimal results.*

Did You Know?

Avocado can float in water when it's ripe. This is due to the air pockets inside the fruit that help it stay buoyant.

NON CLIMACTERIC FRUIT

What is Non-Climacteric Fruit?

Non-climacteric fruits stop ripening once harvested. Their color, taste, and aroma are set when picked.

Examples: Watermelon, Grapes, Citrus fruits, Pineapple



Did You Know? Strawberries won't become sweeter after picking; they need to ripen on the plant.

- **Ripening Before Harvest**

  These fruits ripen while still attached to the plant or tree, meaning they are fully ripe when picked, with their flavour, texture, and colour already developed.

- **No Ethylene Surge**

  Non-climacteric fruits produce little to no ethylene gas, so they don't continue ripening after being harvested. Once picked, their flavour, texture, and sweetness stay the same.

- **Ripening Stops Post-Harvest**

  Since non-climacteric fruits do not continue ripening after being picked, their quality and taste remain constant from the moment they are harvested. This is why these fruits need to be harvested when they are fully ripe.

NON-CLIMACTERIC

Non-climacteric fruits (such as oranges, grapes, and strawberries) do not produce a significant increase in ethylene and do not undergo a "climacteric rise." These fruits must be harvested when fully ripe or near ripe because they do not continue to ripen effectively after being picked. The ripening process of non-climacteric fruits typically follows these stages:

i. **Maturation Phase:**

- *Non-climacteric fruits reach full ripeness while still attached to the plant. During this time, the fruit is actively growing, and its colour begins to change due to the degradation of chlorophyll (as with climacteric fruits).*

ii. **Ripening Phase:**

- *The fruit's sugars increase, acids may decrease, and the texture softens (though less dramatically than climacteric fruits). However, the ripening process does not continue effectively after harvest, and the fruit will not experience the same post-harvest transformation seen in climacteric fruits.*

GRAPES



Grapes are ripe when they are **fully colored**, *plump, and* **detachable** *from the vine with ease. They should not feel overly soft or shriveled.*



Storage Tips

Only wash grapes right before eating them. Keep them dry when storing to prolong their freshness.

Did You Know?

Raisins, sultanas, and currants are all dried grapes.

PINEAPPLE



A ripe pineapple has a sweet aroma, particularly near the base, and its leaves should pull out easily. It should also feel slightly soft when pressed.



Storage Tips

Place it on its side in a cool, dry area away from direct sunlight to prevent over-ripening.

Did You Know?

Pineapples contain an enzyme called bromelain, which breaks down proteins and can function as a natural meat tenderizer.

STRAWBERRY



Strawberries should be harvested when fully ripe. An unripe strawberry will be green or pale, while a ripe strawberry will be bright red (or the color specific to the variety).



Storage Tips

If you're not consuming the strawberries immediately, place them in a cool, shaded areato prevent them from overheating.

For short-term storage, put them in the refrigerator to keep them fresh for about 2–3 days.

Did You Know?

Strawberries have their seeds on the outside. A single strawberry can have around 200 seeds on its surface.

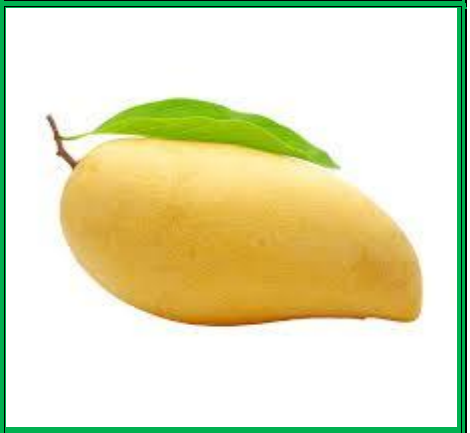
Fruits on the table, colors so bright,

Some ripen fast, others need light.

Climacteric or not, enjoy the taste,

Eat them fresh, don't let them waste.

Key Differences

Feature	Climacteric	Non-Climacteric
Ripening after harvest	*Yes*	*No*
Ethylene production	*High*	*Low*
Storage	*Can store longer*	*Must consume quickly*
Examples	*Banana, Mango*	*Grapes, Citrus*
		

SCAN FOR MORE INFO

Packaging Guide for Climacteric and Non-Climacteric Fruits

Ethylene Management

Climacteric fruits produce ethylene gas during ripening. Therefore, the packaging needs to allow ventilation to prevent the accumulation of ethylene gas, which can cause the fruit to ripen too quickly.

Vented Packaging

Packaging with holes or perforations, such as mesh bags or vented plastic, is used to allow airflow.

Storage Temperature

Before ripening, climacteric fruits can be stored at room temperature to ripen. However, after ripening, they should be stored in the refrigerator in an airtight container to prevent further ripening.

Soft Storage

These fruits become soft after ripening, so soft packaging like foam trays or suitable plastic is used to prevent bruising.





Moisture Control:

Non-climacteric fruits do not produce ethylene, but they are more prone to spoilage due to excess moisture. Packaging should allow ventilation to prevent mold formation and excessive moisture.



Soft and Vented Packaging:

Packaging such as clamshell containers or perforated plastic is used to prevent the fruit from crushing and to ensure moisture control.

Cold Storage:

These fruits need to be stored in a cool environment (refrigerator) to maintain freshness and prevent quick spoilage.

Protection from Pressure:

These fruits are easily damaged by pressure, so soft packaging is required to prevent injury to delicate fruits like grapes or strawberries.

TRANSPORTATION MODES

1. Road Transport:

- *Trucks and Lorries: The most common method for transporting fruits over short and medium distances. Refrigerated trucks (reefers) are often used to maintain the right temperature, especially for non-climacteric fruits like berries and grapes.*

2. Rail Transport:

- *Used for transporting large quantities of fruit over longer distances. Refrigerated rail cars (also known as cold storage trains) help keep fruits like apples and tomatoes fresh during transit.*

3. Air Transport:

- *Airplanes are used for international shipping of high-value fruits like mangoes, avocados, and grapes, which require fast delivery and careful temperature control. This method ensures fruits reach their destination quickly, preserving their quality and reducing spoilage.*

4. Sea Transport:

- *Cargo ships are used for transporting large quantities of fruits internationally. While sea transport is slower, it is cost-effective for bulk shipments of fruits like bananas and pineapples, especially when refrigerated containers are used to maintain the required temperature.*

5. Container Shipping (Refrigerated Containers):

- *Reefers (refrigerated containers) are commonly used across all modes of transport such as road, rail, air, and sea to maintain the cold storage of fruits. This method is particularly essential for fruits that require precise temperature control to prevent premature ripening or spoilage, such as berries, cherries, and grapes.*



SCAN FOR QUIZ

The Art and Science of Fruit Preservation

Methods of Fruit Preservation

1.1 Canning

Detailed explanation on the canning process, types of cans, and how it helps preserve fruit.

1.2 Freezing

Discuss the best practices for freezing fruit, such as blanching, packaging, and labeling.

1.3 Drying

Discuss methods like sun drying, oven drying, and using a dehydrator.

1.4 Preserves & Jams

Teach how to make fruit jams and preserves, which are popular for long-term storage.

1.5 Pickling & Fermentation

Explain how pickling and fermentation work in fruit preservation.









SCAN FOR INFO

Advanced Techniques in Fruit Preservation

>Vacuum Sealing

Vacuum sealing is a method of preserving fruits by removing the air from a plastic bag or container, thereby preventing the growth of microorganisms that require oxygen. This method is particularly useful for long-term storage as it significantly reduces the risk of spoilage due to bacteria, mold, or oxidation.

- *How it Works*
  The air inside a vacuum bag is removed using a vacuum sealer machine, which then seals the bag tightly. Without oxygen, the process of spoilage slows down considerably, and the fruit retains much of its original flavour, texture, and nutritional value.



>Cryopreservation

Cryopreservation involves freezing fruits at extremely low temperatures to preserve them for long periods. Unlike typical freezing, which may cause the formation of ice crystals and damage the fruit's cellular structure, cryopreservation uses ultra-low temperatures (often below -80°C) to slow down the metabolic processes of the fruit without causing cellular rupture.

- **How it Works**
  Cryopreservation is often used in the food industry with the help of liquid nitrogen or specialized freezers. It preserves fruits by halting enzymatic processes and microbial growth, which leads to minimal changes in texture, color, and flavor when thawed.



>Freeze Dry

Freeze drying is a preservation process that involves freezing the fruit and then reducing the pressure to allow the frozen water in the fruit to sublimate (transition from a solid to a gas). The result is a fruit with a very low moisture content, which prevents microbial growth and spoilage.

Freeze drying involves three main steps:

i. **Freezing the Fruit:** *The fruit is frozen at temperatures below -40°C to lock in nutrients and flavor.*

ii. **Primary Drying (Sublimation):** *The pressure around the fruit is reduced, causing the frozen water to sublimate directly from a solid to a gas, bypassing the liquid stage.*

iii. **Secondary Drying (Desorption):** *Any remaining moisture is removed to achieve a low moisture content, typically less than 5%.*



>Modified Atmosphere Packaging (MAP)

Modified Atmosphere Packaging (MAP) is a preservation technique where the air inside the packaging is altered to slow down the natural processes of ripening and spoilage in fruits. The atmosphere within the packaging is usually modified by reducing the oxygen content, increasing the levels of carbon dioxide, or controlling the humidity.

- **How it Works**
  MAP typically involves sealing fruit in a package with an atmosphere that is different from the normal air. For instance, oxygen is reduced to slow down respiration and microbial growth, while carbon dioxide is increased to prevent the growth of harmful bacteria and mold.



>Active Packaging

Active packaging involves packaging materials that interact with the food inside to enhance its preservation.

How it Works

Active packaging uses additives or substances embedded within the packaging material that can absorb or release gases or moisture. For example, some active packaging contains sachets that absorb excess moisture, while others might release controlled amounts of ethylene gas to regulate ripening in fruits.

CONCLUSION

Understanding fruit ripening helps reduce waste and enjoy fruits at their peak. Remember the key differences: climacteric fruits ripen after harvest; non-climacteric fruits do not.

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