Role of The Plant Hormone Ethylene

in Ripening of Fruits

Dedication

We have the honor to dedicate this research to every student willing to learn and know more about plants and their growth hoping to find it useful.

Also it's our present for Doha Independent Preparatory school and its leaders

Mr. abdullhameed Al lengawy

Mr. Azzam Abu Hanieh

And finally

Mr. Gholoum Abdullah .

Special Thanks

We would like to thank our Science Department in Doha Independent Preparatory School for its support and help .

Thanks to Mr. Mohammad Alaili our Science coordinator for his effort in providing us with all the tools and equipments that we needed.

Special thanks to Dr. Yassin Fawy, our science teacher for his guidance and continuous follow up step by step.

Finally , we can add no more words rather than we are so proud to be a part of this outstanding institution.

Doha Independent preparatory school for boys

Index

Introduction

During the process of ripening, fruits (apples) convert stored starch into sugar. In apples and many other commercial fruit, the sweet portion of the fruit evolved as a reward for animal seed dispersers. When seeds are ripe and ready for dispersal, the fruit converts stored starch, which does not taste sweet, into sugar. The plant hormone ethylene initiates the metabolic pathways that lead to this conversion.

Our research is concerned with showing up and proving the relation between ethylene gas and fruit ripening. Also, to what extend we can use the beneficial effect of ethylene in our daily life.

Objectives

The aim of this research and its experiment is to show how the ripening of unripe fruit is affected by the plant hormone ethylene.

At the end of this research, students will know the history, importance, and uses of ethylene then relate its importance (actions) to our daily life.

This Research will answer the following

- Does one bad apple spoil the whole bunch?
- Does it require direct contact?
- Can the contact be through the air?

If so,

- What sort of mechanism accounts for the communication that occurs among the apples?
- What physical and chemical changes occur as a fruit ripens?
- What are the other uses of ethylene?

Materials and Equipment

To do this project you will need the following materials and equipment:

- 8 sealable plastic bags, large enough to hold an apple and a banana,
- 4 ripe bananas,
- 8 unripe apples, notes:
    - *Choose apples that are in the early stages of ripening, these may be obtained at a grocery store.*
    - *You may also use varieties of crab apples or other local ornamental apples that are in the early stages of ripening.*
    - *Store-bought apples may already be too ripe to conduct a ripening experiment.*
- chemicals for iodine stain solution, notes:
    - *These chemicals are not available for purchase by individuals. You will have to order them through your school.*
    - *2% potassium iodide (KI) solution (catalog number 88-3871),*
    - *2% iodine (I) solution (catalog number 86-9091).*
- 500 ml. graduated cylinder,
- 1 liter (or larger) brown glass or plastic bottle for iodine stain solution,
- glass or plastic funnel,
- shallow glass or plastic tray at least 5 cm (approx. 2") deep,
- plastic straws,
- Knife and cutting board for cutting apples.

Experimental procedure

1. If you are unsure whether your apples are really unripe, follow the procedure in steps 7–9 to test one before conducting your experiment.
2. Label the bags:
   a. *Bags #1–4: Control,*
   b. *Bags #5–8: Test*

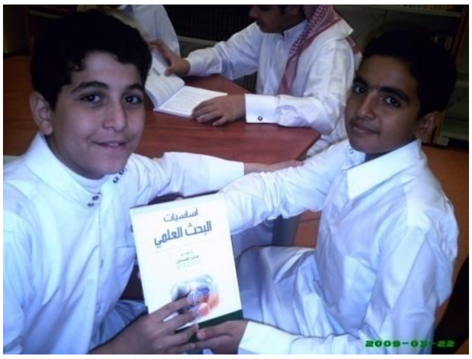
3. In each of the Control bags, place one unripe apple and seal the bag.

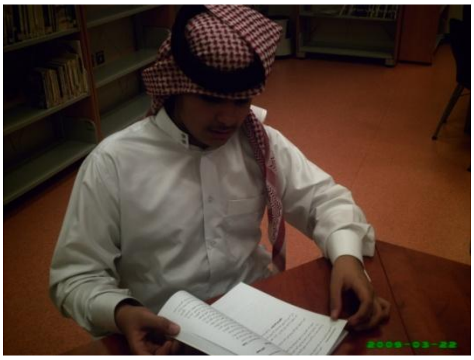
4. In each of the Test bags, place one ripened banana and one unripe apple and seal the bag.

Make sure that the bananas are tapped and fixed away from the apple so that they don't touch each other as shown in test bag 9 and test bag 7.

5. Place the bags together, and observe changes to fruit each day. Record your observations.

6. Students visited the library, and searched the Internet for resources. They developed a hypothesis about the role of ethylene in the ripening of fruit. They were looking up for : **What is ethylene ?**





7. After 2–3 days, use the procedure in steps 8–10 to test the apples for the presence of starch.

8. Students prepared their own iodine stain solution in the following way:

Safety note: Use appropriate care when handling the iodine solutions.

a. Read and follow safety warnings in the material safety Data Sheet (MSDS) accompanying each chemical.
b. Wear protective gloves, eyewear, and a lab coat when handling these chemicals.
c. Do not use metal containers for storing or measuring these solutions. Iodine is corrosive to metals.
d. The solutions will stain skin and clothing.

!! CAUTION:

Be careful with this solution. It will stain your skin and clothing if spilled. Wear protective gloves, eyewear, and a lab coat when handling the staining solution .

e. Use the graduated cylinder to measure 455 mL of the 2% potassium iodide (KI) solution. Carefully pour into the 1 L bottle.
f. Use the graduated cylinder to measure 120 mL of the 2% iodine (I) solution. Carefully pour into the 1L bottle.
g. Add water to make 1 L (about 425 mL).
h. Cap bottle securely and invert several times to mix.

i. The solution will keep for long periods of time in a tightly covered brown glass bottle.

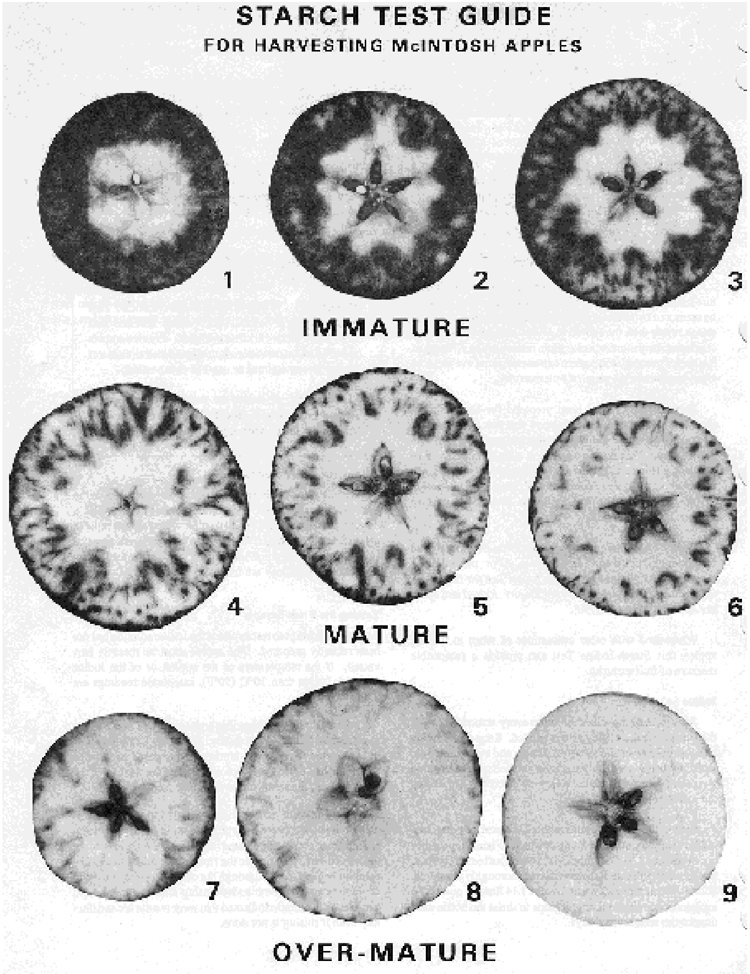
Stain the fruit:

Cut the apple in half (in cross section). Place the cut face of the fruit into the stain. You may want to prevent the cut surface from adhering to the tray bottom by propping it using glass rods or plastic straws.

a. Let the fruit soak in the stain for one minute.
b. Take the fruit out and rinse the face with water. (Rinse away from the staining tray so that the rinse water does not dilute the stain.)
c. **Note:** the staining solution can be poured back into its storage container and used again for a future experiment. Use a funnel and pour carefully!

Quantify the staining:

a. Determine a numeric ripeness score by comparing your apples with the following **Ripeness Chart {rubric} :**



McIntosh apple starch test guide

b. Record the data in your lab notebook.

Analyze your data:

a. Summarize your data by calculating averages for Control and Test conditions.

Observation

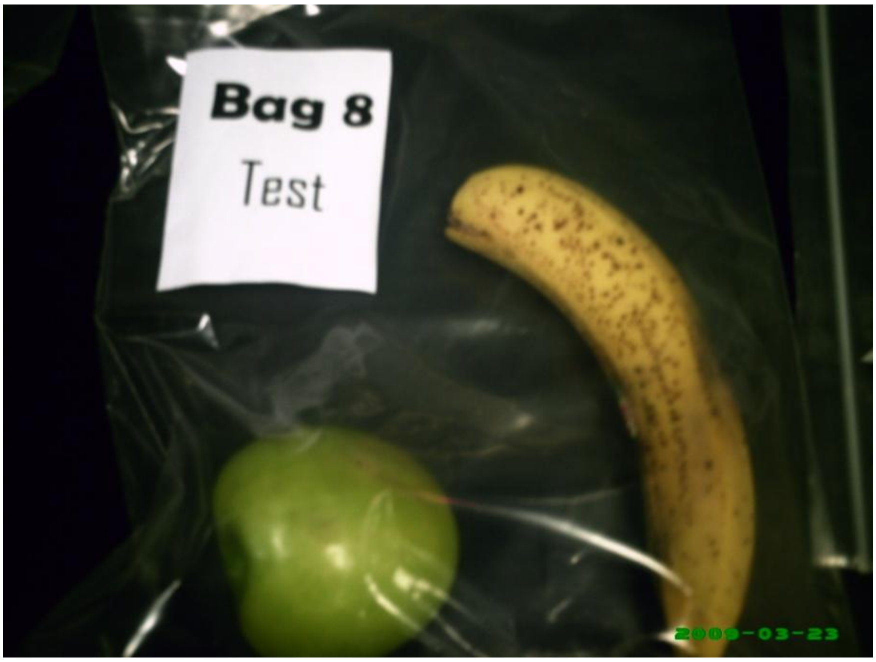
After 4 days { 22.3.09}

Test bag 8:

- The banana in the test bag 8 showed an increase in the black spots
- The apple became slightly yellowish

Control bag 5:
The apple showed no changes.

After 5 days { 23.3.09}



Test bag 8:

- The banana in the test bag 8 showed more black spots.
- The apple became more yellowish.

Control bag 4:

- The apple showed no changes.

After 7 days { 25.3.09}

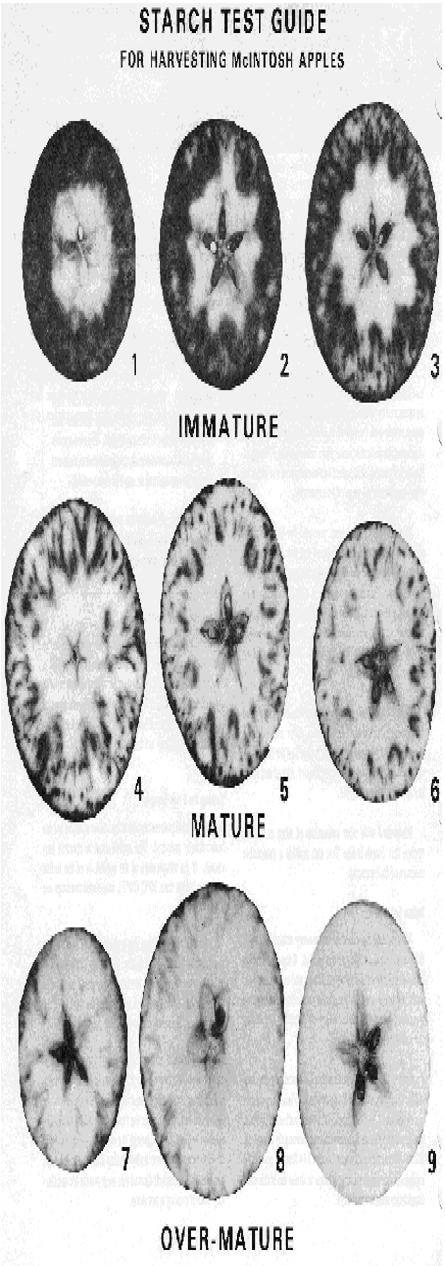
Test bag 6:

- The banana in the test bag 6 showed more black spots.
- The apple became slightly reddish.

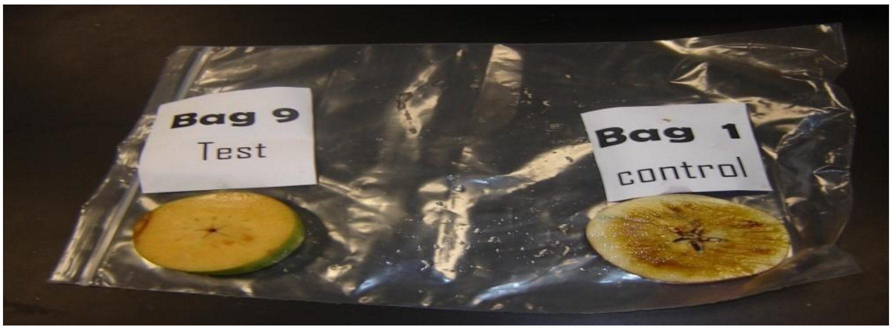
Test bag 7:

- The banana in the test bag 7 became completely black.
- The apple became yellowish red.

Rubric of Apple Ripening



TEST Bag | **Control Bag**



TEST Bag 9 scores 7 | **Control Bag 1 scores 2**

TEST Bag 8 scores 5 | **Control Bag 5 scores 2**

TEST Bag 6 scores 7 | **Control Bag 3 scores 3**

Conclusion

The apples ripened more quickly when it were placed together with the ripe bananas in a sealed container than when it was isolated in the control bags.

Further investigations

- We infer that ethylene may have been responsible for this quicker ripening.
- Another research will be followed to test for the % concentration of ethylene required for that effect.

Discussion

In general, plant tissues communicate using classes of compounds called hormones. These hormones are defined as substances produced in one location that have an effect on target cells in a non-adjacent location.

In plants, germination, growth, development, reproduction, and environmental response are all coordinated through hormones.

Although most of the main plant hormones are transported in the vascular system of the plant, one class of hormones is transferred in gaseous phase. This class includes the plant hormone ethylene.

Ethylene is manufactured and released by rapidly growing tissues (i.e., meristems) in roots, senescing flowers, and ripening fruit. For example, the darkened spots on a ripe banana release great amounts of ethylene.

Ethylene has many effects on plants including being responsible for the stunting of plants in high winds or when repeatedly touched. In addition, ethylene promotes fruit ripening. Like many hormones, it does so at very low concentrations.

Internet research results

Ethylene History:

From 1795 on, ethylene was referred as the *olefiant gas* (oil-making gas), because it combined with chlorine to produce the *oil of the Dutch* (1,2-dichloroethane). Ethylene was first synthesized in 1795 by a collaboration of four Dutch chemists.

In the mid-19th century, the suffix *-ene* (an Ancient Greek root added to the end of female names meaning "daughter of") was widely used to refer to a molecule or part thereof that contained one fewer hydrogen atoms than the molecule being modified. Thus, *ethylene*

(C_2H_4) was the "daughter of ethyl" (C_2H_5). The name ethylene was used in this sense as early as 1852.

In 1866, the German chemist August Wilhelm von Hofmann proposed a system of hydrocarbon nomenclature in which the suffixes -ane, -ene, -ine, -one, and -une were used to denote the hydrocarbons with 0, 2, 4, 6, and 8 fewer hydrogen than their parent alkane. In this system, ethylene became *ethene*. Hofmann's system eventually became the basis for the Geneva nomenclature approved by the International Congress of Chemists in 1892, which remains at the core of the IUPAC nomenclature. However, by that time, the name ethylene was deeply entrenched, and it remains in wide use today, especially in the chemical industry.

The 1979 IUPAC nomenclature rules made an exception for retaining the non-systematic name ethylene, however, this decision was reversed in the 1993 rules so the correct name is now *ethane.*

Ethylene uses:

Ethylene has been used in practice since the ancient Egyptians, who would gash figs in order to stimulate ripening (wounding stimulates ethylene production by plant tissues).

The ancient Chinese would burn incense in closed rooms to enhance the ripening of pears.

In 1864, it was discovered that gas leaks from street lights led to stunting of growth, twisting of plants, and abnormal thickening of stems (Arteca, 1996; Salisbury and Ross, 1992) In 1901, a Russian scientist named Dimitry Neljubow showed that the active component was ethylene.

Doubt discovered that ethylene stimulated abscission in 1917. It wasn't until 1934 that Gane reported that plants synthesize ethylene (Gane, 1934)

In 1935, Crocker proposed that ethylene was the plant hormone responsible for fruit ripening as well as senescence of vegetative tissues (Crocker, 1935).

Ethylene acts physiologically as a hormone in plants. It exists as a gas and acts at trace levels throughout the life of the plant by stimulating or regulating the ripening of fruit, the opening of flowers, and the abscission (or shedding) of leaves. Its biosynthesis starts from methionine with 1-aminocyclopropane-1-carboxylic acid (ACC) as a key intermediate.

Ethylene has long been in use as an inhalatory anaesthetic. When used as a surgical anaesthetic, it is always administered with oxygen with an increased risk of fire. In such cases, however, it acts as a simple, rapid anaesthetic having a quick recovery.

There is no evidence to indicate that prolonged exposure to *low concentrations* of ethylene can result in chronic effects. Prolonged exposure to high concentrations may cause permanent effects because of oxygen deprivation. Prolonged inhalation of about

85% in oxygen (a relatively high concentration) is also slightly toxic, resulting in a slow fall in blood pressure. At about 94% in oxygen, ethylene is acutely fatal.

Effects upon humans Ethylene has a pleasant sweet faint odor, and has a slightly sweet taste, and as it enhances fruit ripening, assists in the development of odor-active aroma volatiles (especially esters), which are responsible for the specific smell of each kind of flower or fruit.

In mild doses, ethylene produces states of euphoria, associated with stimulus to the pleasure centers of the human brain.

How can we use the conclusion of our experiment and research in our daily life.

Apple growers take advantage of this by picking fruit when it is not ripe, holding it in enclosed conditions without ethylene, and exposing it to ethylene right before taking it to market. This process is why we have newly ripened apples grown in temperate North America even in the spring and summer (apples ripen in the fall).

Project Summary

GRADE LEVEL	8
Time required	10 DAYS
Material Availability	**Sponsor : SCIENCE DEPARTEMENT , DOHA INDEPENDENT PREPARATORY SCHOOL**
Cost	**Low (20 – 30 QR)**
Safety	**Adult supervision required. Protective gloves, eyewear and lab coat required when working with iodine solutions.**

Participants

Students:

Aly al Naama

Ahmed mostafa

Ahmed Hussein

Basel Al Sayed

Mosaab Emad

Teacher:

Dr. Yassin Fawy

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