Birzeit university

Department of biology and biochemistry

Biol111

Experiment 5

Scientific investigation:

What makes fruit Go Brown

Nadeen Tokhly

1211518

Aya Dar Badwan 1210423

Rama Hassan 1210006

Zeina Sharkas 1212362

Talin Shreim 1211697

Dr.Seema Dahabrah

Ms.lena Abu Ateh

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Scientific Investigation:

What Makes Fruits Go Brown

*Objectives :

The goal of this experiment: to identify the different causes that lead to change the fruit color and turn it to brown.

observe the chemical and physical effects that make the fruits go brown.

introduction:

Fruits and vegetables browning (ripen) is an important for food and eat. However brown spots and faster browning cause repel of consumers and obstruct the fruits trade. According to scientific investigation, browning phenomenon can study by construct a testable hypothesis after ask question then followed by the careful design and execution of controlled experiments, and finally validation, refinement or rejection of this hypothesis (Carroll & Goodstein, 2009). In this experiment, many

a. investigations were done based on many questions some result supported the hypothesis and some rejected. Browning in Banana caused by enzymatic reactions.

Material:

- Knife
- Banana
- Mortar and pestle
- Toothpicks
- Tongs or foceps
- Kettle (to boil water)
- Thermometers
- Hcl(2%)
- Phenol (1%)
- Ascorbic acid solution at different concentrations (5%, 2.5%. 1.5%, b 1%. 0.5%)
- Sodium hydrogen sulfite (2%)
- Catechol solution in a dark dropper box (1%)
- Nacl(2%)
- Citric acid (2%)
- Sucrose (2%)

Method:

Initial observation:

The banana was cut into two small slices, one of them was crushed by mortar, and the other remained the same, the crushed sample was put on a tile beside the uncrushed piece, then compared and noticed which become brown firstly.

Cut a small piece from the uncrushed sample when it became brown by using a knife, and cut another small piece by using your hands, then compare and notice

• Investigation 1

Two banana slices were taken, one piece was soaked in 1% phenol (to kill microorganisms) and other piece was soaked in pure water. Tongs was used to remove the slices, excess liquids were shaked off. one surface was washed of each slice with 4 drops of catechol. Observed the rate of browning of each slice.

• Investigation2:

Had four bananas' slices and were immersed in water bath at different temperature (Room temperature,40C,60C,100C) for 1min, then by using tongs, removed the sliced and shaken off excess liquid, each surface of slice must be washed with 4 drops of Catechol. Compared between them.

• Investigation 4

Six banana slices were taken and soaked each slice in one of following solutions for 2 min: (5%, 2.5%, 1.5%, 1%, 0.5) ascorbic acid and distilled water. The slices were removed, excess solution was shaked off and the upper surfaces were washed with 4 drops of catechol. The tubes were arranged in sequence to showed which goes brown first and which last.

Investigation (5):

Seven banana slices were taken and soaked one in each of these solution for 2 min: 2% hydrochloric acid, 2% citric acid, 2% sodium hydrogen sulfate (IV), 2% sodium chloride, 2% sucrose, Boiling water, Cold distilled water. Then the slices were removed and the upper surface was washed with 4 drops of catechol.

***Data and Results:**

- initial observation:

When the banana was crushed it turned into brown color faster than uncrushed slices.

- Browning reaction can be observed fast in clear result. Ascorbic acid speed up reaction because it has copper ions, and can be slowed down by adding sulfur ions ($NaHSO_4$) as a certain preservative.

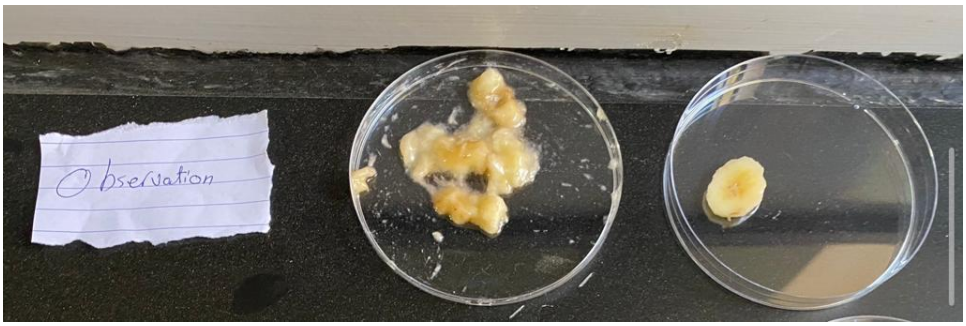


Fig1.1: Crushed and slice banana.

• Investigation 1:

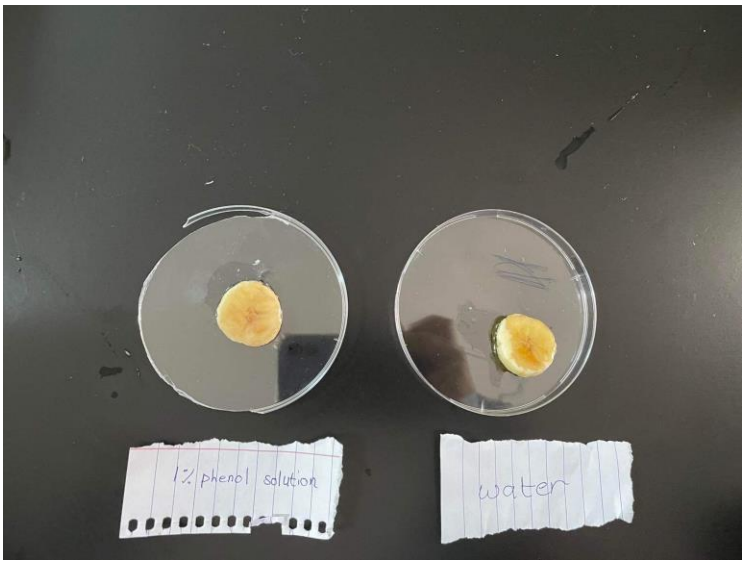


Figure 1.2 :(First observation) when we put

the water and the phenol 1% to the bananas (1 min)

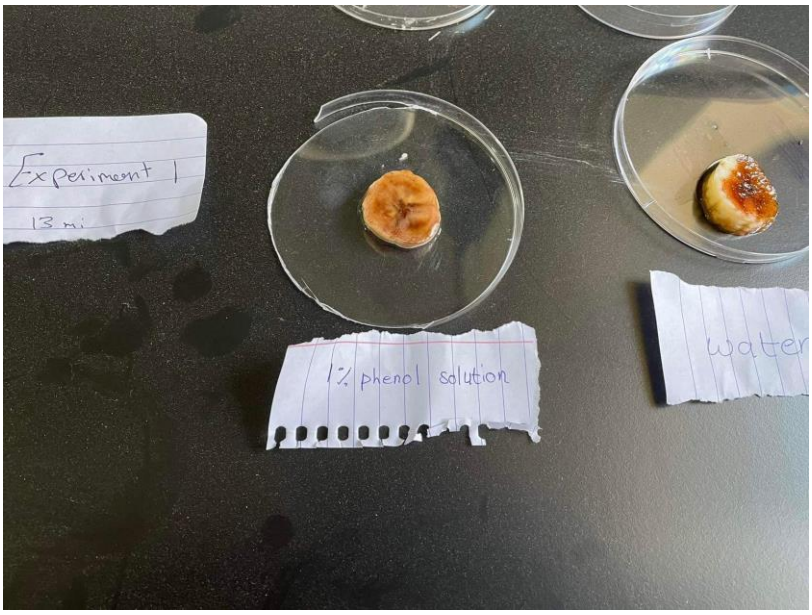


Figure 1.3:(investigation 1) effect of

microorganisms, after 13 min the result that we observed is the water has effect fast on the banana more than the phenol 1%.

• Investigation 2:

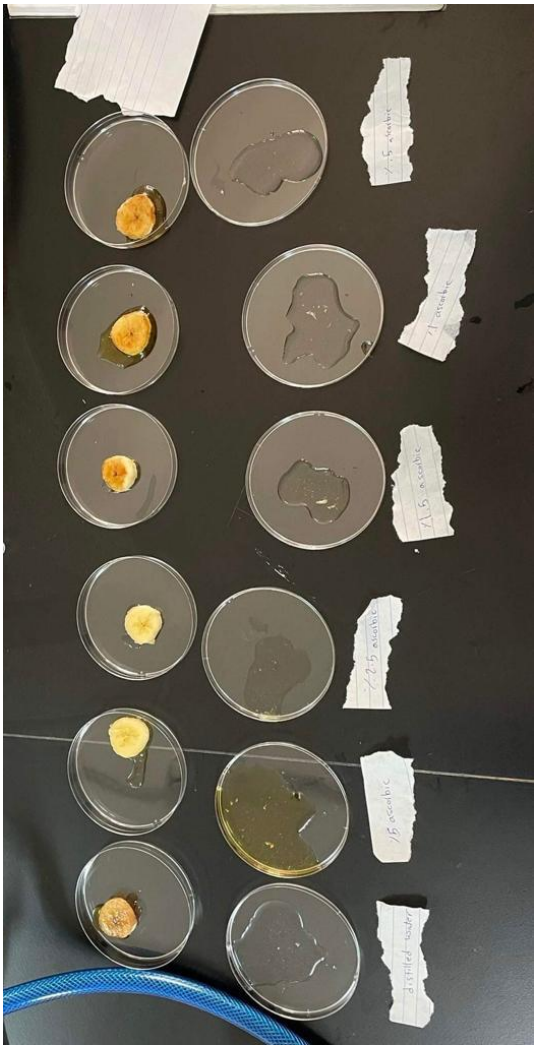
Fig1.4: Browning and different temperature.

Table1.1: The table show the change of color in different temperature.

Temp(°C)	**Room Temperature**	**40**	**60**	**100**
Color	Light brown	Dark brown	brown	Very light brown
The result after one min	4	1	2	3

Investigation 4:

Result: The relation between browning in banana and the concentration of the ascorbic acid was negative.



The substance that we put it on the banana	The speed that banana got brown after 2 min when we put the catechol
Distilled water	++++++
0.5% ascorbic acid	+++++
1% ascorbic acid	++++
1.5% ascorbic acid	+++
2.5% ascorbic acid	++
5% ascorbic acid	+

Investigation 5:

Chemical in the reaction

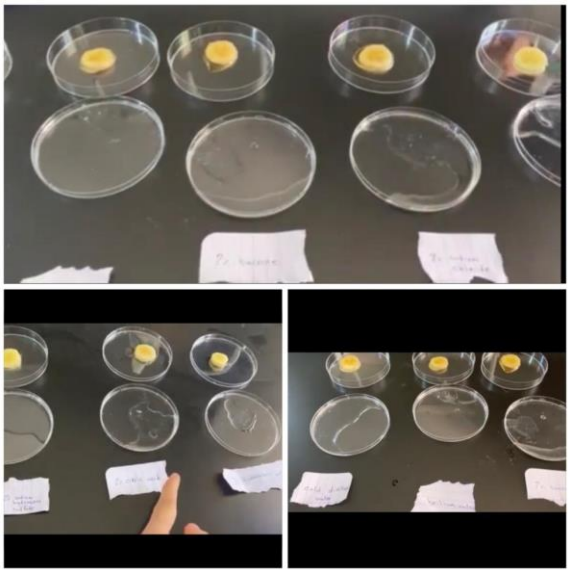


Fig1.5: The effect of (2% Hydrochloric acid, 2% citric acid, 2% sodium hydrogen sulfate, 2% sodium chloride, 2% sucrose, boiling water and cold distilled water)

Chemicals	**2% Hydrochloric acid**	**2% Citric acid**	**2% Sodium hydrogen sulfate**	**2% Sodium chloride**	**2% Sucrose**	**Boiling water**	**Cold distilled water**
Change in color	yellow	Dark brown	yellow	Light brown	Light brown	brown	brown
The speed that banana got brown after 2 min when we put the catechol	7	5	6	4	3	2	1

*Discussion:

-**initial observation**: the crushed slice of banana got brown faster than the uncrushed one. When we crush banana, we damage all the cells unlike the uncrushed, so we let oxygen react with PPO enzyme faster. Room temperature was low, for this, the expirement took some time to observe the changing of color. crushed banana starting brown after 36 minutes but the uncrushed took 43 minutes.

For **investigation 1** the fig1.2 showed the brown color of the two banana pieces at the same time. Where the first piece was immersed in pure water and second piece was dipped in phenol (1%) which was used to kill microorganisms according to the results, it was shown that microorganisms had no relationship to browning and the main reason for the appearance of brown color is the enzyme polyphenol oxidase, it is a copper-containing oxidoreductase which catalyzes two different enzymatic reactions involving oxygen and polyphenolic substrates which are polymerized to dark pigments.(Tinello & Lante, 2018).

For **investigation 2** the fig 1.3 displayed the difference in the color of the banana pieces when exposed to different temperature, as the brown color began to appear in the piece that was exposed to a temperature of 40°C faster than other, meaning that with the end of the experiment, the piece got a dark brown color. The piece, which was exposed to a temperature of 100°C appeared very light. brown. As for those that were placed to a temperature of 60°C they appeared in brown, and the last ones that were placed at room temperature appeared in the light brown color. As a summary, the rate of the reaction increases at the maximum temperature (20-30) °C and not at very high temperatures, and this is evidence that the enzymes control the reaction.

30 40 60 100 Temperature(°C)

-investigation (4): This expirement is to investigate how does the ascorbic acid affect the browning reaction, and the results was, all slices went brown but each one took different time, slices in distilled water and 0,5% ascorbic acid were the fastest then 1% ascorbic acid ,1.5% ascorbic acid, 2,5% ascorbic acid and the last one is 5% ascorbic acid. that because ascorbic acid is a reducing agent, so it can reverse an oxidation reaction – it is an 'antioxidant'. SO, the oxygen reacts with it first, and the more concentration of ascorbic acid, the more time the slice goes brown. (Ascorbic acid slows the browning process.)

For **investigation 5** the fig 1.5 showed that the two pieces on which the hydrochloric acid 2% and sodium hydrogen sulfate 2% were placed remained the same and the color did not change (yellow), the reason being to make the PH level not ideal for the enzyme. Also, dipping in citric acid 2% reduced all color changes evenly, resulting in the least degree of discoloration as citric acid 2% reduces the brown color, either by bonding with phenolic or PPO substrates to form complexes or by forming other compounds(Tsouvaltzis & Brecht, 2017). As for the piece on which sucrose was placed, it appeared light brown due to the decrease in the ability of oxygen to dissolve on the surface of the cell, and the change of color of the piece on which the boiling water was placed it turned brown due to an abnormal enzyme and the last piece, that was submerged in distilled water is the first piece that appeared brown, which distilled water was used to control the banana slice as this results in a decrease in the activities polyphenol oxidase, peroxidase and ascorbic acid oxidase by these gums.

Conclusion:

We conclude that when the surface area is bigger the reaction will go faster, and the microorganisms do not affect the reaction while the enzymes do, but high . temperature and strong chemical substances stop enzyme's work.

Resources:

- https://www.researchgate.net/publication/281582016_Enzymatic_Browning_Polyphenol_Oxidase_Activity_and_Polyphenols_in_Four_Apple_Cultivars_Dynamics_during_Fruit_Development

- Tinello, F., & Lante, A. (2018). Recent advances in controlling polyphenol oxidase activity of fruit and vegetable products. In Innovative Food Science and Emerging Technologies (Vol. 50). https://doi.org/10.1016/j.ifset.2018.10.008

- https://foodcrumbles.com/enzymatic-browning-bananas/

- Tsouvaltzis, P., & Brecht, J. K. (2017). Inhibition of Enzymatic Browning of Fresh-Cut Potato by Immersion in Citric Acid is Not Solely Due to pH Reduction of the Solution. Journal of Food Processing and Preservation, 41(2). https://doi.org/10.1111/jfpp.12829