Exploration Activity: Plant Puzzle

Background Information

Human Pancreatic Amylase (HPA) activity is known to correlate with blood glucose levels. This enzyme is an intermediary in the breakdown of starch to glucose. Figure 1 illustrates this process. When HPA activity is increased, blood glucose levels also increase. Blood glucose levels must be monitored carefully in people who have diabetes, so research in this area has exciting potential for developing pharmaceuticals to help diabetic people cope with their condition.

Maltose, as well as sucrose & lactose, are intermediate sugars in the degradation of starch to glucose.

Figure 1

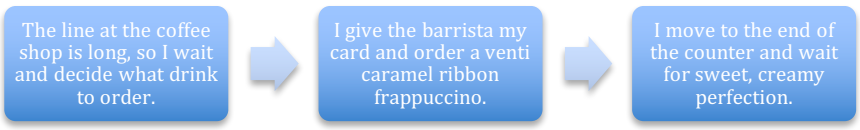
Samples ready for testing at the UBC labs.

Christina Tysoe works at the Michael Smith Laboratory at UBC. She is trying to find effective inhibitors for human pancreatic amylase activity. If the activity of HPA is lowered due to a competitive inhibitor, blood glucose levels will also drop, resulting in fewer health problems due to high blood glucose levels. Imagine you are part of the team of scientists at UBC. You are trying to find a chemical that will act as an inhibitor for HPA. Some recent research has pointed to a group of chemicals known as flavonoids as potential inhibitors. This group of chemicals includes many plant-based extracts, including those found in green tea and wine. Your research group has decided to look at other plant material as possible sources for new inhibitory chemicals. The plant material may contain potential inhibitors that must be extracted from the plant, purified, and then tested on starch samples with HPA to see the resulting starch level. If HPA activity is inhibited, starch will still be present in the samples. If HPA activity is not inhibited, the starch will degrade to simpler sugars.

Procedure

Read through the background information above. Answer the following questions before moving on to the analysis of the data.

1. What are the steps by which starch eventually becomes useable glucose?
2. Where does the breakdown of starch begin in the human body? Are there other locations where starch is digested in the human body?
3. Outline the basic mechanism of competitive inhibition.
4. Draw a flow chart illustrating through sketches or text the steps necessary to test the plant material for potential HPA inhibitors. At each step in the flow chart, it may be helpful to ask the question, 'And then what?' A simplified example is given for you.



   Your flowchart will probably be several steps longer. Remember to be as specific as you can. Start with the raw plant material you will be testing, a plant bulb. The goal is to end with the step where the plant extract is tested with starch and HPA.
5. How could the presence of starch be tested for?

Data & Results

Your teacher will give you a data sheet to interpret. Read through the results and answer the following questions.

1. Why was starch tested by itself in this lab?
2. Which sample had evidence of starch present at the end of the test?
3. Which sample had evidence of no starch present at the end of the test?
4. Were there any inconclusive results? Why do you think this is?
5. What might the presence or absence of starch at the end of the test time indicate?

Analyze and Apply

1. Summarize your results and suggest which sample provides the best potential for further study. Why does your selection meet the criteria for further examination? Are there other possible samples to study?

2. Read the Additional Information Sheet. What are the risks associated with high blood glucose levels? What are traditional treatments for diabetes? Summarize why Montbretin A holds such promise for diabetics.

Additional Lab Information Sheet

Plant Materials Studied in the Activity

- Sample A Hyacinth
- Sample B Crocosmia
- Sample C Narcissus

The sample in this activity that resulted in no degradation of starch was the extract from a plant called Crocosmia. This is a common garden plant in BC. An illustration of this plant is shown in Figure 2.

In order to find the possible plant extracts for study, the Withers Lab at the Michael Smith Laboratories at UBC screened a database of approximately 30,000 plant extracts to look at enzyme activity. In the past, this would have taken months to complete, but using robots to accomplish the assays reduced the time to several days. The CHiBi Lab at UBC (Centre for High-Throughput Biology) is a leader in these trials.

Figure 2

The extract from Crocosmia (Montbretin A) was found to result in no enzyme activity and is a possible source for future pharmaceuticals. In order for this to happen, scientists need to better understand the biosynthesis of Montbretin A. How can we create more of this chemical? How can we make it easier to create? The goal will be to eventually move the synthesis of this into yeasts or create simpler analogs of the chemical in order to increase production of it, allowing for the production of available drugs for the public. Christina Tysoe is attempting to create these analogs for future study. She is looking for ways to keep the functional part of Montbretin A, while simplifying the rest of this complex molecule. See Figure 3 for the structural formula of Montbretin A.

This chemical makes it possible for patients with diabetes to better regulate their blood glucose levels and live healthier lives. With diabetes diagnosis rates on the rise, this research is more relevant than ever and could be a breakthrough in the treatment of this common disorder. Visit the Diabetes Health Centre to find out more information.

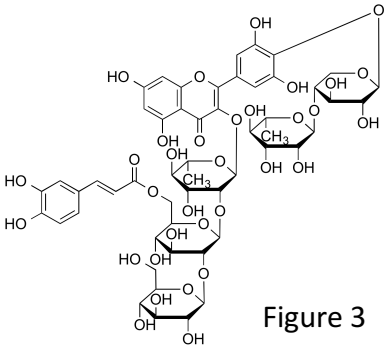


Figure 3

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Data Sheet

Three different bulb extracts were tested with starch and Human Pancreatic Amylase to determine starch levels after three minutes. The results of the test are summarized in the table below.

TEST	Starch	Starch & HPA	Starch, HPA & Sample A	Starch, HPA & Sample b	Starch, HPA & Sample c
t=0 Iodine Drop	blue-black	blue-black	blue-black	blue-black	blue-black
t=3 Min Iodine Drop	blue-black	clear pale yellow	clear pale yellow	blue-black	blue-black specks, small drop of pale yellow