Teacher Notes - Pineapple Proteins

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Aim

In this experiment, students will practice their laboratory skills and apply scientific knowledge in order to evaluate whether they should accept certain claims. It is well known that some fruits such as pineapple will prevent Jell-O or other gelatine products from gelling.

Students will be asked to design an experiment to test this claim. They will also explain their findings using scientific theory.

While the teacher will be checking their design and procedure, students will have the freedom to choose the best way to conduct the experiment. Hence, they will experience the power of scientific research in assessing claims and will use their critical thinking to evaluate their results and make conclusions.

Figure 1: A fresh pineapple

Plan

The reason why pineapple prevents Jell-O from gelling is because of the chemistry of pineapple. It contains a chemical called bromelain which is a mixture of two enzymes from the proteases (protein-digesting enzymes) family. This enzyme denatures if exposed to heat and loses its ability to digest protein. A useful video to explain the action of the enzyme and how to conduct the experiment can be viewed on the following links https://www.youtube.com/watch?v=7t7v8w7EqTM https://www.youtube.com/watch?v=FvCk4QRFj2A

The teacher may like to share these links with students, or ask them to research the effect of adding pineapple to Jell-O before starting the experiment, for a more prescribed experience. This will help

students build an idea of what to expect and hence what to write in their hypothesis. This will also assist them in designing their experiment.

Discuss with students the risks involved in the experiment. Ask students to write a list of each source of risk that they can identify. There is risk involved with using hot water, therefore students will have to be cautious not to spill the water on themselves or their classmates. As they will be using glassware, it is important that they report any breakage to the teacher once it happens. It is preferred that the teacher opens the cans and cut the pineapple for them. Some students can have allergies to the canned food, the pineapple or the Jell-O specially if it has food colouring, so they will have to wear goggles and gloves.

The best way to do this is to discuss with students how they will design the experiment and pose questions in order to encourage their critical thinking.

For example, the teacher can ask students how many tests they are going to do to prove the statement is correct or incorrect. If their answer is that they will do one test and add fresh pineapple to Jell-O, then the teacher can discuss with them the possibility that the Jell-O might not have gelled because they have added too much water or perhaps something else may have gone wrong. This will lead students to think about doing a control test where nothing is added to the Jell-O. Again, the teacher can ask them how to prove if there is a difference between using canned pineapple and fresh pineapple. This will help the students think of doing a third test using canned pineapple.

Conduct

This is an open inquiry experiment. Students will practice how to design an experiment to find a solution to an imposed question. The experiment is exciting because they will test a claim about something that they use in everyday life, Jell-O. The experiment is meant to be an open inquiry, yet with the younger age group, as they will likely need indirect guidance on what they should be doing.

In this experiment, students will likely be doing something similar to figure 2. They will have three beakers and in each beaker, they will add the same amount of hot water and the same amount of gelatine powder (according to the recipe written on the Jell-O pack). They will add fresh pineapple to one beaker and canned pineapple to another beaker and the third beaker will be left as a control. They will then place the three beakers in an ice bath and leave for 10 minutes to settle.

Students should make as many observations as possible and write them down.

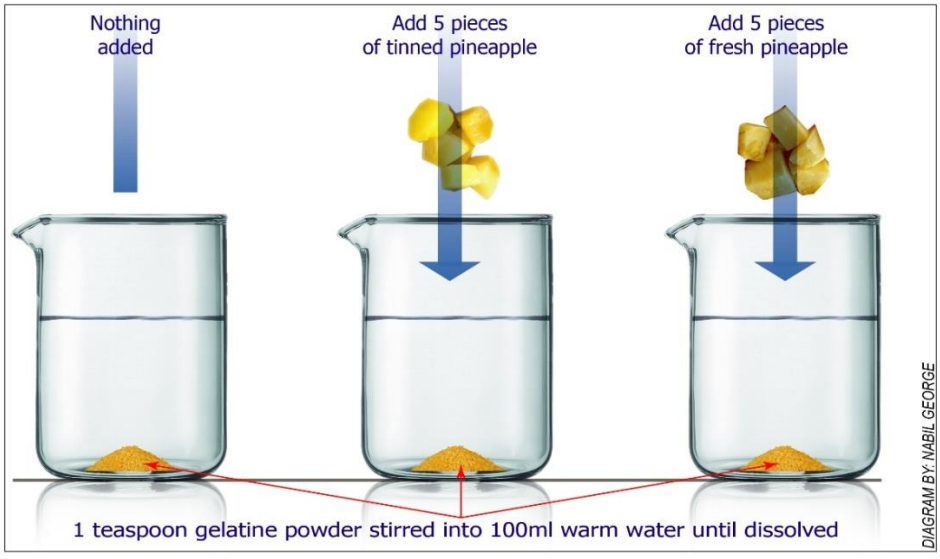

Figure 2: The setup for the experiment

The experiment could be extended to test for other variables as follows:

1. ***Test for the effect of heat on pineapple***
    - Bring fresh pineapple to the boil.
    - Repeat the experiment with the three beakers, but instead of using canned pineapple, use the boiled pineapple.
2. ***Test for the effect of freezing pineapple***
    - Place the fresh cut pineapple in the freezer for an hour before the experiment.
    - Repeat the above experiment replacing the canned pineapple with frozen pineapple.
3. ***Test for the effect of using other fruits known to contain proteases***
    - There are many fruits that contain proteases such as figs, fresh ginger root, papaya, mango, guava, pawpaw and kiwi fruit. Although the enzymes in these fruits are not exactly the same like the bromelain found in pineapple, yet they still belong to the proteases family which digest proteins.
    - Repeat the above experiment, but instead of using canned pineapple use any of the above fruits.
    - Students may also like to repeat the whole experiment using fresh and boiled fruits.
4. ***Test for the effect of using other fruits that are not listed to contain proteases***
    - Repeat the above experiment using any other fruit such as apple or strawberry instead of pineapple.
    - Students will determine whether their chosen fruit contains proteases or not.
5. ***Study the effect of adding meat tenderizer with the Jell-O***
    - Repeat the experiment using two beakers, one with just the Jell-O in water and the other with adding a teaspoon of meat tenderizer.
6. ***Effect of adding meat tenderizer or fresh pineapple or any other fruit on Jell-O that has already set***
    - Instead of adding the meat tenderizer or fruits containing proteases in the Jell-O before it sets, wait until after this to then add the substance to be tested.
7. ***Effect of any of the above experiments on any other gels such as gel desserts and treats or agar***
    - Use any other gel to confirm that the action of the above materials act on any gel.
    - Repeat any of the above experiments using any other type of gel.
8. ***Finding other processes or chemicals that can prevent gel from setting***
    - Other processes such as heating should prevent gel from setting. Students can heat the Jell-O either after setting or during setting and observe what happens.
    - In industry and in daily life situations, gelling can be undesirable, such as in the case of diesel gelling which clogs the filters of cars. Students can add a diesel fuel anti-gel instead of the proteases and study its effect on gelling.
9. ***Compare the time taken by different fruits to destabilize the gelling***
    - To study the ability of different fruits to stop gelling, students can add different fruits to an already set gel and measure the time it takes to destabilize the gel. This would give an indication on the relative strength and amounts of proteases found in different fruits. However, this experiment may require a long time.
    - Another way to conduct the experiment is to use agar in a petri dish and make holes in the agar using a thin spatula. Measure the diameter of the holes and in each hole place equal amounts of very thinly sliced fruits. Leave it for an equal amount of time

(can be left in the fridge for up to 2 days) and then measure the new diameter of the holes.

Encourage students to take photos of their experiment, they can also make a video clip of their experiment.

Hints: In order to have fair results, students should use the same number of fruit pieces and of approximately equal sizes.

Analyse

Depending on the experiment the students design, they will analyse their results accordingly. In all cases, they should write their observations and take photos to include in their final report.

A good way to analyse their results is to tabulate them, this makes it easier to compare the results. For example, if students are to compare the results for the diameter in point (9) in the conduct session, they can tabulate it as follows:

Diameter for fresh pineapple		Diameter for fresh fig		Diameter for fresh papaya	
Before	After	Before	After	Before	After

This is just an example but it depends on which fruits and which experiment they are analysing

Students may also like to plot the results of the diameter before and after on one graph to make the results more visual. A column graph would be suitable for such results.

If more than one group are doing the same experiment, it might be useful to compare their results.

Problem solving and discussion

The results should show that fresh pineapple as well as fresh fruits that are known to contain proteases will prevent the gel from setting. The same applies to the meat tenderizer, which should also destabilize the set gel. This is due to the presence of enzymes that belong to the family of proteases which digests the proteins found in the gel and prevents the formation of links between chains of the gel. These links are the ones responsible for gelling. Although all fruits that prevent gelling contain enzymes classified as proteases, each fruit contain different types of protease enzymes. For example, in pineapple the enzyme found is called bromelain, while in papaya it is called papain and in kiwi it is called actindin.

These enzymes are very sensitive to temperature, so if heated to a certain temperature, they will denature and will no longer be able to digest the proteins. This temperature was found to be about 70^0C[(3)] for the bromelain enzyme. This is why adding the boiled pineapple to the gel should not affect the setting of the gel. Similarly, the canned pineapple will not affect the setting of the gel because it was previously heated, thereby deactivating the enzyme.

Freezing on the other hand, will slow down the action of the enzyme until it retains room temperature, thereby not deactivating it[(4)].

Heating the gel[(5)] would also prevent the setting of the protein as it gets denatured. All gel products, including agar, should behave similarly as they belong to the same collagen protein family.

Conclusion

Students can claim full ownership of the experiment as it is an open inquiry and the experiment is their own design. They can decide which way they want to represent it.

If different groups chose to do different experiments, it would be a good idea to present it as a team project where each team is researching a different aspect of the problem and the results support one outcome.

Referneces

1. Figure 1 https://www.flickr.com/photos/elvissa/137949154/in/photolist-dc2tG-vDjB-8AAEjC-r81pK-72Ppuc-9zviYy-tcPnG-4uocu-4E16JH-9wqEiB-6soLmv-62kezY-4LYaQY-6NAdQQ-8zPx2Z-52WLmF-4UtSpC-ncf9v-6Ux9gp-jCmdVL-jjDmxk-BUFb-QxWr5-CKGGRQ-6G7EKG-cTzKM-eFXbvY-h8Pz1b-Edki-Uw3EeG-qdmNR-8bqvJc-4GcNAX-2hUpw-f8btcj-zLEop7-9k6ULF-6fbFwH-7TKtX8-axZGps-dyN5Dq-eYR8d-7Y26tM-7Nyc9G-StWa8c-39szdy-hPMDz-7iUtSf-6tRaYb-mLVMac/ Author Tricia Licence https://creativecommons.org/licenses/by-sa/2.0/
2. Figure 2 ASELL SCHOOLS, Author Nabil George
3. Truc, T. T., Thanh, L. K. and Muoi, N. V., Effect of pH and temperature on activity of bromelain in pineapple fruit. file:///C:/Users/Doaa/Downloads/mekongfood_1_proceedings_25.pdf
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