

The “Pineapple Problem”

Formative Investigation: Pineapple and Enzymes

Enzymes are responsible for many processes in the body of humans and plants alike. Many enzymes in tropical fruits, like pineapple, break down proteins. For example, meat tenderizers have the enzyme **papain** from papaya fruit that breaks down some of the fiber that makes meat tough. Pineapple has a digestive enzyme called **bromelain** which we will investigate today.



Jello is actually made of a protein known as **gelatin**. Gelatin is made from animal collagen, a protein that makes up connective tissue, such as tendons, bones, and ligaments. When the protein is heated in water, it will form a solution that solidifies into an odd, squishy, jiggly substance, Jello! Given our new knowledge of enzymes, pineapple, and gelatin, we will attempt to answer the following question:

Which type of pineapple (canned or fresh) should be used in a Jello?

Clean-Up Today

As a team, retrieve your cups. The liquid gelatin in the cups can be poured into the sink with water. Remove and throw away pineapple pieces in the trash. The solidified jello may be more difficult to remove. Consider how you can make it “less solid” for easy cleanup.

Analysis

1. Compare the Jello that contained canned pineapple to the Jello that contained fresh pineapple.

The canned pineapple Jello solidified, but the fresh pineapple didn't solidify and remained liquid.

2. **Explain** why canned pineapple could be used to make a delicious/disgusting Jello dish, but fresh pineapple cannot. (Hint: canning often involves heating the fruit and then vacuum sealing it).

To Add Fruit:

REFRIGERATE dissolved gelatin 1-1/2 hours or until thickened. Stir in 1-1/2 to 3 cups chopped fruit (well drained, if using canned). Refrigerate 4 hours or until firm.

NOTE: Do not use fresh or frozen pineapple, kiwi, gingerroot, papaya, figs or quava. Gelatin will not set.

This is because the fresh pineapple contains an enzyme called bromelain that breaks the protein chains in Gelatin. When the protein chains are broken, the solid shape that Jello normally has is broken, and therefore it remains a liquid. In canned pineapple, the pineapple is

heated, which denaturizes the bromelain enzyme in the pineapple and therefore the Gelatin protein chains in the Jello can't be broken.

3. What do you think would happen if you added frozen fresh pineapple to gelatin? Explain your reasoning.

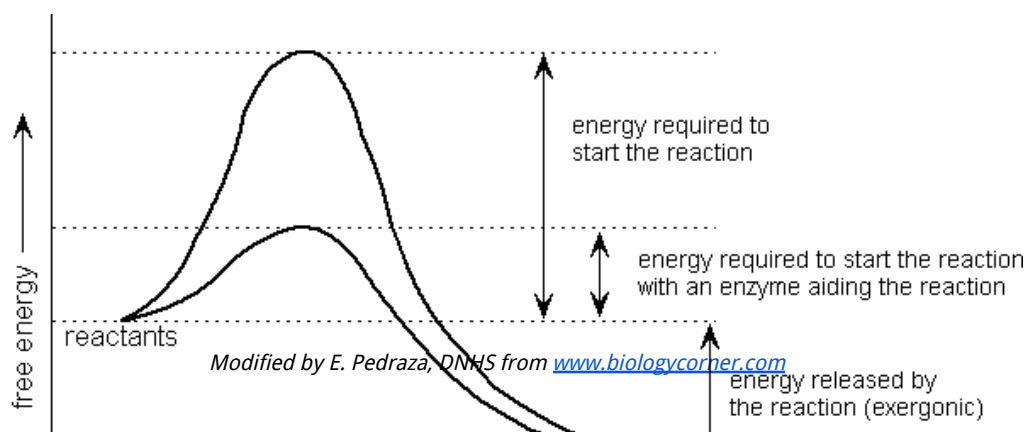
The Jello will still be liquid as bromelain will still be present, as freezing does not denature proteins.

CER:

5. What accounts for the different results we observed in this lab?

Claim	The different results occurred because of the bromelain that was present in the fresh pineapple and the absence of bromelain in the canned pineapple.
Evidence	The Jello with the fresh pineapple remained liquid and didn't set, while the Jello with the canned pineapple did set and became solid. Also, the process of canning the pineapple involved heating, which is a known way of denaturing enzymes.
Reasoning	Bromelain is an enzyme that breaks peptide bonds in proteins. Fresh pineapple contains an enzyme called bromelain that breaks down the peptide bonds present in gelatin in Jello. When the peptide bonds are broken in the gelatin, the solid shape cannot remain. In canned pineapple, bromelain is active and therefore doesn't break the bonds in the gelatin present in the Jello. This is because, before canning, the pineapple is heated, and this denatures all the enzymes in the pineapple, including bromelain.

7. Consider the following graph.



When an enzyme is added to a reaction, it will require ____ energy to start the reaction.

- a. more
- b. less
- c. the same amount

When an enzyme is added to the reaction, ____ energy is released during the reaction.

- a. more
- b. less
- c. the same amount

Adding an enzyme will ____ the amount of products.

- a. increase
- b. decrease
- c. not change

8. Which of the following statements is correct?

- a. Enzymes lower the amount of energy necessary to start a chemical reaction.
- b. Enzymes raise the amount of energy necessary to start a chemical reaction.
- c. Enzymes keep the amount of energy necessary to start a chemical reaction the same.

9. If you removed the fresh pineapple from the gelatin and added it to fresh gelatin, which would you expect to happen?

- a. the gelatin would solidify in an ice water bath
- b. the gelatin would not solidify in an ice water bath

10. Explain your reasoning for #9.

I would still expect it not to solidify because the fresh pineapple still contains bromelain which would still break the peptide bonds of the gelatin proteins. The ice water bath doesn't denature bromelain (or any other enzymes), so this won't change anything.