

PW 04: ALCOHOLIC FERMENTATION

1. Introduction

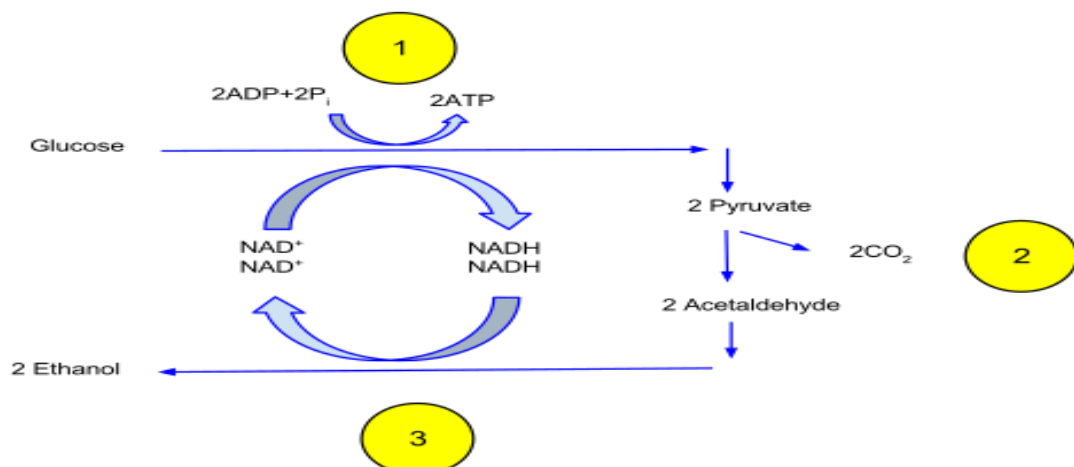
Alcoholic fermentation is a fundamental metabolic process by which certain microorganisms convert sugars into energy in the absence of oxygen. It is primarily carried out by yeasts, especially *Saccharomyces cerevisiae*, and some types of bacteria. This process plays a key role in both natural ecosystems and various industrial applications, including the production of bread, beer, and wine. Alcoholic fermentation is considered an anaerobic process because it does not require oxygen. Although it produces much less energy compared to aerobic respiration, it allows cells to maintain energy production under oxygen-limited conditions. This metabolic pathway is especially important for yeast survival and has been exploited by humans for thousands of years in food and beverage production.

2. Principal

(1) A glucose molecule is degraded through glycolysis into two molecules of pyruvate. The energy released during this exothermic process is used to phosphorylate two ADP molecules, producing two ATP molecules, and to reduce two NAD^+ molecules to NADH.

(2) Each of the two pyruvate molecules is then converted into acetaldehyde, releasing one molecule of carbon dioxide per pyruvate (two CO_2 molecules in total).

(3) The two NADH molecules subsequently reduce the two acetaldehyde molecules to form two ethanol molecules, while NADH is oxidized back to NAD^+ .



3. Practical part

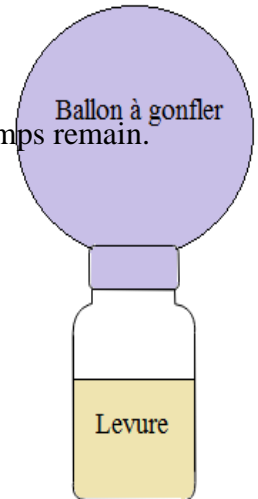
3.1. Material

Baker's yeast (*Saccharomyces cerevisiae*), sucrose, 200 mL flasks, balance, hot plate, balloon, vitamin tablet, small rubber bands, watch glass, spatula, tape, cotton, tongs, denatured alcohol, matches, small beaker, scissors.

3.2. Procedure

3.2.1. First part:

- In a 200 mL beaker, measure 100 mL of warm water.
- Weigh 5 g of baker's yeast and add it to the water. Mix carefully so that no lumps remain.
- Add 5 g of powdered sucrose. Stir until completely dissolved.
- Mix well and pour the solution into the bottle.
- Attach the balloon to the neck of the flask.
- Secure it firmly with a rubber band and seal with tape.
- Place the flask in a water bath set at 30°C.
- Wait 30–60 minutes and observe carefully.
- During this time, gently shake the flask occasionally.



3.2.2. Second part

- After 30–60 minutes, soak a small piece of cotton with denatured alcohol (do not oversaturate; just moisten it slightly) and set it aside.
- Twist the balloon at the top of the flask and hold it tightly closed to retain the gas.
- Cut the balloon at the neck while keeping it tightly closed.
- Hold the soaked cotton with tongs.
- Immediately light the cotton with a match and place it into the beaker.
- Slowly release the gas into the bottom of the empty beaker.
- Observe carefully.

4. Study questions

1. What is the main sugar substrate used in alcoholic fermentation?
2. What are the end products of alcoholic fermentation?
3. How does alcoholic fermentation differ from aerobic respiration in terms of energy yield?
4. What is the chemical equation for alcoholic fermentation?
5. How is pyruvate converted to ethanol during alcoholic fermentation?
6. Give examples of foods or beverages produced using alcoholic fermentation.