Cambridge Assessment International Education

Investigating the effect of changing temperature on respiration in yeast

Transcript

Aerobic respiration produces ATP, adenosine triphosphate, the universal energy currency of life. In aerobic respiration, glucose reacts with oxygen to produce carbon dioxide and water. The carbon dioxide produced during respiration is important in many industrial processes, including bread making.

Yeast is the single-celled microscopic fungus that is used in bread making. During this process, carbon dioxide is released by the yeast as it respires. This gas causes the bread to rise. Food biotechnologists investigate the conditions that affect the rate of respiration in yeast. This is to identify the optimum values of factors such as temperature and oxygen concentration that are used in industrial baking ovens.

However, some indicators of respiration rate, such as the volume of carbon dioxide produced, can be difficult to measure. Instead, in the laboratory, the time taken for a sample of yeast to decolourise a special dye, called methylene blue, can be measured. This investigation considers the effect of varying temperature on the rate of respiration in yeast cells.

Yeast-glucose suspension is measured into six boiling tubes. The boiling tubes are labelled with a series of different temperatures, and a boiling tube marked ‘control.’ This is the range of temperatures over which yeast is most likely to be most active. Methylene blue is added to a different set of six boiling tubes. These are labelled with the same set of temperatures. Each pair of boiling tubes are placed in their respective water baths for at least 10 minutes to ensure the contents reach the desired temperature.

The pair of boiling tubes labelled ‘control’ is placed into a beaker of freshly-boiled water for at least 10 minutes. This high temperature will kill the yeast cells and denature their enzymes.

One pair of boiling tubes are removed from their water bath. The methylene blue is poured into the boiling tube of yeast-glucose suspension. Methylene blue will decolorise in the presence of respiring cells. The rate of aerobic respiration of the yeast can be estimated from the time taken for the mixture to decolour. The faster it changes colour, the greater the rate of respiration of the yeast cells.

The mixture is inverted to mix it thoroughly. The timer is immediately started, and the boiling tube is placed back into the water bath. The sample is not touched or agitated during the incubation period, because any movement will result in the reappearance of the blue colour. The time at which the blue mixture decolorises is recorded. Comparing the colour of the reaction mixture with a tube containing fresh yeast suspension may make the end point of the reaction easier to deduce.

The contents of each pair of boiling tubes are mixed in this way, and the time to decolourisation is recorded one pair at a time. The whole experiment is repeated two more times for each temperature and for the control, in order to calculate a mean rate of reaction.

The yeast suspension that had been placed into the boiling water does not decolourise the methylene blue solution. This control experiment proves that it is the presence and activity of the yeast in the other tubes that caused the decolourisation of the methylene blue.

The data can be used to draw a suitable graph, and can be explained by what we know about the effect of temperature on the rate of enzyme-catalysed reactions. Investigations of this type are used to refine the conditions that employ yeast cultures. This enables bioengineers to improve the efficiency and productivity of many industrial processes.