Mapana Journal of Sciences
2020, Vol. 19, No. 4, 31-35
ISSN 0975-3303|https://doi.org/10.12723/mjs.55.3

Factors like Dilution and Mixing Influence Enzymatic Reactions

Mahin Basha Syed* and Erumalla Venkatanagaraju†

Abstract

Many factors influence Enzyme-catalyzed reactions. The enzyme reacts with a substrate and converts it into products. Enzymes are influenced by temperature, pH, enzyme concentration, and substrate concentration. This paper evaluates the hypothesis of factors that may influence enzyme activity. Two more factors that affect enzyme activity are dilution and mixing. In enzyme-substrate reactions, a small amount of dilution and mixing does not affect the enzyme activity. Dilution and mixing enhance the enzymatic reaction up to a certain limit instead of slowing down the reaction. Increase in dilution results in less interaction of enzyme-substrate, which causes a decrease in the rate of reactions. To the best of the authors' knowledge, this is the first report to show that factors like mixing and dilution also affect enzyme and substrate reactions.

Keywords: Enzyme-catalyzed Reactions, Enzyme Substrate

1. Introduction

Enzymes enhance the rate of a reaction under the influence of certain factors, namely, temperature, pH, substrate concentration, enzyme concentration, and inhibitors [1, 4]. This is the rationale for

* Biochemistry Lab, P.M. Sayeed Calicut University Center, Androth Island, UT of Lakshadweep, India; sdmahinbasha@gmail.com; (**Corresponding Author*)
† Department of Life Sciences, Christ (Deemed to be University), Bangalore, India; erumalla.venkatanagaraju@christuniversity.in

acquiring the knowledge needed to analyze the parameters that influence or determine an enzyme-catalyzed reaction rate. The reaction rate is dependent on the concentrations of the components involved in the reaction [2]. Activity is measured as the initial rate of substrate utilization when no products are present. There are many compounds that may act as inhibitors that repress the activity, so they should not be present. In many cases, the activity is measured in the opposite direction to that of the enzyme's natural function. Nevertheless, with a complete study of the parameters that affect enzyme activity, it should be possible to extrapolate to the activity expected to be occurring in vivo [3]. This paper evaluates other factors that also influence the activity of the enzyme, that is, dilution and mixing.

2. The hypothesis of dilution with hot water in enzyme-substrate reactions

Water is not an enzyme inhibitor and does not change the pH or temperature, and the rate of reaction remains the same. If a small quantity of hot water is added to the enzymatic reactions, the rate of reaction increases gradually. Hot water gives the activation energy to precede the reaction faster and leads to quick formation of enzyme-substrate complexes, thereby quickly forming enzyme and products. The optimal amount of hot water results in enhance enzyme activity (Fig.2). Increasing the temperature of hot water leads to loss of activity by altering an active site by denaturation of the enzyme. In contrast, an increase in the amount of hot water above the optimal level achieves a steady state, as shown in Fig.1. Further increase leads to much dilution and increases the distance between enzyme and substrate, although the enzyme-substrate may not have proper interaction. In humans, after some time, the hot water attains the body temperature, and then the reactions proceed as usual without affecting the rate of reaction. The water may be absorbed inside the body over a period. A small amount of dilution provides a large surface area for the enzyme-substrate reactions to react in a better way.

$$E + S + ▲ \rightarrow ES▲ \rightarrow E▲ + P \qquad \text{Eq 1}$$

▲= Indicates hot water

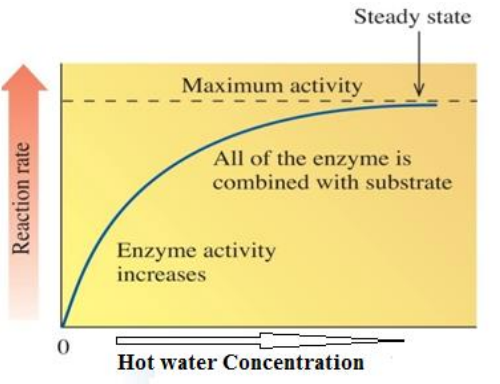

Figure 1: Effect of enzyme activity on diluting with hot water

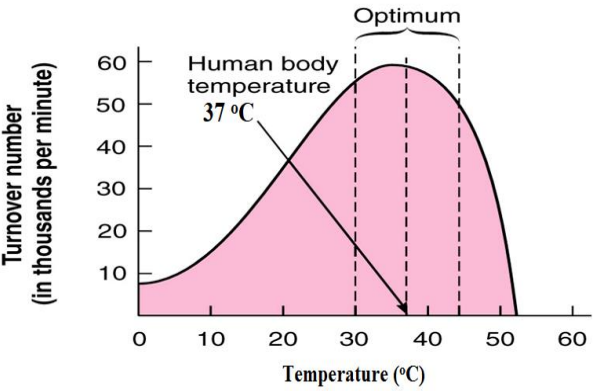

Figure 2: Optimum temperature for enzymatic reactions

3. Dilution with cold water to enzyme-substrate reactions

At low temperatures, enzyme activity is low due to a lack of energy for the reaction to occur. The digestion process delays in humans when diluted with cold water. It requires lots of activation energy

for the enzyme to interact with the substrate in a proper orientation. Food is stored in a refrigerator or freezer to slow spoilage brought on by enzymes.

$$E + S + \Delta \rightarrow \text{No reaction or slow reaction} \qquad \text{Eq 2}$$

$$\Delta = \text{Coldwater}$$

4. Diluting substrate concentration with water

Diluting the substrate concentration with water provides a large surface area for the enzyme to react in a better way. In this, all the substrates are converted into products because enzymes get exposure to reacts with all the substrates. In humans, liquid food is quickly digested than hard food because the liquid provides a large surface area for the enzyme to interact with the substrate. However, too much dilution causes less enzyme-substrate interaction; hence, dilution should be optimum.

5. A mixing factor which affects enzyme-substrate reactions

Mixing affects enzymes and substrate to distribute uniformly in the reactor. Mixing causes the enzyme to be in proximity to the substrate. So, enzymes require less energy to reach the substrate, but mixing requires energy. In humans, mastication is the process of mixing food with enzymes. This process also requires energy. From mouth till the large intestine, the movement of the food is nothing but mixing at various stages and varying pH at different stages for better enzymatic reactions. Improper mixing results in uncatalyzed food. In such cases, most of the substrate is not exposed to the enzyme, which results in uncatalyzed food.

$$E + S + M \rightarrow ESM \rightarrow E + P \qquad \text{Eq 3}$$

$$\text{Where M = mixing}$$

6. Conclusion

The factors like temperature, pH, enzyme concentration, and substrate concentration were discussed in earlier publications. In this paper, two more factors, such as dilution with water and

mixing, which affect enzyme activity, were discussed. These two factors have a significant influence on enzymatic reactions. These two factors have a positive effect or a negative effect on the enzymatic reaction.

References

[1] Mehler, A. H. (1957). *Introduction to enzymology*. Academic Press
[2] Palmer, T. & Bonner, P. L. (2007). Enzymes (2nd ed.). Woodhead Publishing.
[3] Scopes, R. K. (2002). Encyclopedia of Life Sciences. Macmillan Publishers Ltd, Nature Publishing Group.
[4] Mehler, A. H. (2014). Introduction to Enzymology. Elsevier.