Oxidative Stress, Aging & Disease

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***Abstract*—Oxidative stress is a situation concerning bio-organisms in which a formulation of reactive oxygen species (ROS) is elevated beyond the one that can be neutralized, i.e., leads to age and age-related diseases, such as cancer, cardiovascular diseases, neurodegenerative diseases, etc. A water-soluble vitamin C is another interesting antioxidant the other antioxidant is also overcome by redox reaction as was the case in the redox. The discussed paper addresses how the effect of vitamin C concentration changes the rate of hydrogen peroxide (H_2O_2) degradation in an aqueous environment. Different concentrations of vitamin C (0.01–0.10 mol dm^{-3}) were reacted with hydrogen peroxide, and the remaining peroxide was measured at fixed time intervals using iodometric titration with sodium thiosulfate. The results indicated that the rate of hydrogen peroxide decomposition increased significantly with the concentration of vitamin c hence suggesting that the rate of reaction was high since a high number of effective molecular collisions occurred. The dependence of the antioxidant concentration on the kinetics of the reaction is also highlighted in the experiment, which assists in the realization of the chemical characteristics of antioxidants and their potential use in the elimination of oxidative stress in life systems.**

***Index Terms*—Oxidative stress, Vitamin C, Hydrogen peroxide decomposition, Antioxidants, Reaction kinetics, Redox reaction, Iodometric titration.**

I. INTRODUCTION

The chapter presents the concept of oxidative stress, antioxidant chemistry, and the breakdown of hydrogen peroxide by vitamin C. It determines the research problem, objectives, and scope that guides in the study of the effect of vitamin C concentration on the rate of the reaction.

1.1. Background and Context

Oxidative stress is a chemical process that occurs when the reactive oxygen species (ROS) accumulate in biological systems at a higher rate than the neutralizing process. They are very reactive molecules with the capacity of breaking DNA, proteins, and lipids, among others, that contribute to aging, leading to the occurrence of different types of diseases such as cancer, cardiovascular diseases, and neurodegenerative diseases. Widely spread reactive oxygen species is hydrogen peroxide (H_2O_2), which is generated in the course of metabolism, and can be the result of an external factor. Vitamin C (ascorbic acid) is one of the most important water-soluble antioxidants that can be found in a biological system. The opportunity to be used as a reducing agent in the redox reaction, as well as to neutralize the reactive species such as hydrogen peroxide and free radicals, is also predetermined by its chemical properties (Njus et al., 2020).

The vitamin C chemical scheme is, however, complex. It can also be an antioxidant and a prooxidant in different reaction conditions, concentration, and the presence of a catalyst, depending on the conditions. Vitamin C-oxidation agent interaction is therefore also of importance to examine the functions of biological assessment and the kinetic reaction of the chemical reaction. An example of the reactions during decomposition of hydrogen peroxide is an ideal reaction kinetics and redox chemistry to study (Gomperts et al., 2020). Using the correlation of vitamin C concentration and hydrogen peroxide decay rate, it is possible to carry out the quantitative analysis of the antioxidant activity and train in the basic chemical principles of titration analysis and reaction kinetics.

1.2. Problem Statement

However, although this exact correlation between vitamin C concentration and the rate of hydrogen peroxide decomposition cannot always be well-presented in limited laboratory studies, despite vitamin C's well-known antioxidant properties. It has a vast number of works dedicated to the implications of

biology rather than the chemical kinetics of the process. Additionally, vitamin C can produce other effects in other chemical conditions, which can sometimes exceed the oxidation reaction (Kaźmierczak-Barańska et al., 2020). This bifurcating feature confuses one about the impact of the increasing concentrations of vitamin C on the rate at which the hydrogen peroxide will be dissolved in the aqueous medium. Therefore, a scientific investigation will be required in order to determine the effect of the various concentrations of vitamin C on the rate of hydrogen peroxide degradation.

1.3. Objectives of the Study

- To investigate the connection between different levels of vitamin C and the rate of interaction between the degradation of hydrogen peroxide.
- To determine the remaining concentration of hydrogen peroxide at fixed time intervals using titration analysis.
- To investigate the kinetics of the reaction, and to investigate the tendencies between the concentration of vitamin C and the reaction rate.

1.4. Research Question

How does vitamin C concentration (0.01–0.10 mol dm^{-3}) affect the rate of hydrogen peroxide decomposition, measured through titration of residual peroxide at fixed time intervals?

The study of this research is on the chemical interaction of vitamin C with hydrogen peroxide in the water solutions under the conditions of control in the laboratories. The concentration of vitamin C will be 0.01–0.10 mol dm^{-3}, and hence, the other variables, such as the temperature, the volume of a solution, and the concentration of hydrogen peroxide, will be kept unchanged. It will establish the rate of decomposition indirectly by titration of the remaining hydrogen peroxide after some duration of time.

The study is limited to a laboratory level of analysis, and this experiment is not directly applied to biological systems. Despite the fact that vitamin C plays a significant role in the antioxidant defense of the cells, the experiment only imitates the chemistry of the process in solution. This experiment does not modulate the environmental parameters that can influence the reactivity of ascorbic acid, such as pH and ionic strength, among others, which are kept in check (Chang et al., 2021). Besides, inaccuracies in measuring titration and timing may produce small imprecision in the results obtained.

This study contributes to the development of the science of antioxidant chemistry by exploring the interaction between vitamin C and hydrogen peroxide through quantitative reaction analysis using a chemical method. The investigation provides vital knowledge on the effect of vitamin C on the reactive oxygen species through the linking of the antioxidant action and the reaction rate that can be quantified. The research has ensured that ascorbic acid also takes part in the electron-transfer reactions to allow the ascorbic acid to neutralize the oxidizing molecules and radicals (Njus et al., 2020). The reactions of ascorbates are critical in the biological systems as well as the environmental and chemical processes of the reactive oxygen species due to the kinetic character of their actions (Xiao et al., 2022). Educational discrimination of this enquiry includes some IB DP Chemistry inquiries, like redox reactions, reaction rate, and quantitative examination of titration.

II. LITERATURE REVIEW

The literature review below provides a discussion of the previous studies on the issue of chemistry, antioxidant property, and reaction kinetics of vitamin C. The two studies enrich the comprehension of the reaction of ascorbic acid to oxidizing agents such as hydrogen peroxide and can be utilized to provide background knowledge on the present investigation.

Chemical Stability and Bioactivity of Ascorbic Acid: Yin et al. (2022) have reviewed the chemical stability of ascorbic acid in various commercial and different food varieties. As noted by the authors, vitamin C is one of the vitamins exhibiting high tendencies to become oxidized in the presence of air, light, or in the presence of oxidizing substances. This can be defined as its antioxidant property, which can be formulated as the ability of it to lose electrons and convert reactive oxygen molecules into more stable molecules. Loss of an electron on the ascorbic acid is compensated by the ascorbate radical, which becomes rather stable and reacts with the other ascorbate molecules to yield dehydroascorbic acid. The experiment brought out that the three environmental factors that can affect the stability of vitamin C are pH, temperature, and concentration.

Interaction Between Ascorbic Acid and Hydroperoxyl Radicals: Carrillo Diaz et al. (2023) conducted ab initio theoretical studies that investigated the reaction between L-ascorbic acid and the hydroperoxyl radical (HO_2•), similar to the hydrogen peroxide in the oxidative systems. To examine the reaction of the ascorbic acid with hydroperoxyl radicals, researchers employed the techniques of the computational chemistry to determine the energy paths and the reaction mechanism of the reaction. The results proposed that ascorbic acid is a strong electron donor that suppresses the reactive oxygen species by hydrogen atom-transfer reaction as well as electron-transfer reaction. Vitamin C neutralises the radicals in such reactions as it proceeds to reduce them to other, less reactive radicals. The paper had determined that ascorbic acid had an antioxidant activity that was explained by its capability to lose electrons and form stable oxidation products.

Kinetic Spectroscopic Analysis of Oxidation Reactions: Dinc et al. (2023) analyzed the technique of observing a reaction of oxidation by using UV spectroscopic methods. Their experiment focused on diamoxidation of quercetin using oxidizing agents, and established that quantitative analysis through kinetic data could be made on antioxidant reactions. Even though quercetin rather than vitamin C was the focus of their investigation, the study methodology is the most effective in relation to antioxidant reaction-related studies. The authors also used time-dependent measurements to measure reaction rates, and the mathematical analysis was used to interpret the kinetic measurements. The specified method focuses on the importance of determining the concentration of oxidants over time and computing the kinetics of the reaction.

Antioxidant Potential of Ascorbic Acid in Chemical Systems: Thbayh et al. (2022) studied the antioxidant imparting capacity of ascorbic acid over antioxidants like cysteine and 2-aminodithiobacate in the use of ascorbic acid in the antioxidant industry as an additive in polymer preparations. The study found that ascorbic acid is a natural antioxidant that can inhibit oxidative degradation by reacting with the reactive oxygen species. The researchers explained that in effecting the defense of the materials, vitamin C transfers the electrons to the oxidizing molecules, preventing the subsequent oxidation actions from occurring. This is the fundamental electron-giving reaction of redox chemistry and is directly proportional to the reaction of vitamin C with hydrogen peroxide. The other important point noted was that the effect of ascorbic acid as an antioxidant is highly dependent on the concentration.

Significance of Antioxidants and Methods to Evaluate Their Potency: Girish et al. (2023) discussed the role of antioxidants and the forms of analytical techniques that could be used to analyze their effectiveness. The authors outlined that antioxidants play an important role in the defence response of biological and chemical systems against oxidative degradation because of the existence of reactive oxygen species. The review has described some of the experimental procedures used to quantify the antioxidant activity, which are: titration procedures, spectrophotometry, and kinetic studies. The techniques allow the scientists to measure the speed of antioxidants' movement along with the oxidizing species and define their ability to oppose reactive species. The other significant parameter that the authors noted during the study of the antioxidant behavior is reaction kinetics.

Mathematical Modelling of the Vitamin C Clock Reaction: Alsaleh et al. (2025) had developed a mathematical representation of the vitamin C clock reaction, which is an enormously renowned chemical demonstration experiment whereby a vitamin C sample is oxidized in the presence of iodine and hydrogen peroxide. The kinetics of the reaction were observed, and then the two kinetic regimes were established with regard to the reactant concentration. Their mathematical representation depicted that the velocity of reaction of vitamin C must strongly rely on the concentration of vitamin C. The rate gets slower in case of a large concentration of vitamin C because vitamin C will always reduce the concentration of iodine to iodide. Once one adds vitamin C, the rate of the reaction increases exponentially, and a change in color is noticed. Although the response of the vitamin C clock to the direct hydrogen peroxide decomposition is markedly dissimilar, the paper reveals the value of the concentration in the responsive control of the kinetics of reaction.

Hydrogen Peroxide Formation and Redox Reactions in Chemical Systems: Fernandes et al. (2024) explored the electrochemical mechanism of the hydrogen peroxide synthesis by the use of cerium oxide nanostructures through the oxygen reduction reaction. They were concerned about the formation and the application of hydrogen peroxide in redox reactions. The authors emphasized the presence of hydrogen peroxide in most chemical and biological oxidation, which was very critical. It possesses a good oxidizing property, and as such, it is able to react with other substances like antioxidants. The process of its formation and breaking down is therefore the central topic of more knowledge on oxidative reactions. The other observation that occurred during the study is that hydrogen peroxide also participates in the electron-transfer process with antioxidants and leads to the destruction to yield water and oxygen. This renders the research of the hydrogen peroxide reaction in controlled experiments in the investigation of the phenomena of antioxidants into consideration.

Research Gap

The antioxidant activity of vitamin C, its chemical stability, and reaction with reactive oxygen species have been widely studied in the past. Modelling and analytical methods, as used in theoretical reaction mechanisms that are used to study oxidation reactions, have also been tested in research. Despite the experimental studies regarding the level of interest in connection with the influence of the variation of vitamin C concentration on the rate of hydrogen peroxide decomposition, the studies involving the focus of research on the vitamin C concentrations connected with the rate of destroying hydrogen peroxide are scarcely numerous (Fernandes et al., 2024). As a result, the proposed study has a gap in the research on experimental investigation into the correlation existing between steerage concentration of vitamin C and breakdown speed of hydrogen peroxide because of the laboratory-controlled test.

III. MATERIALS AND METHODS

3.1. Chemicals and Apparatus

The experiment involved certain chemicals and laboratory equipment in an endeavor to draw a conclusion on the effect of the concentration of vitamin C on the degradation of hydrogen peroxide. The reactant was a hydrogen peroxide solution (0.5 mol dm^{-3}), the decomposition of which was monitored. The effect of concentration on the rate of reaction was investigated using 0.01, 0.03, 0.05, 0.07, and 0.10 mol dm^{-3} solutions of Ascorbic acid (vitamin C) (Özkan et al., 2024). During the iodometric analysis, potassium iodide solution (10 percent) and sulfuric acid (1 mol dm^{-3}) were added to transform the remaining hydrogen peroxide into iodine. The liberated iodine was titrated using sodium thiosulfate solution (0.01 mol dm^{-3}), and the starch indicator was used to indicate the endpoint of the titration process to ascertain the disappearance of iodine. The solution was made and diluted with distilled water.

To work with the solution, the equipment was provided with a 50 mL burette, a 25 mL pipette, 250 mL conical flasks, and 100 mL volumetric flasks. Other areas comprised measuring cylinders, a stopwatch to measure time, an analytical weight balance to weigh ascorbic acid, a magnetic stirrer to mix the solution, a thermometer, and a water bath that kept the temperature steady at 25 °C.

3.2. Preparation of Vitamin C Solutions

A known mass of solid vitamin C was weighed in an analytical balance, and a stock solution of vitamin C, ascorbic acid, was made. The solid flux was kept in a 100 mL volumetric flask, and it was dissolved in distilled water. The flask was then filled up to the mark to ensure that the solution mixed well (Gazdik et al., 2025).

All solutions were put in another volumetric flask and labeled transparently depending on their concentration. Solutions were made quite early after preparation in order to minimize the chances of ascorbic acid oxidation until the experiment commenced.

3.3. Experimental Procedure

Using a pipette, 25.0 mL of a hydrogen peroxide solution (0.5 mol dm^{-3}) was transferred into a 250 mL conical flask. The flask was put in a water bath at 25 °C to keep the temperature of the reaction constant.

The vitamin C solution of the necessary concentration (10.0 mL) was added to the hydrogen peroxide to initiate the reaction. A magnetic mixer was turned on, and the mixture was stirred with the assistance of a timepiece (Bisrat et al., 2022).

The reaction mixture was sampled (0, 2, 4, 6, 8, and 10) at constant time intervals without a fixed time interval. Clean conical flasks were to be used to analyse the samples.

To find out the remaining hydrogen peroxide, 10 ml and 5 ml solutions of potassium iodide and sulfuric acid, respectively, were added to the sample. With an acidic solution, hydrogen peroxide oxidized the iodide ions to iodine:

$H_2O_2 + 2I^- + 2H^+ \rightarrow I_2 + 2H_2O$

A burette of 0.01 mol dm^{-3} sodium thiosulfate was used to titrate the liberated iodine. Three or four drops of starch indicator were added in case the solution had changed to a pale yellow. Titration was done till the blue color disappeared.

3.4. Reliability and Repetition of Measurements

The experiment was longitudinally repeated three times with measurements in each instance, to enhance the accuracy of the findings. The concentration of sodium thiosulfate applied in the titration was also measured at the sampling time in both trials. The mean volume of titration was calculated and analyzed using it. Cautions were also taken concerning the state of the reaction. The mixture was stored in a water bath at 25 o C to maintain the same temperature throughout the experiment (Shehu et al., 2025). The reactions were tracked at regular intervals of 0, 2, 4, 6, 8, and 10min that resulted in it being possible to track the reaction regularly. Repeating the process on both of the concentrations of vitamin C minimized the error of measurement that is random and enhanced the overall accuracy of the measurements.

IV. RESULTS

4.1. Overview of Experimental Results

The remaining hydrogen peroxide in the reaction product was determined through the iodometric titration. During the process, hydrogen peroxide is used to oxidize iodide ions to iodine and is influenced by acidic conditions. The Freon iodine is then titrated with sodium thiosulfate. Reaction with sodium thiosulfate during the titration process is determined by the volume of the hydrogen peroxide that is left in the sample (Nuffield, 2025).

This was a slow process, and hydrogen peroxide was removed. The result of this was a lower yield of the iodine formed on analysis, and a lesser quantity of sodium thiosulfate was necessary to attain the endpoint of titration. The recorded data of the experiment are shown in three tables with the concentration of vitamin C of 0.01, 0.05, and 0.10 mol dm^{-3}. The correlation of the reaction time, the calculated residual hydrogen peroxide concentration, and the titration volume at all the tables.

4.2. Residual Hydrogen Peroxide at 0.01 mol dm^{-3} Vitamin C

Table 1: Residual Hydrogen Peroxide Measured by Sodium Thiosulfate Titration (0.01 mol dm^{-3} Vitamin C)

Time (min)	Mean $Na_2S_2O_3$ Volume (mL)	Residual H_2O_2 (mol dm^{-3})
0	23.50	0.235
2	22.10	0.221
4	20.80	0.208
6	19.60	0.196
8	18.70	0.187
10	17.90	0.179

The volumes of sodium thiosulfate titration measured and the values of remaining peroxidase hydrogen at various reaction periods in the presence of 0.01 mol dm in the case of the vitamin C concentration. The initial stage of the reaction (0 minutes) took 23.50 mL of sodium thiosulfate, which was equivalent to 0.235 mol dm^{-3} of hydrogen peroxide. With time, the reaction decreased in the volume of the titration.

Upon 2 minutes, the volume of sodium thiosulfate had reduced to 22.10 mL, which is 0.221 mol dm^{-3} of hydrogen peroxide. The titration volume was 20.80 mL at the time when the titration reached 4 minutes, which means that 0.208 mol was used up, hence 0.208 dm -1. Additional reductions were seen at 6 minutes (19.60 mL) and 8 minutes (18.70 mL), which were equal to 0.196 mol dm dmink 3, and 0.187 mol dm dmink 3, respectively.

At 10 minutes, the volumetric rate had dropped to 17.90 mL, meaning that there remained 0.179 mol dm^{-3} of hydrogen peroxide. These findings demonstrate that the concentration of hydrogen peroxide decreased with time, which means that the hydrogen peroxide was constantly decomposed during the entire reaction process.

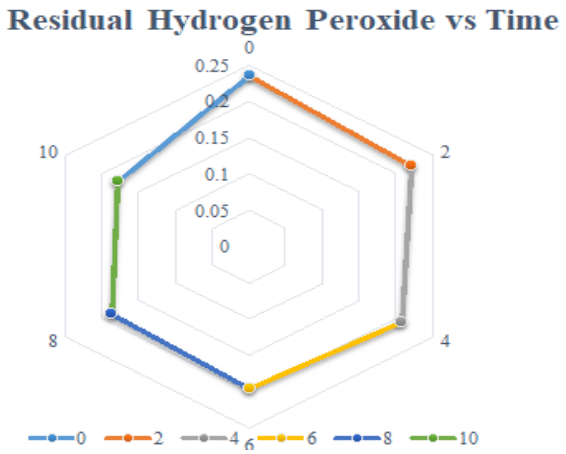

Figure 1: Residual Hydrogen Peroxide vs Time (self-made)

The remaining hydrogen peroxide level progressively goes down with the rise in the duration of the reaction, as depicted in the graph. In the beginning, the concentration is 0.235 mol dm^{-3}, and it decreases at a slow rate to 0.179 mol dm^{-3} after 10 minutes. Such a tendency suggests the hydrogen peroxide-eating of the ledger. The reaction at 0.01 mol dm^{-3} vitamin C is slow, and the rate of decomposition is not that fast.

4.3. Residual Hydrogen Peroxide at 0.05 mol dm^{-3} Vitamin C

Table 2: Residual Hydrogen Peroxide (0.05 mol dm^{-3} Vitamin C)

Time (min)	Mean $Na_2S_2O_3$ Volume (mL)	Residual H_2O_2 (mol dm^{-3})
0	23.40	0.234
2	20.30	0.203
4	18.00	0.180
6	16.40	0.164
8	15.10	0.151
10	13.90	0.139

Table 2 indicates volumes of sodium thiosulfate titration and concentrations of remaining hydrogen peroxide calculated at the concentration of vitamin C of 0.05 mol dm -1. The findings show that the concentration of hydrogen peroxide reduces with the increase in the reaction time.

The amount of sodium thiosulfate that was required to titrate the sample at the initiation of the experiment (0 minutes) was 23.40 mL of sodium thiosulfate, which was equivalent to 0.234 mol dm -. The titration volume during reactions with time was less.

In 2 minutes, the volume of thiosulfate sodium dropped to 20.30 mL, which represented 0.203 mol dm^{-3} hydrogen peroxide that was left in the mixture. Further reduction was found at 4 minutes with a titration volume of 18.00 mL, which is equivalent to 0.180 mol dm -1. When titration reached 6 minutes, the amount of titration volume was 16.40 mL, indicating 0.164 mol dm^{-3} remaining hydrogen peroxide (Sato et al., 2023).

The downward trend was observed at the time of titration of 8 minutes when the titration volume was 15.10 mL, which is equal to 0.151 mol dm -1. After 10 minutes, the volume reduced to 13.90 mL, which indicated that the remaining amount of hydrogen peroxide was 0.139 mol dm^{-3}.

A more significant decrease in concentration of hydrogen peroxide is recorded at the same time compared to the results recorded at 0.01 mol dm^{-3} vitamin C. The tendency shows that the greater the alcohol level of vitamin C, the quicker the hydrogen peroxide is broken.

4.4. Residual Hydrogen Peroxide at 0.10 mol dm^{-3} Vitamin C

Table 3: Residual Hydrogen Peroxide (0.10 mol dm^{-3} Vitamin C)

Time (min)	Mean $Na_2S_2O_3$ Volume (mL)	Residual H_2O_2 (mol dm^{-3})
0	23.60	0.236
2	18.70	0.187
4	15.40	0.154
6	12.80	0.128
8	10.90	0.109
10	9.40	0.094

Table 3 presents the titration volumes of sodium thiosulfate and the calculated concentrations of residual hydrogen peroxide when the vitamin C concentration was 0.10 mol dm^{-3}.

At the start of the experiment (0 minutes), the titration required 23.60 mL of sodium thiosulfate, corresponding to a hydrogen peroxide concentration of 0.236 mol dm^{-3}.

After 2 minutes, the required titration volume decreased to 18.70 mL, indicating 0.187 mol dm^{-3} hydrogen peroxide remaining in the mixture.

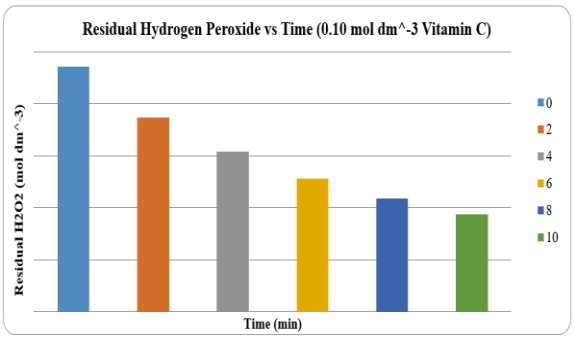

Figure 2: Residual Hydrogen Peroxide vs Time (0.10 mol dm^-3 Vitamin C) (self-made)

The concentration declines from 0.236 mol dm^{-3} at 0 minutes to 0.094 mol dm^{-3} after 10 minutes. This steep downward trend indicates fast decomposition of hydrogen peroxide, demonstrating that 0.10 mol dm^{-3} vitamin C significantly increases the reaction rate.

V. DISCUSSION

5.1. Effect of Vitamin C Concentration on Reaction Rate

The results prove that the speed of the hydrogen peroxide degradation process is conditional on the increase in the concentration of vitamin C. The reduction was slow when the concentration of hydrogen peroxide was brought down to 0.01 mol dm -3. It was concentrated into 0.235 mol dm 3 0.179 mol dm 3 with a time scale of 0-10 minutes, which is a slow reaction. With an increasing concentration of vitamin C to 0.05 mol dm -1, an increased decrease in hydrogen peroxide was observed over the same duration of time (Janbezar et al., 2025). In 10 minutes, the concentration reduced to 0.234 mol dm -3 and 0.139 mol dm -3. This means that there was a more rapid response.

At 0.10 mol dm^{-3}, the drop was significantly higher. Within 10 minutes, hydrogen peroxide was reduced to 0.094 mol dm^{-3} to 0.236 mol dm^{-3}. The greater the rate at which reduction occurs, the faster the rate of the reaction. The greater the concentration of vitamin C in the solution, the greater the number of particles to react. This enhances the likelihood of constructive collisions of the molecules (Alqahtani & Fikry, 2026). This causes hydrogen peroxide to break faster. The association between the concentration of vitamin C and the rate of decomposition of hydrogen peroxide is clear in the results of the experiment.

5.2. Redox Chemistry of the Reaction

This experiment is on reducing reactions and oxidizing reactions. Hydrogen peroxide is a source of an oxidizing agent in the iodometric analysis. When sulfuric acid and potassium iodide are added to it, the hydrogen peroxide is used to convert the iodide ions to iodine. Under acidic conditions, the reaction is:

$H_2O_2 + 2I^- + 2H^+ \rightarrow I_2 + 2H_2O$

The iodide ions lose the electrons in this reaction, and the electrons get oxidized to iodine. The hydrogen peroxide undergoes reduction to water by receiving electrons. The solution of the hydrogen peroxide in the sample is directly proportional to the solution of the iodine solution produced. An iodine liberation is then calculated by sodium thiosulfate titration (Tang et al., 2020). With the aid of the thiosulfate ions, access to the replacement of the iodine by iodide ions is reduced in the following way:

$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$

During the titration process, the iodine and thiosulfate react until all the iodine is consumed. There is a starch indicator just before the endpoint. Iodine is a blue dye of starch. When the reaction is conducted, the iodine blue colour is lost. This is what is known as termination of titration. Then it will be dependent on the concentration of the formed iodine and the concentration of the unreacted hydrogen peroxide; the concentration of the sodium thiosulfate to be used is proportional to the concentration of the formed iodine and inversely proportional to the concentration of the unreacted hydrogen peroxide.

5.3. Biological Relevance: Oxidative Stress and Antioxidants

Vitamin C, which is also known as ascorbic acid is a significant biological antioxidant. It is also able to deliver electrons to reactive oxygen species as well as change them into weaker ones. This curtails the possible cell destruction. The experiment represents a model of a simplified chemical system, which is an antioxidant activity. The amount of vitamin C is directly proportional to the rate of hydrogen peroxide breakdown (Sanjel et al., 2025). It implies that the greater the concentration of antioxidants, the greater the capacity to neutralize reactive oxygen debris.

The biological systems are linked to aging and most diseases, which are linked to oxidative stress, such as cardiovascular diseases and neurodegenerative disorders. The antioxidants, including vitamin C, inhibit the destruction of the cells by mitigating the oxidative harm of proteins, lipids and DNA (Alberts et al., 2025). The experiment has a simplified system that illustrates the effect of the antioxidants during the interactions of the reactions with the reactive oxygen species. It was also established that the decomposition of hydrogen peroxide increased with a relatively high concentration of vitamin C, and this is why vitamin C has protective antioxidant properties.

5.4. Sources of Error and Experimental Limitations

Though the processes were done carefully, some sources of error may have been involved in the results. One of the errors that can be caused is a delay during sampling. Unless the sample was transferred to undergo titration, additional degradation of hydrogen peroxide could occur, which would cause a minor impact on the measured concentration.

The other weakness is the detection of endpoints in titration. This is the visual identification of the fading away of the blue starch-iodine colour. Human judgment can bring small variations in the measured volume of titration (Wardana et al., 2025).

The rate of the reaction could be influenced even by slight fluctuations in the temperature. Though the water bath was employed, there may be a minor change in the temperature.

VI. CONCLUSION AND RECOMMENDATIONS

Conclusion:

This experiment investigated the character of vitamin C in the loss of hydrogen peroxide by iodimetric titration upon different concentrations of vitamin C (0.01–0.10 mol dm^{-3}). These results were a clear sign that the hydrogen peroxide rate was increased with the further concentration of vitamin C addition. At low concentrations (0.01 mol dm^{-3}), the time-dependent reduction of hydrogen peroxide was quite slow whereas at high concentrations (0.05 and 0.10 mol dm^{-3}) it was relatively fast. This means that the greater the vitamin C the greater the effective collisions of the molecules hence, the quicker the redox process of vitamin C and hydrogen peroxide. Such findings provide support to the research question because the concentration of vitamin C was proved to be proportional to the rate of the hydrogen peroxide decomposition reaction.

Recommendations:

Future studies could improve the suggestions to indicate accuracy of the results by applying less complex analytical methods such as spectrophotometry to measure the concentration of hydrogen peroxide continuously as compared to titration. In addition, further research can be done to encompass a wider scope of the vitamin C concentrations, and the reaction time so as to understand more about the reaction kinetics. It would also be beneficial to learn how other factors are influenced by temperature, pH and ionic strength on reaction rate (Alqahtani & Fikry, 2026). The scale up of the experiment to the biological conditions would perhaps help in correlating the chemical findings to the biological systems more effectively and provide more information about the antioxidant impact of vitamin C in ridding off the oxidative stress.

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