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The Role Of Plant Extracts On The Conductivity Of Mineral Salts In Aqueous Solutions

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Abstract
This study explores the effect of natural extracts and their role on the conductivity of various solutions by evaluating the effectiveness of environmentally friendly natural extracts (aloe vera and chamomile) for use in various environmental applications. The study compares the results with those before and after adding the extract. It also examines the effects of saline solutions that were subjected to a comprehensive study under various conditions, including temperature, concentration, pressure, and several other variables, to achieve the best possible outcome for the study. The role of these natural extracts on electrical conductivity was evaluated by reducing conductivity to serve environmental sustainability requirements. Na_2SO_4 salts showed higher conductivity values than NaCl salts. This is due to the chemical composition of the salt compound and the number of ions it possesses compared to NaCl.
Keywords: *Plant extracts, Aloe vera, Chamomile, Kinetics, Thermal properties, Conductivity.*

INTRODUCTION

The electrical conductivity of any chemical solution is one of the important means of understanding the properties of the substance. It is evident that the ability of the solution to conduct electricity depends largely on the presence of ions in the chemical solutions, while taking into account other influential factors such as concentration, reaction time, and temperature [1-3] ,in addition to the effects of adding materials such as plant extracts, which have become a role in recent years. Interest in them has increased to understand their effect on conductivity due to their various environmental benefits, for example, in the environment and agriculture. Most recent research has focused on the use of plant extracts and their role in reducing conductivity. Aloe vera and chamomile extracts are under study for their effect in reducing conductivity. This is due to their role in ion movement, which is measured by their effect on increasing or decreasing ions and their impact on the conductivity values of solutions. Scientific research has shown that plant extracts play a prominent role in improving the chemical and physical properties of solutions, enhancing their use in various fields such as industry, water treatment, agriculture, and more.[4-6] As is well known, salts play a role in influencing conductivity. Two salts were highlighted in this study: NaCl and Na_2SO_4. These salts are readily available and easy to handle, and their structural differences allow them to release ions. The latter has a greater number of ions that can be released into the solution, facilitating comparison. [7-8] They are also widely used in various areas of life and various chemical applications. Because salts play a significant role in improving conductivity, they have consequently impacted the efficiency of agricultural processes.[9] ,biological [10], and industrial and many other sectors .[11-12]

Working in this field also requires precision and consideration of the impact of time and temperature factors, which play an important role in conductivity research. The study of how these reactions reach equilibrium is conducted through kinetic studies of the reaction, reinforced by thermodynamic studies to understand the effect of heat on conductivity, which occurs through heat enhancing the movement of ions. Increasing temperature leads to enhanced conductivity by increasing the movement of ions.[13]

In addition to what has been mentioned, it is necessary to focus on other equally important factors, such as the effect of pH and pressure on conductivity, as they are important topics that influence conductivity values in a solution, whether this effect is negative or positive on the properties of the solution's reaction.

Through what has been mentioned, the current study demonstrates the importance of highlighting the study of the effect of natural extracts on conductivity in chemical solutions. The aim of the research is to evaluate two types of these extracts: aloe vera and baobab, in reducing conductivity. It also includes a study that includes the effect of salts, temperature, time, acidity, and pressure on the properties of the solution and their impact on conductivity. Solutions provide a new vision for how to harness natural materials to achieve environmental sustainability and improve chemical processes.

Experimental Part

Materials and Equipment

Sodium sulfate (Na_2SO_4) , Sodium chloride (NaCl) from Sigma-Aldrich and Merck.

Plant Extracts: Aloe Vera Extract, Chamomile Extract:

Prepare aloe vera and chamomile plants from local plant nurseries or plant stores, then clean them thoroughly and select mature leaves. For aloe vera, cut the leaf and carefully extract the gel, preserving the inner gel during cutting. The gel is then placed in a clean, sterilized blender with a 1:1 ratio of deionized water. Mix to obtain a smooth solution, which is then filtered and stored in a sterile container in the refrigerator. For chamomile, clean the plant, boil, filter, and store in a sterile container in the refrigerator.

Equipment :To conduct this study, a precision balance, a heater, a funnel, filter paper, a conductivity meter, a Hana pH meter, and a water bath were used.

METHOD

1. Saline Solution: These solutions were prepared for both NaCl and Na_2SO_4 at different concentrations (0.1 mol, 0.5 mol, and 2 mol).

2. Adding the Plant Extracts

After preparing the extracts as previously mentioned, the following steps were followed:

5 ml of aloe vera extract were added to 100 ml of the NaCl and Na_2SO_4 saline solution.

The same steps were repeated with the chamomile extract, ensuring smooth and homogeneous mixing.

3. Electrical Conductivity and pH:

Samples were measured for the saline solutions, both with and without the plant extracts, using a conductivity meter. The values were recorded on the screen at time intervals as demonstrated in the experiments, and the pH was also measured.

4. Kinetic and Thermal Measurements:

Kinetic and thermal measurements of the saline solutions were carefully studied, with kinetic time recording and a water bath used for thermal measurements.

RESULTS AND DISCUSSION

The research was conducted and the required measurements were performed after preparing saline solutions in distilled water at different concentrations (0.1 mol, 0.05 mol, 2 mol). Electrical conductivity was studied according to the following mathematical relationship (Equation 1).

$$\Lambda = 1000 * K / C \quad \text{..... 1}$$

Where : Λ : equivalent conductivity
κ : measured conductivity
c : molar concentration of the electrolyte.

Effect of temperature on conductivity

The gradual increase in the apparent conductivity values of both sodium chloride (NaCl) and sodium sulfate (Na_2SO_4) with increasing temperature of the measuring solution proves the accuracy of the experiment, as the increased mobility of ions associated with an increase in their degree of freedom directly increases the conductivity of the solution. It was also observed when comparing the two salts with each other at the same and different temperatures for both salts, both salts showed a distinct linear relationship with a high correlation coefficient, as shown in Figure (1). The measured conductivity values for sodium chloride (NaCl) were lower than those for Na_2SO_4. This reflects the increased mobility of ions in the second salt compared to the first, demonstrating the effect of ion type on mobility, which in turn is reflected in the conductivity of the solution.

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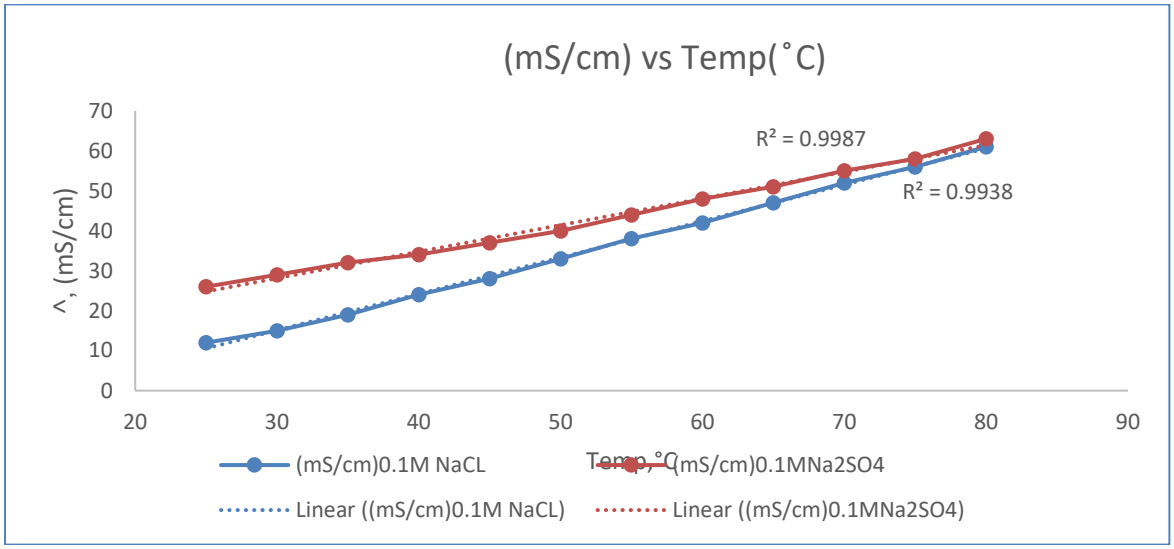

Figure.1: Effect of temperature on conductivity

The effect of pH on ionic mobility of a solution

Measurements show an increase in conductivity associated with a rise in pH in an alkaline solution. This results from an increase in the concentration of hydroxide ions, which contributes to an increase in the ionic mobility of other ions in the solution, directly increasing conductivity. The figure (2)shows that both solutions responded strongly to pH changes due to their ionic composition, which played a significant role in the measurements.

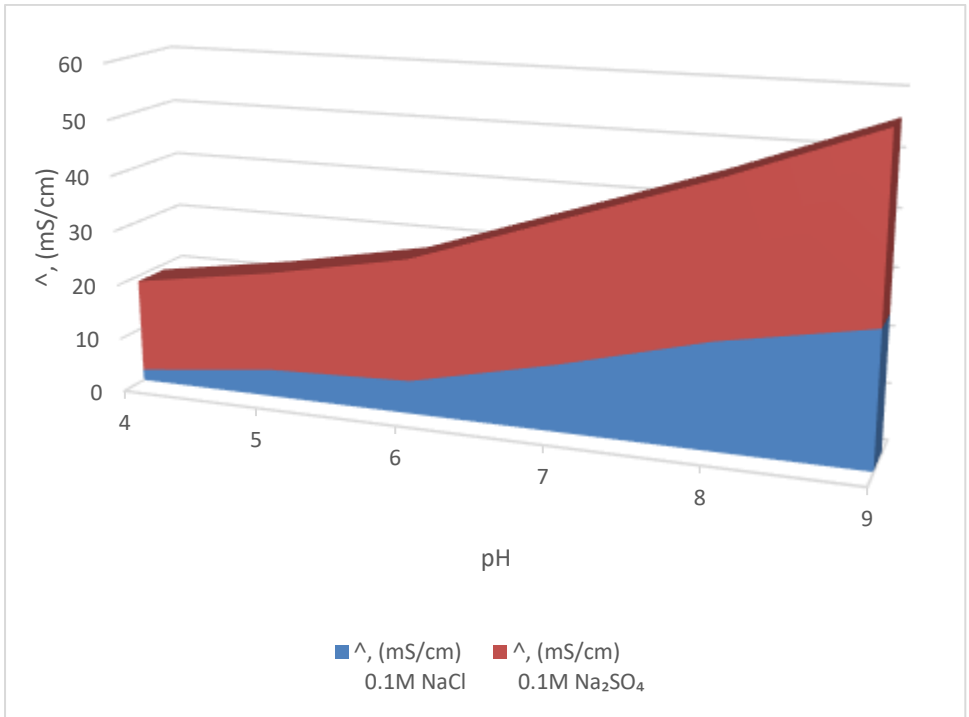

Figure.2: The effect of pH on ionic mobility of a solution

Temperature and its Effect on Conductivity and Concentration

Figure (3,4) shows that conductivity values increase with increasing solution temperature. Heating the solution increases the mobility of ions, giving them kinetic energy that facilitates their movement within the solution in a linear relationship with increasing concentration and temperature. This is clearly demonstrated in the R2 values shown in the figure (for conductivity at different concentrations with changing temperature).

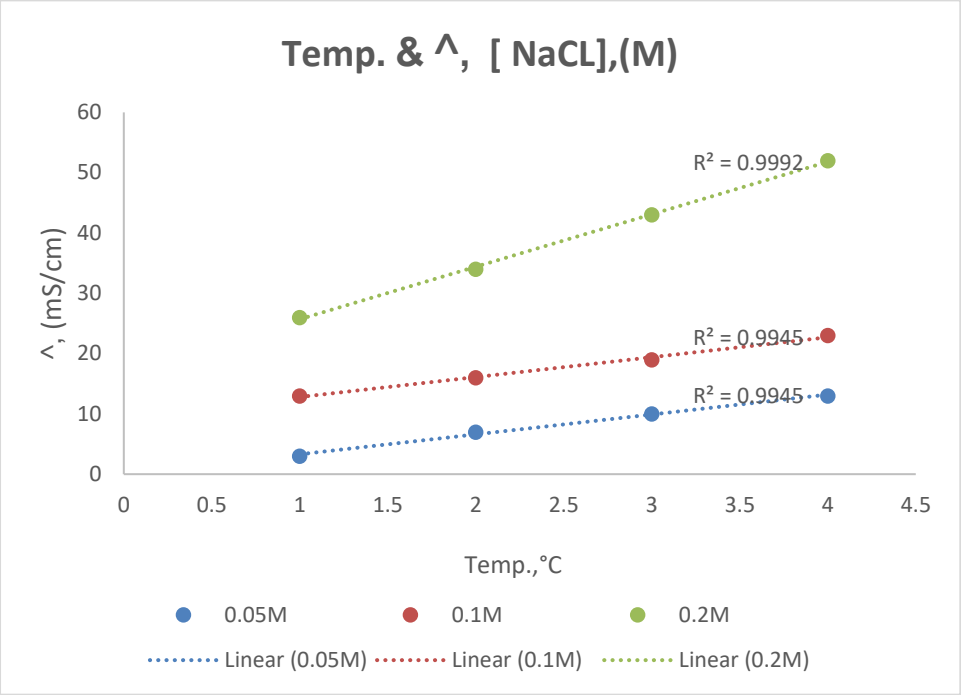

Figure .3.The effect of pH on ionic mobility of a NaCl solution

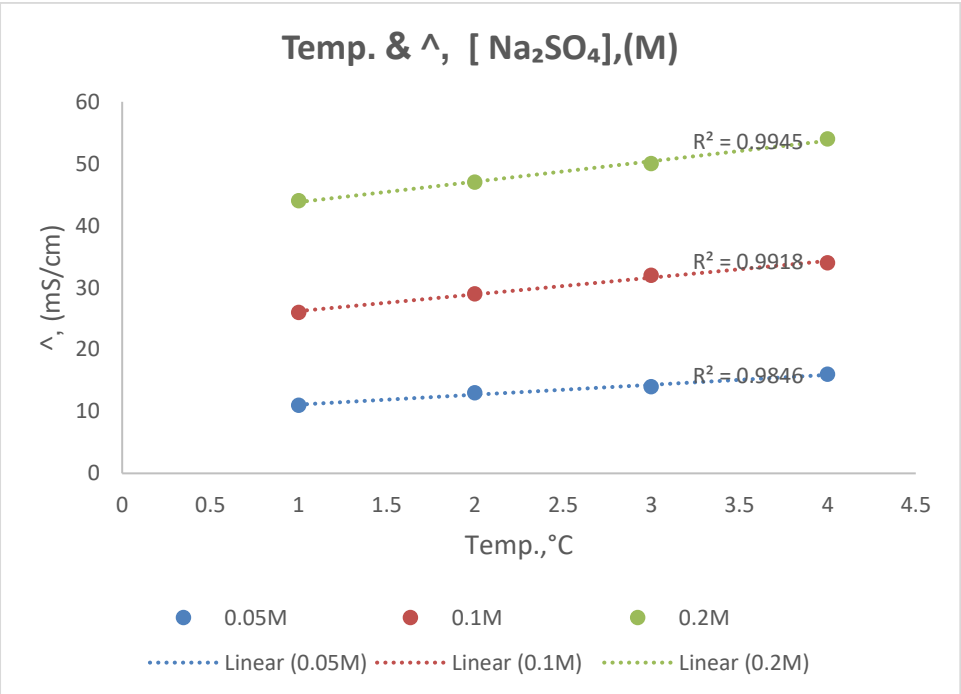

Figure .4.The effect of pH on ionic mobility of a Na_2SO_4 solution

The Effect of Adding Plant Extracts

From the results shown in the figure (5), it is clear that adding extracts plays a role in reducing conductivity. This is likely due to the interaction of the active ingredients in the extracts used (chamomile and aloe vera) with the ions present in the solution, which contributes to reducing the movement of ions. This will play a positive role in improving water quality by purifying it using environmentally friendly natural materials such as extracts.

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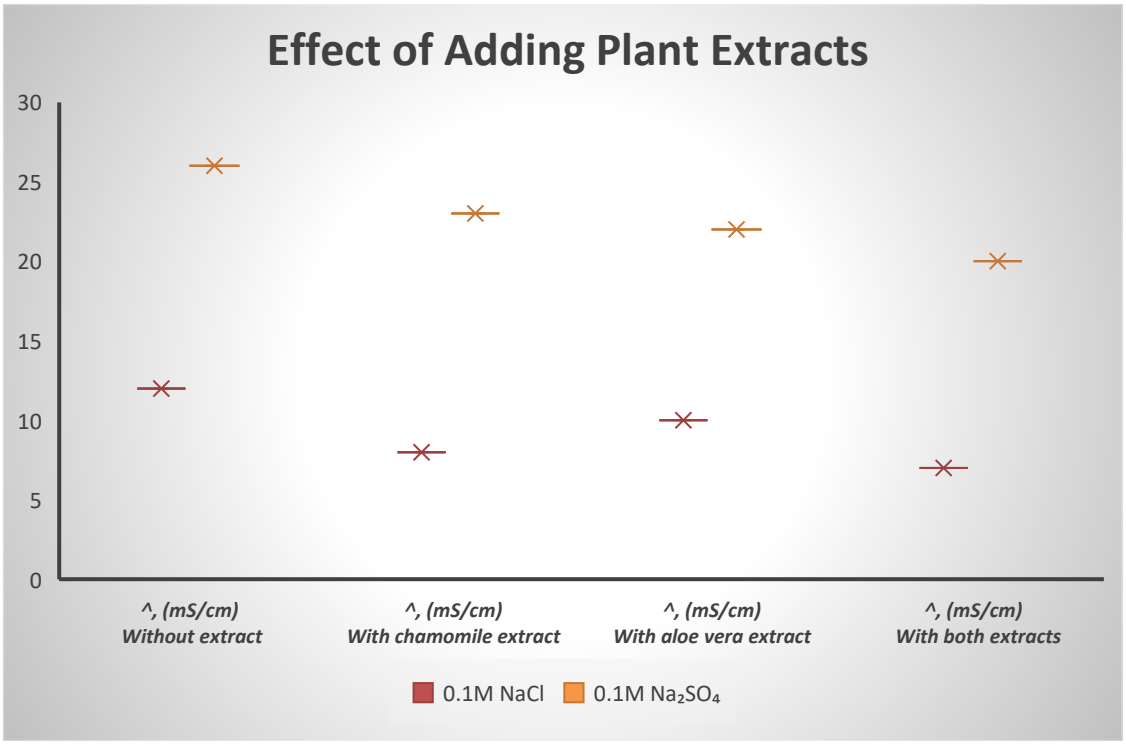

Figuer.5. The Effect of Adding Plant Extracts

Effect of reaction time

The figure (6) shows the stability of conductivity over time as the chemical reactions in the reaction solution reach equilibrium. This type of analysis contributes to understanding the mechanism of the reaction of substances in the solution by understanding the dynamics of the reaction.

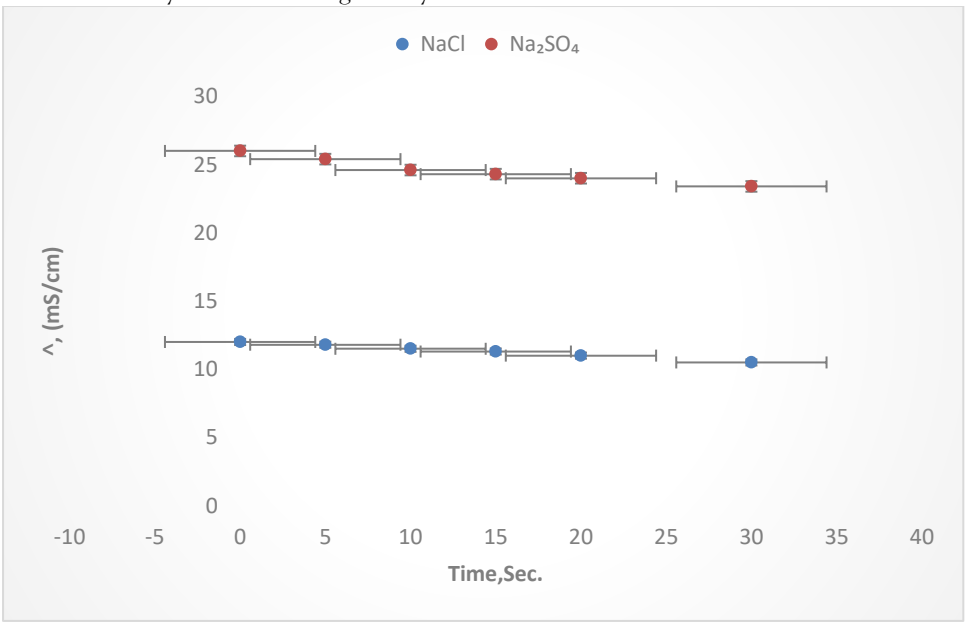

Figure 6. Effect of reaction time of Salt's solutions

A subsequent study was conducted on conductivity with and without the addition of the extract..The results in Figure (7,8) show that the conductivity of the experiment without an extract and for both salts remained nearly constant over time and at constant room temperature, indicating no noticeable interactions. However, by adding the extract to both solutions, it was observed that the conductivity decreased over time, indicating that the solutions interact with the extracts and significantly affect their ions. This contributes to understanding how natural extracts affect the interactions of chemical solutions over time.

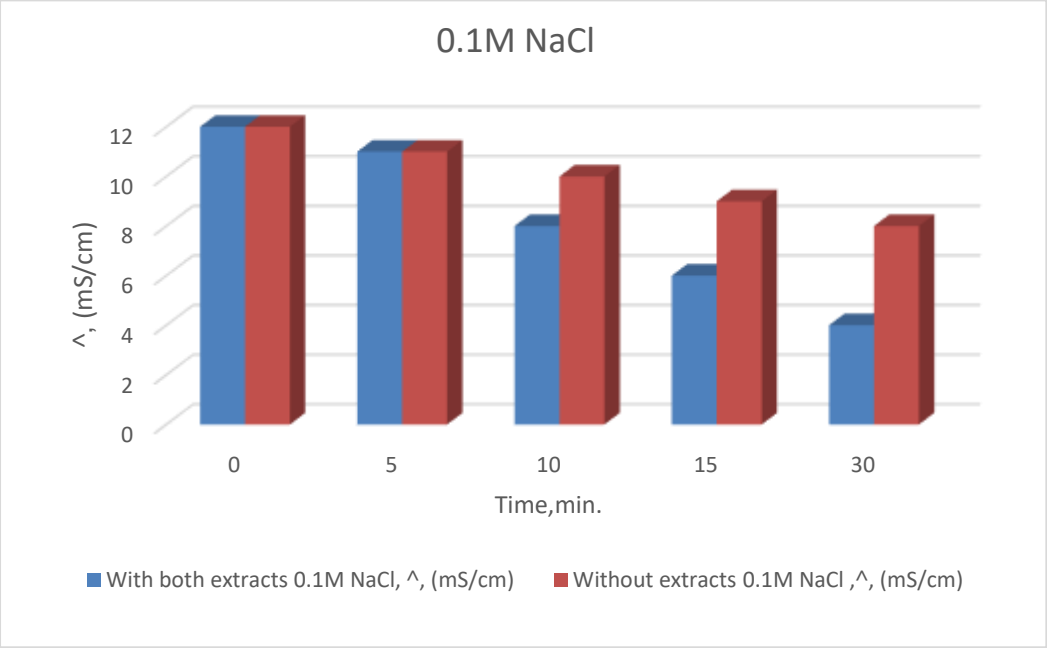

Figure 7. Effect of reaction time of NaCl solution

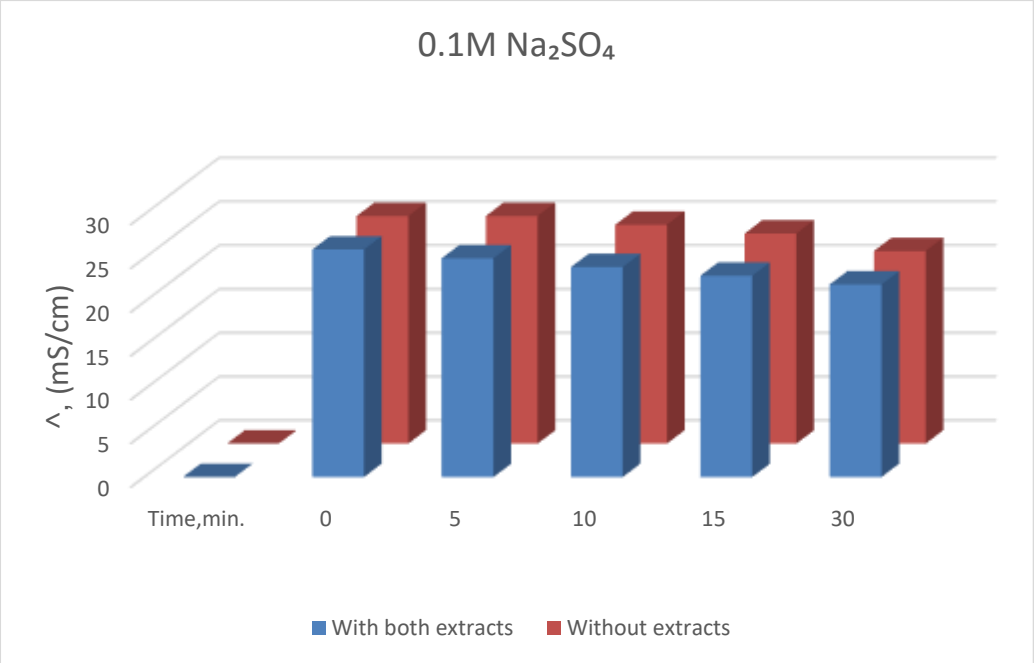

Figure 8. Effect of reaction time of Na_2SO_4 solution

The Effect of Adding Dissolved Solids

Adding non-ionic substances contributes to understanding their effect on ion movement during conductivity measurements of the substances under study. This study noted that sucrose, used as an example of such a substance, reduces the number of free ions, which reduces the velocity of ions and reduces conductivity ,figure (9). This provides an indication of the nature of the effect of additives on the properties of solutions and their applications, such as water treatment.

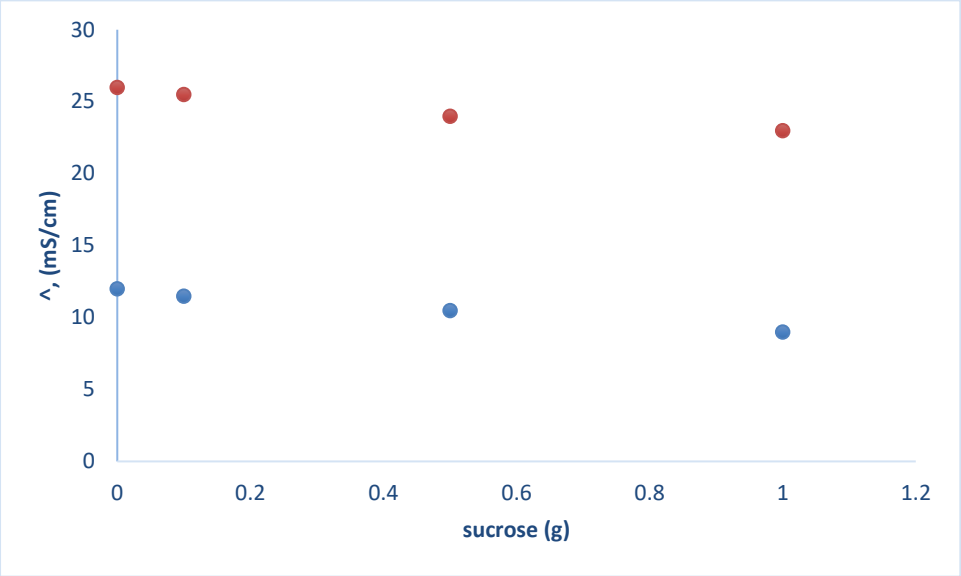

Figure .9. The Effect of Adding Dissolved Solids

The Effect of Pressure

The effect of increasing pressure on the ionic mobility of ions in solution was studied ,figure.10,. A significant increase in conductivity was observed with increasing pressure, indicating that ions become more mobile as pressure increases, enhancing conductivity.

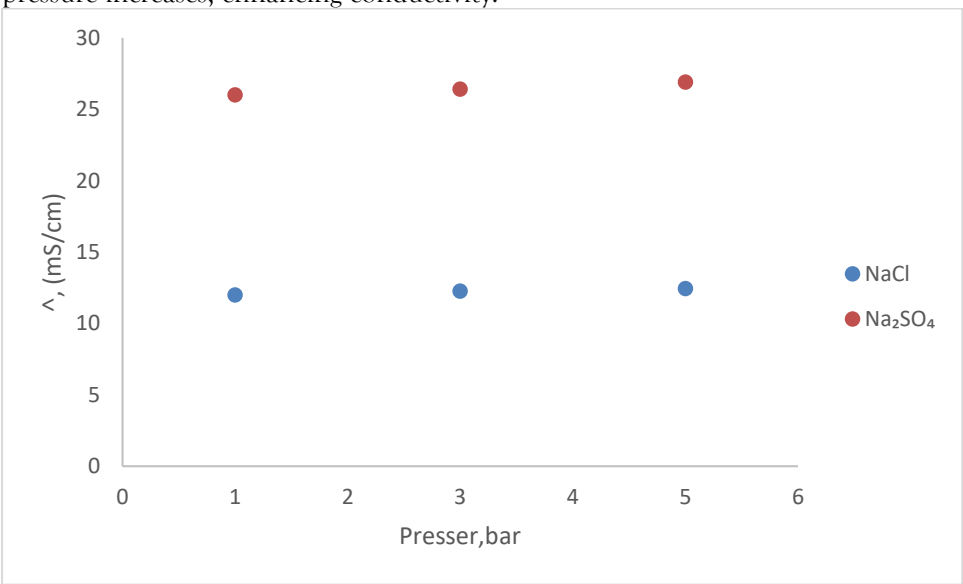

Figure 10. The Effect of Pressure

CONCLUSION

Based on the above, it is essential to understand the role of natural extracts in chemical solutions over time and evaluate the effectiveness of chamomile and aloe vera extracts in reducing conductivity, which contributes to their use in environmental and agricultural fields. This was confirmed by experiments conducted to understand the use of environmentally friendly materials and their benefits to achieve environmental sustainability. The experiments also demonstrated the effect of the salts selected for study on conductivity. Because Na_2SO_4 releases a greater number of ions than NaCl, it was observed that its conductivity was higher, and this was reflected in all subsequent experiments. Given the importance of time in chemical experiments, the stability of the compounds was monitored over time, yielding good results until equilibrium was reached. The effect of these salts was significant with increasing temperature and increasing concentration, while studying the effects of pressure, acidity, and the addition of solids. This was in addition to the effect of natural extracts, which play a role in

understanding the dynamics of chemical reactions and the extent of their positive or negative impact on conductivity. This helps understand the future use of these materials in various fields, such as increasing the efficiency of salts for conductivity, saving energy, or in agriculture, among others.

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