משרד החינוך

המשרד להגנת הסביבה
الوزارة لحماية البيئة
Israel Ministry of Environmental Protection

אשכול פיס חולון
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אגף מדעים
המזכירות הפדגוגית משרד החינוך

THE EFFECT OF PH LEVEL ON THE DISSOLUTION OF SHELLS

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Observation analysis time:	**16.2.25-17.2.25**

Abstract

The experiment examines the effect of pH levels on shells using five beakers with different pH solutions: hydrochloric acid, sodium hydroxide, and distilled water. One shell was placed in each beaker, and their weight was measured at the beginning and end of the experiment, with pH and conductivity levels also recorded. After one week, the shells were reweighed and the pH and conductivity of the solutions were measured again. The goal was to determine if pH changes affect the shells' weight and how they react to different acidity or basicity. Results may suggest that shells maintain internal stability despite pH changes.

The GLOBE Program

We are ninth-grade students, participating in a research project as part of the GLOBE Program, celebrating its 30th anniversary. In this project, we are investigating the hydrosphere—all the water on Earth's surface. We are focusing on measuring the acidity levels (pH) of local water sources.

The GLOBE program provides several protocols for investigating the hydrosphere, enabling students and scientists to explore and monitor various water bodies.

These protocols include measurements of parameters such as:

Alkalinity
Conductivity
Dissolved oxygen
Nitrates
Salinity
Water temperature
Water transparency
pH

By using these protocols, studies can be conducted on the effect of pH levels on mollusk shells, as demonstrated in our study that examined the effect of pH levels on shells using different solutions of hydrochloric acid, sodium hydroxide, and distilled water. The study demonstrates how GLOBE protocols can be used to investigate specific research questions, using measurement equipment such as pH and conductivity sensors, and tracking changes in shell weight over time. The data collected can contribute to a broader understanding of the ecological consequences of environmental changes on different species. We hope to compare our results with data from other places worldwide, contributing to a global understanding of water conditions. This project gives us the opportunity to learn practically about our environment, develop research skills, and understand the importance of international scientific collaboration.

Research Question

How do different pH levels affect the weight and conductivity of shells in water?

Hypothesis: The lower the pH level (the higher the acidity), the more the shell will dissolve, and the conductivity will increase.

Introduction

Oceans, seas, and other bodies of water serve as habitats for a vast array of marine organisms, including mollusks such as oysters and clams. These shellfish possess calcium carbonate ($CaCO_3$) shells, which are susceptible to changes in the chemical composition of their aquatic environment. One critical factor affecting these organisms is the pH level of the water, as fluctuations in acidity can influence the rate at which their shells dissolve.

In recent years, human activities—particularly the increased emission of carbon dioxide (CO_2)—have led to a significant rise in the concentration of carbonic acid in marine ecosystems. This process results in a decrease in oceanic pH, a phenomenon commonly referred to as ocean acidification. The progressive acidification of seawater raises serious concerns regarding the stability of marine ecosystems and its potential impact on vulnerable species, such as shellfish.

This study aims to investigate the effect of water pH on the dissolution rate of mollusk shells and its correlation with electrical conductivity in the surrounding water. Electrical conductivity serves as an indicator of free ion concentration in a solution, and we hypothesize that as acidity increases (i.e., pH decreases), the dissolution of calcium carbonate from the shells will release more ions into the water, thereby increasing its conductivity.

To test this hypothesis, we will conduct an experiment in which oyster shells are submerged in solutions with varying pH levels. Over the course of one week, we will measure changes in shell mass and monitor shifts in water conductivity. The pH and conductivity levels will be recorded using specialized sensors, while the initial and final masses of each shell will be documented to quantify the dissolution rate.

By analyzing the results, this study seeks to provide deeper insight into the relationship between ocean acidity and shell dissolution, contributing to our understanding of the broader ecological consequences of ocean acidification. These findings will help assess the potential threats posed by rising CO_2 levels to marine biodiversity and the resilience of shell-forming organisms within oceanic ecosystems.

Tools and Materials

- 5 Shells
- 5 Beakers
- Drops of NaOH
- Drops of HCl
- Distilled water
- Gloves
- Tweezers
- Digital scale
- pH level sensor
- mixing stick
- Marker

Procedure

1. Prepare the Beakers: Pour 40 mL of distilled water into each of the 5 beakers. (Make sure the distilled water is prepared in advance).

2. Put on Gloves: Wear gloves to avoid direct contact with the chemicals and protect your skin.

3. Add Solutions to Each Beaker:

- In the first beaker, add 12 drops of HCl (Hydrochloric acid).
- In the second beaker, add 1 drop of HCl.
- Leave the third beaker as it is, with only distilled water (no acid or base).
- In the fourth beaker, add 1 drop of NaOH (Sodium hydroxide).
- In the fifth beaker, add 9 drops of NaOH.

4. Stir Each Solution: Use the stirring rod to gently mix the solution in each beaker. After stirring, mark each beaker with a number using the marker to clearly identify them.

5. Measure pH and Conductivity:

- Use the pH sensor and the conductivity sensor to measure the pH level and conductivity of the solution in each beaker.
- Record the pH and conductivity data in a table for each beaker.

6. Weigh the Shells: Weigh each of the 5 shells using a precise scale and record the data in the table.

7. Place the Shells in the Beakers: Carefully place one shell into each beaker, making sure they are fully submerged in the solutions.

8. Wait for a Week: Allow the shells to remain in the beakers for a week to observe any changes.

9. After One Week:

- Use the tweezers to remove the shells from the beakers, ensuring not to touch them directly.
- Weigh each shell again and record the weight in the table.
- Measure the pH level and conductivity of each solution again using the sensors, and record this new data in the table.

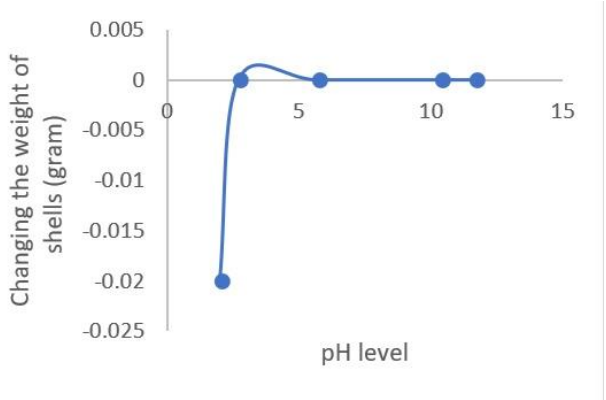
Results

Table 1

Tube	pH level	weight at day 0	weight at day 7	weight difference
1	2	7.24	7.22	-0.02
2	2.7	5.37	5.37	0
3	5.7	5.27	5.27	0
4	10.4	3.66	3.66	0
5	11.7	4.19	4.19	0

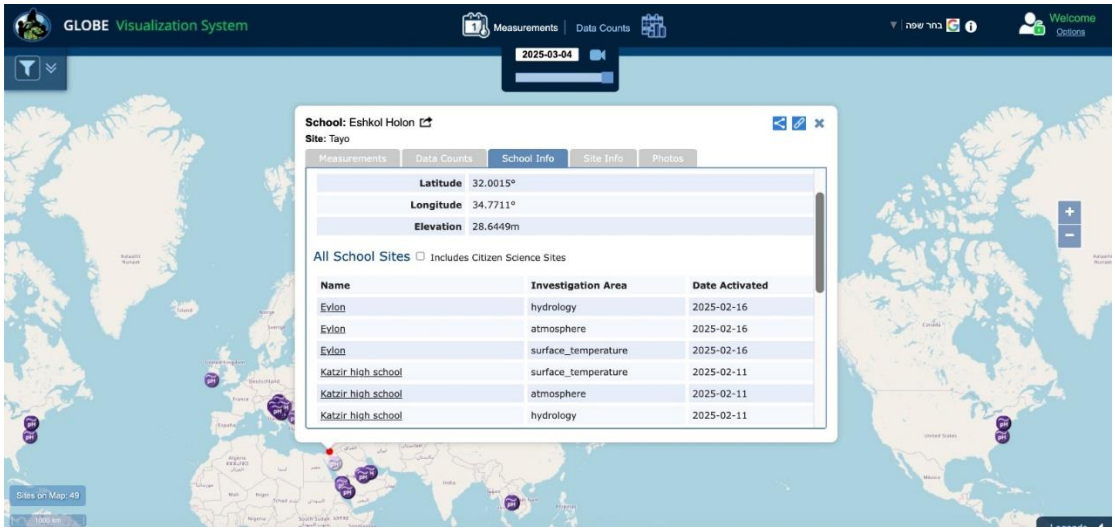
The table shows the change in the weight of shells after 7 days in different pH levels

Graph 1



The graph shows the change in the weight of shells (in grams) as a function of pH level.

Data from GLOBE Visualization System



Conclusions and Discussion

In our study, we examined the effects of different pH levels in distilled water on shells.

The fact is only one of the shells had a change of weight, and it was minor, which indicates that, under the conditions we tested, the shells did not absorb or lose significant amounts of fluids.

It is possible that their shells serve as an effective barrier against acids or that they were not affected by the water's acidity. The findings suggest that the water's acidity level did not have a significant impact on the shells.

It is also possible that the shells were inactive under these conditions or that they do not utilize substances that influence pH levels. Additionally, the experiment's duration may not have been long enough to observe changes in the water. Other factors, such as temperature, oxygen pressure, or the presence of other substances in the water, may also affect the shells.

These results may indicate that shells have the ability to maintain internal stability even under varying pH conditions. It is possible that they have evolved in such a way as to survive in changing marine environments.

Suggestions for Further Research

It is recommended to conduct additional studies over a longer period, under varying environmental conditions, and while examining additional factors. Furthermore, it would be beneficial to test the impact of more extreme acidity levels on the shells.

Additionally, further research could explore the influence of other factors, such as temperature, salinity, and oxygen concentration.

Optional Badges

1) I'm a "**Student Researcher**" Badge

We believe we deserve the "I'm a Student Researcher" badge because, as students participating in the GLOBE program, we are actively engaged in research. We are not just completing a simple project but are involved in conducting serious research for our research paper. Through this process, we are following scientific methods, analyzing data, and gaining insights that contribute to our understanding of the world around us. This badge acknowledges our commitment to learning and conducting research at an academic level.

2) I'm a "**Data Scientist**" Badge

We deserve the "I'm a Data Scientist" badge because, through the GLOBE program, we regularly work with real-world data from the GLOBE database. By utilizing this data, we are not only learning the fundamentals of data science but also applying these skills to our research projects. We analyze patterns, draw conclusions, and improve our methods based on the information available. This experience teaches us how to handle data responsibly and develop a deeper understanding of how data science can be used to drive discoveries and solve problems.

3) I'm a "**Collaborator**" Badge

We should receive the "I'm a Collaborator" badge because our group is composed of six individuals—four from Katsir Middle School and two from Eylon Middle School—working together as a unified team. Collaborating with students from a different school has broadened our perspectives and improved our problem-solving skills. We've learned how diverse study methods and approaches to learning can enhance the quality of our work. This cross-school collaboration has not only helped us grow intellectually but also fostered a deeper sense of teamwork and cooperation, as we share knowledge from different teachers and study programs.

Citations

Shells in the Mediterranean Sea.
https://mafish.org.il/protecting/tenants/oysters/