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MYP Biology 2

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The relationship between the pH level of water and the disintegration of magnesium

Research Question:
How does changing the pH level of water by adding potassium phosphate and performing serial dilution by two-folds affect the dissolution of macronutrient, magnesium, measured by mass?

Background:
Magnesium is one of the macronutrients which is essential for plant growth. Magnesium directly affects plant growth because it is the central element of chlorophyll. As it is widely known, chlorophyll is the vital component which absorbs the sunlight in order to start the process of photosynthesis to create glucose. (Magnesium Basics) Then, the glucose is utilized in order to create ATP for the plant. This crucial mineral, magnesium, and other minerals are in the soil, and they are dissolved in water. Then, the roots of the plant draw in the solution for the necessary nutrients in order to grow. Furthermore, it has been discovered that the different pH level of water can widely affect the rate of dissolving magnesium and other minerals. Therefore, it is essential to control the pH value of water, so more minerals can be disintegrated for the plants to absorb through roots. For magnesium, the optimum pH level of water, the pH level where magnesium disintegrates the best, is 5.5 to 6.0 pH (Mineral Elements Required in Plant Nutrition).

Hypothesis:
If the pH level of water is increased by decreasing the concentration of potassium phosphate into 10%, 5%, 2.5%, 1.25%, and 0.625% through serial dilution. Then, the mass of the mineral, magnesium tablet, will decrease as the pH level of water reaches the optimum pH level. However, the mass of the tablet will start to increase again as the pH level of water exceeds the optimum pH, resulting in the water disintegrating the mineral much less. This is because extremely high or low pH values completely terminate the activity of disintegration. However, when the pH level of water hits the optimum pH, the disintegration becomes most active which results in active disintegration.

Variables:

Variables	Description & Units	How to measure/control
Independent Variables	Changing the concentration of potassium phosphate in water by serial dilution in order to change the pH of water. The concentration should be 10%, 5%, 2.5%, 1.25%, 0.625%.	I will be using electronic balance to measure 10g of potassium phosphate, and I will measure 100ml of distilled water with gradated cylinder. Then, I will perform serial dilution by two-folds.

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Variables	Description & Units	How to measure/control
Dependent Variable	The change in the mass of the magnesium tablet (grams).	I will measure the initial mass and the final mass of the magnesium tablet. Then, I will subtract the initial mass from the final mass in order to measure the change in the mass of the tablet.
Controlled Variables	Type and pH value of water used throughout the experiment. *the pH value must be in the range of 6.8 to 7.2, so it is close to the neutral pH value of 7.0.	I will use distilled water throughout the experiment which has the pH value of about 6.8. Also, I will measure the pH value of the distilled water each time with the pH probe.
	Potassium Phosphate	Must use the same potassium phosphate.
	How long the magnesium tablet is going to be submerged in the different pH values of water (seconds).	The duration must be kept at 15 seconds for each of the independent variables and each trials. The time is going to be kept by stopwatch.
	Type of the magnesium tablet.	Must use the same magnesium tablet in order to keep the type of the tablet constant throughout the experiment.
	Electronic Balance	Must Use the same electronic balance to measure the mass of the variables.
	100ml Graduated Cylinder	Must use the same graduated cylinder for measure the volume of water, then another graduated cylinder to measure the potassium phosphate solution.
	pH probe	Must use the same pH probe; however, it must be washed thoroughly each time I measure pH with it.
	Spatula	Must use the same spatula every trial.
	100ml Beakers	Must use the same beakers to contain the solution and carry out the experiment.
	Stopwatch	Must use the same stopwatch to measure the duration.

Control Group:
The Control Group of this experiment is going to be the magnesium tablet submerged in water with the neutral pH value for 15 seconds. Also, the tablet submerged in 100% potassium phosphate for 15 seconds.

Materials:
- At least 10g of potassium phosphate powder
- At least 15 Magnesium tablets
- 200ml of distilled water
- 1 Electronic balance (±0.05g)
- 2 100ml graduated cylinder (±0.5ml)
- 8 100ml beakers
- 1 pH probe
- 1 spatula
- 1 Stopwatch
- Logger Pro
- Weighing boats
- Labeling tapes and Permanent marker

Procedure:
1. Label 7 100ml beakers with the permanent marker: 10%, 5%, 2.5%, 1.25%, 0.625%, 100% water, and 100% Potassium Phosphate.
2. Measure 100ml of distilled water and pour it into the one left 100ml beaker. Then, measure 10g of Potassium Phosphate and pour it into the distilled water.
3. Stir it well until the Potassium Phosphate is completely dissolved in the beaker, and measure 50ml of the solution with graduated cylinder. Then, pour the 50ml solution into the beaker with the labeling of 10%. *When I say completely dissolved, it indicates that no potassium phosphate crystalized powder must be seen in the beaker.
4. Measure 25ml of the 10% 50ml solution, and pour it into the 5% labelled beaker. Then, measure 25ml of distilled water with another graduated cylinder and pour it slowly into the 5% beaker. *Must use different graduated cylinder for measuring distilled water and the solution.
5. Repeat step 4 for each of the independent values: 2.5%, 1.25%, and 0.625%. *Must remember that when measuring 25ml of the solution to mix with 25ml of distilled water, the solution must be always from the previous percentage solution.
6. After step 5, measure 10ml of distilled water and 10g of Potassium Phosphate. Stir them well until the 10g of Potassium Phosphate is completely dissolved. Then, pour the solution into the beaker with the labeling of 100% Potassium Phosphate.
7. Measure 10ml of water and pour it into the beaker with the labeling of 100% water.
8. Take the pH probe and the Logger Pro and measure the pH level for each of the independent values and control group: 10%, 5%, 2.5%, 1.25%, 0.625%, 100% water, and 100% Potassium Phosphate. Then, record the pH level onto a piece of paper. *When measuring the pH level, dip in the pH probe in the solution for 3 to 4 seconds.
9. Take out 5 magnesium tablets from the container, and measure and record their initial masses onto the paper.
10. Using the spatula and stopwatch, submerge the magnesium tablet into 10% solution beaker and wait for 15 seconds. At 15 seconds, take out the magnesium tablet and measure the mass of it. Then, record it onto the paper.
11. Repeat step 10 for each of the independent values and control group.

12. Repeat steps 2 through 11 for 2 more times to have total of 3 different trials. *Throughout the trials, must use the same beakers, spatulas, graduated cylinders, magnesium tablets, electronic balance, and pH probe.
13. When raw data is complete, calculate the difference between the final mass and the initial mass of the magnesium tablets for each of the independent values. Then, find the average of the differences.

Raw Data

Table 1. Mass of the magnesium tablets after immersed in the different concentration of Potassium Phosphate/different level of pH values for 15 seconds.

Concentration of Potassium Phosphate (diluted by water) (%)	pH value (level)	Mass of the magnesium tablets (g)					
		Trial 1		Trial 2		Trial 3	
		Initial Mass	Final Mass	Initial Mass	Final Mass	Initial Mass	Final Mass
10	5.90	4.15	1.35	4.16	1.56	4.15	1.42
5	6.10	4.16	2.80	4.16	2.76	4.13	2.75
2.5	6.29	4.15	3.16	4.13	3.12	4.15	3.26
1.25	6.48	4.12	3.58	4.15	3.55	4.16	3.52
0.625	6.68	4.13	3.92	4.12	3.90	4.12	3.87
100 water	6.80	4.16	3.97	4.15	3.95	4.16	3.99
100 Potassium Phosphate	4.80	4.15	3.95	4.15	3.98	4.13	3.95

Qualitative Data

Trial 1	1. When the tablet was taken out of the solution, there were a lot of bubbles on the tablet and in the solution. 2. Tablet became considerable small in the 10% concentration of potassium phosphate. However, there were little change in the appearance in the 0.625% concentration. 3. The color of solution turned yellow when the tablet was submerged.
Trial 2	1. All the same characteristics shown in trial 1. 2. I accidentally dropped the tablet back into the solution. 3. faint sizzling sound when the tablet is submerged in the solution.
Trial 3	1. All the same characteristics shown in trial 1 and 2. 2. Found out that the sizzling sound becomes louder when the tablet is submerged into solution with higher concentration of potassium phosphate.

Processed Data

Table 2. Average difference in mass of the magnesium tablets between the initial and final mass.

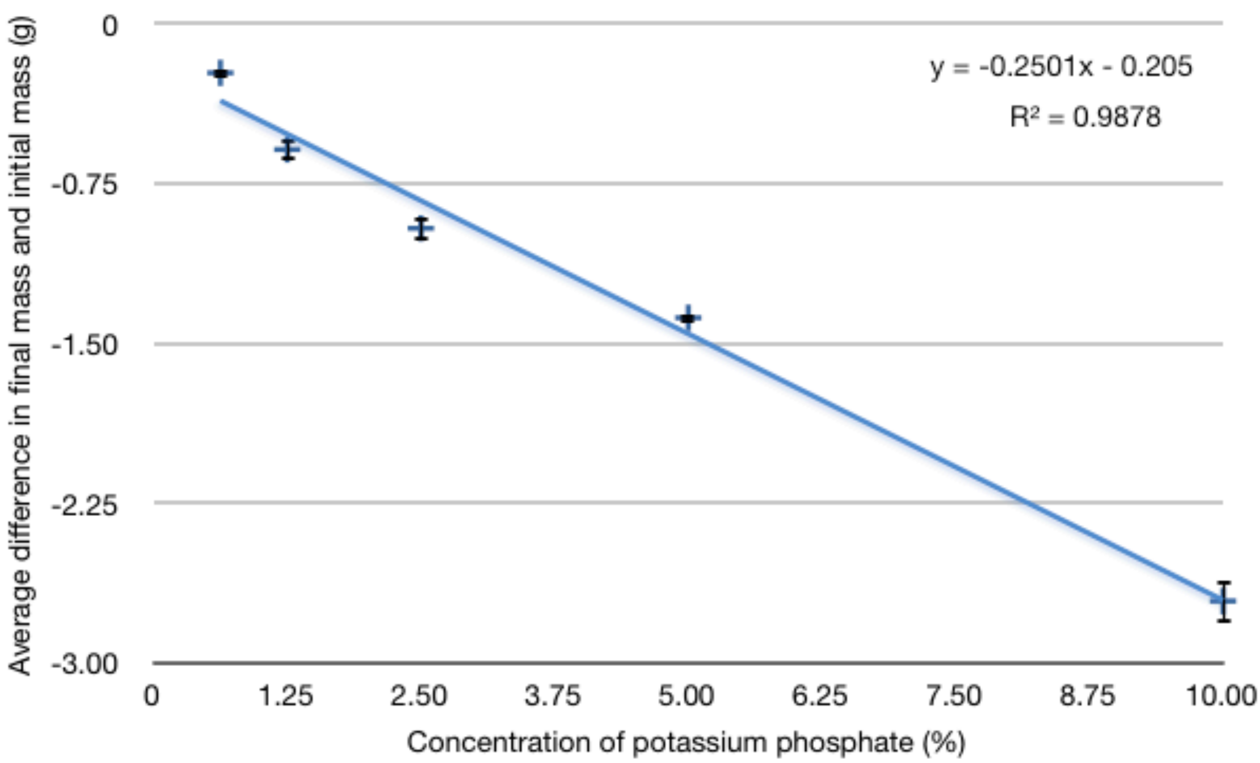
Concentration of the Potassium Phosphate (g)	pH value (level)	Difference in mass of the magnesium tablets (final mass - initial mass) (g)				Standard Deviation (STDEV)
		Trial 1	Trial 2	Trial 3	Average (rounded up to the hundredth place)	
10.000	5.90	-2.80	-2.60	-2.73	-2.71	0.10
5.000	6.10	-1.36	-1.40	-1.38	-1.38	0.02
2.500	6.29	-0.99	-1.01	-0.89	-0.96	0.06
1.250	6.48	-0.54	-0.60	-0.64	-0.59	0.05
0.625	6.68	-0.21	-0.22	-0.25	-0.23	0.02
100 of water	6.80	-0.19	-0.20	-0.17	-0.19	0.02
100 of Potassium Phosphate	4.80	-0.20	-0.17	-0.18	-0.18	0.02

One example of the calculations:
Take the data from Table 1 and find the difference (final mass - initial mass)
1.35 - 4.15 = -2.80
1.56 - 4.16 = -2.60
1.42 - 4.15 = -2.73

Then, find the sum of the differences and divide it by 3 to get the average difference in mass
-2.80 + -2.60 + -2.73 = -8.13
-8.13/3 = -2.71
∴ = -2.71g

Presented Data

Graph 1. Average difference in mass of the magnesium tablets between the initial and final mass.



Conclusion

The research question stated: How does changing the pH level of water by adding potassium phosphate and performing serial dilution by two-folds affect the dissolution of macronutrient, magnesium, measured by mass? My hypothesis to this research question was that if the pH level of water is increased by decreasing the concentration of potassium phosphate into 10%, 5%, 2.5%, 1.25%, and 0.625% through serial dilution. Then, the mass of the magnesium tablet will decrease as the pH level of water reaches the optimum pH level. However, the mass of the tablet will start to increase again as the pH level of water exceeds the optimum pH, resulting in the water disintegrating the mineral much less. This hypothesis was supported by the data collected through experiments.

Referring back to Table 2, it is evident that the average differences between the initial and final mass decreased as the concentration of potassium phosphate decreased and pH level of the solution exceeded the optimum pH. For example, 10% concentration of potassium phosphate with pH level of 5.90 had the average difference of -2.71g. This indicates that the mass of the magnesium tablet decreased 2.71g. On the other hand, 0.625% concentration of potassium phosphate with the pH level of 6.68 had the average difference of only -0.23g. This indicates that the mass of the magnesium table only decreased 0.23g from the initial mass.

Also, looking at Graph 1, it is easy to point out the apparent pattern or trend of the difference in mass of the magnesium tablets as the concentration of potassium phosphate decreases. The trend line demonstrates that as the concentration of potassium phosphate decreases by 10%, 5%, 2.5%, 1.25% and 0.625%, the difference in mass of the magnesium tablets also decreases in order of -2.71g to -1.38g, -0.96g, -0.59g, and -0.23g.

This trend or pattern is due to the characteristics of optimum pH of the mineral, magnesium. It is known that the magnesium in the soil disintegrates the most when the pH level of water reaches the level of 5.5 to 6.0, which is called the optimum pH. When the concentration of potassium phosphate was 10%, the pH level of the water changed to 5.9, which is in the range of optimum pH. Therefore, the difference in the initial mass and the final mass was -2.71g, the largest difference as the magnesium disintegrated the most. However, the difference in mass began to decrease as the magnesium disintegrated less as the pH level of water exceeded the optimum pH due to the lowered concentration of potassium phosphate in water. When, the optimum pH is exceeded either lower or higher, the activity of disintegration is slowly terminated. When the pH value becomes extreme, the disintegration is completely terminated.

In summation, it is evident that the mass of the magnesium tablet decreased less as the concentration of potassium phosphate decreased and the pH level of the water exceeded the optimum pH. The macronutrient, magnesium, is vital mineral to the plant growth. It is the central element of chlorophyll, which is the vital component that absorbs the sunlight in order to create glucose for the plant growth (Magnesium Basics). With the correct pH level of water, it is possible to disintegrate the magnesium in the soil in large amount for the plants to absorb. As my experiments supported my hypothesis, it is important to note that 10% of potassium phosphate in water is the most appropriate to disintegrate the magnesium in the soil.

Evaluation

Reliability of Procedure

My procedure successfully performed what it was suppose to do as it consistently yielded the same results throughout the repeated trials. Throughout the repeated trials, my results were consistently same and demonstrated a clear trend: decrease in concentration of potassium phosphate in water results in increase in the pH value. Therefore, the mass of the magnesium tablet decreased less as the concentration decreased. Also, there weren't any major outliers that could have affected my experiment significantly. Furthermore, any human errors were minimized to ensure that the procedure performs what it is suppose to perform. For example, I made sure to measure the volume of water with more precise graduated cylinder with less uncertainty, and I measured the mass of the magnesium tablets with more precise electronic balance. Therefore, it is evident that my procedure is reliable.

Validity of Procedure

My procedure is not only reliable, but it is also valid because it was able to successfully test the intended scientific concept. My intended scientific concept was to test the affect of pH level of water on the macronutrient of plant, magnesium, which has a vital role in plant growth. Also, my experiment answered my research question through proving and supporting my hypothesis of decrease in concentration of potassium phosphate resulting in decrease in the difference between initial and final mass of the magnesium tablet. Furthermore, I managed to safely control my controlled variables to keep the validity of my procedure. For example, I made sure to use different graduated cylinders to measure the distilled water and the solution containing dissolved potassium phosphate. This was to ensure that the pH level of water does not change by using the same graduated cylinder for measuring both. Also, I used the same electronic balance, beakers, spatulas, and even the stopwatches to ensure the validity of my procedure. Lastly, I included a positive and negative control, control group, to regulate my experiment. In this investigation, I had control group of 10ml of 100% distilled water and 10ml of 100% potassium phosphate. This way I was able to compare and regulate my results by looking at the pH values and mass changes for each trial. Therefore, I can ensure that my procedure is valid.

Errors and Improvements

Even though my procedure is reliable and valid, I did make mistakes throughout my experiment. First, I made a mistake when submerging the magnesium tablet in the solution for 15 seconds. When I was taking out the magnesium tablet with the spatula when it reached 15 seconds, I accidentally dropped the tablet back into the solution. I immediately took it back out within 3 seconds, but it could have affected my results since it could have disintegrated the magnesium tablet more than its correct value. I need to improve on this error by using tweezers to take out the magnesium tablet from the solution rather than spatula. Another mistake was that I did not wait until the tablet was completely dry before measuring the mass of the tablet. This could have affected the mass of the magnesium tablet when measuring because of the mass of the water that has been measured with the tablet. To improve this mistake, I should wipe the tablet dry or wait 24 hours to make sure the tablet is completely dry before measuring the mass of it.

Further Inquiry

In my further investigation, I want to investigate on the optimum pH of the root zone. Throughout my research, I found out that there are tremendous differences between the affects of the pH level of water and the pH level of the root zone. It is known that the pH level of root zone is very crucial to whether a particular plant can survive or not in the particular soil. My second further inquiry is the affects of the other minerals on the plant growth. Through the research, it was evident that magnesium is not the only mineral that is crucial to the survival of plants. I want to investigate and explore the actual affects of the other minerals on the plant growth.

Works Cited

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