SUNLIGHT TO SAFE WATER: A SUSTAINABLE SOLUTION

Jawed Timuri
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ABSTRACT

Access to clean drinking water is a global issue, especially in areas without electricity or advanced water treatment systems. The purpose of this project was to test how different materials—glass, plastic, and metal—affect the effectiveness of a DIY solar-powered water purifier. This project is important because it investigates how material choice can improve a low-cost, environmentally friendly method of purifying water using renewable solar energy. Three identical solar-powered water purifiers were built using the same two bottles per each material. The only difference between the purifiers was the outer container material: one was made of glass, one of plastic, and one of metal. Equal amounts of contaminated water were placed into each purifier and exposed to direct sunlight for to 2 hours. Water quality was measured by recording clarity on a scale of 1-5, the amount of purified water collected in milliliters, and pH levels before and after purification. The results showed that the glass purifier produced the best overall results, collecting the highest amount of purified water and showing the greatest improvement in clarity and pH. The metal purifier showed moderate improvement, while the plastic purifier produced the least purified water. These findings suggest that materials that allow more sunlight to pass through improve the evaporation and condensation process. Overall, this project demonstrates that material selection plays an important role in the efficiency of solar-powered water purification systems.

SCIENTIFIC QUESTION

How does the type of material (glass, plastic, or metal) used in a DIY solar-powered water purifier affect the amount and quality of purified water produced?

HYPOTHESIS

If contaminated water is purified using solar-powered water purifiers made of plastic, glass, and metal, then the glass purifier will collect the greatest amount of purified water because it allows more sunlight to pass through, increasing evaporation and condensation.

BACKGROUND RESEARCH

Many people around the world do not have clean water to drink. The World Health Organization says about 1 million people are estimated to die each year from diarrhea because of unsafe drinking water. Dirty water can contain bacteria, viruses, chemicals, and other harmful substances. That is why we need simple, safe, and affordable ways to clean water, especially in places without electricity.

One way to clean water is called solar distillation. This means using the Sun's energy to clean water. When the Sun heats dirty water, the water turns into vapor, like steam. This is called evaporation. The dirt, salt, and germs cannot turn into vapor, so they stay behind in the original container. The vapor then travels to a cooler place and cools down, turning back into liquid water. This is called condensation. The water that forms is clean because the harmful substances were left behind. This process is similar to how rain is made in nature through the water cycle.

The material of the bottle matters because it affects how much sunlight enters the system. Glass lets most sunlight pass through it, which helps trap heat inside, like a greenhouse. Plastic lets some sunlight through, but not as much as glass. Metal does not let sunlight pass through at all. More sunlight means more heat, and more heat means faster evaporation. Faster evaporation can produce more clean water. That is why the glass purifier should collect the greatest amount of purified water.

PROCEDURES

1. Prepare the containers:
2. Fill each container with the same amount of water (e.g., 100 mL).
3. Insert a straw into each container so it can collect condensed water. Secure it if necessary.
4. Set up for condensation:
5. Place all three containers in direct sunlight or under a bright lamp.
6. Ensure each container receives the same amount of light.
7. Start timing:
8. Record the start time and leave the containers exposed for 2 hours.
9. Collect condensed water:
10. After 2 hours, use the straws to collect the condensed water.

11. Measure the volume of water collected from each container using a measuring cup or graduated cylinder.
12. Measure water quality:
13. Use a TDS meter to measure total dissolved solids of the condensed water.
14. Measure pH using test strips or a digital meter.
15. Record observations:
16. Note differences in volume, TDS, and pH among the three materials.
17. Repeat for accuracy:
18. Repeat the experiment 2-3 times to ensure consistent results.
19. Analyze results:
20. Compare the materials to determine which collects the most water with the best cleanliness (lowest TDS and pH closest to 7).

VARIABLES

Independent:

The type of container material: glass, plastic, or metal

Dependent:

The amount of condensed water collected through the straw (measured in milliliters)

Volume of condensed water collected (mL)

Water cleanliness as measured by TDS (ppm)

Water pH

Controlled:

Volume of water in each container (e.g., 100 mL)

Exposure time (2 hours)

Light source (same sunlight or lamp intensity for all containers)

Size and type of straw used

Room or outdoor temperature (or test all at the same location)

Placement of containers (all at same angle and distance from light source)

Type of water used (same tap or contaminated water source)

MATERIALS

- 3 containers: glass, plastic, metal
- Tap or contaminated water (same source for all)
- Straws (1 per container)
- Small funnel or tape to secure straws
- TDS meter
- pH test strips or digital pH meter
- Timer or clock
- Measuring cup or graduated cylinder
- Notebook and marker for recording data
- Sunlight or bright lamp

RESULTS

Container Material	Trial #	Sunlight Exposure Time (hours)	Amount of Water Collected (mL)	TDS (ppm)	pH	Observations
Glass	1	2	18 mL	8 ppm	6.6	Strong evaporation, heavy condensation
Glass	2	2	21 mL	10 ppm	6.7	Highest temperature reached
Glass	3	2	19 mL	9 ppm	6.5	Consistent condensation in pipe
	Average	2	19.3 mL	8.3	6.6	Greatest water production

RESULTS

Container Material	Trial #	Sunlight Exposure Time (hours)	Amount of Water Collected (mL)	TDS (ppm)	pH	Observations
Plastic	1	2	15 mL	15 ppm	6.5	Slow heating, light condensation
Plastic	2	2	17 mL	13 ppm	6.6	Slight evaporation increase
Plastic	3	2	16 mL	16 ppm	6.4	Minimal condensation
	Average	2	16 mL	14.6 ppm	6.5	Lowest output overall

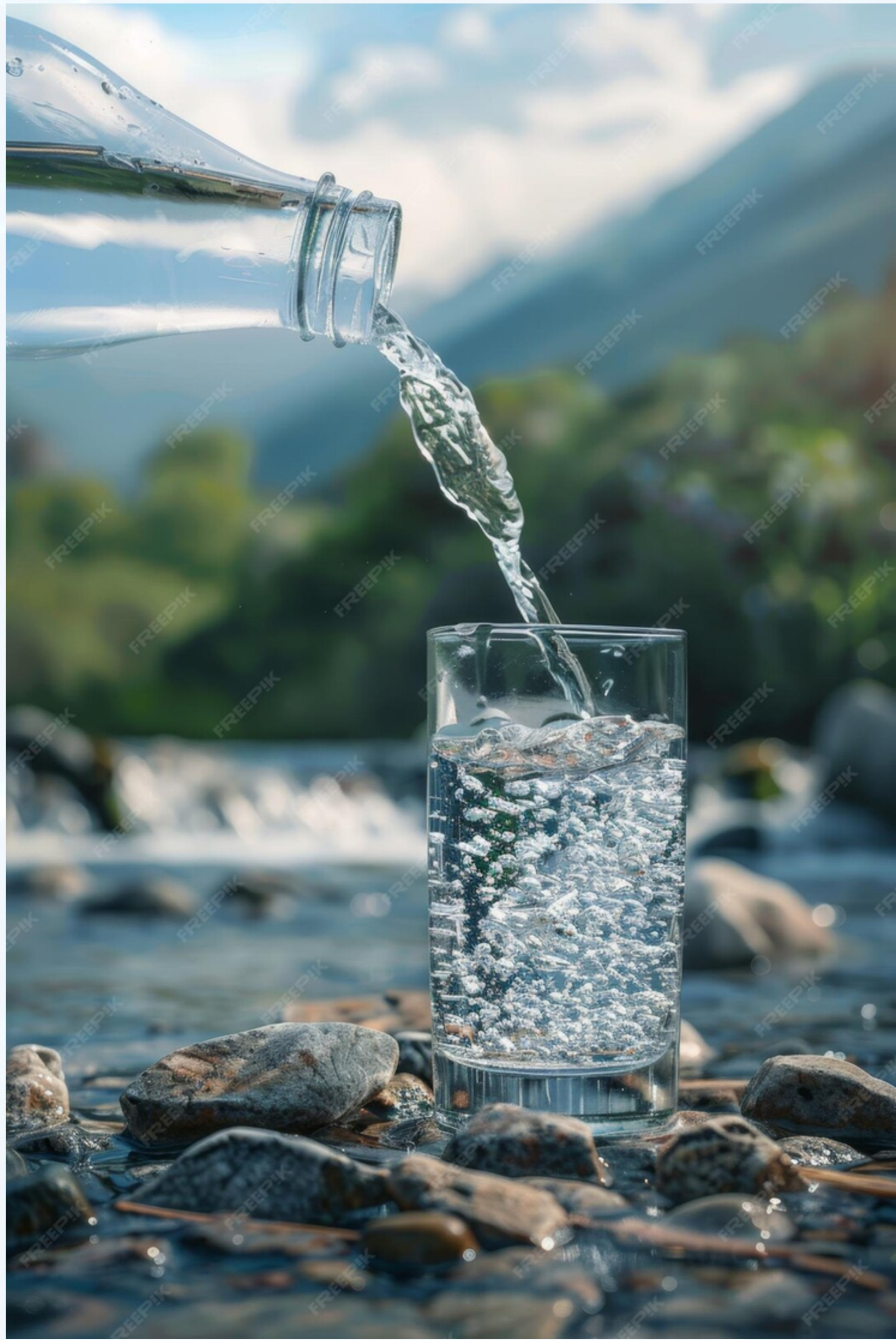
RESULTS

Container Material	Trial #	Sunlight Exposure Time (hours)	Amount of Water Collected (mL)	TDS (ppm)	pH	Observations
Metal	1	2	17 mL	11 ppm	6.4	Moderate condensation
Metal	2	2	18 mL	13 ppm	6.5	Steady evaporation
Metal	3	2	20 mL	12 ppm	6.3	Slightly cloudy surface
	Average	2	18.3 mL	12 ppm	6.4	Medium water production

CONCLUSION

The results of this experiment support the hypothesis that the type of material affects how well a solar-powered water purifier works. The glass container produced the most purified water and showed the best improvement in water quality. The metal container showed moderate results, and the plastic container produced the least amount of purified water.

This suggests that materials that allow more sunlight to pass through increase evaporation and condensation. Overall, glass is the most effective material for a solar-powered water purifier, making it a better choice for creating a simple and sustainable clean water solution.



FUTURE DIRECTION

In the future, this experiment could be expanded by increasing the number of trials to make the results more accurate. The purifiers could also be made larger to see if a bigger system produces more clean water. Another improvement would be to measure additional water quality factors, such as bacteria levels, to better understand how safe the purified water is. Testing the purifier in different locations or seasons could also show how temperature and sunlight intensity affect the results.

These changes would help improve the design and make solar-powered water purifiers more reliable for communities that need safe drinking water.

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