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# Purification of Water by Aloe

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**Summary**

**Phosphate, copper, iron, and nitrate are common contaminants found in water and can cause severe illnesses. These pollutants arise from the use of fertilizers to increase crop production. Obtaining adequate water purification is a continuing and growing problem, especially in Africa. The aloe vera gel from the aloe vera cactus, which is indigenous to Africa, may be used to purify water. The aloe vera gel reduced copper, iron, and phosphate concentrations by 100%, 93%, and 40%, respectively. However, the aloe vera gel was not effective for removing nitrate. The interaction between the aloe vera gel and the pollutants is important because it can provide a simpler way to purify water with natural material that is abundant in African countries.**

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## Introduction

Unsanitary drinking water is a continuing issue in the world. About 1 out of every 9 people today do not have adequate access to clean water (1). It is vital to have access to clean water to meet the basic necessities, to increase the living standard, and to avoid diseases. Each day, 5,000 children worldwide die from waterborne diseases (2). In Africa, 1 in every 5 people does not have access to clean water (3).

Fertilizers are used to increase crop production, but the use of these fertilizers has led to contamination of the drinking water (4). Common contaminants in the water include arsenic, lead, phosphate, copper, iron, chlorine, and nitrate.

This experiment focused on iron, copper, phosphate, and nitrate because these pollutants are common in Africa (5). An increased concentration of iron in the body can lead to hemochromatosis (6). Excessive copper can cause stomach and intestinal distress as well as Wilson's disease (7). Excess phosphate can cause mineral toxicity, an adverse health condition (8). Nitrate poses the danger of causing methemoglobinemia. This is a condition that occurs when the blood's ability to transport oxygen throughout the body has decreased (9).

Common methods of purifying water include reverse osmosis, filtration, and ion exchange. Reverse osmosis is when pressure is applied to water so that it goes through a semipermeable membrane, deionizing the water. However, the machinery required for reverse osmosis is not easily available in Africa (10). Similarly, the equipment required for ion exchange is also not readily available to Africans (11). Simple filtration is a common method in Africa, although it does not remove ions from water, which is why the aloe cactus may be a better alternative (11, 12).

Ongoing studies on cacti have shown that they reduce the concentration of some contaminants in water (12-14). Aloe is a cactus that is native to parts of Africa. The hypothesis is that the addition of aloe gel will effectively decrease the concentration of nitrate, phosphate, copper, and iron in water. In this experiment, aloe will be added to water containing the contaminants and then the change in concentration over time will be assessed.

## Results

Data was collected using test strips to measure the final concentrations of the contaminants after one day and then again the next day. The final concentration of the contaminants was compared to the initial amount. Results are displayed in **Table 1** and **Figure 1.** The comparisons showed that aloe vera gel decreased the concentration of phosphate by an average of 40% (60% of the original phosphate remained) on day 1. There was no change on day 2. Aloe vera gel decreased the

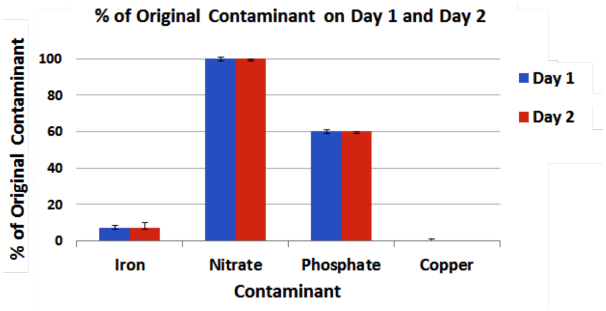


**Figure 1: Effects of aloe vera gel on the contaminants.** This figure shows the percent of original contaminant in the solutions after 1 and 2 days of treatment.

| | Day 0 | | Day 1 Mean | | Day 1 SD | | Day 2 Mean | | Day 2 SD | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Contaminant** | **mg/L** | **%** | **mg/L** | **%** | **mg/L** | **%** | **mg/L** | **%** | **mg/L** | **%** |
| Copper | 3 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Iron | 5 | 100 | 0.36 | 7.2 | 0.13 | 2.68 | 0.36 | 7.2 | 0.13 | 2.68 |
| Phosphate | 50 | 100 | 30 | 60 | 0 | 0 | 30 | 60 | 0 | 0 |
| Nitrate | 50 | 100 | 50 | 100 | 0 | 0 | 50 | 100 | 0 | 0 |

**Table 1**. Effect of gel on contaminant levels. All concentration values are the mean of 5 replicates. Values show the amounts (mg/L) and percentages of original contaminant remaining.

concentration of iron by an average of 92.8% (7.2% of the original iron remained) after one day. Aloe vera gel decreased the concentration of copper as well by an average value of 100% (0% of the original copper remained), and the concentration of copper remained at 0 mg/mL on day 2. Aloe vera gel did not decrease the concentration of nitrate, showing that aloe vera does not remove every contaminant from the water. The concentration of the contaminant in the control tube did not change. Although the aloe vera gel did not decrease the concentration of nitrate, the overall hypothesis was consistent with the data collected for phosphate, iron, and copper. The addition of aloe effectively decreases the concentration of specific contaminants in water.

## Discussion

Contaminated water remains an important problem in certain countries, as it is a cause of waterborne diseases. Although some treatments have been found to eliminate certain contaminants, our experiment focused on purifying water from contaminants found in Africa. Africa is one of the countries with severe water conditions.

This study identifies aloe vera gel as a purifying agent of water, since it decreases the concentrations of some contaminants. We demonstrated that aloe vera gel can remove a few contaminants found in Africa, which has the potential to improve the lives of 345 million people. These results may have been affected by the difference in concentration of the starting samples (with phosphate and nitrate having at least a 10x higher starting concentration than copper and iron). Future experiments should make the initial concentrations of all the contaminants the same, although there is no one concentration that all the test strips test for, making this harder to achieve. How the aloe vera gel purified the water is unknown, although we propose that the aloe vera gel purifies the water from copper, phosphate, and iron by adsorbing the contaminants because of its adhesive nature (15). Because the gel is not made from these contaminants, we could test this hypothesis by studying the components of the gel and recording whether or not the gel contains these contaminants.

Our results support the hypothesis that aloe vera gel trapped the phosphate, iron, and copper, making them no longer free to react with the test strip. Nitrate, however, was not removed. This shows that aloe vera gel does not purify all contaminants. Since aloe vera is still in the solution, a more structural study needs to be performed to extract the aloe vera gel holding the contaminants. The aloe could be extracted via filtration.

Overall, this study provides a framework for purifying water even though aloe vera gel does not purify all contaminants, such as nitrate. Our future experiments would study the time course of decontamination.

## Methods

Tests were performed at room temperature. A 10mL aqueous standard solution for each contaminant was created. The concentration of the contaminants in these solutions matched the maximum concentrations the test strips could measure (phosphate: 50 mg/L, copper: 3 mg/L, iron: 5 mg/L, nitrate: 50 mg/L). This was the initial concentration of the contaminants. A commercial sample of aloe vera gel, which was extracted from the cactus in pure form, was used to decontaminate the water. In short, 0.320 g of aloe vera gel was squeezed out of the tube into the contaminant solutions and mixed. Five replicates were prepared for each contaminant, along with a control tube with just the contaminant and water. The test tubes were stoppered to avoid evaporation of the solution. The final concentrations of each of the replicates for all contaminants were measured after one day and then again on the following day to see if the final concentration changed more between Day 1 and Day 2. The final concentrations were measured using test strips. The accuracy of the test strips was confirmed using known concentrations of contaminant. The expected result was that the addition of aloe would purify the water by decreasing the contaminant level. The purified water could be separated from the aloe vera gel using filtration.

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