Which Oil is Best to Use to Create a Ferrofluid Capable of Retrieving Microplastics?

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Purpose

This project attempts to determine which oil of the four tested can best retrieve microplastics from water. I wanted to find the optimal oil to use to create a ferrofluid, which would then be capable of extracting a large concentration of microplastics. By doing this, we can mitigate the effects microplastics have on marine ecosystems, and clean our oceans.

Introduction

- In 2014, there were an estimated 15 to 51 trillion microplastics in earth's ocean (Authorship 2019). These microplastics are very small (less than 0.5mm), making them difficult to filter out of such an open area as the ocean.

- Thanks to the technological advances made in water treatment, we are able to filter out nearly all microplastics from the water, according to tap water.co. However, this process is tedious, expensive, and inefficient to use on a global scale.

- In order to solve this issue of effectively removing microplastics, I sought to answer the question: Which oil will best remove microplastics when used in conjunction with iron oxide to create a ferrofluid?

- The experiment measures the performances of four commonly found oils, all of which demonstrate robust bonding properties. These oils are: vegetable, castor, canola, and olive.

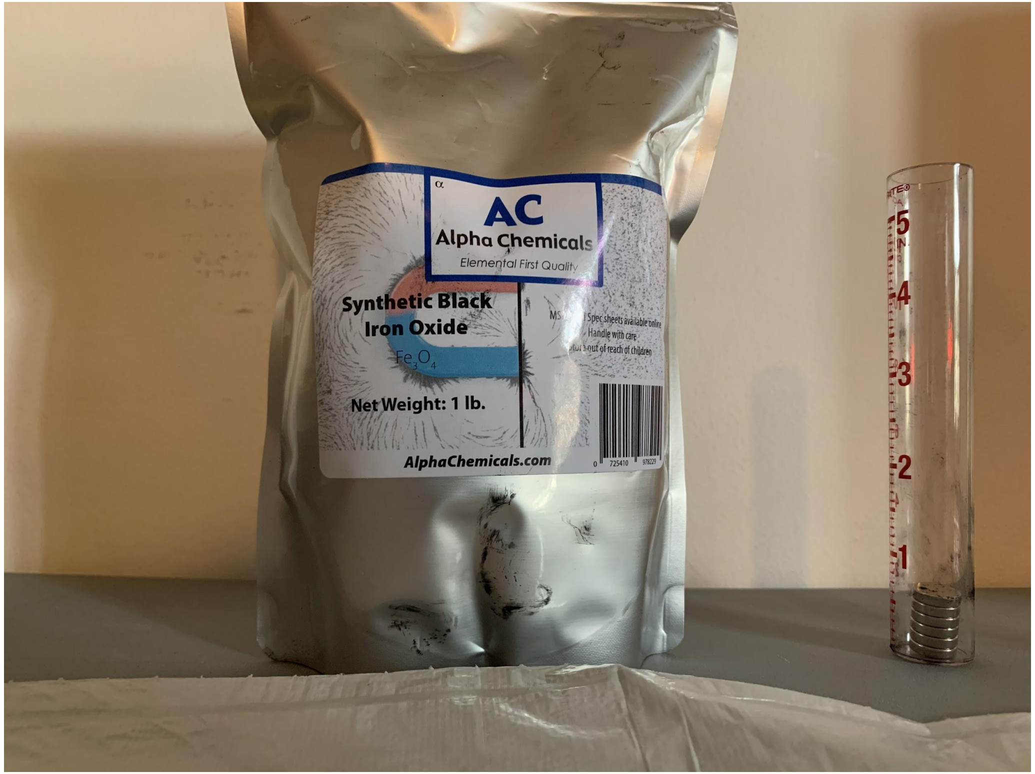
Hypothesis

Of the four oils that I tested (vegetable, castor, canola, and olive), I hypothesized that castor oil would do the best. Research found previous studies that demonstrated castor oil had greater bonding properties than other oils, and could attract the most microplastics in different environmental matrices. It seemed logical in light of this that castor oil would be the best in attracting microplastics.

Oils used in this Experiment

Colorimeter and Turbidity Sensor

Iron Oxide and Neodymium Magnets



Variables

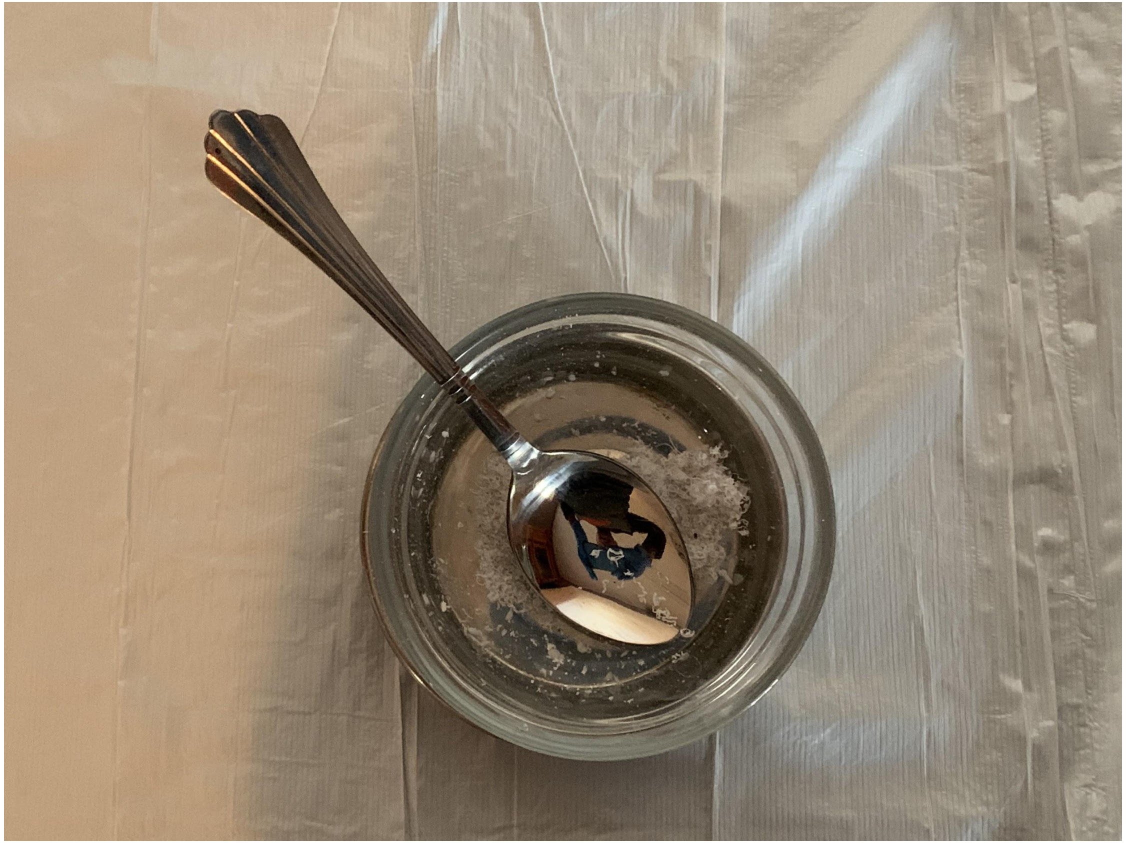
Independent: Oil type.

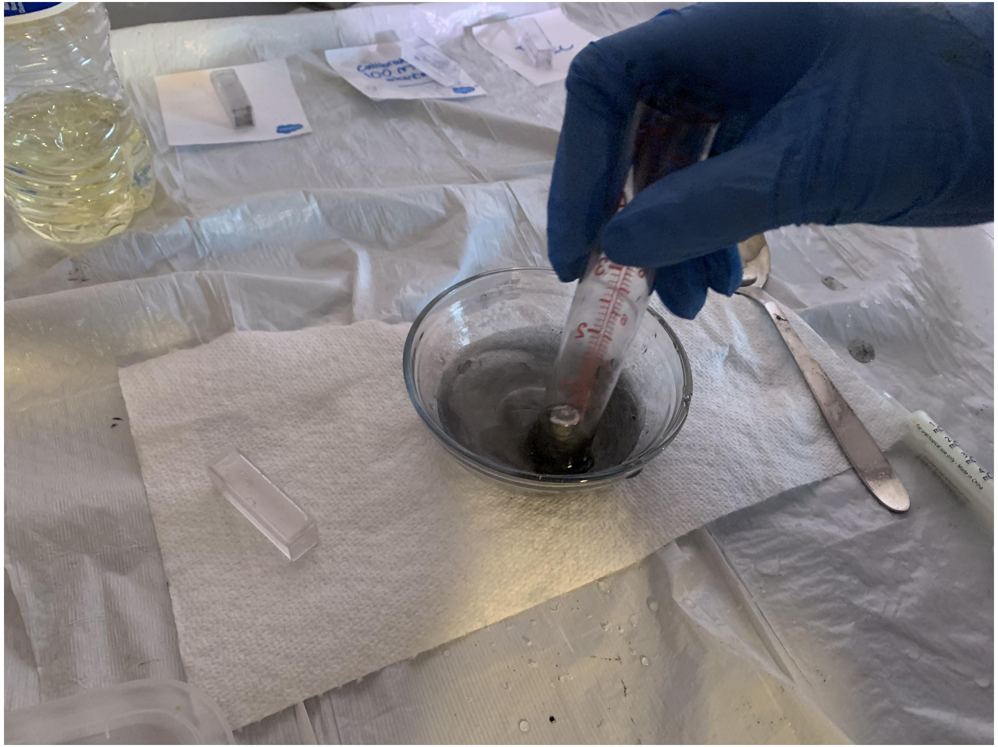
Dependent: Absorbance rate

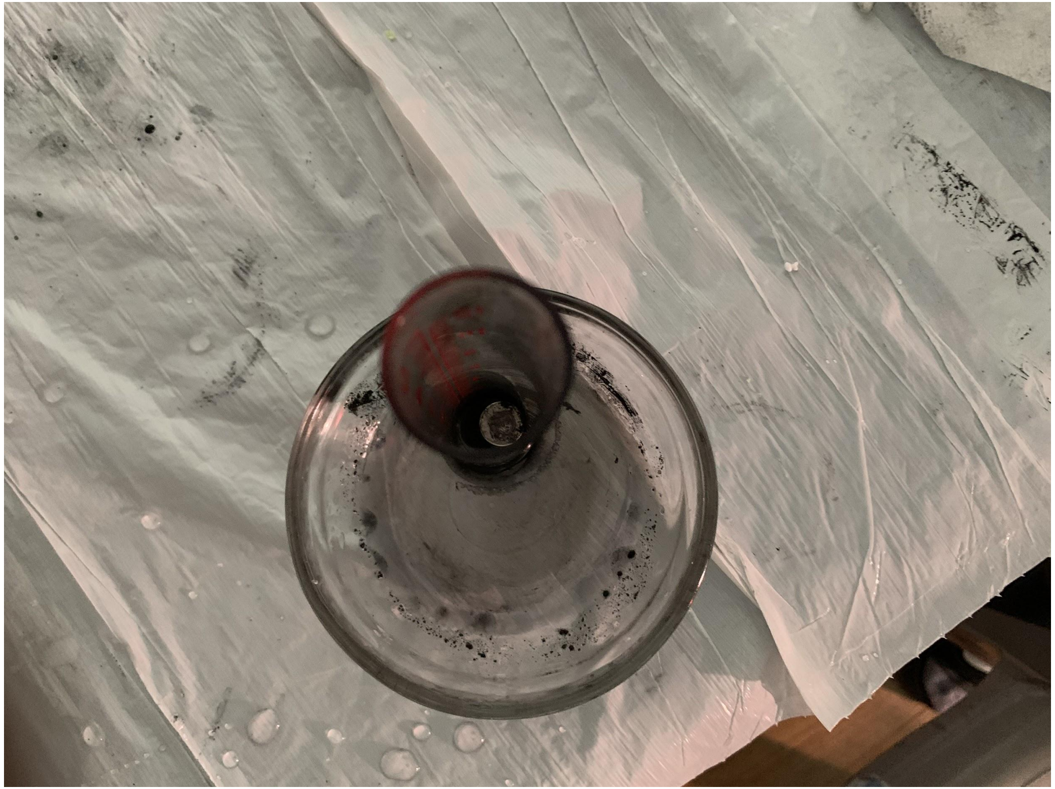
Constant: The equipment (bowls, measuring tools, cuvettes, colorimeters, etc.), wavelength

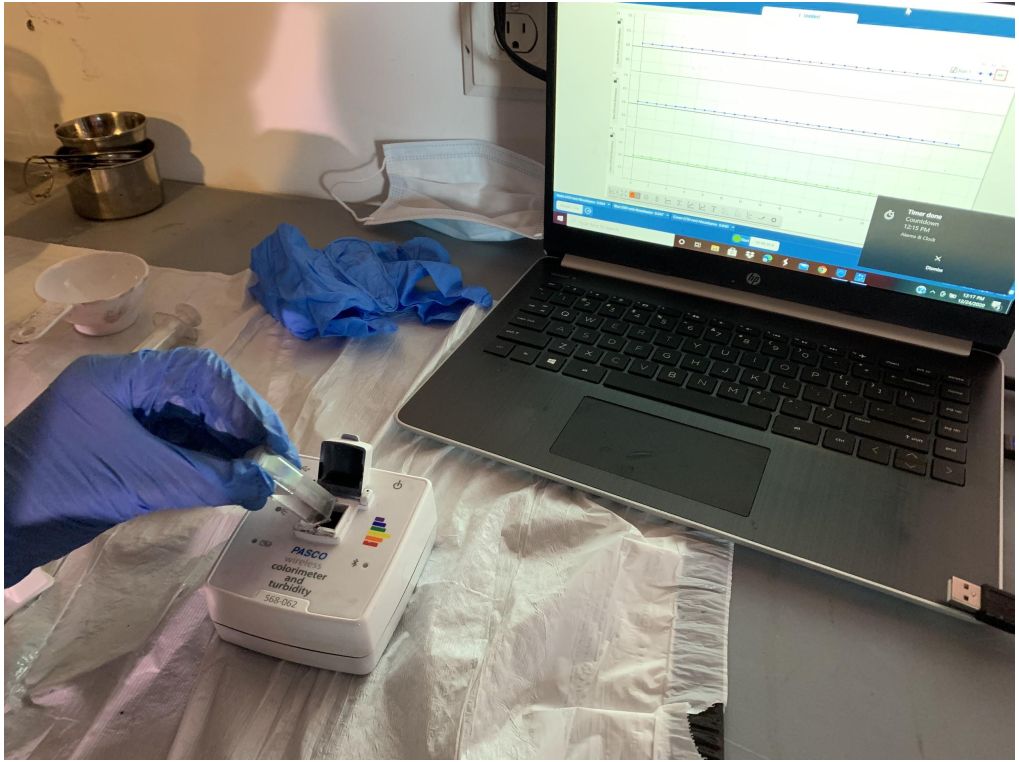
Methods

1. Get microplastics by sanding plastics
2. Mix 1 teaspoon of microplastics into ½ cup pure water.
3. Measure absorbance rate of solution.
4. Mix 2 teaspoons of iron oxide and one teaspoon of oil into solution.
5. Put neodymium magnets inside solution.
6. Measure absorbance rate of solution.
7. Repeat steps 1-6 for each oil 5 times.

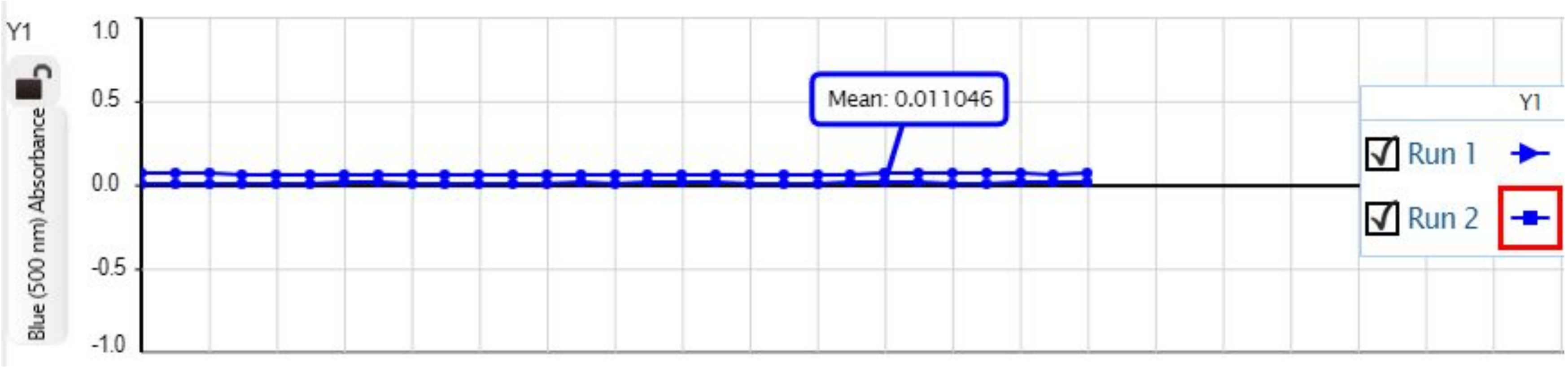


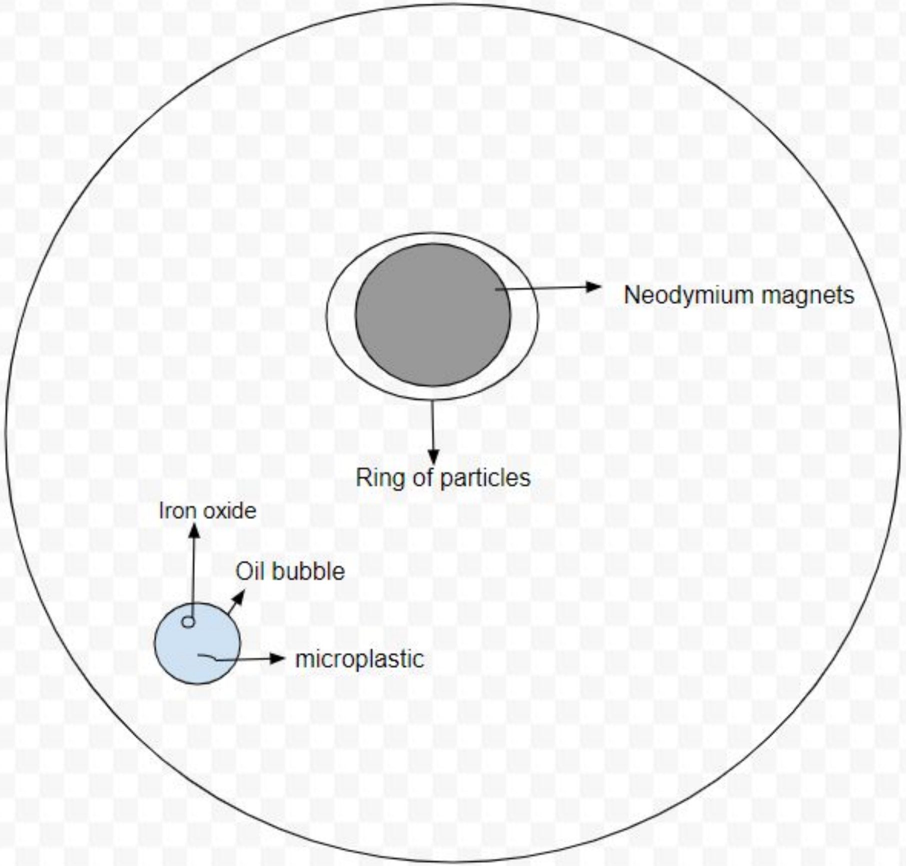





PASCO
wireless
colorimeter
and
turbidity
568-062

Trial Result from Colorimeter





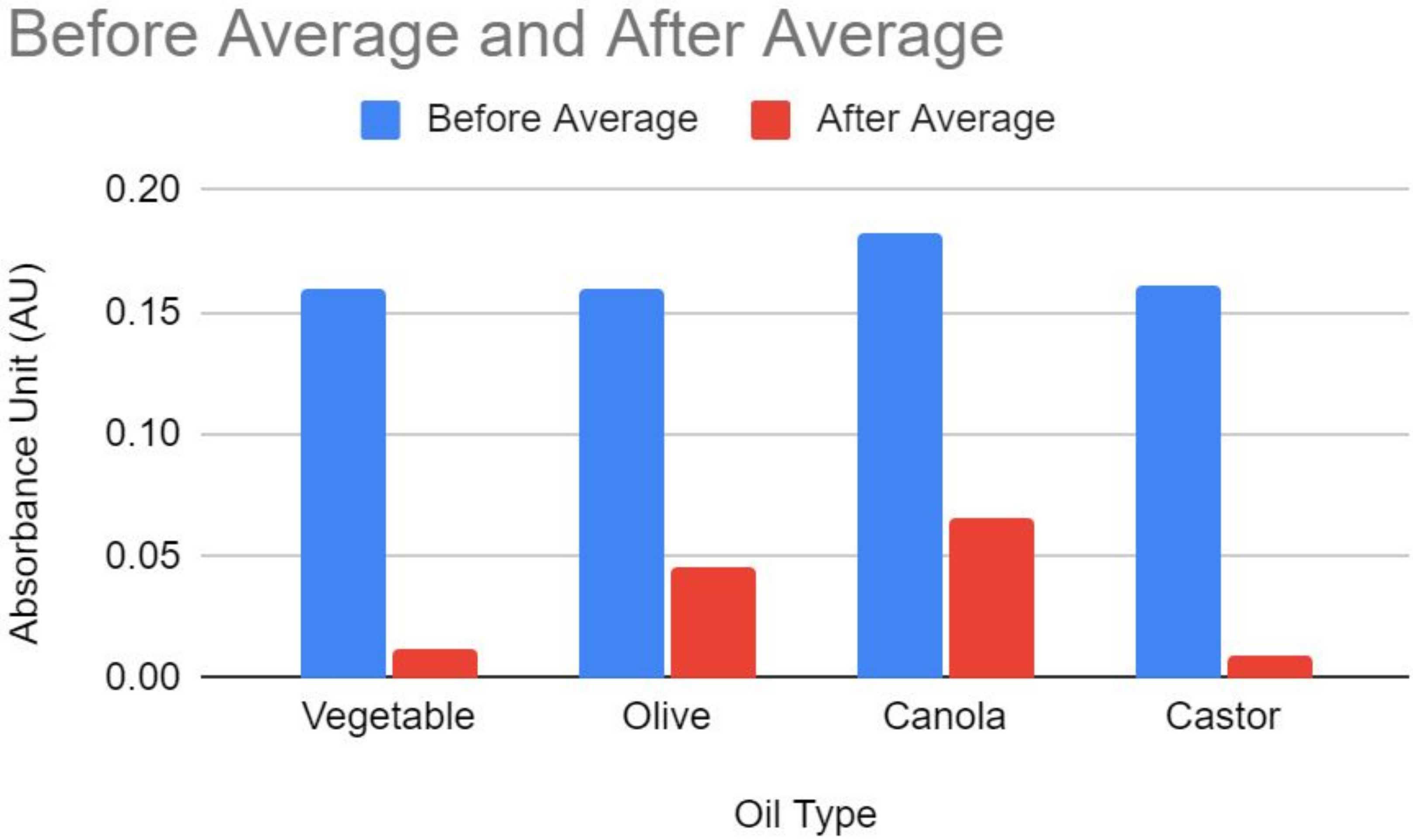
Neodymium magnets
Ring of particles
Iron oxide
Oil bubble
microplastic

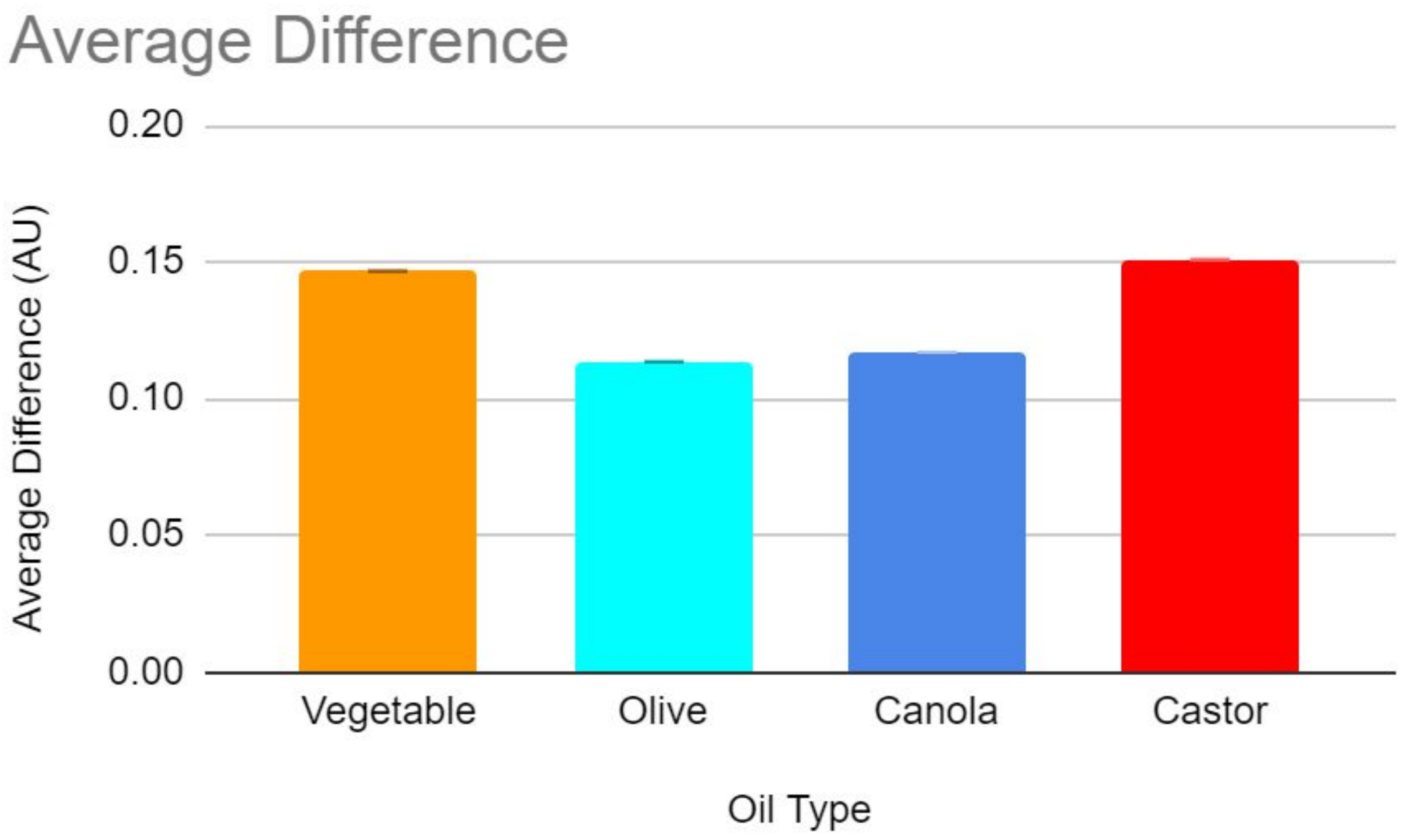
Before Retrieving Microplastics

Oil Name	Trial #					
	1	2	3	4	5	Average
Vegetable	0.1631	0.1685	0.1324	0.1538	0.1781	0.1592
Olive	0.1724	0.1725	0.1584	0.1686	0.1241	0.1592
Canola	0.1686	0.1687	0.1984	0.1921	0.1841	0.1824
Castor	0.1334	0.1746	0.1294	0.1821	0.1821	0.1603

After Retrieving Microplastics

Oil Name	Trial #					
	1	2	3	4	5	Average
Vegetable	0.011	0.0076	0.0301	0.0103	0.0035	0.0125
Olive	0.0782	0.0366	0.0144	0.0864	0.0128	0.0457
Canola	0.1156	0.0884	0.0132	0.0144	0.0956	0.0654
Castor	0.0104	0.0021	0	0.0234	0.0111	0.0094


Before Average and After Average
Before Average
After Average
0.20
0.15
0.10
0.05
0.00
Absorbance Unit (AU)
Vegetable
Olive
Canola
Castor
Oil Type


Average Difference
0.20
0.15
0.10
0.05
0.00
Average Difference (AU)
Vegetable
Olive
Canola
Castor
Oil Type

Data Analysis

- Castor oil and vegetable oil were extremely close, but castor oil narrowly outperformed vegetable oil. Behind these two oils were canola and olive oil, which were also very close to each other.

- In order from best to worst performing, the results are as follows:

- Castor Oil
- Vegetable Oil
- Olive Oil
- Canola Oil

Data Analysis (Continued)

- In order to test if my results were statistically significant, I performed a one-tailed t-test.

- This t-test compared the individual comparisons of each oil in order to check if each comparison was statistically significant or not.

- Important figures would be the alpha level (0.05), and the t-value needed for the results to be significant was approximately 1.8.

Oil Comparisons	t-value	p-value	Significant
Vegetable vs Castor	-0.2639	0.399265	NOT
Vegetable vs Canola	5.07441	0.00096	IS
Vegetable vs Olive	2.37877	0.044631	IS
Olive vs Castor	2.90503	0.009869	IS
Olive vs Canola	0.81623	0.011312	NOT
Canola vs Castor	6.08223	0.000148	IS

Conclusion

- My hypothesis wasn't what I expected, as castor and vegetable oil were so close that their comparison is not statistically significant.
- It is possible that with only five trials, there wasn't sufficient data to show statistical significance between the oils that were close. In the future, I would add more trials.
- The reason why castor and vegetable oil did so well may be based on their density. Both have density of approximately 0.959 g/ml and 0.960 g/ml respectively. A link is clearly suggested as the densities of these oils, which were very close, were also very close in the final results. Canola and olive, the two worst performing oils, had densities of 0.920 and 0.916 g/ml respectively. These were also very close. An article by harvard.edu actually supports this. This is something I want to test in the future.
- This experiment concluded that oils with higher densities may perform better, castor oil and vegetable oil of the four used.

Modifications

I am so glad I was able to do this project. It truly has taught me a lot about lab equipment like colorimeters and their practical real world applications. I am really looking forward to expanding this project in the future, as it has the real potential to combat microplastic in various ecosystems. In the future, I look forward to making several modifications to make my project better. Firstly, I would increase the quantity of trials so as to increase statistical significance. Secondly, I would like to further research the implications oil or iron oxide might have on marine life, and if my small-scale experiment could actually translate to significant real world impacts. Finally, I would like to conduct this experiment with more oils. I only conducted this experiment with four oils because I researched and thought that they were the most accessible and performance worthy. In the future, I really do look forward to utilize more oils in this experiment.

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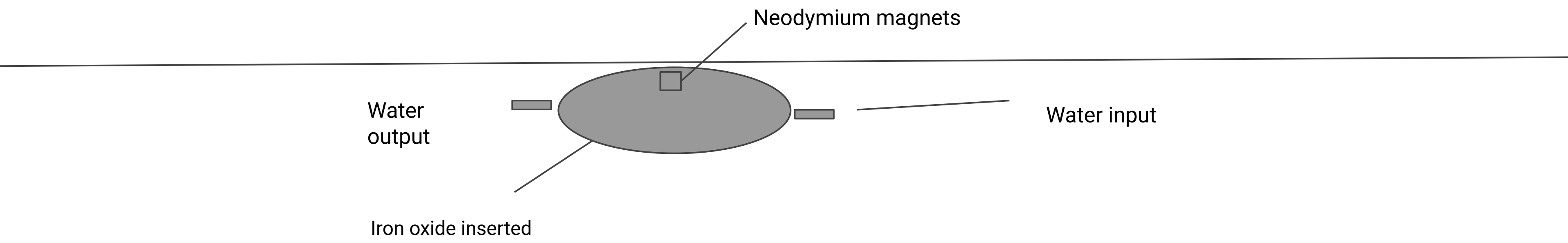
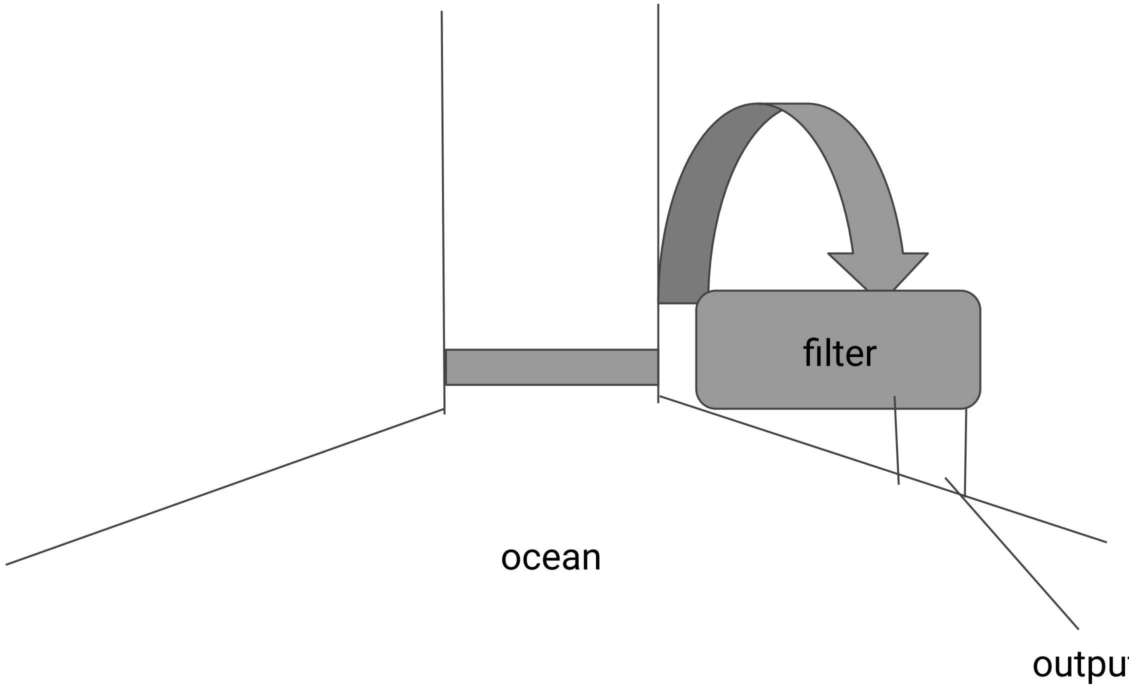
Thank You!


Neodymium magnets
Water output
Water input
Iron oxide inserted


filter
ocean
output

Acknowledgments

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