How Much Plastic do you Drink?

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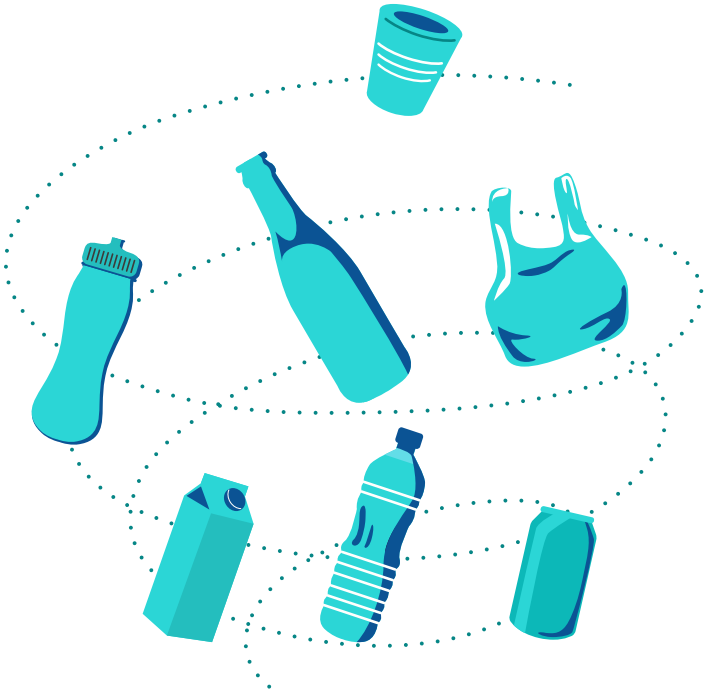

Testable Question

Can you filter out PVA microplastics dissolved from Tide pods into tap water using reverse osmosis?

Background Research - What are they?

- Microplastics are plastic that has broken into smaller pieces and are under 5mm in size.
- Microplastics can come from cigarette filters, textile fibres, or other personal care products such as exfoliators
- Microplastics enter our environment by run off from storms and by wind
- Microplastics have been found everywhere including in the guts of fish and shellfish as well as in human blood
- Microplastics enter your body by ingestion and inhalation
- A common way microplastics are entering your body is by consuming seafood. Researches say that seafood lovers generally consume about 11,000 plastic particles by just eating mussels
- Microplastics can be found from the bottom of your lungs to your bloodstream

Can Microplastics Harm you?

- The chemicals in plastic that make the plastic have strength and flexibility have toxins in them.
- The chemicals in plastics can cause lung disease and cancer.
- The question about harm from microplastics was generated around 40 years ago and since then, more and more species have been identified as being affected by these plastics.
- More than 700 species are being affected by plastics and it has been said that hundreds of millions of wild birds have consumed plastic.
- There have been studies to determine whether these plastics affect living creatures, one of which was that Japanese Quail undergo eating plastics to see if they were affected by them (Parker, 2022). The study was performed by Australian scientists and the chicks were fed microplastics and then observed to see if there were any effects. They were not affected by sickness, death, or having trouble reproducing but they were minorly affected by having minor growth delays shown by their cells (Parker, 2022).
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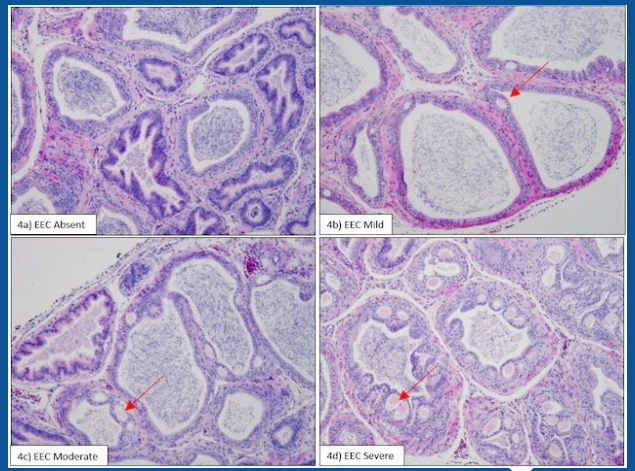
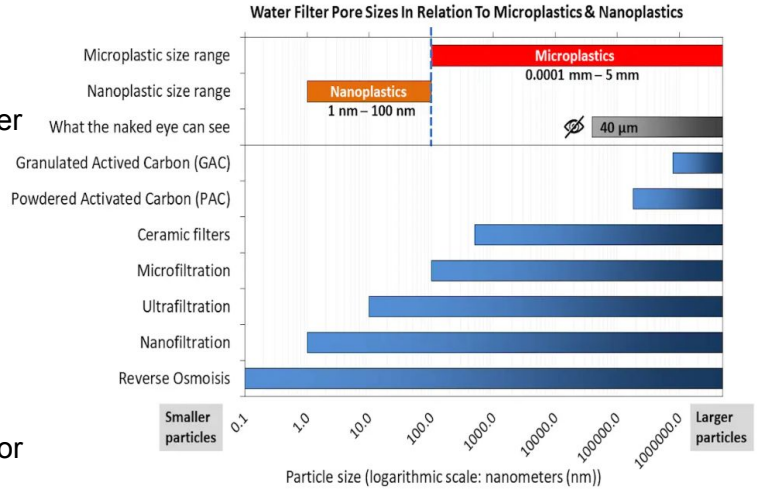


Background Research - Reverse osmosis and about PVA Particles

- PVA which stands for polyvinyl alcohol. PVA is a synthetic plastic polymer that is often used to create thin layers of plastic wrapping and is most commonly used to wrap dishwasher tablets and laundry tablets
- A study suggests that over 75% of PVA plastics run through our waterways and into our soil after they dissolve from laundry and dishwasher pods and then from the waterways they flow into our wastewater and eventually into our environment polluting it with microplastics
- PVA is designed so it can biodegrade, however, scientists say in order for it to truly biodegrade it needs very specific conditions
- Reverse osmosis first removes contaminants from the feed water (unfiltered water) and then forces the water through a semipermeable membrane (Woodard, 2022). A semipermeable membrane has small pores that block contaminants but lets water particles pass through



Variables

01 Manipulated

Reverse osmosis filtration

02 Responding

The amount of microplastic particles found in the pictures of the slides from the filtered and unfiltered samples.

03 Constant

Microscope slides, slide coverslips, dropper, tester, bowl, microscope, reverse osmosis machine, pressure machine, spoon,

Hypothesis

If reverse osmosis water filtration is used to filter a solution with two tide pods dissolved in two litres of water, then the reverse osmosis filter will filter out all of the polyvinyl alcohol (PVA) particles. The hypothesis is based on the fact that the reverse osmosis filter semi-permeable membrane pore size is 0.0001 micrometers wide and a polyvinyl alcohol particle is rarely under 50 micrometers in size. (Research Gate, 1995).

Materials

- Cold water Tide pods
- Tap water
- Two 2 litre bowls
- 20 microscope slides
- 20 microscope slips
- Microscope
- Phone with a usable camera
- 2 Eyedroppers
- Paper towel
- Gloves
- GeekPure reverse osmosis machine
- All Purpose Cleaning Sprayer

Procedure

1. Gather all materials
2. Fill a bowl with 2 liters of tap water
3. Add 2 tide pods
4. Stir with a spoon until fully dissolved
5. Once dissolved use an eyedropper to carefully place one drop of the mixture onto a new microscope slide
6. Then carefully place a coverslip over the droplet
7. Repeat steps 5 and 6 another 5 times so you have 5 slides prepared in total
8. Make sure you mark it with Tide Pod
9. Fill a bowl with 2 litres of tap water
10. Use another eyedropper to prepare 5 slides of tap water
11. Add coverslips on the slide and mark them (tap water)

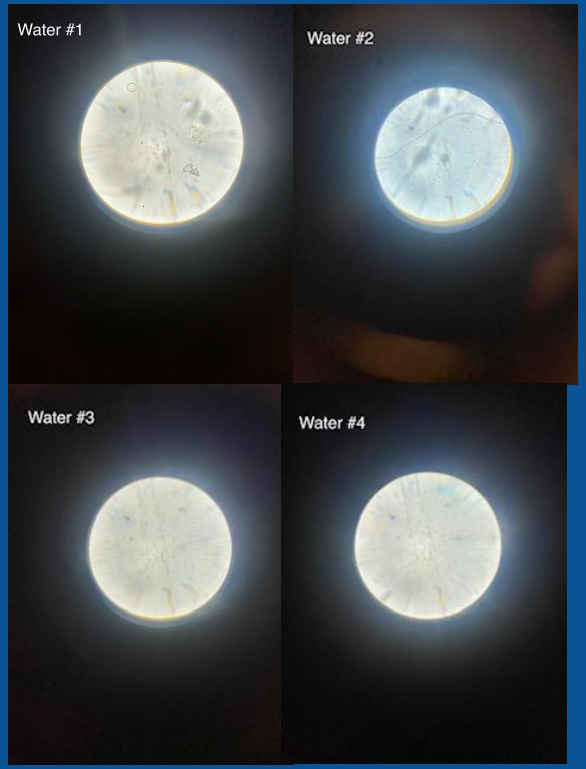
Procedure - Part Two

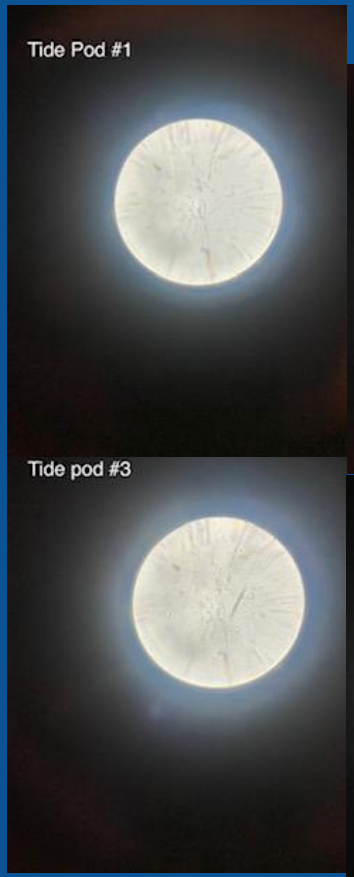
1. Pour the Tide Pod mixture into the All Purpose Cleaning Sprayer
2. Attach the GeekPure reverse osmosis machine to the All Purpose Cleaning Sprayer.
3. Run the rest of the Tide Pod mixture through the machine according to the manufacturer's instructions
4. Collect the filtered water (blue tube) and the rejected water(red tube) and use steps 5-6 to prepare the slides
5. Mark 5 slides each, mark them red tube or blue tube (filtered)
6. After all the slides have been prepared observe each slide carefully under the microscope at 40X magnification
7. Compare the unfiltered and the filtered water by the visible PVA particles
8. Record all observations and take a picture
9. Complete steps 13-15 with tap water prepared in step 9
10. Record results and compare
11. Then fill out a table with the results

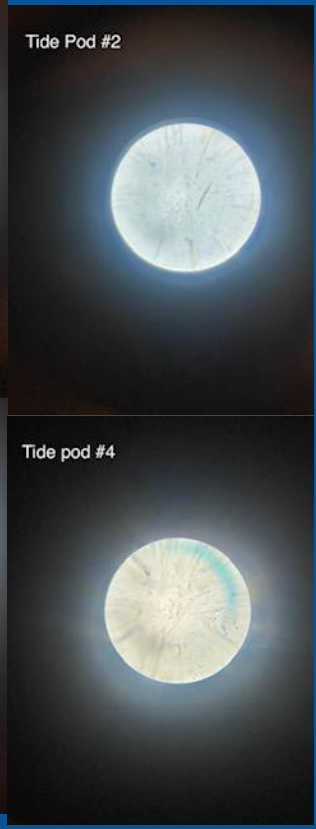
Observations

Solution	Water	Tide Pod + Water	Filtered (Blue) - Permeate	Filtered (Red) - Waste Water
Test # 1	Air bubbles, not a lot of moving particles, collections of bubbles	Lots of small moving particles, and strong laundry scent	No moving particles, only small amounts of bubbles	Lots of particles in splotchy droplets
Test # 2	Lots of bubbles could make out water lines	Many particles	Small bubble clusters in the corners of the slide	Long strings of particles
Test # 3	A lot more bubbles compared to samples 2-3	Many particles and a lot of movement of the PVA particles	Small bubbles but clear	Gray particles
Test # 4	Not many bubbles	String-like particles, formed in line-like strands	Small bubbles but no other particles	Air pockets and a lot of particles
Test # 5	Not many bubbles, the bubble formed in a line	Lots of moving particles	Small particles in a chain	Lots of particles compared to the rest of the samples

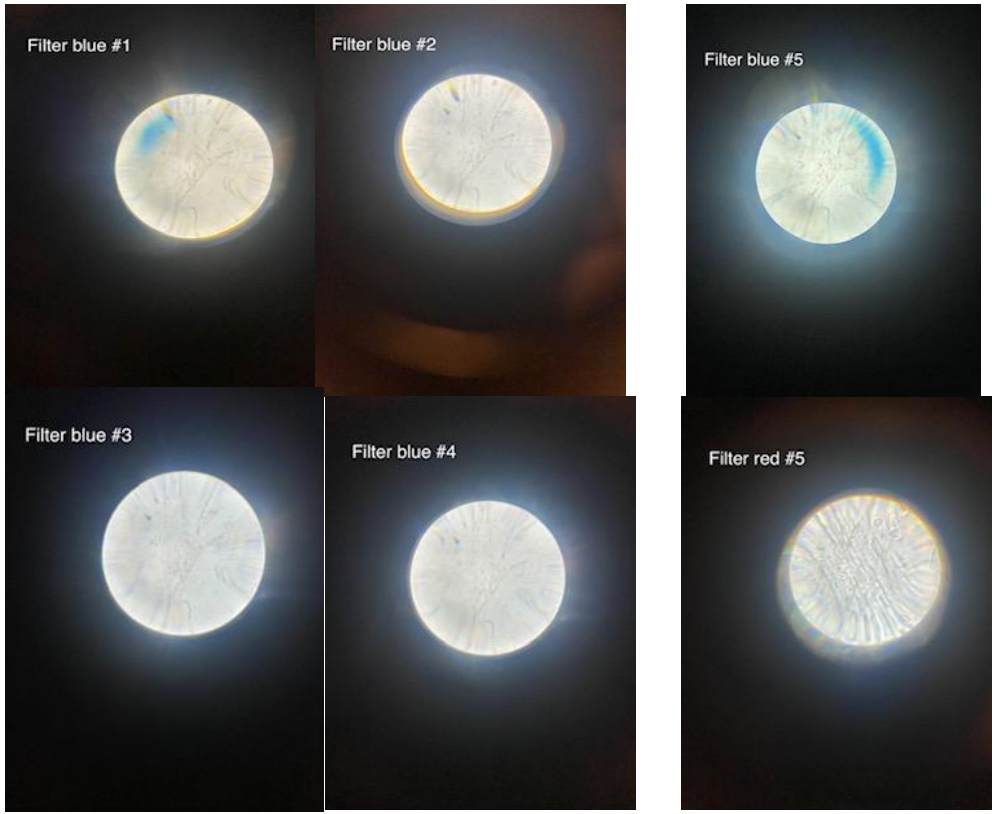
Tap water and Tide Pod Solution Samples

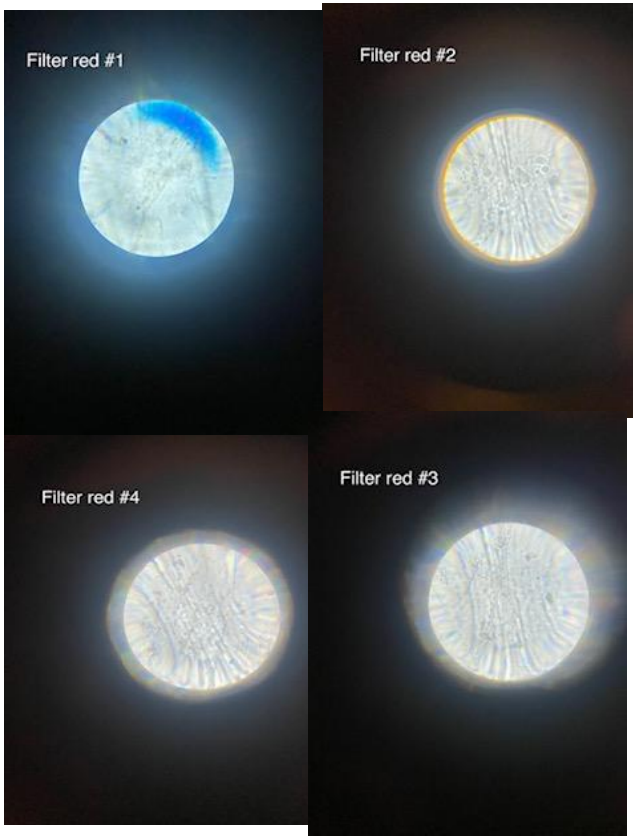






Observations Filtered Red and Filtered Blue





Solution Observations

Tide Pod Solution

- Blue in colour
- Opac no light goes through
- Heterogenous
- Strong scent of laundry
- No undissolved particles visible to the eye

After Filtration

Red Tube (waste water)

- Translucent
- Murky bluish-gray in colour
- Bubbly
- Strong laundry detergent scent
- A lot more out of the red tube then the blue tube

Blue (filtered reverse osmosis water)

- Clear
- A lot less liquid then the red tube
- Transparent
- Very light odor

Analysis

- My experiment showed me that reverse osmosis is an effective way to filter water by removing all of the contaminants. Although it is effective, it does not produce as much filtered water as it does waste water (water that contains contaminants).
- My testable question was ‘Can you filter out PVA microplastics dissolved from Tide pods into tap water by using reverse osmosis filtration’? I think the question did describe my experiment because I was able to test the differences between unfiltered water that had been exposed to PVA and the filtered water that had been exposed to PVA. Although, I think if I was able to have access to better equipment such as a microscope with a higher magnification I would have gotten more accurate results and clearer images where I could see the molecule structures of the PVA particles.
- I also think that there may have been a more effective way to determine if there were PVA particles in the solution other than taking pictures of the microscope slides with a camera. For example, using a microscope that takes pictures itself can get an undisturbed image.
- During my experiment, I noticed something interesting in the waste water stream coming from the red tube. In some samples, under the microscope, the particles would appear to make string-like chains which were expected. In my research, when Tide Pods get flushed into our environment they form chain-like structures which inevitably will clog drainage.
- Overall, my experiment showed that reverse osmosis does filter microplastics out of water. This idea could be taken further in future research.

Conclusion

- In conclusion, based on my experiment, reverse osmosis does filter out PVA (polyvinyl alcohol) microplastics from tap water proving my hypothesis correct.
- However, because I was using a school-provided microscope, it only had about 40 times magnification which is included in my sources of error.
- If I was to continue with this experiment, I would like to figure out if one could see the PVA particles make chains because if this were possible, this would be another reason to want to filter the plastic out of the water. I would also like to see if the process could filter out other types of microplastics like microbeads. .

Application

I think if we limit the pathways allowing microplastics to get into our environment, we could reduce potential negative health effects. An example could be that we could do simple things such as exchanging tide pods for a more environmentally friendly option like powdered detergent. This could decrease the number of microplastics landing in our water source each week. As far as a cost comparison between powdered detergent and tide pods. Powdered detergent is cheaper than liquid or pods and generally has a longer shelf life.

To take the idea of reducing the number of microplastics that land in our water supply and environment further, companies could employ chemical engineers to discover ways to change their cleaning and beauty products so that the products have fewer microplastics in them in the first place.

In addition to the idea of reducing the pathways for microplastics to land in our water supply, my experiment supports the idea of using reverse osmosis filtering for one's home water supply so that people can limit the number of microplastics getting ingested by drinking water. As far as a cost comparison the reverse osmosis machine that I used is relatively inexpensive. My machine cost around seventy dollars. However, this was for a device that filters one water site or tap. If one wanted to apply reverse osmosis throughout the whole house the average cost would be approximately 750-7,500 dollars for the whole house depending on the size of the house. This is a high price point, however, it is worth noting that reverse osmosis machines last a lifetime and one only has to change the membrane every 3-5 years. Given that we are discussing human health, this may be a small price to pay.

Sources of Error

- Spilled a bit of the solution while pouring it into the machine which could have been an effect to how much solution was filtered
- Not switching gloves between observing test samples which could have contaminated the microscope slides
- Using washed-out eyedroppers from other sources which could have contaminated the solution
- The microscope lens was dirty so it had some dust particles in each picture which might have been confused as PVA particles
- Another error would be using a stronger magnification microscope

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Thanks!

Do you have any questions?