GARBAGE PATCH KIDS – FALL 2016

Microbeads in Planktonic Organisms

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Physics and Environmental Science

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Abstract

By Natalie Smith

Microbeads negatively affect the environment and marine life. Microbeads are non-biodegradable plastic spheres that are found in cosmetic products, body washes, & hand soaps. Most of the time marine life will try to digest the beads, but starve to death because of lack of nutrients. The purpose of this experiment was to see the effects of microbeads on brine shrimp and other planktonic animals. The objective was to see if there could be an alternative to microbeads that wouldn't harm the planktonic animals. Researchers collected qualitative data regarding the contents of digestive tracts of daphnia and brine shrimp, noting if brine shrimp and daphnia would digest walnut pieces and microbeads. After provided the tanks with microbeads and walnut pieces, the group then used ethanol to make the animals immobilized. Data was collected by placing thirty planktonic animals under the microscope to see if their prediction was correct. In this experiment, the group found that "The data collected showed that more alternatives filled shrimp than microbead filled shrimp" (Results section, 2016). There was no data for the daphnia as they had a high mortality rate. Conclusion: In conclusion, this study found that brine shrimp were able to consume and digest alternatives to microbeads.

1) Introduction

Microbeads are small plastic balls found in many exfoliating products on the market today. In an eight ounce bottle of exfoliant there are up to 350,000 beads ranging in size from 0.0004 to 1.24 millimeters (Carr, 2016). Microbeads are used in cosmetics and other personal care items for several different reasons. The first, and most popular, is for exfoliation. They are ideal for exfoliation because they will not breakdown in solutions like soaps and cleansers unlike some common alternatives like sugar and salt. Also, they're rounded and are not too abrasive on the skin while still performing as a skin exfoliant (Beat the Microbead, 2016).

Most microbeads are made from polyethylene which is known to absorb and leach toxins making it an especially dangerous material to expose to marine environments (Hrala, 2016). These toxins cause immune, neurological, and fertility defects in the fish it affects. This can be devastating to populations like Melanotaeniidae and Perca fluviatilis who have been tested and researched by labs from Australia to Sweden. Due to the nature of their size, these beads are not filtered out by the sewage filtration plants (Beat the Microbead, 2016). Once exposed to the water these beads may be ingested by small organisms. When they eat contaminated items, the toxins accumulate in their fat tissues. When eaten by a larger animal, the toxins become even more concentrated in its body. (Mader, 1997) This occurs because polyethylene cannot be metabolized or digested, and is left to build up. This worsens as these smaller organisms are ingested by larger animals making its way throughout the food web, affecting us (Forster, 2016).

In our experiment we will test the quantity of consumption of microbeads and microbead alternatives by Artemia, commonly known as Brine Shrimp. The objective of this experiment is to study how microorganisms ingest microbead alternatives in comparison to microbeads, aiming to answer, "Do Brine Shrimp ingest microbead alternatives at a similar rate to microbeads?" The results of this experiment will give insight into two things: Brine Shrimp consumption of these products and also help inform if alternatives are a solution to planktonic animal consumption of these products. Due to the size difference between microbeads and our microbead alternative, we predict that the Brine Shrimp will not ingest the alternative substance.

2) Methodology

a.) Independent Variable

Our independent variable, is the presence of microbeads and microbead alternatives in our Brine Shrimp habitat to resemble their presence in the ocean. We have decided to increase the density of microbeads and alternatives because of the small time frame we have.

b.) Dependent Variable

Our dependent variable is whether or not the Brine Shrimp and Daphnia ingest the microbeads and, or the alternative. We have selected to use Brine Shrimp because they're of similar size to the organisms we are concerned about, are readily available, and we are able to control their life span. We decided to add Daphnia because we wanted to test a slightly larger organism.

c.) Control Variable

The control variables are the amount of microbeads from and walnut shells in a tank by weight, the amount of Brine Shrimp in a tank, tank size, water temperature, and length of exposure to the pollutants.

d.) Confounding Variable

The confounding variables is the health of the Brine Shrimp and the density of the animals in water collected for analysis.

e.) Sample Size

The sample size for this experiment will be six. The first two will be our control groups, one of Daphnia and one of Brine Shrimp which will only be fed regular food marketed for Brine Shrimp and Daphnia. The other four will either have 1 gram of microbeads, or 1 gram of walnut shells.

f.) Materials

- ❑ 2 grams of microbeads extracted from Bath & Body Works hand soap
- ❑ 2 grams of walnut bark extracted from Nuxe Gelee Exfoliante Douce
- ❑ Spirulina (food for Brine Shrimp and Daphnia)
- ❑ Brine Shrimp
- ❑ 3 sets of 30 Daphnia

- ❑ Tablespoon Measurement
- ❑ 6 Tanks
- ❑ 3 Air pumps
- ❑ Pump splitter
- ❑ 5 Air Stones
- ❑ 2 Instant Ocean Salt packs
- ❑ Refractometer
- ❑ Fine Screen
- ❑ Microscope
- ❑ Flashlight
- ❑ Data Sheet
- ❑ Glass Slides
- ❑ Weigh boats
- ❑ High sensitive measure scale
- ❑ Camera

g.) Primary Research Method

1. Set up three tanks of Brine Shrimp by adding Instant Ocean salt until there is a 30-35% level of salinity.
2. Label each tank the following
    a. Control
    b. Microbead
    c. Alternative
3. Let tanks sit for 24 hours to allow cysts to hatch
4. In control tank put 1 grams of food in tank
5. In microbead tank put 1 grams of microbeads in tank
6. In alternative tank put 1 grams of microbead alternative, walnut shells, in tank
7. Allow a 24 hour period for natural consumption
8. Set up another three tanks with fresh water for the Daphnia
9. Repeat labeling with a "control", "microbead" and a "walnut shell" tank
10. Keep the ratio of microbeads and alternatives to water the same for the Daphnia tanks

11. Repeat with a 24 hour settling period followed by a 24 hours for natural consumption
12. Remove a tablespoon of Brine Shrimp from tank as well as a tablespoon of Daphnia
13. Observe Brine Shrimp and Daphnia under a microscope
14. Tally the number of Brine Shrimp and Daphnia with food, microbeads, microbead alternative, and nothing in their stomach.
15. Repeat for all tanks

Animal Care:

Preliminary Care:

1. Set up tanks
2. Added instant ocean salt until salinity levels in water reached 35%
3. Let water aerate for 24 hours

Daily Care Schedule:

1. Keep water aerated using air stones running at rated so that the bubbles from the stones break the surface of the water
2. Maintain salinity levels between twenty-eight and thirty-six with Refractometer
3. Feed brine shrimp and daphnia with 0.1 grams of spirulina at the end of everyday

4)Results

This study references data collected over a nine day period from October 17,2016 to October 26, 2016. The data that was collected from brine shrimp and Daphnia. The numbers represent the quantitative data collected, showing the amount of species examined with microbeads or microbead alternatives in their bodies. The qualitative data that was collected was the behaviors of the brine shrimp, and observations about what the brine shrimp digested. Due to the fact that there was only one surviving Daphnia the following figure shows only the data collected from brine shrimp.

The first tank held our control group. This tank only had 0.1 grams of spirulina introduced in the water for the first five days. Thirty of the thirty brine shrimp that were examined had traces of spirulina in their bodies.

The second tank held the experimental group that had the microbeads, as well as the spirulina. Twenty-six of the thirty brine shrimp had only spirulina in their systems while the remaining four had both microbeads and spirulina.

The third tank held a group where walnut shells were introduced, as well as the spirulina. Twenty-six of the thirty-eight brine shrimp had only spirulina in their systems while the remaining twelve had both spirulina and walnut shells in their system. We decided to collect a higher number of brine shrimp from the alternative tank so when we compared the difference we would have similar ratios.

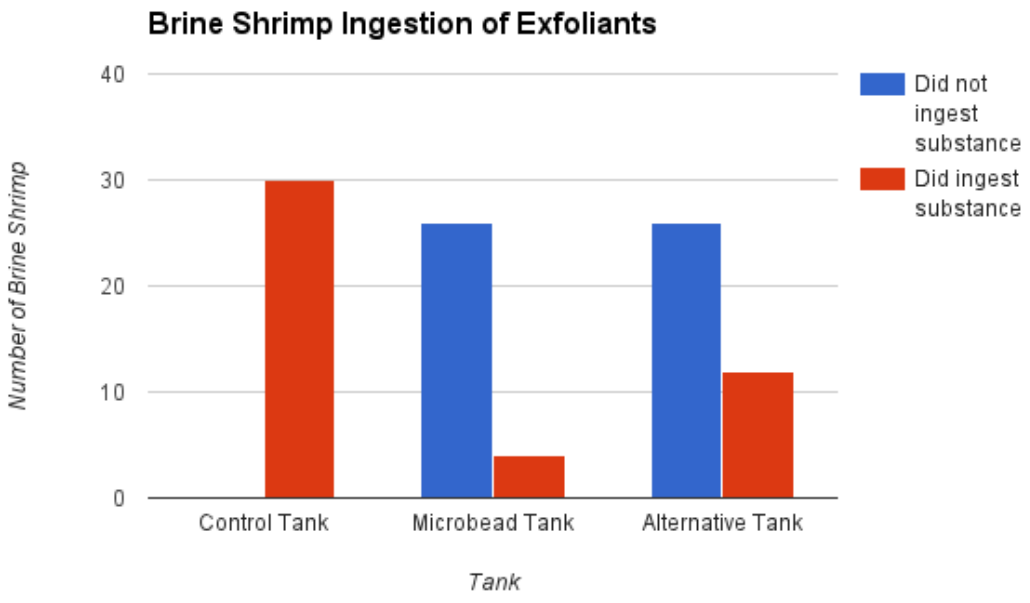

Figure 3: Findings represented with the number of brine shrimp that had corresponding substance compared to the number of brine shrimp that only ingested spirulina.

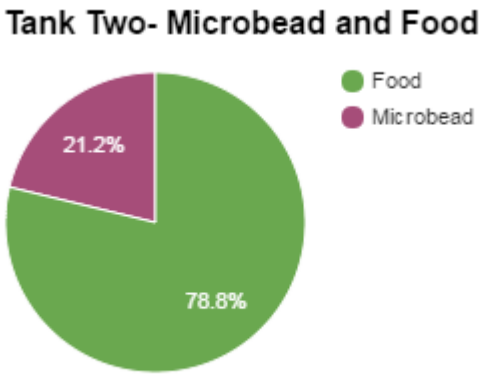

Figure 4: Findings represented shows the percentage of brine shrimp that ingested microbeads compared to food within that substance's tank.

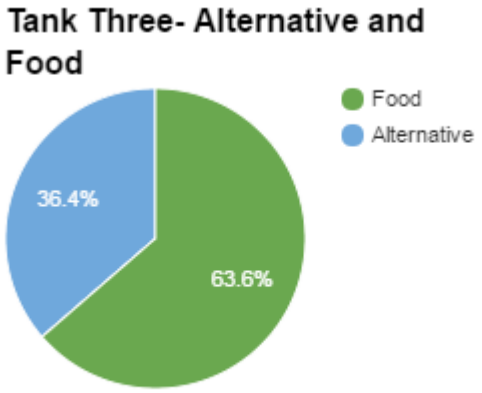

Figure 5: Findings represented shows the percentage of brine shrimp that ingested microbead alternatives compared to food within that substance's tank.

3)Discussion

We found that microplankton, at this life stage, are more likely to consume an organic microbead alternative than they are to consume a plastic microbead.

When the alternative was found it was solely in the digestive tract of the organisms. This indicates that the size and organic nature of the walnut shells are appealing and safe to the health of the Brine Shrimp. We think that the biodegradable nature of the walnut shells allow them to become small enough to enter the planktonic organisms and pass through with ease.

Through our research we can infer that brine shrimp are intentionally eating these substances. We can infer this because brine shrimp feed by directing food towards their mouth via a series of undulating appendages and digest food through a simple digestive tract.(GSLEP) It is also possible that they are feeding on walnut shells more frequently because it is a dark brown color which is the color of an algae that they feed on called diatom.(Westminster College)

Another aspect that we found interesting was the size the microbead alternative, in our case walnut shells, were able to break down to. Figure 2 shows a Brine Shrimp with small dots along its digestive tract. We think that there is a high likelihood that these are small, broke down pieces of walnut shells. This would explain why the Brine Shrimp were able to ingest the alternative a lot easier.

Originally it was predicted that the brine shrimp would consume more of the microbeads because they are much smaller than the walnut shells. However, to mimic real life circumstances we grinded up the shells. This allowed for the brine shrimp to be able to consume them easier.

Our research did not support the original prediction. The brine shrimp ate the the walnut shells at a higher rate in comparison to microbeads. We know that they were hungry enough to eat because all specimens had traces of spirulina in their systems which means that brine shrimp have a lesser tendency to eat the microbeads.

Figure 1(Above left): Brine Shrimp from the Control Tank. A brine shrimp with food (Spirulina) in its digestive tract. This is a controlled example which allowed us to have a baseline for the rest of the shrimp.

Figure 2 (Above right): Brine Shrimp from the Microbead Alternative tank. Brine shrimp taken from the tank with microbead alternatives. There are small, light brown specks along the digestive tract that we believe are broken down pieces of walnut bark.

References

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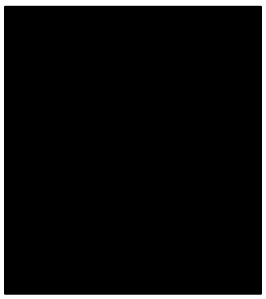
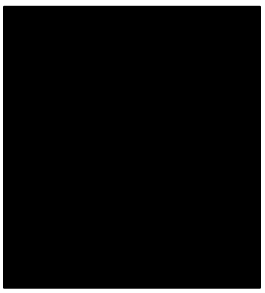
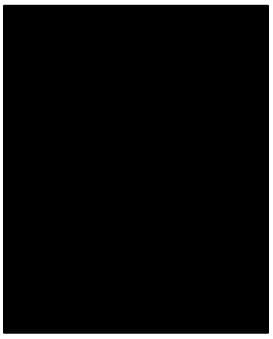
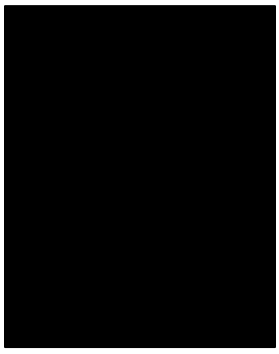
Appendix

Date:11/1/16 Name(s) of Data Collector(s)/Roles: Nicole, Gloriann, Eve, Juan Audrey, Brian, Mayra, Fernando

	Food	Microbeads	Microbead Alternative
Tank 1 (food)	All(30)		
Tank 2 (MB)	26	4	
Tank 3 (MBA)	21		12

Animal Care

Tank	Day	Salinity (Between 28-36)	Fed .1g Spirulina	Notes	Data Collector
Cntrl	10/17 10/18 10/19 10/20 10/21 10/22	35 35 35 35 35 35	✓ ✓ ✓ ✓ ✓ ✓	Adding Shrimp: 47.3g 43.6g	
Micro	10/17 10/18 10/19 10/20 10/21 10/22	35 35 35 35 35 34	✓ ✓ ✓ ✓ ✓ ✓	Adding Shrimp: 47.3g 44.1g 1.06g +MB	

Alt	10/17 10/18 10/19 10/20 10/21 10/22	35 35 35 35 35 35	✓ ✓ ✓ ✓ ✓ ✓	Adding Shrimp: 47.3g 43.6g 1.07 +MBA	