

Optical Brighteners in Laundry Detergents: Assessment of Photodegradation

and Possible Endocrine Disruption

Background

Over the course of two and a half weeks in the summer of 2011, the Huntington Breast Cancer Action Coalition and Great Neck Breast Cancer Coalition sent two high school students- a junior from Huntington and a senior from Great Neck- to conduct research at Silent Spring Institute in Newton, MA. Named for the book *Silent Spring* by environmentalist Rachel Carson, Silent Spring Institute is a research center dedicated to improving human and environmental health by alerting people- especially women- of everyday exposures to chemicals that could potentially cause breast cancer, endocrine disruption, and other developmental problems. Under the direction of mentors Dr. Julia Brody, Dr. Ruthann Rudel, and Melissa White, the two interns carried out an experiment they designed to test the rate of light-caused degradation of optical brighteners in laundry detergents.



What Are Optical Brighteners?

❖What are they? Optical brighteners, also known as brightening agents and fluorescent whiteners (here they are abbreviated OBA's), are chemicals used in laundry detergents that trick the eye into thinking that clothing is whiter and brighter than it actually is, but without actually cleaning it.

❖How do they do this?

- UV (ultraviolet) radiation is absorbed and re-emitted as visible blue light
- This counteracts with dull and yellow spots on clothing and causes white clothing to appear extremely bright.
- They chemically break down when exposed to light, or *photodegrade*, so the brightening gradually loses its effect until the clothing is washed again.

❖What else are they used in? OBA's are found in a variety of products, including white paper, cosmetics, and plastics.

❖Why are they bad? There are several reasons why OBA's should be avoided:

- When released into natural water systems through wastewater leakage, OBA's poison aquatic life such as fish and plants, and have the potential to mutate bacteria.
- When OBA chemicals come in contact with the human skin and are exposed to light, they start to chemically break down and react with the skin, causing an irritating, sunburn-like sensation.
- They have not been proven harmful, but neither have they been proven safe.
- Some OBA chemicals are derived from harmful chemicals, such as benzene.
- They also may share similar chemical building blocks with harmful chemicals- since some OBA's are composed of stilbenes, they may have properties similar to DES, a carcinogenic stilbene estrogen once used for pharmaceutical purposes.

Materials

- ❖5 amber bottles
- ❖Aluminum foil
- ❖Filtered water
- ❖Graduated cylinder
- ❖Pipettes
- ❖15 5-mL glass vials
- ❖Five different generic detergent brands
- ❖"AquaFluor" (including the standard for experimentation)
- ❖Masking tape
- ❖Marker
- ❖Timer/stopwatch
- ❖"AquaFluor" Fluorometer (measures fluorescence of liquids and aqueous solutions)
- ❖Fluorometer cuvettes

Important Terms

- ❖**Carcinogen:** a carcinogen is any substance that has a direct impact in causing cancer.
- ❖**Diethylstilbestrol (DES):** Synthetic nonsteroidal stilbene estrogen used in the treatment of miscarriages, later proven to be carcinogenic.
- ❖**Endocrine disruptors:** Endocrine disruptors are chemicals that disrupt endocrine- or hormonal- messages, causing cancerous tumors, birth defects, and other developmental problems.
- ❖**Photodegradation:** The degradation of a substance when exposed to light.
- ❖**Phototoxicity:** Often caused by the chemicals present within optical brighteners, phototoxicity occurs when light interacts with the chemical, causing it to photodegrade and create skin irritation.
- ❖**Stilbene-types:** one group of chemical compounds, which contain a fluorescing compound called fluorophore, that may be used as optical brightening agents; since both OBA's and DES (mentioned earlier) are composed of stilbene-type building blocks, they may have similar chemical properties.



Purpose

The purpose of this experiment was to find out the rate of photodegradation- or degradation due to exposure to light- of the optical brighteners in five different brands of detergents.

Hypothesis

If a dilution of laundry detergent is left exposed to the light and another is left in the dark, then the dilution left in the light will have its optical brighteners photodegrade faster.

Methods

1. Materials were obtained.
2. A 50-ppm fluorometer-calibration solution was mixed using the standard detergent and water.
3. The fluorometer was calibrated using the solution made in Step 2.
4. In separate labeled amber bottles, 0.5 mL of each detergent was mixed with 100 mL of water. For each of the 2x-concentrated detergents, 0.25 mL was mixed with 100 mL of water in separate labeled bottles.
5. Solutions were left to stand still in the closed amber bottles to let the bubbles settle.
6. Each detergent brand dilution was placed into 3 vials, one covered in foil and labeled C (control) and two uncovered labeled T1 and T2.
7. After the foam had settled, each vial was filled with the detergent solution corresponding to its label. (The leftover dilutions were left in the amber bottles as stock solutions.)
8. All 15 vials were left in the light (the solutions inside the foil-covered vials would be protected from the light by the foil).
9. After the solutions had been left in the light for a certain amount of time, fluorescence was measured using the AquaFluor fluorometer and recorded. Fluorescence was measured at the end of each of the following time intervals: three intervals of 20 minutes each, two intervals of 30 minutes each, and three intervals of 1 hour each.
10. All readings charted were graphed.

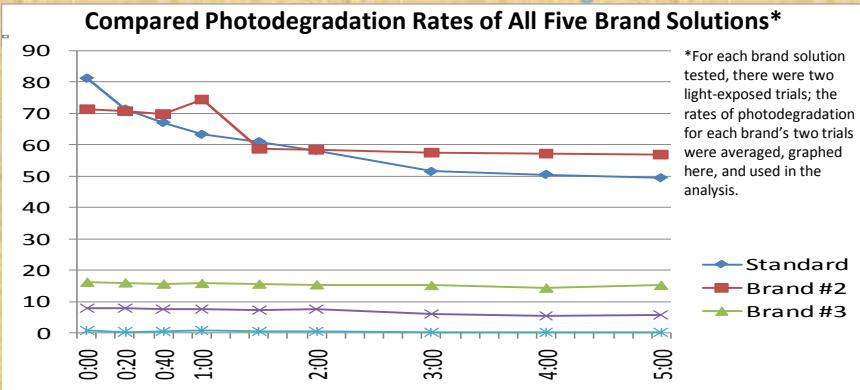
Acknowledgements

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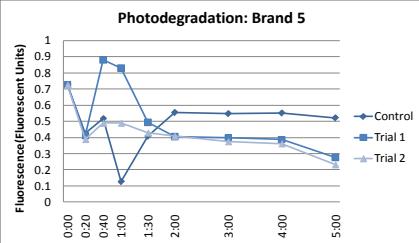
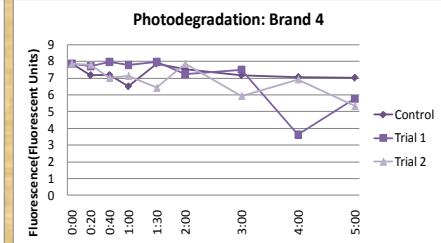
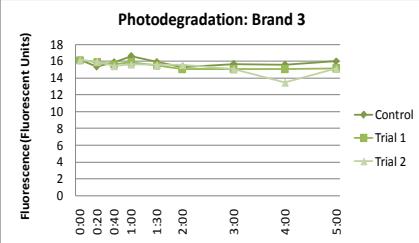
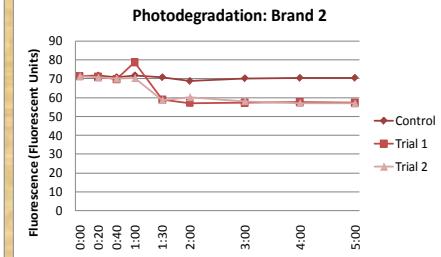
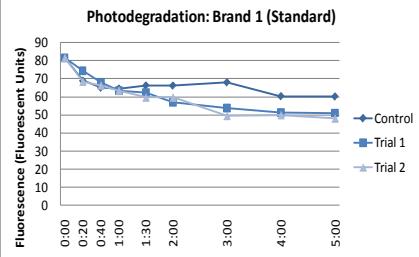
Special thanks to Agi Sardi for generously sharing her home with us while we were on this internship!

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Results & Graphs



Please note that the scales used on the graphs for Brands 3, 4, and 5 are different than the scale used for the graphs of Brands 1 and 2.



CONCLUSIONS

- ❖Optical brighteners have faster rates of degradation when in the light than when in the dark.
- ❖Greater fluorescence of a sample generally meant that the sample had a higher rate of photodegradation and greater net decrease in fluorescent units over the course of the five hours.
- ❖Brands 1 and 2 probably had OBA's that were more fluorescent but in lower concentrations than the other brands' OBA's.

Discussion

- ❖Whether the cause of faster photodegradation was greater concentration, greater fluorescence, or both, remained undetermined, since the brightening chemicals used in each detergent were not identified and different brightening chemicals differ in photodegradation rates and levels of fluorescence.
- ❖Because of this, relative concentrations of OBA's in the samples were not determined.
- ❖Every time a sample was poured into a cuvette to have its fluorescence measured, it was exposed to light, possibly distorting results.
- ❖Light distribution among the vials may not have been equal.
- ❖The vials were left indoors- artificial light is not as bright as light from the sun and may not have the same effects on OBA's as natural sunlight
- ❖Some measuring tools were not too accurate
- ❖Technical difficulties were experienced during the calibration of the fluorometer
- ❖Although there are no known studies as of yet showing that OBA's cause endocrine disruption, more research needs to be done since stilbenes found in OBA's are estrogen mimickers which may cause mammary tumors.

What Can YOU Do?

- ❖Avoid buying detergents that contain OBA's:
- Many detergent brands do NOT say on their labels that they contain optical brighteners
- If a detergent brand explicitly says that it does not contain optical brighteners, it probably doesn't.
- OBA's stick to clothing in the form of a chemical residue that leaves it stiff unless heated and fluffed in a dryer, but if you use a detergent that doesn't have OBA's, you can line-dry your clothes and they will still turn out soft. Not using the dryer as often will also save energy- and money.
- ❖Spread the word- tell your friends and family to avoid using detergents with OBA's in them and to use alternative brands.
- ❖Stay up-to-date on human health research and findings at www.SilentSpring.org, www.hbcc.org, and www.greatneckbcc.org.

