The Effects of Lemon Juice and UV Rays as Stain Removers

Introduction

This project is a continuation of my science fair project from last year. Last year I tested baking soda, white vinegar and lemon juice as stain removers. After my experiment I discovered that the lemon juice was the most effective in removing stains. This left me wondering how effective lemon juice could be with more concentrations of lemon juice and longer exposure to UV rays.

The goal of this science project is to further research lemon juice and UV rays as effective stain removers. This topic is of interest because children get stains on their clothes and store bought stain removers have harsh chemicals, which can harm children and the environment. If a safe alternative is discovered children can help take care of their own laundry.

Background Information

Fruit Juice, mustard, and tomato sauce are all common stains that can be difficult to remove due to oxidization. This means that over time they can turn yellow or brown due to oxygen. All three of the stains are considered oxidizable stains.

Oxidizable stains can be the most difficult to remove once dried because oxygen causes them to loose electrons changing their chemical composition. When treating this stain type, a physical stain may be removed but some color, melanin caused by the oxidization, can be left behind. Normally oxidizable stains are treated with chlorine or oxygen bleach. These can be harmful chemicals and can cause damage to clothes and people.

Acids can be used as stain removers and are naturally found in lemon juice. The acids are citric acid, malic acid, ascorbic acid (vitamin C), oxalic acid, tartaric acid, and lactic acid. Citric acid makes up most of the acid found in the juice.

UV light is a type of invisible radiation produced by the sun and certain lights. It can break down the chemical bonds of a stain and can super charge cleaning agents to help remove stains.

Since lemon juice is acidic it can be super charged by UV light to help remove stains. Once combined they work together as a non chemical bleaching agent. Bleaching agents can treat oxidizable stains.

Question & Hypothesis

Question:

Can lemon juice and UV rays remove oxidizable stains? I am trying to discover if lemon juice and UV rays can be a natural way to remove oxidizable stains instead of using chemicals.

Hypothesis:

After doing my research, I have found out that lemon juice is acidic, and UV rays are a natural whitener and sanitizer. When they work together it can act as a bleaching agent.

Therefore, I hypothesize that lemon juice and UV rays will be able to remove oxidizable stains, such as tomato sauce, mustard, or fruit juice with the best results when treated for longer periods of time. This is because when lemon juice and UV rays are combined, they act as a bleaching agent.

Materials

- Fruit Juice
- Tomato Sauce
- Mustard
- 5x5 White Fabric Squares, to put stains on
- Lemon Juice, for stain treatment
- UV Light, for stain treatment
- Sebum Spray (1 part jojoba oil, 1 part olive oil, ¼ part castor oil, 3 drops of squalene, spray bottle) to account for natural oils of humans
- Laundry Detergent, to wash fabric squares
- Washing Machine, to wash fabric squares
- Microfiber cloth
- Safety Pins to pin fabric squares to microfiber cloths for washing
- Measuring Spoons to measure stain's, detergent, and lemon juice
- Rubber Spatula to spread stain's
- Towels for clean up

Methods

1. Apply 1 teaspoon of fruit juice to 8 of the fabric squares, 1 teaspoon of tomato sauce to 8 of the fabric squares, and 1 teaspoon of mustard to the 8 squares of fabric.
2. Apply 1 teaspoons of lemon juice to 6 of the squares of fabric.
3. Leave 2 squares of fabric untreated with lemon juice.
4. Pin 3 squares treated with lemon juice to the green microfiber cloth and pin 3 squares treated with lemon juice to the pink microfiber cloth. Pin the 2 untreated squares to separate grey microfiber cloths.
5. Set all samples inside cardboard UV Box, tape up the box, and turn on the UV Light.
6. Remove the squares pinned to the green microfiber cloth for 4 hours and one of the untreated squares. Remove the remaining squares after a total of 8 hours.
7. Prepare the stains for washing.
8. Measure out laundry detergent.
9. Load fabric squares with a load of towels into a washing machine.
10. Spray all material with sebum spray to account for the natural oils of humans.
11. Remove samples when wash is complete and let all fabric squares air dry after washing.
12. Assess results.

Results

Notable Findings:

- **Supercharging the lemon juice did not have a notable effect on the stain's vs prolonged exposure to only UV rays.**
- **Grape juice had the best results overall in having the stains removed.**
- **There does not seem to be a notable difference in UV ray exposure time and lemon juice.**

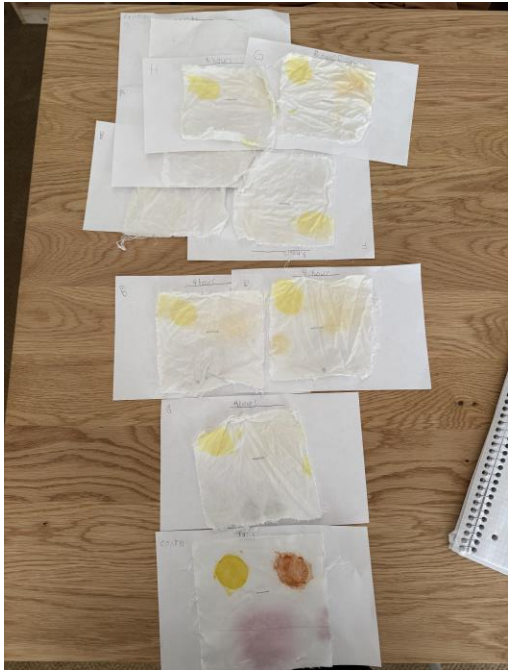
Possible Skews:

- **Some of the stains became contaminated by others on the same square.**
- **A UV Lamp was used and not direct exposure to Sun produced UV Rays.**
- **Some of the samples did not air dry as long as others due to an unforeseen interruption.**
- **The amount of acid in the lemon juice was unknown.**
- **Accessing my results against the control was subjective as it was a visual scale and not using a spectrometer.**

Assessing Results Against Control

Mustard

Grape Juice



Tomato Sauce

Ranking the results on a one to ten scale based on how well each type of stain was removed compared to the control of no stains vs the control of untreated and unwashed stains. No Stain was rated as a 1 and Untreated Stains was rated as a 10.

Results Table

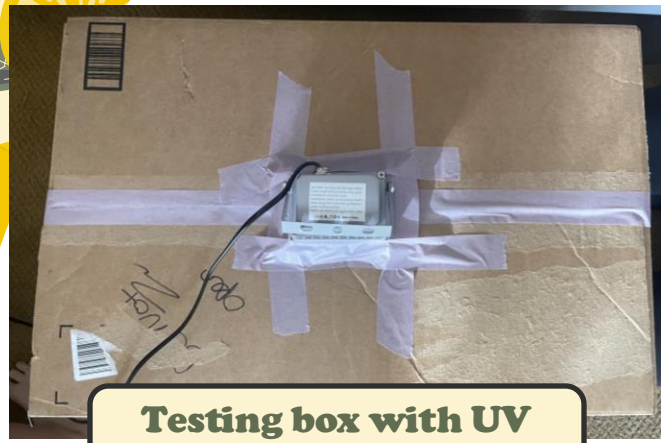
		No Stains Control	Stains Control	4 Hours				8 Hours				Average Stain Removal
				A	B	C	D	E	F	G	H	
Stain Removal Scale	Mustard	1	10	3	4	6	7	1	5	9	8	5.4
	Tomato Sauce	1	10	6	7	4	5	1	3	9	5	5.1
	Grape Juice	1	10	1	3	4	3	1	1	1	1	2.6
	Average Treatmer	1	10	3.333333	4.666667	4.666667	5	1	3	6.333333	4.666667	4.366667

Results Chart

Scale:
1 = Stain Completely Removed
10 = No Stain Removed

Test Squares Key:
A & E= Not treated with lemon juice
B-D & F-H = Treated with lemon juice

Photos



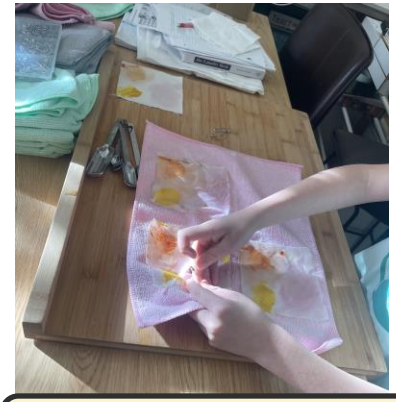
Testing box with UV Light attached

Stained Squares

Spraying laundry with sebum spray

Testing box with stain and treated squares

Treating stains with lemon juice



Pinning squares to microfiber cloth

Conclusion

My hypothesis was proven incorrect. Combing lemon juice and UV rays did not effectively remove all oxidizable stains. The combination had the best results with grape juice. I believe the results were different than expected because the amount of citric acid found in the lemon juice used was not enough to remove the stain.

If I were to do this experiment again, I would test pure citric acid to see if the results would change, I would also rinse the stains soon after applying them and use more test squares. I would like to test real sunlight vs UV light.

From this experiment, I learned that natural methods like UV light can help remove some stains, but lemon juice did not make as much of a difference as expected.

Implications and Ideas

This project shows that UV light can help remove some stains, especially grape juice. This is important because many stain removers use chemicals that can be harmful. Using sunlight or UV light could be a safer way to remove stains found on clothes.

The experiment made me curious about new things. I wonder if stronger lemon juice or pure citric acid would work better in combination with the UV light. I also wonder if using real sunlight vs UV light would remove more of the stains. In the future I would test more fabrics, try strong acids, and compare sunlight to UV light.

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