Mia Story

Ecology, Environment and the Anthropocene

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The Perfect Substitute to Save our Environment

Dyeing clothes may seem like a short inconsequential process, when in reality, it affects the environment and many living things, especially aquatic life. The reason why this process is so harmful is due to the harsh chemicals and toxic waste that is emitted after a textile is dyed. Not only is there a lot of toxic waste, there is also an extensive and unnecessary amount of water waste. There are many ways to combat this issue and I have done extensive research to know the ways in which this process can be done efficiently, safely and naturally.

The first synthetic dye was created in the 1850's called Mauveine, accidentally discovered by W.H. Perkin(Sudarshan S, 2023). This dye is a beautiful purple/magenta and was the first dye to become mass produced creating a boom in the textile dyeing industry. Everyone wanted to be the next to discover a new shade. After this discovery, the mass production of other synthetic dyes emerged completely, changing the way clothing and colored textiles were made and sold. This new way of dyeing textiles changed the clothing industry making the once long and extensive journey to beautifully dyed clothes short and effective.

When looking at the dyeing process for textiles, there are many reasons as to why it is harmful to our environment. From start to finish, there are three main steps in the modern dyeing process. Preparation, Dyeing and Finishing. The amount of water used in each step is excruciating but

unfortunately the easiest way to achieve fast and effective vibrant textiles. The water that is used is also unable to be recycled because of the heavy chemicals leading to toxic waste dumped into waterways.

Although it depends heavily on the fiber and type of textile, the process stays relatively the same. Preparing the fabric is the key to make sure there are no impurities in the fabric to ensure an even application(Farah Maria Drumond, 2013). Water is used to rinse and clean the fabric and if the fabric will be sold as white, bleach is used to ensure a vibrant white color. After the first step of preparing the fabric, the next step is the dyeing. Fabric or fibers are then dipped into a hot water solution that is mixed with chemicals and synthetic dyes. The length of time and amount of times the fabric is submerged in water depends on the specific dye and the fibers that the fabric is made from. There is also not a single dye that can dye all fibers which is why so many other chemicals are needed during this step of the process(Farah Maria Drumond, 2013). The last step, finishing, is to ensure that the quality of the fabric is up to par and is waterproof, antistatic, soil resistant, etc. The fabric is then dipped into another solution containing other chemicals mixed with water.

The one thing that each of these steps have in common is the usage of water. As we can see, each step of the dyeing process uses lots of water that is then dumped into waterways. Water waste from textile plants is classified as the most polluting out of all of the different industries and production which is extremely disheartening as an aspiring Fashion Designer interested in textile design and production. I believe the biggest change that could happen to lessen the water usage and waste is companies being okay with imperfection. Some of the biggest aspects of this process is prioritizing having a perfect outcome and perfect product, although impossible.

While learning about the toxic process of dyeing textiles, keeping in mind what the future of textile dyeing is more important than the current process. The downsides of natural dyeing is frustrating but for the sake of the environment, extremely needed. Natural dyes are more expensive due to the production time and how much it costs to derive whatever dye is needed from natural sources such as

flowers or insects(Sasmita, 2012). Natural dyes are also not as pigmented as synthetic dyes making them less appealing to brands who focus on vibrant textiles.

Through my research, I was also able to learn more about specific dyes and their upsides and downsides. This helps me further understand the ways in which companies can make their textiles environmentally friendly. The different dyes produce different colors using different chemicals. There are Acid Dyes, Basic Dyes, Disperse Dyes, Indigoid Dyes, Flavonoid Dyes, etc. that are all different chemical structures. Azo dyes are the most common dyes and they account for 60-70% of all dye structures. The reason why azo dyes are so common is because of their performance, price, stability, wide range of color and more.

For my first scientific concept, I wanted to focus on the dye itself instead of the process and figure out what the best substitute for synthetic dyes is. I wanted to base this decision on efficiency, process, amount of waste and deriving process. Natural dyes are obviously best for the environment after the fact because they do not pollute our environment but keeping in mind how these dyes are extracted is also important. In my opinion the best substitute would be dyes derived from plant materials because it does not involve killing insects and in most cases, does not involve killing the plant as a whole. Some plants such as turmeric are used as dyes and the deriving process does not involve killing the roots enabling more growth to occur after the fact. Although using plants to dye textiles is the best option, the dye stuff content in plant material is low which calls for solvent. Solvents are used to better help the color stick to the fibers of the textiles and many solvents such as mordant are highly toxic containing heavy metals(Lizamoni, 2021). This is why not only does the dye need to be safe but the other products that are used to dye. Some alternatives to toxic mordants are Potassium aluminum sulfate, oxalic acids and tannic acid. The combination of a natural plant dye such as turmeric and potassium aluminum sulfate will give an amazing outcome and could replace many current dyeing materials.

After deciding the best replacement to synthetic dyes, it is also important to me to be realistic with this change and think about whether or not this change is achievable on a large scale. For my second scientific concept I did further research and thought about the probability of this change. In all honesty, the current state of our textile dyeing industry does not allow for this change to happen due to the obsession with trends, money and instant production. Brands are too consumed with selling their product quickly and constantly that spending a little more money or time on textile dyeing is not at the forefront of minds. On a larger scale I believe this switch would be an extremely hard thing to accomplish. However, on a smaller scale or for personal use, I do think it is achievable as long as the proper knowledge is used. I have come to learn that the morals of smaller brands are much better and priorities better align with those of people who care about the environment which is ironic because bigger brands have much more money. All in all, I do think it can be worked on and small steps go a long way especially when it comes to big companies. Even the smallest change can have a much needed impact.

For my third and final scientific concept, I looked into the most obvious part of the environment that is affected by this toxic waste pollution. Aquatic life. The waste that is dumped into the various different bodies of water causes long term effects to the living organisms as the darkened color of the water makes it harder for photosynthesis to occur (Bruno, 2019). Most synthetic dyes are highly concentrated and vibrant which darkens the water. The darker the water is, the less amount of light shines through. The chemicals and other toxic waste also harms the health of aquatic animals as the toxic pollution is not a suitable environment for them to live a long and healthy life. As animals die and this toxic waste enters the food chain, the ecosystem as a whole becomes severely damaged making it difficult to create healthy future generations.

Now that I have learned the pros and cons to different dyes and chemicals used, I can better incorporate this knowledge into my final creative project. I would love to do a series of dye testing using different natural materials and seeing which is the best option for personal use. In theory it would be better for me to do it on a larger scale but in the interest of time, personal dyeing makes more sense and I

can be more accurate. After I do a series of dye tests, I want to wash the swatch a few times to see if there is wear over time. Obviously, it would be very different from regular wear and tear but I would love to get a sense of whether or not that specific dye is usable without a heavy chemical mordant. After finding the best dyes and the best fibers to use with those dyes, I would then make a garment to explore using the naturally dyed textiles and bringing appreciation to imperfect and less vibrant dyes.

Another way in which I can use scientific ideas into my creative work is by making a sculpture that depicts the current modern textile dyeing process. By making a miniature model, it would put this issue into perspective for people who don't really understand or care about the way in which their clothing is dyed. This sculpture would have scientific information on little plaques all throughout to make it an informative piece just as much as it is an art piece. The biggest thing that helps spread awareness about environmental issues is putting into perspective the issues that are currently happening.

My last idea was to make a short film documentary by interviewing many different people and seeing what they know about the textile dyeing industry. I think it is very informative and is a great way for people to really understand what is going on. When people learn about the clothing they're wearing, they feel more inclined to consume intentionally and care about what they consume. I would love for the people in my interview to be able to reflect on their consumption and choices while also learning something new. I understand that not everyone will care or change their lifestyles but even spreading just a little bit of awareness is important to me and something I will always be working towards.

If I were to choose the creative project that focuses more on factual information and spreading awareness, my target audience would be anyone and everyone. I think making people understand issues like this is extremely important even if they aren't part of the textile industry. I think this creative project could help make people understand the severity of toxic waste and be able to give them a reason to consume clothes in a more conscious way. If I were to lean more towards the dye testing or performing other tests, my target audience would be small brands and artists. The tests that I would do are only on a

small scale and I wouldn’t be able to account for mass production. I would love to cater this specific creative project to young students/artists like me as well to show that creating sustainable art and fashion is possible. As I mentioned before, one of the biggest reasons why big companies tend to steer away from natural dyes is because it's not a perfect dye and is not as vibrant as many brands would like. For my dye test option, I think it would be a way to accentuate the light natural colors and show the beauty in natural substitutes

Ultimately, this issue may seem like just a small part of the Fashion Industry but actually produces an absurd amount of waste and pollution. It is extremely important for society to really understand smaller issues that are not talked about enough. Synthetic dyes are a small part of the fashion industry that can have a natural substitute if done correctly and efficiently creating a real change for the better.

Bibliography

Baliarsingh, Sasmita, et al. "Exploring sustainable technique on natural dye extraction from native plants for textile: identification of colourants, colourimetric analysis of dyed yarns and their antimicrobial evaluation." *Journal of Cleaner Production* 37 (2012): 257-264

Conceptual

- The main issues with dyeing with natural colorants is the poor fastness qualities, low exhaustion colors and cost making it more common for mordant to be used with the natural dyes which defeats the purpose of the natural dye in the first place (mordant is used to intensify the color and fastness and derived by metals that can be toxic for the environment)

Factual

- Natural dyes in the world of textile coloration is being of interest to more people now that standards are being imposed by specific countries as a response to the toxic and environmentally unfriendly the current dyeing process is

Chequer, Farah Maria Drumond, et al. "Textile dyes: dyeing process and environmental impact." *Eco-friendly textile dyeing and finishing*. IntechOpen, 2013.

Factual

- There is no dye that can dye all fibers of a textile which is Acids
    - Leveling agents
    - Promoting agents
    - alkali/bases
    - Emulsifying oils
    - Softening agents
- Over 10,000 different dyes and pigments are used industrially and over 7x10^5 tons of synthetic dyes are annually produced worldwide
- Treatments with chemical compounds are used to finish the dyeing process
- Dyes and pigments have a high stability against light temperature, water, bleach, chemicals, detergent, etc.

Conceptual

- Why during the dyeing process, chemicals are needed to ensure a even color throughout
- Most of these dyes tend to stay in the environment because they are made to not be washed or rinsed out
- The chemicals and solvents used alongside the dyes are what make these dyes more durable which is good for brands but bad for the environment once the piece is thrown away
- The water waste that comes from the textile industry comes mainly from the dyeing and finishing process

- The color of the dyes in the waterways is part of the reason of the damage to the aquatic environment due to the lack of photosynthesis that can occur with limited light

Chungkrang, Lizamoni, Smita Bhuyan, and Ava Rani Phukan. "Natural dyes: extraction and applications." *International Journal of Current Microbiology and Applied Sciences* 10.1 (2021): 1669-1677.

Factual

- The government of germany was the first to ban azo-dyes in manufacturing, dyeing and importing in 1995 followed by the netherlands in 1996 along similar lines

This article has in depth description of most all of the dyes, chemicals and processes used in textile dyeing process

Lellis, Bruno, et al. "Effects of textile dyes on health and the environment and bioremediation potential of living organisms." *Biotechnology Research and Innovation* 3.2 (2019): 275-290.

Conceptual

- The color of these dyes are not only aesthetically damaging but also reduces the penetration of light making it harder for photosynthesis to occur under water
- To help ensure the sustainability of the environment for the future, physical, chemical and biological technologies have to be used

Sudarshan S, Harikrishnan S, RathiBhuvaneswari G, Alamelu V, Aanand S, Rajasekar A, Govarthanan M. Impact of textile dyes on human health and bioremediation of textile industry effluent using microorganisms: current status and future prospects. J Appl Microbiol. 2023 Feb 16;134(2):lxac064. doi: 10.1093/jambio/lxac064. PMID: 36724285.

Factual

- The world's first synthetic dye was made in 1856 called Mauvine discovered by W.H. Perkin
- Azo dyes account for up to 60-70% of all dye structures known to exist and right under them come anthraquinone dyes because of their high dyeing performance, easy usage and cheap production costs

Conceptual

- Synthetic dyes are in huge demand because of the constant and rapid textile development
- Since Synthetic dyes are the faster way to dye textiles, it caters to bigger brands