

EXTRACTION OF DYES FROM HOUSEHOLD WASTE

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Abstract: Dyeing is a crucial and complex process in the clothing industry. Textile processing industries are major environmental polluters, of synthetic dyes. So to avoid this pollution, extraction of dyes was done from food products, which is the by-product of household. Dyes derived from natural sources have emerged as an important alternative to synthetic dyes. The present scenario with global concern is the encouragement of developing natural color pigments, using eco-friendly and biodegradable materials. Therefore, in this study, household waste materials like tea waste, dried Hibiscus flower, pomegranate peels, used coffee grounds, etc., were used to extract the dye with the use of a mordant such as alum for better color absorption. The color developed was used on cambric fabric and tested for washing properties (colorfastness).

Keywords: Dyes, Mordant, Extraction, Conscious consumer

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I. INTRODUCTION

Nature is full of beautiful colors that have always attracted our attention. Historically dyes were used for painting the body, coloring the food and the walls of caves along with their day-to-day objects which were used in their life. It is a crucial and complex process done in the clothing industry. These dyes derived from natural sources have emerged as an important alternative to synthetic dyes. Synthetic dyes are very harmful to the environment as well as for our well being. People are not aware of the methods and techniques utilized for the dyeing process done with synthetic dyes, the waste of water used for dyeing and the pollution of the watershed away in various rivers. So there is a soaring desire amongst consumers to help promote ethical fashion, where all the process used for the construction of the garment will not harm the environment at any stage of its process. The term conscious consumer is on the rise as the havoc caused by the fast fashion industry on the environment is glaringly obvious for everyone to see. As the waste increases in seemingly every aspect and corner of the world, the need of searching sustainable practices, methods, and techniques increases.

With an increasing awareness of environment pollution and health hazards associated with use of synthetic dyes, people are turning towards the forgotten ancient art of natural dyeing. Natural dyes are not only biodegradable but non-toxic and hypoallergenic too. Toxic residual waste from textile dyeing process often ends up being dumped in our precious rivers, oceans that harm the marine life. By using natural dyes with non-toxic mordant, there is no waste production at the end as it can be neutralized with white vinegar and safely used to water plants. Using natural dyes is a no-brainer option for making a cleaner ecosystem. The present scenario is focused more towards the utilization of vast diversity of natural resources of colour pigments for their use in food materials, pharmaceuticals and textiles, in place

of the synthetic counter pass. The purpose of this study was to clear the ethical dilemma of many dyers using fruits and vegetables to produce natural dyes which seems counterproductive. The usage of edible materials for dyeing clothes is irresponsible as we face global crises like food shortages and world hunger. Here, the researcher aimed to collect waste and non-edible dyestuff to produce an array of beautiful colors.

II. MATERIAL AND METHOD

The sourcing of the waste materials is as follows:

1. Hibiscus flower waste was procured from the temples which were used to worship lord Ganesha.
2. Yellow and orange Marigold flower waste was sourced from goddess Laksmi's temple in Vadodara.
3. Tea waste was collected from the local tea stalls after it was brewed and thrown away.
4. Coffee ground waste generated after coffee is brewed in Brewgarteem cafe which is located in Ahmedabad.
5. Bougainvillea Leaves is a flowering ornamental vine with thorns. It belongs to the family of Nyctaginaceae. As people don't consume its leaves, the researchers discovered it in local regions of Vadodara where it grows in abundance.
6. Pomegranate peels were collected from Neelam Juice Corner from the same city.

The Substrate used for dyeing was first scoured so that all the impurities, dirt, and dust were removed which later on will help for the better absorption of dyeing.

Coloring of Cambric fabric was done in three stages:

- A. Extraction of dyes from the waste sourced.
- B. Mordanting (Alum)
- C. Dyeing.

A. Extraction of Dye

Various experiments were conducted for the best possible extraction of dyes from the waste which was collected from different places of cities. The waste

was collected and washed thoroughly with water to remove any dirt and dust present in that raw material. The waste was then ground into powder using a grinder. To get the best extraction, the experiment was conducted in an aqueous extraction process under the Relatively humid temperature of 37 ± 2 with a Material: Liquor ratio of 1gms:10ml. The water was then boiled until the dye was released in water. The extraction process took about 20 minutes for tea, coffee, and turmeric. While it took 45 minutes for hibiscus, bougainvillea, marigold, and pomegranate peel. After the dye(color) was extracted, and to preserve it for a longer time it was stored in the refrigerator for further use.



Figure 1: Dye color

B. Mordanting

The French present participle "Mordre" (to bite) is from where the concept of "mordant" derives. The hue of red bites into the cloth as a result of the mordants. Mordant compounds include many kinds of hydroxides (such as calcium hydroxide) and oxides (such as ferric or lanthanum oxide), in place of metal salts such as sulphates (magnesium, aluminium, zinc, copper, cobalt, nickel, manganese, or stannous sulphate). Among the most frequently utilised mordant compounds in natural dyeing are ferrous sulphate (green vitriol, $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$), copper sulphate (blue vitriol, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$), the metal dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$), stannous chloride ($\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$), and aluminium potassium sulphate (alum, $\text{KAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$). Here, in the second process the fabric is immersed into Alum (Tannin Treatment) used as a natural mordant. The ratio of alum: weight of the fabric i.e. 6g of alum was taken for 100g of fabric. The alum was mixed with enough hot water to enable the fabric to be moved around freely. The fabric was inserted in the mordanting solution and was left to simmer for 45 minutes. Later on, the fabric was left to cool in the pan.

C. The Dyeing Process

In the third process of dyeing, experimentation was done at a relatively humid temperature of 37 ± 2 C for 30 to 45 minutes. In the process, it was noted that if the absorption can be increased, by adding neutral electrolyte to the bath i.e. Sodium Chloride (NaCl) and sometimes glauber's salt (Na_2SO_4) was used which is very important when the process has natural mordanting.

The wet fabric was placed in the dye bath and was brought to a slow boil. It was left to simmer for 15 to 20 minutes. After adding electrolyte, it was again kept to boil for another 15 minutes for better absorption. In the meantime, the researchers would stir it occasionally. When the desired color was achieved, the vessel was removed from the heat, and the fabric was left overnight in the same vessel. Then on the next day, the fabric was removed and washed thoroughly until the waste ran clear. At last, the fabric was left to dry in the shade. And the wastewater was used to water the plants.

III. RESULTS AND DISCUSSIONS

The naturally dyed fabric need to be tested for its washing and light fastness. So after Dyeing the testing was done and the results are as follows:

Washing Fastness

The colored samples are then placed between the two fabrics, which are gray fabric (non-dyes) for testing the color fastness. All three samples were held together with stitching around the edges. Any soft detergent in the ratio of 0.15 grams of detergent in 30 ml of water was taken and immersed in the bath for 30 minutes. Then the specimen was removed and rinsed again in cold water. This procedure was done for at least five to eight times. It was observed that there was little bleeding for the first two washes and then the fabric retained its colour.

The color of one fabric after dyeing it with hibiscus is deep wine. But after washing it with plain tap water, it changes color permanently to green. The color remains vibrant green after all the successive washes.

Light Fastness

The prepared specimen was exposed to sunlight for whole one day, to evaluate the color fastness. The result of color change was evaluated with the unexposed specimen which was between the undyed fabric (gray).

It was noted that the color faded when it was exposed to sunlight.

Observation of Dyed Fabric



Figure 2: Observation of dyed fabric

For a much better understanding and outlook of the whole natural dyeing process on clothes, here are some of the pictures of pieces which were dyed by our students to showcase the final results of these dyes using the materials mentioned above.



Figure 3: Samples of dyed products
The process of utilizing waste into to create accessory and working for surface ornamentation.



Figure 4: The final collection created by the waste for sustainable practice

CONCLUSION

The art of coloring (dyeing) is as old as man's civilization. Historically, people used natural pigments to decorate their caves, clothes, and body. Recently, interest in the use of natural dyes has been growing rapidly due to the result of stringent environmental standards imposed by many countries in response to toxic and allergic reactions associated with synthetic dyes. It is crucial in the current context of sustainable development, which incorporates the principles of environment, economics, politics, culture, social effect, and human health. The focus is more on the utilization of the vast diversity of natural resources for color pigments to use in food materials, pharmaceuticals, and textiles, in place of their

synthetic counterparts. The key idea behind this was to safeguard human health while protecting and prolonging life on Earth. Creativity has no boundaries. If the natural resources are utilized in the best possible way, taking into consideration the life of the future generation will surely flourish. In this study not only the waste was utilized for creating a vibrant palette, but also efforts were made to ensure that no residue was left that is harmful to the environment. So after the third stage of dyeing, the wastewater was used to plant the trees.

RECOMMENDATIONS

India is inhabited by one of the finest plant biodiversity in the world, placing 11th globally. Dyeing is a vast category to explore when it comes to the extraction of dyes using mordant. Here, the researcher had only explored using one mordant i.e. alum. For further research, different mordants can be used for the different color palette and their absorption. Also pre-mordanting and post-mordanting will give different perspectives for future research into natural dyeing using waste resources.

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