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Eco-Friendly Textile Printing: Assessing Cotton Substrates for Pre- and Post-Mordant Imprint Methods

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ABSTRACT

Among the many vital purposes of clothing are protection, identity, and decoration. While traditional techniques like screen printing and block printing are still frequently employed, printing techniques are a major part of the approaches used to improve materials. Eco-printing, which uses plant materials to produce distinctive colors and patterns on fabrics, has recently become a modern and ecological method. In this procedure, mordants—especially a few natural mordants—are essential because they improve color quality by altering the base color of the fabric and the natural pigment of the flower and leaf, producing unexpected outcomes. The purpose of this study is to examine how pre-mordanting and post-mordanting affect cotton fabrics printed with natural dyes made from flowers and leaves in terms of color quality, shape, depth, fastness characteristics, and overall aesthetics. Flower and leaf impression printing, sometimes referred to as floral impressionism or pounding, is a cutting-edge method that harnesses the organic hues and forms of flowers to produce one-of-a-kind prints on textiles. This environmentally friendly technique transfers the complex patterns and vivid colors of fresh flowers or leaves by pressing them into cloth by hand or with a hammer for the printing press. Adopting sustainable methods like flower and leaf impression printing might transform fabric printing and lessen pollution as the textile industry comes under fire for its substantial environmental impact. A few advantages of natural printing that improve the environment and design aesthetics are: 1. Eco-Friendly Methods, 2. Sustainable Textiles,3. Little Waste, 4. Distinctive Style, 5. Raising Awareness, and 6. Inventive.

Keywords: Eco-printing, Screen printing, Block printing, Pre- and Post-Mordant imprint

INTRODUCTION

Flower and leaf impression printing, sometimes referred to as floral impressionism or pounding, is a cutting-edge method that harnesses the organic hues and forms of flowers to produce one-of-a-kind prints on textiles. This environmentally friendly technique transfers the complex patterns and vivid colors of fresh flowers or leaves by pressing them into cloth by hand or with a hammer for the printing press. Adopting sustainable methods like flower and leaf impression printing might transform fabric printing and lessen pollution as the textile industry comes under fire for its substantial environmental impact.

The Textile Industry's Effect on the Environment:

One of the greatest environmental polluters in the world is the textile industry, which releases synthetic dye waste into the environment and accumulates synthetic fabric in landfills, seriously contaminating soil and water. Both human health and aquatic ecosystems are at risk from these toxins. Sustainable manufacturing methods that put environmental health first are desperately needed to address these problems.

Overview of Eco-Printing:

Eco-printing is a technique that prints on fabric using different plant parts. By directly extracting pigments from plant materials, this method enables the creation of

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distinctive and organic designs. The two most widely used eco-printing techniques are:

1. **Bind and Steam Technique:** This technique involves arranging and binding various plant parts between fabric layers. The pigments are then transferred onto the fabric by steaming the layers, producing unique and colorful designs.
2. **Hammering or pounding technique:** Using a soft hammer, the plant material is pounded directly onto the fabric. Rich and detailed designs are produced by wrapping and steam-setting the fabric after the pigments are discharged.

Impression printing's advantages:

1. **Eco-Friendly Process:** Non-toxic, biodegradable ingredients are used in flower impression printing. Flowers are a great option for sustainable dyeing because they are frequently used in food and pharmaceutical items and are generally safe for human consumption.
2. **Sustainable Fabrics:** Compared to synthetic textiles, natural, sustainable fabrics like hemp, organic cotton, or linen are less harmful to the environment and biodegradable.
3. **Minimal Waste:** The procedure produces very little waste because fresh flowers are used, and any plant elements left over can be composted to help maintain ecological balance.
4. **Unique Aesthetic:** The fine features of the flowers utilized are captured in each print, giving textile products a personalized touch. Customers seeking unique, handcrafted goods are drawn to this distinctiveness.
5. **Raising Awareness**: This method can promote more environmentally conscious consumer choices and increase awareness about sustainable practices by highlighting the beauty of flowers and the possibility for eco-friendly printing.

METHODOLOGY

Fabric :

Cotton scoured and bleached fabrics were used in this study in domestic cotton. A Paramount thickness tester was used to gauge the textiles' thickness in order to guarantee uniformity in the eco-printing substance.

Plant Material:

The printing material for Hong Kong, or Bauhinia X Blakeana orchid trees, was the subject of this investigation. Three types of this flower—one with light pink blossoms, another with purple and white flowers—were employed in this investigation. This tree belongs to the genus Bauhinia and is a hybrid leguminous tree.

Mordants:

The mordant employed in both the pre-mordanting and post-mordanting processes was aluminum potassium sulphate, or alum. Alum's abundance, affordability, and accessibility make it a sensible choice for eco-printing. Additionally, it is thought to be a safe mordant. Alum contains aluminum ions, which have a significant affinity for cellulosic fibers. These ions act as a bridge between the dye molecules and the fibers, enhancing color retention and print quality. Copper sulphate is another mordant that is utilized. It is used in natural dyeing to increase the color and wash and light fastness of the dyes. Natural dyes can have their blue and green tones enhanced by copper sulfate, which also intensifies yellow dyes. It is less abrasive than tin, but it can still degrade dye hues.

Overview of Technique/ Methodoloy:

1. **Fabric Preparation Prior to Printing:**
   1. 100% cambric cotton was bleached and scoured to get rid of impurities and make it ready for dye absorption.
   2. Next, a natural mordant called aluminum potassium sulphate was applied to the fabric.
2. **The process of mordanting:**

Pre-Mordanting: Before dyeing, the materials were

treated with an aluminum potassium sulphate solution, which allowed the mordant to adhere to the fibers. For three to four hours, the scrubbed and bleached fabric was immersed in a 5% mordant solution (depending on the fabric's weight) in hot water.

The cloth was rinsed in cold water, dried in the shade, and then taken out of the solution. After being cut from the mordanted materials, samples measuring 12 cm by 6 cm were saved for printing.

Weigh copper sulfate according to the weight of the cloth or sample before using it as a mordant. In hot water, dissolve copper sulfate. Pour cold water over the fabric to cover it. Stirring occasionally, let the fabric remain in the liquid for the entire night. As an alternative, heat the mixture to less than a simmer for one to two hours.

Post-Mordanting: To improve color adherence, the materials were submerged in the mordant solution following the printing process (For both aluminum potassium sulphate and copper sulphate).

3. Eco-Printing Method: The prepared cloth was adorned with fresh flowers and leaves. The pigments from the leaves were transferred onto the cloth using either the bind and steam method or the hammering method, depending on the technique utilized.

After printing, the fabrics were steam-treated to improve the print clarity and set the colors.

Pre-mordanted fabric samples and freshly plucked flowers and leaves (making sure none are harmful) are prerequisites for printing:

- Iron or wooden hammer;
- A5-sized plastic transparency sheet;
- one-inch masking tape; and
- Scissors
  Felt bedding on a printing table;
- Rough cloth

Method:

Place the cloth that has been pre-mordanted and post-mordanted on the printing table. To construct the desired design, arrange the flowers and leaves using the printing method of your choice.

1. **Hammering:** To extract the pigments from the arranged plant material, gently hammer it. To get the desired effects, make sure your hand makes complete contact with the flowers and leaves, but be careful not to harm them.
2. **Resting Period:** Give the printed fabric a minimum of one hour to rest so that the pigments from the flowers and foliage can be released onto the cloth.
3. **Last Steps:** After the resting period, carefully remove the masking tape from the direct print samples and let them dry thoroughly.

ASeveral experiments will be carried out for color fixing after printing.

Testing: The final prints were put through a number of tests to make sure they met the required standards for colorfastness, general quality, shape, depth, and print quality.

RESULTS AND DISCUSSION

Using various flowers and leaves, mordant kinds, mordant concentrations, and mordanting techniques (before and post), the color fastness and overall print quality of eco-printed cotton bleached fabric were assessed. The evaluation was based on aesthetic appeal, depth of shade, print evenness, sharpness of outline, and overall grading following washing.ISO 105 series; AATCC 8) (Table 1).

With weighted mean scores ranging between 3.0 and 4.0 across the majority of characteristics, the results show that prints created with Rosa x damascena, Bauhinia x blakeana, Alternanthera (green), Tagetes patula, and Solanum tuberosum consistently achieved extremely good overall performance. Rosa x damascena scored the highest among these for both aesthetic appeal and outline sharpness (3.94), especially when printed with 5% aluminum potassium sulfate under post-mordanting circumstances (Haar *et al.,* 2013).

Bougainvillea glabra and Asparagus, on the other hand, generated relatively lower evaluations, particularly in terms of print evenness and aesthetic appeal, suggesting limited appropriateness for hammer-based eco-printing on cotton textiles (Kasikovic *et al.*, 2016).

Impact of Mordanting Technique and Type:

In both pre- and post-mordanting, aluminum potassium sulphate (Alum) performed better, producing sharper outlines, better print evenness, and enhanced shade depth.(Haar *et al.*, 2013).

Table 1 : Mordant's impact on prints' color, form, depth, and quality

Flowers and leaf	Sharpness of Outline	Evenness of Print	Depth of Shade	Aesthetic Appeal	Image washed Sample	Over all Grading (color fastness to washing)	Name and % of mordant used	Type of Mordanting
1. Rosa x Damascena 2. Bauhinia x Blakeana 3. Solanum Tuberosum	3.94	3.19	3.13	3.94		4	5% Aluminium potassium Sulphate	Post Mordanting
1. Bauhinia x Blakeana 2. Tagetes Patula 3. Alternanthera Green	3.06	3.25	3.44	3.44		3	5% Aluminium potassium Sulphate	Pre Mordanting
1. Asparagus 2. Bauhinia x Blakeana 3. Tagetes patula	3.00	2.69	3.13	3.13		2/3	5% & 15% Aluminium potassium Sulphate	Pre & Post Mordanting
1. Rosa x damascene 2. Senna marileandica 3. Alternanthera(green)	3	2.5	3.5	3		3	5% & 15% Copper sulphate	Pre & Post Mordanting
1. Bougainvillea glabra 2. Solanum tuberrosum 3. Alternanthera	3.44	3	3.5	3		3	5% Copper Sulphate	Pre Mordanting
1. Alternanthera 2. Tagetes Patula	3	2.95	4	3		4	5% Copper Sulphate	Post Mordanting

While post-mordanting improved color depth and visual contrast in some flower imprints, pre-mordanting with alum generally produced more uniform prints.

Particularly with Alternanthera and Tagetes patula, copper sulphate yielded good outcomes, but it also caused noticeable color changes.

One noteworthy finding was that Alternanthera leaf prints changed from brown to olive green after being post-mordanted with copper sulfate, demonstrating the major impact of mordant–plant interactions on final color outcomes (Kasikovic *et al.*, 2016).

Color Fastness Efficiency:

The color fastness of cotton bleached fabrics mordanted with copper sulfate and aluminum potassium sulfate ranged from excellent to very good:

On the grey scale, washing, dry cleaning, sweating, and crocking fastness received scores of 4–5, suggesting little stains and color loss.

With a score of 3, the light fastness findings were mediocre, typical of many natural dye systems, and suitable for use in crafts and fashion.(ISO 105-B01).

Conclusion:

Based on the results, it can be said that, when the right mordants and mordanting techniques are used, eco-printing on bleached cotton cloth utilizing flower and leaf imprint technology is both technically and aesthetically possible (Kasikovic *et al.*, 2016; Tajuddin, 2018).

Rosa x damascena, Bauhinia x blakeana, Alternanthera, Tagetes patula, and Solanum tuberosum were discovered to be the best plant materials for

producing high-quality prints with good color fastness qualities. Asparagus and Bougainvillea glabra yielded moderate outcomes and were relatively less effective.

Under both pre- and post-mordanting methods, aluminum potassium sulphate proved to be the most successful mordant, providing reliable print quality and robust fastness characteristics.(Haar *et al.*, 2013).

Overall, the study demonstrates that eco-printed cotton textiles can attain excellent durability and visual appeal, satisfying the practical and aesthetic demands of sustainable textile goods. The method works well for fashion clothing, accessories, and specialty sustainable products despite having a moderate level of light fastness (Tajuddin, 2018).

The results promote the use of eco-printing in modern sustainable fashion and craft-based textile practices by highlighting its potential as an economically relevant, artistically rich, and ecologically conscious textile printing technique.

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