International Journal of Applied Social Science
(An International Double Blind Peer Reviewed / Refereed Research Journal of Social Science)
Volume 11 (11 & 12), November & December (2024) : 738-742
Received : 29.10.2024; Revised : 14.11.2024; Accepted : 29.11.2024

RESEARCH PAPER
ISSN : 2394-1405 (Print)
DOI: 10.36537/IJASS/11.11&12/738-742
Published Date : 26.12.2024

Impact of Pre - Post Mordanting with Aluminium Potassium Sulfate on Hammer-Printed Cotton from Rose and Marigold Flowers

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ABSTRACT

Interest in sustainable textile coloring options has increased due to growing health and environmental concerns about synthetic dyes. This study examines the efficacy of eco-friendly hammer printing, or "eco-printing," on cotton fabric using natural pigments made from marigold (Tagetes patula) and rose (Rosa × damascena) flowers. The evaluation of the effects of aluminum potassium sulfate (alum) pre- and post-mordanting on print quality and color fastness characteristics was the main focus. After hammer printing bleached cotton fabric with fresh flowers, it was mordanted with alum at different concentrations (5%, 10%, 15%, 20%, and 25%) using both pre- and post-mordanting techniques. Textile experts evaluated the printed samples subjectively for overall aesthetic appeal, print evenness, depth of shade, and sharpness of outline. Standard Indian testing techniques were used to objectively evaluate color fastness to washing, rubbing (dry and wet), and sunlight. The findings showed that, in comparison to post-mordanting, pre-mordanting with aluminum potassium sulfate consistently resulted in better evenness, shade depth, and print quality. Mordant concentrations between 15% and 25% produced the best results. Among the chosen plant materials, rose and marigold flowers produced the most distinctive and eye-catching impressions. Pre-mordanted samples showed greater resistance to sunlight and rubbing, while post-mordanting slightly improved wash fastness at higher concentrations. Color fastness properties improved significantly with mordant application. The results prove that aluminum potassium sulfate is a suitable and eco-friendly mordant for cotton eco-printing. The study emphasizes hammer printing as a practical, sustainable substitute for traditional textile printing techniques and advocates for the resurgence of natural dye ing techniques.

Keywords: Aluminum potassium sulfate, Eco-printing, Natural dyes, Hammer printing, Mordanting, marigold, Rose, Sustainable textiles

INTRODUCTION

The widespread use of synthetic dyes and dangerous chemicals during the dyeing and printing processes makes the textile industry one of the biggest contributors to environmental pollution. Untreated or insufficiently treated textile effluents are frequently dumped into water bodies, creating a serious ecological imbalance and putting workers and the surrounding communities at risk for skin conditions, respiratory issues and cancer. Growing consumer consciousness and legal limitations on harmful dyes have sparked a resurgence of interest in environmentally friendly substitutes (Whelan, 2009).

Natural dyes, obtained from plants, animals, and minerals, offer a sustainable choice because they break down naturally, are non-toxic, and have a low environmental impact (Flint, 2008). While natural dyes may have drawbacks like lower color yield and moderate durability, these issues can be resolved with proper mordanting techniques (Haar and Doty, 2017).

Eco-printing, also referred to as botanical or hammer printing, is a modern method for designing textile surfaces. It transfers pigments from plant materials directly onto fabric using physical pressure. This technique combines

How to cite this Article: Choudhary, Monika and Pant, Suman (2024). Impact of Pre - Post Mordanting with Aluminium Potassium Sulfate on Hammer-Printed Cotton from Rose and Marigold Flowers. *Internat. J. Appl. Soc. Sci.,* **11** (11 & 12) : 738-742

traditional dyeing practices with artistic creativity, creating unique designs while using fewer chemicals (Martin, 2001; Flint, 2008).

This study examines the effects of pre- and post-mordanting with aluminum potassium sulfate on cotton fabrics printed with rose and marigold flowers. The goal is to identify an improved and eco-friendly printing process (WGSN, 2020).

Eco-Printing and Hammer Printing Technique:

Eco-printing is a direct printing method where pigments from fresh plants are pressed onto textiles. Unlike traditional printing, which uses prepared dye pastes, eco-printing allows natural pigments to create organic patterns directly on fabric (Flint, 2008).

This method is both an art and science. It depends on various factors, such as:

- Type and age of plant material
- Fiber type (cellulose or protein)
- Choice of mordant
- Quality and pH of water
- Length of contact time

Successful pigment transfer requires direct contact between the plant material and the fabric (Martin, 2001). Hammer printing, in particular, creates sharp impressions and preserves the natural shape and texture of flowers and leaves, leading to distinctive and impressionistic designs (Haar and Doty, 2017).

METHODOLOGY

Selection of Fabric and Plant Material:

Bleached cotton fabric was chosen for this study because of its common use and cellulose-based structure. Fresh flowers from rose (Rosa x damascena) and marigold (*Tagetes patula*) were selected for their rich pigments and printing potential (Flint, 2008).

Selection of Mordant:

Aluminum potassium sulfate (alum) was chosen as the main mordant due to its historical use, low toxicity, and environmental friendliness. Alum helps fix dyes by forming stable metal-dye-fiber bonds, which improves color depth and durability (Flint, 2008; Haar and Doty, 2017).

Mordanting Techniques

Five concentrations of alum (5%, 10%, 15%, 20%, and 25% based on fabric weight) were used with two methods:

Pre-Mordanting:

Cotton samples were soaked in a hot mordant solution at 90°C for 45 minutes, using a 1:50 fabric-to-liquor ratio. The mordanted fabric was then hammer printed.

Post-Mordanting

In this method, fabrics were first hammer printed with flowers and left to rest for 1–2 hours. The printed samples were later mordanted under the same conditions (Haar and Doty, 2017).

Hammer Printing Process:

Fabric samples measuring 7" x 7" were arranged with flowers between layers of fabric, supported by blotting paper and plastic sheets. The materials were hammered evenly to transfer pigments onto the fabric. Afterward, the printed samples were shade-dried.

Assessment of Print Quality:

Twenty clothing and textile experts assessed print quality using a five-point scale for factors like:

- Sharpness of outline
- Evenness of print
- Depth of shade
- Overall aesthetic appeal

Color Fastness Testing:

Color fastness to washing, rubbing (both dry and wet), and sunlight was evaluated using standard Indian test methods (IS: 3361-1979, IS: 766-1988, IS: 686-1985).

RESULTS AND DISCUSSION

Effect of Mordanting Technique on Print Quality:

Pre-mordanting with aluminum potassium sulfate consistently delivered better print quality than post-mordanting. Concentrations of 15–25% showed sharper outlines, more even prints, and deeper shades. This improved performance is due to better penetration of mordant ions into the fiber, creating stronger dye-fiber bonds during printing (Flint, 2008; Haar and Doty, 2017) (Table 1).

Post-mordanted samples showed lighter shades and less clarity, especially at lower mordant concentrations

Table 1 : Effect of pre - post mordanting with aluminium potassium sulphate on quality of print of fabric printed with rose and marigold Flowers (*Rosa x damascene & Tagetes patula*)

Sr. No.	Criteria	% of Mordant 5% Pre	% of Mordant 5% Post	Pre-Mordanted	Post Mordanted
1.	Sharpness of Outline	4.25	4.06		
2.	Evenness of Print	3.88	2.81		
3.	Depth of Shade	3.88	2.69		
4.	Aesthetic Appeal	4.19	3.19		
Sr. No.	Criteria	% of Mordant 10% Pre	% of Mordant 10% Post	Pre-Mordanted	Post Mordanted
1.	Sharpness of Outline	3.81	3.94		
2.	Evenness of Print	3.19	2.31		
3.	Depth of Shade	3.69	2.56		
4.	Aesthetic Appeal	4.13	2.81		
Sr. No.	Criteria	% of Mordant 15% Pre	% of Mordant 15% Post	Pre-Mordanted	Post Mordanted
1.	Sharpness of Outline	4.31	4.25		
2.	Evenness of Print	4.00	3.88		
3.	Depth of Shade	4.13	3.69		
4.	Aesthetic Appeal	4.31	4.13		
Sr. No.	Criteria	% of Mordant 20% Pre	% of Mordant 20% Post	Pre-Mordanted	Post Mordanted
1.	Sharpness of Outline	4.44	4.38		
2.	Evenness of Print	4.06	3.25		
3.	Depth of Shade	4.19	3.0		
4.	Aesthetic Appeal	3.94	3.88		

(5–10%). However, aesthetic appeal improved at higher concentrations, with little difference noted at 25%.

Color Fastness Properties:

Sunlight Fastness:

Un Mordanted samples had poor sunlight fastness (grade 2). Mordanting greatly improved resistance to fading, and pre-mordanted samples had better ratings

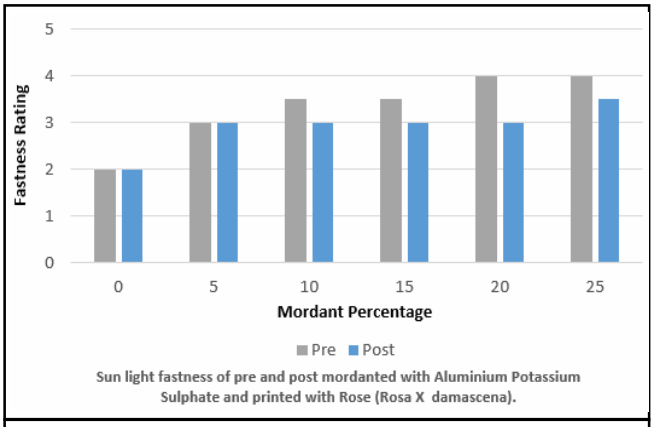

Fig. 1 : Rose Flower (Rosa x damascena)

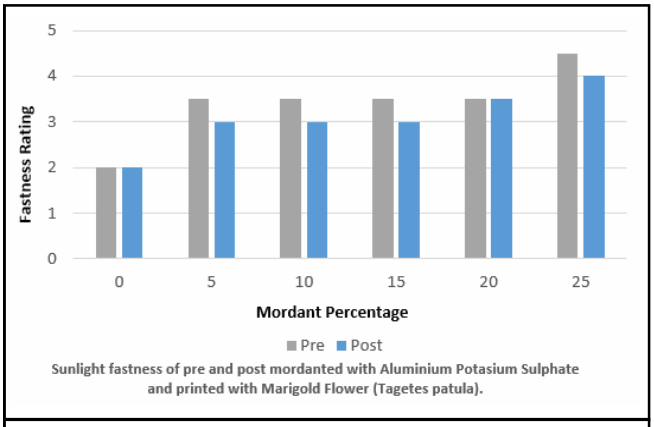

Fig. 2 : Marigold Flower (*Tagetes patula*)

than post-mordanted ones. The highest fastness was observed at 25% mordant concentration (Fig. 1 and 2).

Wash Fastness

Wash fastness noticeably improved with higher mordant concentrations. Post-mordanted samples had slightly better wash fastness at greater concentrations (20–25%), indicating better fixation during the post-treatment (Fig. 3 and 4).

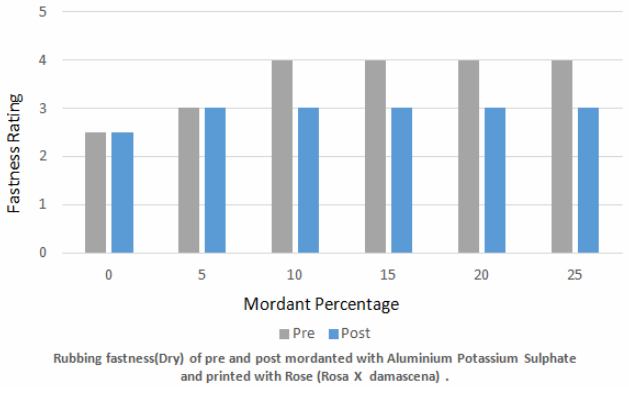

Fig. 3 : Rose Flower (Rosa x damascena)

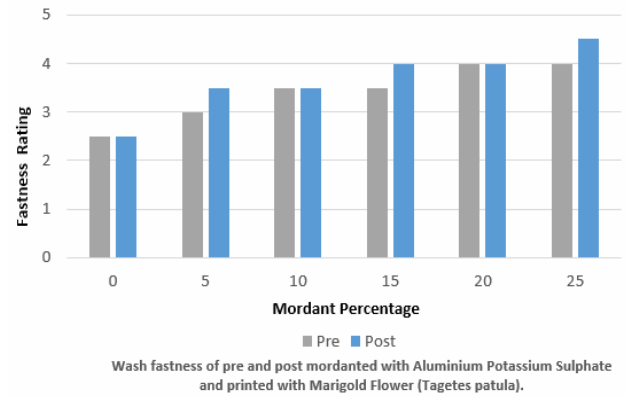

Fig. 4 : Marigold Flower (*Tagetes patula*)

Rubbing Fastness:

Both dry and wet rubbing fastness improved significantly with alum mordanting. Pre-mordanting was especially effective in increasing wet rubbing resistance, particularly for fabrics printed with roses. Even at low concentrations (5%), marigold prints achieved good rubbing fastness (Dharshini and Nagaveni, 2023) (Fig. 5 & 6).

Conclusion:

This study clearly shows that aluminum potassium sulfate is an effective and environmentally friendly mordant for hammer printing cotton with rose and marigold flowers. Pre-mordanting outperformed post-mordanting in print quality, shade depth, and overall aesthetic appeal. Both methods improved color fastness.

Eco-printing stands out as a viable alternative to traditional textile printing, reducing chemical use, minimizing environmental harm, and supporting sustainable design (Flint, 2008; Haar and Doty, 2017; WGSN, 2020). The findings advocate for reviving traditional dyeing practices and exploring more natural pigments and eco-friendly textile technologies.

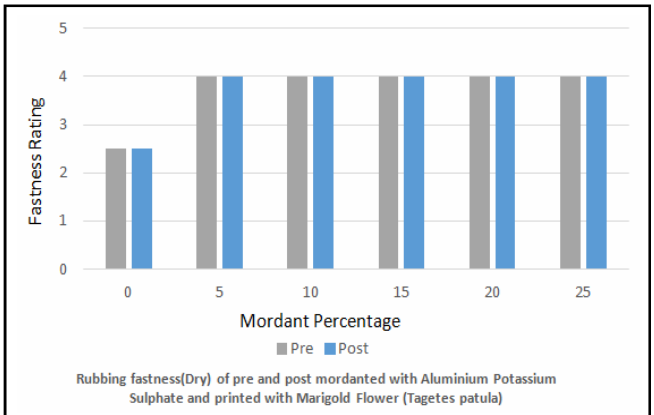

Fig. 5 : Rose Flower (Rosa x damascena)

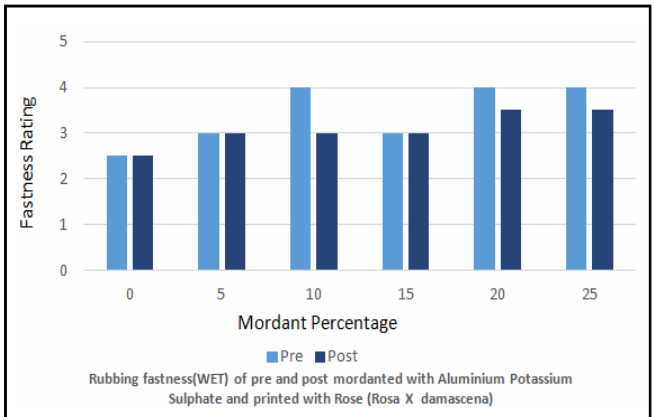

Fig. 6 : Marigold Flower (*Tagetes patula*)

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