THE PROGRESS: A Journal of Multidisciplinary Studies
Vol.6, No.3 (September, 2025), Pp.162-175
ISSN (Online): 2958-292X, ISSN (Print): 2958-2911
DOI: https://doi.org/10.71016/tp/z9nbdn06

Original Article **https://hnpublisher.com**

An Investigation into Eco-Printing Techniques on Cotton Using Different Mordants

Rabia Shoukat[1], Asna Mubashra[2], Sobia Asim[3]

[1]Lecturer, Department of Textile Design, Lahore College for Women University, Lahore, Pakistan.
[2]Chairperson, Department of Textile Design, University of the Punjab, Lahore, Pakistan.
[3]Research Scholar, Department of Textile Design, University of the Punjab, Lahore, Pakistan.
Correspondence: asna.cad@pu.edu.pk[2]

ABSTRACT

Aim of the Study: This study involves application and assessment of the eco-printing of guava and eucalyptus leaves on cotton fabric. On cotton fabric, it is applied using steaming techniques, boiling techniques and madder mordant. Leaves printed on cloth were used to assess the results of steaming techniques, boiling technique and madder mordant. Alum, ferrous oxide, and madder mordants were used to pre-mordant the cloth.

Methodology: In this study, two independent variables were investigated: 100% cotton fabric and eucalyptus and guava leaves. This research is based on quantitative data. This is an experimental study. Various eco-printing techniques were used on cotton cloth. The leaves of eucalyptus (Eucalyptus camaldulensis) guava (Psidium guajava) and 100% cotton cloth were used in the experiment. The experimentation sample size in this study is five pieces of 8 by 10-inch cotton cloth.

Findings: The result revealed that guava had a dark green print with detailed printed veins of leaves, and the reverse of the guava leaf also revealed a result of the dark green outline of the leaf, but the eucalyptus was faded. The iron mordant with steaming technique showed black outlines of eucalyptus and guava leaves with fading eucalyptus and guava colors. The result of eucalyptus and guava leaves was dark green as a steaming technique with alum and iron mordant. Colors are leaking outside the boundaries of leaf impressions on eucalyptus and guava. The rolling process, followed by boiling with madder mordant, produced clear and light tones of equal red hues of leaves, with detailed prints of guava leaves and appropriate outlines and colors of eucalyptus leaves.

Conclusion: To conclude, "Eco-Printing" is the study of nature, its qualities, and how to effectively employ them in an artistic creation. Plants must go through a process that involves interacting with rodents in order to obtain the pigments that go with their prints. The ideal plants to use in eco-printing are determined by a researcher via practice and study. After testing with the leaves and blossoms of several plants, guava leaves produced satisfactory results.

Keywords: Eco-Printing, Mordants, Sustainability.

Article History

Received:
August 02, 2025

Revised:
September 21, 2025

Accepted:
September 26, 2025

Online:
September 30, 2025

1. INTRODUCTION

Eco-printing is a contemporary application of natural dyeing processes. Plants are encased in fabrics or paper, bundled by wrapping around rods or stacked in layers, and then steamed or submerged in hot water to extract the pigments and form a print made with plant dyes in eco-printing or dyeing (Feldberg, 2014).

The history of how this technology was discovered has been forgotten throughout time. While it is most likely that it has been practiced as an artisan skill for thousands of years, we can date its history as a more formal technique back to the Middle Ages. Herbalism, the reproduction catalog, and plant taxonomy arose as a result of increased scientific interest and improved organization during the period (Tondro, 2013).

The eco-printing technique was discovered in the mid-1990s by the artist India Flint, who utilized water-cooked eucalyptus leaves combined with iron particles. Prior to the 1800s, natural dyes were the only source of color dyes for textiles. Traditionally, "tea" was made by boiling plant ingredients in a huge copper or iron kettle with a filter. When the metals reacted with the "tea," a multicolored fiber was formed. To keep an equal color, the dye was regularly swirled. While certain plants do not create vivid colors, the art of natural dyeing has improved and expanded over time, allowing dyers to select the appropriate plants for their goals (Kelley, 2018; Danila et al., 2021).

The procedure transfers the plant pigments onto the fabric or paper, which is thereafter let to cool in a situ pot. The fabrics or paper can be eco-printed by burying them in the ground, rusting with metals in acid (like vinegar), or solar-soaking in water or dye if given a prolonged resting period. Another name for it is "Nature Printing." The 18th century saw the development of this procedure. In order to provide a direct imprint of elements like lead, gum, and photographic plates, this topic goes through a number of steps. The photographic plates are then utilized in the printing process (Feldberg, 2014).

Eco-printing is also known as Self-Printing since the print is created by the inked plant rather than an artist making markings on paper away from the specimen. Natural printing is gaining popularity because of its environmental friendliness, green chemistry, and eco-friendly processes. Natural dyes have historical, cultural, and economic worth when it comes to textile coloring. Until the middle of the nineteenth century, natural dyes were the primary colors accessible for textile dyeing and printing operations. A 17-year-old Englishman named 'Sir William Henry Perkin' invented and developed the first synthetic organic dye in 1856. After the introduction of synthetic dyes, the usage of natural dyes for textile dyeing declined significantly. Every country has its own flora and fauna, which should be utilized and safeguarded. This option might be realized in order to prevent the creation of new sustainable and environmentally friendly natural dye sources. Methods of dyeing and printing that use reusable colorants and biodegradable plant and fruit waste. Natural dye sources, such as bulk and by-products, are both environmentally safe and long-lasting. Natural colors were recovered from plant waste such as rosemary rose, lavender, tea extracts, orange peel, rose wastes, and fruit and vegetable pulp, as well as the exterior green shell of an almond fruit and crude olive (Flannery, 2017).

The color and intensity of the prints vary depending on the metal used. In the context of dyeing, they are known as "mordants." The word "mordant," which is derived from the Latin "to bite," causes the fibers of cloth or paper to become more pliable, extending the life of the dye after washing and light exposure. However, there is significant disagreement as to whether the procedure can still be referred to be "eco" when metal salts are injected. To avoid a conflict, some people refer to the technique of printing with botanicals as "nature printing," "printing with leaves," or "plant printing," although ultimately, it is the same thing. There is not much of a distinction between nature printing on fabric and nature printing on paper. Plant prints can be created without the use of any mordants, however, pre-mordanting with iron or alum can enhance the quality of the prints and prolong their durability. The only textiles that should be printable are those made of natural fibers. Most household colors are made of petroleum chemicals, thus they won't work on synthetic cloth. Bamboo, rayon, and cotton are all excellent choices. Wool is an excellent material for printing. Most environmental printers find that silk rapidly becomes their go-to

cloth after giving it a try. On silk, even shoddy patterns lacking distinguishable leaf forms appear beautiful due to the delicate gradations of the natural color. Not every cloth has the same impact as a print, and not every leaf makes a beautiful print. Finding which local leaves work and which don't requires a lot of trial and error with this strategy. A significant difference may be made by practicing with the mordant after years of experience. It's a good thing that most printing becomes boring because of the pot colors left on the cloth, but certain effects produce beautiful anti-prints while others just leave the dye effect and refuse to take any color from the dye pot (Kelley, 2018).

Eco-printing is an alchemical process that perfectly combines science and art. The final print is affected by a number of factors, including the age and section of the dye plant, the growth circumstances of the plant, the textile fiber, the choice of mordant, the choice of dye helpers, the amount of resting time, and so on. A good eco print necessitates a strong and direct connection between the plant and the substrate, regardless of other variables. Plant components should be cooked in water or natural dye, or securely wrapped in a pre-mordant textile or sandwiched between layers of cloth. Print effects can be created by layering, tying, folding, clamping, or sewing metals, pebbles, twigs, and other things onto the cloth (Feldberg, 2014).

2. LITERATURE REVIEW

The plant pigments are extracted onto the cloth or paper, which is then allowed to cool in place. If the fabrics or paper are allowed to rest for a longer period of time, they can be eco-printed by composting them in the ground, rusting them with metals in acid (e.g. vinegar), or solar-soaking in water or dye. Predictable prints as well as "surprises" can come from intelligent dye plant mixtures and the application of mordants (Feldberg, 2014). Other practitioners have documented their contact print processes more extensively in books, blogs, and academic papers, most notably Canadian dye scholar Karen Leigh Casselman (Casselman, 2004), who coined the term "eco dye" and mentored well-known eco-print artisan and author India Flint (Flint, 2008).

Flint was inspired by European traditional customs of coloring eggs with herbs. Her subsequent usage of the term "eco print" has now become mainstream among international hobbyists 10 who are creating eco print processes at home and reporting their work to a growing online audience (Flint, 2008).

Figure 1: *The reverse of a 1779 uncut continental currency sheet.*

Benjamin Franklin created the design of the nature print to be used on Pennsylvania money in the decades preceding the American Revolution. The history of nature printing, which is the term for the process of creating a print by utilizing the surface of a natural item, such as a leaf, is examined by author and printing history specialist Roderick Cave. Originally created in the Middle Ages to aid people who were gathering medicinal plants, the practice has now developed into a rigorous scientific method used to multiply plants and create collections of both flora and wildlife. The method made use of emerging photography technology in the 19th century, and tattoo artists, graphic designers, botanists, and others are still drawn to this age-old art style today (Cave R, 2010).

Figure 2: *A leaf nature print.*

2.1 Contact Printing

The impact of various mordants, applications, and fixation techniques on generating amazing patterns, textures, and color shades was examined using cotton, viscose, Tencel, Tencel/cotton, and cotton/polyester mix textiles. Once the most suitable ways were identified, visual effects were effectively accomplished. Light colors and weak and extremely fuzzy traces on fabrics may be created with mere water, independent of plant or recipe content. If brighter and more remarkable traces are required, experimental parameters such as fabric/fiber and mordant type, fastening, packing, wrapping, fixing procedures, and so on, must be employed. In these operations, recipes must be employed, which must take into account technical knowledge, experience, and practices, as well as each parameter. The protein structure of animal fibers was replicated using egg white, which proved to be an effective method. Egg white appeared to improve the print impact due to its protein structure and adhesive qualities, resulting in sharper-edged, attractive, and vivid graphics. Plants may cling to fabric by creating visible and vibrant markings, textures, and colors. The results differ depending on the cloth and mordant used. The finest traces and deepest colors were generated with iron mordant. Alum mordant produces lighter/softer colors and patterns.

If a rolling bar is not employed, plants may become more deformed or have more subdued patterns. Steaming the product that has been wrapped in aluminum foil aids in producing more striking visual effects on the surface of the fabric. By boosting plant patterns, altering color tones, and boosting a wider variety of colors, mordants increase the color creation of eco prints.

Tones such as cinnamon, brown, and green; dark hues of khaki, mink, brown, and navy; and lighter or softer shades of pink, reddish, and yellow Precise recipes, technical know-how, experience, and practice are necessary for successful patterns. A single parameter change may produce a vast array of distinct

designs with remarkable diversity. Designers and artists may express their boundless creativity and imagination using the contact/eco print and dyeing process, which is a vast and varied application field that blends art and science (İşmal, 2016).

2.2 Eco-Printing Plants

For oranges and reds, use bloodroot (Sanguinaria canadensis) and Coreopsis sp. (such as C. lanceolata and C. verticillata); Canada For yellows, use goldenrod (Solidago canadensis) and staghorn sumac (Rhus typhina) together with a sumac tannin mordant; for teals and turquoises (which have richer hues), use violet blossoms (Viola sp.). Many native ferns provide complex deep greens, while alder species like Alnus incana, Cottonwood (Populous sargentii), elderberries (Sambucus sp.), blackberry fruit (Rubus sp.), and deep blue or magenta (when smooshed or painted onto a mordant surface) provide black and purple hues (Feldberg, 2014).

2.3 Plants for Eco-Printing, Both Native and Introduced

These plants provide consistent color for contact printing. Many others provide usable color. Experimentation and keeping good notes are the way to progress.

1) Acer palmatum, often known as Japanese maple. Greens, blues, greys, pinks, and lavenders (from autumn leaves).
2) Serviceberry (Amelanchier canadensis). Purples (berries) and greens (leaves).
3) Catalpa speciosa (Catalpa pods) is a species of catalpa. Dark brown.
4) Coreopsis spp. (C. verticillata, C. lanceolata). Colors like oranges and reds.
5) Cotinus coggygria (Smokebush): Oranges, blues, greens, and browns (in-season leaves).
6) Yellows, oranges, greens, and browns from Eucalyptus spp. Plant in a pot. Exotic.
7) Greens, blues, purples, and turquoise in Iris x germanica (Tall Bearded Blue Iris).
8) Black walnut (Juglans nigra). Leaves (greens) and fruits (browns).
9) Prunus cistena (Purple Sandcherry) is a kind of tree native to the Mediterranean region. Dark green, purple, and deep grey are all options. Prunus serotina hybrid.
10) Prunus virginiana (Chocolate). Dark green, purple, and deep grey are all options.
11) Greens (leaves) of Rosa spp.
12) Rhus typhina (Sumac): Yellows, chartreuse (leaves); pinks, reds (fruits/blooms).
13) (Marigold) Tagetes spp. Greens, oranges, and yellows (petals) (Feldberg, 2014).

2.4 Natural Dye Bath

Plant color does not automatically mean dye color, since the natural dye history shows that almost any plant may create some color. Unlike a conventional dye bath, the contact print method frequently allows pigments to show up as different colors. Blue, green, purple, and turquoise may all be contact printed simultaneously on a substrate by a blue bloom, like the Tall Bearded Blue Iris. The same blue iris flower, when treated in the traditional technique of the artist, yields a uniform bluish purple and a consistent green with alum (Feldberg, 2014).

2.5 The Relationship between Eucalyptus and Eco-Printing

The scientific name for eucalyptus is 'Eucalyptus Globulus,' a composite phrase of the Greek words 'Eu' (meaning well) and 'kalipto' (meaning covered). This name is taken from the shape of the calyx enveloping the bloom. With more than 1200 types and subspecies worldwide, eucalyptus is one of the

largest trees in the world. It is an evergreen hardwood native to Australia. From March to November, flowers in shades of yellow, white, and crimson bloom. The fruits are hemispherical and the leaves have a pleasant scent. Eucalyptus is used as a raw material for tar, rubber, and oil; during natural dyeing, it produces gin and oil that resemble rubber. Particularly oil is recognized to have sterilizing qualities.

Furthermore, eucalyptus first appeared in the association's booklet references in the mid-1900s and has a good affinity for wool, since it was suggested as a dye suited for wool socks for military troops at the time. Furthermore, eucalyptus has good colorfastness to sunlight without degradation of dyes and may fix colors on wool, silk, and other animal materials without the need for chemical mordants. After dyeing, the color of Eucalyptus leaves varies based on their gathered state, such as fresh, dried, or picked off the tree without falling from the tree. Furthermore, it should be mentioned that one of the features of eucalyptus is that even the leaves taken from a single tree are combined with variable amounts of substances, thus the color may vary as a consequence of dyeing.

This color variation has been determined to be weather-related. The colors are vivid in dry conditions, and if it rains before harvest, the color changes quickly from deep red to pale green. When processed in water in its natural condition, eucalyptus is a khaki dye, however, when eco-printed utilizing leaves directly harvested from trees, orange, tan, and light green patterns can be produced. Eucalyptus Cinerea is a popular cultivar in flower shops all over the world. It is distinguished by bluish-gray foliage. When immersed in hot water, it quickly turns green, and after approximately ten minutes of boiling, it turns khaki.

Wool and silk are used for eco-printing because the flavonoids and tannins found in eucalyptus leaves have a great coloring effect when printed on animal fibers. The dyed leaves are dried and used as dried flowers, and the aroma of eucalyptus has insecticidal and insect-preventing properties. The stem may be boiled and reused as a dye solution, which is utilized in the dyeing process. When mordant, blood red and methyl orange are mordant with iron extract as natural dyes, purple, purple, and red colors may be generated depending on the amount of dye that is a material that can harmoniously complement the color of eucalyptus (Jeong, 2017).

2.6 Eco-Printed Surface Characteristics

Natural dye tradition reveals that practically every plant will produce some color; nevertheless, plant color does not always correspond to dye color. Yellow is a secure bet for an eco-print, but it's not the last option because fate favors the curious and risk-taking eco-dyer. The tendency of plant pigments to divide into unexpected constituent colors, providing impressions of "broken color" on the substrate, with patterning and colorings of a spontaneous nature, is a fascinating and appealing feature of an eco-printed surface. These effects can be made more predictable by using mordents (pre- or post-dyeing) and dye assistants like iron or copper selectively, by applying acids (e.g., vinegar) or alkalis (e.g., ammonia) to shift pH, or by combining dye plants in the bundle to mix new colors right on the substrate. For instance, pH-sensitive red cabbage, which environmentally prints blue with alum, will generate a mixed spectrum of greens and blues when sprayed with vinegar and placed next to goldenrod blossoms or some Osage orange (Maclurapomifera) dye powder; it will make blue reds when printed next to yellow.

Eco-dying can be done with most of the dyeing and over-dying techniques used in the traditional dye trade. However, not every color that is anticipated for conventional dye applications will show up in the eco-print procedure. In September, Goldenrod (Solidagocanadensis) prints green from the foliage but deep yellow from the bloom. Young Fustic (Cotinuscoggygria) prints blue, orange, red, and yellow on its fall leaves. Pigments can frequently show up as distinct colors during the contact print process—separations that are lost during a typical dye bath. For instance, a blue flower with delphinine, an anthocyanin pigment, like the Tall Bearded Blue Iris, may contact print many shades of blue, green, purple, and turquoise simultaneously on a substrate. The artist's traditional way of processing the identical blue iris flower results in a consistent green with alum and a uniform bluish-purple without alum. This

approach involves pressing iris juice onto an alum-mordant linen cloth that serves as a color reservoir when soaked in glairs.

The Target flower head, calyx, and all will produce rich golden yellows or oranges when dyed in an immersion dye bath. Contact printed on a protein fiber (like silk), the Target petals dye prints a spectrum of yellows and oranges, while the calyx dye prints dark green (even when dry). In the autumn, Smokebush, Japanese maple, and Sweet Gum leave exhibit similar color separations. Thus, every particular plant during the season might be home to a variety of hues that can be encouraged to expose themselves as individuals using the proper methods, dye helpers, and substrates (Shankaracharya, 2018).

2.7 Determining Plants for Eco-Printing

A plant's color, scent, and water content may all be utilized to assess whether or not it can be utilized as coloring in eco-printing. The success of the eco-printing process is significantly influenced by this water content. One sign that certain plants can be utilized as natural dyes is if they have a strong fragrance. Hand-rub the leaves or rub them on a piece of fabric. The leaves of plants have the potential to be utilized as natural dyes when they leave stains. Give the leaves ten minutes to soak in boiling water. This plant may also be used as a natural coloring agent when the water changes color. There are, in theory, a lot of advantages to be gained from the many eco-printing procedures that are used (Mardiana, 2020).

2.8 Eco-Printing Techniques' Practical Benefits

Fabric is not the only material that can be utilized in an eco-print; anything that can take on the natural color of the flowers and leaves may be used. Fabric items made with eco-printing processes are significantly more distinctive than plain fabric or cloth patterned with digital printing techniques. Products with eco-printing look even better, with elegant and sophisticated designs complementing their distinctive appearance. An alternate strategy to lessen the harm that chemical waste from textile companies does to the environment and ecosystems is to employ eco-printing. There are currently few competitors, which makes eco-printing a good business possibility because many individuals are not involved in it. When producing eco-printed goods, less money is needed than when coloring directly from nature. The field of eco-printing allows for a great deal of flexibility in design creativity, and technological development can lead to ongoing improvement in product quality (Mardiana, 2020). Eco-printing is a one-of-a-kind process for extracting pigments and prints from natural items and applying them as art. Five techniques are used to assess the results of eco-printing. Eco-printing using three steaming procedures and two boiling techniques. To assess and experiment with the outcomes of plant prints created using various procedures.

2.9 Study Objectives

1) To apply and assess eco-printing of eucalyptus and guava leaves on cotton fabrics using steaming processes and alum mordants.
2) To apply and assess eco-printing of eucalyptus and guava leaves on cotton fabrics using steaming techniques and ferrous oxide mordants.
3) To apply and assess the eco-printing of eucalyptus and guava leaves on cotton fabrics using steaming procedures with alum and ferrous oxide mordants.
4) To apply and assess eco printing of eucalyptus and guava leaves on cotton fabric using the rolling technique first and subsequently the boiling-madder mordant process.
5) To apply and assess eco printing of eucalyptus and guava leaves on cotton fabric using first the boiling technique and then the rolling-madder mordant technique.

3. RESEARCH METHODOLOGY

This section outlines the materials and procedures employed in the current research project. True experimental research was used in the study. In this study, two independent variables were investigated: 100% cotton fabric and eucalyptus and guava leaves. This research is based on quantitative data. This is an experimental study. Various eco-printing techniques were used on cotton cloth.

3.1 Population

There are about 750 species in the genus Eucalyptus, and the sample utilized in this study is Eucalyptus camaldulensis, which belongs to the family of Eucalyptus found in Pakistan's Himalayan highlands. Psidium cattleyanum, pineapple guava, and Feijoa sellowiana are among the 30 species of guava, and the sample utilized in this study is guava (Psidium guajava). Cotton is classified into three weight categories: lightweight (up to 200 GSM), medium (200-400 GSM), and heavy (400+ GSM), with the sample used in this investigation being lightweight (160 GSM).

3.2 Sample

The leaves of eucalyptus (Eucalyptus camaldulensis) guava (Psidium guajava) and 100% cotton cloth were used in the experiment.

3.3 Sample Size

The experimentation sample size in this study is five pieces of 8 by 10-inch cotton cloth.

3.4 Mordants

Alum, iron oxide, and madder were employed to fix the color. Mordants like iron and alum were used to prepare the cloth before the procedure in order to retain the print of the leaves. Madder was used in this method to prepare the cloth and plants before the procedure in order to get even mulberry prints on the fabric.

3.5 Instruments For Collecting Data

- Gauze Roll.
- Boiling Beaker.
- Burner Steamer.
- Steel pipe.
- Alum mordant.
- Ferrous Oxide mordant.
- Madder mordant.

In order to prevent the fabric from seeing the natural colors found in plants, three methods of sampling were pre-mordant by soaking in a mordant solution for an hour before rolling with plants. This treatment was necessary prior to the operation. In the final sample, the mordant is only applied to the plants for five minutes. Subsequently, the plant pieces are embellished on the outside and rolled by attaching them to a silky substance formed like a roller. However, it was securely wrapped to allow the plant to make complete touch with the cloth. In this procedure, three fixation techniques were employed.

Three methods of fixation will be used:

- Direct boiling in water- The Fabric Roll directly boils in water.
- Fabric Roll was steamed in a steamer using non-contact boiling in water.
- Rolling technique: The Fabric Bundle is rolled back and forth on a smooth surface.

3.6 Procedure

3.6.1 Steaming Technique

Steaming With Alum: Used cotton cloth that was 8 by 10 inches in size. Fill a beaker halfway with 600 ml of water. Bring the water to a boil. 30 grams of alum were added to the boiling water. Allow Alum to completely dissolve in water. The cloth should then be immersed in hot water for 10 minutes. Turn off the hob and set aside the cloth for 2 hours. After 2 hours, remove the fabric from the Alum mordant and rinse with water. Now, lay the cloth flat and put the guava and eucalyptus leaves in an arrangement. Took a metal rod. The cloth should be rolled into a bundle, covered with plastic wrap as you roll, and securely fastened with thread. Steam it for fifteen minutes now. Remove the bundle from the steamer and allow it to cool. Unroll the bundle once it has cooled, then set it outside to dry.

Steaming With Ferrous Oxide: Took, an 8 by 10 inch piece of cotton cloth. Fill a beaker with 600 ml of water. 5 grams of ferrous oxide were taken and added to the water. Next, for one hour, add the guava and eucalyptus leaves to the iron mordant. To get rid of any extra finish, rinse the cloth with fresh water and allow it to dry. Now spread the cloth out and arrange the guava and eucalyptus leaves. Using a metal rod, roll the cloth into a bundle, cover it with plastic wrap, and secure it with thread. Steam it for an hour now. Remove the bundle from the steamer and allow it to cool. Unroll the bundle once it has cooled, then set it outside to dry.

***Steaming With Alum And Ferrous Oxide*:** Took an 8 by 10 inch piece of cotton cloth. Fill a beaker with 600 ml of water. Water that has reached a boiling point. 30 grams of alum were taken and added to the boiling water. Allow the alum to fully dissolve in the water. Next, submerge the cloth in boiling water for ten minutes. After turning off the hob, leave the cloth inside for two hours. Remove the cloth from the alum mordant after two hours and give it a quick rinse in fresh water. Added 5 grams of ferrous oxide to 600 ml of water. Next, for one hour, add the guava and eucalyptus leaves to the iron mordant. Remove the leaves from the mordant and use tissue paper to dab away any extra water. Lay the cloth flat when the leaves and fabric have been mordant, then arrange the guava and eucalyptus leaves. Using a metal rod, roll the cloth into a bundle, cover it with plastic wrap as you roll, and secure it with thread. Steam it for an hour now. Remove the bundle from the steamer and allow it to cool. Unroll the bundle once it has cooled, then set it outside to dry.

3.6.2 Boiling Technique

Roll and Boil: Took a cotton cloth measuring eight by ten inches. Put 250 ml of water into a beaker. 3 tablespoons of madder and 1 gram of ferrous oxide were added to the water. Soaked leaves in a solution of iron and madder for two hours. 700 ml in a new beaker of water. Water that has reached a boiling point. Boiling water was mixed with 30 grams of alum. Let the alum in the water dissolve completely. The fabric should then be immersed in hot water for 10 minutes. Leave the cloth inside the hob for two hours after turning it off. After two hours, take the cloth out of the alum mordant and quickly rinse it with fresh water. After removing the leaves from the mordant, any excess water was absorbed using tissue paper. Lay the cloth flat when the leaves and fabric have been mordant, then arrange the guava and eucalyptus leaves. Using a metal rod, roll the cloth into a bundle, cover it with plastic wrap, and secure it with thread. Now spend ten to fifteen minutes thoroughly rolling the bundle back and forth on a plain surface. Now let it boil in water for one hour. Remove the bundle and allow it to cool when it has boiled. Unroll the bundle and let it cool outside to allow it to dry naturally.

Boil and Roll: Took a cotton cloth measuring eight by ten inches. Put 250 ml of water into a beaker. 3 tablespoons of madder and 1 gram of ferrous oxide were added to the water. Leaves soaked in madder and iron oxide mordant for two hours. 700 ml in a new beaker of water. Water that has reached a boiling point. Boiling water was mixed with 30 grams of alum. Let the alum in the water dissolve completely. The fabric should then be immersed in hot water for 10 minutes. Leave the cloth inside the hob for two hours after turning it off. After two hours, take the cloth out of the alum mordant and quickly rinse it with

fresh water. Removed the leaves from the mordant and absorbed any excess water using tissue paper. After mordanting the leaves and fabric, spread the cloth flat and arrange the guava and eucalyptus leaves. Using a metal rod, twist the cloth into a bundle, wrap it in plastic wrap, and bind it firmly with thread. Boil it in water for 1 hour. After boiling, remove the bundle and allow it to cool. Roll the bundle back and forth on a flat surface for 10 - 15 minutes. Unroll the bundle and leave it outside to dry.

4. RESULTS

After applying eco-printing techniques, the results were evaluated by leaves printed on fabric. The result of steaming techniques (alum mordants, ferrous oxide, alum, and ferrous oxide mordants), boiling technique (roll + boil) (boil + roll) madder mordants, were examined.

The experimental research on eco printing by using the leaves of eucalyptus and guava and evaluating the results of prints of leaves. The analysis of data as per the sequence of objectives.

Objective 1

To apply and assess eco-printing of eucalyptus and guava leaves on cotton fabrics using steaming processes and alum mordants.

a) Guava leaf. **b)** Eucalyptus leaf.

Figure 3: *Guava and Eucalyptus leaves with alum mordant.*

Figure 3 shows the outcome of testing with steaming procedure with alum mordant using eucalyptus and guava leaves. The guava leaf produced a dark green print with finely printed veins of leaves, and the back of the guava leaf produced a dark green outline of the leaf, but the eucalyptus leaves produced a fairly faded result from front and back.

Objective 2

To apply and assess eco-printing of eucalyptus and guava leaves on cotton fabrics using steaming techniques and ferrous oxide mordants.

a) Guava leaf. **b)** Eucalyptus leaf.

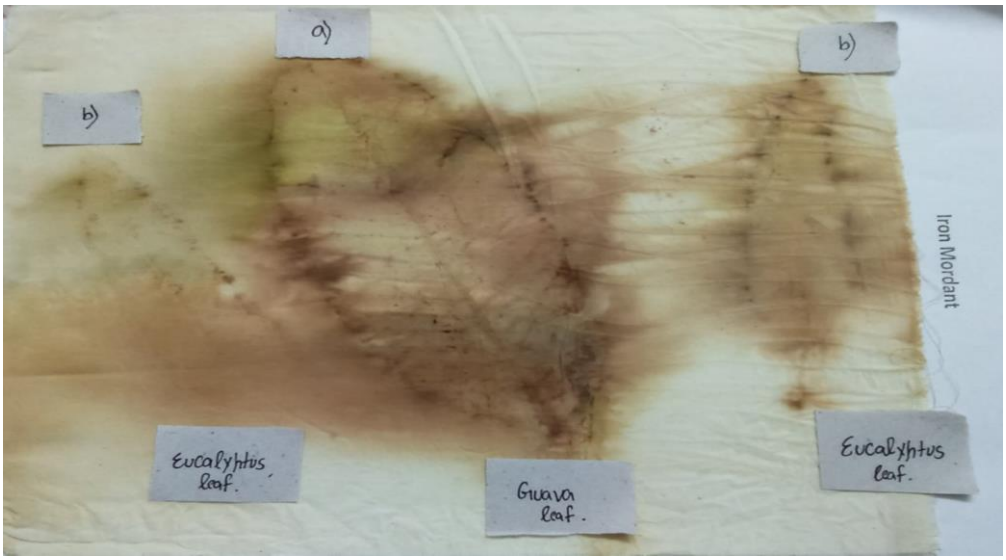

Figure 4: *Guava and Eucalyptus Leaves with Ferrous Oxide Mordant.*

Figure 4 shows the results of testing with steaming procedure with iron mordant using eucalyptus and guava leaves. The end product is a cotton fabric with black outlines of eucalyptus and guava leaves and fading colors of eucalyptus and guava.

Objective 3

To apply and assess the eco-printing of eucalyptus and guava leaves on cotton fabrics using steaming procedures with alum and ferrous oxide mordants

a) Eucalyptus leaf. **b)** Guava leaf.

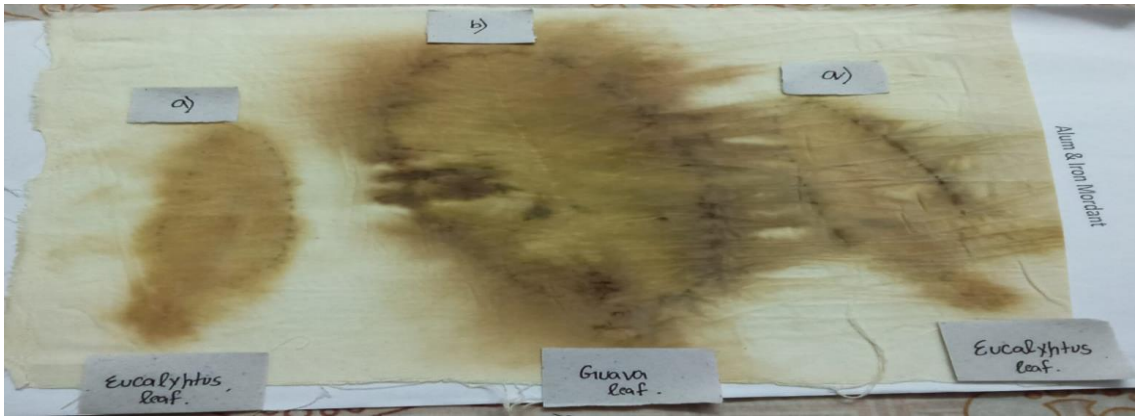

Figure 5: *Eucalyptus and Guava leaves with Ferrous Oxide and Alum Mordant.*

Figure 5 shows the result of testing with steaming procedure with alum and ferrous oxide mordant using eucalyptus and guava leaves. The end effect is eucalyptus and guava leaf outlines in dark green. Colors are leaking outside the limits of leaf designs onto a cotton cloth, and eucalyptus and guava appear faint.

Objective 4

To apply and assess eco printing of eucalyptus and guava leaves on cotton fabric using the rolling technique first and subsequently the boiling-madder mordant process.

a) Eucalyptus leaf. **b)** Guava leaf.

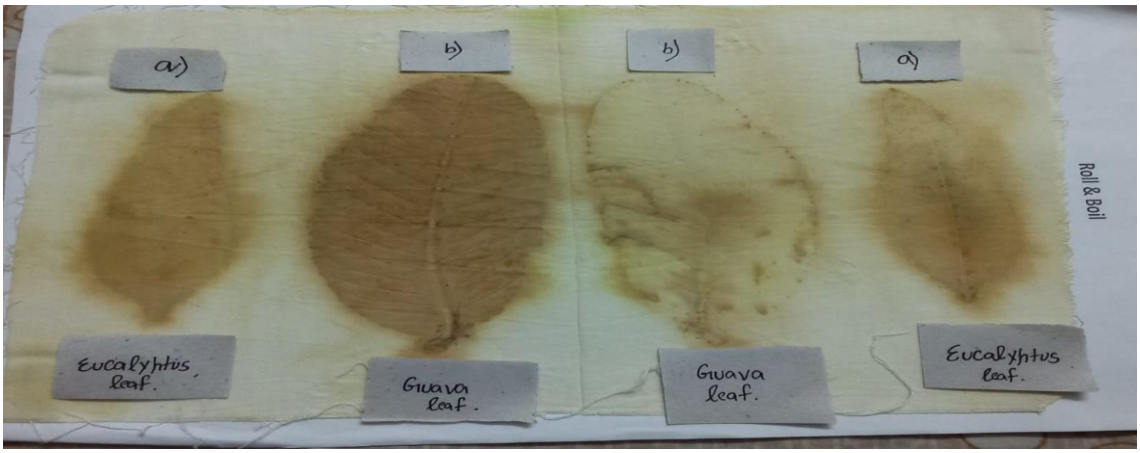

Figure 6: *Eucalyptus and Guava leaves with Rolling and Boiling Mordant*.

Figure 6 shows the result of testing with the rolling technique and then boiling with Madder Mordant on eucalyptus and guava leaves. The finished product has clear and light tones of equal red hues of leaves, realistic prints of guava leaves, and appropriate outline and colors of eucalyptus leaves.

Objective 5

To apply and assess eco printing of eucalyptus and guava leaves on cotton fabric using first the boiling technique and then the rolling-madder mordant technique.

a) Eucalyptus leaf. **b)** Guava leaf.

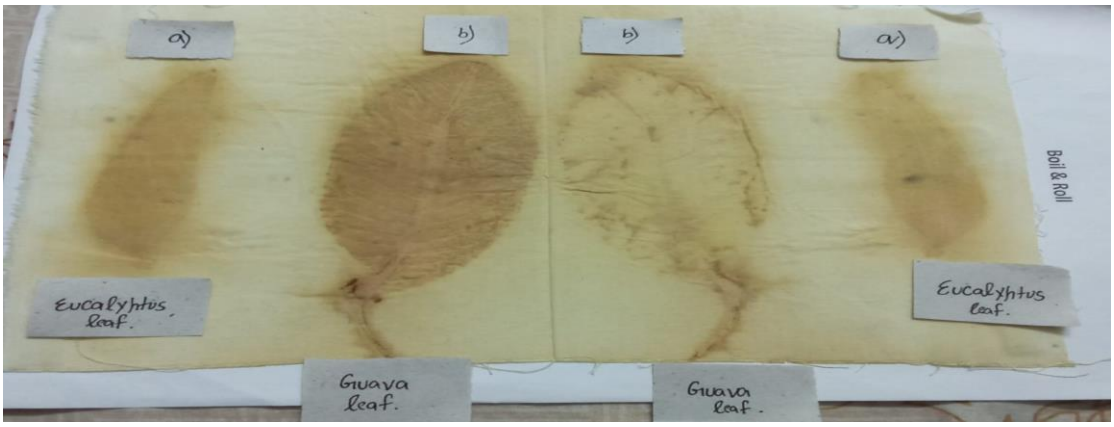

Figure 7: *Eucalyptus and Guava leaves with Boiling and rolling Mordant.*

Figure 7 shows the result of testing with the boiling procedure and then rolling with Madder Mordant using eucalyptus and guava leaves. The finished product has clear and light tones of equal light red shades of leaves, as well as detailed printing of guava leaves and appropriate outline and colors of eucalyptus leaves.

All of the findings were evaluated and determined that the steaming procedure with the alum mordant yielded the best results. The guava leaf had a deep green pattern with delicately printed leaf veins, and its reverse side had the same deep green outline, but the eucalyptus leaves were much more faded on both the front and back of the leaf.

5. CONCLUSION

To conclude, "Eco-Printing" is the study of nature, its qualities, and how to effectively employ them in an artistic creation. Plants must go through a process that involves interacting with rodents in order to obtain the pigments that go with their prints. The ideal plants to use in eco-printing are determined by a researcher via practice and study. After testing with the leaves and blossoms of several plants, guava leaves produced satisfactory results. The results of the alum mordant steaming technique revealed that guava had a dark green print with detailed printed veins of leaves, and the back of guava leaf also gave a result of the dark green outline of the leaf, whereas eucalyptus leaves from the front and back were very faded on cotton fabric. The steaming process with iron mordant produced black outlines of eucalyptus and guava leaves with fading colors of eucalyptus and guava on cotton fabric. The result of the steaming process with alum and iron mordant was dark green outlines of eucalyptus and guava leaves. Colors are leaking outside the limits of leaf designs onto cotton cloth, and eucalyptus and guava appear faint. The rolling process, followed by boiling with madder mordant, produced clear and light tones of equal red hues of leaves, as well as detailed prints of guava leaves and appropriate outlines and colors of eucalyptus leaves. The boiling procedure, followed by rolling with Madder mordant, produced clear and light tones of equal red hues of leaves, as well as detailed prints of guava leaves and appropriate outlines and colors of eucalyptus leaves. Finally, a leaf print was used to analyze the outcome. The second approach, which involved rolling and boiling leaves with madder mordants, produced good results in a quantitative study, whereas the best leaf prints were obtained using steaming procedures with alum mordant. The finest plant prints and outcomes come from practicing and researching different plant species and mordants.

Acknowledgements

None.

Conflict of Interest

Authors declared NO conflict of interest.

Funding Source

The authors received NO funding to conduct this study.

ORCID iDs

Rabia Shoukat [1] https://orcid.org/0009-0006-6362-9377
Asna Mubashra [2] https://orcid.org/0000-0003-0743-6846
Sobia Asim [3] https://orcid.org/0009-0007-3851-3337

REFERENCES

Atkins, A. (1843). Photographs of British Algae: *Cyanotype Impressions (5 volumes).* Available at https://digitalcollections.nypl.org/collections/28d304b0-c612-012f-cd39-58d385a7bc34

Bozacı, B. (2016). *Doğanın Şarkısı Ekolojik Baskı*, İzmir.

Cardon, D. (2007). *Natural dyes. Sources, tradition, technology and science*, Deffner & Johann.

Cave, R. (2010). *Impressions of Nature: A History of Nature Printing. London: British Library*. The British Library Publishing.

Çolak, S., Arğun, F. N., & Kaygusuz, M. (2021). Fashionable Leather Products from Ecofriendly Desinged Vegetable Tanned Leathers. *Motif Akademi Halkbilimi Dergisi, 14*(36), 1384-1398. https://doi.org/10.12981/mahder.976782

Danila, A., Muresan, E.I., Chirila, L. & Coroblea, M. (2021). *Natural Dyes Used in Textiles: A Review*. *International Symposium "Technical Textiles - Present and Future"*. Edition 2021 (pp. 52-59). Gheorghe Asachi Technical University of Iasi. 2021. https://doi.org/10.2478/9788366675735

Feldberg, W. (2014). Eco Printing with Native Plants. *Turkey Red Journal, 18*(2), 18.

Flannery, M. C. (2013). The Herbarium as Muse*:* Plant Specimens as Inspiration. *Biology International, 53*, 23-34.

Ismal Ö E, (2016). Institute, Patterns from Nature: Contact Printing. *The Journal of Textile Association, 77*(2), 81-91.

Işmal, Ö.E., Yıldırım, L. (2019). Metal mordants and mordants, The Impact and Prospects of Green Chemistry for Textile Technology. *The Journal of Textile Institute,106*, 4, 343.

Jeong, IS, & Kang, KY (2017). *Eco Printing.* Available at https://www.meridianjacobs.com/meridian-jacobs-blog/2019/6/16/eco-printing

Martius, E. W. (2019). Prints from Life: *The History of Nature Printing.* Available at https://www.theguardian.com/environment/gallery/2010/aug/19/impressions-of-nature

Richards, L., Tyrl, R. J. (2005). *Dyes from American Native Plants: A practical guide.* Timber Press.

Tondro, C. (2013). Tutorial Leaf Monitoring. Tutorial 3 Eco Printing Basics. https://www.youtube.com/watch?reload=9&v=WU9GQPDIBT0