STUDY REPORT ON NATURAL PIGMENTS

A practical exploration of local plant-based dyes in creative education

NATURAL PAINTS FOR SUSTAINABLE ART AND CRAFTS

Erasmus+ KA2 «Plant&Paint»

Soares dos Reis School of Arts

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Exploring Natural Colors through Local Plants

Introduction

Within the Erasmus+ project "Plant&Paint," students from class 12ºA2, enrolled in the subject Project and Technologies, embarked on a hands-on exploration of natural plant-based pigments. The study aimed to discover sustainable, historically rich, and artistically valuable natural dyes by reconnecting with local biodiversity. Through this initiative, students developed environmental awareness, cultural appreciation, and creative expression, contributing to the broader goals of the Plant&Paint Erasmus+ initiative.

About the Study

This project is part of a larger Erasmus+ collaboration that brings together schools from various countries to investigate and revive traditional, plant-based dyeing techniques. The Portuguese team focused on natural dye extraction, testing on textiles, and creative production, aligning with one of the project's work packages. The main participants were students from 12ºA2 and their teachers, whose collaboration was central to the success of the experimentation and documentation process.

1. Discovering Local Plant-Based Colors

1.1 Exploring Regional Plants

The students researched native and regionally adapted dye plants, while the team of teachers from the international projects group cultivated these species, including:

1. Rubia peregrina (local madder)
2. Isatis tinctoria (woad)
3. Reseda luteola (weld)
4. Anthemis tinctoria (dyer's chamomile)
5. Hypericum perforatum (St. John's wort)

6. Achillea millefolium (yarrow)

These species were chosen for their traditional use and color potential. The process included sowing, cultivating, harvesting, and documenting each step, with photographs illustrating species identification, harvesting, and preparation for dye extraction.

1.2. Regional Dye Plants

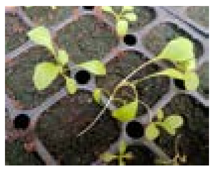
As part of the Plant & Paint Erasmus+ project, students researched, sowed, cultivated, and experimented with several dye plants that have played a significant role in European textile history. Each plant was selected for its traditional use, color potential, and relevance to sustainable, natural dyeing practices.

Below, we detail the main species explored, their historical significance, and practical dyeing notes:

Rubia peregrina (Local Madder)

- Historical Use: Madder roots have been used for millennia to produce red dyes for textiles. Archaeological evidence shows madder-dyed fabrics dating back to ancient India and throughout Europe, including Viking Age finds and Merovingian graves. Madder was also the source of the famous "Turkey red" process, a staple of European textile industries.
- Pigment Chemistry: The roots contain anthraquinone compounds, notably alizarin, which yield a range of reds from pink to deep crimson. Modern analysis highlights the importance of gentle extraction to preserve sensitive dye molecules.
- Cultivation & Dyeing: Students grew and harvested roots, then experimented with extraction by boiling and fermentation. The roots must be cleaned, chopped, and soaked before dyeing. For best results, fibers are mordanted with alum. Madder can also be combined with indigo or iron mordant for purples and browns.

Isatis tinctoria (Woad)



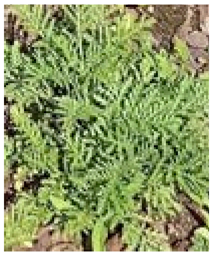
- Historical Use: Woad was the principal source of blue dye in Europe before the introduction of indigo. It was widely cultivated from ancient times through the Middle Ages, and woad-dyed textiles have been found in Viking and Roman sites.

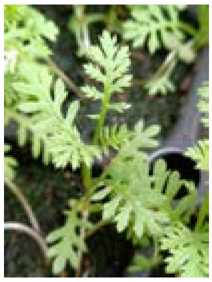
- Pigment Chemistry: The leaves contain precursors to indigotin, the blue pigment. Extraction requires fermentation and reduction, followed by oxidation in air to develop the blue color.
- Cultivation & Dyeing: Students grew woad, harvested leaves, and processed them using traditional methods: maceration, fermentation, and aeration. Dyeing wool with woad involves careful control of reducing agents, temperature, and time to optimize color strength.

Reseda luteola (Weld)

- Historical Use: Weld is one of the oldest and most reliable sources of clear, lightfast yellow dyes. It was cultivated throughout Europe, often growing wild along roadsides and embankments.
- Pigment Chemistry: Weld contains luteolin, a flavone responsible for its bright yellow color, which is highly stable and lightfast.
- Cultivation & Dyeing: Students harvested aerial parts (stems, leaves, flowers) and extracted dye by simmering in water. Alum-mordanted fibers yield the brightest yellows. Weld can be combined with indigo for greens, and with iron for olive shades.

Anthemis tinctoria (Dyer's Chamomile)





- Historical Use: Dyer's chamomile has been used in Turkish carpets and European textiles for warm, strong yellows and tangerine shades (when mixed with madder).
- Pigment Chemistry: The flowers are rich in yellow pigments, best extracted with hot water.
- Cultivation & Dyeing: Dried flower heads are soaked and simmered; the dye bath is then used to color protein fibers (wool, silk) mordanted with alum. The intensity of color depends on the ratio of plant material to fiber.

Hypericum perforatum (St. John's Wort)

- Historical Use: Known for its medicinal properties, St. John's wort also yields dyes. Alum-mordanted fabric can turn green, while unmordanted fabric produces pink or yellow hues.
- Pigment Chemistry: The plant contains hypericin and related compounds, which are sensitive to light and pH.

- Cultivation & Dyeing: Students experimented with solar dye baths and traditional simmering, noting that the freshness of the flowers and timing of harvest significantly affect color outcomes.

Achillea millefolium (Yarrow)

- Historical Use: Yarrow produces yellow dyes with good color fastness and was used traditionally in rural Europe.
- Pigment Chemistry: Contains luteolin, like weld, but gives a different shade of yellow.
- Cultivation & Dyeing: Flower heads are simmered in a mildly alkaline bath (with soda ash) for one hour. The dye bath is strained, and mordanted fibers are added and simmered. Iron can be added for olive tones.

Classroom Process:

Students were involved in every stage - from seed to final dye bath. They recorded observations on plant growth, environmental conditions, and extraction methods. Each dyeing session included careful mordanting of fibers, preparation of plant material, and testing of different extraction and dyeing parameters to compare color yield and fastness. The documentation included photographs of plant identification, harvesting, dye baths, and finished textiles, creating a valuable visual and scientific record of the project.

Summary Table: Regional Dye Plants

Plant Name	Part Used	Main Pigment(s)	Color on Fiber	Historical Notes
Rubia peregrina *Rubia peregrina*	Root	Alizarin, purpurin	Red, pink, purple	Ancient/Medieval Europe
Isatis tinctoria *Pastel dos tintureiros*	Leaf	Indigotin	Blue	Pre-indigo Europe
Reseda luteola *Lírio dos tintureiros*	Stem/leaf/flower	Luteolin	Bright yellow	Ancient/Medieval Europe
Anthemis tinctoria *Camomila das tintureiras*	Flower	Flavonoids	Warm yellow	Turkish/European carpets
Hypericum perforatum *Hipericão*	Flower/leaf	Hypericin	Green, pink, yellow	Medicinal/dye plant
Achillea millefolium *Milefólio*	Flower	Luteolin	Yellow, olive	Rural Europe

Through this comprehensive approach, students not only learned about the chemistry and artistry of natural dyes but also gained insight into the cultural and ecological importance of these plants, reinforcing the value of sustainable practices in both art and science.

1.3 Sustainable Aspects

Throughout the Plant & Paint Erasmus+ project, students developed a practical understanding of the sustainability benefits of natural pigments over synthetic dyes. They learned that plant-based dyes are biodegradable, non-toxic, and hypoallergenic, making them safer for both the environment and people. Since these pigments come from renewable resources, their use supports biodiversity and reduces reliance on non-renewable materials. Additionally, natural dyes lower the environmental impact of textile and art production by requiring less energy and water and by generating less pollution. The project also highlighted the cultural and educational value of natural dyes, helping to preserve traditional knowledge and foster a more respectful relationship with nature.

2. Experimenting with Natural Pigments

2.1 Methods of Extraction

Participants in the Plant & Paint project employed traditional and scientifically informed methods to extract natural pigments: decoction (boiling plant materials, though prolonged heat risks degrading sensitive dyes), fermentation (microbial conversion, e.g., indigo leaves soaked 10–15 hours yield blue indoxyl via oxidation, requiring precise conditions), and mordanting (using alum, iron, or tannins to fix dyes to fibers before/during/after dyeing, enhancing colorfastness). While modern techniques like solvent/microwave extraction were noted, equipment limitations prioritized traditional approaches. This hands-on process emphasized optimizing variables like time, temperature, and mordant selection for effective pigment release and application.

2.2 Testing on Different Materials

Natural pigments were tested on yarns (wool and silk), fabrics (cotton, linen, silk), and other surfaces like paper and cosmetics to assess their versatility, dye affinity, and colorfastness. Students documented each step, noting that silk yielded deeper colors, mordants were essential for cotton, and lightfastness varied across materials. This thorough process helped identify effective methods for applying natural dyes in both artistic and practical uses.

2.3 Challenges & Solutions

Working with natural dyes posed challenges such as achieving vibrant color intensity, ensuring color stability against fading, and managing differences in dye uptake between protein and cellulose fibers. Variability in pigment content due to plant age and growing conditions also led to inconsistent results. To overcome these issues, students experimented with different extraction times, mordant types, and dyeing temperatures, and combined multiple dyes to enhance both color range and fastness.

2.4 Reflections from Participants

Both students and teachers found the hands-on process engaging and rewarding, as discovering vibrant plant-based colors sparked creativity and curiosity. They appreciated connecting traditional knowledge with modern sustainability, and many noted that working with natural materials was both therapeutic and inspiring. The project also enhanced observational and critical thinking skills while deepening respect for botanical diversity and ecological responsibility.

3. Techniques: Ecoprint & Flower Pounding

3.1 Ecoprint Technique

Overview:

Ecoprinting is a sustainable method that transfers the colors and shapes of plants directly onto fabric.

Step-by-Step Guide:

Materials Needed: Natural fabric (cotton, linen, silk) or watercolor paper; fresh leaves/flowers (preferably rich in tannins); mordant solution (alum or soy milk); plastic wrap or parchment paper; rolling pin or PVC pipe; strong string or rubber bands; large pot or steamer; gloves.

Step 1: Prepare the Fabric

Wash with neutral soap. Mordant:

Cotton/linen: Soak in soy milk (1:1 with water) for several hours or overnight, then air dry.

Silk/wool: Soak in alum solution (8% alum to weight of fabric) for 1 hour, rinse, and dry.

Step 2: Prepare Plant Material

Gather fresh leaves and flowers, soak in warm water for 30–60 minutes.

Step 3: Arrange the Plants

Lay the damp, mordanted fabric flat. Arrange leaves and flowers on one half, then fold over or cover with another piece of fabric.

Step 4: Bundle and Secure

Roll tightly around a PVC pipe or rolling pin, wrap with plastic/parchment, and secure with string or rubber bands.

Step 5: Steam or Boil

Place the bundle in a steamer or above boiling water (not submerged), steam for 1.5 - 2 hours, allow to cool completely (ideally overnight).

Step 6: Reveal and Rinse

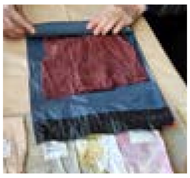
Unwrap and remove plant material. Rinse in cold water with a little salt, dry in the shade.

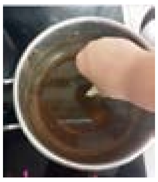
Photographs documented each step, providing a comprehensive resource for replicating the technique.


1- Prepare the Fabric


2 - Prepare Plant Material


3 - Arrange the Plants


4 - Bundle and Secure


5 - Steam or Boil


6 - Reveal and Rinse

3.2. Flower Pounding (Pounding) Technique

Overview:

Flower pounding is a creative process where fresh flowers and leaves are hammered onto fabric to transfer their natural pigments.

Step-by-Step Guide:

Materials Needed: Pre-mordanted cotton fabric or watercolor paper; fresh flowers/leaves; hammer or mallet; plastic sheet/parchment/mica; tape (optional); wooden board; bowl of cold salted water.

Step 1: Prepare the Fabric

Use pre-mordanted cotton or ironed fabric. Place on a sturdy board.

Step 2: Arrange the Flowers

Arrange flowers/leaves as desired. Cover with plastic/parchment/mica and optionally secure with tape.

Step 3: Pound the Plants

Gently but firmly hammer the covered flowers/leaves, working from the center outwards until pigments transfer.

Step 4: Remove Plant Material

Peel away the covering and plant remains to reveal colorful imprints.

Step 5: Fix the Colors

Soak in cold salted water (1 tbsp salt per liter) for 10–15 minutes, rinse gently, and dry in the shade.

Photographs documented each step, providing a comprehensive resource for replicating the technique.


1 - Prepare the Fabric


2- Arrange The Flowers


3 - Pound the Plants


4 - Remove Plant Material


5 - Fix the Colors

4. Practical Applications & Creative Outcomes

The project culminated in textile pieces, design prototypes, and painted artworks, compiled in the catalog of Module 1 works from 12ºA2. A short video tutorial summarized the project steps, techniques, and key learnings, serving as documentation and inspiration for other schools involved in Erasmus+.

5. Results

Students successfully extracted a variety of natural pigments from local plants, achieving a wide range of colors. Ecoprinting produced unique, plant-shaped patterns on textiles, while flower pounding resulted in vibrant, detailed imprints that directly transferred color from plants to fabric. Throughout the process, participants developed practical skills in sustainable art, traditional dyeing, and the science of plant-based pigments.

6. Conclusions & Next Steps

The “Plant & Paint” project offered a hands-on learning experience that blended environmental education, cultural heritage, and creative exploration. By engaging in dye plant cultivation, ecoprinting, and flower pounding, students developed key observational, creative, and critical thinking skills, while helping to revive traditional, sustainable techniques. These eco-friendly methods are now integrated into the Artistic Production curriculum as complementary tools, enhancing both technical skills and environmental awareness, and reflecting global trends in sustainable art and design education.

Future Directions

The experimentation phase created a strong foundation for exploring advanced dyeing, textile printing, and collaboration with partner schools, with potential expansion into biomaterials, modular textile design, and wearable technology—supporting sustainable artistic production trends. Sharing results digitally and through workshops will benefit the wider community, while integrating these techniques into the Artistic Production curriculum equips future artists and designers with both traditional skills and environmental awareness, fostering eco-conscious creativity in the industry.

By

Mariana Rêgo

Textile Teacher

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Porto, Portugal