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# BioChromes with Food waste

## - Introduction to Natural Dyeing Workshop -

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# 1. Substances used in Textiles cause externalities, raising concerns




Fig. 1 - SUBSTANCES USED IN TEXTILES, The Ellen MacArthur Foundation (2017)

# Sustainable choices demands knowledge

**8,000 different chemicals** are used in the textile industry, one of the **most chemically intensive industries** on earth, second **biggest water polluter** after agriculture.

Kumari, P, et al., (2013). Eco – Textiles: For Sustainable Development



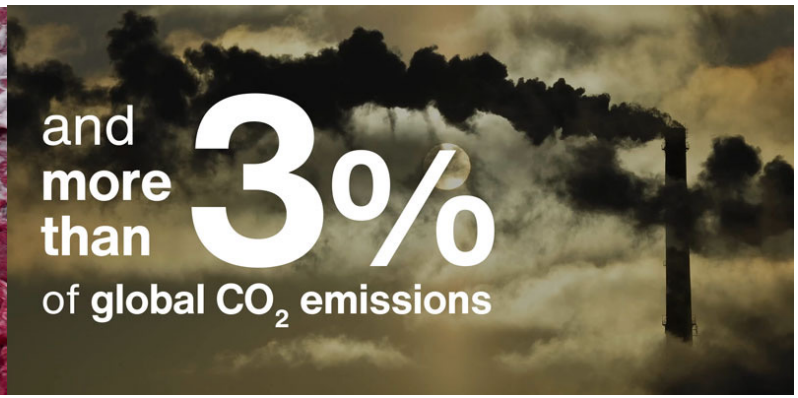




Fig. 2 and Fig. 3 – Textile Dye water pollution, Textile industry CO2 Emissisions, photo by www.textileworld.com



Fig. 4 – **Natural Dyes and Fibres fabrication** – Bacterial Dye, Hibiscus Dye; Alginate/Agar Bioplastics, Fabricademy, Iceland Bootcamp 2019

# 2. What are BioChromes?

Old natural dyes require land and time.
Modern dyes based on petrochemicals; risks to human health and the environment (i.e. dye bath contains chemicals).

- Biochromes are natural colours produced by plants, algae, bacteria, fungi, or animals, responsible for their characteristic colours and often used as sustainable alternatives to synthetic colourants (Delgado et al., 2024).

- Natural colours (including non-organic) are a solution for an industrial scale up and sustainable development.

# Natural Dyes?

A **Dye is a liquid that is soluble in water** and put into the material.

Materials can be coloured by various processes (e.g. impression, adsorption, diffusion).

## Organic Dyes

- Plants
- Animals
- Organisms

## Inorganic Dyes

- Mineral Dyes

# Natural Inks

Inks consist of a liquid vehicle (solvent, such as water or ethanol) combined with a colourant.

They are applied directly to the material through printing, coating, or spraying.

Unlike dyes, inks generally do not chemically bind to the substrate; instead, they adhere by absorption, solvent evaporation, or precipitation depending on the process.

Inks may also incorporate additives such as waxes or polymers to improve stability and performance (Nussinovitch, 1997; Delgado et al., 2024).

# Modifiers

These are substances applied after the dye bath to extend the number of shades. The same modifier in combination with different mordants will produce different colours as well.  With some dyes, the colour change is dramatic, with others is subtle and soft.  Some modifiers change the pH of the water; others act as a stronger mordant.
Can be divided into 4 typologies of modifiers: Acidic, Alkaline, Copper and Iron Modifies.

name: **Burel** | origin: **Serra da Estrela, Portugal**
material: **100% sheep wool** | fibre: **animal hair** | mordant: **Alum**



# Plant Dyes – plants (flowers, stems, leaves, bark, wood) and algae



Fig. 5 – **Vegetal dyes in fabrics**, by Fabricademy, Iceland Bootcamp, 2019



Fig. 6 – **Alginate BioPlatic with different Spirulina Dyes** , 1 month dry, from author, photo by Luís Silva Campos, Jan. 2021

# Animal Dyes – insects and mollusc



Fig. 7 – **Cochineal on cotton,** Marjo, The Easy Blues Blogloving, 2020

# Organism Dyes – bacteria and mycelium



Fig. 8 – **Bacterial Dye in Silk,** Janthinobacteriuml lividum (JI), Fabricademy, Iceland Bootcamp 2019



Fig. 9 – **Mycelium Cosmetics** - Alchemical Mycology - Cosmetics by @jadlerdesign

# Inorganic Dyes – minerals, earths, salts and metals




Fig. 10 – **Limonite from California**, Early Futures Ocher Archive [http://earlyfutures.com/].

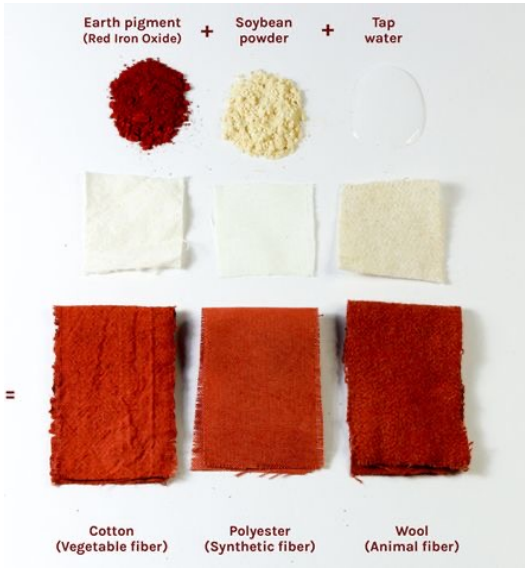



Fig. 11 – **Earth Pigment Dye**, Ane Baztarrika, Waag TextileLab Amsterdam



Fig. 12 – **Foresting Colour Inks**, MAKE INK, Jason Logan (2028I

# 3. Materials to Dye

**Dye Stuff**
Used teas and tisanes, coffee grains,
onion skins, avocado peels and pits,
red cabbage, carrot cuts and beetroot…

**Materials to Dye**
Vegetal and animal fibres
threads, yarns, fabrics and felts

**Mordants and scouring agents:**
Alum powder - potassium aluminium sulphate, $KAl(SO_4)_2$
Cream of tartar - potassium hydrogen tartrate, $KC_4H_5O_6$
Acid: alum, white vinegar or lemon juice
Alkaline: Soda ash - Sodium carbonate, Na2Co3

# 4. Fibres preparation

Fig. 13 – Scouring, Tannin and Mordant, Drying different Skeins, TextileLab Amsterdam, 2020



## Make Skeins

Make skeins of the yarn and threads – 4 x around the arm (depending on fibre volume - 3, 5 or 8).

## Weight of Fibres (WoF)

Weight the dry fibres and, calculate and weight tannin, scouring agent, mordant and Dye stuff.

# Preparing Animal Fibres

1. **Scouring Bath** – Rinse gently with luke water and a little soap (pH neutral soap). Avoid shocking with hight temperature damages animal fibres. Remove and rinse.

2. **Mordant Bath** – Submerge with luke water (37-40ºC), with 10-20% Alum/ WoF, and 5-10% cream tartar/ WoF (cream tartar, or vinegar), and gently simmer. Dip fibres in the bath (turn off) for 1 h. Avoid shocking temperature. Remove, rinse and hang to dry.

# Preparing Vegetal Fibres

1. **Scouring Bath** – Boil 30 min with sodium carbonate (Soda ash) - 2 tbs for 4 Lt water.

2. **Tannin Bath** – (optional step, improves mordant). Boil 30 min in water with 10%-15% tannin/ weigh of fibres (WoF). Remove and rinse.

3. **Mordant Bath** – Boil in 8-10% alum/ WoF, dip fibres in the bath (turn off) for 1 h. Remove, rinse and hang to dry.

# 5. BioChromes with Food waste



Fig. 14 – **Food Dyes – Coffee, Turmeric, Hibiscus,** Fabricademy, Iceland Bootcamp 2019

# Turmeric Dye

Curcuma powder

- **500ml Distilled Water**
- **10g Turmeric[1] powder or 1/8 WoF**
- **Alum[2], vinegar or lemon juice**
- **Soda ash[3]**

1. Prepare and measure your materials.
2. Boil 500ml distilled water. Dissolve **Turmeric powder** into a paste using a tbs of boiling water and, add to pot. Turn to 80ºC (medium-low) for 15 min.
3. Filter the liquid dye using a paper filter. Measure pH (approx. pH 5).
4. Modify with **acid: pH 2/3 = light yellow**, with alum (or tbs vinegar or lemon juice).
5. Modify with **neutral: pH 6/7 = yellow-orange** increase with 0,005g Soda ash (1/2 mg).
6. Modify to **alkaline: pH 9/10 = reddish-brown**, with soda ash. Adjust pH with 0,5gr (1/2 g) soda ash per 100ml water

**Note:** test this protocol with powder spices like hot paprika and cinnamon

[1] **Turmeric** = *Curcuma longa*
[2] **Alum** = Potassium Alum Sulphate
[3] **Soda ash** = Sodium Carbonate

# Hibiscus Dye

Flowers and herbs

- **1,5Lt Distilled Water**
- **100g Hibiscus[1] flowers**
- **Alum[2], vinegar or lemon juice**
- **Soda ash[3]**

1. Prepare and measure your materials.

2. Add 100 gr of **Hibiscus flowers** into 1,5Lt Distilled water. After boiling, turn to 80ºC for 30 min. Filter/ remove the flowers.

3. Measure pH (**approx. pH 3 = red**) and divide in in 3.

4. Modify with **neutral: pH 7 = blue**: starting with 0,005g Soda ash (1/2 mg) to increase or, starting with decrease with 0,005g Alum 1/2 mg.

5. Modify to **alkaline: pH 9/10 = grey**, with soda ash. Adjust pH with 0,5gr (1/2g) soda ash per 100ml water

**Note:** test this protocol with any herbs and flowers

[1] **Hibiscus** = *Hibiscus sabdariffa*
[2] **Alum** = Potassium Alum Sulphate
[2] **Soda ash** = Sodium Carbonate

# Red Cabbage Dye

Vegetables and beans

- **1,5Lt Distilled Water**
- **100g Red cabbage[1]**
- **Alum[2], vinegar or lemon juice**
- **Soda ash[3]**

1. Prepare and measure your materials. Cut the cabbage in small pieces.

2. Add 100g **Red cabbage** and 1,2Lt distilled water, boil 1 hour. Water will evaporate approx. to 1/3. Filter/ remove the cabbage pieces using a strainer.

3. Measure pH (approx. **pH 5,5 = lilac**). Divide in 4 goblets with 100ml. Keep one.

4. Modify to **acid: pH 2/3 = purple**, with alum (or tbs vinegar or lemon juice). Adjust pH starting with 0,5g soda ash per 100ml water.

5. Modify with **neutral: pH 7 pH 6/7 = blue**: starting with 0,005g Soda ash (1/2 mg) to increase or, starting with decrease with 0,005gr Alum 1/2 mg.

6. Modify to **alkaline: pH 9/10**, with soda ash. Adjust pH with 0,5gr (1/2 gram) soda ash per 100ml water.

**Note:** test this protocol with any vegetable and black beans

[1] **Red Cabbage** = *Brassica oleracea (rubra)*
[2] **Alum** = Potassium Alum Sulphate
[2] **Soda ash** = Sodium Carbonate

# 6. References


Delgado, C., Forman, G. & Apolinário, A. Blue-Green Horizons: Redefining Alginate Bioplastics with Spirulina Dyes. Mater Circ Econ 6, 7 (2024). https://doi.org/10.1007/s42824-023-00099-1

Ibáñez-García A, Berbegal-Pina R, Vidal R, Martínez-García A. Sustainability in the Development of Natural Pigment-Based Colour Masterbatches and Their Application in Biopolymers. Polymers. 2024; 16(15):2116. https://doi.org/10.3390/polym16152116

Kumari, P., Singh, S. S. J., & Rose, N. M. (2013). Eco – Textiles: For Sustainable Development, 4(4)

Logan J, Ondaatje M, Kolyn L (2018) Make ink: a forager's guide to natural ink making. Abrams, New York

The Ellen Macarthur Foundation, (2017), A New textile Economy. Retrieved from https://www.ellenmacarthurfoundation.org




# Thank you!

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