Artificial and Natural Pigments, Organic Colorants and Flower Crops that Produce Dyes

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Introduction

Natural dyes are coloring agents derived from organic sources. Up until the mid-19th century, natural dyes were the standard for all forms of textile dyeing and printing. The introduction of synthetic dyes led to a decline in natural dye usage, even though they were cost-effective and offered excellent fastness properties. However, increasing consumer awareness about the negative effects of synthetic dyes, global environmental concerns, and stringent environmental regulations have sparked a resurgence in the use of natural dyes. The hues obtained from these sources are visually stunning. Dyes derived from the roots, stems, leaves, or flowers of various plants have different properties and applications.

Benefits of natural dyes

- Natural dyes are sourced from the environment, making them eco-friendly.
- They yield gentle and pleasing colors.
- These dyes offer outstanding protection against UV rays.
- Certain natural dyes, like turmeric, possess anti-microbial properties, providing protection for both the fabrics and the wearers against microbial threats.
- Some natural dyes have properties that repel mosquitoes and resist flames.
- Minimal Environmental Impact – Due to their natural origins, natural dyes are environmentally safe, which makes them attractive to consumers. They are biodegradable, and their disposal does not lead to pollution.
- Renewable – Natural dyes come from sustainable sources that can be utilized without causing harm to the environment.
- Safe – Some natural dyes, such as carmine found in lipsticks, are safe when ingested and do not pose health risks.

Classification of Natural Dyes

Natural dyes can be categorized in various ways, as noted by

(a) **According to their source of origin**

1) Vegetable/Plant Origin

2) Insect/Animal Origin

3) Mineral Origin: The key mineral pigments come in several colors,

• Red Pigments, • Yellow Pigments, • Green Pigments, • White Pigments, • Black Pigments.

(b) **Based on solubility**

1) Soluble natural dyes - These dyes are soluble in water .Ex. Betalains,Anthocyanins.

2) Insoluble natural dyes - These dyes are insoluble in water.Ex Indigo,Anthraquinone dyes.

(c) **Based on their substantive properties**

1) Substantive dyes can also be further categorized as direct, acid, or basic.

2) Non-substantive dyes require a mordant to enhance their binding to materials, which typically have low or no affinity for the dye. The traditional definition of mordant dyes has expanded to include those that can form complexes with metal mordants. Many of these dyes produce different hues or shades depending on the mordants used.

(d) **Based on the colors produced**

1) Monogenetic: These produce a single color regardless of the mordant used with the fiber.

2) Polygenetic natural dyes; they produce varying colors with different mordants (e.g., logwood, alizarin, fustic, and cochineal).

(e) Based on Plant Parts Used

Flowers: *Tagetes patula*, *Hibiscus rosa-sinensis*, *Butea monosperma*.

Leaves: *Indigofera tinctoria*, *Strobilanthes cusia.*

Roots/Rhizomes: Rubia tinctorum, Curcuma longa.

(f) **According to chemical composition**

1) Indigoids 2) Berberine 3) Carotenoids 4) Quinonoids 5) Flavonoids 6) Dihydropyran-based Dyes 7) Betalains 8) Tannins.

1. **Indigoids**, including indigo and indirubin, are blue pigments that have been traditionally derived from plants like Indigofera tinctoria. Although they are primarily utilized as natural dyes, these compounds may serve defensive roles in plants, although their specific functions are less understood compared to other pigments.

2. **Berberine**, a yellow alkaloid found in Berberis species, acts as a defensive compound with antimicrobial properties that help protect plants from pathogens. In humans, berberine has been researched for its potential health benefits, which include antimicrobial and metabolic effects.

3. **Carotenoids** are pigments that provide yellow, orange, and red hues to many plants. They play essential roles in photosynthesis by capturing light energy and shielding chlorophyll from photooxidative damage. Furthermore, carotenoids serve as precursors to plant hormones like abscisic acid, which regulates growth and responses to stress.

4. **Quinonoids**, such as juglone, play a role in plant defense. They can exhibit allelopathic effects, which inhibit the growth of neighboring plants, and have antimicrobial properties that help guard against pathogens.

5. **Flavonoids** encompass a wide variety of polyphenolic compounds that impact the coloration of flowers and fruits, attracting pollinators. They also assist in protecting plants from UV radiation and oxidative stress, and are involved in symbiotic relationships, like aiding in nitrogen fixation in legumes.

6. **Dihydropyran**-based dyes are synthetic compounds employed in various applications, including as fluorescent probes. These compounds are not naturally present in plants and therefore lack a defined biological role.

7. **Betalains** are pigments that occur in plants of the Caryophyllales order, serving as a substitute for anthocyanins in these species. They provide red and yellow coloration to flowers and fruits, which helps attract pollinators. Additionally, betalains demonstrate antioxidant properties and may enhance stress tolerance.

8. **Tannins** are polyphenolic compounds that protect plants from herbivores and pathogens through their astringent taste and ability to precipitate proteins. They are typically found in abundance in young leaves, fruits, and seeds, which are particularly susceptible to predation. Tannins also contribute to the regulation of plant growth and responses to environmental stresses.

These compounds together support plant survival by participating in vital processes such as photosynthesis, defense mechanisms, reproduction, and stress responses.

SCIENTIFIC NAME	FAMILY	PLANT PARTS	COLOUR	PIGMENT
Tagetes erecta	Asteraceae	Flowers	Yellow	Lutein
Bougainvillea glabra	Nyctaginaceae	Bracts	Red	Betalain
Calendula officinalis	Asteraceae	Flowers	Yellow	Yellow
Magnolia champaca	Magnoliaceae	Flowers	Pale yellow	Flavonoids
Callistephus chinensis	Asteraceae	Flowers	Pink	Flavonoids
Hibiscus rosa sinensis	Malvaceae	Flowers	Red	Anthocyanins
Celosia cristata	Amaranthaceae	Flowers	Brownish colour	Betacyanins (Betalain)
Eucalyptus	Myrtaceae	Tree bark Flowers	Yellow Bright yellow	Quercetin
Gernera Jamesonii	Asteraceae	Flowers	Red	Anthocyanin
Lantana camars	Verbenaceae	Flowers	Yellow	Anthocyanin
Gomphrena globosa	Amaranthacea	Flowers	Purple	Betacyanins
Indigofera tinctoria	Oleaceae	Flowers	Yellow	Carotenolds
Ixora coccinea	Rubiaceae	Flowers	Red and purple	Anthocyanin
Bixa orellana	Bixaceae	Seeds	Yellow Dark	Carotenoids
Nelumbo nucifera	Nelumbonacea	Seed	Reddish brown	Proanthocyanidin

Lawsonia inermis	Lythraceae	Leaves	Yellow	Quinonold
Tropaeolum majus	Tropaeolaceae	Flowers	Yellow	Carotenoids
Pandanus amaryllifolius	Pandanaceae	Leaves	Green	Chlorophyll
Opuntia ficus indica	Cactaceae	Fruits	Red	Betalain
Rhododendron arboreum	Ericaceae	Flowers	Violet	Anthocyanin

Conclusion

The extraction method used is determined by the type of flower, desired oil quality, and intended application. Steam distillation is still the most popular method due to its efficiency and effectiveness. Delicate flowers, such as jasmine and tuberose, may benefit from solvent extraction or enfleurage to maintain their nuanced smells. New approaches, such as CO_2 extraction and microwave-assisted hydrodistillation, promise to preserve delicate molecules while maximizing efficiency.

Refrences

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