Studies on the extraction, optical characteristics, and ageing of natural pigments from different flower plants - A Review

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Abstract: In order to determine the optimal dye removal process, We detailed the colour extraction procedures and solvents used to extract five distinct flowering plants (ethanol and water). Five natural dyes have numerous distinct functional groups present, according to their FTIR spectra. To separate the dyes from their solutions, analytical tests such Vacuum evaporation, column chromatography, and UV spectroscopy were used. Pigment colors in floral extracts were studied using UV-Vis, and the results revealed pronounced bandgaps and higher adsorption maxima in the visible area. One of the pigments under research, Alternanthera ficoidea, has the minimum direct bandgap (1.69 eV) and Absorbed by the material

value (6.33 meV) of all the pigments. The yield rate of dye extraction using water solvent increased from 11.7% to 24.7% to 11.3-32.4%.[1].

1. INTRODUCTION-

An important aspect of people's cultures all across the world is the use of colours. Dyeing doesn't just seem to be used to make something beautiful; it also seems to be used to show the cultures of other areas and provide hints about the differences between modern societies and ancient civilizations. Natural dyes are those that are derived from nature without using a chemical process. Natural colours are derived from several sources, including vegetation, minerals, creatures, or insects. They are typically non-toxic and non-allergic. Human existence is impossible without natural colours. They are also harmless when used and maintain the ecological balance. The use of natural dyes declined as artificial colourants were developed in the nineteenth century. Artificial colours are available**[1].**

Anthocyanin, flavonoids, hibiscus acid, organic acid, hydroxycitric acid, and polysaccharides are only a few of the active substances found in roselle flowers **[15].**

Flowers and fruits of numerous plants frequently contain anthocyanins. Anthocyanins were primarily found in the red, violet, and blue blooms. Red flowers include the pink blossom, the red hibiscus, the red rose, the red pineapple sage, the red clover, and the red hibiscus. The red blossoms are edible. Blue flowers (cornflower, blue chicory, and blue rosemary), as well as purple flowers, are frequently used in cooking (Purple mint, lavender,purple passion flower, purple sage). Traditional uses for several of these flowers include food, folk medicine, and colourants. Fruits that are red, purple, or blue are frequently eaten for their health benefits in addition to their traditional uses. Blackcurrants, berries, and other red to blue-hued fruits contain the pigmented anthocyanin pigments that act as potent antioxidants. Aside from that, anthocyanin-rich foods like red and black **[2].**

The strong reddish-purple colouring pigments in beetroot are known as betalains **[18].**

Carotenoids and flavonoids make up the majority of floral pigments **[19].**

Typically, spectrophotometry, colorimeters, or comparison charts are used to examine the qualitative qualities of the pigments.. It is necessary to comprehend and investigate pigments at the molecular level in order to employ them later because qualitative colour assessment simply aids in making assumptions **[3].**

For all five natural dyes, the FTIR spectra showed the existence of numerous distinct functional groups. To separate the dyes from their solutions, analytical procedures such vacuum evaporation, column chromatography, and UV spectroscopy were used. The pigments in floral extracts were the subject of UV-Vis experiments, which revealed obvious bandgaps and large absorption peaks in the visible area. Alternanthera ficoidea demonstrated the least intensity of the pigments that were examined **[1].**

Response surface approach was used to optimise the process of removing a natural pigment from the Ceiba speciosa flower **[8].**

To better understand the origins of the colour spectrum, pigments were extracted from flower petals of seven different colours and profiled and quantified using High – Performance liquid chromatography (HPLC) as well as Liquid Chromatography-Mass Spectrometry (LC-MS) **[13].**

2.Materials and Methods –

a) Dye extraction process

The petals of flower specimens from the natural dye-producing plants Separations were made between Alternanthera ficoidea, Pereskia bleo, Rosa ards rovar, Portulaca grandiflora, and Celosia argentea var. christie. With distilled water, the samples were thoroughly cleaned. The average size of the collected petal samples was 0.5 cm, and they were dried at room temperature. From each sample, 1g of dried petals were collected, a glass beaker was filled with 50 ml of either ethanol or water solvent, and this was enough to completely cover the petals. Water and ethanol are extracted using a magnetic and ultrasound-assisted method **[1].**

b) Accelerated solvent extraction

This research set out to determine how well ASE, an environmentally friendly technique for recovering polyphenols and pigments from wild nettle leaves, performed (NL). As an extraction solvent, ethanol (96%) was used to perform ASE at various temperatures (20, 50, 80, and 110 C), static times (5 and 10 min), and cycle numbers (1-4). Using ultrasound aided extraction (UAE) at 80 °C for 30 min. as a reference, the effectiveness of ASE was compared. HPLC was used to analyse the polyphenol and the pigment, and ORAC was used to measure the antioxidant capacity. Six carotenoids and their derivatives, chlorophylls a and b, and seven polyphenols from subclasses of hydroxycinnamic acids and flavonoids were also discovered and measured. Chromogenic **[4].**

c) Extraction of color pigments/dye

All of the components were carefully weighed (50g) and homogenised with a tiny amount of water. Following that, extraction was done using 100 ml of a 70:30 ethanol and water mixture in an orbital shaker for 24 hours at 250 C and 60 RPM. All of the extracts were put through a muslin filter and stored in the refrigerator until they were needed **[5].**

Although it is a well-known and straightforward approach, solvent extraction of plant pigments has significant drawbacks, including a lengthy exposure period and a low yield **[14].**

Traditional techniques that have been extensively employed in industry and laboratories for this purpose include soxhlet extraction, maceration, and hydrodistillation. Many unconventional techniques, Due to the advantages of the former in terms of decreased solvent consumption, speeded up extraction times, and environmental friendliness, the former have recently replaced conventional techniques. These include liquid – liquid separation, high pressure extraction, thermo extraction, ultrasonic extraction, pulsed-electric field extraction, as well as enzyme-assisted extraction. A critical step that must be carefully completed before the separation stage is the pre-treatment of plant sources to boost the durability of natural pigments. Using the four main classes of plant pigments—chlorophylls, carotenoids, betalains, and anthocyanins—as examples, a thorough evaluation of suitable pretreatment and extraction techniques is offered in this work **[6].**

3.NATURAL DISTRIBUTION OF PIGMENT-

The two most common pigments in nature are chlorophyll and carotenoids. They play a crucial role in the fundamental processes that support life on earth. The primary sources of the organic components necessary for the creation of other living things like vertebrates and invertebrates include plants, photosynthetic bacteria, and protozoa. Additionally to their color-giving abilities, carotenoids, betalains, and anthocyanins can be used in food as sources of vital vitamins, amino acids, and quality-control markers. Colorants called flavonoids have a lot of potential as medicines. The key field of study on natural food grade colours is process development and the utilisation of new and existing technology for production optimization. It is necessary to thoroughly examine the Potential of "natural food grade bio colourant" in biotechnology **[7].**

As a defence mechanism against ecological challenges like Cold-adapted bacteria and fungus in the cryosphere produce a range of colours as a result of oxidative stress, UV light, and low temperatures for viable source for natural pigment production**[12].**

4.CLASSIFICATION BASED ON COLOUR-

There are numerous ways to categorise natural dyes. The initial categorisation was done using the alphabet. Later, the focus was changed to chemical structure, and grouping within each structure class according to colour was done. These were later categorised in various additional techniques, such as depending on colours, chemical makeup, application, and origin **[20].**

The colour that natural dyes add to the textile substrate is a common criterion by which they are categorised.

4.1 RED- 32 natural dyes in red are listed in the Color Index. The majority of the red pigments are concealed within the dull-gray bodies of insects, in the barks or roots of plants, or in their pigments. Al or morinda (Morindacitrifolia), cochineal (Coccuscacti), madder, wood/sappanwood (Caesalpineasappan), and lac dye are a few of the most notable constituents (Coccuslacca).

4.2 BLUE- Only four blue natural dyes—natural indigo, sulphonated natural indigo, Kumbh (Manipur), and the flowers of Japanese 'Tsuykusa' used mostly for producing awobana paper—are listed in the Color Index. Indigo is the only practical option available amongst blue natural dyes.

4.3 YELLOW- In the category of natural dyes, yellow is the hue that is both most prevalent and plentiful.

There are 28 yellow dyes in the Color Index list. The essential compounds can be found in tesu blossoms (Buteamonosperma), barberry (Berberisaristata), and kamala (Mallotusphilippensis) (Mallotusphilippensis).

Marigold, turmeric, harshingar, kamela, annatto, tesu, berberis, larkspur, and dolu are among plants that naturally contain the colour yellow. The rhizomes of the plant Curcuma longa are what give turmeric its colour. Orange-haired Kamela on the pads of the feet, there is a glandular pubescence of crimson powder. Mallotus phillipinensis) has a variety of colouring components, such as chaconnes (rottlerin, isorottlerin): the colour created reacts quickly with soap, despite having a modest fastness to light, alkalis and acids.

4.4 GREEN- Green dye-producing plants are uncommon. Since ancient times, green hues have been produced by combining wood (Isatis tinctoria) and indigo with yellow dyes. Wood and subsequently indigo were used to further colour woollen fabric that had been dyed yellow with dyer's green weed and mordant with alum that a once Kendal green is produced. You can also get soft olive greens. when iron mordant is used on yellow-dyed fabrics.

4.5 BROWN AND BLACK- there are countless natural sources available for brown, practically without end. Acacia catechu, in particular, provide the wood for the old brown dye known as "cutch," which is used to colour cotton hue. According to Color Index, there are six dyes available in black. Some Iris plant roots, lac, carbon, and other materials that are commonly black in colour caramel

4.6 ORANGE- Oranges can be produced by the same dyes that produce reds and yellows. Sources for a natural orange colour include annatto, barberry, and sweet pepper blood root, among others.

5.Aging effects-

Ozone and oxygen cause natural colours to break down, which is accelerated by incident light this results in the ageing effects. Knowing the ageing effects after the natural dyes have been extracted is crucial for understanding the stability of intermolecular bonds or the form of colour fading. Over the course of 60 days, the absorbency and FTIR spectra of a water solvent were examined. was possible to study the ageing effects of the extracted dyes **[1].**

Table 1. Description of the raw materials (natural dyes).

English name	Botanical name	Plant family	Used parts	Color of used parts
(a) Time Flower	*Portulaca grandiflora*	Portulacaceae	Petals	Deep pink
(b) Red rose	*Rosa ards rovar*	Rosacea	Petals	Red
(c) Plumbed cockscomb	*Celosia argentea ver. Cristia*	Amaranthaceae	Comb of roster	Light red
(d) Desert rose	*Pereskia bleo*	Cactaceae	Petals	Orange
(e) Border plant	*Alternanthera ficoidea*	Amaranthaceae	Leaves	Light pink

Flower Color

Color	Pigment	Example
Yellow	Carotenoid	Rose
	Flavonol	Primrose
Orange	Carotenoid	Lily
	Anthocyanin and Flavone	Snapdragon
Scarlet	Anthocyanin	Geranium
	Anthocyanin and Carotenoid	Tulip
Magenta or Crimson	Anthocyanin	Camellia, Begonia
Violet	Anthocyanin	Verbena
Blue	Anthocyanin and copigment	Poppy, Leadwort
	Anthocyanin-metal complex	Cornflower

Nettle habitat changes had a significant impact on the quantities of the bioactives that were measured; sample from the continental region having greater levels of polyphenols, whereas those from the coastal region had much more pigments in them. **[9].**
Natural pigment photosensitizer used for Dye sensitive solar cell **[10].**

6. Pharmacological prospects-
Anticancer, antidiabetic, anti-inflammatory, antibacterial, anti-obesity, anti-oxidative, neurocytoprotective, antihypertensive, hepatoprotective, and antiatherosclerotic actions are just a few of the therapeutic uses for monascus pigments and their derivatives **[11].**

Due to pollution prevention, biological protection, and ease of use, the use of eco-friendly natural dyes is growing **[16].**
Marigold flower natural dye exhibits good colorfastness qualities without compromising the fibre structure **[17].**

7. Conclusion
This study has shown that it is possible to separate dyes from low-cost resources such as Time Flower, Red Rose, Plumed Cockscomb, Pereskia bleo, Rosa ards rovar, Celosia argentea var. cristia, Alternanthera ficoidea, and Portulaca grandiflora (Border Plant). Knowing the aging effect of the dyes In an oxygen-rich atmosphere has tremendously benefitted research on photocatalytic studies and real effluent of applications of solar cells. This study will considerably advance our understanding of the optical properties and ageing impacts on organic dyes and open up new possibilities for enhancing synthetic dyes for use in real-world scenarios. **[1].**

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