Survey and Evaluation of Natural Colour Yielding Potential of Himalayan Plant Species

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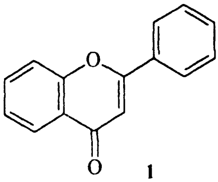
The ecological and health hazards associated with the chemical dyes have become a great environmental concern especially for food, cosmetic and pharmaceutical industries. Therefore, the demand and search for new and novel sources of natural colour is increasing. The rich biodiversity of Himalayan ecosystem has not been assessed for their natural colour yielding potential. Hence, to identify the newer sources of colouring matters, surveys of NW Himalaya were carried out and 24 plant species belonging to 19 families were screened for the presence of colouring matter. Different shades of yellow and orange are found to be the most predominant natural colours (66.6%) followed by shades of green (26.6%) and red (6.6%). The UV-Vis spectral characteristics suggested that most of the colouring extracts contain flavonoids, anthraquinone, chlorophyll and carotenoids; however, tannin was also dominating in certain species. Therefore, we suggest that the Himalayan species are a rich source of natural colours and analyses based on extraction of colouring matter in ethanol coupled with UV-Vis spectra can be of immense value in screening the plant species for identification of new and novel sources of natural colours.

Key Words: Natural colour, Himalayan plant species, UV-Vis spectra.

INTRODUCTION

Colour plays an important role in acceptability of food as well as cosmetics by the consumers because the quality of the product is often judged by its colour. It does not only lead to rapid identification of the product but also responsible for its ultimate acceptance; therefore, it becomes a vital constituent in industries. The major natural colourants are anthocyanin, betalaine, carotenoids, chlorophylls and quinones[1–5]. The commerce of natural dyes was once upon a time considered as a measure of the economic prosperity of a nation[6–9]. With the advent of synthetic dyes in the 1850's, the demand for natural dyes reduced leading to the collapse of the whole dye industry. However, recently the safety of synthetic colours has also been questioned which has led to a reduction in the number of permitted colourants. In fact, some of the European countries have completely banned the use of synthetic dyes as food colourants. Allergy, irritation and carcinogenecity are the main health hazards caused by the use of chemical colours in cosmetics. Therefore, people have again realized the importance of natural dyes in food, cosmetic and pharmaceutical industries and the thrust to identify the new sources of natural colouring matter is increasing.

India's vast plant resources represented by 20,000 species inhabiting a wide range of ecological niches have enormous economic potential. The rich biodiversity of the Himalayan ecosystem has not been assessed for their colour yielding potential. Therefore, to identify new sources of natural colours, Kanasar ranges of NW Himalaya were surveyed and 24 plant species were tested for the presence of colouring matters. To identify the probable class of chemical compounds, the UV-Vis spectra (within the range of 200–700 nm) of coloured extracts were analyzed.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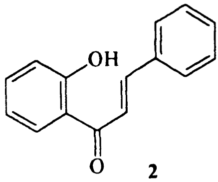
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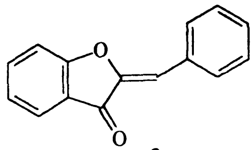
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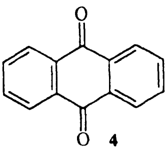
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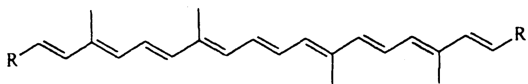
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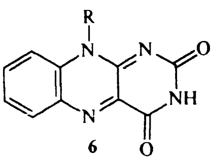
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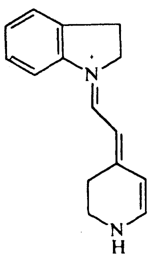
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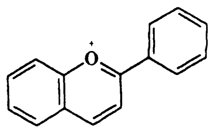
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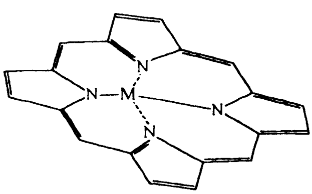
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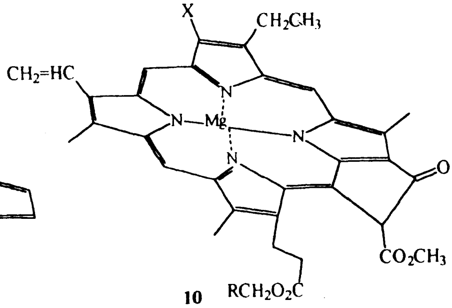
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EXPERIMENTAL

Survey and collection of plant species: Field surveys of Kanasar ranges of NW Himalaya (7000–9500 ft above mean sea level) were undertaken to assess the ecological diversity of the habitats and selection of sampling sites. Different sampling sites varying with the ecological conditions were selected and as many as 24 plant species were sampled and brought to the base camp.

Extraction of colouring matters: The plant material was segregated into different tissues (root, stem, leaf, bark, flower, fruit, etc.). The plant tissues were percolated in absolute ethanol for 24 h at room temperature (25°C). Observations were taken on the type and intensity of the colour and colour yielding potential of the species was determined.

UV-Vis spectrum analyses of colouring matters: To characterize the crude colour extracts, the absorption spectrum of different crude coloured extracts within the wavelength range of 200–700 nm was recorded. Based on the number of peaks and their absorption maxima (λ_{max}), the probable class of compounds was determined.

RESULTS AND DISCUSSION

The preliminary examination of the coloured crude extracts of various plant species and determination of probable class of compounds responsible for the predominant colour is a prerequisite to identify the new and novel natural colour yielding bioresources. The extraction of colouring matter from 24 plant species belonging to 19 families revealed that different shades of yellow and orange are the most predominant natural colours (66.6%) followed by shades of green (26.6%) and red (6.6%).

Ethanol (95%) is the most versatile solvent, which extracts a wide range of classes of compounds, whereas chloroform and pyridine should be avoided due to their absorption maxima in the range of 200–260 nm.[10] Although, these solvents are suitable for the extraction and characterization of carotenoids. Solvents such as water, methanol, hexane, petroleum ether and ether are also useful in certain studies.

UV-Vis spectroscopy is solvent-sensitive and the value of UV-Vis spectra in identifying the class of compounds is related to the general position of the wavelength maxima. For example, hydroxynaphthoquinones show absorption maxima near 400 nm and bathochromic shift with addition of alkali and carotenoids shows three distinct peaks in 400–500 nm region, with little absorption on either side. A list of spectral properties of the different classes of plant pigments is summarized in Table-1. Therefore, the analyses based on UV-Vis spectra and

TABLE-1
UV-VIS SPECTRAL RANGE* OF DIFFERENT CLASSES OF COLOURING MATTERS

S. No.	Classes of colouring materials (colour)	Visible range λ_{max} (nm)	UV range λ_{max} (nm)
1.	Flavonoids (yellow) **(1)**	360–400	250–270
2.	Chalcones **(2)** and aurones **(3)** (yellow)	360–430	240–260
3.	Anthraquinones (yellow) **(4)**	420–470	3–4 intense peaks (200–300)
4.	Carotenoids (yellow to orange) **(5)**	400–500	—
5.	Flavins **(6)**	420–460	270–280
6.	Betacyanins (mauve) **(7)**	500–560	250–270
7.	Anthocyanins (mauve to red) **(8)**	470–550	270–275
8.	Cytochromes (yellow) **(9)**	545–605	—
9.	Chlorophylls (green) **(10)**	640–660 and 430–470	—

*All values are approximate; actual values vary with solvent used, the pH and other physical states of pigments.

TABLE-2
DETAILS OF THE PLANT SPECIES SCREENED FOR THEIR NATURAL COLOUR YIELDING POTENTIAL

S. No.	Family	Plant species	Plant part used	Colour (ethanol)	UV-Vis λ_{max} (nm) (ethanol)	Probable class of compound
1.	Anacardiaceae	*Lannea coromandalica*	Stem bark	Yellowish orange	252, 258, 319	Flavonoids
2.	Caesalpiniaceae	*Bauhinia variegata*	Stem bark	Yellowish orange	252, 258, 282, 293	Flavonoids
3.	Celasteraceae	*Euonymus achinatus*	Stem	Yellowish green	215, 276, 606, 665	Chlorophylls
4.	Fabaceae	*Desmodium sp.*	Root	Yellow	233, 318	Flavonoids
5.	Geraniaceae	*Geranium ocellatum*	Root	Yellow	258, 324	Flavonoids
			Stem	Orange yellow	252, 259, 338, 391	Flavonoids
		Geranium wallichianum	Root	Reddish orange	230, 278	
			Stem	Yellow	259, 341	Flavonoids
6.	Hypericaeae	*Hypericum oblongifolium*	Fruit	Yellowish orange	253, 259, 275, 452	Carotenoids
7.	Lamiaceae	*Salvia nubicola*	Root	Yellowish orange	258, 291, 443	Anthraquinone
		Meriandra strobilifera	Root	Orange	252, 258, 473	Carotenoids
8.	Mimosaceae	*Albizia julibrissin*	Stem bark	Orange red	257, 309	Tannins
			Leaf	Green	249, 289, 603, 645	Chlorophylls
9.	Myrsinaceae	*Myresine africana*	Root	Orange	252, 259, 305	
			Stem	Orange yellow	256, 309	Flavonoids
10.	Pinaceae	*Picea smithiana*	Root bark	Orange	240, 281, 450	Carotenoids
11.	Polygonaceae	*Rumex nepalensis*	Stem	Yellowish green	234, 279, 610, 643	Chlorophylls
			Root	Orange yellow		
			Fruit	Green	247, 287, 298	
			Leaf	Yellowish green	259, 303, 609, 650	Chlorophylls

S. No.	Family	Plant species	Plant part used	Colour (ethanol)	UV-Vis λ_{max} (nm) (ethanol)	Probable class of compound
12.	Ranunculaceae	*Thalictrum javanicum*	Root	Yellow	255, 311, 429	Flavonoids
13.	Rhamnaceae	*Rhamnus virgatus*	Leaf	Yellow green	260, 301, 612, 650	Chlorophylls
			Stem bark	Yellowish orange	260, 280, 420, 470	Anthraquinones
14.	Rosaceae	*Rubus foliolosus*	Root	Yellowish green		
		Cotoneaster microphylla	Root	Yellow	260, 333	Flavonoids
			Leaf	Green	255, 269, 609, 642	Chlorophylls
			Stem	Yellowish green	260, 313, 570	
		Prinsepia utilis	Root	Orange yellow	249, 288, 302	
			Fruit	Purple	247, 309, 485	Anthocyanins
			Leaf	Green	257, 611, 640	Chlorophylls
			Stem	Yellowish grreen	257, 308, 413	
15.	Rubiaceae	*Rubia manjith*	Root	Yellowish orange	253, 259, 266, 448	Anthraquinones
		Galium elegans	Root	Yellow	209, 268, 409	Flavonoids
16.	Rutaceae	*Xanthoxylum armatum*	Root	Yellowish orange	227, 281, 303	Flavonoids
17.	Salicaceae	*Populus ciliata*	Stem	Yellowish green	259, 399, 606, 664	Chlorophylls
18.	Saxifragaceae	*Bergenia ciliata*	Root	Yellow	227, 257, 305	Flavonoids
19.	Thymclaeaceae	*Wikstroemia canescens*	Root	Yellow	281, 340	Flavonoids

solubility may help in determining the probable chemical class of colouring matter and its use for various purposes.

The spectral characteristics suggest that most of the colouring extracts contain flavonoids, anthraquinone, chlorophyll and carotenoids; however tannin was also dominating in a few plants (Table-2). It may be noted that chlorophylls, carotenoids and flavonoids representing green, orange and yellow pigments are the major categories of natural food colournats; however, quinones are the major colourants widely used in cosmetic industry. These observations further support that the UV-Vis absorption spectra are of immense value in identifying new sources of natural colourants.

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