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REVIEW ARTICLE

Unexplored treasure of the Garhwal Himalayas: Dye yielding Plants for Sustainable Dyeing

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Abstract

The *Bhotiya* tribes of Chamoli district residing in the border regions of Garhwal Himalayas are well known for their traditional expertise in making a range of woolen garments and materials. The Garhwal Himalayan region is gifted with a variety of plants that have been considered as a source of number of natural products. Decades ago, these plants were used by *Bhotiya* people for wool dyeing. The indigenous practice has declined manifold due to invasion of use of synthetic dyes. In the present study, effort has been made to revive the century old tradition of natural dyeing by the available resources of the region. Botanical survey was done for the exploration of the flora of the region with the view of identifying plants with the potential of yielding natural textile dyes. A catalogue of fifty dye yielding plants in Indian Himalayan region was prepared along with their availability, family, color potential, altitude and commercial viability. This catalogue was supported by the secondary data obtained from various published sources.

Keywords: Textiles, *Bhotiya* tribes, natural dye, sustainability, dye fielding plants, Garhwal Himalayas.

Introduction

The Himalayas has been a perennial source of attraction and challenge to human intellect throughout the ages. The unique Himalayan ecosystem plays host to a large number of animals, plants, rare herb shrubs and trees that have been considered as a source of number of natural products. Amongst the several assets the vegetation provides an everlasting and interesting field of investigation. The diversity, copiousness as well as uniqueness of the plant component in various habitats retained sound and aesthetic environment of the Himalayas. Most of the plants of the Garhwal region are well known for their heterogeneous uses. However a number of plants found in abundance are still inadequately explored and need a through chemical investigation for their proper utilization. In recent past couple of years excessive exploitation of vegetation unplanned land use, natural disaster and several development process accelerated deterioration of bio diversity and harmonious ecosystem of the Himalaya (Atkinson, 1989).

The Indo-Tibetan people who have made their homes in the High Himalayas for centuries (Mana and Niti valleys of Upper Chamoli) were called 'Bhotiyas'. The Bhotiya tribes, from ancient times when they had trade with Tibet, accepted the woolen industry as an essential part of their lifestyle. Decades ago this abundant Himalayan flora was used by local folk for wool dyeing in this cottage industry (Nautyal *et al.,* 2003). Conventionally these people neither purchased nor cultivated these dye-yielding plants.

Unfortunately, this indigenous practice of using natural dyes had almost vanished even from the remote villages of Uttarakhand (Walton, 1989). In recent years, a growing interest in the revival of natural dyes had been manifested. This interest was a result of the worldwide movement to protect the environment from indiscriminate exploitation and pollution by the industries (Dayal and Dobhal, 1999). The synthetic dyes that produce a large variety of colors also produce toxic waste, which was hazardous to humans (Gulrajani, 1992). The present investigation is targeted to carry out techno-economic survey as well as field survey for the documentation of dyeing technology practiced in the industry by natural dyes. The analysis was done to identify the reasons for quitting the use of these natural dyes. It also aims to prepare a catalogue of the flora of the region with potential of textile dyeing. With the aim of revival, survey of the region was done in order to know dyes being used traditionally in the region. Botanical survey was also done to know flora of the region with potential of textile dyes. For this data was gathered by seeking information from local botanists and scientists of various scientific organizations namely Jari Buti Sansthan, Chamoli, H.N.B. Garhwal University, Srinagar Garhwal and Forest Research Institute, Dehradun. This information was supported by extensive literature survey from Economic Botany of the Himalayas and Himalayan Gazetteer by Atkinson (1989), Ethno botanical Studies in U.P Himalayas by Gaur *et al*. (1985), Economic Products of North Western Provinces Part-III and Flora of Chamoli (Nautiyal *et al*., 2001).

Table 1. Traditional dyes used in the region.

Local name	Botanical name	Part used	Color yield	Fastness
Dolu	*Rheum emodi*	Root	Yellow	Very good
Akhrot	*Juglan regeia*	Fruit rind	Rust-brown	Good
Tantri	*Rheum moorcroftianum*	Fruit	Yellow	Good
Kilmora	*Berberis aristata*	Root	Yellow	Very good
Khoksha	*Remux Nepalensis*	Steam	Yellow	Fair
Banj ka jhula	*Parmelia usnea*	Lichens	Blue, orange	Good
Kaphal	*Myrica esculenta*	Bark	Maroon, brown	Good
Darim	*Punica grantum*	Fruit rind	Golden yellow	Fair
Burans	*Rhodendron araborium*	Flower	Pink, maroon	Fair
Tun	*Toona ciliate*	Flower	Red	Fair
Haldi	*Curcuma longa*	Root	Yellow	Good

History of natural plant dyeing in the region

For several decades, some of the local plants of the region were used by the crafts persons for dyeing wool. Based on interview with the crafts persons of the region, some plants have been recognized. Mainly used plants are *Tantri (Rheum moorcroftianum)* and *Dolu (Rheum emodi)* for yellow color *Kaphal (Myrica esculenta)*, *Burans (Rhododendron aboreum)* and *Akhrot (Juglan regia)* for brown and maroon colors and *Tun (Tuna ciderila)* for red color. To complete their palate they used original wool color as a ground color i.e. black and cream.

Color characteristics of the conventional plant dyes

The indicated results in Table 1 are based on the field survey done in the selected villages of the Chamoli district, where traditional woolen craft is being practiced for generations. The data is chemically unchecked hence those plants are mentioned which were conventionally being used by the folk of the region and results are based on their experiences. Color characteristic is defined in the terms of serviceability.

Sources of dye: Conventionally these people neither purchase nor cultivate these dye-yielding plants. They collect the raw material from the jungle nearby the villages. Collection of the raw material was not an easy job. To get the required stuff they used to climb high peaks and collect the raw material. For some high altitude plants sources they have to wait for months as routes for those places are normally closed due to snow.

Cost of material procurement: The cost of material procurement cannot be estimated in the terms of money, rather can be calculated in the terms of time, labor and high risk associated with the procurement of the raw material. With the risk of life these people climb high peaks in search of dye yielding plants they need. Throughout the year they wait to complete the color palate as the blooming time for various plants is in different season. To obtain the required amount of raw material and desired color range many efforts has to be made and cost can only be estimated it is not included in their final product.

Mode of extraction and application: The art of dyeing was limited to few people and was kept a big secret by those who excelled by this art. Those who were masters or experts of this art to maintain secrecy generally did dyeing at night, as a matter of fact none of the respondent at present could give a detailed account of dyeing technique used by the earlier people which result in color fast dyeing. The extraction of the dye from various plants of the region is more or less same, however some plants need vigorous treatment and extra care on the other hand some plant gives good yield of the color without much effort. Before dyeing, the balls of wool are made into hanks. Care was taken so that uniform dyeing may take place. Modes of extraction for some commonly used dye yielding plants are follows:

Kilmora*;* Roots of the plant were taken out and it was dried and crushed into small pieces. Water was boiled in a vat (iron, brass and copper) with little amount of common salt along with crushed *Kilmora* roots for 15 to 20 min and consequently yellow colored extract was sieved. For dyeing 1 kg of wool, around 5 L of water was boiled with approximately 50-60 g of fresh root. Hanks of wool were immersed into the bath for 1 h. The woolen threads are stirred thoroughly for a long time to ensure thorough and uniform soaking. Sometimes, a small quantity of soda ash was also poured in the prepared solution, for better coloring. Dyed hanks were dried in the shade.

Dolu; Root of the plant is taken out and it is dried, crushed into small pieces. Water is boiled into a vat (iron, brass and copper) with little amount of common salt. Water along with crushed kilmora roots is boiled for 15 to 20 min and consequently yellow colored extract is sieved. Hanks of wool are immersed into the bath for 30 min and then are dried in the shade.

Akhrot**;** Outer skin of the walnut is peeled off, dried and crushed. Crushed material is boiled repeatedly boiled in the water. This is then sieved. The extracts yield brown to rust color. Hanks of wool are immersed into the dye bath in the M: L of 1:10 for 30 min. Material is allowed to be in cold water for 8-12 h.

***Haldi*;** Roots of turmeric are crushed and boiled in the water for 15 min. Curd water is added into it and is again boiled for another 15 min. This gives golden yellow color. Hanks of wool are immersed into the bath 30 min and then are dried in the shade.

Reasons for quitting natural dyeing

Collection of natural plants was associated with high risk of life and involved lot of labor. These people have to climb up to hills to get the raw material, which is not only difficult and time taking but is risky as well. Some times for completing the color palate of the design they have to wait for the whole year, as the blooming season for different plants is different. Synthetic dyes were introduced as a government movement because the state government had put restriction on plucking certain plants as they are rare and some of them have medicinal utility.

- The dyeing process is very complex.
- Color yield is very low.
- Whole product is dependent upon the availability of the raw material.
- Color range is limited.

List of dye yielding plants presently available in Garhwal Himalayan region- Prospects

The dyes of vegetable origin may be broadly divided into four classes:

1. From the plants growing wild.
2. From the plants grown on the account of some other product but can be used as textile dyes.
3. From the by-products, which are otherwise domestic or industrial wastes.
4. From the plants specially cultivated for the purpose.

Plants such as various species of lichens, *Stephania glabra, Toona cedrela, Toona hexandra, Urtica urdis* are weeds grow wild, with no commercial importance but are potential source of natural dyes (Walts, 1972). The second class belongs to plants such as turmeric, *Khair* which are primarily used for condiments, medicines and are also identified as natural dyes used for textiles. The third class belong to those plants which are grown for some other purpose but their unused parts can be viable source of natural dyes like *Punica grantum, Juglan regia.* The last class is under experimental process in the hills, though some of the NGOs are cultivating dye-yielding plants on the selected areas of Uttarakhand as worldwide movement to protect the environment from indiscriminate exploitation and pollution by the industries. Plants such as *tantri, dolu, Kilmora* etc. are being experimented in Uttarakhand for the same. Flora explored was short listed and a catalogue of the dye yielding plants in Indian Himalayan region was prepared along with their availability, family, color potential, altitude and commercial viability (Table 2).

Commercial viability of available flora

Before proceeding to the experiments and drawing any inference it was necessary to study the commercial viability of the explored plants of the region. The viability can be described in the terms of availability, accessibility and use in such a manner that it may not lead to the exploitation of the environment. Viability of the following explored plants was reviewed. Plants like *Alkabir, Dhai, Gindaroo*, though are good source of natural dyes but are not commonly available. These species are found in scant patches among the Himalayan flora above 7000 ft. These are not viable for commercialization as their habitat is in very high altitude, therefore accessibility is difficult. There are certain plant species which are declared rare by forest department of India and hence government have imposed ban on plucking or exploiting such plants in any manner. However, these plants are rich sources of dyes and were used by *Bhotiyas* long back. Examples of these plants are *Dolu, Ratanjot, Laljari, Taxus,* and *Jjatamasi.* Certain plant which are good sources of dyes also have other commercial value and can be used for more valuable product like medicines or food. Such plants are also not advisable for commercialization unless they are specially cultivated for natural dyeing purpose.

Source of dye from some plants is heart wood, root or stem which if used will destroy whole plant and more over propagation of some plants is not easy. Therefore, extracting textile dyes from such plants is not advisable as it may lead to environmental degradation. For example *Symplocs crataegoi* is a tree found in abundance, though exploitation of tree plant is not advisable from environment point of view but extraction of the leaves will not be hazard. Plants which are grown wild like *Kilmora, Kandali* and *Khoksha* are viable sources of natural dyes as these plants are in abundance. They can be propagated easily. *Akhrot* have domestic utility. Skin of walnut fruit is a domestic waste hence has great economic viability. *Curcuma longa* Cultivated throughout the Himalayan region for food color as cultivation is not difficult it also has economic viability for dyes. *Harda* and *Behra* are very common in Tropical belt. For centuries these were used as an Ayurvedic medicine and today also there is a great significance of these plants. These plants are cultivated for the same. For textile dyeing also these plants have been explored and much more can be done on this research material for the purpose of the dye. *Jhula: Jhula* includes several species of lichens e.g.; *Permalia* sp., *Usnea* sp., *Ramlina* sp., *Solrina* sp., *Umblicraia* sp., etc. Research material is available in plenty. This plant has good scope for commercialization. *Remux nepalensis* genus has at least four species in the Himalayan range from 1000-7000 ft. Research material is available in plenty some work is already being done on it. *Kilmora* has so many species and is found in a wide range of altitude.

Table 2. List of dye yielding plants presently available in Garhwal Himalayan Region.

Local name	Botanical name	Part used	Altitude	Color range	Availability
Akalbir	*Datisca cannabina*	Root, leaves, stalks	10-15000 ft.	Red, yellow, olive green	Scanty patches
Akhrot	*Juglan regia*	Rind	4000-11000 ft.	Rust brown-maroon	Domestic availability
Arusa	*Justicia adhatoda*	Leaves	6000 ft.	Orange/yellow	Common
Babul	*Acacia Arabica*	Fruit rind	3000- 13000 ft.	Brown and black	Common
Bahera	*Terminalia belerica*	Fruit	Tropical belt to 5000 ft.	Brown	Common
Banj ka jhula	*Parmelia usnea*	Whole thallus	5000 ft. to 7000 ft.	Lemon, orange, brown	In abundance
Bebhang	*Datisca indica*	Flower	5000 ft. to 7000 ft.	Red	In abundance
Bel	*Aegle marmelos*	Fruit rind	Tropical belt 3000 ft.	Black	Common
Bhamor	*Cornus capitata*	Bark	5000- 7000 ft.	Brown, red	Common in oak forest
Bhinkol	*Prinsepia utilis*	Fruit, seed	1000-13000 ft.	Blue, yellow	Common
Burans	*Rhododendron arboretum*	Flower	1000-9000 ft.	Pink, Maroon	Common
Chalpuri	*Parmelia kamtchadalis*	Whole thallus	5000 ft. to 7000 ft.	Rose tinge	Common
Chalpuri	*Parmelia tinctoria*	Whole thallus	5000 ft. to 7000 ft.	Yellow	Common
Chattar	*Berberis chitria*	Root	3000-7500 ft.	Yellow	Common
Chir (pine)	*Pinus roxburghii*	Needles, bark	3000 to 6000 ft.	Green-yellow	Common
Darim	*Punica grantum*	Fruit rind/bark	4500-6000 ft.	Yellow, Brown	Common/in domestic use
Dhai	*Woodfordia floribunda*	Flower	Ascending 4500 ft.	Red	Not common
Dhak	*Butea monosperma*	Flower	Up to 1500 ft.	Yellow	Common
Dhola	*Woodfordia fructicosa*	Flower	Tropical belt up to 6000 ft.	Red	Common
Dolu	*Rheum emodi*	Root	10000-15000 ft.	Yellow	Rare
Gandaila	*Murraya koengli*	Stem	4500-6000 ft.	Brown	Common
Gindaroo	*Stephania glabra*	Root	7000 ft.	Lemon yellow	Not very common
Haldi	*Curcuma longa, C. domestica*	Root/rhizome	Throughout Himalayas 4500 ft.	Yellow	Common in farms
Harda	*Terminalia chebula*	Bark/ leaves	Tropical belt up to 5000 ft.	Pale green	Common
Harshingar	*Nyctantheus arbortristis*	Flower	6000 ft.	Orange	In abundance
Jatamasi	*Nardostachya grandiflora*	Flower	10000-15000 ft.	Maroon	Rare
Kachiri	*Hedychium spicatum*	Root	5000-7000 ft.	Scent cloth	Common
Kail (Indian pine)	*Pinus wallichiana*	Leaves	Up to 14000 ft.	Yellow-deep orange	Common
Kandali	*Urtica ardens*	Stem/root	Throughout Himalayas up to 140000 ft.	Pale green-yellow	Very common like weed
Kaphal	*Kaphal*	Bark	5000-15000 ft.	Maroon, yellow	Common
Khair	*Acacia catechu*	Bark	Tropical zone-5000 ft.	Brown	Common
Kilmora	*Kilmora*	Root, stem	5000-15000 ft.	Yellow	Common
Kilmora	*Berberis asiatica*	Root, stem	5000-15000 ft.	Yellow	Common
Koksha	*Rumex nepalensis*	Stem	1000 to 7000 ft.	Yellow	Common
Konk (kum kum)	*Euonymus tingens*	Bark	4500-8000 ft.	Yellow	In abundance
Kurri	*Lantana camara*	Flowers	Upton 8000 ft.	Yellow, red	Common
Lal jhari	*Geranium wallichianum*	Root, stalk	7000-11000 ft.	Red, maroon	Rare
Lodh	*Symplocos crataegoides*	Bark and leaves	3000-7000 ft.	Yellow, used with combination of madder	Common
Maddar	*Rubia mangistha*	Bark	4000-9500 ft.	Reddish brown color	In abundance
Madder,Indian	*Rubia cordifolia*	Bark	4000-9500 ft.	Reddish brown color	In abundance
Ratanjot	*Geranium napalense*	Bark, root	10000-15000 ft.	Maroon, purple	
Ruina (roli)	*Mallotous phillippensis*	Fruit rind	7000-14000 ft.	Orange, red	Common
Sandan	*Stephania glabra*	Root	6000 ft.	Yellow	Not common
Semal	*Salmalia malbarica*	Spines	Tropical belt up to 5000 ft.	Green yellow	Common
Tantri	*Rheum emmorcroftianum*	Root	7000-12000 ft.	Yellow	Common/abundance
Thaner	*Taxus baccata*	Bark	7000-14000 ft.	Inferior red	Not common
Tun	*Toona cedrela*	Seed/flowers	Up to 6000 ft.	Yellow and red from seed	Not very common
Tun	*Toona ciliata*	Flowers	Up to 6000 ft.	Yellow	Not very common
Tun	*Toona hexandra*	Flowers	Up to 6000 ft.	Orange	Not very common
Tungla	*Rhus parviflora*	Bark, flowered, drupe	Tarai to Himalayas up to 7000 ft.	Brown, yellow, orange	In abundance
Udis (kunch)	*Alnus nepalensis*	Bark	1000-7000 ft.	Red	Rare

Kurri, an exotic weed causing environmental problem is good source of dye. *Pinus roxburghi, Pinus wallichinun* both the species found in the hills are very common. Pine needles are considered great fire hazard for the forest and therefore, could have viability for natural dyes as well as reduction of fire hazard. *Dhola* is abundantly found throughout the hills. *Alnus nepalisis* is very common plant. This species can be experimented for extraction of the dye as it was being used before introduction of synthetic dyes. Other plant sources which are viable for commercialization for dyeing are *Babool* (Fruit rind), *Bebhang* (flower), *Bhinkol* (fruit), *Burans* (flower), *Dhak* (flower), *Harshringar* (flower), *Kaphal* (bark, leaves), *Konk* (bark), *Ruina* (fruit rind), *Tungla* (flower*), Udis* (bark). These plants are in abundance and do not involve any environmental hazard.

Conclusion

A need to reconstruct ancient and traditional dyeing plant sources of Garhwal Himalayas was an effort to incorporate sustainable approach for dyeing wool by the local artisans by using ancient indigenous resources which are plentiful or otherwise waste and does not lead to landfills responsible for environmental damage of any kind. There was abundance flora available, in order to achieve acceptable shade gamut it can be explored keeping environmental balance in mind. The catalogue provided in this review will certainly prove to be great resource for dyeing utilization for the local woolen craft. Optimization of dyeing process can be done on various generic fibers.

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