



## Diversity of natural dye yielding plants in district Bilaspur, Himachal Pradesh, India

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### Abstract

The use of natural dyes has been rapidly increasing due to the enforcement of strict environmental standards by the Environmental and Pollution Control Board of many countries in response to allergic reactions and toxics of synthetic dyes. The present study documented the data related to the diversity of natural dye yielding plants in the district of Bilaspur, Himachal Pradesh, India. A total of 51 species belonging to 45 genera and 30 families were recorded as the source of natural dyes. Fabaceae (8 species) is found to be dominant followed by Anacardiaceae (5 species), Rosaceae (4 species), Combretaceae and Euphorbiaceae (3 species each), Berberidaceae, Lythraceae, Oleaceae and Rutaceae (2 species each) and remaining 21 families were represented by having one species each. Among the plant parts used, fruits and flowers were the maximum sources of natural dyes contributing 25.49% followed by barks (23.52%), leaves (17.64%), roots (11.76%), wood (5.88%), rhizomes, latex and gall (1.96% each).

**Keywords:** natural dyes, Bilaspur, fabaceae, anacardiaceae, species

### Introduction

The use of natural dyes as a colouring material is as old as textiles. They have been primarily used for colouring food, leather, and textiles made from natural fibers like silk, wool and cotton. Natural dyes are derived from plant parts like roots, wood, bark, stem, leaves, flowers, fruits and seeds, insect secretion and minerals. Man has always been fond of colours and the art of dyeing has long past as revealed by the finding of the garment with traces of madder dye in the ruins of the Mohan Jodaro and Harappa (3500 BC). The written record of the use of natural dyes was found in China dated 2600 BC (Shiva, 2007) <sup>[1]</sup>. There have been over 2000 pigments known from various parts of plants of which only about 150 are commercially exploited. In India about 450 plant species are known to be the source of natural dyes (Chandramouli, 1995) <sup>[2]</sup>.

The use of natural dyes has been rapidly increasing due to the enforcement of strict environmental standards by the Environmental and Pollution Control Board of many countries in response to allergic reactions and toxics of synthetic dyes (Kamel *et al.*, 2005) <sup>[3]</sup>. Natural dyes have many advantages as they are eco-friendly, biodegradable, safe for body contact, unsophisticated, obtained from renewable sources and also have a minimum possibility of chemical reactions. (Brian, 1998; Prabhu and Bhute, 2012) <sup>[4, 5]</sup>. Further carcinogenic, non-biodegradable nature of synthetic dyes and their hazardous effects on human health and the environment has re-established the need for natural dyes for human (Yusuf *et al.*, 2016) <sup>[6]</sup>. The traditional knowledge of natural dyeing is now practised by older people only and this indigenous knowledge has been vanishing rapidly among the new generations. This traditional knowledge of dye yielding plants is very essential for community based development and eco-friendly products. Therefore, the protection and conservation of the dye yielding plant resources are necessary and it can be done by creating awareness among the local residents and involving them along with the Forest department for their *ex situ* and *in situ* conservation.

Himachal Pradesh is a hilly state of India located Indian Himalayan Region and is one of the richest reservoirs of biological diversity. Topographically, Himachal Pradesh can be divided into three zones- The Shivaliks or outer Himalayas, inner Himalayas or mid Himalayas and the alpine zone or greater Himalayas. The district Bilaspur lies between 31° 12' 30" and 31° 35' 45" North latitudes and between 76° 23' 45" and 76° 55' 40" East longitudes in the outer Himalayas next to Punjab plains and forms a part of the basin of river satluj. The district is rich in flora. Bilaspur district has three types of forest namely Northern Tropical Dry Deciduous, Himalayan Sub-Tropical Pine Forest, and Lower Western Himalayan Temperate Forests (Champion and Seth, 1968) <sup>[10]</sup>. The 93% population of the district resides in rural areas, associated with the occupation of agriculture, animal husbandry and horticulture. People of the area are religious, God fearing, ecofriendly, and hardworking. The indigenous knowledge about the plant resources of district Bilaspur is documented by some workers (Sharma and Mishra, 2009; Gautam *et al.*, 2011; Kumar, M., 2015; Kumar, S., 2017, 2019; Bhardwaj and Seth, 2017; Kumar *et al.*, 2018; Kumar *et al.*, 2022) <sup>[7, 8, 11, 12, 13, 14, 15, 16]</sup> during last few years, but there are no studies on natural dye yielding plants. The traditional knowledge of natural resources is progressively eroding in society due to modernization and the loss of traditional cultural systems. Thus there is a strong need for the conservation of indigenous knowledge and to make it available for future generations. The objectives of the present study were to document the diversity, botanical name, common name, family, plant part used and colour produced of dye yielding plants of district Bilaspur of Himachal Pradesh.

### Materials and Methods

The current study is based on the literature review and field surveys. A detailed list of dye yielding plant species was prepared by gathering information from secondary sources, such as published scientific studies in journals, books, periodicals, published floras, PhD thesis, conference

proceedings, forest working plans, from the study area and other parts of the state and country. A total of 30 articles have been consulted of which 21 were taken for detailed investigation (list of references). For the assessment of dye yielding plants, extensive and intensive surveys were also conducted in the selected villages of districted Bilaspur. Local knowledgeable elder people were interviewed and information on indigenous uses and traditional practices of dye yielding plants was documented. The languages used while interacting with the informants were the local dialect, Kahluri as well as Hindi. Data has been arranged on botanical name, common name, family, plant life forms, plant parts used, the colour of dye and source reference.

Fresh samples of the species were collected and identified with the help of local and regional floras (Collet 1902; Polunin and Stainton, 1984 Chowdhery and Wadhwa, 1984; Sood and Thakur, 2004 Kumar, M., 2015)<sup>[17, 19, 9, 11]</sup>. Species were verified from their currently accepted name(s) in online nomenclature sources (<http://www.theplantlist.org> and <http://www.tropicos.org>). The results of the study were presented in the table-1.

### Results and Discussion

In the present study total of 51 species belonging to 45 genera and 30 families were recorded as the source of natural dyes (Table 1).

Table-1

Sr No.	Name of Plant and Common Name	Family	Habit	Part Used	Colour of dye	References
1	<i>Acacia catechu</i> Willd. Khair	Fabaceae	T	Wood	Brown	Vankar, 2002; Klaichoi <i>et al.</i> , 2014; Singh <i>et al.</i> , 2020
2	<i>Acacia nilotica</i> (L.) Delile Kikar	Fabaceae	T	Fruit	Black-brown	Vankar, 2002; Jamadar and Sannapamma, 2018; Siva, 2007
3	<i>Aegle marmelos</i> (L.) Correa. Bael	Rutaceae	T	Fruit	Yellow	Gokhale <i>et al.</i> , 2004; Borah and Phukon, 2009; Pathania <i>et al.</i> , 2021
4	<i>Albizia lebbek</i> Benth. Siras	Fabaceae	T	Bark	Red	Kumari <i>et al.</i> , 2019
5	<i>Anogeissus latifolia</i> Wall. Dhau/Chhal	Combretaceae	T	Leaf	Black	Nautiyal and Kaul, 2003; Gaur, 2008
6	<i>Artocarpus lakoocha</i> Roxb. Dheu	Moraceae	T	Root	Yellow	Nautiyal and Kaul, 2003; Borah and Phukon, 2009-10; Prabhu and Bhute , 2012
7	<i>Bauhinia purpurea</i> Lam. Karyala	Fabaceae	T	Bark	Purple	Gokhale <i>et al.</i> , 2004; Borah and Phukon, 2009-10; Kumari <i>et al.</i> , 2018
8	<i>Bauhinia variegata</i> L. Karyala	Fabaceae	T	Flower	Purple	Gaur, 2008
9	<i>Berberis aristata</i> DC. Kashmal	Berberidaceae	Sh	Root	Yellow	Borah and Phukon, 2009-10; Kumari <i>et al.</i> , 2018
10	<i>Berberis lyceum</i> Royle. Kashmal	Berberidaceae	Sh	Root	Yellow	Kumari <i>et al.</i> , 2018; Kumari <i>et al.</i> , 2019
11	<i>Bombax ceiba</i> L. Semal	Bombaceae	T	Flower		Pathania <i>et al.</i> , 2021
12	<i>Butea monosperma</i> (Lam) Kuntze. Plah	Fabaceae	T	Flower	Yellow	Borah and Phukon, 2009-10; Kumari <i>et al.</i> , 2018; Siva, 2007
13	<i>Cassia fistula</i> Linn. Aalas	Fabaceae	T	Bark	Red	Gokhale <i>et al.</i> , 2004; Borah and Phukon, 2009-10
14	<i>Celtis australis</i> L. Khidak	Cannabaceae	T	Bark	Yellow	Kumari <i>et al.</i> , 2018
15	<i>Cotinus coggygria</i> Scop. Tung	Anacardiaceae	Sh	wood	Yellow	Prabhu and Bhute , 2012; Kumari <i>et al.</i> , 2018
16	<i>Curcuma longa</i> L Haladi	Zingiberaceae	H	Rhizome	Yellow-orange	Borah and Phukon, 2009; Pathania <i>et al.</i> , 2021; Prabhu and Bhute , 2012 Kumari <i>et al.</i> , 2019;
17	<i>Deeringia amaranthoides</i> (Lam.) Merr. Bhirangya	Amaranthaceae	Sh	Fruit	Red	Sarkar <i>et al.</i> , 2011
18	<i>Emblica officinalis</i> Gaertn. Amla	Euphorbiaceae	T	Fruits-Bark	Dark-brown	Borah and Phukon, 2009-10; Prabhu and Bhute , 2012; Kumari <i>et al.</i> , 2019; Pathania <i>et al.</i> , 2021
19	<i>Grevillea robusta</i> A.Cunn. ex R.Br Silver oak	Proteaceae	T	Leaf -flower	Yellow-green	Gaur, 2008; Pathania <i>et al.</i> , 2021
20	<i>Hibiscus rosa-sinensis</i> L. Shoe flower	Malvaceae	Sh	Flower	Red, purple	Bose and Nag , 2012; Kumari <i>et al.</i> , 2018
21	<i>Impatiens balsamina</i> L. Tiurya	Balsaminaceae	H	Leaf-flower	Red	Gokhale <i>et al.</i> , 2004; Kumari <i>et al.</i> , 2019
22	<i>Jasminum humile</i> L. Chameli	Oleaceae	Sh	Root	Yellow	Borah and Phukon, 2009-10; Kumari <i>et al.</i> , 2018
23	<i>Jatropha curcas</i> L. Jablota	Euphorbiaceae	Sh	Bark	Blue	Prabhu and Bhute , 2012; Kumari <i>et al.</i> , 2018
24	<i>Juglans regia</i> L. Khod	Juglandaceae	T	Fruit	Brown	Prabhu and Bhute , 2012; Kumari <i>et al.</i> , 2018; Kumari <i>et al.</i> , 2019
25	<i>Justicia adhatoda</i> L. Basuti	Acanthaceae	Sh	Leaf	Yellow	Gokhale <i>et al.</i> , 2004; Kumari <i>et al.</i> , 2018
26	<i>Kigelia Africana</i> (Lam.) Benth.	Bignoniaceae	T	Root	Yellow	Prabhu and Bhute , 2012; Kumari <i>et al.</i> , 2018
27	<i>Lannea coromandelica</i> (Houtt.)	Anacardiaceae	T	Bark	Red	Borah and Phukon, 2009-10; Gaur 2008

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28	<i>Lawsonia inermis</i> L. Mahendi	Lythraceae	Sh	Leaf	Red	Vankar, 2002; Gokhale <i>et al.</i> , 2004; Pathania <i>et al.</i> , 2021
29	<i>Mallotus philippinensis</i> Muel. Kamal	Euphorbiaceae	T	Fruit	Red	Borah and Phukon, 2009-10; Kumari <i>et al.</i> , 2018; Gaur, 2008
30	<i>Mangifera indica</i> L. Amb	Anacardiaceae	T	Bark-leaf	Yellow	Borah and Phukon, 2009-10; Gokhale <i>et al.</i> , 2004; Pathania <i>et al.</i> , 2021
31	<i>Murraya koenigii</i> (L.) Spreng. Gandhela	Rutaceae	Sh	Fruit	Purple	
32	<i>Nyctanthes arbor-tristis</i> L. Kurri	Oleaceae	T	Flower	Yellow/ orange	Gokhale <i>et al.</i> , 2004; Borah and Phukon, 2009-10; Prabhu and Bhute, 2012
33	<i>Osyris lanceolata</i> Hochst. & Steud. Kaila	Santalaceae	Sh	Root	Red	Kumari <i>et al.</i> , 2018
34	<i>Pistacia integerrima</i> J. L. Stewart ex Brandis Kakarya	Anacardiaceae	T	Galls on leaves	Yellow	Kumari <i>et al.</i> , 2018; Kumari <i>et al.</i> , 2019
35	<i>Prinsepia utilis</i> Royle Bhekhalya	Rosaceae	Sh	Fruit	Blue	Gaur, 2008; Kumari <i>et al.</i> , 2019
36	<i>Prosopis chilensis</i> (Molina) Stuntz.	Fabaceae	T	Fruit	Yellow	Kumari <i>et al.</i> , 2018
37	<i>Prunus cerasoides</i> Buch.- Ham. ex D. Don Paja	Rosaceae	T	Bark-flower	Red	Gaur, 2008; Kumari <i>et al.</i> , 2019
38	<i>Prunus persica</i> (L.) Batsch Aadu	Rosaceae	T	Leaf	Green	Gokhale <i>et al.</i> , 2004; Kumari <i>et al.</i> , 2018; Pathania <i>et al.</i> , 2021
39	<i>Psidium guajava</i> L. Amarud	Rosaceae	T	Leaf	Black-Brown	Gaur, 2008
40	<i>Punica granatum</i> L. Daru	Punicaceae	Sh	Fruit-flower	Yellow-Red	Kumari <i>et al.</i> , 2019; Pathania <i>et al.</i> , 2021; Kumar <i>et al.</i> , 2015
41	<i>Reinwardtia indica</i> Dumort.	Linaceae	Sh	Flower	Yellow	Kumari <i>et al.</i> , 2018
42	<i>Syzygium cumini</i> (L.) Skeels Jamun	Myrtaceae	T	Bark	Brown	Kumari <i>et al.</i> , 2018; Pathania <i>et al.</i> , 2021; Borah and Phukon, 2009-10
43	<i>Tagetes erecta</i> L. Genda	Asteraceae	H	Flower	Yellow-golden	Borah and Phukon, 2009-10; Kumari <i>et al.</i> , 2018; Pathania <i>et al.</i> , 2021
44	<i>terminalia bellirica</i> roxb. Baheda	Combretaceae	T	Bark-fruit	Black	Gaur, 2008; Kumari <i>et al.</i> , 2018
45	<i>Terminalia chebula</i> Retz. Harad	Combretaceae	T	Fruit	Blue	Vankar, 2002; Prabhu and Bhute, 2012; Kumari <i>et al.</i> , 2019
46	<i>Toona ciliata</i> Roem. Tooni	Meliaceae	T	Flower	Yellow	Borah and Phukon, 2009-10; Prabhu and Bhute, 2012; Kumari <i>et al.</i> , 2018
47	<i>Urtica dioica</i> L. Bichchhu booti	Urticaceae	Sh	Leaf		Siva, 2007; Pathania <i>et al.</i> , 2021
48	<i>Vitex negundo</i> L. Bana	Lamiaceae	Sh	wood	Gray	Kumari <i>et al.</i> , 2018; Swamy <i>et al.</i> , 2016
49	<i>Woodfordia fruticosa</i> Kurtz. Dhauvi	Lythraceae	Sh	Flower	Yellow, Red	Gokhale <i>et al.</i> , 2004; Pathania <i>et al.</i> , 2021
50	<i>Wrightia arborea</i> (Dennst.) Mab Kayod	Apocynaceae	T	Latex	Yellow	Sarkar <i>et al.</i> , 2011; Gaur, 2008
51	<i>Ziziphus jujube</i> Mill. Baer	Rhamnaceae	T	Bark	Pink, Red	Gokhale <i>et al.</i> , 2004; Kumari <i>et al.</i> , 2018; Chungkrang <i>et al.</i> , 2018

H-herb, Sh-shrub, T- tree

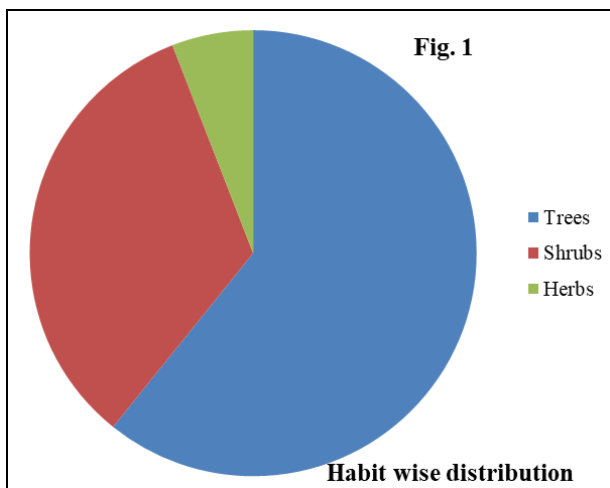


Fig 1

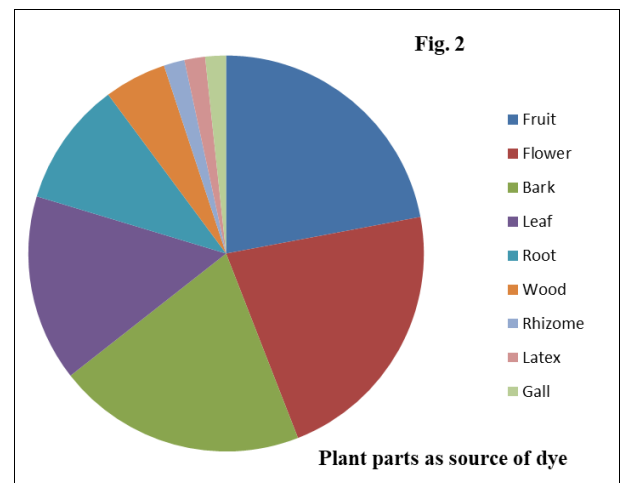


Fig 2

Fabaceae (8 species) is found to be dominant followed by Anacardiaceae (5 species), Rosaceae (4 species), Combretaceae and Euphorbiaceae (3 species each), Berberidaceae, Lythraceae, Oleaceae and Rutaceae (2 species each) and remaining 21 families Acanthaceae, Amantharaceae, Apocynaceae, Asteraceae, Balsamiaceae, Bignoniaceae, Bombaceae, Canabaceae, Juglandiaceae, Lamiaceae, Linaceae, Malvaceae, Meliaceae, Moraceae, Myrtaceae, Proteaceae, Punicaceae, Rhamnaceae, Santalaceae, Urticaceae and Zingiberaceae were represented by having one species each. The species recorded were mostly trees, which constitute (60.78%) of the total species, followed by shrubs (33.33%) and herbs (5.88%) (Fig. 1).

Among the plant parts used, fruits and flowers were the maximum source of natural dyes contributing 25.49%, followed by barks (23.52%), leaves (17.64%), roots (11.76%), wood (5.88%), rhizomes, latex and gall (1.96% each) (Fig. 2). It was observed that due to change in socio-cultural traditions and more dependence on modern market resources, the rural inhabitants have lost the most of their knowledge regarding natural dyes. A superficial knowledge of natural dyes was recorded from the elder generation and most of the data presented in this paper were from secondary sources. Results also showed that district Bilaspur has lots of diversity of plants which are the potential source of natural dyes. Results of the present study were also supported by the earlier reports of the surrounding areas (Gaur, 2008; Kumari *et al.*, 2018; Kumari *et al.*, 2019; Pathania *et al.*, 2021) [29, 30, 27, 26].

### Conclusion

The present study enumerated the diversity of economically important dye yielding plants in the district of Bilaspur. Natural dyes are high in demand not only in the textile industry but in cosmetics, leather, food and pharmaceuticals due to their eco-friendly, safe nature. Natural dyes have not commercially succeeded like synthetic dyes due to lack of availability of precise technical knowledge on the extraction and dyeing technique and habitat destruction of plants. So, there is an urgent need for proper collection, documentation, assessment and characterization of dye yielding plants for their future use.

### References

- Siva R. Status of natural dyes and dye-yielding plants in India. *Current science*,2007:92(7):916-925.
- Chandramauli KV. Sources of natural dyes in India- A compendium with regional names, PPST. Foundation Chennai, 1995.
- Kamel MM, El Shishtawy RM, Yussef BM, Mashaly H. Ultrasonic assisted dyeing: III. Dyeing of wool with lac as a natural dye, *Dyes Pigments*,2005:65:103-110.
- Brian GJ. Dyeing what comes naturally to the dye house. *Journal of Society for Dyers and Colorists*,1998:114(4):240.
- Prabhu KH, Bhute AS. Plant based natural dyes and mordants: A Review *J. Nat. Prod. Plant Resour.*,2012:2(6):649-664.
- Yusuf M, Khan SA, Shabbir M, Mohammad F. Developing a Shade Range on Wool by Madder (*Rubia cordifolia*) Root Extract with Gallnut (*Quercus infectoria*) as Biomordant. *Journal of Natural Fibers*,2016:14(4):597-607.
- Sharma P, Mishra NK. Diversity, utilization pattern and indigenous use of plants in and around a cement factory in Bilaspur District of Himachal Pradesh Northwestern Himalaya. *Biological Forum – An International Journal*,2009:1(2):70-80.
- Gautam AK, Bhatia MK, Bhadauria R. Diversity and Usage Custom of Plants of South Western Himachal Pradesh, India. Part-I. *Journal of Phytology*,2011:3(2):24-36.
- Sood SK, Thakur S. *Ethnobotany of Rewalsar Himalaya Dist. Mandi, Himachal Pradesh, India*. Deep Publ., New Delhi, 2004.
- Champion HG, Seth SK. *A Regional Survey of the Forest Types of India*. Govt. of India, Publication, Delhi, 1968, 404.
- Kumar M. Studies on woody plants of District Bilaspur, Himachal Pradesh. Ph D Thesis, H.P. University Shimla, 2015. - [shodhganga.inflibnet.ac.in/handle/10603/127884](http://shodhganga.inflibnet.ac.in/handle/10603/127884)
- Kumar S. Species Diversity and Ethnobotanical Uses of Family Moraceae in District Bilaspur, Himachal Pradesh (India). *Asi J. Adv. Basic Sci.*,2017:5(2):122-126.
- Kumar S. Wild Edible Plants Consumed by Rural Communities in District Bilaspur, Himachal Pradesh, India. *J. Biol. Chem. Chron.*,2019:5(2):01-11.
- Bhardwaj J, Seth MK. Medicinal plant resources of Bilaspur, Hamirpur and Una districts of Himachal Pradesh: An ethno-botanical enumeration. *J. Med. Plants Studies*,2017:5(5):99-110.
- Kumar G, Thakur K, Kumar V, Jyoti. Some Overlooked Ethno-medicinal Plants of District Bilaspur, Himachal Pradesh (INDIA). *Int. J. Eng. Pure Appl. Sci.*,2018:3(2):87-94.
- Kumar S, Ashok D, Sharma V. Ethnic uses of plants belonging to family solanaceae and convolvulaceae in district Bilaspur, Himachal Pradesh, India. *International Journal of Botany Studies*,2022:7(11):1-9.
- Collet H. *Flora Simlensis*. Thacker Spink and Co. Calcutta and Shimla, Reprinted 1971. Bisjen Singh Mahendera Pal Singh, Dehradun, 1902.
- Chowdhery HJ, Wadhwa BM. *Flora of Himachal Pradesh, Analysis*. Botanical Survey of India, Calcutta, 1984, 1-3.
- Polunin, O.; Stainton, A. *Flowers of the Himalaya*. Oxford University Press, Delhi, 1984.
- Vankar PS. Commercial viability of natural dyes Heena, Harada, Catechu and Babool for textile dyeing. *Natural Product Radiance*,2002:1(4):15-17
- Klaichoi C, Mongkholrattanasit R, Sasivatchutikool N, Rungruangkitkrai N. Fastness and Printing Properties of Cotton Fabric Printed with Natural Dye from *Acacia Catechu* Willd. *Advanced Materials Research*,2014:1030-1032:426-429.
- Singh PP, Sharma D, Chatterjee S. Application of Acacia Catechu Natural Dye on Banana Fiber. *Ergonomics International Journal*,2020:4(1):1-8.
- Jamadar D, Sannapamma KJ. *Acacia nilotica* Pods: A Natural Dye Source for Textile Colouration. *Int. J. Curr. Microbiol. App. Sci.*,2018:7(1):602-612.
- Gokhale SB, Tatiya AU, Bakliwal SR and Fursule RA. Natural dye yielding plants in India. *Natural Product Radiance*,2004:3(4):228-234.

25. Borah DK, Phukon R. Use of indigenous dyes for economic upliftment and sustainable livelihood. *Asian. J. Home Sci.*,2009-10:4(2):395-397.
26. Pathania MS, Bhardwaj P, Pathania D S. Preliminary Study on Few Dye Yielding Plants of District Solan, Himachal Pradesh. *International Journal of Progressive Research in Science and Engineering*,2021:2(8):764-771.
27. Kumari P, Samant SS, Puri S, Singh A, Rathore S. Diversity, indigenous uses and traditional practices of dye yielding plants in Central Himachal Pradesh, North western Himalaya. *Indian Journal of Traditional Knowledge*,2019:18(3):560-564.
28. Nautiyal S, Kaul AK. *Eds. Non-timber forest products of India*. Dehradun, Jyoti Publishers, 2003.
29. Gaur RD. Traditional dye yielding plants of Uttarakhand, India. *Natural Product Radiance*,2008:7(2):154-165.
30. Kumari P, Seth MK, Gagotia R. Dye Yielding Woody Plants along the National Highway from Parwanoo to Kaurik in Himachal Pradesh. *Haya: The Saudi Journal of Life Sciences (SJLS)*,2018:3(2):134-139.
31. Sarkar A, Dasgupta S, Paul TK. Uses of *Deeringia amaranthoides* (Amaranthaceae) by Totos. *ENVIS Newsletter*,2011:16(2):6.
32. Bose S, Nag S. Isolation of Natural Dyes from the Flower of *Hibiscus Rosa-Sinensis*. *American Journal of PharmTech Research*,2012:2(3):761-770.
33. Swamy NW, Gowda NK, Sudhakar R. Natural Dye Extracted from *Vitex negundo* as a Potential Alternative to Synthetic Dyes for Dyeing of Silk. *J. Inst. Eng. (India) Ser. E*,2016:97(1):31-38.
34. Chungkrang L, Phukan AR, Kalita, B. Eco-dyeing of wool yarn with *Ziziphus jujuba* Mill. (Ber) and its colour fastness properties. *Journal of Applied and Natural Science*,2018:10(3):1046 -1052.