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Cover: Oil painting of Humpback Whale *Megaptera novaeangliae*. © R. Mahesh.



Diversity of dye-yielding plants traditionally used by ethnic communities of Assam, India

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Abstract: Many plant species contain natural colouring matter in their leaves, seeds, fruits, roots or bark, suitable for use as dyes. This paper deals with the diversity of traditional dye-yielding plants used by ethnic communities in Assam, India. Field investigation was carried out in villages of upper, middle, and lower Assam, and information was collected based on a semi-structured questionnaire, interviews, and discussions among the major ethnic communities. We report a checklist of 45 plant species used by 13 ethnic communities, including vernacular names and plant parts used. Women in every ethnic group of Assam have rich traditional knowledge of colouring textiles and other objects with dyes extracted from locally available plants, and of fixing them to different bases. Natural dye-yielding plants have immense significance in the socio-economic and socio-cultural life of these ethnic communities. Proper documentation and exploration of dye-yielding plants will help to preserve traditional knowledge.

Keywords: Biodiversity, bio-resources, community, documentation, exploration, ethnic community, mordents, natural dye, scientific approach, textile industry, traditional knowledge.

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Author contribution: This work was carried out in cooperation among all authors. All the authors contributed to the design of the study. Hena Parbin and Abhijit Chandra Roy have done all the collection work, extraction of dye and wrote the first draft of the manuscript. Author Krishna Kanta Medhi identified plant samples and authors Bhuban Chandra Chutia and Utpal Bora contributed to the management and execution of the study and supervised the whole work. All authors read and approved the final manuscript.

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INTRODUCTION

Natural sources have long been widely used for dyeing. Plant-based natural dyes were first recorded around 2600 BC in China. The Indus Valley Civilization also used dyes from plant sources (Siva 2007). Plant and animal products are used for dyeing (Gupta 1999), and leaves, fruits, barks, seeds, and roots of many plant species are used for extracting colour. Natural resources endemic to a particular region are used in different parts of the world for their own natural dyeing tradition. In the second half of the 19th Century with the invention of synthetic dyes, the use of natural dyes started declining (Saravan & Chandramohan 2011). Synthetic dye has replaced natural dye for the rapid industrialization of textile production due to its easy availability and simple application process in ready-to-apply form. The beauty of natural dyes, however, has survived among specific communities that traditionally pass the knowledge to their next generation without proper documentation. Various research across the world has revealed the toxic effect of synthetic dyes. They release harmful chemicals, causing health hazards and degrading nature's ecological balance. The effluents of synthetic dyes contain carcinogenic and mutagenic chemicals, which pose a serious threat to living organisms (Novotny et al. 2006; Mathur & Bhatnagar 2007; Uddin et al. 2014). Due to growing awareness on health and the environment, the use of natural dye is revived because of its eco-friendly and biodegradable nature (Prusty et al. 2010). Throughout the world, textile industries have shown dynamism in terms of growth and export performance of natural dye (Cautisicos 2006). Applications of natural dye on natural fibers not only have high compatibility with the environment but also provide health benefits to the wearer (Sarkar 2004; Singh et al. 2005). Despite the several advantages of natural dyes over synthetic, the present international consumption of natural dye is only 1% of the synthetic. This limitation is caused by a lack of scientifically validated information on dye-yielding sources, along with technical drawbacks related to dye extraction and a standardization process (Patil et al. 2012).

Natural dye-yielding plants are one of the most important natural resources found in Assam. The ethnic people are only now exploring its high potential for commercial and industrial expansion. Women in every ethnic group of Assam have perfected ways of colouring textiles and other objects with dyes extracted from locally available plants and fixing them to different bases. The state of Assam has a large number of major

tribes and sub-tribes broadly belonging to the Indo-Mongoloid racial stock, including ethnic groups like Tai Ahom, Kacharis, Rabhas, Chutias, Bodos, Tiwas, SaraniaKacharis, MechKacharis, Thengal-Kacharis, and Deoris, with varied composition of cultural diversity. The information regarding dye-yielding plant in Northeast India is meager (Borthakur 1990; Ahmed & Borthakur 2005; Mahanta & Tiwari 2005; Sharma et al. 2005). Kar & Borthakur (2007) reported 47 dye-yielding plants from Assam. Akimpou et al. (2005) reported 25 dye-yielding plants used by Karbis of Assam. Hence, the present study has been undertaken to investigate and explore the availability of natural dye-yielding plant species in Assam and gather information on traditional knowledge associated with the use of natural dyes. A need of the hour is a proper exploration of dye-yielding plants traditionally used by the ethnic communities of Assam to generate a database of natural dyes, which will significantly help augment the textile industry.

MATERIALS AND METHODS

Study area

For the exploration of natural dye-yielding plants, the entire region of Assam is considered. Assam is one of the states of northeastern India, located at 26.2006° N, 92.9376° E, covering an area of 78,438 km² with diverse ecological conditions.

Biodiversity exploration of dye-yielding plants

The survey was started in April 2019 and completed in March 2021. Extensive surveys were conducted in eight districts of upper Assam, two districts of middle Assam, and one district of lower Assam. Rural artisans from 13 different communities were interviewed, and a structured questionnaire was provided pertaining to various information regarding the traditional use of dye-yielding plants and preparation methods. A list of dye-yielding plants was compiled, comprising 45 species used by 13 communities in Assam.

Sample collection

The surveyed plants were photographed, and various parts of the plants, such as roots, seeds, leaves, and bark, used for dye extraction, were collected for preparation of a herbarium using a standard herbarium technique (Jain & Rao 1977). The collected plant samples were identified in consultation with plant taxonomist, monographs and relevant literature.

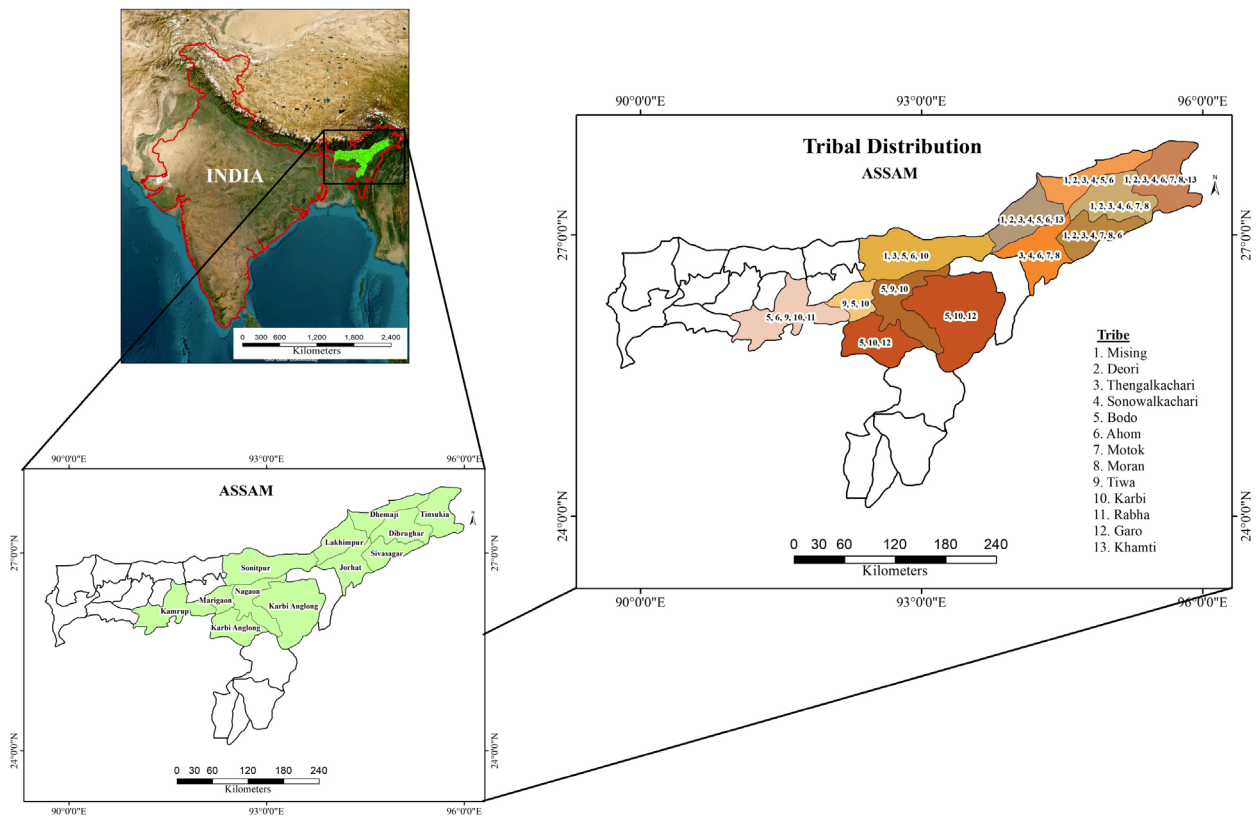


Figure 1. Study area of dye yielding plants used by 13 different communities of Assam.

RESULTS

Plant-based natural dyes are used for traditional dyeing by different communities of Assam. The part used in the extraction of dye, along with the vernacular name of the plant, is given in Table 1 & 2. From 13 different communities of Assam, 45 dye-yielding plants are recorded. Rutaceae, Rubiaceae, Moraceae, and Euphorbiaceae families were found to be dominant, with the Garo community utilizing eight different dye-yielding plant species, the highest diversity of usage among the 13 communities surveyed. These plants have been used by people of different communities to dye silk, yarns of wool, cotton, and garments.

DISCUSSION

Traditional costumes and colour combinations elucidate the identity of a particular community. Ethnic people extracted dye from different parts of plants to colour natural fibers like Eri silk yarn. Natural dye, like synthetic dye, can also be used to colour textiles at any stage, such as fiber, yarn or fabric. Mordants are used

in the dyeing process to improve dye fastness. They have an affinity for both textile fibers and dyes. By using different metallic mordants variation in color can be achieved with the same dyestuff. Along with its eco-friendly nature, natural dyes are also soothing to eyes in harmony with nature. Beautiful colours on textiles, obtained with plant-based dyes, show significant variation among different plant sources and parts.

The present investigation recorded 45 dye-yielding plant species belonging to 30 families from different regions of Assam, and discusses the richness of the traditional knowledge of dyeing in 13 communities of Assam. Among them, the Garo community reported using eight plant species for dyeing. Sutradhar et al. (2015) recorded 39 species of dye-yielding plants belonging to 26 families from Tripura. Gaur (2007) reported 106 dye-yielding plant belonging to 63 families from Uttarakhand Himalaya. His extensive survey showed that the majority of dye resources belong to dicotyledons, with the exception of four monocots, three gymnosperms, and three lichens. Kar & Borthakur (2007) investigated and documented 47 species of dye-yielding plants prevalent among five communities of Assam, viz., Assamese, Bodo, Karbi, Mising, and Deori.

Table 1. List of dye-yielding plants traditionally used by 13 different communities of Assam.

| | Scientific name | Family | Vernacular name | Colour of the dye |
|----|--|------------------|-----------------------------------|---|
| 1 | <i>Acanthus</i> sp. | Acanthaceae | Indigo grass / Neel gos | Dark Blue |
| 2 | <i>Aegle marmelos</i> | Rutaceae | Bel | Yellow |
| 3 | <i>Ageratum conyzoides</i> | Asteraceae | Gundhuabon | Soft green |
| 4 | <i>Allium cepa</i> | Liliaceae | Onion / Piyaj | Red |
| 5 | <i>Anthocephalus cadamba</i> | Rubiaceae | Pumgos (roghugos) / RaghuKadam | Yellow |
| 6 | <i>Areca catechu</i> | Arecaceae | Tamul | Dark brown |
| 7 | <i>Artocarpus integrifolia</i> | Moraceae | Jackfruit / Kathal | Yellow |
| 8 | <i>Artocarpus lacucha</i> | Moraceae | Bohot | Yellow |
| 9 | <i>Baccaurea ramiflora</i> | Phyllanthaceae | Leteku | Orange red |
| 10 | <i>Bixa orellana</i> | Bixaceae | Jorot / Annatto | Orange |
| 11 | <i>Calamus viminalis</i> | Arecaceae | Betguti | Yellow |
| 12 | <i>Ceriscoides campanulata</i> | Rubiaceae | Bihmona | Reddish-brown |
| 13 | <i>Citrus aurantiifolia</i> | Rutaceae | Kajinemu | Golden yellow |
| 14 | <i>Citrus reticulata</i> | Rutaceae | Orange / Komola | Yellow |
| 15 | <i>Corchorus capsularis</i> | Tiliaceae | Juteplant / Morapat | Light brown |
| 16 | <i>Curcuma longa</i> | Zingiberaceae | Kesahaldhi | Yellow |
| 17 | <i>Dillenia indica</i> | Dilleniaceae | Owtenga | Brown |
| 18 | <i>Diospyros melanoxylon</i> | Ebenaceae | Kendu | Brown |
| 19 | <i>Eclipta prostrata</i> | Asteraceae | Keheraj | Black |
| 20 | <i>Emblica officinalis</i> | Euphorbiaceae | Aamlokhi | Black |
| 21 | <i>Ficus bengalensis</i> | Moraceae | Aahot | Brown |
| 22 | <i>Garcinia xanthochymus</i> | Clusiaceae | Tepor-tenga | Yellow |
| 23 | <i>Hibiscus rosa-sinensis</i> | Malvaceae | JobaPhul | Purple |
| 24 | <i>Indigofera tinctoria</i> | Fabaceae | Sibu / Assam indigo | Blue |
| 25 | <i>Lawsonia inermis</i> | Lythraceae | Jetuka | Bluish- black |
| 26 | <i>Melastoma malabathricum</i> | Meleostomataceae | FutuKola | Black |
| 27 | <i>Mangifera indica</i> | Anacardiaceae | Mango | Yellow |
| 28 | <i>Mesua ferrea</i> | Calophyllaceae | Nahar | Yellow |
| 29 | <i>Musa velutina</i> | Musaceae | Kolakhar | Reddish-brown |
| 30 | <i>Nyctanthes arbor-tristis</i> | Nyctanthaceae | Sewali | Orange |
| 31 | <i>Oryza sativa</i> | Poaceae | Dhankher | Yellow-brown |
| 32 | <i>Punica granatum</i> | Lythraceae | Dalim / Pomegranate | Yellow |
| 33 | <i>Rubia cordifolia</i> | Rubiaceae | Manjistha | Red |
| 34 | <i>Sapindus mukorossi</i> | Sapindaceae | Monichal | Light brown |
| 35 | <i>Spondias pinnata</i> | Anacardiaceae | Amora | Brown |
| 36 | <i>Syzygium cumini</i> | Myrtaceae | Jamun | Black |
| 37 | <i>Tagetes patula</i> | Asteraceae | Narzi / GendhaPhul | Yellow |
| 38 | <i>Tectona grandis</i> | Verbenaceae | Sagoon | Yellow |
| 39 | <i>Terminalia catappa</i> | Combretaceae | Silikha | Black |
| 40 | <i>Camellia sinensis</i> var. <i>assamica</i> | Theaceae | Tea | Pale green (Fresh leaves) Brown (Dried leaves) |
| 41 | <i>Trewia nudiflora</i> | Euphorbiaceae | Velou | Reddish-brown |
| 42 | <i>Ziziphus jujube</i> | Rhamnaceae | Bogori | Brown |
| 43 | <i>Argemone mexicana</i> | Papaveraceae | Siyalkata | Yellowish-green |
| 44 | <i>Impatiens roylei</i> | Balsaminaceae | Demderuka | Brown |
| 45 | <i>Basella rubra</i> | Basellaceae | Puroi | Maroon |

Table 2. Dye-yielding plants used by different communities of Assam.

| Community | Scientific name | Vernacular name | Parts used | |
|---|---|-----------------------------------|---------------------|------------------|
| Khamti | <i>Ceriscoides campanulata</i> | Bihmona | Whole plant | |
| | <i>Sapindus mukorossi</i> | Monichal | Stem bark | |
| | <i>Artocarpus heterophyllus</i> | Jackfruit | Stem bark and roots | |
| | <i>Garcinia cowa</i> | Teportenga | Roots | |
| Mising | <i>Terminalia chebula</i> | Silikha | Fruits | |
| | <i>Ziziphus jujuba</i> | Bogori | Stem bark | |
| | <i>Camellia sinensis</i> var. <i>assamica</i> | Tea | Leaf | |
| | <i>Syzygium cumini</i> | Jamun | Stem bark | |
| | <i>Areca catechu</i> | Tamul | Seed/ seed peel | |
| | <i>Calamus viminalis</i> | Betguti | Seed/fruit | |
| | <i>Anthocephalus cadamba</i> | Pungos (roghugos) / RaghuKadam | Stem/bark | |
| Deori | <i>Citrus aurantifolia</i> | Bortenga | Fruit skin | |
| | <i>Syzygium cumini</i> | Jamun | Stem bark | |
| | <i>Artocarpus heterophyllus</i> | Jackfruit | Stem bark | |
| Thengal-kachari | <i>Dillenia indica</i> | Owtenga | Stem bark | |
| | <i>Oryza sativa</i> | Dhankher | Seed | |
| Sonowalkachari | <i>Citrus aurantifolia</i> | Bortenga | Straw/ stem | |
| | <i>Musa velutina</i> | Kolakhar | Dried stem | |
| Tiwa | <i>Spondias pinnata</i> | Amora | Dried stem | |
| | <i>Aegle marmelos</i> | Bel | Fruit | |
| | <i>Camellia sinensis</i> var. <i>assamica</i> | Tea | Leaf | |
| | <i>Ficus benghalensis</i> | Aahot | Bark | |
| | <i>Acanthus</i> sp. | Niligos | Leaf | |
| | <i>Curcuma longa</i> | Halodhi | Rhizome | |
| | <i>Basella rubra</i> | Puroi | Seed | |
| Karbi | <i>Hibiscus rosa sinensis</i> | JobaPhul | Flower | |
| | <i>Emblia officinalis</i> | Aamlokhi | Bark | |
| | <i>Nyctanthes arbor-tristis</i> | Sewali | Flower | |
| | <i>Diospyros melanoxylon</i> | Kendu | Seed/ fruit | |
| | <i>Allium cepa</i> | Onion | Rhizome | |
| | <i>Trewia nudiflora</i> | Velou | Seed/ fruit | |
| | <i>Mesua ferrea</i> | Nahar | Seed/ fruit | |
| | <i>Terminalia chebula</i> | Silikha | Fruit | |
| | Bodo | <i>Tectona grandis</i> | Sagoon | Stem, bark, leaf |
| | | <i>Ageratum conyzoides</i> | Gundhuabon | Flower |
| <i>Lawsonia inermis</i> | | Jetuka | Leaf | |
| <i>Sapindus mukorossi</i> | | Monichal | Fruits | |
| <i>Camellia sinensis</i> var. <i>assamica</i> | | Tea | Leaf | |
| Garo | <i>Terminalia chebula</i> | Khilikha | Seed/fruit | |
| | <i>Eclipta alba</i> | Kehraj | Black | |
| | <i>Baccaurea remiflora</i> | Leteku | Leaf | |
| | <i>Rubia cordifolia</i> | Manjistha | Whole plant | |
| | <i>Acanthus</i> sp. | Indigo grass | Whole plant | |
| | <i>Artocarpus heterophyllus</i> | Jack fruits | Stem/bark/wood | |

| Community | Scientific name | Vernacular name | Parts used |
|-----------|---------------------------------|-------------------|------------------|
| | <i>Indigofera tinctoria</i> | Indigo | Whole plant |
| | <i>Curcuma longa</i> | Halodhi | Rhizome |
| Rabha | <i>Punica granatum</i> | Dalim/Pomegranate | Fruit skin |
| | <i>Tagetes patula</i> | Narzi/GendhaPhul | Flower |
| | <i>Artocarpus heterophyllus</i> | Jackfruit | Stem/ bark/ wood |
| | <i>Terminalia chebula</i> | Khilikha | Seed/ fruit |
| Motok | <i>Citrus aurantifolia</i> | Rababtenga | Fruit skin |
| | <i>Oryza sativa</i> | Dhankher | Poaceae |
| | <i>Musa velutina</i> | Vimkolorkoldil | Plant |
| | <i>Terminalia chebula</i> | Khilikha | Seed/ fruit |
| | <i>Spondias pinnata</i> | Amora | Fruit/ bark |
| | <i>Mangifera indica</i> | Mango | Bark |
| | <i>Artocarpus lacucha</i> | Bohot | Fruit |
| Moran | <i>Citrus reticulatus</i> | Orange | Fruit skin |
| | <i>Corchorus capsularis</i> | Morapat | Whole plant |
| Ahom | <i>Malestoma malabathricum</i> | FutuKola | Fruits/ flower |
| | <i>Bixa orellana</i> | Jorot/Annanto | Seed |
| | <i>Argemone mexicana</i> | Siyalkata | Seed |
| | <i>Impatiens roylei</i> | Demderuka | Flower |

From five districts of Arunachal Pradesh, Mahanta & Tiwari (2005) recorded 37 species of dye-yielding plants belonging to 26 families. Fabaceae was dominant, with six species, followed by Euphorbiaceae and Moraceae with four each, and Juglandaceae with two species, the remaining 21 families represented by one species each. Borgohain et. al. (2018) studied natural dyes and textiles as cultural markers among the Tai Phake of upper Assam. Colour combinations and costume variations differentiate age gradation among males and marital status among females. They also observed that colours such as black, violet, purple, and green are dominated by synthetic dye while yellow is extracted from the bark of *Garcinia xanthochymus*. They also noted that the culture is now confined to surviving aged women of the tribe. This study on natural dyes thus presents potential application and immense scope for small-scale industrial prospects.

CONCLUSION

The present study on natural dye-yielding plants of Assam revealed the rich traditional culture among the communities of Assam. This unique indigenous knowledge and practice on dye-yielding is declining day by day among the new generation because of the

easy availability of cheap synthetic dyes and a modern attitude and lifestyle. It observes that the traditional practice of dye-making has survived only among a few elderly people, and there are few attempts to conserve and promote this beautiful treasure of traditional knowledge. The natural dyes obtained from plant sources are biodegradable, non-toxic and environmentally friendly. Dyes have multifarious applications, including an emerging branch of medicine, Chromotherapy, which relies heavily on natural dyes. Synthetic dyes contain chemicals that may cause sensitivities and potential health concerns. Dyes used in textiles, food, beverages, perfumes, lotions, and medicines must adhere to special safety measures like being nontoxic, less or non-allergenic, biodegradable, and eco-friendly. It is of the utmost necessity to document and conserve the valuable treasure of this traditional knowledge system, without which we will lose vital information on the utilisation of natural resources around us. Systematic and scientific approaches for the extraction, processing, and usage of natural dyes, along with their conservation strategy, will benefit the ethnic community of Assam, enhancing their economy and intensifying future bio-prospecting and eco-friendly products.

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