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Exploration and extraction of plant based natural dye from Nagaon district for dyeing Eri silk yarn

Md. Akib Hussain[1*], Shehnaz Siddika Rasid[2], Anjela Ahmed[3], Bhuban Ch. Chutia[4]
[1] Junior Research Fellow, SEEM Department, Central Muga Eri Research and Training Institute, Jorhat, Assam, India
[2] Assistant Professor, Department of Zoology, Mariyam Ajmal Women's College of Science and Technology, Hojai, Assam, India
[3] Research Scholar, Department of Zoology, Nowgong University, Nagaon, Assam, India,
[4] Assistant Professor, Department of Zoology, Nowgong University, Nagaon, Assam, India

Abstract
The indigenous tribes of North-Eastern India have long engaged in the practice of rearing Eri silkworms and making Eri silk fabric. The state of Assam, in particular, is widely recognized for its significant contribution to the nation's production of raw silk. The state's marginal farmers encounter several obstacles throughout the fabric-making process and may not receive the results they were hoping for. Since Assam is one of the most biologically diverse states in the country, the current shift in the fashion and textile industries toward sustainability and eco-friendliness can have a significant impact on the creation of natural dye from a variety of natural resources. In order to determine the color implications for Eri silk yarn, the current study focuses on extracting natural dye from available floral samples from the Nagaon district.

Keywords: Eri silk-yarn, natural dye, mordants

Introduction

In the verdant landscapes of North East India, particularly in Assam, the art of cultivating and weaving wild silk is deeply intertwined with the region's rich tapestry of life and culture. Among Assam's diverse silk offErings, the enigmatic Eri silk stands out for its unique method of extraction, one that preserves the life of the silkworm. Eri silk is obtained from a sericigenous insect called Eri silkworm (*Samia ricini* Donovan) which is a polyphagous non-mulberry silkworm that consumes more than 30 different host plants, the castor leaf (*Ricinus communis* L.) is its primary food source (Bukhari *et al.,* 2019) [9]. Unlike conventional silk production where cocoons are boiled with the larvae inside to ensure uninterrupted thread, Eri silk cocoons are crafted with an intentional aperture, allowing the moth to emerge freely. This compassionate approach to silk production has garnered admiration from vegans and Buddhists alike, earning Eri silk the moniker of "Peace silk or Ahimsa silk" for its harmonious coexistence with nature. According to the Central Silk Board of India's annual report, the production of raw Eri silk increased dramatically in the last two years, from 1,089 metric tons in 2001–02 to 7,349 metric tons in 2022–23. This growth represents a Compounded Annual Growth Rate (CAGR) of 9.07% over the previous 20 years, of which the state of Assam alone is responsible for 74.66%. The cross-sectional shape, surface characteristics, density, and fineness of Eri silk make it a desirable staple fiber. It weighs more and is darker than other silks. It is the softest silk fiber available, feels like cotton, and has the luster, bulk, and warmth of other silks. Its many characteristics set it apart from other fibers (Kariappa 2006 and Chollakup *et al.,* 2008). Its thermal qualities allow it to be cool in the summer and warm in the winter. It also blends well with synthetic fibers, wool, cotton, jute, and other natural silks (Somashekhar, 2003). Eri silk, which is white like mulberry silk and has a naturally coated color unlike other natural silks like Tasar and Muga, shows promise for use in dyeing processes without the need for bleaching agents. Consumers are drawn to fabrics dyed with natural dyes in the textile industry these days because they feel good about wearing clothing that is devoid of chemicals or that won't damage their skin. Natural resources, mostly derived from plant or animal materials, are used to make natural dye. They are merely coloring agents. Natural coloring materials that can be used as dyes in a variety of industries can be found in the leaves, seeds, fruits, bark, and roots of many plant species. Plant dyes are a possible source of natural dyes due to their abundance and ease of availability. However, the use of mordant became more crucial due to the growing interest in natural plant colors. For the majority of natural dyes to permanently set in any fiber, a mordant of some kind is needed. To make the dye molecules insoluble in water, metal ions from mordants function as electron acceptors for electron donors to establish coordination bonds with the dye molecules. Better dye uptake and retention as a result yield higher depth of shade and improved color fastness characteristics. Alum, chromium, stannous chloride, copper sulfate, ferrous sulfate, and other substances are common mordants (Singh and Bharati, 2014) [29]. Because synthetic dyes are more affordable, offer a greater variety of vibrant shades, and have significantly better fastness properties than natural dyes, the textile dyeing industry currently uses an excessive amount of synthetic dyes to meet the required coloration of textiles for global consumption (El-Nagar *et al.,* 2005; Iqbal *et al.,* 2008) [11, 17]. Such dyes have detrimental effects on the eco-balance of the environment and pose major health risks when applied (Bruna and Maria 2013; Goodarzian and Ekrami 2010; Jothi 2008) [8, 13, 18]. Because of this, natural dyes are one of the most viable possibilities for creating a more environmentally friendly textile dying process, and the growing number of recent publications reflects this enthusiasm. The simple availability and abundance of plant leaves makes them potential sources of natural colors. The study's objective was to assess the efficacy of dyes made from several locally accessible plant sources for dyeing Eri silk. Observing the dyes' aqueous

extraction process and investigating the potential for utilizing various mordants to create trendy colors from the dyes in anticipation of future textile industry opportunities were the specific goals.

Materials and Methods

Study Area

The study is based on surveying in the Nagaon District of Assam, which has a total area of 4435.3 square kilometers and borders the Sonitpur district and the Brahmaputra river in the north, the West Karbi Anglong and North Cachar Hills in the south, and the East Karbi Anglong and Golaghat district in the east. The district extends from 250 -45' to 260 -45' N Latitude and 920 -33' to 92 0 -6" E Longitude. The district's ethnic population is well-versed in Eri culture, which is a village craft whose raising, spinning, and weaving techniques are passed down from generation to generation as the distinctively beautiful and appealing Eri silk fabric, which doubles as the Assamese people of Northeastern India's national garment.

Sample Collection

In order to extract dye, samples of nine distinct plants were gathered from the survey. Roots, seeds, flowers, fruits, and bark are among the plant parts that are employed in the extraction process. Samples are included in the section below:

1. Areca-nut (Local Name: Tamul)

The fruit of the native South Asian and Pacific Island *Areca catechupalm* tree is known as areca nut, or suparii. Because betel leaves are frequently used to wrap it for chewing, it is also known as betel nut. In contrast to ripe fruit, which has a yellow or orange husk and fruit that hardens to akin to wood, fresh fruit has a green husk and a very soft nut inside. The endosperm or seed is eaten raw, cooked, sun-dried, or cured. Areca nuts can be eaten on their own or as part of prepared foods such pan masala, mawa, and supari. Areca nuts are known as paan or betel quid when they are eaten with lime, betel leaf, and tobacco or not. For added flavor, it could contain cardamom, catechu, cloves, etc. The nuts have a variety of medicinal uses. The main components of areca nut are lipids, carbohydrates, and polyphenols. Areca nut polyphenols include flavonols, hydrolyzable tannins, and condensed tannins. The most bioactive parts of areca nut are polyphenols (Prabhu *et al.,* (2014) [23].

2. TurmEric (Local Name: Halodhi)

The tuberous rhizomes, or subterranean stems, of the perennial herbaceous plant *Curcuma longa*, a member of the ginger family (Zingiberaceae), have been used as a condiment, textile dye, and fragrant stimulant in medicine since ancient times. Turmeric is a native of southern India and Indonesia and is grown extensively both on the Indian Ocean's islands and on the continent. It was used as a spice and a perfume in antiquity. The rhizome smells like pepper, tastes warm and slightly bitter, and is a bright orange-yellow color that stains well. Turmeric contains a high concentration of phenolic chemicals, specifically curcuminoids known as demethoxy and bisdemthoxycurcumin. The polyphenol curcumin, commonly referred to as C.I.75300 or Natural Yellow 3 in textile terminology, is the active ingredient in turmeric rhizome (Lechtenberg *et. al.,* 2004; Teli *et. al.,* 1994) [21, 32].

3. Manjistha (Local Name: Manjit, Manjistha)

Rubiacordifolia, often known as Common Madder or Indian Madder, is a species of flowEring plant in the coffee family, Rubiaceae. It is a perennial, prickly climber with a stem, growing up to 12 m long. Leaves are highly variable, ovate lanceolate, 5-7 nerved, 2-10 cm long and 2-5 cm broad, occurring in whorls of 4-6. Flowers are fragrant, minute, whitish or greenish yellow. Fruit is minute, glabrous, 1-2 seeded, dark purplish or blackish when mature. During August-October plant carries flower and fruit. Roots are perennial, long, cylindrical, and rusty brown in colour. It has been cultivated for a red pigment dErived from roots. Genus *Rubia* fell into about 70 species distributed widely around the world, a total of 36 species and 2 varieties were reported from China. The extracts and phytochemicals of *Rubia* plants had drawn considerable attention due to their potent bio-activities. Today there is growing interest in chemical composition of plant based medicines. Several bioactive constituents have been isolated and studied for pharmacological activity. *R. cordifolia* is an important medicinal plant commonly used in the traditional and Ayurvedic system of medicine for treatment of different ailments (Verma *et. al.,* 2016) [34].

4. Myrobalan (Local Name: Hilikhaa)

Terminaliachebula is a tree in the Combretaceae family, found wild in the forest of India and surrounding countries at high altitudes; that produces a fruit known as a myrobalan. The herb is known as Haritaki, Bihara and Harada in different dialects, and is one of the three fruits found in the traditional formulation of Triphala. It is used as a bowel regulatory tonic and gentle laxative in Traditional Ayurvedic Medicine. It has emollient properties and bitter principles that encourage pEristalsis and proper digestion. It contains five tastes: sour, sweet, pungent, bitter, and astringent, with the most predominant being bitter and astringent. *Haritaki* (*Terminaliachebula* Retz) is held in high esteem in Ayurveda for its properties to prevent and cure diseases. It has enjoyed the prime place among medicinal herbs in India since ancient times. It is called the 'King of Medicines' and is always listed first in Ayurveda because of its extraordinary therapeutic benefits (Ratha and Joshi, 2013) [24].

5. Parijata (Local Name: Hewali)

Nyctanthus arbor-tristis Linn., belonging to the family Oleaceae, is a fabulous plant having high medicinal value. It is commonly known as *har–singhar* in Hindi, *Parijata* in Sanskrit and night jasmine in English. It is widely distributed in sub-Himalayan regions and southwards to Godavari and is predominantly native to southern Asia. The geographical distribution of the plant extends from northern Pakistan and southern Nepal through northern India and south east to Thailand and also in other parts of the world. Due to it's high therapeutic value now a day it is a matter of interest for research in bio-medical science to explore more accurate therapeutic index, in terms of active principles that could be the marker compound of the plant. Broad spectrum medical use of the plant and it's different parts are described in various Ayurvedic literatures (Hiremath *et. al.,* 2016) [16].

6. Annatto (Local Name: Hendur)

Bixaorellana L., or annatto, is a member of the Bixaceae family. It is a native of Central and South America, growing to a height of 3–6 m. It is one of the earliest known plants to

produce natural dyes. It has the name of Francisco de Orellana, a Spanish adventurer, and has been used historically for body painting, sun protection, treating heartburn and stomach problems, and warding off evil. The species *B. orellana* is known as the lipstick tree because indigenous people have traditionally utilized the pulp from its seeds externally to improve the appearance of lips. The coloring and bleaching of dairy food products, particularly bread goods, cream desserts, butter milk desserts, rice flour, and corn starch, are among the many uses for anthocyanins. Numerous classes of phytoconstituents, such as carotenoids, apocarotenoids, sterols, aliphatic compounds, monoterpenes and sesquiterpenes, triterpenoids, volatile oils, and other miscellaneous compounds from all parts of this plant, have been isolated through extensive research studies conducted in the last few decades (Rather *et al.*, 2016) [25].

7. Marigold (Local Name: Narji, Gendha)

The leaves of the annual herb marigold are a pale green color. This plant produces powerful, disagreeable-smelling flowers from the start of summer until the first frost. The most frequent species in the plant kingdom are *Tagetes* species, which are members of the Asteraceae family and are utilized as ornamentals as well as in cosmetic preparation and medicine. It comes in a variety of colors and fragrances. The most prevalent color is yellow. The extraction procedure is mostly utilized to use flowers for all of these uses. *Tagetes*, often known as calendula, is a highly efficacious herb that can be applied to any area of the skin that is inflamed, be it from an illness or physical trauma. Marigold (*Tagetes*) ointment is a great cosmetic repair for minor skin damage, such sunburn or subdermal broken capillaries (Singh, 2016) [28].

8. Onion (Local Name: Piyaaj)

Grown for its edible bulb, the onion (*Allium cepa*) is a herbaceous biennial plant in the Amaryllis family (Amaryllidaceae). Though it is currently grown all throughout the world, mostly in temperate regions, onions are most likely native to southwest Asia. Despite having few nutrients, onions are prized for their flavor and are frequently used in cooking. They are used as a cooked vegetable as well as a flavorful addition to stews, roasts, soups, and salads. The oldest crop that has been farmed and is frequently used in traditional and ethnoscientific medicine to cure a variety of diseases is allium cepa (Ashwini and Sathishkumar, 2014) [4]. Onion is used as an anti-helminthic (Hertog *et al.*, 1992) [15], hypoglycemic (Oginmodede *et al.*, 2012; Akash *et al.*, 2014) [3], anti-inflammatory, unti-rheumatic, antispazmolitic, diuretic, anti-thrombotic, anti-septic (Goodarzi *et al.*, 2013; Kirilov *et al.*, 2014), anti-asthmatic, and hypocholesterolemic remedy (Pineda, de la Calzada, 2013) [14].

9. Malabar Spinach (Local Name: Puroi-Haak)

A member of the Basellaceae family, malabar spinach is also known as *Basellarubra* Roxb. (*Basellaalba* L.). *Basellarubra* L. and *Basellaalba* L. are the two species of the plant that Linnaeus classified according to taxonomy. The traits of their leaves and the colors of their stems set these two species apart. Indian spinach, Malabar spinach, Ceylon spinach, climber spinach, and vine spinach are other names for *Basellaalba* L., sometimes known as *Basellarubra* L. Common names include basella in French, spinaciodellacina in Italian, indischerspinat in German, espinacablanca de Malabar in Spanish, and Malabar spinach in English. Tropical Asia and tropical Africa are its native growing regions, and it is believed to have originated in India and Indonesia. Malabar spinach is an evergreen. The roots exhibit lateral growth and are fibrous. Depending on the characteristics of the stem variety, the stem can have a range of hues and be fleshy, succulent, thin, smooth, and bright. On the stem, the leaves disperse spirally. Because the length of the leaf exceeds its width, the leaf is oblong and has a short stem. There is evidence of side branching on the stem. Depending on the type, flowers on the leaf seat might be white, red, or pink. The leaves of bractea are tiny and rough. Fruits are tiny and come in crimson or black hues. Testa on seeds are thick, black-brown, and have a brilliant, rough surface (Acikgoz and Adiloglu, 2018) [1].

Process of dye extraction

- **Areca-nut:** After being soaked in water 20 times, areca nuts were boiled, extracted for 60 minutes, and then filtered. There were two iterations of this process. A dyeing solution was made by combining the first and second extracts. The extracts can also be cooked to soak up surplus water, then cooled to harden for later use.
- **Turmeric:** Once the fresh turmeric rhizomes have been cleaned with hot water to get rid of any dirt, they are sliced. After that, the slices were cut, dried for three days in the sun, and then again for 30 minutes at 100°C in a hot air dryer to get rid of any remaining moisture. The aqueous extraction process, which involves boiling the dry rhizomes of turmeric with water, was used to extract the dye.
- **Manjistha:** The aqueous extraction process is used to extract natural colors from the roots of manjistha. The roots are first dried, pounded into a powder, and then submerged in water for 12 hours at a pH of neutral. Following the extraction, the extracts were filtered to get rid of the insoluble residues and cooled to 30°C. After using an evaporative drying procedure to dry the solutions in a hot sand bath, dry powder was created for later usage.
- **Myrobalan:** The Myrobalan fruits are used to extract dye; this tannic extract is made from the nuts' rich, naturally occurring tannin that has a low color. Myrobalan nuts are first cooked in water for around half an hour. Thirty times as much water is ued as silk thread.
- **Parijata:** The flower is soaked in either cold or hot water to extract the dye; often, cold water is utilized.
- **Annatto:** The annatto plant's seeds are used to extract the color. Typically, boiling with water or socking are used for extraction. Bixin and Norbixin are the two primary colorants found in annatto plants.
- **Marigold:** The aqueous extraction process is used to extract dye from both flowers and foliage. Both fresh and dried flowers are used in this situation. Dry flowers require more time to remove the dye than fresh flowers do. The dried flower was ground into a powder for later use.
- **Onion:** By boiling the onion's outer skin with water, dye is removed. Onion peels were gathered, combined with water, and cooked to 65°C for 60 minutes. Filtration was the last step in removing the liquid dye from the skin.
- **Malabar Spinach:** Its seeds are used to extract dye. After being gathered, seeds are carefully cleaned. Seeds are ground and filtered after being cleaned. For dying, filtered dye is utilized.

Process of mordanting

The most crucial step in getting fibers ready to accept color is mordanting. For the longest-lasting and most resilient colors, use a mordant. The two types of mordants that are mostly used in this investigation are listed below:

1. **Alum (Potassium Aluminium Sulphate):** Alum plays the role of a chemical agent that facilitates a reaction between the dye and the fabric in order to set the colour when utilizing natural dyes. It is not a stand-alone colour source; it can be added to the dye source to affect it. After the mordant is injected into the cloth, the dye reacts with it during the dying process to create a chemical connection that securely binds the dye to the fabric.

2. **Iron (Ferrous Sulphate):** Iron mordant for use with natural dyes to colour protein fibers such as wool, hair, and silks. By chemically bonding with the fiber, iron mordant forms attachment points that bind with natural dye colorants to produce light-fast and wash-fast colours. Depending on the plant used, it changes the colour derived from dye plants, darkening the color, or "saddening," turning yellows into oranges, reds into browns, and purples into blacks.

Mordanting process of Eri silk-yarn

Mordant is added in accordance with the weight of the Eri-silk yarn, which is 15% alum (15 grams of alum for 100 grams of Eri-silk yarn) and 2% iron (2 grams of iron for 100 grams of Eri-silk yarn, respectively). In a large container filled with hot water, the mordant is dissolved in a small container filled with warm water in a ratio of 30:1, or 30 liters of water for every kilogram of silk yarn. The water's temperature is now progressively raised to 85°C and kept there for at least an hour after the Eri-silk yarn is put to the container. Now, the silk yarn is allowed to cool for twenty minutes. The extra water is soaked out of the silk yarn and let to dry in a shaded area.

Application of extracted natural dye on Eri silk-yarn

Following the mordanting process, the natural dye that was previously taken from different plant is added to the Eri-silk yarn. The silk yarn and dye mixture is left for two to three days. The dyed silk yarn is now drying in the shade, and care must be taken to prevent it from coming into touch with direct sunlight.

Results

Different color sheds are achieved (table 1) after the correct mordanting and dyeing process using natural dyes taken from nine different plants. Their particular observations are shown below.

Table 1: Result of colour obtained by Eri silk-yarn after dying with natural dye extracted from different locally available plants

Plant Name	Parts Used	Sample Quantity	Boiling Period	Mordant Used	Mordant Quantity	Treatment Time	Thread Quantity	Colour Obtained
Areca-nut	Fruit	15 gm	60 min	Alum and Iron	1.5 gm and 0.2 gm	1 hrs	10 gm	Brown
Turmeric	Rhizome	15 gm	30 min	Alum	1.5 gm	1 hrs	10 gm	Yellow
Manjistha	Root	15 gm	60 min	Alum	1.5 gm	1 hrs	10 gm	Red
Myrobalan	Fruit	15 gm	10 min	Iron	0.2 gm	24 hrs	10 gm	Green
Parijata	Flower	15 gm	60 min	Alum	1.5 gm	6 hrs	10 gm	Yellow
Annatto	Seed	15 gm	30 min	Alum	1.5 gm	12 hrs	10 gm	Orange
Marigold	Flower	100 gm	60 min	Alum	1.5 gm	1 hrs	10 gm	Deep Yellow
Onion	Peel	15 gm	30 min	Alum	1.5 gm	12 hrs	10 gm	Green
Malabar Spinach	Seed	100 gm		Alum	1.5 gm	24hrs	10 gm	Purple

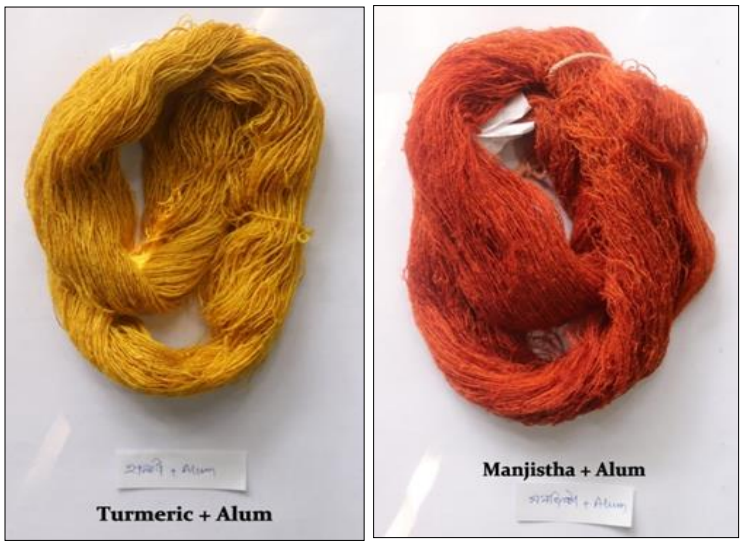
Observation 1: A sample of 15 grams of areca nuts is taken, and it is cooked for 60 minutes to extract the dye. Taken as a mordant are 1.5 g of alum and 0.2 g of ferrous sulphate. The Eri-silk yarn is dyed for approximately an hour, and 10 grams of Eri-silk are used. After the dyeing procedure, brown is the color that is produced (Figure 1A and 1B).

A **B**

Fig 1: Eri silk-yarn died with extraction of Areca nut and Alum mordant (A), Areca nut and Ferrous sulphate mordant (B)

Observation 2: To extract the dye, 15 grams of turmEric rhizome are obtained and cooked for 30 minutes. One takes 1.5 grams of alum as a mordant. The Eri-silk yarn is dyed for approximately an hour, and 10 grams of Eri-silk are used. Yellow is the color that is produced during the dyeing procedure (Figure 2A).

Observation 3: A sample of 15 grams of manjistha roots is obtained, and it is cooked for 60 minutes to extract the dye. One takes 1.5 grams of alum as a mordant. The Eri-silk yarn is dyed for approximately an hour, and 10 grams of Eri-silk are used. The dyeing method yielded a red color (Figure 2B).

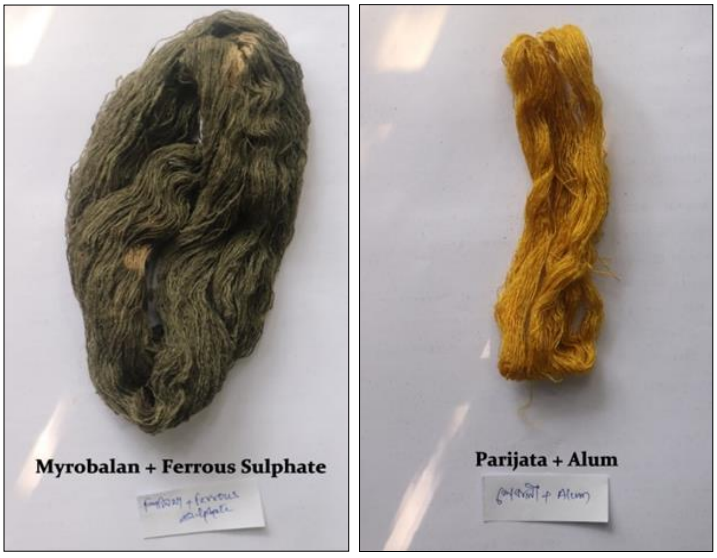


A **B**

Fig 2: Eri silk-yarn died with extraction of Turmeric and Alum mordant (A), Manjistha and Alum mordant (B)

Observation 4: Fruit samples of myrobalan weighing 15 grams are obtained, cooked for 60 minutes, and dye extracted. 2 grams of ferrous sulphate and 1.5 grams of alum are used as a mordant. A total of 10 grams of Eri-silk were used, and the dye was applied to the yarn for around a 24-hour pEriod. After dying, green is the color that is produced (Figure 3A).

Observation 5: A 15 gm sample of parijata flowers is obtained, and they are cooked for 60 minutes to extract the dye. One takes 1.5 grams of alum as a mordant. The Eri-silk yarn is dyed for around six hours, and ten grams of Eri-silk are used. Yellow is the color that is produced during the dyeing procedure (Figure 3B).



A **B**

Fig 3: Eri silk-yarn died with extraction of Myrobalan and Ferrous sulphate mordant (A), Parijata and Alum mordant (B)

Observation 6: An annatto seed sample weighing 15 grams is obtained, and it is cooked for 60 minutes to extract the coloring. One takes 1.5 grams of alum as a mordant. The Eri-silk yarn is dyed for around 12 hours, and 10 grams of Eri-silk are used. Red is the color produced by the dyeing process (Figure 4A).

Observation 7: A 100 gram sample of marigold flowers is taken, and it is cooked for 60 minutes to extract the dye. One takes 1.5 grams of alum as a mordant. The Eri-silk yarn is dyed for approximately an hour, and 10 grams of Eri-silk are used. The dyeing technique yielded a vivid yellow color (Figure 4B).

A B

Fig 4: Eri silk-yarn died with extraction of Annatto and Alum mordant (A), Marigold and Alum mordant (B)

Observation 8: A sample of 15 grams of onion peel is obtained, and it is cooked for 30 minutes to extract the dye. Alum (1.5 gram) is used as a mordant. Ten grams of Eri-silk were used, and the dye was applied to the yarn for around twelve hours. Green is the color that results from the dyeing process (Figure 5A).

Observation 9: To extract the color, 100 grams of Malabar spinach seeds are sampled. One takes 1.5 grams of alum as a mordant. Ten grams of Eri-silk were used, and the dye was applied to the yarn for approximately twenty-four hours. Purple is the hue that is produced during the dying process (Figure 5B).

A B

Fig 5: Eri silk-yarn died with extraction of Onion and Alum mordant (A), Malabar spinach and Alum mordant (B)

Discussion

According to A.N. Banerjee *et al.*, (2017), the natural dyes' general color fastness in the presence of natural mordants was found to be good to very good, with the exception of the black shade containing iron ore, where light fastness was marginally lower than that of the other dyes. Eri silk yarn that has been dyed with a particular natural dye and is in the presence of natural mordants is typically rated as having good color fastness to washing qualities. A stronger focus on encouraging the use and production of natural dyes could significantly improve environmental sustainability. To this end, more young employees should receive scientific training, and employers in rural areas should support their efforts by offering employment-oriented programs. Excellent UV protection was found in Eri silk yarns colored with Andaman satinwood leaves, Golden shower pods, Neem bark, Sappan, Acacia bark, and Burma padauk bark by N. Rungruangkitkrai *et al.*, in 2020 [26]. Moreover, the UV protection property was noted in the UPF value following post-mordanting with $AlK(SO_4)_2$ and $FeSO_4$. Consequently, post-mordanting and natural dyes were used to provide UV protection for the eri items, which included a garment, scarf, and hat. To create items with a fashionable color and superior UV protection, natural indigo was combined with the reddish-brown color of Sappan and Burma padauk bark. Based on Nabaneeta Gogai's (2010) study, it can be inferred that annatto seed dye can be used to dye eri silk yarn and fabric in an efficient manner, improving the quality of eri silk. Therefore, adding value to this "poor man's silk" by natural dyeing enhances its aesthetic qualities, making it more marketable for use in creating a variety of eye-catching items. According to S.

Bhuyan & N. Gogoi (2013) [6], datura dye can yield a variety of delicate and natural tints when applied to eri silk threads. The copper sulphate-mordanted sample exhibited good fastness against sunshine, sweat, pressing, washing, and crocking. Conversely, the *Datura stramonium* plant possesses a multitude of medical qualities. Pains, boils, pimples, asthma, dandruff, piles, and other conditions are treated with it (Agharkar, 1991) [2]. Therefore, eri garments made from datura-dyed Eri silk strands may provide pain relief for the body. Therefore, using *D. stramonium* to dye Eri silk yarns and fabrics gives them a fresh look and helps produce a wider range of goods. To keep up with the latest trends in the domestic and global markets, Eri silk must be improved in terms of both quality and aesthetic value. In contrast to the natural dying technique, eco-friendly dye has had a significant impact recently as fashion designers have realized the beauty of natural dyes again because of their well-known benefits and environmentally friendly nature. However, only a small percentage of people utilize natural dyes. In the northeastern districts, handloom clusters are widely dispersed and much sought for. Since handlooming is an environmentally favorable method of producing textiles, using natural dyes in conjunction with various natural mordanting agents truly completes the creation of sustainable textiles.

Conclusion

The findings indicated that several natural dyes might be derived from plants that are readily available nearby and used as a substitute for synthetic colors. Vibrant colors are formed by the natural dyes. These are non-toxic and non-allergic in addition to being biodegradable. This indicates that they are far more eco-friendly and suitable for usage around people. Retaining the original color of plants, fruits, or flowers is a simple process. Generally speaking, eri fiber produces a stunning natural off-white hue. Adding natural dye can raise the silk yarn's market value and possibly develop a different sustainable business model.

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