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Effects of tea and annatto dye mixture on physical properties of eri silk fabric

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Abstract
In recent years, natural dyes have gained popularity as a safer alternative to dangerous synthetic colours. Due to the knowledge of potential risks during the creation of synthetic dyes produced through abrasive chemical reactions and the utilisation of petrochemical-based basic ingredients. Such dyes need a lot of energy to produce, and their negative effects on the environment increase pollution. Numerous of these dyes, particularly the azo-based ones, have been discovered to be cancer-causing. Since natural dyes are non-toxic, biodegradable, and secure, the search for eco-friendly dyes is essentially global in scope. In this study, different colours were achieved on Eri silk fabric by combining two different natural dyes namely annatto (*Bixa orellana*) seeds and tea leaves (*Camellia seninsis*) in different ratios. Various mordants, including Aluminium potassium sulphate [Alk$(SO_4)2.\ 16\ H_2O$], copper sulphate ($CuSO_4$), stannous chloride ($SnCl_2$), and ferrous sulphate ($FeSO_4$), as well as mordanting techniques, were used to carry out dyeing in both aqueous and alkali medium. Physical properties like tenacity, elongation, thickness wicking, and stiffness were also evaluated.

Keywords: Annatto seeds, natural dye**,** eco-friendly, eri silk, tea leaves

Introduction
Eco-friendly, environment-safe natural products and dyeing techniques are today's need for textiles. The biggest change to the environment is supposed to be done by the dyeing units. It is known to generate many waste items including water based effluents as well as solid waste and hazardous waste. Therefore the key elements for preventing pollution are adoption of natural dyes. Natural colouring substances are now developing trends for their use all over the world because of health hazards and toxicity problems created by synthetic dyes. Natural dyes have the ability to produce a wide range of tints and shades, with the same dye material.

Silk has a natural affinity for dyes, probably because of its good penetrability. Various types of natural dyes can be applied on silk with different mordants producing a wide range of colours. All these desirable qualities of silk make it suitable for apparel purposes. Silk is used extensively in luxury fabrics, apparel, home furnishings, and accessories [1, 2].

The use of natural colour is tremendously increasing on cotton but on silk it is limited due to the non-availability of standard colour catalogues, precise, and specific ways of application, and standard norms. In this study, an attempt was made to combine two natural dyes namely tea leaves and annatto seed for dyeing eri silk fabric. This will help in obtaining different shades of colour on eri silk fabric. If there had been more significant research on the use of natural dyes, it is probable that they would already be much more widely used than they currently are.

Materials and Method
For conducting the study, the Annatto seeds (*Bixa orellana*) were collected from Chowldhuwa of the Lakhimpur district of Assam. The collected seeds were, cleaned and dried and tea leaves (*Camellia assamica*) were collected from the tea garden of Assam Agricultural University, Jorhat. The tender tea leaves from below the third leaves which were not required for the manufacturing of tea were selected for the study. The collected leaves were cleaned, washed, and dried as the colour obtained from dry leaves are brighter than fresh ones. Eri silk (*Samia ricini*) fabric with plain weave were collected from the local market of Jorhat.

Chemicals used
The chemical used for the study were Hydrogen peroxide, Soda ash/ sodium bicarbonate,

Aluminium potassium sulphate (metallic salt)/ alum, Sodium chloride, and Lactic acid, USP 85% of LR grade.

Mordants used

Four mordants namely Aluminium potassium sulphate (metallic salt)/ alum [Alk $(SO_4)_2.16\ H_2O$], Copper sulphate ($CuSO_4$), Ferrous sulphate ($FeSO_4$) and Stannous cloride ($SnCl_2$) were used for the study. Mordants are the substance capable of binding a dye to textile fabrics [3]. Mordant helps to produce faster shades by forming an insoluble compound of mordant and dyestuffs within the fiber itself [4, 5].

Degumming

Before dyeing degumming was done for removing the sericin and uniform dyeing. For this, the silk fabric was boiled in a washing soda solution (5g/lit) at 60 °C for 30 min. Fabrics were washed properly in running water and dried.

Bleaching

Bleaching improves the whiteness property and also imparts uniform absorbency and a high degree of dyeability. For this, the silk fabric was boiled in 1% H_2O_2 at 50 °C for 30 min. Fabrics were then washed properly in running water and dried.

Optimization of different dyeing conditions

A series of experiments were conducted to optimize the different dyeing conditions namelydye extraction medium, dye extraction time, dye material concentration, the combination of ratio, dyeing time, the concentration of mordants, mordanting time, mordanting methods, etc. for dyeing of Eri silk fabric with tea (*Camellia seninsis*) and annatto (*Bixa orellana*) dye.

In all the experiments, the values of some of the variables like material to liquor ratio for extraction (1:50), material to liquor ratio (1:30) for dyeing, extraction temperature (100 °C), and dyeing temperature (70 °C) for the study were kept constant based on some research findings [6, 7, 8].

Extraction of dye

For the selection of extraction medium, 3 methods were selected i.e., aqueous, alkaline, and acidic. After testing, it was found that an aqueous medium was more suitable based on percent dye extraction. In this method, 1gm dye material was mixed in 100 ml of soft water at 100 °C for 1 hour.

Dyeing of Eri silk fabric

The Eri silk fabrics to be dyed were weighed. The extracted dye liquor was taken as per requirement at material to liquor ratio 1:30. The optical density of the dye liquor was recorded. The Eri silk fabrics were placed in the dye liquor and dyed for 45 minutes in the dye bath with occasional stirring. After completion, the fabrics were removed and the optical density of the liquor was recorded. The fabrics were then soaped, washed, rinsed, and dried in shade. The percentage of dye absorption (%) of the fabric was estimated by using the following formulae:

$$\%\text{ of dye absorption} = \frac{\text{OD of the liquor before dyeing - OD of the liquor after dyeing}}{\text{OD of the liquor before dyeing}} \times 100$$

Optimization of mordanting methods

Optimization of the mordanting method was carried out by adopting the pre, post, and simultaneous mordanting methods. Absorption (%) of dye by the Eri silk fabric was calculated from optical density values for different mordanting methods. The method showing the maximum dye absorption was selected as the optimum method for each mordant.

Pre-mordanting method

The pre-mordanting method was done by mordanting the fabric first and then dyeing. For this method, an aqueous solution was prepared by dissolving the required amount of mordant in water. The fabrics were boiled at 70 ºC in this solution for 30 minutes and then entered into the prepared dye solution for dyeing.

Simultaneous mordanting

In this method, the mordants and dye were applied simultaneously in the same bath. The Eri silk fabrics were placed in the extracted dye bath and dyed for 15 minutes. The required amount of mordant was added to the dye solution by lifting the fabric and mixing properly. The fabrics were then dyed in the solution for 30 minutes.

Post mordanting

In this method, the sample was first dyed with dye solution and then mordanted. A mordanting bath was prepared as per the recipe for mordanting. After dyeing the samples were removed with the help of a glass rod and then entered in the mordanting bath and heated to a temperature of 60-70 °C for 30 minutes. Then the samples were allowed to cool, rinsed, and dried in shade.

Optimization of combination ratio of tea and annatto

The combination ratio was optimized by extracting tea: annatto dye at different ratios *viz.*, 10:90, 20:80, 30:70, 40:60, 50:50, and optical densities of the extracted dye liquor for different ratios were recorded. The dye extraction ratio was optimized based on the maximum optical density value obtained by the dye liquor for different ratios. After testing 70:30 is optimized for the study.

Evaluation of physical propertiesof dyed Eri silk fabric

Prior to testing, all the samples were conditioned to attain moisture equilibrium and tested in the standard atmospheric condition of 65±2 percent relative humidity and temperature 25°±2 °C as per ASTM Standard (1970) [9]. Samples were prepared as per the BIS method (IS: 6359-1971) [10].

The dyed Eri silk fabric was evaluated for its physical properties like count, tenacity (kgf), elongation (%), moisture regain (%), thickness (mm), stiffness (cm), and wicking height (cm).

Results and Discussion

Effect of dyeing on tenacity (kgf) and elongation (%) of dyed Eri silk fabric

The tensile strength and elongation of raw and dyed fabrics were assessed and data were systematically presented in table 1.

Table 1, indicated that among the dyed fabric highest tensile strength was showed by fabric mordanted with ferrous sulphate in the warp (0.164kgf) and weft (0.360kgf) direction while the minimum tensile strength of 0.146 and 0.307 kgf were showed by stannous chloride and without mordanted fabric both in warp and weft direction respectively.
From table 1 it was inferred that among the dyed fabrics, the maximum elongation was noticed in alum (warp-26.91%) and stannous chloride (weft-31.46%) mordanted samples and the least elongation was observed in ferrous sulphate mordanted fabric both in the warp (22.04%) and weft (23.96%) direction. The factors, which have influenced the tensile strength of the fabric, are yarn type, yarn fineness, number of ends and picks per unit length, and different chemical processes during dyeing which has a remarkable effect on the variation in tensile strength of fabrics [11, 12].
On the basis of ANOVA, it was found that there is a highly significant difference between the raw and dyed fabrics in both warp and weft ways of tensile strength and elongation.

Table 1: Effect of dyeing on physical properties of dyed Eri silk fabric

Dyed fabric sample	Tenacity(Kgf)		Elongation (%)	
	Warp	Weft	Warp	Weft
Raw fabric	0.189	0.433	17.41	24.15
Without mordant	0.155	0.390	17.81	24.72
Alum mordanted	0.159	0.295	21.04	29.49
Copper sulphate mordanted	0.148	0.297	22.51	26.59
Ferrous sulphate mordanted	0.147	0.361	20.39	27.47
Stannous chloride mordanted	0.132	0.287	24.56	32.04
SEd(±)	0.014	0.02	1.391	1.789
CD	0.028	0.04	2.783	3.578

Effect of dyeing on thickness and wicking behavior of dyed Eri silk fabric with combination dyes

The thicknesses of dyed fabric are found to increase in comparison to the raw fabric. The raw fabric showed a thickness of 0.39mm which increased to 0.65, 0.69, 0.71, and 0.73mm for stannous chloride, without mordant, alum copper sulphate, and ferrous sulphate mordanted fabric respectively.
From table 2, it was inferred that among the fabrics the highest wicking height after dyeing was observed in copper sulphate (8.68 cm) in the warp direction, and in the weft direction highest wicking behavior (9.3cm) showed by stannous chloride mordanted fabric. On the other hand, the lowest wicking behavior (7.48cm) in warp and (6.3 cm) weft direction was shown by without mordant and copper sulphate mordanted fabric.
It could be inferred that the thickness and wickability are more in the case of dyed fabric than the raw fabric. This might be due to the swelling of fabrics on degumming, bleaching, and various treatments during dyeing.
The statistical analysis relating to the thickness of the fabric depicted the significant difference between the raw and dyed fabrics. From the analysis, it was also revealed that wicking height in both the warp and weft direction of fabrics showed a significant difference at 5% level of significance.

Table 2: Effect of dyeing on thickness and wicking behavior of dyed Eri silk fabric with combination dyes

Fabric	Thickness (mm)	Wicking height (cm)	
		Warp	Weft
Raw fabric	0.39	5.72	5.74
Without mordant	0.69	7.48	8.8
Alum mordanted	0.71	7.84	8.76
Copper sulphate mordanted	0.71	8.68	6.3
Ferrous sulphate mordanted	0.73	7.6	8.34
Stannous chloride mordanted	0.65	8.62	9.3
SEd(±)	0.02	0.237	0.205
CD	0.04	0.475	0.411

Effect of dyeing on moisture regain percent and count of dyed Eri silk fabric with combination dye

The experimental data obtained from the fabric count and moisture regain were listed in table 3.
The data presented in the table illustrated that among the dyed fabric the highest count 55 in warp and 58 in weft was observed in stannous chloride and without mordanted fabric. Followed by the lowest 42 in warp and 52 in weft direction was observed in ferrous sulphate mordanted fabric.
Regarding the moisture regain percentage it increased after dyeing and the highest 8.33 % was shown by without mordanted and ferrous sulphate mordanted fabric and the lowest 5.88 percent showed by stannous chloride mordanted fabric.
The increased and decreased fabric count might be due to the consolidation of yarn during dyeing and swelling and absorption of the dye. And regarding the moisture regain percentage may be due to degumming and various processes of ongoing dyeing.

Table 3: Effect of dyeing on moisture regain percent and count of dyed Eri silk fabric with combination dye

Fabric	Moisture regain (%)	Count	
		Warp	Weft
Raw fabric	5.55	47	54
Without mordant	8.33	44	58
Alum mordanted	7.14	51	54
Copper sulphate mordanted	7.69	45	53
Ferrous sulphate mordanted	8.33	42	52
Stannous chloride mordanted	5.88	55	56

Effect of dyeing on the stiffness of dyed Eri silk fabric with combination dyes

Table 4, reflects the investigated data of raw and dyed fabrics. The minimum stiffness of 2.262 in warp and 2.912 in the weft direction among the dyed fabric wereshown byferrous sulphate and alum mordanted fabric. While the maximum stiffness of 2.508 in warp and 3.398 in the weft direction wasshown by alum and copper sulphate mordanted fabric. From the table, it was seen that the stiffness or bending length of the weft direction was more compared to the warp direction. The decreased bending length might be due to degumming, bleaching, and dyeing of fabric.

However, the statistical analysis revealed that they are highly significant in both warp and weft direction at 5 percent level of significance.

Table 4: Effect of dyeing on the stiffness of dyed Eri silk fabric with combination dyes

Fabric	Stiffness	
	Warp	**Weft**
Raw fabric	4.44	4.49
Without mordant	2.32	3.11
Alum mordanted	2.51	2.91
Copper sulphate mordanted	2.31	3.39
Ferrous sulphate mordanted	2.26	3.27
Stannous chloride mordanted	2.35	3.14
SEd(±)	0.052	0.078
CD	0.105	0.157

Conclusion

The combination of tea and annatto dye improved the colour of Eri silk fabric with different hues. Dyeing with different mordants decreased the tenacity and increased the elongation of the Eri silk fabric. After the application of dye thickness, moisture regain and wicking capacity also showed an increasing trend. The stiffness of the silk fabric has decreased without the mordant but increased while using mordants, and there is not much change in the count of the fabric. Based on the findings, improvements in the methods for dying of Eri silk with natural dyes may win over a large number of consumers.

Reference

1. Needles LH. Textile fibers dyes, finishes and processes. Standard publisher's distributors, Delhi. 2001, 6-67, 188, 201.
2. Vatsala R. Text book of textiles and clothing. Published by Indian Council of Agricultural Research, New Delhi, India, 2003, 92.
3. Hussain on Dyeing of eri silk yarn with coral jasmine flower (*Nystanthus arborthisis*). M.Sc. (H.Sc.) Thesis submitted to Assam Agricultural University, Jorhat, 2002.
4. Bains S, Kaur K, Kang S. Comparative study of colour fastness properties of dyed cotton with Arjun (*Arjuna terminela*) dye using mordant and their combination. Tex. Trends 2006;XLVIX(2):41-43.
5. Nalankilli G. Natural dyes and the challenges. Paper presented in the seminar on new vistas for jute diversified products at SITRA, June 16, Coimbatore. UNDP and Ministry of Textile, India, 1997, pp. 229-230.
6. Bansal A, Rani S, Sharma A, Sood A. Dyeing of silken yarns yarns with beribery dye. Textile Trends, 2006XLVIII(12):39-40.
7. Gogoi N. on Studies on bleaching and dyeing behaviour of eri (*Philosomia ricini*) silk and evaluation of its physio-chemical properties. Ph.D. (H.Sc.) Thesis, Assam Agricultural University, Jorhat, 2004.
8. Gulrajani ML. Introduction to Natural Dyes. Indian Institute of Technology, New Delhi, 1992.
9. ASTM Year Book. American Standard on Textiles Materials. 1970;24:15.
10. BIS Test Method. Conditioning of Textiles Bureau of Indian Standard, New Delhi, 6359-1971.
11. Maliik Z, Tanwari A, Sheikh H. Influence of Plain and Twill (3/1) Weave Designs on the Tensile Strength of PC Blended Fabrics. Research Journal of Engineering and technology. 2011;30(1):25-26.
12. Yadav S, Pruthi N, Singh SSJ, Rose NM. Effect of *Kachnar* Bark dye on physical properties of silk. International Workshop on Natural Dyes, 5th-7th March; c2014. p. 277-280.