"COMPARATIVE STUDIES ON ACID DYEING OF ERI SPUN SILK YARN"

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ABSTRACT: Dyeing of all three types of eri spun silk yarns. *Viz*. Soap and soda, enzymatic and eco eri degummed yarns using soft water at is done using Acid Red dye. The dyed yarn is analysed for the efficiency of coloration, tenacity, break elongation and colour fastness to washing, rubbing, perspiration and light. The tenacity of the yarn produced by using eri silk degummed with HTHP (Novel method) is higher by about 30 percent. The yarn produced by the HTHP (Novel method) in has shown better elongation. Also, the yarn has better absorption of dye and improved fastness properties. The colour strength of dyed yarn with novel method of degummed eri spun silk yarn is marginally more than the other two methods. The Enzymatic degummed eri spun silk yarn has poor performance in taking up dye compared to the other two methods of degumming of Eri Silk. K/S value is proportional to dye concentration in the substrate. The individual grade for colour fastness is between 3/4 to 4 for light, between 2/3 to 4/5 to washing, between 3 to 4/5 for rubbing and 3 to 4/5 for perspiration. In all the cases of dyed yarn produced with Eri silk degummed with Novel method has shown better grading standing rank 1. The Conventional Soap-Soda method stood at relative rank 2 and Yarn produced with Eri silk degummed with Enzyme method is at 3.

Keywords: Eri spun silk yarn, acid dyes, K/S, Tensile Strength, Colour and Wash Fastness

1. INTRODUCTION:

Dyeing is a complex process involving the proper selection of dyes from various classes of dyes and a proper process of dyeing, so that the yarn and the fabric get the desired shade and necessary fastness to washing, light, perspiration, rubbing, etc. The silk fibre has affinity for various classes of dyestuffs. The dyes recommended for dyeing of silk includes acid dyes, acid milling dyes, metal complex dyes, basic dyes, direct dyes and reactive dyes [1-4]. Apart from the above-mentioned classes of dyes, natural dyes can also be applied onto silk. In India, silk dyeing is commonly done in small dye houses by different methods. Large quantities of silk materials are dyed using acid dyes, metal complex dyes and direct dyes. Majority of the dyers in small dye houses employ simple equipment's for dyeing. Process for dyeing should involve proper maintenance of liquor ratio, temperature, pH and liquor / material movement to get quality dye. In addition to this, the selection of dyes should be based on the exhaustion properties of the dye-stuffs in compound shades for achieving uniform dyeing.

Pre fibre process plays a major role in getting desired shade and quality. For cotton, wool it is scouring and bleaching done before dyeing. In silk degumming is an essential and important pre-process. In silk industry Yarn dyeing is largely employed for strategic reasons.

1.1 DYEING OF SILK WITH ACID DYES

Acid dyes can be easily applied on silk and therefore are largely used for dyeing. They are applied generally in the presence of an organic or inorganic acid and hence are called acid dyes. They produce wide range of brilliant shades. However, the fastness properties of individual dyes vary depending on the chemical structure and molecular weight of the dyes. Acid dyes may be generally represented as $R\text{-}SO_3Na$. When an acid dye is dissolved, they produce dye anions ($R\text{-}SO_3^-$) and colorless sodium cations. These dye anions are exhausted on to the silk substrate in the presence of an acid [5-7]. The acid dyes are relatively easy to dissolve, but care is necessary to avoid the possibility of un-dissolved particles getting deposited on the material. Acid dyes are having very good affinity towards protein fibers and they are usually applied under acidic conditions. [7-9].

2 MATERIALS AND METHODS

2.1 Materials

Eri spun silk yarns of Soap and soda, enzymatic and High Temperature High Pressure (Novel method-Without chemicals) degummed spun silk yarns were used for dyeing. For each trails 200 g of eri spun silk yarns were used. The dye used is acid dyes Red NS. In addition, soft water, Glauber salt and acetic acid of LR grade is used as dyeing accessories.

2.2 Methods

Exhaust dyeing of acid dyeing of eri spun silk yarn.

The dyeing of eri spun silk yarns applied in temperature controlled electrical dye bath. The dye recipe is given in the table.1

Table.1 Silk Dyeing Recipe

Sl. No.	Particulars	Value
1	Material to Liquor Ratio	1: 40
2	Glauber Salt, %	10
3	Acid Red NS, %	3
4	Acetic Acid of 40% Conc, %	6
5	pH	4 - 6
6	Temperature, °C	85 – 90
7	Time, Min	45

The Dye and chemicals were taken on weight of material

The required quantity of water, dyes and chemicals were measured exactly as per requirement. The material entered was pre-soaked in cold water to ensure penetration of dye. Soft water (hardness of 50-100 ppm) used for dyeing. The required amount of dye is made into a smooth paste using cold water and sufficient amount of boiling water is added to dissolve it completely. The dye solution is filtered before adding it into the dye bath. The dyeing is initiated at 40°C and the temperature is allowed to rise gradually to 85°C. Boiling is avoided as it affects the strength and luster of eri spun silk yarn. Addition of glauber salt as leveling agents is added to the dye bath. The dyeing carried out in a dye bath containing dye solution, 6% acetic acid of 40 % strength and 10 % of glauber salt for a period of 45 minutes at 85°C to 90°C. Then the dyed materials are taken out and wash in cold water and dried under the shade.

Determination of Colour Evaluation

Qualitative measurement of dye uptake can be made optically by measuring light absorption characteristics of the dye remaining in the dye bath. Quantitative measurement is made in instrumental with the help of Spectrophotometer with optical radiation of wavelength ranging from 400 – 700 nm.

The increase in the dye concentration on dyed textile material results in a decrease in the reflectance, which is most marked at the wavelength usually corresponding r closely to the λ_{max} of the dye in solution. The reflectance is measured against a white reference (Barium Sulphate or Magnesium Oxide) which should be non-linear function with dye concentration. The Kubelka – Munk equation is given by;

$$K / S = \frac{(1 - r)^2}{2r} = f(R)$$

Where r = Reflectance %

K refers to absorption coefficient and S refers to scattering coefficient. Unlike reflectance, K/S is an additive function at any particular wavelength.

CCM systems will have the colour library of different dyes and the procedures to be undertaken for dyeing. The colour that needs to be developed is either fed to the system directly in the form of LCh values or other forms *viz*. XYZ, Lab etc. In the event of unknown material, the values are measured with the help of spectrophotometer and then the values are fed into the programme. The CCM systems then predict the quantity and type of dye to be considered and the economics involved as well as the fastness properties that can be achieved by following the said dyeing procedure.

Determination of colour fastness

Evaluation of Colour Fastness of textiles is developed by AATCC and subsequently adopted by national and international standards. Testing is divided into two parts.

- First part is the exposure or treatment, which may be duplication of treatment that the fabric might be subjected to in actual use or it may be simulated actual use condition in laboratory.
- The other part is the evaluation of colour change. This is carried out by comparing the dyed sample subjected to evaluation and the staining of colour to adjoining white fabric comparing against Standard gray scales.
- The standard test methods used as shown in table.2

Table 2 Standard Test Methods and Instruments Used

Sl. No	Colour Fastness Test	Standard Method	Instrument used
1	Fastness of Textile Material to Artificial Light	IS 2454: 1985	Xenon Lamp
2	Colour Fastness of Textile Material to Washing	IS/ISO 105 C10:2006 A (1)	Launderometer
3	Colour Fastness of Textile Material to Rubbing	IS 766: 1988	Crock Meter
4	Colour Fastness of Textile Material to Perspiration	971: 1983	Perspirometer
5	Yarn Tensile and elongation	ASTM D: 3822	INSTRON

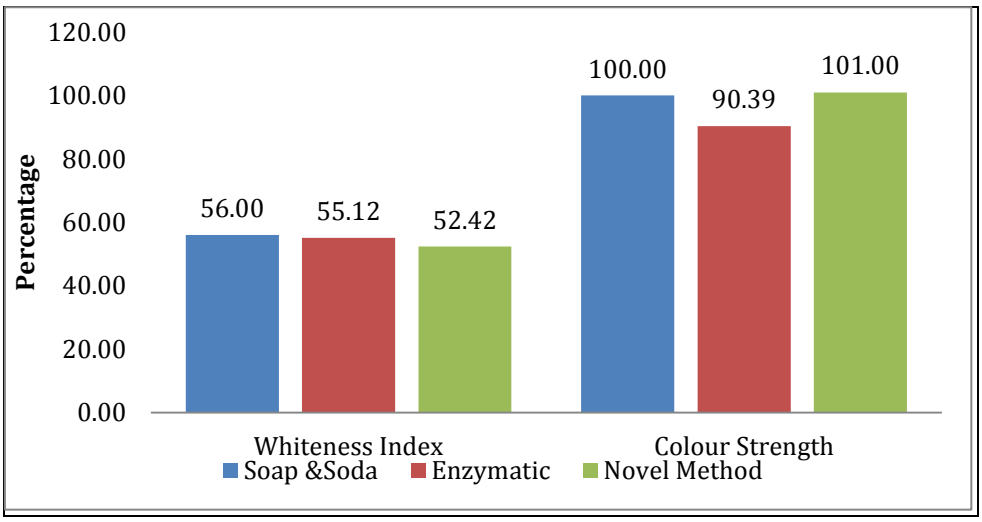
3. RESULTS AND DISCUSSION

Three different degummed eri spun silk yarns were dyed with acid dyes in tub dyeing method as described in experimental and the results obtained are summarized and discussed below.

3.1 Colour Measurement on dyed eri spun silk yarns.

The figure.1 shows the Whiteness Index of degummed Eri silk yarns and Colour Strength of dyed Eri silk yarns produced with three different degummed eri spun silk yarn.

Figure.1 Whiteness Index and Colour Strength of Eri spun yarns



The whiteness index of soap and soda method is whiter than the other two methods which may be due to the action of soap and soda on the fibroin. The colour strength indicates the quantum of dye particles present in the material. The colour strength varies from 0 to 200 % or more. Lower the value means less dye content in the fibre and higher the value means more dye content in the fibre structure. The enzymatic degummed eri spun silk yarn has poor performance in taking up dye compared to the other two methods of degummed Eri spun silk yarns.

Table.3 shows measurement of dye solution before dyeing and after dyeing of Eri spun silk yarns by three different degummed eri spun silk yarns.

Table.3 Colour measurement of dye solution

Status of Dye solution	Condition / Type of material	K/S at 500 nm	L	a	b	C	h	CCM ΔE
Before dyeing	Control	5.0	35.23	67.94	59.93	90.59	41.41	
After dyeing	Soap &Soda	0.2341	84.74	7.08	3.78	8.11	27.75	37.74
	Enzymatic	0.2534	83.98	7.56	3.82	9.26	31.25	31.52
	Novel method	0.2052	86.18	6.8	1.2	6.91	9.96	39.40

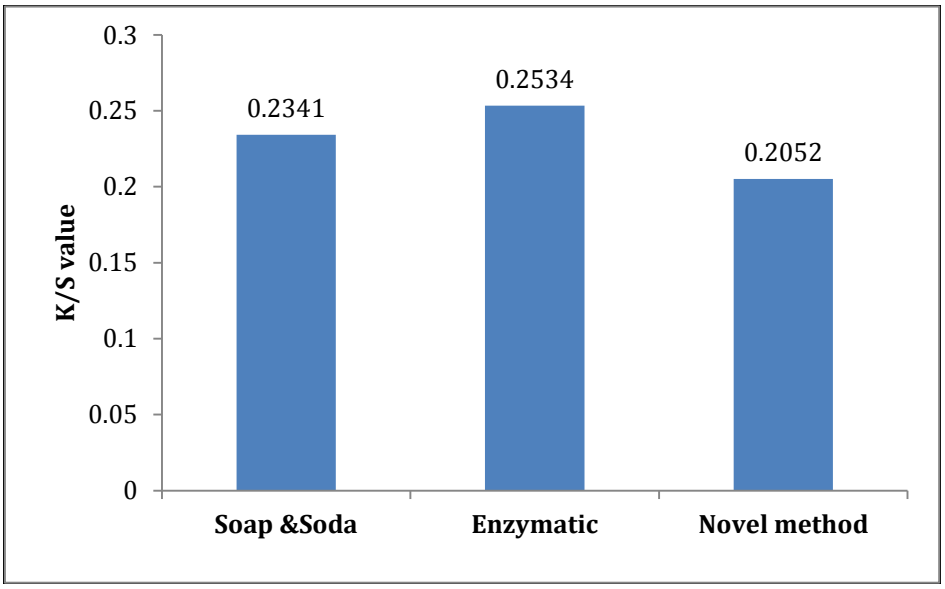
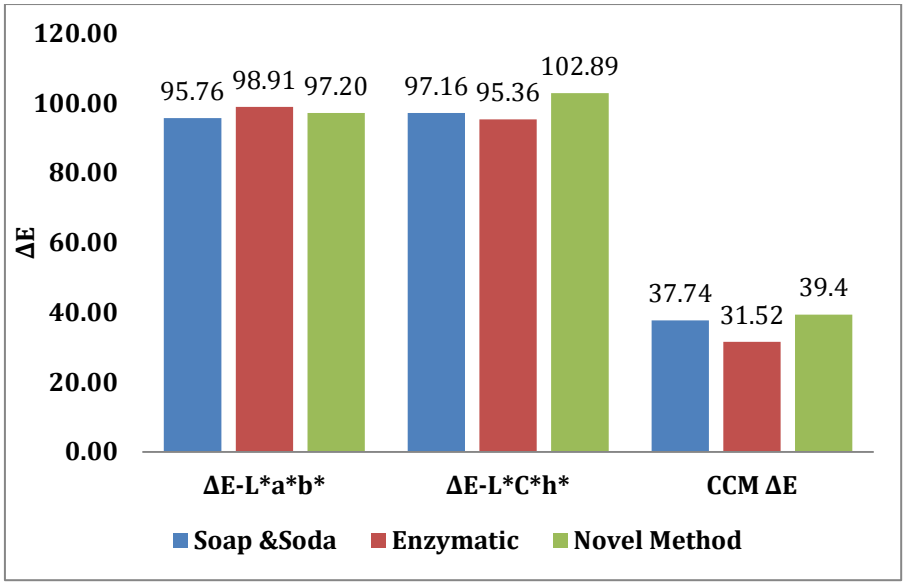


Figure.2 K/S value of Dye Solution

K/S value is proportional to dye concentration in the substrate. The values are of dye solution after dyeing. It can be seen that the dye uptake in eri spun silk using Novel method of degummed yarn is highest compared to soap soda method and least in enzymatic degummed yarn as K/S value of dye solution.

Figure.3 shows the colour differences based on different measures. From the chart it is evident that all three yarns show the same trend with measurement made based on L*a*b and L*C*h. The trend is different for colour difference made by using Computer Colour Matching Instrument. But in all cases yarn produced by Soap-Soda and Novel Method of degummed yarns are closer indicating yarn made from Eri silk degummed with Enzyme is not advisable.

Figure.3 Colour Difference



h - Hue – (angle of the hue in the CIE Lab colour wheel)

K/S value is proportional to dye concentration in the substrate. It is observed that, the K/S values of the dye solutions before treatment and after treatment has drastically changed indicating the exhaustion level. The results of K/S after dyeing is observed, then it is clear that the dye uptake in eri spun silk using Novel method of degumming is highest compared to soap soda method and least in enzymatic degumming method.

L is Lightness from black (0) to whiteness (100). From the table it is again clear that higher values after dyeing compared to control dye solution confirms the above drawn observation.

The parameter a – Colour values from green (-) to red (+) and b - Colour values from blue (-) to yellow (+). The dye being Acid red has to have a>b, and the table value justifies the same. Also the much lower value of 'a' and 'b' of the dye solution after dyeing the yarn degummed with Novel method of degumming indicates the higher dye absorption from the yarn.

C is measure of Chroma (relative saturation), and h-Hue is a measure of colour. Higher is these values higher is the saturation and colour intensity respectively. Thus, it needs to be high in control dye solution. After dyeing it reduces and level of reduction is high in yarn produced with Eri silk degummed with Novel method followed by Soap-Soda and Enzymatic methods.

The Computer Colour Matching difference being larger between dyed yarn of Soap-Soda method and Enzyme method of degumming than Soap-Soda method and Novel method of degumming indicates that Enzyme method is inferior.

Colour Fastness to Light.

Table 4 shows the results of colour fastness to artificial light.

Table. 4 Grading of colour fastness to light

Sl. No.	Type of Method	Results
1	Soap &Soda	3/4
2	Enzymatic	3
3	Novel Method	4

Colour fastness to light of the eri dyed spun yarn using Novel method of degumming shows better result compared to other two varieties of dyed eri spun yarns.

Colour Fastness to Washing.

Table.5 shows the results of colour fastness to washing.

Table. 5 Grading of colour fastness to Washing

Sl. No.	Method	Results		
		CC	SC	SS
1	Soap &Soda	2/3	4/5	3
2	Enzymatic	2/3	4	3
3	Novel method	4/5	4/5	4

The colour fastness to washing of eri dyed spun silk yarn made from Novel method of degummed yarn gives better result than the other two, both with colour change and staining of adjacent samples.

Colour Fastness to Rubbing

Table.6 shows the results of colour fastness to rubbing.

Table. 6 Grading of colour fastness to Rubbing

Sl. No.	Method	Results	
		Dry	Wet
1	Soap &Soda	4/5	3/4
2	Enzymatic	4	3
3	Novel method	4/5	4

The colour fastnesses to rubbing of dyed samples for three different degummed eri spun silk yarns are all same for both wet and dry rubbing.

Colour Fastness to perspiration

Table.7 shows the results of colour fastness to perspiration. The results reveal that, the different methods of degummed eri spun silk yarns are performing similarly with respect to colour fastness to both acidic and alkaline condition of perspiration with reference to colour change as well as staining of adjacent fabrics.

Table.7 Grading of colour fastness to Perspiration

Sl. No.	Method	Acid			Alkali		
		CC	SC	SS	CC	SC	SS
1	Soap &Soda	3	4/5	3	3	4	3
2	Enzymatic	3	4	3	3	4	3
3	Novel method	3/4	4/5	3/4	3/4	4	3

Yarn tenacity and elongation

Table.8 shows the effect of dyeing on yarn tenacity and elongation.

Table.8 Effect of dyeing on Yarn Tenacity and Break elongation

Degumming Method	Undyed Eri Spun Yarns		Dyed Eri Spun Yarns	
	Tenacity, gpd	Elongation, %	Tenacity, gpd	Elongation, %
Soap &Soda	0.98	12.50	0.92	12.57

	(20.74)	(16.63)	(22.17)	(15.29)
Enzyme	0.91 (20.27)	11.70 (15.84)	0.90 (16.56)	12.60 (13.67)
Novel Method	1.33 (15.04)	14.33 (5.91)	1.17 (9.15)	13.66 (5.16)

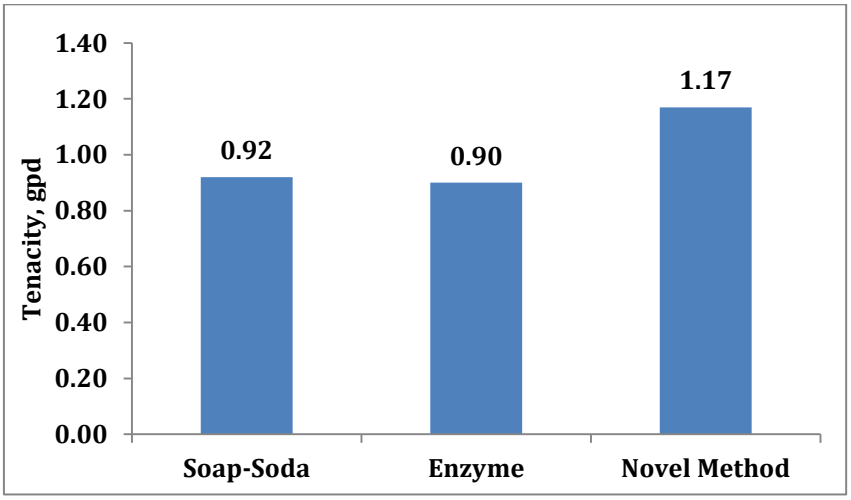
It can be observed that slight reduction in tenacity is observed of dyed yarn. In Eri silk degummed with enzyme reduction is not marked compared to other two methods of dyeing. The Variance test and Mean test shows that there is no significant difference between variance and mean tenacity as well as Break elongation percent. In dyed yarn also tenacity of Eri spun yarn degummed by Novel method is highest.

With reference to break elongation no appreciable effect is seen before and after dyeing of Eri silk degummed with all three different methods. The dyeing has not affected Yarn tenacity and Break elongation percent.

The CV percent is within the practical range. The Novel method is more consistent.

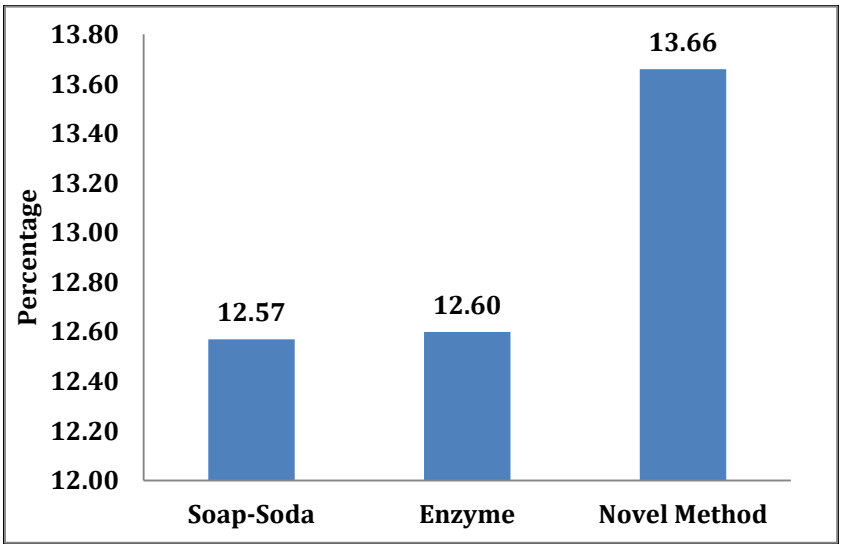
Figure.4 and 5 shows the effect of dyeing on yarn tenacity and elongation.

Figure.4 Tenacity of Dyed Yarns



There is no great difference in Tenacity and Break elongation percent. It is in the same trend as that of undyed yarn. Anyhow both tenacity and Break elongation is better in dyed yarn produce with Eri silk degummed by Novel method.

Figure.5 Break elongation of Dyed Yarns



4. Conclusions

The chapter describes the dyeing of Eri spun silk yarn to know how the degumming process has an effect on dyeing. The yarn was dyed with Acid Red NS with a routine Acid dyeing procedure of spun silk. The exhaustion of dye in the solution is better with Eri spun silk yarns degummed with Novel method. The Colour fastness properties of dyed Eri spun yarns from Novel method is one grade better than the other two degummed eri spun silk yarns. Also, the tenacity and elongation are not affected.

In all the cases Dyed yarn produced with Eri silk degummed with Novel method has shown better grading as it has a relative ranking of. That of Conventional Soap-Soda method stood at relative rank 2 and Yarn produced with Eri silk degummed with Enzyme method is poor.

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