"VALUE ADDITION TO RAW COCOON SHELL OF ERI SILKWORM THROUGH COLOURING WITH BIO-MATERIALS"

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Abstract

With objectives to support Eri silkworm cocoon producers to get additional income from produced cocoon shells and to overcome some of the problems related to Eri yarn in colouring process, this research work had been undertaken to study value addition aspects of raw Eri cocoon shell. Extracts of biomaterials like carrot, turmeric, Silikha, red beet, teak leave, onion and red beet stem were used to colour degummed Eri cocoon shells. These biomaterials gave colour shades differently and also resulted biomaterial specific weight regains parameters. Silikha and turmeric produces highest percentage of colour shade and maximum weight regain, whereas carrot resulted lowest colour shade and weight regain. As spanning of coloured cocoon shells produce coloured Eri yarn, damage like swelling and loose of twisting cannot happen to yarn. Being eco-friendly, people acceptance is more and easily available, colouring with biomaterials is practically viable.

Key points: Biomaterial, mordant, degumming, yarn. Cocoon shell, texture, silk fibre, fabric, fastness.

Introduction

Among tribes of North Eastern Region of India, a sizable population of rural area have been culturing Eri silkworm for their own demand as well as a mean of supporting livelihood. Generally they culture this silkworm to produce cocoons which they use for fabrics production from cocoon shell and, pupa as food or sale for earning money. Most of them immediately sale harvested cocoon as raw cocoon shells and live pupa. A small section of them reel their produced cocoon shell into yarn which in turn either used for weaving to Eri fabrics or sale as yarn in market. In general, the business personal purchase their raw cocoon shell or yarn from farmers and then span into yarn or weave into fabrics. Sometime the businessman colours the yarns to get higher price. The market value of final Eri Silk Fabrics and raw cocoon shell differs vary greatly. Price of Eri fabrics is several times more than raw Eri cocoon shells. Thus, middlemen earn much more than what the producers earn from raw cocoon selling. This is because cocoon producers do not go further activities beyond with raw cocoon shell. After purchasing raw cocoon shells, business personal process the shell, make yarn, dye the yarn and weave into fabrics. At each stage value of the products increase and finally value of fabrics reach manifold times than raw cocoon shell. Generally dyeing yarn increases price of the coloured fabrics by giving extra looks with colourful designs. So, colouring adds extra value to the product. Dyeing is the application of dyes or pigments on textile materials such as fibres, yarns, cocoons, and fabrics with the goal of achieving colour with desired colour fastness. In textile, processing dyeing is an integral part where textile coloration is done to make the fabric lively[(1)].In this process, we can use generally two types of colouring materials, one is natural dye and another one is synthetic dye. Natural dyes are the material which are collected from bio-materials found naturally in the surroundings. Some of widely used natural dye material are *Terminelia chetula* Retz. (Sohtung leave), *Tsuga canadensis*, *Snepsohmylleng*, *Oroxylum indicum*, *Waitlam pyrthat*, *Baccaurea ramiflora*, Lour used in Meghalaya on Eri silk yarn in order to get good fastness properties without damaging the environment [(2, 3)].Eco-friendly dyes have gained much importance in dyeing of textiles, especially silk fabrics. Some other natural dyes which were studied included Jatropha, Lantana, Hamelia, Euphorbia, Kilmora, and Wallnut. The acidic media exhibited maximum percent absorption for Jatropha, Lantana, Hamelia, and Euphorbia dye, while Kilmora and Walnut dye showed good results in alkaline medium (12). Synthetic dyes are produced from cheap petroleum sources, vastly used commercially to impart colour to textiles because they have simple dyeing process with good fastness properties [(1)]. Most of the natural dyes require mordant to create an affinity between the dye and fibres. Among the metal and its oxides, potassium dichromate, stannous chlorides, stannic chlorides, ferrous sulphate, cupric sulphate and aluminium sulphate are the most commonly used as mordent [(4)]. Silk fibre is protein fibre that is produced from silk worms. It is composed of different alpha amino acids orienting to form long chain polymer by condensation and polymerization. Silk fibre consists of 97% protein and the others are wax, carbohydrate, pigments, and inorganic compounds. The proteins in silk fibre are 75% fibroin and 25% sericin by weight, approximately. The sericin makes silk fibre to be strong and lacklustre, therefore, it must be degummed before dyeing [(5)]. The fibroin fibber is the yarn the can be used to prepare fabrics of textiles. To get the yarn, sericin content of cocoon shell has to be removed by warming with lime solution for sufficient time. Silk, a protein fibre, consists of two elements, namely fibroin, a filamentous protein, and sericin, a non-filamentous protein. The process of eliminating sericin, otherwise known as gum, is known as degumming. A number of agents can be used for degumming which vary from simple water to complex enzymes. Also degumming aids are added in the bath to assist the process. Moreover, water quality, pH of the bath and addition of certain salts play a role in determining the efficiency of the process [(6)]. Degumming of silk involves the cleavage of peptide bonds of sericin, either by hydrolytic or enzymatic methods, and the subsequent removal of sericin from the silk fibroin. Hydrolysis of sericin can be carried out under neutral, alkaline or acidic conditions. Boiling-off in alkaline soap solution is the most popular degumming method [(7)]. Concentration of degumming agent in water solution plays a vital rule in mechanical properties of regenerated silk films. Damage with exposure of silk fibrils was caused at 5% Na_2CO_3 concentration but no microstructure destruction was observed at 0.005% Na_2CO_3 concentration. A suitable choice of Na_2CO_3 concentrations should be seriously considered to promote the development of different performances and applications of silk-based materials [(8)]. Different types of degumming processes of raw silk cocoons influence most of the mechanical properties of silk fabrics and the handle of fabrics improves substantially following degumming process[(9)]. The mechanical properties of a regenerated Silk Fibroin film were strongly affected by the degumming method. The soda method and the soap/soda method using sodium carbonate resulted in a higher crystallinity index than the other methods. The

degumming method strongly affects the molecular weight and solution viscosity of the regenerated silk fibroin. The molecular weight and viscosity of the regenerated SF, according to the degumming method, was in the order of urea method > HTHP method ≈ acid method > soap/soda method ≈ soda method [10, 11].

Generally, colouring of Eri silk yarn is largely practice to get coloured Eri fabrics. But this practice has disadvantages as dying process make Eri yarn loosen. Fabrics prepared from loosen yarn is not fine in strength and durability. So, objective of this study is to get tight and coloured Eri yarn by colouring Eri cocoon shells with bio-material dyes.

Materials and Method

Biomaterials for colouring purpose are selected on basis of available literary information and traditional knowledge. Biomaterials selected for this experiment are carrot, onion, red beet, turmeric powder, teak leaf, and red beet steam. All these collected biomaterials wash in clean water and allow to dry. 250 grams of each bio-material is weighted, cut into small pieces and grinded in an electric grinder along with ½ litre distilled water. Extract of each bio-material is prepared separately by sieving and adding extra distilled water to make it 500 ml. Extracts are stored in refrigerator. For each bio-material, 50 gm of Eri cocoon shells are taken for colouring. These cocoon shells are separately degummed in 0.5 % caustic soda solution by boiling for 10 minutes. After boiling in caustic soda solution, cocoon shells are washed repeatedly in running water until caustic soda solution is fully wash out of cocoon shells. 10 grams of potassium aluminium sulphate, commonly known as "Fitkiri" is added in two litters of distilled water in a container and warmed. Solution is stirred until dissolution of potassium aluminium sulphate is complete. Degummed cocoon shells are kept in this warm solution of potassium aluminium sulphate solution for 10 minutes. These cocoon shells are ready for colouring. Here, potassium aluminium sulphate is used as mordant.

Now, extract of bio-material is boiled where prepared cocoon shells are to be deepened and moderately warmed for 10 minutes. After boiling is over, cocoon shells are removed and washed in cool water repeatedly until extra colour remove from cocoon shells. Each of the coloured cocoons are to be prepared for spanning by spreading it mechanically into a loose flat piece and dried in sunlight. This is done by giving mechanical pressure on the cocoon shell keeping it in a flat container with little water. Thus, these loosen, flat, coloured cocoon shells are span into coloured Eri yarn.

Results And Discussion

As per methodology, experimental works were conducted at the laboratory of the station. Biomaterials were collected from natural habitat as well as from market. Eri cocoon shells for experiment were collected from farmer produced in single crop so as to maintain same origin stoke of cocoon shell. This ensured the same response of cocoon shell to colouring biomaterials. Extracts of each biomaterial of 250 grams were prepared in distilled water. Equal quantity of extract of each biomaterial was taken for colouring equal quantity of cocoon. Prior to colouring, cocoon shells of 5 grams lots were loosely tighten separately in mosquito plastic net which in turn boiled for 10 minutes in 0.5 % water solution of NaOH to remove sericin content of cocoon shells. This loosens the treated cocoon shell and make fibroin filament free. After degumming, cocoon shells were treated with mordent. Potassium aluminium sulphate was used as mordent in this experiment. Then, equal quantity of processed cocoon shells of 5 grams were treated separately with colour extracts. According to biomaterial extracts, treated cocoon shells got differently coloured as shown in photographs of Table No.01. Cocoon shells coloured with 'Teak Leave' extract resulted violet colour, turmeric extract produced yellow colour, red beet ash colour, carrot cream colour, onion olive green, silikha khaki colour and red beet stem ash colour. Except onion extract, all other biomaterial extract yielded same coloured cocoon shells with their treated extract. Onion extract colour is light pink. But while coloured as per this methodology, resulted into light olive green coloured cocoon shells.

Table -1: Experimented data of colouring raw Eri silk cocoon with different biomaterials.

Sl. No.	Bio-material used	Extract of bio-material	Raw cocoon shell (Control)	Coloured process cocoon shell	Percentage of colour absorption	Weight loss		Weight gain over degumming (gm)	Final weight loss (gm)
						Initial weight (gm)	Weight after colouring (gm)		
1.					70 %	05	04.945	0.07	0.055
2.					90 %	05	04.965	0.09	0.035
3.					70 %	05	04.945	0.07	0.055
4.					20 %	05	04.895	0.02	0.105

5.					50 %	05	04.925	0.05	0.075
6.					90 %	05	04.965	0.09	0.035
7.					30 %	05	04.905	0.03	0.095
8.					0%	05	4.875		0.125

During degumming process, all lots of cocoon shell boiled in NaOH solution lost their weight that has been found 0.125 grams from original 5 grams. This is the weight loss of control as shown in table-1. This lost weight is the weight of sericin content present in cocoon. After degumming process cocoons were treated with mordent and then with colour extract, which resulted weight gain by cocoon shell lots treated with different biomaterial extracts. But each lot showed different weight gain according to respective biomaterial extract. Maximum weight gain over degumming has been found in cocoon shell lots treated with extract of Turmeric and Silikha i. e. 0.09 grams. On the other hand minimum weight gain has been observed in cocoon shell lot treated with extract of Carrot. Table -1 shows weight gain by cocoon shell treated in extract of different biomaterials. This table also shows variation in percentage of fastening properties of Biomaterials taken for colouring agents. Highest fastening percentage has been shown by Turmeric and Silikha i.e. 90% whereas Carrot has lowest fastening percentage i. e. 20%.

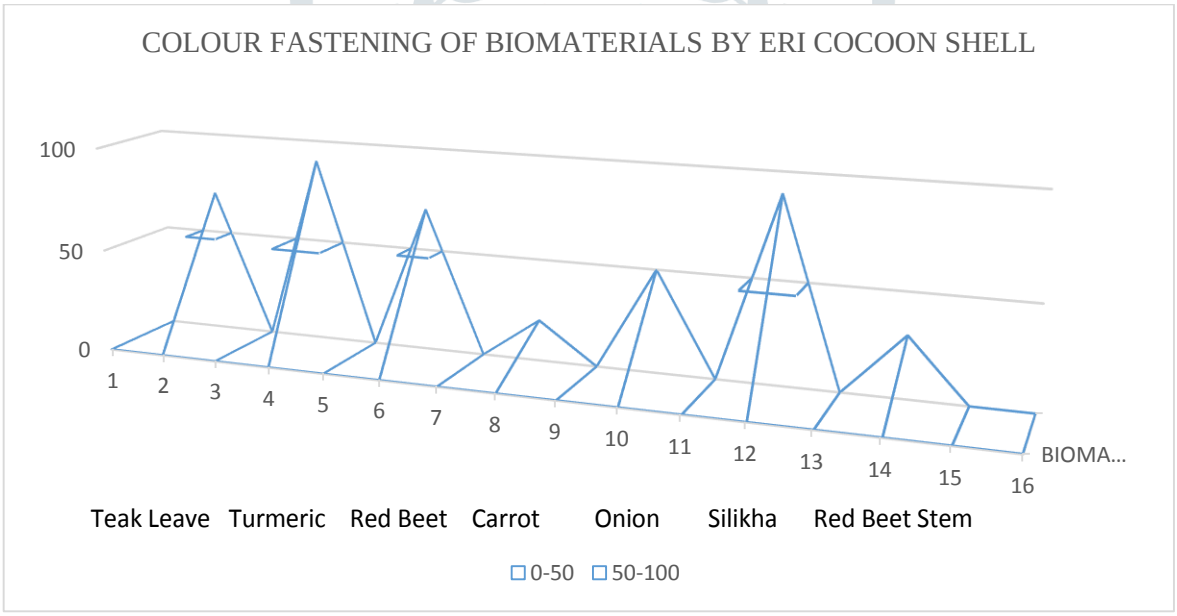

Figure- 1: Graphical representation of colour fastening of different biomaterials by Eri cocoon shell.

Generally in Eri silk fabrics production, yarns are produced directly from raw cocoon shells that give natural white-creamy colour yarn. To produce different coloured fabrics, these natural yarns are treated with different colouring materials and mordents through a process of boiling or warming the yarn. Prior to colouration, mordanting is done at 80^0 C temperatures for 30 minutes and then left for another 30 minutes in mordent solution. Mordanted yarns are coloured in colour solution warming at 80 – 85^0 C temperature for one hour[(4)]. These processes affect the force-displacement characteristic of yarn fibres. X-ray diffraction result shows decreased crystallinity of Eri yarn fibres [(13)]. Various dyeing conditions were optimized with different mordents for dyeing Eri silk with annatto and a little decrease was observed in breaking strength and other physical properties of dyed Eri silk [(14)]. Thus, dying process not only brought changes in Eri silk fibres but also loosening and swelling of Eri yarn. Eri yarn coloured through simple process generally produces fabrics of low quality texture. Instead of dying yarn, dying cocoon shell resulted coloured yarn similar to non-dying yarn in quality. Fabrics with this coloured yarn gives texture same to fabric texture of non-coloured fabrics. This is found to be the result that loosening and swelling of yarn cannot happen in case of cocoon shell dying technique as yarns are not subjected to mordanting and colouration processes.

Biomaterials are easily available in surrounding environment of nature and eco-friendly that have no effects on human skin besides being non-photo reactive. The revival of the use of natural dyes world-wide is primarily due to the increasing environmental consciousness to-day. Colouring of Eri silk with natural dye enhance the fabric as well as its aesthetic values [(14)].In early days, silk was dyed with vegetables dyes which were extracted from roots, stems, stalks, foliage, barks and seeds of different plants[(15)]. A result of this study reveals that different biomaterials give not only different colour look, but also results variations in colour shades under same conditions and procedure of colouring. This can be assumed because of concentrations and types of colour chemicals present are different in different

biomaterials. Absorption and fastening response by fibre of Eri silk are different to colour chemicals present in bio-materials. Absorption is further depend upon the role of water, action of electrolyte, effect of temperature and pH value[16].Figure-1 clearly shows that turmeric

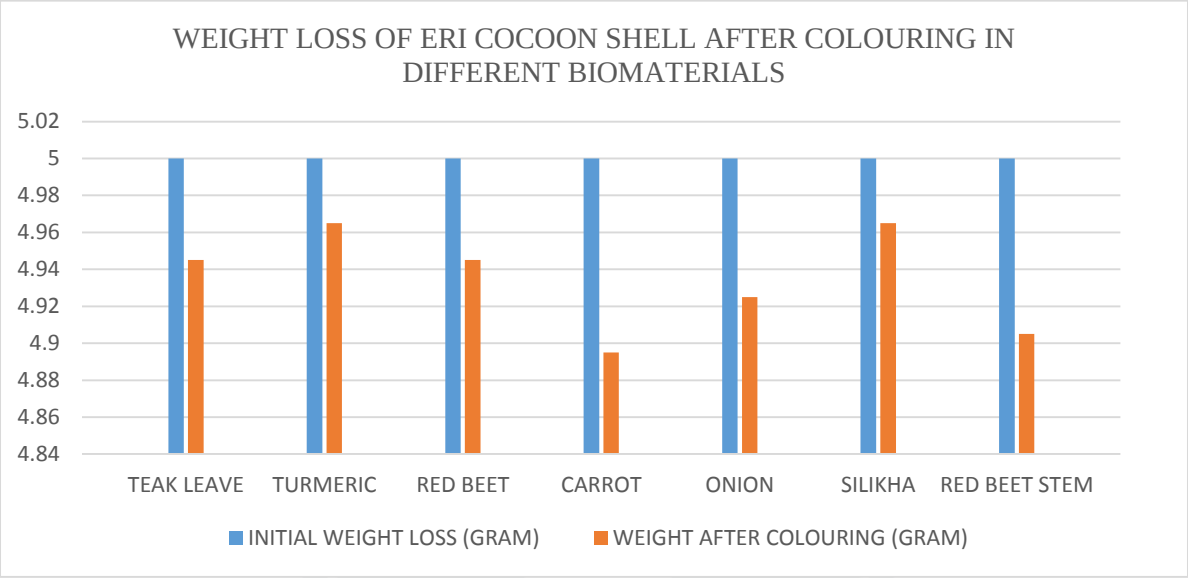

Figure-2: Final weight loss of Eri cocoon shell after degumming and colouring process.

and Silikha have the highest colour absorption and fastening properties giving the darkest colour shade to Eri cocoon shell. Colouring with onion extract gives very light colour shade. Colour shadings of treated Eri cocoon shells are of in the order Carrot < Red Beet Stem < Onion < Teak Leave = Red Beet <Silikha = Turmeric.

Another important economic characteristic changed during dyeing process is loss of weight. During degumming of cocoon shells, weight of cocoon shell lost and through dyeing with colouring biomaterials regains its lost weight to certain extent that has been shown in the Table-1 and Figure-2. During degumming with soda or sodium hydroxide solution, sericin content of cocoons remove that resulted more or less uniform weight loss that accounted 25 gram per kilogram of degummed cocoon shells. Degumming loss of about 10% was found without any significant deterioration of single fibre tensile characteristics [17]. The silk cocoon sericin removal percentage by autoclave degumming is found to be maximum (23.67%) as compared to conventional alkaline degumming (22.28%) [18]. But regain of degummed cocoon shell weight loss is fully depend upon type of colouring biomaterial as shown in Figure-2. This is due to differential penetration and absorption properties of colouring biomaterial into eri silk fibres. Figure-1 and Fugure-2 also reveal a correlation between percentage of colour shading and weight regain by degummed cocoon shells. This correlation is directly proportional to each other i.e. increase or decrease on percentage of colour shading will result in increase or decrease in weight regaining. Thus, minimum weight loss is found in coloured cocoon shells with Turmeric and Silikha, whereas maximum weight loss is recorded in coloured cocoon shells with Carrot.

Conclusion

Eri cocoon shell can excellently be coloured with naturally available biomaterials. These coloured cocoons can be span into coloured yarn like normal non coloured Eri yarn without compromising qualities. Fabrics workouts from this coloured yarn are absolute normal like non-coloured traditional Eri fabrics with same texture quality. Farmers producing Eri cocoon shell generally sell their raw cocoon at low prise in comparison to prise of end fabric products. If farmers adopt this cocoon shell colouring technology, will get 30–40% additional prise of their cocoon shells. Difficulty to maintain yarn quality during colouring process can also be solved by this practice of colouring cocoon shells before spanning. Regain of weight loss during degumming process vary with different colouring biomaterials, colouring with biomaterial that results maximum weight regain is commercially beneficial.

Under this project, trainings at farmer's doorstep are being conducted to adopt this technology at their end before selling their hard earn cocoon shell to get higher selling prise. Action photographs in these aspects are given as Photo Sheet –1.

		
PREPARATION OF COCOONS FOR COLOURING		COCOONS TREATED IN COLOUR EXTRACTS

		
SPREADING OF COLOURED COCOONS		SUN DRYING OF COLOURED COCOONS

Photo Sheet- 1: Action photographs of Value Addition Training on colouring Eri cocoon shells as outcome of research works of the paper.

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