International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(4): 1451-1455

Received: 01-05-2019
Accepted: 03-06-2019

Gogoi Nabaneeta
Professor & Principal Scientist, College of Community Science Assam Agricultural University Jorhat, Assam, India

Sangma S Trasilchi
M.Sc (Home Science), College of Community Science, Assam Agricultural University, Jorhat, Assam, India

Bhuyan Smita
Assistant Professor College of Community Science, Assam Agricultural University, Jorhat, Assam, India

Correspondence
Bhuyan Smita
Assistant Professor College of Community Science, Assam Agricultural University, Jorhat, Assam, India

Block printing on cotton and silk fabrics with annatto (*Bixa orella*) dye and evaluation of its properties

Gogoi Nabaneeta, Sangma S Trasilchi and Bhuyan Smita

Abstract
This paper concern with the evaluation of physical properties of mulberry silk and cotton after printing with ecofriendly natural dyes. Annatto seed use as a new dye source for block print on cotton fabric and mulberry silk with alum and ferrous sulphate as mordant. The annatto seeds were collected and extracted by using alkaline medium. Different printing variables such as dye material concentration; dye extraction ph, dye paste and thicker ratio, viscosity of the dye liquor, fixer concentration, mordant concentration were optimized for making the printing paste. Evaluation of colourfastness and physical properties of the cotton and Mulberry silk block printed fabric was done. The result reveals that annatto can be successfully used for printing of mulberry silk and cotton fabric and has good colorfastness properties and also enhance physical properties of fabrics which can replace synthethic dyes.

Keywords: Eco friendly dye, block print, colour fastness properties, physical properties, synthetic dye

Introduction
Dyes can be defined as substances that when applied to a substrate provides colour by a process that alters crystal structure of the colour substances (Bafna, 2011) [8]. Natural dyes are colours derived from minerals, animals and plants source. Dyeing and printing of fabrics with natural dyes are ancient craft used by mankind from time immemorial. In earlier day silk was dyed with vegetable dyes which were extracted from roots, stems, stalks, barks and seeds of different plants. In India about 500 varieties of plants are available that can yield natural dyes (Mahela *et al*. 2006) [15]. Natural dyes can produce acceptable range of beautiful shades of colours that are mentioned in (Brains *et al.* 2005) [16]. The use of natural dyes in textile printing is a technique which can be used without damaging the fabric. Till 18th century India was the largest exporter of textiles, obviously hand woven and processing with natural dyes in the world. (Paul, 2011) [2]. In today's world there is a growing trend in favour of natural colourants as natural dyed fabric have the potentiality to sold at a higher price and are harmless to wearer (Bharadwaj. N 2017) [11]. Weakness of natural dyes as cost effective, inadequate degree of fixing colour and low colourfastness properties had currently decrease the use by only about 1% of textile dyers (Gulrajani, 2001, Choudhury AK.2018) [9, 13]. Use of mordants in textile dyeing enhances the colour quality of the fabric due to the increased efficiency in absorption, colour strength and quality (Geelani *et al*. 2016) [12]. Textile printing is also localized dyeing, and block printing is the oldest type of printing method being practiced from earlier. It is easier to print and mix colour with natural dyes as natural colour complement each other and are never or rarely clash. The objective of the research are to identifying the source and types of natural dyes, understanding the application of natural dyes and identifying the possible extraction and study of colorfastness and physical properties of natural dyes on silk and cotton by using block printing as application method.

Methodology
In the study, the mulberry silk fabric weighted 43g/inch, thickness 43 mm, tearing strength 76.8 g and fabric count of 34 warp (thread/inch and weft 21 thread/inch) and cotton fabric with pale yellow colour is selected for the study. Prior to the printing process the fabrics were degummed to remove the gum that served as protective layer and can give an patchy effect on dyeing if it left on fabric (Bhuyan S and Gogoi N, 2006). For printing annatto (*Bixia orellana*) has been selected as dye source.

At first the annatto seeds were boiled in aqueous solution for 15 minutes at 60 C temperatures, and then dried in sunlight to dry the seeds for converting them to powdered form.

Optimization of different values

The dye particle size were evaluated using a sieve containing 9 different sizes of about 1000um-45um and allow separation in a sieve shaker machine for 30 minutes.

$$\text{Percentile of particle (\%)} = \frac{\text{Weight of separated particle of particle size}}{\text{Total wt of sample}} \times 100$$

$$\text{Percentile of particle (\%)} = \frac{\text{Weight of separated particle of particle size}}{\text{Total wt of sample}} \times 100$$

Annatto dye was extracted in alkaline medium by adding sodium carbonate to the extracted bath by following the procedure adopted by Bhuyan and Gogoi, 2016 [6].

Different ph values, thickner ratio, dye paste ratio. Viscosity of annatto, fixer concentration, were taken as per optimized (Sangma and Gogoi, 2007)

For application of printing paste on eri silk fabric, the dye liquor was first added with the thickner and stirred for five minutes. Than the fixer was added in the dye paste and again stirred for five minutes and the required amount of alum and ferrous sulphate of mordant concentration was added separately in the dye paste and stirred vigorously for 40 minutes for uniform printing paste. Mulberry silk and cotton fabric was ironed and fixed on the printing table with pins. Block was put on in printing paste which is poured on pads and was made fix on the fabric by giving prominent press and dried in air. Printing sample were steamed for a period of 1 hour at a boiling temperature and than dried in shade in an airy condition.

Testing of colour fastness test

Prior to testing the speciments were conditioned to moisture equilibrium and tested in standard atmospheric condition of 65+2 percent relative humidity as per IS method (1971)

And preparation test was done as per IS method (1972).

Colourfastness properties like colourfastness to washing, was tested by using sasmira laundro meter and rated according to grey scale range. The washfastness rating was also rated by using grey scale rating from1-6. Colourfastness to pressing (dry and wet) was done by subjecting to hot iron in both dry and wet condition. Both the colour change and colour stain were observed. Colourfastness to sunlight was seen by exposing the fabric to the direct effect of sunlight simultaneously for different days for a time period of 9 am to 5 pm. Colourfastness to perspiration was assessed by using ASTM (1968) [3] methods using hot air oven.

Testing of physical properties

Physical properties like Fabric weight is determined by using electronic balance (ASTM 1968) [3]. Tearing test were performed according to IS (7702-1975) using elementary tearing tester. Faric count was determined by using peak glass and thickness is determined by using thickness tester as per ASTM 1968 method.

Findings and discussion

The present investigation was carried out to study "Block printing on cotton and mulberry silk fabric with annatto dye". It was found that the optical density of extracted dye liquor was found maximum (0.292) in 15ml of concentration, pH 8 was selected as optimum extraction pH value, the dye liquor and thickener ratio at 1:2 was found very good in all the respects like sharpness of design, clearity of design and as well as washing fastness. 1.5 per cent concentration fixer was selected as optimum concentrations. The findings of the study from the Table 1 can be clearly observed that washing fastness of alum mordanted mulberry printed sample were found good for colour change and very good for colour staining in 18% concentration. On the other hand in concentration of ferrous sulphate, mulberry fabric showed 2-3 grades in 2.5% both in colour change and colour stain. Hence, 18% alum mordant concentration and 2.5% ferrous sulphate mordand concentration were selected as optimum mordant concentration for mulberry fabric. It was observed that washing fastness of alum mordanted cotton printed sample were found good for colour change and very good for colour staining in 18% concentration. On the other hand in concentration of ferrous sulphate, cotton fabric showed 2-3 grades in 2.5% both in colour change and colour stain. Hence, 18% alum mordant concentration and 2.5% ferrous sulphate mordanted concentration were selected as optimum mordant concentration for cotton fabric.

Findings of the colour fastness test

It was revealed from the table 2 that the majority of the respondent rated sample UT (untreated) of Ca, Ma under negligible change in colour by 75 per cent and 85 per cent respectively and rated as slight change in colour by 20 per cent and 15 per cent respectively which is the maximum rated among the other three ratings i.e. noticeable change, considerable change and much change. In case of Ca and Ma of AT1 (after treatment with alum) 79 per cent and 80 per cent of respondent expressed their preferences under negligible change in colour followed by 11 per cent and 12 per cent as slight change in colour, Regarding sample AT2 (after treatment with ferrous sulphate) of sample Cc and Ma 84 per cent and 95 per cent of the respondents rated the sample as neligible change in colour after washing followed by 13 per cent and 5 per cent as slight change in colour. To exhibit better fastness to washing all the mordanted samples designs showed better fastness to washing than unmordanted sample.

It was noted from the Table 3 that the sample Ca and Ma UT was rated as slight change in colour by 81 per cent and 88 per cent respectively and by 84 per cent,and 88 per cent of the respondents expressed their preferences as negligible change in colour in case of Cb and Mb of AT1 followed by 12 as slight change in colour. In case of ample AT2 of CC 89 per cent of panel noted as negligible change in colour and 10 per cent as slight change in colour and 1 per cent as noticeable change in colour. And for the sample Mc and 94 per cent respondents rated the sample as negligible change followed by 3 percent as slight change in colour on exposure to sunlight.

In dry crocking, it was revealed from the Table 4 that in sample UT of Ca, Ma 87, 97 per cent of the respondents rated the sample as negligible stain while 94 per cent, 89 per cent of the respondents rated as negligible stain in case of Cb, Mb of AT1. Regarding the sample AT2 of Cc and Ec gives better result of colour fast to crocking i.e. 100 per cent of respondent

reported the sample as negligible stain or no stain respectively, while of Mc 98 per cent of the respondent expressed their view as negligible stain and the rest 2 per cent as slight stain.

In wet condition, it was cleared from the table 5e that majority of the respondents for all the three printed samples of UT, AT1 and AT2 rated under slight change in colour by 80, 83 per cent for Ca, Ma respectively, 91, 87 for Cb, Mb respectively and by 82 and 78 for Cc and Mc respectively.

The above result indicated that design with mordanted sample showed better fastness to crocking in both dry and wet condition in the entire printed sample. A wet fabric crock more than dry fabric because of the moisture assist in removing dye (Lyle, 1976) [4] In grey scale evaluation better results were indicated regarding all the treated samples for both design, where the sample of designs of AT2 showed better fastness to colour change and colour staining than UT and AT2.

From the evaluation it was concluded that preference of visual inspection and Grey Scale result were almost for all the samples.

From the Table 7 it was evident that all the samples had increased in warp and weft direction per inch compared with the original (O). The fabric count in warp direction was greater than that of weft direction. In case of UT, increased count was observed by 4.16, 4.83 per cent in warp direction and 14.81, 6.97 per cent in weft direction. The count had increased by 6.00, 7.69 and 3.22, 13.04 per cent in warp and weft direction respectively. It was observed that the fabric count of AT2 sample increased in both directions. The fabric count increase more in weft direction, i.e., 12.00 per cent and 7.89 in warp direction.

From the observation it was clear that the fabric had more or less effect on count after printing. This indicated that all the fabric shrunk and the rate of shrinkage was not equal for all samples. Shrinkage depends on the type of fabric construction (Lyle, 1976) [4] Gogoi (1998) stated that after dyeing or printing the fabric count had increased in both directions.

From the Table 8 it was seen that the weight of treated and untreated fabric, the weight if all printed samples increased in weight/unit area. The increased weight of untreated sample (UT) was found 3.33, 2.12 aper cent respectively. Now, the increased weight of all treated samples i.e. AT1 and AT2 were 3.17, 2.0, and 3.17, 2.08 per cent respectively.

The increased in weight was due to various mordants or due to adsorption or dyes in the fabric. There might be increased in number of size of interstices (air holes) which may lead to change in weight per unit area as indicated in table.

Table 1: Optimization of mordant concentration for mulberry and cotton fabric

Sl. No.	Mordant	Mordant concentration (%)	Washing fastness grade Cotton fabric		Washing fastness grade Mulberry silk	
			CC	CS	CC	CS
1.	Without mordant	-	2	3	2	3
2.	Alum	2	3	2-3	3	2-3
		6	3	3	3	3
		10	3	2-3	3	2-3
		14	2-3	3	2-3	3
		18	2-3	2-3	2-3	2-3
		22				
3.	Ferrous Sulphate	0.5	2	2-3	2	2-3
		1.0	2-3	2	2-3	2
		1.5	2	2-3	2	2-3
		2.0	2	2-3	2	2-3
		2.5	2-3	2-3	2-3	2-3
		3	2-3	3	2-3	3

Note: CC: Colour changes, CS: Colour stain

Table 2: Rating effect of printed samples on washing fastness (in percentage)

Sample	UT		AT1		AT2	
Preference	Ca	Ma	Cb	Mb	Cc	Mc
Negligible change	85	65	75	80	84	95
Slight change	10	25	15	12	13	5
Noticeable change	5	10	5	6	3	-
Considerable change	-	-	5	2	-	-
Much change	-	-	-	-	-	-

Table 3: Rating effect of printed samples on colour fastness to sunlight (in percentage)

Sample	UT		AT1		AT2	
Preference	Ca	Ma	Cb	Mb	Cc	Mc
Negligible change	3	4	84	88	89	94
Slight change	81	88	12	10	10	3
Noticeable change	12	8	4	2	1	3
Considerable change	3	-	-	-	-	-
Much change	1	-	-	-	-	-

Table 4: Rating effect of printed samples on colour fastness to crocking (dry and wet) (in percentage)

Sample	Dry crocking						Wet crocking					
	UT		AT1		AT2		UT		AT1		AT2	
Preference	Ca	Ma	Cb	Mb	Cc	Mc	Ca	Ma	Cb	Mb	Cc	Mc
Negligible change	87	97	94	89	100	98	2	2	4	-	-	-
Slight change	8	3	4	7	-	2	80	83	91	87	82	78
Noticeable change	3	-	4	2	-	-	14	10	5	12	14	22
Considerable change	2	-	-	2	-	-	4	5	-	1	4	-
Much change	-	-	-	-	-	-	-	-	-	-	-	-

Table 5: Rating effect of printed samples on colour fastness to pressing (dry and wet) (in percentage)

Sample	UT				AT1				AT2			
Preference	Cad	Caw	Mad	Maw	Cbd	Cbw	Mbd	Mbw	Ccd	Ccw	Mcd	Mcw
Negligible change	99	-	98	4	100	84	89	88	-	-	-	-
Slight change	1	-	2	88	-	12	7	10	-	-	-	-
Noticeable change	-	-	-	8	-	4	2	2	-	-	-	-
Considerable change	-	-	-	-	-	-	2	-	-	-	-	-
Much change	-	-	-	-	-	-	-	-	-	-	-	-

Table 6: Colour fastness grades for printed samples

Colour fastness												
Sample	Design	Washing fastness		Light fastness	Crocking fastness				Pressing fastness			
					Dry		Wet		Dry		Wet	
		CC	CS	CC	CC	CS	CC	CS	CC	CS	CC	CS
UT	Ca	2	3	2	3	1-2	1-2	2-3	2-3	2-3	2-3	2-3
	Ma	2	3	2	3	1-2	1-2	2-3	2-3	2-3	2-3	2-3
AT1	Cb	2-3	3	2-3	2-3	2	2	3	3	3	3	3
	Mb	2-3	3	2-3	2-3	2	2	3	3	3	3	3
AT2	Ca	2-3	3	2-3	2-3	2	2	3	3	3	3	3
	Ma	2-3	3	2-3	2-3	2-3	2-3	2-3	3	3	3	3

CC: Colour changes, CS: Colour stain

Table 7: Effect of printed samples on count (Thread/inch)

Direction of the fabric	O		UT		AT1		AT2	
	C	M	Ca	Ma	Cb	Mb	Cc	Mc
WARP	48	62	50	65	53	70	53	70
% change in warp			+4.16	+4.83	+6.00	+7.69	+6.00	+7.69
WEFT	27	43	31	46	32	52	32	52
% change in weft			+14.81	+6.97	+3.22	+13.04	+3.22	+13.0

Table 8: Effect of printed samples on fabric weight (g/m^2)

Aspect	O		UT		AT1		AT2	
	C	M	Ca	Ma	Cb	Mb	Cc	Mc
WARP	0.60	0.47	0.63	0.48	0.65	0.49	0.65	0.49
% change in warp			+3.33	+2.12	+3.17	+2.0	+3.17	+2.08

Note: '+'ve sign indicates increase in fabric count

Table 9: Effect of printed samples on fabric Thickness (mm)

Aspect	O		UT		AT1		AT2	
	C	M	Ca	Ma	Cb	Mb	Cc	Mc
WARP	21	10	22	12	23.5	15	23.5	15.5
% change in warp			+4.7	+20.0	+6.81	+25.0	+6.81	+29.1

Note: '+'ve sign indicates increase in fabric count

Summary and conclusion

With an increase of awareness towards natural dyes due to environmental pollution and health hazards associated with synthetic dyes natural dyes had been selected for block printing (Sathianarayan. M.P, Narendra. B, 2012) [7]. For successful commercial use of natural dyes the appropriate and standardized dyeing technique should be adopted. Less expensive production of natural dyes, affordable industrial method and less use of water can sustain natural dyes for future. The plant colorant annatto was investigated to determine its potential use as a natural dye for conventional and novel textile applications. Alum was selected as a mordant. Different techniques of mordanting and a broad set of variations in the dyeing recipes were applied to achieve optimization and an improvement in colour fastness properties. It was observed from the study that colourfastness properties of mordanted samples showed more colourfastness than unmordanted samples.

It could be concluded that annatto (Bixa orellana) dye can be successfully used for block printing on mulberry silk and cotton fabric with different mordants. Physical properties like Fabric weigh, count and fabric thickness of printed samples

was increased due to the increases in fabric count. All the printed samples had been recorded to have an increases in tearing strength due to the increased in the size of dye molecule after using mordant.

Reference

1. Paul S, Grover E, Fathema N, Verma K. Natural dyes in product development, Textile Asia. 2008; XLVIX(7):34-35
2. Paul BB. Application of Natural dyes on textiles, the traditional way in Rajasthan. Colourage. 2011; LVIII(6):70-77
3. ASTM. Standard test methods, American Society of testing materials, Philadelphia, 1968, 434-450p.
4. Lyle DS. Modern textile. John Wiley and soons Pvt.ltd. new York, 1976, 120p.
5. Gogoi N. Studies on bleaching and dyeing behavior of eri (*Philosomia ricini*) silk and evaluation of its physio-chemical properties, Ph.D. (H.Sc) Thesis, Assam Agricultural University, Jorhat, 2014.
6. Bhuyan S. Value addition of Eri silk with *Datura* Stramonium (*datura*) – A natural Colourant, Ph. D (H.Sc) Thesis Assam Agricultural University, Jorhat, 2016.
7. Sathianarayan MP, Narendra B. Eco friendly natural dyes: A Comparitive study with direct dyes Research Journal of Textile and Apparel. 2012; 16(2):25-33.
8. Bafna A, Devi SS, Chakrbati T. Azo dyes, present and future, Environmental reviews 2011; 19:350-370
9. Gulrajani ML. Present status of natural des Indian journal of fiber and Textile Research. 2001; 261(2):191-201.
10. Tripathi G, Yadav MK, Padhyay P, Misra S. Natural dyes with future aspects in dyeing of textiles: A research article, International Journal of Pharma Tech research z. 2015; 8(1):96-100
11. Bharadwaj N, Dadsena M. Extraction and evaluation of dyeing quality of natural Cucurmina, Journal of Innovations in Applied Pharmaceutical Science e-ISSN 2455-5177, 2017.
12. Geelani SM, ARA S, Mir AN, Bhat JA, Mishra PK. Dyeing and fastness properties of *Quercus robur* with natural mordants on natural fiber textile and clothing sustainability, 2016b, 2-8. DOI 10.1186/s40689-016-0019-0.
13. Choudhary AK. Eco friendly dyes and dyeing Advanced materials and technologies for Environmental application-Advz mat Tech Env. 2018; 2(1):145-176
14. Sangma T. Block printing on cotton and silk fabric with annatto dye". M. Sc (H. Sc) Thesis Assam Agricultural University, Jorhat, 2017.
15. Mahela G, Goundar I, Vahishree S. Red Sander- A dye source for cotton. Textile Trends. 2006; XLVIX(5):33-36
16. Brains S, Kaur K, Kang S. Colour fastness properties of dyeing wool with golden drop (*Onosma echioides*) dyes using combination of mordamnts. Colourages. 2005; LII(5):51-54.