Natural dyeing of Himalayan nettle fibre using by-product of *kattha Industry*

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ABSTRACT : Eco consciousness towards the natural sources increases the demand for natural dyeing of unconventional fibre. The main aim of the present study was dyeing of Himalayans nettle fibre with natural dye. i.e., black cutch dye (a by-product of *kattha* factory). Different dyeing parameters such as dye concentration, dyeing time, dyeing temperature and MLR were optimized. Mordanting process was also carried out to improve the colour fastness of the dyed samples. One natural mordant i.e. myrobalan and two synthetic mordants namely; alum and ferrous sulphate were used for mordanting. All the mordanting parameters such as mordanting concentration, mordanting time, mordanting MLR were optimized for all three mordanting methods. Optimum results in terms of percent absorption were achieved, when nettle fibres were dyed with 6% concentration of dye for 60 minutes at 90˚C keeping MLR ratio was 1:40. Colourfastness was found to be improved with the use of mordants. Black cutch dye gave good results in term of colour strength, LAB values and other fastness properties. Dyeing of nettle fibres with by-product of *kattha* industry would be helpful in value addition of Himalayan nettle fibre for further product diversification.

Key words: Black cutch dye, Himalayan nettle, Natural dye

Natural dyeing process is gaining attention in present era as consumer's awareness for eco- preservation, eco safety and health concerns has been increased due to various harmful effects of synthetic dyes on environment. Denizil (2000), reported that various organic and harmful chemicals are being released in rivers due to synthetic dyeing processes which causes various harm to aquatic life. It has also been reported that up to 200,000 tons of these synthetic dyes are lost to effluents every year during dyeing process, which causes various harmful effects on human health (Ogugbue, 2011). Considering these harmful effects, academic as well as industrial researchers have shifted their focus towards natural dyeing process. Various researches are being aimed at to exploring eco friendly substitutes for minimizing the harmful environment impact of synthetic dyes. However, the colours obtained from natural dyes are limited and light in shade as compared to synthetic dyes but these subtle shades are in a huge demand in fashion industry due to its uniqueness and elegance in shades. Natural dyeing is done generally on natural fibres such as cotton wool and silk fibres. Unconventional fibres can also be dyed with natural dye due to it's cellulosic nature. Presently, the interest towards the natural dyeing of unconventional fibres has also been increased, as it not only adds aesthetic value to the fibre but create a complete eco-friendly cycle (Filigoj, 2013). Uttarakhand state has a diverse flora, therefore provides various kinds of unconventional fibres, Himalayan nettle (*Girardinia diversifolia*) fibre is one of them (Lepcha, 2009). Himalayan nettle plant is a perennial plant found in temperate and sub-tropical Himalayas, between 1200 to 2900 meters above sea level. It is grown abundantly in the Garhwal region of Uttarakhand (Gurung, 2012). It is considered as an eco-friendly fibre as it does not require water or pesticides to flourish. Recently after realizing its potential in the field of textiles, many organizations of Uttarakhand are exploring the possibilities of product development from nettle, which is aimed at generating livelihood opportunities for the rural people of Uttarakhand. Various kinds of products such as stole, bags, jackets etc. are made from Himalaya nettle fibres. Exploration and value addition of nettle fibres through natural dyeing would pave a way to improve aesthetic appeal of the fibre as well as final product, which further enhances its market. Hence the main aim of the present study was to add value to Himalayan nettle fibre using black cutch dye, a by- product generated from *kattha* factory during *kattha* manufacturing. This would also help in productive use of *kattha* industry waste. Dark catechu or cutch, is marketed in the form of small cubes or blocks, rusty brown or dull orange in colour and of conchoidal fracture. It is used mainly for industrial purposes such as tanning of leather and dyeing of cotton as well as of silk. *Kattha* (*Acacia catechu)* is found mainly in the region of Punjab, Garhwal and Kumaon, Bihar and

Orissa (Anonymous, 2018). Value addition of nettle fibre using a by-product of *Kattha* industry will provide diversity to the product range of Himalayan nettle fibre. It helps in maintaining eco-safe environment. This would also pave a way to enhance the market value of Himalayan nettle products, which further leads to livelihood generation.

MATERIALS AND METHODS

The black cutch dye powder was procured from *kattha* factory, Haldwani, Uttarakahnd. Processed nettle fibres were carded for dyeing. Before dyeing, the fibres were treated with myrobalan. Myrobalan as a mordant increases the absorbency of dye with fibre thus improves the fastness properties of the dye. Dye extraction parameters such as dye concentration and extraction time were optimized. Dyeing parameters such as dyeing time, dyeing temperature and dyeing MLR were also optimized. All these parameters were optimized on the basis of maximum percent dye absorption by the fibre.

Optimization of dye concentration

Various concentrations of dye material viz 2, 4, 6, 8, 10 g per 100 ml of water were taken. Black cutch dye powder at different concentrations was extracted for 1 hour at 90^{o}C and filtered. The optical density of the dye liquor was measured before and after dyeing of Himalayan nettles fibres, hereby absorbency was calculated.

Optimization of dye extraction time

Catechu powder was soaked overnight in water with MLR ratio of 1:100. After that extraction process was carried out at 90^{o}C for 30, 45, 60 and 75 minutes. The cooled dye extract was filtered and absorbency values were recorded. The absorbency value with maximum absorption was selected.

Optimization of dyeing time

After optimizing dye concentrations for extraction of dye and dye extraction time, time of dyeing for nettle fibres was optimized. Nettle fibres were dyed for 30, 45, 60 and 75 minutes at 90°C keeping the MLR 1:50. The absorbency of the dye liquor was calculated by measuring optical density of liquor before and after dyeing.

Optimization of dyeing temperature

Following the optimization of dyeing time, dyeing temperature was optimized for black cutch dye powder. Stock solution with optimized dye concentration was prepared. This stock solution was poured into four beakers, maintaining MLR 1:50. Dyeing was carried out at four different temperatures i.e. 60°C, 70°C, 80°C and 90°C for 60 minutes in dyeing bath.

The temperature which gave the best results with regard to percent absorption selected for final treatment.

Optimization of material liquor ratio for dyeing

After optimizing dyeing time and temperature, MLR for dyeing was optimized. Himalayan nettles fibres were dyed using 1:20, 1:30, 1:40 and 1:50 MLR. The optical density of dye liquor was measured before and after Himalayan nettles fibres was dyed with different MLR. Optimum dyeing MLR was determined based on the maximum dye absorption.

In present study one natural mordant i.e. myrobalan and two synthetic mordants namely, alum and ferrous sulphate were used. Three types of mordanting methods viz. pre mordanting (Mordanting followed by dyeing), simultaneous mordanting (Dyeing and mordanting was carried out simultaneously) and post mordanting (Dyeing, followed by mordanting) were used for the present study.

All the parameters such as mordanting concentration, mordanting time, mordanting MLR were optimized for all three mordanting methods.

Optimization of mordant concentration

Before dyeing all the fibre samples were pre-treated with myrobalan. Varying concentrations of myrobalan viz. 10, 15, 20 25 percent were taken on the weight of fibre. According to this the calculated amounts were i.e., 0.10, 0.15, 0.20 and 0.25/100 ml respectively. For synthetic mordant different percent concentration i.e. 1, 1.5, 2 and 2.5 were taken on weight of fibre. On the basis of percent 0.010, 0.015, 0.020 and 0.025/100 ml were taken for alum and ferrous sulphate mordant. Stock solution were prepared using these concentrations and required amount was taken as per selected MLR.

Optimization of mordanting time

Himalayan nettle fibres were mordanted for different time duration viz. 15 minutes, 30 minutes, 45 minutes and 60 minutes. The optical density of dye liquor was measured before and after dyeing of Himalayan nettle fibres at various time duration. Optimum mordanting time was determined based on the maximum dye absorption.

Optimization of mordanting MLR

After optimizing mordanting time, MLR for mordanting was optimized. Himalayan nettle fibres were mordanted using 1:20, 1:30, 1:40 and 1:50 MLR. The optical density of dye liquor was measured before and after Himalayan nettles fibres was dyed with different MLR. Optimum mordanting MLR was determined based on the maximum dye absorption.

Selection of wave length for dye absorption

For selecting the optimum wave length of dye, dye extract was subjected to visual light using SS5100A spectrophotometer. The wavelength, at which peak optical density obtained, was taken as the suitable wavelength for the colour of dye for optimizing the dyeing conditions using absorbance of dyed fibre. Optical density of filtered dye extract was measured. The percentage of dye absorption was calculated using following formula.

Percentage of dye absorption = O.D before dyeing –O.D after dyeing/ O.D before dyeing x 100

Colour measurement of the dyed samples (LAB) and Colour strength (K/S) of dyed and mordanted samples

The K/S and L*, a*, b* values of control and mordanted samples was determined by measuring surface reflectance of the samples using a SS5100A spectrophotometer and ColourLab plus software.

Colourfastness

Colourfastness of dyed samples against washing, rubbing, perspiration and light were assessed using standard test methods i.e IS: 3361-1979- Test no. 2, IS: 766-1956, IS: 971-1956, IS: 2454-1985 respectively for each test. K/S and colourfastness tests were performed for the final samples dyed and mordanted using optimised conditions.

RESULTS AND DISCUSSION

Dyeing of Himalayan nettle fibre
Optimization of parameters for dye extraction

Dye extraction parameters like dye concentration and extraction time were optimized for the present study.

Optimization of dye concentration for extraction

Black cutch dye powder was boiled in water for 1 hour using different concentrations (2g, 4g, 6g, 8g and 10g per 100 ml of water) of dye powder for extraction of dye. Table 1 reveals that 6 percent concentration of dye has given maximum value (65.99) of percent absorption after that, as the concentration increased the percent absorption rate was found to be slightly decreased. It was found minimum (12.00) for 2 percent concentration of dye. Hence 6% concentration of dye was selected as optimum concentration for further study.

Optimization of extraction time

Extraction time for black cutch dye was also optimized using selected concentration of dye i.e 6 %. It is clear from the Table 2 that maximum percent absorption 78.28 was observed, when dye was extracted for 75 minutes, whereas minimum percent absorption value of 28.47 was recorded for 30 minutes. Hence 75 minutes of extraction time was selected for further optimization process.

Optimization of fibre dyeing parameters

Dyeing parameters viz. dyeing time, dyeing temperature and MLR was optimized for Himalayan nettle fibre using black cutch powder as natural dye source.

Table 1: Percent absorption of dye liquor at different dye concentration

S. No.	Concentration (%)	Percent Absorption
1	2	12.00
2	4	20.29
3	6*	65.99
4	8	64.38
5	10	63.76

*Selected concentration

Dyeing time

Nettle fibre was dyed at 6% concentration for different dyeing time (30, 45, 60 and 75 minutes). Table 3 shows that percent absorption was found maximum i.e., 54.36 when the fibre was dyed for 60 minutes. It is clear from the Table 3 that when dyeing of nettle fibre was carried out for 45 minutes, minimum percent absorption 37.00 was observed. When fibre dyeing was carried out for maximum time period i.e 75 minutes, observed value of percent absorption was 51.190. Hence 60 minutes of dyeing time was selected for further work.

Dyeing temperature

Nettle fibre was dyed for 60 minutes with 6% concentration of dye at different temperatures (60°C, 70° C, 80° C, and 90° C) It is clear from the Table 4 that resultant percent absorption was maximum (63.83) at 90°C. Percent absorption was found to be minimum when the fibre was dyed at 60°C. Whereas, percent absorption was found to be 57.59 and 58.90 when dyeing was carried out at 70°C and 80°C respectively. It can be inferred from results that percent absorption of dye increased with the increase in temperature. Hence 90°C temperature was selected as optimum dyeing temperature on the basis of maximum percent absorption.

Material liquor ratio

Table 5 reveals that Nettle fibre was dyed with black cutch dye (6%) at 90°C for 60 minutes using different MLR viz, 1:20, 1:30, 1:40 and 1:50. Maximum percent absorption 75.93 of dye was obtained when the fibre was dyed using 1:40 MLR. Hence 1:40 was selected as optimum MLR.

Table 2: Percent absorption of dye liquor at different extraction time

S. No.	Time (min)	Percent Absorption
1	30	28.47
2	45	35.33
3	60	37.54
4	75*	78.28

*Selected extraction time, Dye conc.-6%, Temp-90°C

Table 3: Percent absorption of dye liquor at different dyeing time

S. No.	Time (min)	Percent Absorption
1	30	24.60
2	45	37.00
3	60*	54.36*
4	75	51-19

*Selected dyeing time, Dye conc.- 6%, Dyeing temp.- 90°C, M:L:R- 1:50

Table 4: Percent absorption of dye liquor at different dyeing temperature

S. No.	Temperature (°C)	Percent Absorption
1	60	26.00
2	70	57.59
3	80	58.90
4	90*	63.83

*Selected dyeing temperature, Dye conc.-6%, Dyeing time.- 60 min, M:L:R- 1:50

Table 5: Percent absorption of dye liquor at different MLR

S. No.	M:L:R	Percent Absorption
1	1:20	56
2	1:30	61
3	1:40*	75.93
4	1:50	27.66

*Selected MLR, Dye conc.-6%, Dyeing time.- 60 min, Dyeing temp.- 90°C

Optimization of Mordanting Parameters

Mordants namely myrobalan, Ferrous sulphate and Alum were used in the study. Mordanting parameters such as mordant concentration, mordanting time and MLR were optimized for each mordants.

Optimization of mordanting parameters for Myrobalan mordant

Concentration of myrobalan

Table 6 reveals that maximum percent absorption value was observed 85.38 and 99.71 in case of pre mordanting and simultaneous mordanting respectively at 0.10 percent concentrations of myrobalan mordant while in case of post mordanting the maximum percent absorption value was 48.10 at 0.20 percent concentration. It is clear from the results that the value of percent absorption decreased with the increase in concentration.

Mordanting Time

It is evident from the Table 7 that maximum percent absorption was 98.73 at 60 minutes in case of pre-mordanting. Whereas, percent absorption was found to be maximum i.e., 94.93 and 90.84 for simultaneous and post mordanting respectively when dyeing was carried out at 45 minutes.

MLR

It is clear from Table 8 that maximum percent absorption 34.82 and 29.01 was observed at 1:50 MLR for pre and simultaneous mordanted samples respectively. In case of post mordanted samples the maximum percent absorption i.e., 31.61 was observed at 1:40.

Optimization of mordanting parameters for Ferrous sulphate

Concentration of Ferrous sulphate

Mordanting was done at 0.01, 0.03, 0.05 and 0.07 (g/100 ml) concentrations of ferrous sulphate mordant for optimization of mordant concentration. Results of calculated percent absorption for different mordanting methods are given in Table 9. Table 9 reveals that 0.01 percent dye concentration has given maximum value

Table 6: Percent absorption of dye liquor at different concentrations of myrobalan mordant

Concentration (g/100ml)	Percent Absorption		
	Pre Mordanting	Simultaneous Mordanitng	Post Mordanting
0.10	85.38	99.71	41.95
0.15	77.16	99.23	44.25
0.20	55.38	99.66	48.10
0.25	57.69	95.57	42.33

Dye conc.-6%, Dyeing time.- 60 min, Dyeing temp.- 90°C, M:L:R- 1:40

Table 7: Percent absorption of dye liquor at different mordanting time of myrobalan mordant

Time	Percent Absorption		
	Pre Mordanting	Simultaneous Mordanitng	Post Mordanting
15 min	92.40	89.87	82.38
30 min	92.405	88.60	80.31
45 min	91.130	94.93	90.89
60 min	98.73	65.00	81.35

Dye conc.-6%, Dyeing time.- 60 min, Dyeing temp.- 90°C, M:L:R- 1:40

Table 8: Percent absorption of dye liquor at different mordanting MLR of myrobalan mordant

MLR	Percent Absorption		
	Pre Mordanting	Simultaneous Mordanitng	Post Mordanting
1:20	13.64	12.50	11.50
1:30	21.27	22.36	12.56
1:40	17.80	22.87	31.61
1:50	34.82	29.01	23.62

Dye conc.-6%, Dyeing time.- 60 min, Dyeing temp.- 90°C, M:L:R- 1:40

(71.80) of absorption in case of pre mordanting. Hence 0.01 g/100 ml concentration was selected as optimum concentration for pre mordanting. In case of simultaneous and post mordanting, the maximum percent absorption was observed 48.00 and 64.92 respectively at 0.03 (g/100 ml) and 0.05 (g/100 ml) concentration of $FeSO_4$ mordant respectively. Hence 0.03 (g/100 ml) and 0.05 (g/100 ml) concentrations were selected as optimum concentration of $FeSO_4$ mordant for simultaneous and post mordanting method.

Time

It clearly revealed from the Table 10 that maximum percent absorption 64.14 was observed at 45 minutes for pre mordanted samples while in case of simultaneous and post mordanting, the value of maximum absorption were 65.00 and 65.13 respectively when the samples were dyed for 60 minutes. On the basis of these observations, 45 minutes were selected as optimum time for pre mordanting method, whereas in case of simultaneous and post mordanting the optimum time was 60 minutes.

Material Liquor Ratio

Pre, simultaneous and post mordanting were done at different MLR for optimization of MLR for $FeSO_4$ mordant. It is evident from Table 11 that maximum percent absorption was 38.25 when dyeing was carried out using 1:40 MLR in case of pre-mordanting method. In case of post mordanting also the maximum absorbency 63.25 was observed at 1:40 MLR while in case of simultaneous mordanting the maximum percent absorption was 52.75 at 1:50 MLR. Therefore 1:40 MLR was selected for pre-mordanting and post mordanting while 1:50 MLR was selected for simultaneous mordanting method.

Optimization of mordanting parameters for Alum

Concentration of Alum

Table 12 clearly reveals that maximum percent absorption i.e 68.0 and 26.51 was observed at 0.03(g/100ml) concentration of alum mordant in case of

Table 9: Percent absorption of dye liquor at different concentrations of FeSO4 mordant

Concentration (g/100ml)	Percent Absorption		
	Pre Mordanting	Simultaneous Mordanitng	Post Mordanting
0.01	71.80	47.80	43.41
0.03	62.29	48.00	24.87
0.05	69.46	47.31	64.92
0.07	57.95	32.58	90.10

Dye conc.-6%, Dyeing time- 60 min, Dyeing temp.- 90°C, Mordanting time-60 min, Mordanting temp-90°C, MLR-1:40

Table 10: Percent absorption of dye liquor at different mordanting time of $FeSO_4$ mordant

Time	Percent Absorption		
	Pre Mordanting	Simultaneous Mordanitng	Post Mordanting
15	26.24	47.73	47.73
30	42.97	35.00	35.00
45	64.14	60.00	60.00
60	62.54	65.00	65.13

Dye conc.-6%, Dyeing time- 60 min, Dyeing temp.- 90°C, MLR-1:40, Mordanting conc.- as selected for each mordanting method, Mordanting temp-90°C,

Table 11: Percent absorption of dye liquor at different MLR of $FeSO_4$ mordant

MLR	Percent Absorption		
	Pre Mordanting	Simultaneous Mordanitng	Post Mordanting
1:20	36.56	46.44	36.65
1:30	39.67	25.35	22.06
1:40	38.25	34.69	63.256
1:50	27.04	52.75	66.281

Dye conc.-6%, Dyeing time.- 60 min, Dyeing temp.- 90°C, MLR-1:40, Mordanting conc.- as selected for each mordanting method, Mordanting temp.-90°C, Mordanting time-60 min.

both pre and post mordanting respectively while in case of simultaneous mordanting the maximum absorption i.e 66.99 was observed at 0.05 (g/100ml) concentration of alum mordant. Hence 0.03 (g/100ml) concentration was selected for both pre-mordanting as well as post mordanting method while in case simultaneous mordant method 0.05 (g/100ml) concentration was selected for alum mordant.

Time

It is evident from the Table 13 that maximum percent absorption was 64.14 at 45 minutes for pre mordanting method while in case of simultaneous mordanting and post mordanting method, values of the maximum absorption were 65.00 and 65.13 respectively for 60 minutes of time.

MLR

It is clear from Table 14 that values of maximum percent absorption were 17.80 and 20.81 at 1:40 MLR in case of pre and simultaneous mordanting while in case of post mordanting the maximum percent absorption (37.63) was observed at 1:50. Hence 1:40 was selected as optimum MLR for pre mordanting as well as for simultaneous mordanting. In case of post mordanting, 1: 50 MLR was selected as optimum MLR ratio.

Colour strength (K/S, L*, a* b*) value of natural dyed samples

Colour strength (K/S) and L*, a*, b* of all the dyed fibres were measured. K/S and L*, a*, b* values of the samples dyed with black cutch dye and treated with natural mordant (myrobalan) and synthetic mordant (Ferrous Sulphate and Alum) are given in Table 15.

The results indicated that the K/S value of dyed samples mordanted with myrobalan was found to be higher (86.366) as compared to control sample i.e 51.624 which was dyed without myrobalan treatment. Lightness value was also found to be higher (87.917) in case of control sample. a* value was observed to be slight higher (8.863) in case of samples mordanted with myrobalan in comparison to the control samples while b* value was

Table 12: Percent absorption of dye liquor at different concentration of Alum mordant

Concentration (g/100ml)	Percent Absorption		
	Pre Mordanting	Simultaneous Mordanitng	Post Mordanting
0.01	25.0	22.50	18.950
0.03	68.0	58.09	26.51
0.05	24.1	66.99	46.00
0.07	53.3	72.41	31.30

Dye conc.-6%, Dyeing time- 60 min, Dyeing temp.- 90°C, MLR-1:40, Mordanting time-60 min., Mordanting temp-90°C

Table 13: Percent absorption of dye liquor at different mordanting time of Alum mordant

Time	Percent Absorption		
	Pre Mordanting	Simultaneous Mordanitng	Post Mordanting
1	15	26.24	47.7347.73
2	30	42.97	35.0035.00
3	45	64.14	60.0060.00
4	60	62.54	65.0065.13

Dye conc.-6%, Dyeing time.- 60 min, Dyeing temp.- 90°C, MLR-1:40, Mordanting conc.-as selected for each method of mordanting., Mordanting temp-90°C,

Table 14: Percent absorption of dye liquor at different MLR for mordanting of Alum mordant

MLR	Percent Absorption		
	Pre Mordanting	Simultaneous Mordanitng	Post Mordanting
1:20	11.74	14.59	12.40
1:30	25.17	26.15	11.56
1:40	17.80	20.81	33.62
1:50	33.80	27.04	37.63

Dye conc.-6%, Dyeing time.- 60 min, Dyeing temp.- 90°C, MLR-1:40, Mordanting conc.-as selected for each method of mordanting., Mordanting temp-90°C, Mordanting time-60 min observed to be lower (18.279) for the samples treated with myrobalan in comparison to the control samples which indicates less yellowness.

It is clear from the same Table 15 that in case of synthetic mordants the K/S value of samples treated with Fe mordant was found to be higher (115.506) as compared to dyed samples treated with Alum mordant i.e. 112.404. Lightness value was observed to be higher (96.973) in case of the samples treated with Alum mordant. Observed a* value of alum treated sample was found to be 8.665 which was higher than a* value of the samples treated with Ferrous Sulphate mordant which was 6.830. While b* value was observed to be higher (16.984) for the samples treated with alum mordant in comparison b* value (15.136) of the samples treated with Ferrous Sulphate mordant. It is clear from the analysis of Table 15 that the K/S value of mordanted samples was found to be increased for all samples as compared to control samples. L values of the mordanted and dyed samples decreased indicating darker shades as compared to unmordanted dyed samples. However, the mordants and mordanting techniques did not show any major change in a and b values.

Colour fastness properties of natural dyed fibre

Colour fastness to sunlight

Fading in light is partly due to ultraviolet radiation which initiates chemical degradation of the dye molecule through loosely held electrons of the chromophores. Fading of dyed textile materials do not occur so readily in artificial light especially incandescent and fluorescent lights since these light sources do not emit significant quantities of ultraviolet radiation.

It is clear from the Table 16 that Good (5) light fastness was exhibited by the samples mordanted with natural and synthetic mordants

Colour fastness to washing

The loss of colour during laundering is referred to as lack of wash fastness or 'bleeding'. Colour loss will occur during laundering if the dyes have been used which is held loosely by the fibre, that is, dye that has not penetrated sufficiently or dye which is held only by week forces such as hydrogen or van der Waal's forces (Gohl and Vilensky, 1983).

Table 15: Colour strength (K/S, L*, a* b*) value of dyed samples

Type of dye	Treatments	K/S (ΔE)	L* (ΔL*)	a* (Δa*)	b* (Δb*)
Natural	Control (Without myrobalan mordant)	51.624	87.917	8.668	19.260
	With myrabalan as mordants	86.336	87.492	8.863	18.279
	Myrobalan + Ferrous Sulphate	115.506	86.297	6.830	15.136
	Myrobolan + Alum	112.404	86.973	8.665	16.984

Table 16: Colorfastness ratings of natural dyed fibre

Dyed and Mordanted Fabric samples	Sun light	Colorfastness grades												
		Washing			Rubbing				Perspiration					
					Dry		Wet		Acidic			Alkaline		
		CC	CS		CC	CS	CC	CS	CC	CS		CC	CS	
			C	W						C	W		C	W
Dyed sample	5	4	3	4/5	4	4	3	4	3	4	4	4	4	4
Natural mordanted and dyed sample	5	4/5	4/5	4/5	5	4	5	4	4/5	4/5	4/5	4	4/5	4/5
Ferrous Sulphate mordanted and dyed sample	5	5	4	4/5	5	4/5	5	4	4	3/4	4	4	4/5	4/5
Alum mordanted and dyed sample	5	5	4/5	5	5	4/5	5	4	4	4/5	4/5	4	4/5	4

It is clearly evident from the Table 16 that the good results of washing fastness were exhibited by the sample dyed with myrobalan mordant having rating of 4/5 i.e. slight to negligible change in color with slight to negligible staining (4/5) on cotton as well as on wool. While control sample had 4 rating i.e. slight change in color along with noticeable staining (3) on cotton and slight to negligible staining (4/5) wool fabric (Table 16).

The probable reason attributed to good washing fastness is the tannin component of the dye, which may help in bonding with the fibre, thereby assisting in proper fixation on the fibrous material. Hence, mordanting alters the light sorption characteristic of tannin, as well as makes them insoluble in water and ultimately improves washing fastness properties.

In case of mordanting with synthetic mordants (Ferrous Sulphate and Alum) good results of washing fastness were exhibited mordant having 5 rating i.e. negligible change in color and slight to negligible staining on cotton and wool fabrics.

Colour fastness to rubbing

It is clear from the Table 16 that in case of dry rubbing fastness test, the sample dyed without myrobalan mordanitng showed slight change (4) in colour and slight staining (4) on cotton fabric as well as on wool. On wet rubbing slight staining (3) on cotton as well as on wool fabric was observed. While myrobalan mordanted dyed samples showed negligible change (5) in colour with slight staining (4) on cotton in case of both dry and wet rubbing fastness test. In case of synthetic mordants, it can be seen from Table 16 that the dry rubbing fastness of the samples was observed to be improved with use of mordants. Ferrous Sulphate and alum mordanted sample showed negligible change in color. Slight to negligible staining (4/5) was observed in both mordants in case of dry rubbing. Samples of wet rubbing showed slight staining (4) for both mordanted samples.

Colour fastness to perspiration

It is clear from the Table 16 that in case of acidic perspiration fastness, Noticeable change in colour (3) was observed in control samples while in case of alkaline perspiration the slight change (4) in colour was observed. In case of dyed samples, which were mordanted using myrobalan mordant, acidic perspiration and alkaline perspiration fastness rating for change in colour was observed 4/5 (Noticeable change in colour) and 4 (Slight change in colour) respectively. Slight staining on cotton as well as on wool was observed in case of both alkaline and acidic perspiration test.

Dyed samples which were mordanted with ferrous sulphate and alum has shown slight change in colour (4), slight staining on cotton and wool fabric was observed in case of both acidic and alkaline perspiration fastness.

CONCLUSION

Himalayan nettle fibre was dyed successfully with 6% dye concentration for 60 minutes at 90^0C when MLR was kept 1:40. Pre mordanting method was found suitable for both the synthetic mordants. Optimum concentration of Alum and Ferrous Sulphate ($FeSO_4$) mordant was 0.03 (g/100ml) and 0.01 (g/100ml) respectively. Fastness properties of dyed sample were observed to be sufficient in terms of practical use. It can be concluded from the present study that value addition of Himalayan nettle fibres through natural dyeing using by product of kattha industry will not only add value to the final product range but also help to maintain a sustainable environment.

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