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Effect of Combination of Reactive Red Dye - 120 in Dyeing Silk Fibre with Vegetable Dyes.

Md. Lutfor Rahman*, M.I. H.Mondol**, M. K. Hossain, Seatara Khatun, GRM Astak Mohal Khan & Md. Jahidul Islam.
BCSIR Laboratories, Rajshahi - 6206, Bangladesh.
** BCSIR Laboratories, Chittagong Attests BCSIR Laboratories, Rajshahi - 6206, Bangladesh.*
*** Department of Applied Chemistry & Chemical Engineering Rajshahi University, Rajshahi, Bangladesh.*

Abstract: *Silk is a very fine, regular, translucent natural animal protein fibre. Raw and degummed silk fibre were dyed with extracted vegetable dyes, such as catechu brown, waste dab shell and waste banana stem dyes mixed with Reactive Red - 120. Silk fibre becomes more permanently even and bright when it is dyed with 2.0 - 3.0% of the mixed dyes. In each case, optimum conditions of dyeing were determined and fastness characteristics were studied.*

Key Words: *Silk Fibre, Catechu brown dye, Banana stem dye, Reactive Red-120, Degummed Silk, Pottasium Aluminium Sulphate.*

I. Introduction:

Silk is a natural animal protein fibre. It is described as the strongest, finest, and most expensive fibre due to its unique characteristics. It is the exceptional fibre which can be used in its raw state in weaving and wet processing[1,2,3]..However, from the scientific, technological and aesthetic points of view, silk fibre has long been a subject of interest to man for a long time. As silk exhibits both acidic and basic properties it can be dyed with almost all types of dyes like direct, acid,basic, reactive, vegetable dyes etc.

In textile industry the entire dyeing activities are fully dependent on imported synthetic dyes. It is well known that most of the synthetic dye possesses some adverse action e.g. allergic actions etc. on human body.[4]. But natural dye has almost no adverse action on human body. Keeping this idea in mind and also to reduce import cost on synthetic dyes, we tookup the present investigation, starting first with extraction of dyes from natural sources and then their application on natural fibres. The present paper deals with the effect of dyeing of extracted vegetable dyes mixed with Reactive Red-120 and the fastness characteristics of the dyed fibred.

II. Materials And Methods:

2.1 Extraction of vegetable dyes:

Extraction of the three vegetable dyes, such as catechu brown dye (CBD), dabshell dye (DSD) and banana stem dye (BSD) were discussed in our previous paper[5]. Reactive Red dye-120 (RR-120) were purchased from a local market and used without further purification. Silkfibre was collected from Bangladesh Sericulture Research and Training Institute, Rajshahi. The fibre was degummed with soap solution of strength 3.5gm/litre at pH 10.0-10.5 and at 90-1000C for 1 hr. in the liquor ratio 1:30[6].

2.2 Methods of Dyeing:

Vegetable dyes were mixed with Reactive Red-120 in the ratio 9:1. The dye baths were prepared with 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5 and 4.0% of the mixed dyes. Before immersing the fibre in the dyebath, it was wetted with distilled water and squeezed. Dyeing was started at $40^{0}C$ in the fibre-liquor ratio 1:20. The temperature was slowly increased almost to the boiling point within about 30 minutes and continued for 90 minutes with occasional stirring, then allowed to cool in about 30 minutes. After dyeing, the fibre was squeezed over dye baths so that not a single drop of spent dye liquor was lost. The fibre was dried at room temperature. The amount of residual dye in the liquor was determined colouremetrically. Then the amount of dye absorbed by the fibre was calculated out.

III. Results And Discussion:

3.1 TABLE-1:Effect of dye concentration on dyeing of Degummed Silk with CBD, DSD and BSD blended with R.R-120

Dye concentration%	Dye Exhaustion,%			
	R.R-120	CBD+R.R-120	DSD+ R.R-120	BSD+ R.R-120
0.5	78.30	74.25	66.00	82.00
1.0	69.55	55.20	52.32	64.23
1.5	57.20	44.80	51.77	63.20
2.0	48.90	35.25	50.82	60.75
2.5	46.10	32.01	49.60	59.10
3.0	42.75	31.75	49.10	58.00
3.5	41.10	29.45	48.02	57.37
4.0	39.78	28.01	48.84	58.02

From the table-1, it is seen that dye absorption by degummed silk fibre decrease with the increase of dye concentration in the dye bath. This may be explained that the presence of more dye ions hinder absorption of dye to the fibre whereas rare ions favour it. With the increase of dye concentration, the total quantity of the absorbed dyes increases too, while the relative quantity of selected dyes diminishes[7,8]. At equilibrium a more or less pronounced selective absorption of the dye by the fibre is observed up to full exhaustion of the dye bath. This selective absorption is induced by forces of interaction of the dye and the fibrous material. The exothermic reactions that take place during dyeing confirmed the occurrence of the interaction[8].

From the experiments it was observed that bright and even shade was produced when degummed silk fibre was dyed with 3.0% CBD+ R.R-120, 2.5% DSD+ R.R-120 and 2.0% BSD+ R.R-120. Above or below these concentrations of dyes, dull and uneven shades were obtained. The effective concentration of dyes e.g. 3.0% catechu brown dye blended with reactive red, 2.5%. Dab shell dye blended with reactive red and 2.0% Banana Stem dye blended with reactive red correspond to 31.75%, 49.60% and 60.75% dye exhaustion respectively from the dyebath.

3.2 TABLE-2:Effect of Electrolyte concentration on dyeing of Degummed Silk with CBD, DSD and BSD blended with RR-120 under optimum dye concentration.

Electrolyte concentration%	Dye Exhaustion,%			
	R.R-120	CBD+R.R-120 (3.0% dye)	DSD+ R.R-120 (2.5% dye)	BSD+ R.R-120 (2.0% dye)
0	10.25	4.25	28.15	16.12
3	23.78	16.12	40.11	36.32
5	35.20	25.22	49.00	44.14
7	38.10	32.11	52.10	49.21
9	45.07	39.04	54.09	56.45
11	50.85	43.78	56.25	54.65
13	62.20	48.00	56.25	64.78
15	62.20	48.00	56.25	64.78

From the table-2 it is observed that 4.25% CBD+RR-120, 28.15% DSD+RR-120 And 16.42% BSD+RR-120 were from the dye bath containing 3.0%, 2.5% and 2.0% dye respectively by degummed silk fibres without electrolyte in the dye bath i.e. zero concentration of electrolyte. This means that in the absence of electrolyte vegetable dyes blended with RR-120 have a poor affinity towards silk fibre.

From the table-2 it is also observed that the absorption of dye increased with the increase of electrolyte concentration in the dye bath upto saturation absorption. The dye absorption reaches saturation when degummed silk is dyed in presence of 11-13%, potassium aluminum sulphate as electrolyte for all dyes. Above or below these percentages of potassium aluminum sulphate, shades were uneven and dull.

3.3 TABLE-3: Effect of time on dyeing of Degummed Silk with CBD, DSD and BSD blended with RR-120 (under optimum concentrations of the dyes)

Dyeing Time in minute	Dye Exhaustion,%			
	R.R-120	CBD+R.R-120	DSD+ R.R-120	BSD+ R.R-120
20	21.50	18.00	38.59	42.50
30	32.50	27.01	45.43	53.15
40	37.81	32.71	52.00	59.15
50	44.28	41.00	54.10	62.21
60	47.50	43.15	57.23	62.01
70	52.30	46.00	57.23	63.49
80	63.62	48.00	57.23	64.71
90	63.62	48.00	57.23	64.71

From the table-3, it is observed that the absorption of dye by degummed silk increase linearly with the progress of dyeing time and it reaches maximum when dyeing time were 60-80 minutes i.e. 80 min. for CBD+RR-120, 60 min. for DSD+RR-120 and 80 min. for BSD+RR-120. The absorption of these three blended dyes from the dye bath at the equilibrium dyeing time were 48%, 57.23% and 64.71% dye respectively. The absorption remains almost the same on further increase of dyeing time.

3.4 TABLE-4: Effect of temperature on dyeing of Degummed Silk with CBD, DSD and BSD blended with RR-120 under optimum concentrations of the dyes.

Dyeing temperature	Dye Exhaustion,%			
	R.R-120	**CBD+R.R-120**	**DSD+ R.R-120**	**BSD+ R.R-120**
Room temp.	24.58	22.25	41.10	47.00
40	35.20	31.00	50.04	52.45
50	40.35	35.79	54.22	57.15
60	45.28	40.05	57.12	60.79
70	50.05	43.02	58.03	64.70
80	53.40	47.23	59.89	66.45
90	58.25	49.15	59.00	66.00
100	64.40	48.32	58.25	65.79

From the table - 4, it is observed that the absorption of dye by degummed Silk fibre increased with the increased of dyeing temperature and achieves maximum absorption at 90˚C for CBD+RR-120, 80˚C for DSD+RR-120 and 80˚C for BSD+RR-120. When the solution temperature increased, the thermal energy coming from outsides impeded aggregation and therefore, increased in the amount of the non- aggregation dye particles in the solution. Hence, the effect of temperature and consequently increase in the kinetic energy of the dye molecules tends to break up large aggregate into smaller units[9,10]. The absorptions of these three blended dyes at effective temperature were 49.15%, 59% and 66% respectively.

Dyeing behavior and nature of raw silk though apparently looks similar to that of degummed silk fibre. However, dye uptake by raw silk is higher than that of degummed silk. The plausible explanation of such behaviors is that raw silk contains about 25% sericin which is removed by degumming. sericin is a gummy substance which has a greater water absorbing power. So, raw silk containing sericin, absorbs greater amount of dyes than the degummed silk from the dye bath[3].

3.5 TABLE-5: Colour fastness and change in colourof Raw silk dyed with CBD+RR-120, DSD+RR120, and BSD+RR120 on exposure to sunlight in air.

Exposure period (hours)	Fastness grades and colour			
	RR-120	CBD+RR-120	DSD+RR120	BSD+RR120
00	4 (Medium chocolate)	5 (deep chocolate)	5 (deep brown)	5 (deep red)
50	4	4-5	4-5	4-5
100	4-3	3-4	4	4-5
150	3	3	4	4
200	3-2	3	3-4	4
250	2	2-3	3	4

3.6 TABLE-6: Colour fastness and change in colour of Degummed silk dyed with CBD+RR-120, DSD+RR120, and BSD+RR120 on exposure to sunlight in air.

Exposure period (hours)	Fastness grades and colour			
	RR-120	CBD+RR-120	DSD+RR120	BSD+RR120
00	4 (Light chocolate)	5 (chocolate)	5 (brown)	5 (red)
50	4-3	5	4-5	5
100	3	4-5	4	4-5
150	2-3	4	3-4	4-5
200	2	3-4	3-4	4
250	2	3	3	3-4

It is observed from the tables 5 and 6 that the Colour fastness of silk fibre with mixed dye is better than that of RR-120 and the change in colour of dyed fibre occurs within 50-100 hours exposure and then slight or no change occurs on further increase of exposure time. This is possible due to the mechanism of the light action produced by the dye on the fibre.

IV. Conclusion:

A simple inexpensive method of dyeing silk fibre was developed using extracted vegetable dyes mixed with Reactive Red-120. It was observed that the dye uptake by raw silk was higher than that of degummed silk and the latter attained a comparatively more permanent. Colour and brighter even shade when treated with 2.0 to

3.0% of the mixed dyes at 80-90˚C for 60 to 80 minutes in presence of 11-13% Potassium aluminum sulphate as electrolyte. The shades were fast to sunlight and wash.

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