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Silk Dyeing Combine with Vegetable and Reactive Dyes

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ABSTRACT

Silk is a very fine, regular, translucent natural animal protein fibre. Raw and degummed silk fibres were dyed with extracted vegetable dyes such as catechu brown, waste dabshell and waste banana stem dyes mixed with Reactive Red 120. Silk fibre became more permanently even and bright when it was 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, Vegetable dye, Catechu brown.

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[1-3]. 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 possess 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 reduce import cost on synthetic dyes, we took up the present investigation, starting first with the 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 fibre.

MATERIAL AND METHODS

Extraction of vegetable dyes

Extraction of the three vegetable dyes, such as catechu brown dye (CBD), dubshell dye (DSD) and banana stem dye (BSD) were discussed in our previous papar[5]. Reactive Red 120 (RR120) were purchased from a local market and used without further purification. Silk fibre was collected from Bangladesh Sericulture Research and Training Institute, Rajshahi. The fibre was degummed[6] with soap solution of strength 3.5 gm/litre at pH 10.0-10.5 and at 90-100 °C for 1hr in the liquor ratio of 1:30.

Method of dyeing

Vegetable dyes were mixed with RR120 in the ratio of 1:9. The dyebaths 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 dye bath, it was wetted with distilled water and squeezed. Dyeing was started at 40 °C in the fibre-liquor ratio of 1:20. The temperature was slowly increased almost to the boiling point within about 30 min and continued for 90 min using a dyeing machine, then allowed to cool in another 30 min. 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 colorimetrically. Then, the amount of dye absorbed by the fibre was calculated out.

RESULTS AND DISCUSSION

From the Table 1, It can be seen that dye absorption by degummed silk fibre decreased with the increase of dye concentration in the dye bath. This is happened that the presence of more dye ions in the dye bath hindered absorption of dye to the fibre whereas rare ions favoured it. With the increase of dye concentration, the total quantity of the absorbed dyes increases too, while the relative quantity of selected dyes diminished[7a,8].At equilibrium, a more or less pronounced selective absorption of the dye by the fibre was observed up to full exhaustion of the dye bath. This selective absorption was 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 experimental it was observed that bright and even shade was produced when degummed silk fibre was dyed with 3.0% CBD+RR120, 2.5% DSD+RR120 and 2.0% BSD+RR120. Above or below these concentration of dyes, dull and uneven shades were obtained. The effective concentration of blended dyes are 3.0% CDB+RR120, 2.5%. DSB+RR120 and 2.0% BSD+RR120 correspond to 31.75%, 49.60% and 60.75% dye exhaustion respectively from the dye bath.

From the Table 2, it can be observed that 4.3% CBD+RR120, 28.2% DSD+RR120 and 16.4% BSD+RR120 were absorbed 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 electrolyte. This means that in the absence of electrolyte vegetable dyes blended with RR120 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 absorption reached saturation when degummed silk was dyed in presence of 11-13% potassium aluminium sulphate as electrolyte for all dyes. Above or below these concentration of potassium aluminium sulphate, shades were uneven and dull.

From the Table 3, it is observed that the absorption of dye by degummed silk increased with the progress of dyeing time and it reached maximum when dyeing time were 60-80 min, i.e 80 min for CBD+RR120, 60 min for DSD+RR120 and 80 min for BSD+RR120. The absorption of these three blended dyes from the dye bath at the equilibrium dyeing time were 48.0%, 57.2% and 64.7% respectively. The absorption remains almost the same on further increase of dyeing time.

From the Table 4, it is observed that the absorption of dye by degummed silk fibre increased with the increase of dyeing temperature and achieved a maximum absorption at 90 °C for CBD+RR120, 80°C for DSD+RR120 and 80°C for BBD+RR120. When the solution temperature increased, the thermal energy coming from outsides impeded aggregation and therefore, increase in the amount of the non-aggregated 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[7b,9]. The absorption of these three blended dyes at effective temperatures were 49.2%, 59.0% and 66.0% respectively.

Table 1: Effect of dye concentration on dyeing of degummed silk fibre with CBD, DSD and BSD blended with RR120

Dye concentration, %	Dye exhaustion, %			
	RR120	**CBD+RR120**	**DSD+RR120**	**BSD++RR120**
0.5	78.3	74.3	66.0	82.0
1.0	69.6	55.2	52.3	64.2
1.5	57.2	44.8	51.8	63.2
2.0	48.9	35.3	50.8	60.8
2.5	46.1	32.0	49.6	59.1
3.0	42.8	31.8	49.1	58.0
3.5	41.1	29.5	48.0	57.4
4.0	39.8	28.0	48.8	58.0

Table 2: Effect of electrolyte concentration on dyeing of degummed silk fibre with CBD, DSB and BSD blended with RR120 under optimum dye concentration

Dye concentration, %	Dye exhaustion, %			
	RR120	**CBD+RR120 (3.0% dye)**	**DSD+RR120 (2.5% dye)**	**BSD+RR120 (2.0% dye)**
0	10.3	4.3	28.2	16.4
3	23.8	16.1	40.1	36.3
5	35.2	25.2	49.0	44.1
7	38.1	32.1	51.1	59.2
9	45.1	39.0	54.0	56.5
11	50.9	43.9	56.2	54.7
13	62.2	48.0	56.2	64.8
15	62.2	48.0	56.2	64.8

Table 3: Effect of time on dyeing of degummed silk fibre with CBD, DSD and BSD blended with RR120 (under optimum concentration of the dyes)

Dyeing time, min	Dye exhaustion, %			
	RR120	**CBD+RR120**	**DSD+RR120**	**BSD++RR120**
20	21.5	18.0	38.0	42.5
30	32.5	27.0	45.4	53.2
40	37.8	32.7	52.0	59.2
50	44.3	41.0	54.1	62.2
60	47.5	43.2	57.2	62.1
70	52.3	46.0	57.2	63.5
80	63.6	48.0	57.2	64.7
90	63.6	48.0	57.2	64.7

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

Table 4: Effect of temperature on dyeing of degummed silk fibre with CBD, DSD and BSD blended with RR120 (under optimum concentration of the dyes)

Dyeing temp,	Dye exhaustion, %			
°C	RR120	CBD+RR120	DSD+RR120	BSD++RR120
Room temp.	24.6	22.3	41.1	47.0
40	35.2	31.0	50.0	52.3
50	40.4	35.8	54.2	57.2
60	45.3	40.1	57.1	60.8
70	50.1	43.0	58.0	64.7
80	53.4	47.2	59.9	66.5
90	58.3	49.2	59.0	66.0
100	64.4	48.3	58.3	65.8

Table 5: Colour fastness and change in colour of raw silk dyed with CBD+RR120, DSD+RR120 and BSD+RR120 on exposure to sunlight in air

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

Table 6: Colour fastness and change in colour of degummed silk dyed with CBD+RR120, DSD+RR120 and BSD+RR120 on exposure to sunlight in air

Exposure	Fastness grades and colour			
period, h	RR120	CBD+RR120	DSD+RR120	BSD+RR120
00	5 (Light chocolate)	5 (Chocolate)	5 (Brown)	5 (Red)
50	3-4	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 DR120 and change in colour of dyed fibres occurs within 50-100 h exposure and then slight or no change occurs on further increase of exposure time. The colour fastness of degummed silk fibre is much better than that of raw silk fibre. This is possible due to the mechanism of the light action produced by the dye on the fibre.

CONCLUSIONS

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 a comparatively more permanent. Colour and brighter even shade when treated with 2.0-3.0% of the mixed dyes at 80-90°C for 60-80 min in the presence of 11-13% potassium aluminium sulphate as electrolyte. The shades of used dye is fast to sunlight and wash.

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