Effects of water, acids, alkalis and sunlight on the colorfastness of dyed silk fabrics

by A. Nayeem Faruqui.

Abstract: Improved multi-voltine variety of Rajshahi silk fabric was dyed with Reactive Orange 14, Reactive Brown 10, Direct Orange 31, Direct Yellow 29 and Mordant Blue 9 dyes. The effects of water, acids, alkalis and sunlight on the tenacity and colorfastness of Rajshahi silk fabric have been investigated. In the cases of acid all the dyed fabric shows excellent results but in some cases of water, alkalis and sunlight dyed fabric shows unsatisfactory results.

Introduction
Silk has never lost its luxury appeal and today all houses in their top fashion products are showing it. Its characteristics of strength, fineness, and length permit more cloth to be made from one pound of silk than any other natural fibre. In recent times, attempts have been made to improve properties of silk such as crease recovery, wash and wear properties, anti-photo yellowing, water and oil staining resistance, dyeability and colorfastness. In this work, investigation will be made on dyeability and colorfastness properties of Rajshahi silk. It is imperative to enhance the attractiveness of the silk fabric by dyeing as well as by improving its colorfastness. If a textile material is dyed to enhance its pleasing appearance, the color must withstand exposure to light, weather, moisture washing, etc., for a certain limit. It is also expected that the dyeing should be level and uniform.

Some excellent work has been done on solvent effect on dyed silk in different silk producing countries of the world. But in the case of Bangladesh no research which is worth mentioning has so far been carried out on solvent effects to Rajshahi silk. In the absence of proper research on Rajshahi silk, these luxurious, but valuable fabrics do not have its good properties, and as result absence of proper research on Rajshahi silk, these luxurious, but valuable fabrics do not have its good properties, and as result it does not attract the attention of the buyers. In this research work, effects of water, acids, alkalis and sunlight on colorfastness of Rajshahi silk fabric dyed with Reactive Orange 14, Reactive Brown 10, Direct orange 31, Direct Yellow 29 and Mordant Blue 9 have been investigated.

Materials and Methods

Materials
As a material for investigations, improved multi-voltine variety of mulberry silk fabric was collected from Bangladesh Sericulture Research and Training Institute (BSR and TI), Rajshahi, Bangladesh. Reagent grade sodium carbonate (99.5%), sulphuric acid (98%), ammonia solution (25%), sodium hydroxide (98%); Reactive Orange 14, Direct Yellow 29, Reactive Brown 10, Direct orange 31 and Mordant Blue 9 dyes were purchased from Sigma (USA), Tartaric acid (99.5%) from BDH (England) and glacial acetic acid (99.7%) from Merck (Germany), and wheel soap from Uniliver Bangladesh Ltd.

Methods - Degumming of Silk fabrics
Silk fabric was degummed by the optimum degumming method. To select optimum dyeing conditions of modified silk fabric, concentration of dye and electrolyte, dyeing time and temperature were selected accordingly. The percentage of dye absorption was calculated with the spectrophotometric analysis.

a. Selection of dye concentration: Six dye baths were prepared with 0.5, 1.0, 1.5, 2.0, 2.5, and 3.0% dye on the basis of weight of modified silk fabric, and the dyeing was carried out at 85°C for 60 min. The electrolyte concentration was 10%, and the fabric–liquor ratio was 1:50. The concentration of dye that gave the silk fabric even and maximum shade was selected for dyeing.

b. Selection of electrolyte concentration: Eight dye baths were prepared with 0,3,5,7,9,11,13 and 15% aluminium sulphate as electrolyte. The fabric was then dyed with selected concentration of dye, and the dyeing temperature and fabric–liquor ratio were same as above. The electrolyte concentration that gave the maximum absorption of dye by fabric was selected for dyeing.

c. Selection of dyeing time: Seven dye baths, each containing selected dye concentration and electrolyte concentration, were prepared, and the fabric was dyed at varying times as 30, 40, 50, 60, 70 and 80 min. The minimum dyeing time at which the maximum dye absorption was obtained was selected for dyeing.

d. Selection of dyeing temperature: Each of seven dye baths containing selected concentration of dye and electrolyte was prepared. Then fabrics were dyed at the selected time by varying temperature as 50, 60, 70, 80, 90 and 100°C. The lowest temperature at which maximum absorption was obtained was selected as dyeing temperature.

Calculation of the quantities of dye & electrolyte from stock solution
To calculate the quantities of dye and electrolyte, the following formula was used:

Stock solution required (mL) = \( \frac{W \times P}{C} \)

Where W is weight (in grams) of fabric sample to be dyed, P is percentage of dye and electrolyte to be used (expressed on the basis of the weight of fabric) and C is Concentration of stock solution.

Effects of water, acids, alkalis and sunlight on the colorfastness test
The colorfastness tests were carried out of the dyed silk fabrics after treatment of water, acids, alkalis and after 250 h exposure under the sun, without protecting from weathering. After every 50 h, the fastness was assessed by the ‘Grey Scale’ for assessing change in color comparing with the control grade ‘5’.

Results and discussion

Dyeing
The fabric was dyed with Reactive Orange 14, Reactive Brown 10, Direct Yellow 29, Direct Orange 31 and Mordant Blue 9. The dye uptake depends on the concentration of dye, concentration of electrolyte, dyeing time and temperature of the dye bath; therefore, an attempt was made to determine the optimum dyeing conditions for making the process more economical.

Effects of water on dyed silk fabric
Effects of different conditioned water on dyed silk fabric were investigated and summarized in Table-II given on the next page.
In case of distilled water and demineralized water there was no color change. The color of dyed silk fabrics become blackish, when it was immersed in subsoil and deep well water. This is because the subsoil and deep well water contain different minerals and silk fabric readily absorbs the mineral matters from the water and becomes discolored (blackish).

On the other hand the surface area and distilled water does not contain any minerals and for this, silk fabric can not absorb any minerals from the surface or distilled water and hence no discolorization is observed.

It is observed from the Table-III that the effects of different acids on dyed silk fabrics such as sulphuric acid, acetic acid and tartaric acid is excellent for all the cases of Reactive Orange 14, Reactive Brown 10, Direct Orange 31, Direct Yellow 29 and Mordant Blue 9 Dyes.

It is observed from the Table-IV that the effects of different alkalies such as, sodium hydroxide, sodium carbonate and ammonium hydroxide of dyed silk fabric are satisfactory in most of the cases but in some cases it give unsatisfactory results by changing color and decreasing the shade.

It is evident from the table that sodium hydroxide and sodium carbonate are more effective to change in color than ammonium hydroxide. Mordant Blue 9 to sodium hydroxide and Sodium carbonate spotting give blue color.

From the Table-V, it is seen that the silk fabric dyed with Reactive Orange 14, Direct Orange 31 and Direct Yellow 29 exhibits considerably better colorfastness on exposure to sunlight in air than other dyes used in the present investigations. Reactive Brown 10 and Mordant Blue 9 showed poor colorfastness to sunlight.

Dyestuffs do not possess the same degree of fastness to light on silk and this may be due to one or more important factors. One factor that certainly has an important bearing on the light fastness of various dyestuffs on silk fabric is the change in color of dyed silk on exposure to light.

The colorfastness of dyed fabric depends on the physical and chemical properties of the fabrics, the class of the dyes and their forces of interaction; the intensity of light and many other factors.
It is also observed from the Table-V, that the change in color of dyed fabric occurs abruptly within 50-100 hours exposure and then no or slight change occurs on further increase of exposure time. This is, possibly, due to the mechanism of the light action produced by the dye on the fabric.

An intensive oxidation of the fabric is due to the capacity of the molecule, exited by the absorption of the short wave or UV-light to be reduced because of the NH₂ group (amino acids) contained in silk.

As a result, the glycidyl radicals formed in silk fibroin by the irradiation immediately react with atmospheric oxygen and changes to peroxy radicals. This oxidation reaction occurs at the earlier time of light exposure. After completion of the reaction the change in color or fading does not occur rapidly6.

**Conclusion**

The effect of in subsoil and deep well water on the dyed Rajshahi silk fabric is remarkable and the color of dyed silk has been changed by the absorption of minerals from the water. But in the case of demineralized water and distilled water the dyed fabric exhibits its original color.

In the case of acid, the fabric exhibits good colorfastness after spotting with acid. Spotting with alkalies, e.g., sodium hydroxide and sodium carbonate were more reactive with dyed silk fabric than ammonium hydroxide.

After exposure to sunlight in air the silk fabric dyed with Reactive Orange 14, Direct Orange 31 and Direct Yellow 29 exhibits considerably better color than Reactive Brown 10 and Mordant Blue 9. Considering all the effect it was seen that dyed silk fabric withstands their color in demineralized water and distilled water.

**References**


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**Table-V: Effect of sunlight on dyed silk fabric**

<table>
<thead>
<tr>
<th>Exposure period (hr)</th>
<th>Reactive Orange 14</th>
<th>Reactive Brown 10</th>
<th>Direct Yellow 29</th>
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<th>Mordant Blue 9</th>
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<td>5 (Brown)</td>
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**Major company in Bangladesh selects THEN-AIRFLOW®**

Further cementing their technologically leading position in the Bangladeshi textile processing industry, Chaity Composite Ltd. has placed an order for three THEN-AIRFLOW® SYNERGY 1500 machines, complete with THEN’s dye-house management solution and a chemicals dispensing system.

Highlighting the economic and ecological benefits this investment, Chaity Group’s Managing Director, Mr. Md. Abul Kalam says: “Our acquisition of THEN-AIRFLOW machines will provide us with the lowest water, chemicals and energy consumption in the industry and thus with the most competitive operating costs. Moreover, our high-profile buyers are demanding an increasingly better performance in ecological terms, such as water conservation and minimum effluent discharge. We can now guarantee this for the foreseeable future with our new THEN-AIRFLOW.”

The newly ordered machines will be set up at Chaity Composite’s dyehouse in Narayangonj.

**THEN Maschinen GmbH**

THEN-Maschinen GmbH is the technology leader in piece dyeing. Its patented THEN-AIRFLOW® technology introduced some 25 years ago enables a true ULLR (ultra-low liquor ratio) of 1:3.5 with cotton knit fabrics – including fabric pick-up and free liquor. Some 2,000 THEN-AIRFLOW® units are in operation worldwide.

As higher awareness of limited water and energy resources is spreading around the globe rapidly, demand for THEN-AIRFLOW® technology is significantly shifting beyond traditional European and American markets towards Asia and the Indian sub-continent. THEN Maschinen GmbH is a member of the Fong’s Group. **◆**