Natural Dyeing with Anthocyanins from *Hibiscus rosa sinensis* Flowers

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ABSTRACT: A new approach for natural dyeing with anthocyanin has been discussed along with a convenient method of extraction. Anthocyanin from Hibiscus flowers has been extracted by developing a method using methanolic solution of 4% citric acid. The new method gave better yield of anthocyanin as compared with methanolic solution of 0.1% hydrochloric acid. It has been also shown that pH of the extract plays an important role on the dye, thus by adjusting the pH of the extract at 4, dyeing of cotton and silk together with metal mordanting gave different colors. The best dyeing results were obtained for stannous mordanted fabrics in terms of fastness properties. The role of metal ion complexation of stannous salt with the dye extract has been confirmed through UV-Vis and FTIR spectra. Antioxidant activity of the anthocyanin extract seemed to have contributed to enhance the fastness properties of the dyed fabrics. © 2011 Wiley Periodicals, Inc. J Appl Polym Sci 122: 3361–3368, 2011

Key words: *Hibiscus rosa sinensis*; anthocyanin; dye; citric acid extraction; metal complexation; UV-Visible; FT-IR spectra

INTRODUCTION

Anthocyanins are natural colorants which have extensive range of colors and occur widely in nature. Anthocyanins are the most important dye ranging from orange, pink, red, violet to blue in the flowers and fruits of the vascular plants. They are harmless and water soluble which makes them interesting for their use as natural water soluble colorants. Another significant property of anthocyanins is their antioxidant activity, which is known to play a vital role in the prevention of neuronal and cardiovascular illnesses, cancer, and diabetes.[1]

Despite the great potential of applications that anthocyanins represent for food, pharmaceutical, and cosmetic industries, their use has been limited because of their relative instability and low extraction percentages.[2] Their use in textile is negligible as they lack affinity for the fiber and cannot sustain washing. Nevertheless, anthocyanins are good food colorants, because in those applications color fastness properties do not play such an important role as for the textile applications. Currently, most investigators are engaged in solving the problems that are associated with isolation and stability of anthocyanins, their purification, identification and their end uses.

In this article, anthocyanins from *Hibiscus* flowers have been extracted by an advantageous technique of using citric acid with methanol instead of hydrochloric acid. Presence of citric acid in the anthocyanin extract was found to be safe for textile dyeing particularly silk using different mordants, instead of hydrochloric acid.

The extraction of anthocyanins using ethanol acidified with citric acid (0.01%) instead of hydrochloric acid is reported.[3] Citric acid is less corrosive than hydrochloric acid, chelates metals, maintains a low pH, and may have a protective effect during processing[4] compared the efficiency of extraction with three different solvents—methanol, ethanol, and water-that were acidified with either hydrochloric acid or different organic acids, and found that methanol extraction was 20% more effective than ethanol and 73% more effective than water when used for anthocyanin recovery from grape pomace. They also reported that hydrochloric acid was most effective when used in combination with ethanol, whereas citric acid was more effective with methanol, and acetic acid was more effective with water. The choice of citric acid-methanol was preferred over acetic acid-water combination as the former showed better dye extraction.

The color of extracts from flowers having anthocyanins can be rich source for textile dyeing. Most natural dyeing is done with the use of mordants, most commonly heavy metal ions. The mordant

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allows many natural dyes which would otherwise just wash out to attain acceptable wash fastness. A mordant remains in the fiber permanently, holding the dye. Each different metal used as a mordant produces a different range of colors for each dye. The metal-anthocyanin complexation has a significant role in textile dyeing. This chelate formation and its effect both on color and stability of metal complexes is commonly known and utilized in textile dyeing since ancient time.[5] The effect of Al^{3+} and Sn^{2+} on the juice color of anthocyanins-rich fruits juices was studied[6] and found that color stability improved with both Sn^{2+} and Al^{3+}. This research group had worked on fruit juices. Thus metal play a significant role on the stability of anthocyanins. Stability and complexation of cyanidin-3-glucoside (one of the important anthocyanins) and raspberry juice extract in the presence of selected cations was studied.[7]

In this article, special emphasis has been shown on the application of stannous chloride salt as mordant in anthocyanin dyeing. Tin binds well with anthocyanin and increases wash fastness incredibly and leaves a beautiful color on the fabric. At different pH anthocyanin gave varied colors and after binding with tin the color can adhere well on fabric. We have used a new technique for concentrating the anthocyanin extract by lyophilization. It is a technology used to freeze-dry products such as biological/plant samples. It is a process that removes water from a substance. This dehydration process is performed under vacuum while the substance is in a frozen state.

EXPERIMENTAL

Chemicals

HCl, methanol, $KAl(SO_4)_212(H_2O)$,$CuSO_4$ and $SnCl_2$, 3-carboxy-3-hydroxypentanedioic acid (all from S D fine), distilled water (DW, Millipore) were of analytical grade.

Plant material

Hibiscus rosa sinensis flowers were collected from the Indian Institute of Technology Campus, Kanpur, India and they were kept in cold (20°C) and dark storage until processed (the shelf life was found to be for more than a month). Petals of flowers chosen were cut into small pieces and extracted into methanol (S D Fine, 96% (v/v)), keeping them overnight.

Determination of moisture content in fresh hibiscus rosa sinensis flowers

Moisture content is the quantity of water contained in a material. Hundred grams of fresh hibiscus flower is taken to determine the moisture content. The sample was kept in an oven at 100°C for 5 to 6 h and then weighed. The procedure was repeated to get a constant weight.[8]

Moisture content was calculated in % by using the following equation:

$$M_n = [(W_w - W_d)/W_w) \times 100 \quad (1)$$

where M_n = moisture content (%) of material, W_W = wet weight of the sample, and W_d = weight of the sample after drying.

$$\% = [(100 - 15)/100] \times 100,$$

$$\% = (85/100) \times 100, \text{ thus} \% = 85$$

Anthocyanin extraction

Anthocyanin extraction was carried out by two different solvents: HCl and citric acid. In the first method anthocyanins were extracted from flowers with 0.1% HCl (v/v) in methanol for 2 to 3 h at room temperature, in darkness without heating or stirring.[9] The mixture was filtered on a Buchner funnel and the remaining solids were washed with 0.1% HCl in methanol until a clear solution was obtained. The combined filtrates were dried using a rotary evaporator at 55°C. The concentrate was dissolved in DW and the solution obtained was used for dyeing.

In the second method anthocyanins were extracted from flowers with 4.0% citric acid (w/v) in methanol for 2 to 3 h at room temperature, in darkness without heating or stirring. The mixture was filtered on a Buchner funnel and the remaining solids were washed with 4.0% citric acid in methanol until a clear solution was obtained. The combined filtrates were dried using a rotary evaporator at 55°C. The concentrate was dissolved in DW and the solution obtained was used for dyeing.

Total anthocyanins measurement using pH differential method

Total anthocyanin analysis was performed using a spectrophotometric differential pH method, according to, Ref. [10] with a few modifications. Two freeze-dried or lyophilized samples of 500 mg were treated with 10 mL of buffer solution of pH 1.0 (125 mL of 0.2*M* KCl and 375 mL of 0.2*M* HCl), and 10 mL of buffer solution of pH 4.5 (400 mL of 1*M* sodium acetate, 240 mL of 1*M* HCl, and 360 mL of DW), respectively. The mixture was homogenized and centrifuged twice at 4°C at 5000 rpm for 15 min. The supernatant was collected and its absorbance was read at 510 nm. The spectra recorded in a Heλios α

Thermo spectrophotometer at 25°C, against the solvent using quartz cells.

The concentration (mg/L) of each anthocyanin was calculated according to the following formula and expressed as Cy-3-glc equivalents:

$$A \times M_w/\mathrm{DF} \times 10^3/\varepsilon \times 1$$

where A is the absorbance $= (A_{\lambda\text{vis-max}})_{\text{pH 1.0}} - (A_{\lambda\text{vis-max}})_{\text{pH 4.5}}$, MW is the molecular weight (g/mol) = 449.2 g/mol for Cy-3-glc, DF is the dilution factor (0.2 mL sample is diluted to 2 mL, DF = 10), and ε is the extinction coefficient ($L \times \text{cm}^{-1} \times \text{mol}^{-1}$) = 26,900 for Cy-3-glc, where L (path length in cm) = 1. For comparison, the same extinction coefficient was used for other standards to calculate the concentration of each anthocyanin and thus results reported is expressed as Cy-3-glc equivalents.

Scouring of cotton and silk

Cotton and silk fabrics were washed with solution containing 0.5 g/L sodium carbonate and 2 g/L nonionic detergent (Labolene) for 30 min, keeping the material to liquor ratio at 1 : 50. The scoured material was thoroughly washed with tap water and dried at room temperature in shade.

Mordanting

Weighed cotton/silk samples were treated with different metal salts, only premordanting with metal salts was carried out. The percentage of mordant used is 2% solution. The fabric was immersed in the mordant solution and then it was brought to heating and the temperature of the solution was raised to 60°C in a half an hour and maintained in this temperature for 30 min. Mordanted cotton and silk should be used immediately because some mordants are very sensitive to light.

Dyeing

The cotton and silk were dyed with anthocyanin extract, keeping M : L ratio at 1 : 40 (although M : L ratio is on the higher side, it worked well in our case). Forty grams of anthocyanin extract was diluted in 1000 mL water for a piece of fabric weighing 10 g, keeping the fabric in dye bath for about two hours at 35°C. However for cotton dyeing it was used directly (at the pH of the dye bath) while in the case of silk dyeing the pH was maintained at 4 by adding buffer solution (sodium acetate and acetic acid). The dyed material was washed with cold water and dried at room temperature; it was then dipped in brine for dye fixing (it probably aids in the dyeing process by helping to drive the dye onto the fiber, out of solution, so that it is in the right place for any bonding to the fiber to occur). This is a method practiced by traditional natural dyers in India. The color strength was determined colorimetrically using Premier Colorscan, (India) at the maximum wavelength (λ_{max} 520 nm) of the natural colorant.

Apparatus

1. Ultra violet-visible spectroscopy: The extracted anthocyanin was scanned through UV-Vis spectrophotometer (Heλios α Thermo Electron Corp.).
2. Fourier transform infra-red spectroscopy: FTIR of anthocyanin dye was recorded on Vertex 70 model, Bruker, Germany.
3. Xenoster: Used to test the light fastness of the dyed fabric.
4. Wash wheel—Thermolab model: Used to test the washing fastness of the dyed fabric.
5. Perspirometer—Sashmira model: Used for the testing of perspiration fastness of the dyed fabric.
6. Crock meter—Ravindra Engg. Model: Used for testing the rubbing fastness of the dyed fabric.
7. Color matching system: The reflectance of dyed fabrics was measured on a Premier Colorscan.

Fastness testing of dyed samples

The dyed samples were tested according to Indian standard methods.[11] The specific tests were: color fastness for light, IS-2454-85, color fastness to rubbing, IS-766-88, color fastness to washing; IS-687-79, and color fastness to perspiration, IS-971-83.

RESULTS AND DISCUSSION

Anthocyanins are one of the most abundant natural dye available. These are the vacuolar dye found in almost every part of higher plants and water soluble strong colors and have been used to color food since historical times. Chemically, anthocyanins are subdivided into the sugar-free anthocyanidine aglycons and the anthocyanin glycosides. As vegetative dyestuff must have oxochrome groups to obtain good results in dyeing so as anthocyanin has many oxochrome units. Cyanidin (the most common anthocyanin) has five oxochrome groups. The hibiscus anthocyanin mainly comprises of Cyanidin-3-Sophoroside (available at: http://www.liberherbarum.com/Pn3366.htm) as shown in Figure 1.

Anthocyanin from hibiscus was extracted using both 0.1% HCl and 4% Citric acid and it was found

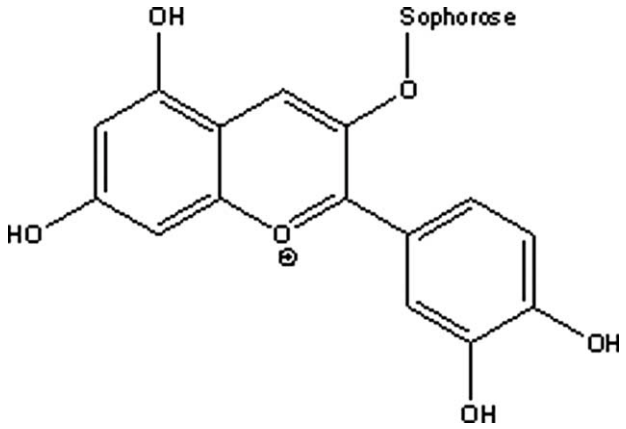

Figure 1 Main colorant in Hibiscus flower—cyanidin-3-sophoroside.

that citric acid gave good yield and better color too. Total anthocyanin content extracted from hibiscus flowers using different acids are shown in Table I. The extraction of anthocyanins using ethanol acidified with citric acid (0.01%) instead of hydrochloric acid was reported by Main et al.[3] Ethanol would be preferred for food use to avoid the toxicity of methanolic solutions. Citric acid is less corrosive than hydrochloric acid, chelates metals, maintains a low pH, and may have a protective effect during processing.[12] It is also reported by Yang et al.[13] fairly good yield of anthocyanin extraction from purple corn cob.

The stability of anthocyanins depends on the structural changes between flavylium cation. The

TABLE I
Total Anthocyanin Content by Different Acids

Extracting acid	TAC (mg/kg)
0.1% HCl	116.64
4.0 % Citric acid	166.84

color of the extract obtained was also affected by the pH value in the solution ranging from red to dark purple at pH 2.5 to pH 5. However, the total anthocyanin content in the extracts was quite stable in the pH values ranging from 2.5 to 5.0 used in the study. The anthocyanin content was stable at lower pH (<3) but the color of the extracts faded at higher pH values (<4.5). Degradation percentages of total anthocyanins in the extracts kept at 25°C were 7 to 20% lower than that maintained at 35 to 40°C. The study shows that suitable storage condition for colored anthocyanin dye in extracted form is under acidic conditions and should be kept in the dark. Other factors found to affect the pigment stability were light and elevated temperature which caused increased pigment degradation.

Effect of pH on anthocyanin color

pH has a major effect on the color of anthocyanins. They are redder and more intense in color at low (acid) pH and bluer and less intense in color at a higher pH. This may be observed by the λ_{max} shift from 520 to 552 nm as the pH value increased from 2.55 to 4.5, which was visually confirmed by

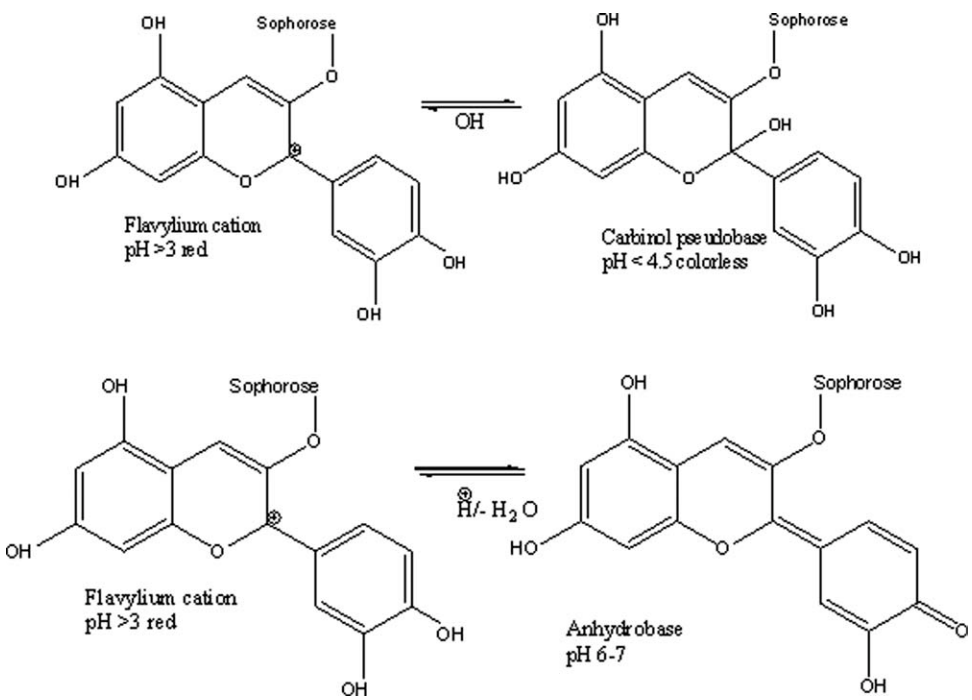

Figure 2 a and b. Conformations of cyanidin in aqueous solution under varying pH.

TABLE II
Color Coordinates of the Hibiscus Extract at Different pH

	Intrinsic 2.55	pH 3	pH 4	pH 5	pH 6
L	45.78	20.39	6.75	2.79	1.93
*a**	66.14	50.16	34.86	19.27	13.64
b*	58.50	35.02	11.62	4.79	3.33
C	88.30	61.17	36.74	19.85	14.04
H	41.47	34.90	18.42	13.97	13.72

differences in the color of the solution. At pH 2.0, anthocyanins exist in the colored oxonium or flavylium form [Fig. 2(a)] and at pH 4.5 they are predominantly in the colorless hemiketal form [Fig. 2(b)].

The anthocyanin system undergoes a variety of molecular transformations as the pH changes (available at: http://www.demochem.de/p26[lowem]anth-e.htm). In slightly acidic aqueous solutions, anthocyanins exist as essentially four molecular species in chemical equilibrium: red flavylium cation, blue quinonialbase, colorless carbinol pseudo base and yellowish chalcone. At acidic pH i.e., 1 to 3, anthocyanins exist predominantly in the form of the red flavylium cation [Fig. 2(a)]. Increasing the pH leads to a decrease in the color intensity and the concentration of the flavylium cation which undergoes hydration to produce a colorless carbinol pseudobase. The highly conjugated benzo-pyrilium structure is disrupted due to a nucleophilic attack of water at the position 2 of the anthocyanidin skeleton.[14] A rapid proton loss of the flavylium cation takes place as the pH shifts to higher values. Now the equilibrium is shifted toward a purple quinoidal anhydrobase at pH < 7 and a deep blue ionized anhydrobase at pH < 8. When pH increases further the opening of the central pyran ring of carbinol form yields, the light yellow chalcone form. The transmittance of anthocyanin extract of different pH (strong acid to strong alkaline) gave color tones from dark red to mauve. These colors are reproducible and increasing or decreasing pH quickly changes the color of extract. The color coordinate values for the anthocyanin extract of hibiscus at different pH are described in Table II.

TABLE III
Shift in λ_{max} (nm) in Hibiscus Anthocyanin with Change in pH

pH	λ_{max}	pH after adding $SnCl_2$	λ_{max}
Intrinsic 2.55	520	1.81	520
3	520	3	538
4	525		
5	545		
6	546	6	560
7	560		
8	578		
9	565	9	552

Metal and anthocyanin conjugation

Anthocyanin-metal complex constitutes a viable alternative for color stabilization, particularly if the metals involved do not imply a risk for the environmental pollution. One of the main characteristics of anthocyanins and anthocyanidins with *o*-dihydroxyl groups in the B ring (Cy, Dp, Pt), is their ability to form metal-anthocyanin complexes.[15] Some studies about the color stability in plants, suggest that the blue colors are due to a complexation between anthocyanin and some metals such as Al, Fe, Cu, and Sn.[16] Production of metal-anthocyanin complexes was suggested by changes in color of the samples as shown by *L*, *a**, *b**, and hue angle *h* values.

Role of Sn^{2+} on the thermal degradation of cyanidin 3-sophoroside was studied.[17] It was found that anthocyanin dye in strawberry, raspberry, and cherry preserves could be stabilized by the addition of alum as well as stannous and stannic chloride salts.[18]

The flavylium cation forms stable complex with Sn^{2+} which in turns interact with the -OH groups of cellulose of cotton or $-NH_2$ groups of silk through oxochromes of the colorant. These are referred as inner complexes. Sn^{2+} forms a violet complex with the red flavylium cation. Some metals, such as Fe^{3+} and Al^{3+} form stable deeply colored coordination complexes[15] with anthocyanins that bear *ortho*-dihydroxyphenyl structure on the B-ring. Anthocyanin extract from hibiscus flower also formed a purple

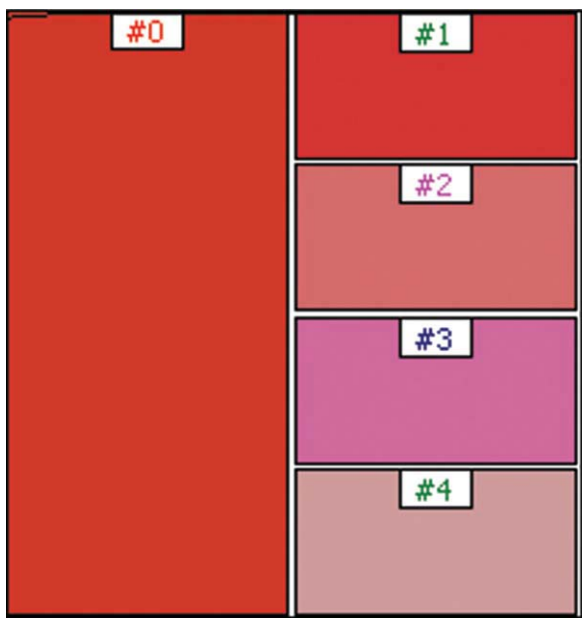

Figure 3 Color of anthocyanin extract at intrinsic and different pH. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

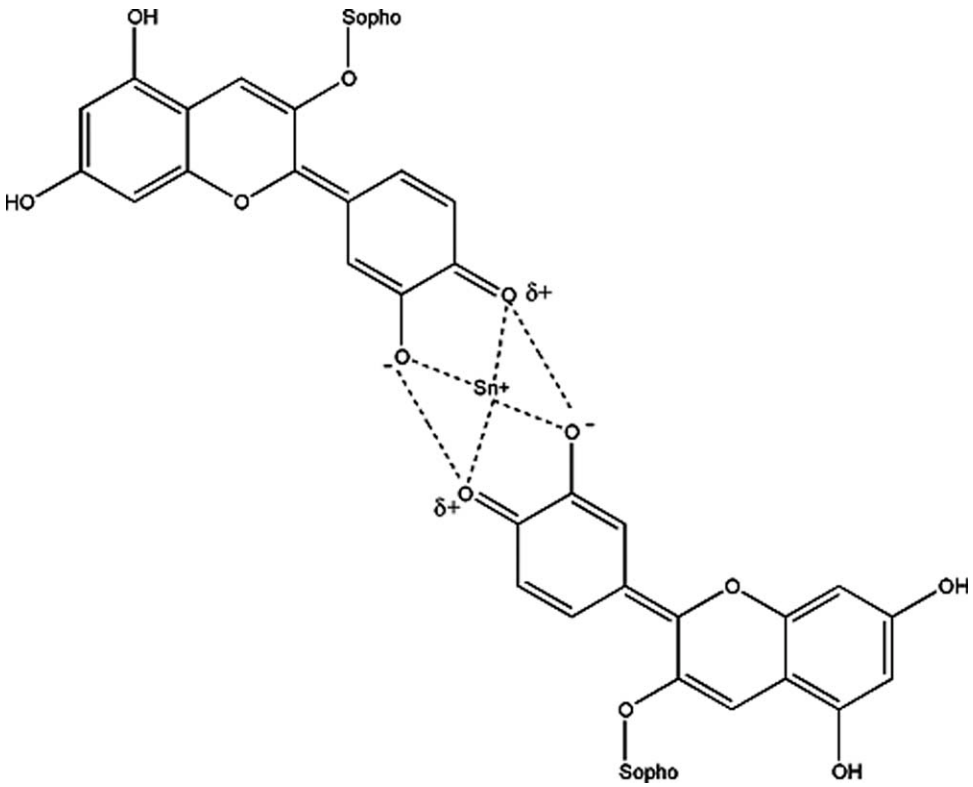

Figure 4 Tin complex of cyanidin-3-sophoroside.

color complex with Sn^{2+} as shown in Table III and Figures 3 and 4.

Intramolecular effects such as copigmentation of anthocyanin-metal complexes play a vital role in the formation of the rich color. At a narrow pH domain (pH 2–4) in which color amplification due to complexation, is at a maximum, has been found to give bright red color to the extract. Therefore, due to the enormous potential of natural anthocyanins as healthy dye, there is increasing number of reports found in the literature on diverse fields such as: development of analytical techniques for their purification and separation, applications in food,[19] identification and distribution in plants,[20,21] quantitative analysis using chromatographic and electrophoretic techniques,[22,23] and dyed wool with crude anthocyanin extract of hibiscus flowers.

Change in λ_{max} with addition of stannous salt

The intrinsic pH of the anthocyanin extract from hibiscus is 2.55 and shows an intense peak at λ_{max}

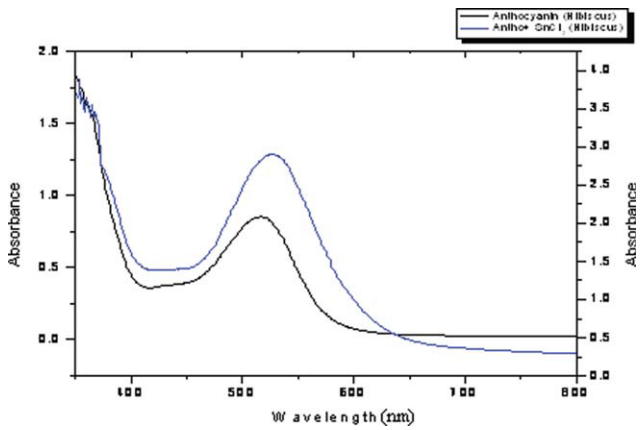

Figure 5 Visible spectra of hibiscus anthocyanin extract and hibiscus anthocyanin-Sn extract. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

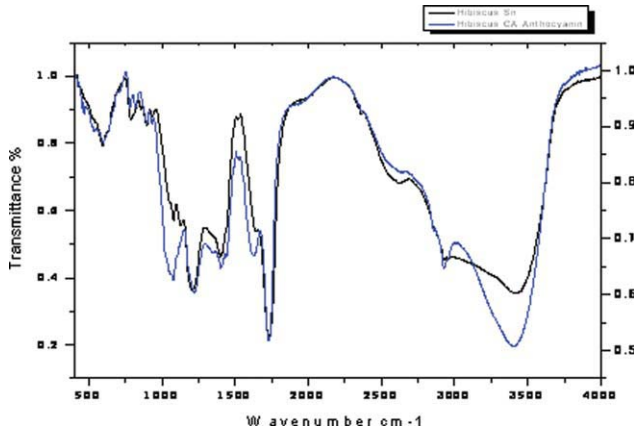

Figure 6 FTIR of Hibiscus anthocyanin extracted with citric acid (blue) and Sn chelated anthocyanin (black). [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

TABLE IV
Cotton Dyeing with Hibiscus Anthocyanin

Mordant	*L*	*a**	*b**	*C*	*H*	*K/S*
Control	41.97	40.23	2.72	40.32	3.87	66.69
Alum	41.97	40.11	2.71	40.20	3.87	60.59
$CuSO_4$	41.53	38.29	2.11	38.34	3.15	55.66
$K_2Cr_2O_7$	41.98	19.50	12.59	23.03	32.13	62.18
$SnCl_2$	37.34	19.51	−16.29	25.42	320.14	149.25

TABLE V
Silk Dyeing with Hibiscus Anthocyanin

Mordant	*L*	*a**	*b**	*C*	*H*	*K/S*
Control	43.45	31.40	−0.17	31.04	359.69	52.34
Alum	43.48	31.03	0.04	31.03	0.08	51.14
$CuSO_4$	43.34	30.10	−0.02	30.10	359.95	48.31
$K_2Cr_2O_7$	43.45	27.41	2.41	27.41	5.05	66.53
$SnCl_2$	40.54	16.27	−14.08	21.52	319.13	128.88

520 nm. Shifting of λ_{max} with change in pH is very prominent in the case of hibiscus flower extract. Stannous chloride lowered the pH of the anthocyanin extract from 2.55 to 1.81. At pH 3, 6, and 9, the λ_{max} shifts to 538 nm, 560 nm, and 552 nm, respectively, as shown in Table III.

Visible spectra of hibiscus extract and hibiscus-Sn extract at the same concentration is shown in Figure 5. It shows the change a shift in λ_{max} by the addition of stannous salt. This is very apparent. The change in color profile after adding stannous salt to anthocyanin extract at different pH was due to change in λ_{max} (Table III). Better chelation of Dye-Sn complex to the fabric is possibly responsible for good wash and light fastness.

The FTIR spectra of hibiscus anthocyanin dye (shown by blue line) and tin chelated anthocyanin (shown by black line) depict that anthocyanin dye shows intense peaks at 3500 (hydroxyl group) and at 1710 cm^{-1} (carbonyl group) whereas the Sn-chelated dye showed less intense peaks at the aforementioned values, through which it can be concluded that these changes are due to metal chelation by the *o*-hydroxy carbonyl moiety of the anthocyanin molecules as shown in Figure 6. Further more there are some changes in IR which can be seen at 1628 (aromatic -C = C-), 1220 (-O-C = O)-, 1127 (-C-C-), 929 cm^{-1} due to bonding with tin.

Dyeing of cotton and silk by hibiscus anthocyanin extract

Table IV shows the CIEL *a** *b** values of dyed cotton fabrics with Hibiscus anthocyanin extract after premordanting with different mordants, the dyeing after pretreatment with different inorganic salts caused shade change from dark pink, brown to purple. Varied hues of color were obtained from premordanting the cotton with alum, $SnCl_2$, $CuSO_4$, and $K_2Cr_2O_7$ and were dyed by anthocyanin extract of hibiscus flowers as shown in the Figure 7 and Table IV. The different mordants not only cause difference in hue color and significant changes in *K/S* values but also *L* values and brightness index values. The best values for *K/S* measured for cotton were obtained with stannous chloride.

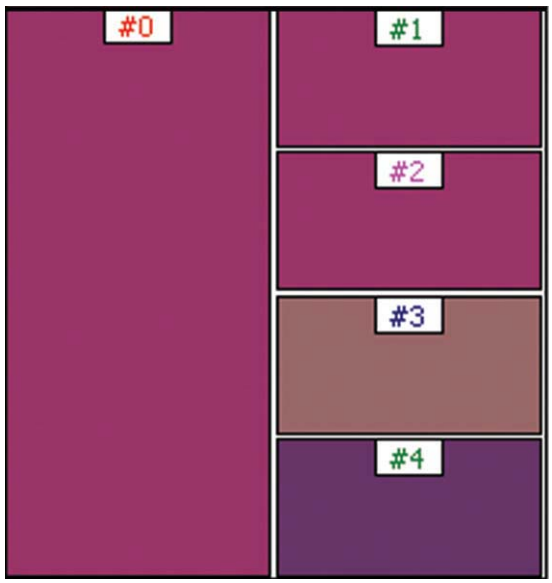

Figure 7 Hibiscus dyed cotton with different mordants. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

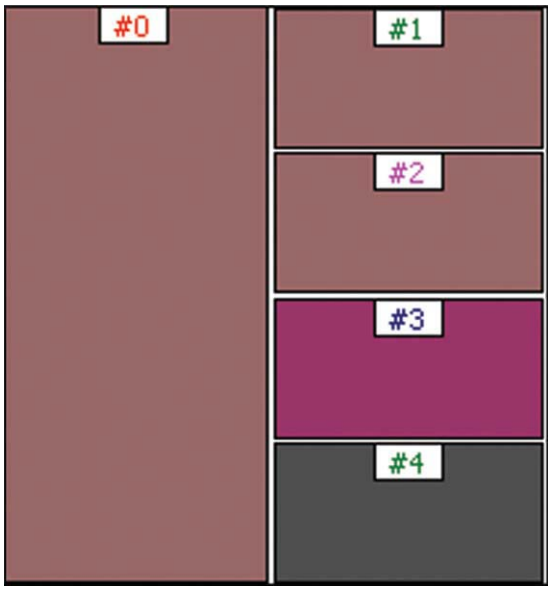

Figure 8 Hibiscus dyed silk with different mordants. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

TABLE VI
Fastness Properties of Dyed Cotton and Silk Fabrics with Different Metal Mordants with Hibiscus

	Wash–perspiration–rubbing–light					
Dyeing methods	WF[a]	Per_{acidic}	Per_{basic}	Rub_{dry}	Rub_{wet}	LF[b]
Cotton (control)	2–3	2	2	2–3	2–3	2
Cotton (Alum)	4	4	3–4	3–4	3–4	4
Cotton ($SnCl_2$)	4–5	4	4	4	4	4–5
Cotton ($CuSO_4$)	4	4	4	4	4	4
Silk (control)	2	2	2–3	2–3	2	2
Silk (Alum)	4	4	4	4	4	4
Silk ($SnCl_2$)	5	4–5	4–5	4–5	4–5	4–5
Silk ($CuSO_4$)	4–5	4	4	4	4	4–5

[a] Wash fastness.
[b] Light fastness.

Table V shows the CIEL *a* b** values of dyed silk fabric with hibiscus anthocyanin extract after pretreatment with different metal mordants, the dyeing with different mordants imparted a shade change from pink, brown to purple. Varied hues of color were obtained from premordanting the silk with alum, $SnCl_2$, $CuSO_4$, and $K_2Cr_2O_7$ and were dyed by anthocyanin extract of hibiscus flowers as shown in the Figure 8 and Table V. However, the *L* and *a** values showed dullness as compared to cotton. The best values are obtained with stannous chloride.

In the dyeing of cotton and silk fabrics, the best results were obtained from the premordanting method at acidic value (pH 4). Different color shades/tones were obtained of pinks (Al, Cu, and Cr) and purple (Sn). These color tones were obtained at pH 4. Utilization of anthocyanin extract from hibiscus flowers has been found to have good agronomic potential as a dye plant. Metal mordant when used in conjunction with the anthocyanin extract of *Hibiscus rosa sinensis* was found to enhance not only the dye ability but also the fastness properties of the dyed fabrics as compared with the controlled sample. Enhancement of dye uptake was better than nonmordanted fabric. Even the fastness properties in this case showed good results. The two step process of premordanting then dyeing was developed for the ease of industrial application.

The results of the washing fastness were also investigated and it was seen that the results were good particularly for $SnCl_2$ mordanted fabrics as shown in Table VI due to special conjugation of anthocyanin color moieties and stannous.

CONCLUSIONS

Hibiscus extract, already used to give color and flavor to beverages and many other food items whereas utilization of anthocyanin extract from hibiscus flowers as a source of dye plant has been attempted for the first time for textile dyeing. Use of metal mordant such as Sn, Al, and Cu in conjunction with the anthocyanin extract of *Hibiscus rosa sinensis* was found to enhance the dye ability along with improved fastness properties of the dyed fabrics as compared with the controlled sample. The two-step dyeing process of cotton and silk fabrics with pre mordanting method at acidic value (pH 4) yielded different color tones on silk and cotton specially one with tin mordanted having very good wash and light fastness. The developed shades will surely be liked by consumers in present global textile market.

This work was done mainly for utilization of natural dyes in silk industry.

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