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Extraction and Application of Novel Eco-friendly Natural Dye Obtained from Leaves of Sanamicky on Silk Fabric

Ebtsam S. Al-Amoudy[1*]

[1]*King Abdelaziz University, Jeddah, Saudi Arabia.*

Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

Sanamicky plant as a source of natural dye was used to dye silk fabrics; this plant has not been exploited as natural dye by far. Optimization of natural dye extraction from sanamicky leaves with respect to dye bath concentration to aid exhaustion was done. The effect of changed dye bath concentration on the reflectance spectra was followed using spectrophotometer tool and CIE tristimulus values. The color parameters including L, a, and b values were determined. The data obtained indicated that the color parameters were highly affected by changing dye concentration by this new dye. The color fastness of fabric was very important aspect, as end use of fabrics depends on this property. The silk dyed fabric samples with sanamicky were evaluated for color yield, color difference and color fastness to light, washing, rubbing, light, perspiration and heat. Finding shows that the natural dye extracted from sanamicky leaves have good potential in textiles dyeing and can be exploited further. So, the present work gives the chance to produce different hues from a new traditional natural dye to improve the natural dyeing cultural heritage to meet the environmental future demands technology of high quality fantastic dyed pattern through an economical point of view. It was seen that pH of 3 and temperature of 80°C were the ones that produced the best results in and silk.

**Corresponding author: E-mail: e.al-amoudi@hotmail.com;*

Keywords: Sanamicky plant; natural dye; optical properties; textiles dyeing; dyeing condition.

1. INTRODUCTION

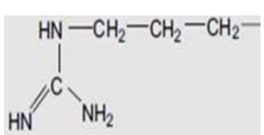
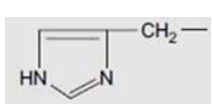
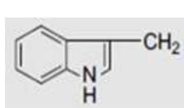
Silk worms produce protein fiber discovered 2700 BC. Silk fibers consist of 97% protein-fibroin, a filamentous protein and sericin (gum), a non-filamentous protein and also other impurities such as pigments, wax, carbohydrates, and inorganic salts. The proteins in the silk fiber are approximately 75% fibroin and 25% sericin by weight. The sericins strengthen the silk fiber and make it lack luster; therefore, it must be degummed before dyeing [1-3]. Silk is a natural protein (polypeptide) fiber which is composed of 18 amino acids with various reactive functional groups including hydroxyl and amine groups (Table 1) [4].

As a kind of protein fibers, silk was believed to be bonded to dyes mainly due to ionic interaction between free chemical groups of dyes and the carboxyl groups of silk. Silk fibers are protein-based and have a general chemical formula $NH_2.CHR.COOH$. There are various functional groups that can be found in proteins, which determine the polymer properties. The most important ones for dyeing of silk are COOH and NH_2 [5]. In dying process, dyes in solutions are adsorbed and diffused into the fiber, establishing with it physicochemical interactions [6].

Silk fiber is well known for its water absorbency, dyeing affinity, thermal tolerances, insulation properties and luster. Also, silk has unique combination of properties, such as high tensile strength, pleasant handle, and excellent draping property etc., which are not observed in any other fiber. Silk has never lost its appeal and today, it is being shown by all top fashion houses, and dyeing enhances its appeal and beauty. Silk fiber can be used in many products such as precious fabrics, parachutes, tire lining materials, artificial blood vessels, and surgical sutures. Silk fibers can be metalized and their conductivity increased, decorative material created, surface pattern, changed or functions such as water repellency applied. Also, fabrics can be made bioactive for medical applications like bandages, implants and surgical garments. Silk fibers are used in optical instrument because of their fine and uniform diameter and high strength and stability over a range of temperature and humidity. Using ceramic sensors such as piezo-fibers, it will be even possible to insert fibers into textiles to realize applications such as wearable computers.

Coloring is one of the most and delightful arts and the most important branches of manufacture. Before the mid of 19th century professional dyers of fine silks and woolens had to rely on such homely substances and dried insects, roots and leaves of plants, concluding that natural dyes are an education in ecology and ethics, where no other dyes provide a better opportunity teaching how to protect and respect the environment [7].

Table 1. The hydrogen and amine groups and the residues of the amino acids of silk

Functional group	Residue (R)	Amino acids	Composition (mol %)
- OH	$CH_3CH(OH)$ -	Threonine	0.91
	$HOCH_2$ -	Serine	12.10
- NH_2 or - NH -	$H_2NCH_2CH_2CH_2CH_2$ -	Lysine	0.32
		Arginine	0.47
		Histidine	0.14
		Tryptophan	0.11

The increased realization in the textile industry as well as among the conscious consumers to develop and demand eco- friendly methods of dyeing textiles has led to revive the old traditions of natural dyes as these are safer in use with minimum health hazards [8]. These are easily disposable, biodegradable, and can be used to make compost for agricultural purposes after they had been extracted. Our environment possesses potentially abundance of natural sources of colors. The plant world furnishes the principle source of dye stuff by which color could be developed and gives the yarn and the fabric a natural sheen. Recent findings claim that naturally dyed textiles have therapeutic properties, provide relief for arthritis, diabetes, headaches and over-excited nerves and are also good for blood circulation [9].

Various national and international organization are engaged in extracting color for dyeing from natural sources and efforts are still being made by researchers to overcome various drawbacks of natural dyes such as availability, poor reproducibility, lack of desirable fastness properties on textiles and lack of scientific information on the chemistry of dyeing and standardized dyeing methods [10]. Furthermore, natural dyes are known to exhibit better biodegradability, less toxicity, eco-friendly alternative to synthetic dyes*6 and some dyes also possess medicinal properties [11,12].

Nowadays, textile dyeing processing industry is one of the major environmental polluters; synthetic dyes have been in use globally in textile industries due to their availability, lower prices and wider ranges of bright shades with considerably improved color fastness properties in comparison with natural dyes [13]. But according to the application of synthetic dyes, much water effluent generated during textile dyeing would pollute the environment as it contains a heavy load of chemicals, where it is estimated that 10-15% of the dye is lost in the effluent during the dyeing process [14]. Thus renewed international interest has arisen in natural dyes which have gained momentum due to the increased awareness of the environmental and health hazards associated with synthetic dyes [14], in addition to their creative potential, excellent fastness, repeatability, softness lustrous subtle and bright where appearance is generally regarded as the most important textile attribute for consumer acceptance and end use. The natural dyes present in plants and animals are pigment molecules [15], which impart color to the materials. Natural dyes may have a wide range of shades, and can be obtained from various parts of plants including roots, bark, leaves, flowers, and fruit [16].

Senna (from Arabic *sanā*), the sennas, is a large genus of flowering plants in the legume family Fabaceae, and the subfamily Caesalpinioideae. This diverse genus is native throughout the tropics, with a small number of species in temperate regions. The number of species is estimated to be from about 260 [17] to 350 [18]. The type species for the genus is *Senna alexandrina*. About 50 species of *Senna* are known in cultivation [19]. *Senna alexandrina* is an ornamental plant in the genus *Senna* (Fig. 1). It received the names "Alexandrian senna" and "Egyptian senna" because Alexandria in Egypt was the main trade port in past times. It is used in herbalism. *Senna alexandrina* is also known under the names Egyptian senna, Tinnevelly senna, East Indian senna or the French *séné de la palthe.* It grows natively in upper-Egypt especially in the Nubian region, and also near Khartoum (Sudan), where it is cultivated commercially. It is also grown elsewhere, notably in India and Somalia. Alexandrian Senna is a shrubby plant that reaches 0.5–1, rarely two meters in height with a branched, pale-green erect stem and long spreading branches bearing four or five pairs of leaves (Fig. 1). These leaves form complex, feathery, mutual pairs. The leaflets vary from 4 to 6 pairs, fully edged, with a sharp top. The midribs are equally divided at the base of the leaflets. The flowers are in raceme interior blossoms, big in size, coloured yellow that tends to brown. Its legume fruit are horned, broadly oblong, compressed and flat and contain about six seeds. When cultured, the plants are cut down semi-annually, dried in the sun, stripped and packed in palm-leaf bags. *Senna alexandrina* is used in medicine in the form of senna pods, or as herbal tea made from the leaves, as a laxative [20,21].

The present work concentrates in using sanamicky as natural dye for dyeing a natural fabric (silk). The dyeing properties were evaluated through studying the dye-ability and light fastness characteristics under the effect of different variables such as chemical structure of the dye and its concentration, nature of the substrate. Also, the silk dyed fabric samples were evaluated for color yield, color difference and color fastness to light, washing, rubbing, light, perspiration and heat.

Fig. 1. *Senna alexandrina*

2. EXPERIMENTAL DETAILS

2.1 Materials

2.1.1 Fabric samples

Silk samples, 55 g per m^2 in weight and 0.06 cm in thickness produced in Akhmim, Egypt, were used for investigation without any purification.

2.1.2 Extraction of colorant

Dried leaves of the plant called sanamicky were used for obtaining the dye used in the present research without the application of any mordant in the dyeing process. 50 g of these leaves after crushing it were immersed in 500 ml of distilled water and allowed to boil for 1 hour.

The optical density of the extract solution after filtration was evaluated, and taken as a measure of concentration, by a Shimadzu (VIS) Double Beam Spectrophotometer with standard illuminant C (1174.83) Model V-530 and band width 2.0 nm cover the range 200-2500 nm with accuracy ±0.05%. Fig. 2 shows the absorption spectrum of the aqueous extract of the sanamicky leaves. It represents two peaks at yellow color range: the first has λ_{max} at 420 nm of optical density 2.77 and the second has λ_{max} at 460 nm of optical density 1.55. The dried leaves of sanamicky plant were found to discharge color in hot water very easily. Increasing the quantity of barks from 2 to 12 g per 1000 ml, water boiled for 1 hour is accompanied with the increase in color strength and depth in color.

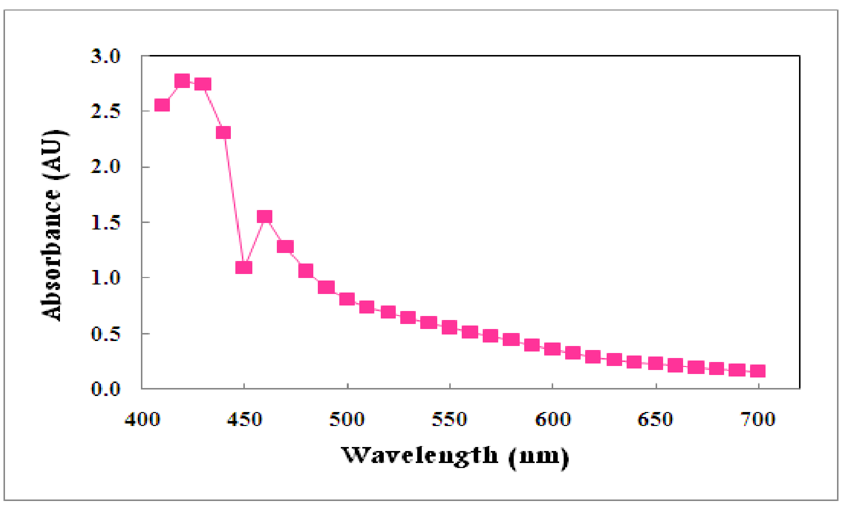


Fig. 2. The absorbance spectrum of extract of sanamicky leaves allover UV-Vis range

2.1.3 Dyeing method

Dyeing of silk fabrics was carried out using a liquor ratio of 1:50 at 80℃ for 1 hour for each concentration [22]. Then the samples were thoroughly washed with cold water and dried at ambient temperature. Different shades were obtained by using various concentrations. It produced shades ranging from hell yellow to dull yellow. Thus, a wide range of shades was obtained from a single source of dye.

2.2 Spectroscopic Measurements

The measurements in the visible range from 400 to 700 nm for the blank and dyed silk with sanamicky dye were carried out using a Shimadzu (VIS) Double Beam Spectrophotometer with standard illuminant C (1174.83) Model V-530 and band width 2.0 nm covers the range 200-2500 nm with accuracy ±0.05%. The CIE Colorimetric System, CIE 1931 2-degree Standard Observer were used to analyze the color properties [23,24].

The tristimulus values X, Y, and Z of any color were found by multiplying together, the numerical values of reflectance from the reflectance curve of the color in question with the spectral distribution curve and the values of the energy of the radiation falling on the specimen at definite intervals of wavelength, and integrating the results over the whole range of the visible spectrum. The tristimulus values X, Y, and Z were very seldom used for designating a color. Each tristimulus value was divided by the sum of the three values (X, Y, and Z) and then denoted as x, y and z. The hunter coordinates L, a, and b of the blank and dyed silk fabrics by different concentrations of sanamicky dye was calculated from the values of x, y and z. A higher values of a and b indicate brightness which is more due to redness and yellowness, respectively, and their negative values indicate greenness and blueness which are more towards the dull side. A lower value of L results in a greater depth of the dye. The human eye can detect small differences in color, but it is difficult to quantify color difference (ΔE) accurately. Instrumental measurements can overcome this problem by using modern instruments that are able to measure tristimulus values accurately and reproducibly, and the ΔE is used, the function of which is to provide a single number which is more precise and nearly equivalent to the grade of the visual difference between different colors [25].

The color yield or color strength (K/S) of the dyed silk fabrics by sanamicky dye was determined from the tristimulus values in the visible spectrum region 400-780 nm and the reflectance percentage at the maximum absorption wavelength (λ_{max} = 460 nm). K/S was calculated using Kubelka-Munk relation [26-28]:

$$K/S = (1 - R)^2 / 2R \quad (1)$$

K is known as the absorption coefficient (is dependent on the dye stuff) and S is the scattering coefficient (is dependent on the substrate).

The absorption coefficient (α) was calculated from the optical transmission and reflection spectrum in the range from 400 to 700 nm by using the equation [29-31]:

$$A = (1/d)\ \ell n\ [(1-R)^2 / T] \quad (2)$$

Where R is the reflectance, T is the transmittance (≈ 10^{-4} in the present work) and d is the thickness of the sample (0.01 cm).

2.3 Fastness Properties

Light fastness is the resistance of a material to a change in its characteristics as a result of light exposure. All the silk fabrics under test were exposed to artificial day light using Tera Light Fastness Tester [32] for 160 hours at a temperature of 25±2℃ and at a relative humidity of 65±5%. A standard blue scale was hanged alongside the samples (ISO 105-B02).

The dyed samples were evaluated for color fastness to washing and for both alkaline and acidic perspiration in accordance to the AATCC Standard method (AATCC, 1997 & 1996). Wash fastness tests were carried out according to the ISO 105-C10 method. A specimen of the textile in contact with one or two specified adjacent fabrics is mechanically agitated under specified conditions of time 30 minutes and 50℃ for temperature in soap or soap and soda solution, then rinse and dried. The change in the color of the specimen and the staining of the adjacent fabric were assessed with the reference to the original fabrics, using the grey scale. Perspiration fastness was evaluated according to ISO 105-E04 method.

Rubbing fastness was determined using Martendale method and according to ISO105-X12.

Heat resistance was tested by keeping the silk fabrics at various temperatures viz. 50, 60 and 70℃ for 30 minutes in the oven without water.

3. RESULTS AND DISCUSSION

3.1 Visible Spectroscopic Analysis

From the values of the reflectance (%), R%, measurements (data not shown for simplicity), the variations of color parameters [L, a, b, and ∆E] were calculated for silk fabrics dyed with sanamicky with different concentrations before and after exposure to artificial day light for 160 hours. The results were tabulated in Table 2.

As well known, L parameter measures the brightness of the fabric and varies from 100 for perfect white to zero for black. From the table for L results, it is noticed that L value decreased steeply by increasing dye bath concentration from 2 to 6 g/l by about 6%, and then stay nearly constant till 10 g/l of dye bath concentration, and then a small decrease occurred at 12 g/l concentration. This result means that, by increasing the concentration of the dye bath for dyeing silk fabric, the value of the color parameter L decreases, i.e., the fabric becomes dull yellow. After 160 hours of light exposure, the L behaves the same trend and the values of L increased by about 6.5% than that before exposure, i.e., the silk fabrics became brighter.

The color constant, a, varies from green for negative value and red for positive value. The color parameter, a, value drops when increasing dye bath concentration from 2 to 4 g/l by about 133%, and then an increase by about 90% at dye bath concentration of 6 g/l. No remarkable change occurs in the value of ‘a’ till reaching a dye bath concentration of 12 g/l. Drop in ‘a’ value means that greenness dominant, while increase in ‘a’ value indicates redness. After exposure to artificial light for 160 hours, the values of ‘a’ have the same trend, but all its values at all dye bath concentrations increased than that of the unexposed ones.

The color parameter, b, Increases dramatically at dye bath concentration from 2 to 8 g/l, then decreases steeply at both 10 and 12 g/l of dye bath concentrations. Increase in ‘b’ value means yellowness, while decrease means blueness. After exposure to artificial day light for 160 hours, the ‘b’ trend takes the same track but all its values increase than that of the unexposed ones.

The behavior of the color difference (∆E) shows increases by increasing dye concentration from 2 to 6 g/l then stays constant till concentration of 12 g/l. After exposure to artificial day light ∆E values decrease than that values before exposure and have the same behavior as that of before exposure.

The observed changes in the color parameters with the increase in the concentration of dye bath may be due to the change in the physical bonds and then changes in the molecular configuration of the fabric, which may lead to formation of new doping centers of the polymeric material. In addition, the obtained results of the color parameters are of great importance for the improvement of the optical properties of the fabrics.

Color strength (K/S) value of a dyed material has a close relationship to the amount of dye absorbed by the fabric. The effect of increase in the quantity of sanamicky leaves in the extraction bath on relative color strength (K/S) of the fabric is shown in Fig. 3. With increase in the quantity of sanamicky leaves in the extraction bath (up to 6 g/l); the color strength values increases markedly. Further increase in the quantity of the dye (up to 10 g/l) in the extraction bath does not give noticeable increase in the color strength value of fabric, rather it remains constant. This effect can be attributed to the phenomenon of dye getting saturated in limited quantity of water which is used for extraction, thus dye solution achieving a state of equilibrium. It can also be said that, higher the quantity of sanamicky leaves in the extraction bath, higher is the coloring component extracted and higher is the color strength of the fabric dyed with these extracts until the dye exhaustion on fabric attains equilibrium, i.e., equilibrium between the dye in solution and the fiber surface has limited adsorption capacity for dye molecules, when dye concentration in the bath increases the surface gradually gets saturated keeping K/S values almost constant.

In addition, it is clear from the figure that, by increasing the dye concentration up to 12 g/l, the K/S values increased (about 77 and 83% before and after exposure to artificial day light for 160 hours, respectively) which indicating deeper shades. Also, the effect of the dye bath concentration can be attributed to the correlation between dye and silk fibers. Since the dye used is a water soluble dye containing anionic groups it would interact ionically with the protonated terminal amino groups of silk fibers via ion exchange reaction. This ionic attraction would increase the dye-ability of the fiber. This increase in the dye-ability by increasing the concentration may be attributed to the enhanced desorption of the dye [33], and also, may be due to the greater availability of the dye molecules in the vicinity of the fiber which was achieved by increasing the dye concentration. Since the dye-ability increase with decrease in crystallinity o the fabrics, that as is amorphousity increases, the diffusion increases too and this agrees well with the previously reported results [34-37].

The absorption spectral response (α) for the silk fabrics dyed with sanamicky dye under investigation is calculated in the visible wavelength range 400-700 nm (i.e., in the photon energy range 3.10-1.77 eV) and is represented in Fig. 4. It is noticed from the figure that the absorption coefficient values increase markedly with increasing wavelength for all samples. Also, it is clear that the absorption coefficient values decrease gradually with increase in the concentration of the dye bath.

The change in the absorption coefficient may be due to the change in the chemical bonds between the fabric and the dye, which form other molecular species [38]. This in turns leads to the formation of new color centers [39], i.e., preferential light absorption at particular wavelength. The dye components role is to strength the linkage between the reactive species of the silk fabric chemical groups and their polar groups. Besides, hydrogen bonds are found between hydroxyl group of the fabric and the chemical groups of the dye.

Table 2. The color parameters (L, a, b, and ∆E) for silk fabrics dyed with sanamicky before and after exposure to artificial day light for 160 hours

Conc. (g/l)	L		a		b		∆E	
	Before	After	Before	After	Before	After	Before	After
2	62.51	67.38	2.79	5.09	28.02	31.90	37.68	37.99
4	59.71	64.88	1.25	3.92	29.3	30.82	40.45	38.41
6	58.08	63.61	2.17	6.50	32.86	35.76	44.19	43.45
8	58.13	63.82	1.75	6.34	33.34	35.66	44.49	43.23
10	57.64	62.80	1.58	5.65	32.46	34.97	44.17	43.15
12	56.25	60.10	1.86	6.30	31.54	34.67	44.50	44.65

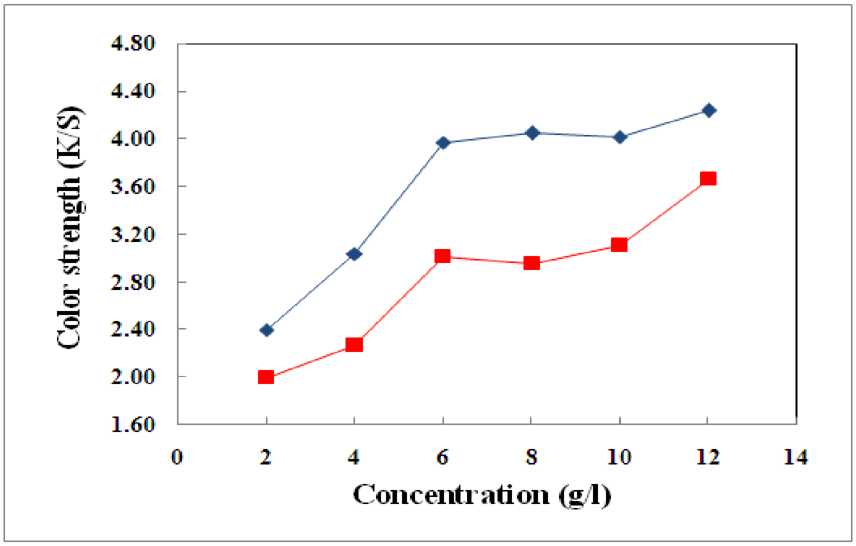


Fig. 3. Relation between color strength values and dye bath concentration used for dyeing silk fabrics with snamicky before (♦), and after (■) exposure to artificial day light for 160 hours

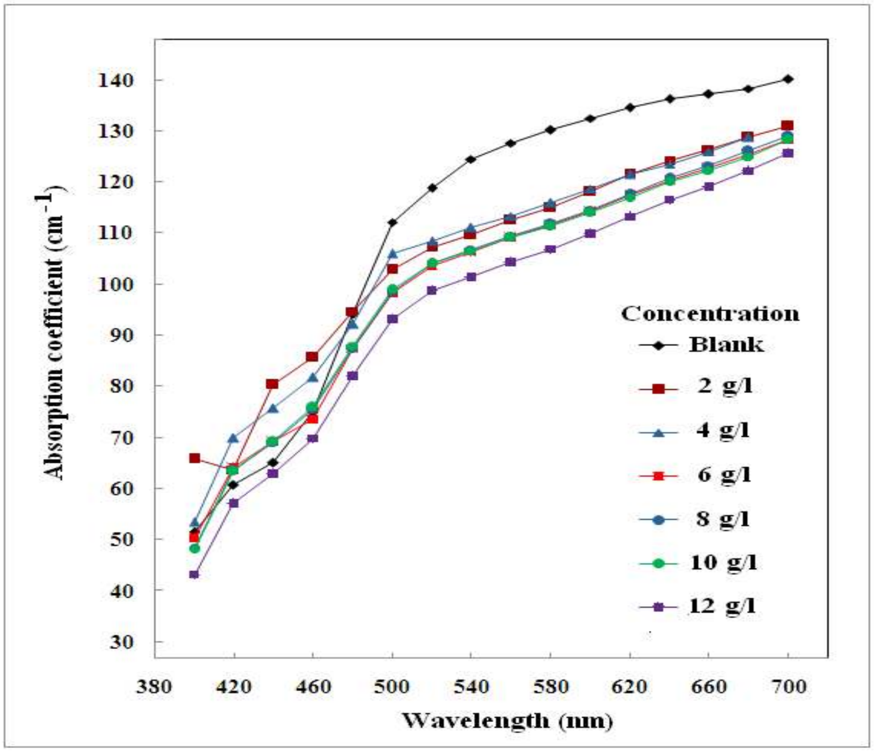


Fig. 4. Relation between the absorption coefficient values and dye bath concentration used for dyeing silk fabrics with sanamicky before and after exposure to artificial day light for 160 hours

Table 3. Color fastness grades (color change, cc, and case of staining, cs) of sanamicky dye on silk fabrics

Conc. (g/l)	Washing		Light	Perspiration				Rubbing			
				Acid		Alkali		Dry		Wet	
	cc	cs	cc	cc	cs	cc	cs	cc	cs	cc	cs
2	(4/5)	4	(4/5)	(3/4)	(3/4)	(3/4)	(3/4)	4	(4/5)	4	4
4	(4/5)	4	(4/5)	(3/4)	(3/4)	(3/4)	(3/4)	4	(4/5)	4	4
6	(4/5)	4	(4/5)	(3/4)	(3/4)	4	4	4	(4/5)	4	4
8	(4/5)	4	(4/5)	4	4	4	(4/5)	(4/5)	(4/5)	(4/5)	(4/5)
10	(4/5)	(4/5)	(4/5)	4	4	(4/5)	(4/5)	(4/5)	(4/5)	(4/5)	(4/5)
12	(4/5)	(4/5)	(4/5)	4	4	(4/5)	(4/5)	(4/5)	(4/5)	(4/5)	(4/5)

3.2 Color Fastness

The color fastness of silk fabrics dyed with sanamicky dye is presented in Table 3. Washing, perspiration and rubbing fastness results were assessed with respect to grey scale and results for light fastness were assessed with respect to blue wool scale. Washing and rubbing fastness values of the samples dyed with different dye bath concentration show comparable results. In case of washing, perspiration and rubbing, the results being expressed in terms of change in color and staining of adjacent cotton and silk fabric.

From Table 3 it is evident that the light fastness grade of all the samples at different concentrations was 4/5 which indicating very good grade. Exposure of textile fabrics to light may result in changes to color and fiber properties. It is a complex process which is greatly affected by various factors, among which are the presence of water vapor and oxygen in the atmosphere, extent of air diffusion, chemical constitution of the dye, nature of the textile substrate, nature of the bond between the dye and the substrate, aggregation of the dye, energy of the incident radiation, temperature, and the presence of impurities in the dye-polymer system [40].

Also, light fastness is increased by increasing the dye concentration due to the enhancement in dye aggregation inside the fibers. Polarity of the substrate as well as its physical structure exerts a considerable influence in light fastness. The polar groups of the substrate tend to neutralize the polar group of the dye molecules in contact with the substrate by coulombic attraction, thereby decreasing fading.

The photo-degradation of the dyed polymer matrix is largely affected by free radicals produced that have high chemical activities upon irradiation. Also, the light stability of dyes depends on its physical state, i.e., size and location of associated particle and relative ease with which transient reactive species are formed on absorption. The crystalline amorphous ratio and molecular orientation of the substrate not only determine the state of aggregation of the dye inside the substrate, but also the rate of transportation of water vapor and air to the excited dye molecules [41]. A general rule followed by most dyes is that light fastness improves with rise in fiber treatment and the amount of voids present on its surface. Greater voids volume means higher light fastness of the dye fiber due increased association of the dye particles. It is also recorded that stronger dye-fiber bonds result in easier transfer of the excitation energy from the dye molecules to the macromolecules of the fiber. Hence, stronger covalent bonds result in higher aggregation of dye molecules in the substrate, increase in consumption of activation energy for dissociating the bond and consequently, less observed fading [42,43]. These results called the fact that, the void effect is dominant over the diffusion restriction effect on one hand. On the other hand, the strength of the covalent bonding formed between the dye and the substrate had affected considerably the light fastness property. In case of silk the dye, the NH group forms a series of strong covalent bonds resulting higher light fastness values. It is well known that the higher the polarity the higher the covalent bond and the higher the light fastness.

As represented in Table 3, the wash fastness grade for dyed silk fabric by sanamicky for color change (cc) was 4/5 at all concentrations, while in case of staining (cs) it was 4 for concentration from 2 up to 8 g/l then increase to 4/5 for concentrations 10 and 12 g/l (good to very good). It is been reported that wash fastness of the dye is influenced by the rate of diffusion of the dye and state of the dye inside the fiber [44].

From Table 3 the grade of perspiration grade for color change under acidic medium for silk fabric dyed with sanamicky at concentration of dye bath up to 6 g/l was 3/4 (very fair fastness), while at higher concentration it became 4. In case of alkaline medium, perspiration fastness grade for color change for silk fabric dyed with sanamicky was 3/4 for dye concentrations 2 and 4g/l then increase to 4 for concentration 8 g/l followed by grade 4/5 (very good) for both concentrations 10 and 12 g/l. Fastness rating for color staining for dyed silk fabric under acidic medium was 3/4 (very fair) at low concentration of dye, then increase to 4 and 4/5 (good and very good) at higher dye concentrations.

It is also noticed in Table 3 that dry and wet rubbing for color change was 4 (good) for silk dyed with sanamicky at dye concentration up to 6 g/l and then increase to 4/5 at concentration from 8 up to12 g/l. The dry rubbing fastness grade for color staining (cs) for all dyed silk fabrics at different concentrations of dye bath was 4/5 (very good), while that for wet rubbing was 4 (good) for all samples at concentration from 2 up 6 g/l, then increased to 4/5 for concentration up to 12 g/l.

It was found that all the dyed silk fabrics acquire fastness of grade (good), i.e., no change occur in heat fastness by increasing dye bath concentration. The control samples exhibited lower fastness properties, and dyed samples showed improved fastness properties with reference to light, washing, rubbing and perspiration. The reason attributed is the content of the dye, which may help in fixation of the dye with the fiber. Hence, dye concentration alters the light sorption characteristics of the dye. As well as makes it insoluble in water and ultimately improve washing fastness properties. It is evident from the data of Fig. 3 and Table 3 that the dye bath concentration plays an important role to the produced color strength and light fastness of the examined dyed samples. In virtue of the greater availability of the dye molecules at higher dye concentration present in the adjacent to the fabric surface, resulting in higher color strength and consequently, improved light fastness property.

4. CONCLUSIONS

The natural colorant obtained from sanamicky leaves has been successfully used as an eco-friendly dye to obtain different shades of yellow. In this study, the dye-ability of silk fabrics dyed with sanamicky dye extraction through changing dye bath concentration has been investigated. Color fastness properties to light, washing, perspiration, rubbing and heat of the silk samples dyed with sanamicky were improved, it could be used for commercial purposes and attain acceptable range. The use of this natural dye can be therefore being a potential substitute for the synthetic dyes which contain harmful and banned components.

It was concluded that the color values with respect to L, a, and b as well as K/S values were found to be influenced by the concentration of the dyeing bath with respect to the chemical structure of the used dye, where a broad variation in shade and color depth was achieved, given that the dye is environmentally and ecological acceptable for dyeing technology.

The present study was planned to be looked out for safer alternative for dyeing with natural dyes. It was found that sanamicky leaves dyes can be successfully used for dyeing of silk fabric to obtain wide range for soft hell shades. The process of extraction is simple and environmental friendly. The overall fastness properties of the dyed fabrics ranged from good to very good to excellent.

The present work shows that, leaves of sanamicky can be used as dye for coloring textiles. These are grown throughout India and it is easily available plant. Different shades of color can be obtained using different chemical and natural mordants. The washing, light, and rubbing fastness of all dyeing with mordants were quite good. The dye has good scope in the commercial dyeing of silk.

Tests of washing fastness showed satisfactory results indicating that there was a good fixation of the dye on the fiber. Considering that the dyeing process has great contribution of chemisorptions which promoted good color fastness to laundering, it is concluded that dyeing with sanamicky has huge advantages as the textile wastewater is much more degradable than the textile waste water produced with synthetic dye.

More importantly the dye registered suitable color fastness to light, washing, Perspiration, rubbing and heat in the range of grades 4 to 4/5.

The use of natural dyes however can offer not only a rich and diverse source of dyestuff, but also provide an alternative source and sustainable income to farmers through harvest and sale of these plants. Hence, the present study was undertaken with the objectives of extraction and application of eco-friendly natural dye from sanamicky leaves on silk.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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