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Appliance of Natural Gums as Thickeners in the Process of Cotton Printing

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Abstract

In the present world, printing is most noteworthy of all the processes used to decorate textile materials. It is a renowned process used in textile industry to augment the aesthetic appeal of the fabric to gratify the buyer taste. Primarily, printing is a type of coloring in which the colors are applied to a particular areas rather than entire fabric. Thickeners are used to confine the coloring matter on the design during printing method. The use of synthetic thickeners in printing industry leads to a number of harmful effects on the environment. Hence in this study we have emphasized the use of different eco-friendly natural gums as thickeners to reduce the consequences on the environment. The printed samples were then assessed for color fastness to wash and rubbing. Experimental observations showed that the natural gums of neem, babul and moringa can be successfully used in printing of cotton fabrics as indigenous and natural thickeners.

Keywords: Thickener; Cotton; Neem; Babul; Moringa; Screen printing

Introduction

In this world with speedy change in taste and fashion of generations, at present the printing is most noteworthy process utilized to beautify the textile materials. Printing is an art used to add a varied pattern on a piece of woven fabric by using gorgeous vibrant colors. The inspiration for these printed designs with many iconic trendy prints arrived from the beginning of civilization across the globe [1]. The evidence of fabric prints rendezvous back to the 4th and 5th century BC. The first general method of textile printing originated in China, where the wood block printing samples of 220 AD have been discovered. Of course the techniques have changed rather a lot over the years, but textile printing is an ancient art of fabric.

Textile printing is the branch of textile wet processing industry and is becoming widely accepted technique for all fibers, varieties of fabrics and garments. Fundamentally, printing is a type of coloring, in which the colors are applied to a particular areas rather than whole fabric. The resultant multicolored patterns have beautiful and artistic effects, which enhances the value of the cloth more than that of the plain dyed. To confine the coloring matter to the design area, it is pasted with the help of a thickening agent. A successful print involves correct color, sharpness of mark, levelness, good hand and efficient use of dye. All these factors depend on the type of thickener used.

Thickeners used in textile printing are high molecular weight viscous compounds gave a sticky paste with water, which impart stickiness and plasticity to the printing paste. These thickeners facilitate to preserve the design outlines without spreading even under high pressure. The main purpose of thickeners in textile industry is to hold or adhere the dye particles on the desired areas of the fabric until the dye transferred onto the fabric surface and its fixation got over. Thickener will provide the required viscosity to the printing pastes, prevent the premature reactions between the chemicals of the print paste and helps to seize the ingredients of the print paste on the fabrics. The thickener must be stable and compatible with the dyes and dyeing auxiliaries used [2].

The thickener may be a natural or synthetic polymer. The use of man-made thickener in printing industry leads to several harmful effects on the environment. But this effect can be minimized by using eco-friendly natural thickeners in place of synthetic one [3]. The sources of natural thickeners are being extensively stretched throughout the plant kingdom and easily available in a large extent. The constituents of natural thickener are non-allergic and non-toxic to human being and cause no health hazard. The foremost required property of thickeners in textile printing is that, they have to be either soluble in water or absorb water to form viscous solution. This requirement is completely fulfilled by natural thickeners. In this work we have used naturally and easily available gums of plants grown around our institutes as thickeners. The gums of Neem, Babul and Drum Stick trees are used as thickeners in printing of cotton using reactive dye.

Materials and Method

Materials

***Azadirachta indica* gum:** *Azadirachta indica* commonly known as Neem is an evergreen and wonder tree of modern era. Since time immemorial it has been used by Indians for various purposes because of its extensive properties. It possesses antibacterial, anticarcinogenic, antiviral, cytotoxic and anti-inflammatory properties. The phytochemical constituents present in Neem are nimbidin, nimbin, nimbolide, azadirachtin, gallic acid, epicatechin, catechin and margolone. The chief active constituent azadirachtin is an effective antimicrobial agent.

Neem Gum is normally exudates from Neem tree by induced or natural damage. The bark of Neem possesses antibacterial and deodorant activity. Due to various internal activities the Neem bark

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discharges apparent, intense and brown-colored gum substance, which is non-bitter in flavor and dissolves in cold water. The gum is a versatile by product. The gum exudates from the stem of *Azadirachta indica* tree consists of a mixture of proteins and polysugars. The presence of D- glucose, D-glucoronic acid, L-arabinose, L-fucose, mannose, xylose, rhamnose, D- glucosamine, aldobiuronic acid, serine, threonine and aspartic acid in *Azadirachta indica* gum is reported. In addition, it also contains organic fatty acids [4,5].

Acacia nilotica gum: Acacia is a genus of shrubs and tree belongs to the subfamily of *Mimosoideae* of the family *Fabaceae* or *Leguminosae*. In India it is generally known as 'Babul'or 'Kikar'. It is moderate sized tree with spread crown and broadly scattered in tropical and subtropical countries. This plant possesses antibacterial, antifungal, antiviral, antimicrobial, antihypertensive, antimalarial and antispasmodial activities. It is a single stemmed plant and stems exude a reddish color gum. *Acacia nilotica* gum is known as 'Indian gum Arabic'. *Acacia Nilotica* gum varies in color from very pale yellowish brown to dark reddish brown depending on the amount of tannins in the sample. The gum contains galactose, L-arabinose, L-rhamnose and four aldobiouronic acids [6].

***Moringa oleifera* gum:** *Moringa Oleifera* is a fast growing drought resistant tree generally known as Moringa or Drumstick. It is the extensively cultivated variety of the genus Moringa of the family *Moringaceae*. This rapidly growing tree was utilized by the ancient Indians, Romans, Greeks and Egyptians for various purposes. *Moringa oleifera* is an important food commodity and received an enormous attention as the 'natural nutrition of the tropics'. Now a day, it is widely cultivated and become common in many locations in the tropics. The gum exudates from the stem of *Moringa Oleifera* is initially white in color and changes to reddish brown or brownish black on exposure. Gum is sparingly soluble in water. It swells in contact with water and gives a highly viscous solution. *Moringa Oleifera* gum is a polyuronide, the purified form contains L-arabinose, D-galactose, D-glucuronic acid, L-rhamnose, D-mannose and D-xylose [7].

Chemicals: Chemicals such as urea (NH_2CONH_2), sodium bicarbonate ($NaHCO_3$), wetting agent (soap), sodium chloride (NaCl), m- Nitrobenzene sulphonic acid, acetic acid (CH_3COOH) and C.I. Reactive RedM_8 B dye are used in the printing process.

Fabric: Cotton is the most vital natural vegetable fiber used in the world to produce apparel, home furnishings and industrial products. It can be dyed easily with a wide variety of colors. Cotton fabrics are able to absorb significant amount of moisture. Cotton garments are therefore comfortable and cool, passing on the perspiration from the body into the surrounding air [8]. Thus commercially available cotton fabric was procured from the market, which was plain weaved with 114g/m^2 weight.

Methods

Scouring: Scouring is a treatment that reduces the impurities present in the fabric and facilitates the reproducibility of dyeing with good finishing results. The complex natural impurities present in cotton substrate are removed with the aid of alkaline scouring agent and detergent, in order to enhance the uniformity of further processes. The cleaned fabric is treated in a bath containing 3% sodium hydroxide, 2% sodium carbonate and 1% wetting agent and boiled for 2 to 3 hour with M:L ratio of 1:50. It enhances the absorbance capacity of the fabric and leads to uniform dyeing [9].

Bleaching: Even after the scouring process the fabric still contains naturally occurring coloring matter, which can be removed with the help of bleaching agents. The bleaching process involves the use of both oxidizing and reducing bleaching agents, where as hydrogen peroxide is a commonly used one. In the bleaching process hydrogen peroxide liberates per hydroxyl ion, which is highly unstable. In the presence of oxidisable substances (colored impurities in cotton), the per-hydroxyl ions decompose and bleaching takes place [10,11].

The scoured fabric is bleached by using two bath methods. The bath is prepared by taking 2% hydrogen peroxide, 2% caustic soda and 3% sodium silicate with M:L ratio of 1:30. Then material is dipped into the bath at 40°C and temperature of bath raised up to 80°C and maintained for two hours. Afterwards the fabric is treated in a second bath. The second bath is prepared by taking 4% hydrogen peroxide, 3% caustic soda and 4% sodium silicate with M:L ratio of 1:30. Then the material is immersed into the bath at 40°C and temperature of bath raised to 90°C and continued for two hours. It gives uniform whiteness to the fabric and also enhances the absorbency property, which helps for perfect dying.

Extraction of gum: The gum collected from trees (injured site) was shade dried, powdered to desired size and passed through sieve [12]. The dried gum powder of 10g was added to 250cm^3 distilled water and stirred for 6-8 hrs at room temperature. The solution is subjected to centrifuge. The clear solution obtained is rich in dissolved gum known as supernatant. But the residue contains still gum, so it was washed with water and the washings were added to supernatant. This process was repeated for four more times. Then the supernatant was made up to 500cm^3 and treated with twice the volume of acetone (1000cm^3) by continuous stirring. The precipitated material was washed with distilled water and dried at 50-60°C.

Printing recipe: The printing of reactive dye was carried out by direct style on cotton. Printing paste was prepared by using Xg of reactive dye (1g, 3g and 5g), 20g urea, 3g Resist Salt, 4g sodium bicarbonate, 43g thickener (6% Paste) and 25 cm^3 water and total to 100gm paste. The above ingredients are mixed with the help of an electric stirrer to get uniform paste. The screen printing was used to print on cotton with above paste. Then it has dried at 40°C and steamed quickly in saturated steam for 5-10 minutes. The cotton printed fabric was washed and soaped with 5g/litre at 70-80°C for 15 minutes. Finally printed fabric with natural gum as thickener is subjected to hot wash and cold wash followed by drying [13-14].

Fastness tests: Color fastness is one of the important factors in case of buyers demand. Color fastness of dyed sample was assessed for washing and rubbing fastness.

Fastness to washing: Since the consumers clean their fabric at several times in the lifespan of the textile. Change of color or staining on another garment during laundering is by and large directly apparent to the consumer. Also it has a high impact on user's gratification. So assessment of color fastness to wash is enormously important. Color fastness to washing of the printed fabric samples was determined as per ISO 105-C10:2006 method [15].

Fastness to rubbing: Fastness to rubbing is used to ensure that

Table 1: Color fastness of printed cotton fabric with various thickeners.

Thickener	Color fastness to Washing	Color fastness to Rubbing	
	Grade	Grade	
		Dry	Wet
Azadirachta Indica gum	4-5	4-5	4
Acacia Nilotica gum	4-5	4-5	4
Moringa Oleifera gum	4-5	4-5	3-4

Grades Note: 5 - Excellent; 4 - Good; 3 - Fair; 2 - Poor; 1 - Very Poor.

fabric doesn't transfer its color when rubbed against another layer of fabric or material. This test is also known as crocking and carried out by using a crock meter. Rubbing fastness test is carried out for both dry and wet cotton fabrics, where cotton fabric either in wet or dry form rubbed against the surface of the printed fabric to remove unfixed dye particles. Color fastness to rubbing of the dyed fabric samples was assessed as per ISO: 105-X12 method [16].

Results and Discussions

Rubbing fastness properties of printed fabric

The color fastness properties of screen printed samples were assessed for dry and wet rubbing. The degree of rubbing depends on the moisture content of textiles and also the covalent linkage between the reactive dye and fibre. Several textiles transfers more color when they are wet. Here, all three screens printed fabrics with different natural gum thickeners showed good dry rubbing fastness compared to that of wet rubbing fastness. The dry rubbing fastness grades are found well to excellent (4 to 5) for the cotton fabrics printed with *Azadirachta Indica* gum and *Acacia Nilotica* gum as thickeners. These two samples also showed good rubbing fastness grade even for wet rubbing (grade 4). But in case of cotton fabric printed with *Moringa Oleifera* gum thickener, the rubbing fastness degree is good to excellent for dry rubbing and for wet rubbing it is fair to good (3-4). The color fastness to washing and rubbing on printed cotton fabrics is presented in Table 1.

Wash fastness properties of printed fabric

Washing fastness grades for the color change of all the three samples with different thickeners were observed between 4 to 5. Washing fastness grades clearly reveals that very slight color change was observed with different thickeners. The results indicated that the cotton fabric printed using natural thickeners, which extracted from Azadirachta Indica, *Acacia Nilotica* and *Moringa Oleifera* gums showed good to excellent wash fastness. The superior washing property of colorant may be due to the kinetics and thermodynamic effects of the thickener and dye complex formed.

Conclusion

The thickeners can be successfully extracted from the gums of natural resources, Azadirachta Indica, *Acacia Nilotica* and *Moringa Oleifera*. The entire process of extraction of gum is simple and eco-friendly. All the printed samples with natural gum thickeners exhibited the excellent fastness towards washing and dry rubbing. Even the wet fastness rubbing grade is good to excellent for the fabrics printed with *Azadirachta Indica* and *Acacia Nilotica* gums as thickeners. Fabric printed with *Moringa Oleifera* gum thickener showed fair grade for wet rubbing fastness compared to other two thickeners,. The whole process of extraction and printing is environment friendly and simple. The printing of reactive dye using natural thickeners can be done on all types of fabrics. It considerably reduces the dependency on effluent treatment plants. It prevents pollution and reduces the cost of effluent treatment for industries. From the present study it can be concluded that by using the gums of Azadirachta Indica, *Acacia Nilotica* and *Moringa Oleifera* trees as thickening agents, cotton fabric can be printed with reactive dye valuably.

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