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Effect of annatto and Arjuna dye extract for improving colour fastness properties of direct printed silk fabric

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Abstract
Natural dyes which were ignored during last sixty years into background by synthetic dyes, are recently again becoming object of consumer interest due to awareness of possible risks arisen by synthetic dyes. These days the consumer interest towards natural dyes is increased because natural dyes are eco- friendly and non- toxic in the nature. Although, ecological awareness among the public has led to a renewed investigation of natural dyes, a lot of work has been carried out for dyeing of textiles using natural dyes but the work on printing is very limited. In order to fulfil the gap, a study was conducted to standardization of printing paste using two natural dyes Annatto and Arjuna were selected along with thickening agent guar gum powder, fixing agents chitosan, two mordants myrobalan and alum and cold pressed coconut oil as plasticizer to develop direct prints on silk fabric. The natural dye was extracted by aqueous extraction method followed by ultra-sonication of the dye extract. The two print paste combinations were developed with the combinations of two natural dyes and printing auxiliaries using standardized recipe. The screen printed silk fabric samples exhibits very good to excellent colour fastness properties and the developed prints was found highly acceptable among consumers for use as home textiles.

Keywords: Natural dyes, natural printing auxiliaries, guar gum powder, chitosan, screen printing

Introduction
Natural dyes has been used in India from thousands of years for dyeing and printing of textiles. India has a rich and diverse tradition in the textile industry with extremely sophisticated printing and decorating technique. Earlier, natural dye sources Madder, Tesu flowers, Indigo, Turmeric, Annatto, Morinda, Henna, Sappan wood, Barberry etc. are widely used as textile colorants (Uddin *et. al.*, 2022) [10]. But after the development of synthetic dyes, people rapidly shifted towards this due to its low cost, easy availability, wide range of shades and consistency along with good fastness properties (Savvidis *et. al.*, 2017) [9]. Instead of this few areas of world continued to maintain the use of natural dyes in textile industry for dyeing and printing. However, during the last few decades, the use of synthetic dyes is gradually decreasing due to increase environmental awareness and harmful effects because of either toxicity or their non-biodegradable nature and natural dye started regaining interest in textile dyeing and printing industries for its non-toxic and environment friendly nature (Yusuf *et. al.*, 2017) [11].
Now a days, both large and small textile manufacturing units have begun exploring natural sources for dyeing and printing of fabric in sustainable way (Sangamithirai, 2023) [8]. Dyeing and printing is the process of colouring the textile substrate like fibres, yarn or fabric with the dyes to enhance the aesthetic value of fabric. In dying process, the whole fabric is covered uniformly with one or more colours while in textile printing one or more colours are applied in in a predetermined pattern. (Abdelrahman, 2020) [1]. Traditionally textile printing techniques categorized into two types i.e. direct and indirect printing. The direct printing techniques is most popular method includes block printing, screen printing, digital printing, etc. whereas indirect printing technique includes resist printing, discharge printing, etc. (M. El-Kashouti, 2019) [4].
In order to develop print paste with better colour fastness characteristics along with sharp and defined designs, printing auxiliaries such as thickeners, fixing agents, etc. were needed with combinations of dye stuffs. (Panda, 2013).

Materials and Method

Selection of natural dyes and printing auxiliaries

In order to develop eco- friendly prints on silk fabric, two natural dyes Annatto and Arjuna were selected. The natural printing auxiliaries like guar gum as thickening agents, chitosan as fixing agents, alum and myrobalan as mordants and coconut oil as plasticizer were selected for the present study.

Preparation of printing paste

The dye extract used to develop print paste was extracted by aqueous method followed by the ultra-sonication of the dye extract. The scouring of silk fabric was carried out in order to remove impurities from the fabric as well as to increase the fabric absorbency as well as to achieve uniform printing and proper penetration of printing paste. The print paste is developed using the combinations of dye extract and printing auxiliaries, guar gum powder, myrobalan, alum, chitosan and coconut oil. The mordants were directly incorporated in the print paste. The standardized recipe was used to develop print paste combinations. The print paste combinations developed are as follows-

1. Annatto dye + guar gum powder + myrobalan + alum +chitosan +coconut oil (PPC 01)
2. Arjuna dye + guar gum powder + myrobalan + alum +chitosan +coconut oil (PPC 02)

After 18 hour, the prepared combinations further underwent for ball milling process, in order to make the print paste consistency smoother. Each prepared paste was subjected for 30 minutes at medium speed in ball milling machine. After ball milling process, the printing paste were ready to directly apply on the fabric surface.

Printing on the fabric

Screen printing technique was adopted for the study to develop direct prints on scoured silk fabric. The silk fabric was then printed by using combinations of developed print paste. For screen printing, the suitable amount of developed direct print paste was poured on the screen mesh and with the help of squeegee the print paste was transferred on the fabric. After printing, the samples were kept for 24 hours at room temperature.

After treatment

The screen printed samples were then dried, fixed by steaming process and rinsed in cold water. Each printed sample was subjected to steaming at 100^0 C for 10 minutes, The developed samples were assessed for subjective and objective evaluation on various parameters.

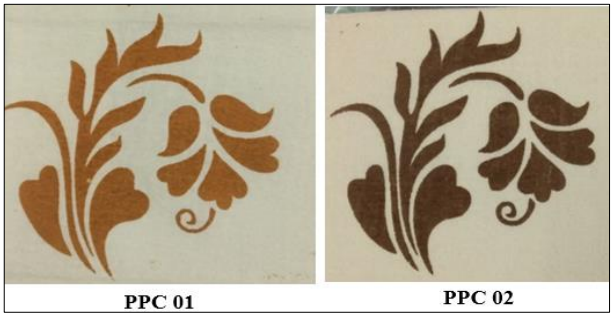

Fig 1: Screen printed silk fabric samples printed with developed print paste combinations

Results and Discussion

The printed samples were evaluated by subjective evaluation on various parameters like depth sharpness and uniformity of design and for colour fastness to washing, rubbing and light.

Subjective evaluation: For subjective evaluation, a panel of ten experts of Textiles and Apparel Designing assessed the printed samples on selected parameters such as depth of shade, uniformity of design and sharpness of design. The 5 point rating scale were used to evaluate the printed samples. The mean score obtained by the samples are shown in Table 1.

Table 1: Mean of the developed samples on various parameters

Print paste combinations	Parameters			
	Uniformity	Depth of shade	Sharpness of design	Mean
PPC 01	4.3	4.4	4.7	4.47
PPC 02	4.5	4.4	4.7	4.53

(PPC = Print Paste Combination, PPC 01 = annatto dye print paste combination, PPC 02= Arjuna dye print paste combination)

The samples printed with PPC 01 shows overall 4.37 mean in terms of uniformity of design, depth of shade and sharpness of the design whereas PPC 02 exhibits total 4.53 mean.

Objective evaluation

By using standard test procedures, the samples printed with annatto and arjuna dye extract were evaluated for the wash, rubbing and light fastness properties.

Table 2: Colour fastness of develop printed samples with annatto and Arjuna dye extract

Print paste combination	Parameters				
	Wash fastness		Rubbing fastness		Light fastness
	CC	CS	Dry rubbing	Wet rubbing	
PPC 01	4	4	4	4	6
PPC 02	4	4/5	4	3	8

(PPC = Print Paste Combination, PPC 01 = annatto dye print paste combination, PPC 02= Arjuna dye print paste combination, CC = Color Change, CS= Color Staining)

Note: 1- Very poor, 2- Poor, 3- Good, 4- Very good, 5- Excellent, 6- Very good, 7- Excellent

The screen printed silk fabric samples, combination PPC 01 exhibits good wash, rubbing and light fastness properties whereas PPC 02 exhibits good to excellent wash fastness, rubbing and light fastness properties. In case of wash fastness both samples showed very good wash fastness for both colour change and colour staining. With respect to dry rubbing, both samples exhibits very good fastness whereas in case of wet rubbing they showed good to very good fastness. The light fastness of the samples printed with PPC 01 exhibits very good fastness whereas PPC 02 gave excellent light fastness. The printed samples were found to be highly appreciable by consumers to develop home textiles products.

Hence, the results showed that the silk fabric direct printed using annatto and arjuna dye extract with guar gum powder as thickening agents and chitosan as fixing agent produce better results in terms of shades and colour fastness properties.

Conclusion

Findings conclude that the direct printed silk fabric samples using Annatto and Arjuna natural dyes exhibits better colour

fastness properties with standardized print paste using optimized printing auxiliaries. The results were found very encouraging and showed good potential for the use of natural dyes in textile printing industry in sustainable manner.

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