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5. Improved Dyeing of Polyester Fabric using Peanut Pod Natural Dyes, Al2So4, CuSo4 and FeSo4 Mordanting Agents

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ABSTRACT

Natural dyes are gotten from plants, spineless creatures, or minerals. The greater sources of natural dyes are vegetable colors from plant sources-roots, berries, bark, leaves, and wood—and other natural sources, for example, parasites and lichens.

Natural Dyess are mostly used to color regular textures like cotton, silk, wool, jute and so on. In any case, next to no data is accessible on coloring of synthetic textures like polyester, acrylic, nylon and so forth.

This paper is on utilization of natural dyes on natural fabrics as well as synthetic fabrics. The coloring of synthetic fabrics with natural dyes requires pre-treatments to produce hydrophilic groups. This paper highlights about the mordanting forms used to do coloring with natural dyes on natural fabrics and synthetic fabrics.

KEYWORDS

Natural dyes, synthetic fabric, mordanting, colorfastness properties.

1. Introduction:

Dyeing is the way toward including color on textile material items. The principal motivation behind the coloring on material can be increment esteem expansion, change of the execution and satisfy of the client's needs [2, 4]. Textile dyeing industry at present uses intemperate measure of manufactured colors to meet the required hue of worldwide utilization of textiles because of less expensive costs, more extensive scopes of bright shades, and impressively enhanced fastness properties in contrast with natural dyes. Coloring is an old craftsmanship which originates before composed records [26-28]. Its practice could be followed back amid the Bronze Age in Europe. That time, textile was dyed from natural sources like natural products, plants, berries, fruits and so on [10,19,31].

Natural dyes are known for their utilization in shading of food substrate, leather and in addition common strands like silk, wool and cotton as significant territories of use since pre-notable circumstances [1, 3].

Despite the fact that this old specialty of dyeing textiles with natural colors withstood the assaults of time, however because of the wide accessibility synthetic dyes at a prudent value, a quick decrease in natural dyeing proceeded with [1, 20].

Be that as it may, even following a century, the employments of natural dyes never disintegrate totally and they are by and large still utilized as a part of better places of the world [25, 30]. In this way, natural dyeing of various textiles and leathers has been proceeded with primarily in the decentralized part for claim to fame items other than the utilization of synthetic colors in the vast scale segment for general apparels/textiles [5, 6].

Polyester fiber (polyethylene terephthalate), PET) is an important synthetic fiber holding a highest market share in textile industry [7-9]. Polyester is a growing fiber for textile applications, particularly in the fashion industry. The future of polyester appears bright as more and more consumers are attracted by its easy-care properties. While the use of polyester is still restricted in some applications because of its low moisture regain [11-13].

Dyeing textiles with natural dyes has long been studied, especially for natural fibers like cotton and silk. Majority of the natural dyes are well soluble in water, so they can readily dye on hydrophilic textile fibers. Natural dyes are rarely found in use for dyeing synthetic fibers as these fibers are rather hydrophobic, in particular polyester fabrics [14, 15].

This makes a marginal possibility to produce the natural-dyed synthetic fabric textiles to fulfill a demand on an eco-friendlier textile product. It was proposed that the solubility parameter of the dyes and the textile substrates was the parameter took part in dyeability of the dye on the textiles [16, 17].

The dye which has a solubility parameter nearly similar to that of the fabric would exhibit a good dyeing property, then again, if the dye and the fabric have a great difference in the solubility parameter, the dye would exhibit a poor dyeing property on the fabric. This may be applied for studying polyester dyeing with natural dyes having varying water solubility. It was expected that the less water soluble, hydrophobic dyes would build-up well on the polyester fabric, whilst the water-soluble ones would hardly dye on the fabric [18, 21].

2. Materials and Methods:

2.1. Growing and Characterization of Peanut Pod:

The peanut is developed as a yearly product. It can grow up to 21/2 feet (75 centimeters) high and from 3 to 4 feet (90 to 120 centimeters) over. Peanut plants range in types from bunch plants to runner plants 6-8. Bunch plants develop upright [22]. Runner plants spread out on or close to the ground as they develop as appeared in Figure 1.

Figure 1: Peanuts found from the roots and crushed powder of the Peanut Pod

2.2. Cultivation:

Peanut plant develops best in light, all around depleted and sandy soil. They require much daylight, warm temperature, direct precipitation, and an ice free developing time of four or five months.

Farmers set up the dirt by plowing it deeply and thoroughly. Loose soil is vital so that the pegs can infiltrate the dirt effectively. Agriculturists plant nut seeds 2" to 3" (5 to 8 centimeters) profound at intervals of 3" to 6" (8 to 15 centimeters), and in rows 24" to 36" (60 to 90 centimeters) separated [23].

2.3. Selection of Dye Source and Extraction Method:

The initial segment of this research work was to get the peanut pods. For this examination work peanut pods were gathered from nearby market of Beawar City and afterward arranged it into two fragments, dim and light shading nut pod then after this nut unit were dried into non daylight territory [12].

After dried we crushed them into blender processor. Readiness of the color shower for coloring utilizing regular color includes soaking, crushing and boiling are normally important to separate the color from the vegetable matter. When all is said in done the coarser the material, the more it to be soaked and boiled as appeared in Figure 2 and Figure 3. During the time spent crushing, processor is utilized to make it in the powder shape. At the point when the powder shape is prepared, it is mixed with water solvent and warmed on gas burner to remove/extract the color/dye [24].

3. Mordanting:

A few dyes can be applied by any of 3 strategies (pre, simultaneous and post) however by and large one of the procedures gives preferable outcomes over the other if there should arise an occurrence of the vast majority of dyes.

a. Natural Mordants: - Alum (Al_2So_4), Copper Sulphate ($CuSo_4$) and Ferrous Sulphate ($FeSo_4$)
b. Optimization of mordant concentration: -10% concentration of mordant was used. The mordanting was done and samples were dyed employing extraction time, dye, dyeing time, dyeing temperature. Optimum mordant concentration was decided on the basis of evenness, brightness and darkness of the colour.

3.1 Preordaining:

The fabric is mordanted to start with, washed altogether with water and after that it is colored with dye arrangement. It's being a two bath process, expends additional time, water, steam. This technique gives most level outcomes.

3.2 Simultaneous Mordanting and Dyeing:

It is one of bath prepare dyeing and mordanting is done together in same bath. The texture to be mordanted and dyed must be secured with water, so that can be mixed effectively and color and severe can course altogether and achieve each part rapidly. Texture ought to be legitimately checked and accommodated that; mordant ought to be very much dissolved before dyeing blended with fabric.

3.3 Post Mordanting:

It comprises of basic coloring and since the lake is not framed at this stage, perfect preparation of color happens. The resulting mordanting settled the dye through lake arrangement [29].

4. Selection of Textile Substrate:

We have taken textures for this test work and that is polyester texture. Assurance of preparatory information of texture -

4.1 Thread count - One square cm was set apart on the polyester texture and number of warp and weft strings were counted. Five readings were taken and after that average was calculated.

4.2 Thickness of the fabric- Thickness analyzer was utilized to gauge thickness. Fabric was pressed to evacuate wrinkles. The lever of pressure foot was raised and texture was put on avail. Pressure foot was discharged gradually and thickness of texture was measured in mm from dial following 30 seconds. Thickness was determined at ten different places and mean was figured [12].

4.3 Weight per unit area- Five example or tests of 5"×4" were cut aimlessly from texture and weighted on electrical balances. The average of these five readings was taken [23]. Weight/Unit area was computed as given underneath -

$$W = \frac{\text{wt(gm)}}{28} \times \frac{36 \times 36}{20(\text{square inch.})}$$

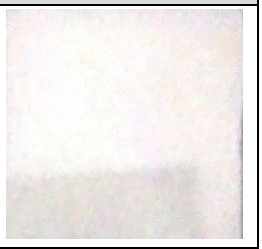
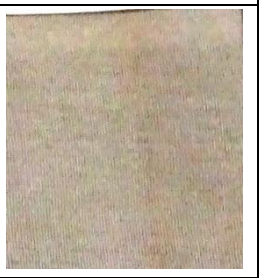
5. Result for Colorfastness on Different Fabric with Peanut Pod and Mordants:

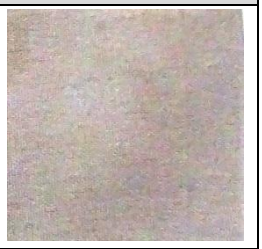
Great colorfastness keeps on being significant worry of the purchasers. Beauty of color on any fabric is of no incentive to purchaser unless the color is viewed as quick under conditions, it will be utilized, and that is the reason in this study colorfastness of various chemicals on various textures was evaluated. The texture is as per the following Polyester. The above examined focuses can be comprehended by various examination with five point gray scale, which is given by the six distinct tables.

Table 1: Polyester fabric with Copper Sulphate in Pre, Simultaneous and Post mordanting condition

Fabric	Specimen	Dye & Mordant	Dye %	Mordanting	Color Change Sun Light	Color Change Rubbing (Wet)	Color Change Rubbing (Dry)	Color Change Washing Fastness
Polyester Fabric		Peanut Pods(pp)	-	-	-			
	1	PP+ Copper Sulphate	10%	Pre	3/5	4/5	4	3/4
	2	PP+ Copper Sulphate	15%	Pre	3/5	4/5	4/5	4
	3	PP+ Copper Sulphate	10%	Simultaneous	3/5	4	4/5	4/5
	4	PP+ Copper Sulphate	15%	Simultaneous	4	4	4/5	4
	5	PP+ Copper Sulphate	10%	Post	4	4	4/5	4
	6	PP+ Copper Sulphate	15%	Post	3/4	4/5	4/5	4/5

Table 2: Polyester fabric using Copper Sulphate with K/S Analysis

Fabric	Specimen	Dye & Mordant	Dye %	Mordanting	K/S Value	Testing Results
Polyester	1	PP+ Copper Sulphate	10%	Pre	14.32	
	2	PP+ Copper Sulphate	15%	Pre	13.98	
	3	PP+ Copper Sulphate	10%	Simultaneous	14.53	
	4	PP+ Copper Sulphate	15%	Simultaneous	13.81	
	5	PP+ Copper Sulphate	10%	Post	14.26	

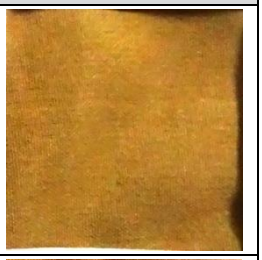
Fabric	Specimen	Dye & Mordant	Dye %	Mordanting	K/S Value	Testing Results
	6	PP+ Copper Sulphate	15%	Post	14.48	

It can be observed from the table 1 and 2 that Polyester fabric is reacted with the copper sulphate mordanting agent with 10% and 15% dyed solution. Here we have worked on three different conditions as Pre, Simultaneous and Post mordanting. In this we have observed that Polyester fabric gives good result with the 15% simultaneous and 10% in the post mordanting condition with in all tests and 15 % simultaneous good k/s value.

Table 3: Polyester fabric with Ferrous Sulphate in Pre, Simultaneous and Post mordanting condition

Fabric	Specimen	Dye & Mordant	Dye %	Mordanting	Color Change Sun Light	Color ChangeRubbing(Wet)	Color Change Rubbing (Dry)	Color Change Washing Fastness
Polyester Fabric		Peanut Pods(pp)	-	-	-			
	1	PP+ Ferrous Sulphate	10%	Pre	4/5	4/5	5	4/5
	2	PP+ Ferrous Sulphate	15%	Pre	4/5	4/5	5	4/5
	3	PP+ Ferrous Sulphate	10%	Simultaneous	4	4	4/5	4
	4	PP+ Ferrous Sulphate	15%	Simultaneous	4	4/5	4	4/5
	5	PP+ Ferrous Sulphate	10%	Post	4	4	4/5	4/5
	6	PP+ Ferrous Sulphate	15%	Post	4/5	4/5	4	4/5

Table 4: Polyester fabric using Ferrous Sulphate with K/S Analysis

Fabric	Specimen	Dye & Mordant	Dye %	Mordanting	K/S Value	Testing Results
Polyester	1	PP+ Ferrous Sulphate	10%	Pre	13.17	
	2	PP+ Ferrous Sulphate	15%	Pre	12.98	
	3	PP+ Ferrous Sulphate	10%	Simultaneous	14.83	
	4	PP+ Ferrous Sulphate	15%	Simultaneous	14.86	
	5	PP+ Ferrous Sulphate	10%	Post	13.57	
	6	PP+ Ferrous Sulphate	15%	Post	13.91	

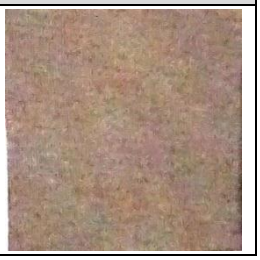
It can be observed from the table 3 and 4 that Polyester fabric is reacted with the ferrous sulphate mordanting agent with 10% and 15% dyed solution. Here we have worked on three different conditions as Pre, Simultaneous and Post mordanting.

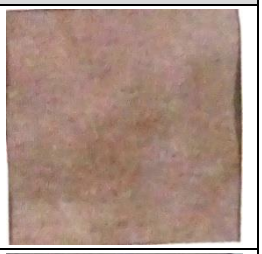
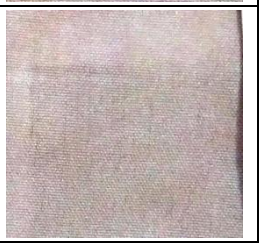
In this we have observed that Polyester fabric gives best result with thepre, simultaneous and post mordanting in 10% & 15% with all tests and 10% & 15% in pre mordanting condition gives good k/s value results.

Table 5: Polyester fabric with Alum in Pre, Simultaneous and Post mordanting condition

Fabric	Specimen	Dye & Mordant	Dye %	Mordanting	Color Change Sun Light	Color Change Rubbing (Wet)	Color Change Rubbing (Dry)	Color Change Washing Fastness
Polyester Fabric		Peanut Pods(pp)	-	-	-			
	1	PP+ alum	10%	Pre	3/4	3	3/4	3/4
	2	PP+ alum	15%	Pre	3/4	3	3	3/4
	3	PP+ alum	10%	Simultaneous	3	3	3/4	3
	4	PP+ alum	15%	Simultaneous	3/4	3	3/4	3
	5	PP+ alum	10%	Post	3	3	3	3
	6	PP+ alum	15%	Post	3/4	3	3/4	3/4

Table 6: Polyester fabric using Alum with K/S Analysis

Fabric	Specimen	Dye & Mordant	Dye %	Mordanting	K/S Value	Testing Results
Polyester	1	PP+ alum	10%	Pre	14.36	

Fabric	Specimen	Dye & Mordant	Dye %	Mordanting	K/S Value	Testing Results
	2	PP+ alum	15%	Pre	14.94	
	3	PP+ alum	10%	Simultaneous	15.14	
	4	PP+ alum	15%	Simultaneous	15.38	
	5	PP+ alum	10%	Post	15.86	
	6	PP+ alum	15%	Post	15.74	

It can be observed from the table 5 and 6 that Polyester fabric is reacted with the alum mordanting agent with 10% and 15% dyed solution. Here we have worked on three different conditions as Pre, Simultaneous and Post mordanting.

In this we have observed that Polyester fabric gives good result with the 10% in the pre mordanting condition and 15% in the post mordanting condition and 10% in pre mordanting condition gives good results in k/s value.

6. Conclusion:

So far, less work has been carried out on dyeing of synthetic fabric with natural dyes. Synthetic fabric requires pretreatment process before dyeing with natural dyes. Among pretreatment process majority of the work is carried out on mordant process. The natural dye along with mordant gives good fastness properties. There is need to carry out more research work to improve the fastness properties of natural dye on synthetic fabrics. There is need to develop data base with production of appropriate shade card for synthetic fabrics. (over all result of this study polyester fabric with ferrous sulphate in pre mordanting condition gives good to very good results)

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7. References:

1. Ali, S. Wazed, Subbiyan Rajendran, and Mangala Joshi. "Synthesis and characterization of chitosan and silver loaded chitosan nanoparticles for bioactive polyester." Carbohydrate Polymers 83.2 (2011): 438-446.
2. Aspland, J. R. "Disperse dyes and their application to polyester." Textile Chemist and Colorist 24 (1992): 18-18.
3. Billah, Shah M. Reduwan, Robert M. Christie, and Renzo Shamey. "Direct coloration of textiles with photochromic dyes. Part 1: application of spiroindolino naphthoxazines as disperse dyes to polyester, nylon and acrylic fabrics." Coloration Technology 124.4 (2008): 223-228.
4. Brodmann, George L. "Dyed polyester fabrics with improved lightfastness." U.S. Patent No. 4,812,139. 14 Mar. 1989.
5. Chen, Hsiou-Lien, and Leslie Davis Burns. "Environmental analysis of textile products." Clothing and Textiles Research Journal 24.3 (2006): 248-261.
6. Dastjerdi, Roya, and Majid Montazer. "A review on the application of inorganic nano-structured materials in the modification of textiles: focus on anti-microbial properties." Colloids and Surfaces B: Bio interfaces 79.1 (2010): 5-18.
7. Drivas, Ioannis, Richard S. Blackburn, and Christopher M. Rayner. "Natural anthraquinonoid colorants as platform chemicals in the synthesis of sustainable disperse dyes for polyesters." Dyes and pigments 88.1 (2011): 7-17.
8. El-Naggar, A. M., et al. "Antimicrobial protection of cotton and cotton/polyester fabrics by radiation and thermal treatments. I. Effect of ZnO formulation on the mechanical and dyeing properties." Journal of applied polymer science 88.5 (2003): 1129-1137.
9. Gorensek, Marija, and FranciSluga. "Modifying the UV blocking effect of polyester fabric." Textile Research Journal 74.6 (2004): 469-474.
10. Gulrajani, M. L., Deepti Gupta, and S. R. Maulik. "Studies on dyeing with natural dyes: Part I—Dyeing of annato on nylon and polyester." (1999).

11. Gulrajani, M. L., et al. "Application of silk sericin to polyester fabric." Journal of applied polymer science 109.1 (2008): 314-321.
12. Megha Kumari Chhipa, Sandhya Srivastav, Neetee Mehta "Suitability of Dyes from Peanut Pod on Different Fabrics Using Copper Sulphate Mordanting Agent," International Journal of Textile and Fashion Technology (IJTFT), Vol. 7, Issue 1, Feb (2017), 1-10.
13. Gupta, Deepti, Shipra Kumari, and Mohan Gulrajani. "Dyeing studies with hydroxyanthraquinones extracted from Indian madder. Part 2: Dyeing of nylon and polyester with nordamncanthal." Coloration Technology 117.6 (2001): 333-336.
14. Joshi, Mangala, S. Wazed Ali, and Subbiyan Rajendran. "Antibacterial finishing of polyester/cotton blend fabrics using neem (Azadirachtaindica): a natural bioactive agent." Journal of Applied Polymer Science 106.2 (2007): 793-800.
15. Khosravi, A., et al. "Synthesis and spectroscopic studies of some naphthalimide based disperse azo dyestuffs for the dyeing of polyester fibres." Dyes and pigments 69.1 (2006): 79-92.
16. Kim, Tae-Kyung, Young-A. Son, and Yong-Jin Lim. "Thermodynamic parameters of disperse dyeing on several polyester fibers having different molecular structures." Dyes and Pigments 67.3 (2005): 229-234.
17. Lehocky, Marian, and Ales Mracek. "Improvement of dye adsorption on synthetic polyester fibers by low temperature plasma pre-treatment." Czechoslovak Journal of Physics 56.2 (2006): B1277-B1282.
18. Lin, J. I. A. O. "Dyeing of polyester fabric with natural dye turmeric [J]." Dyeing and Finishing 4 (2005): 002.
19. Lunt, James, and J. Bone. "Properties and dyeability of fibers and fabrics produced from polylactide (PLA) polymers." AATCC REVIEW 1 (2001): 20-23.
20. Maeda, Shingo, et al. "One-bath dyeing of polyester/cotton blends with reactive disperse dyes in supercritical carbon dioxide." Textile research journal 74.11 (2004): 989-994.
21. Parvinzadeh, Mazeyar, and Roozbeh Hajiraissi. "Macro-and microemulsion silicone softeners on polyester fibers: evaluation of different physical properties." Journal of surfactants and detergents 11.4 (2008): 269-273.
22. Pasquet, V., et al. "Vanillin, a potential carrier for low temperature dyeing of polyester fabrics." Journal of Cleaner Production 43 (2013): 20-26.
23. Megha Kumari Chhipa, Sandhya Srivastav, Neetee Mehta, "Study of Dyeing of Cotton Fabric using Peanut Pod Natural Dyes using Al2So4 CuSo4 and FeSo4 Mordanting Agent", International Journal of Environmental & Agriculture Research (IJOEAR), Vol-3, Issue-2, (2017).
24. Perelshtein, Ilana, et al. "Sonochemical coating of silver nanoparticles on textile fabrics (nylon, polyester and cotton) and their antibacterial activity." Nanotechnology 19.24 (2008): 245705.
25. Räisänen, Riikka, Pertti Nousiainen, and Paavo H. Hynninen. "Emodin and dermocybin natural anthraquinones as high-temperature disperse dyes for polyester and polyamide." Textile Research Journal 71.10 (2001): 922-927.
26. Saligram, A. N., S. R. Shukla, and Manisha Mathur. "Dyeing of polyester fibres using ultrasound." Coloration Technology 109.7-8 (1993): 263-266.
27. Sarmadi, A. Majid, and Young Ah Kwon. "Improved Water Repellency and Surface Dyeing of Polyester Fabrics by Plasma Treatment." Textile Chemist & Colorist 25.12 (1993).

28. Sarmadi, Majid, A. R. Denes, and F. Denes. "Improved Dyeing Properties of SiCi 4 (ST)-Plasma Treated Polyester Fabrics." Textile Chemist & Colorist 28.6 (1996).
29. Son, Young-A., Jin-Pyo Hong, and Tae-Kyung Kim. "An approach to the dyeing of polyester fiber using indigo and its extended wash fastness properties." Dyes and Pigments 61.3 (2004): 263-272.
30. Xu, Weilin, and Xin Liu. "Surface modification of polyester fabric by corona discharge irradiation." European Polymer Journal 39.1 (2003): 199-202.
31. Yoon, Mee-Young, Jim Kellis, and A. J. Poulose. "Enzymatic Modification of Polyester." AATCC review 2.6 (2002)