ISSN: 2582-8118 ***Volume 2, Issue 6; Nov 2022***

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYSIS IN SCIENCE AND ENGINEERING

Web: https://www.iarj.in/index.php/ijrase/index

6. Study on Dyeing of Linen Fabric Using Peanut Pod Natural Dyes and Mordanting Agents Al2So4, CuSo4 and FeSo4

Megha Kumari Chhipa
Department of Home Science,
Bhagwant University,
Ajmer, Rajasthan, India.

Vishwa Nath Maurya
Executive Vice-Chancellor,
Chartered International Da Vinci University,
Delaware, USA.

Sandhya Srivastav
Department of Home Science,
Bhagwant University,
Ajmer, Rajasthan, India.

ABSTRACT:

Eco-friendly textiles are those textile products which do not contain any hazardous or toxic substance and are biologically degradable, so that they do not cause any damage to the environment. The Asian countries like India have a rich heritage and tradition of using natural dyes obtained from natural sources, as they are eco-friendly for textile products. However, after the discovery of synthetic dyes a steady decline in the use natural dyes has been noticed. The introduction of synthetic caused health hazards as well as environmental pollution. Hence textile colourists have started using natural dyes for colouring fabrics. These natural dyes exhibit better bio degradability and have better compatibility with the environment. In this colouring work, we have used the peanut pod as natural dye. Peanut pod as natural dye which is available plenty in India can be used as ecofriendly textile product. This material has been evaluated to find the effects of biodegradability and compatibility with environment in textile industries. Peanut pod are crushed and then alum, copper sulphate and ferrous sulphate as mordants are mixed with it. Fabric such as linen is coloured. The colored fabric has been tested for chemical and physical characteristics.

KEYWORDS

Peanut Pod, Dye Source, Mordanting Methods, Mordanting Agents, Natural Mordants.

1. Introduction:

Generally, dyes have its diverse applications such as in textile, paper, cosmetic, food, pharmaceutical and leather industries. The discovery of man-made synthetic dyes in the mid of 19th century triggered the end of the large-scale market for natural dyes. Water pollution due to discharge of non-biodegradable coloured effluents from textile dye manufacturing and textile-dyeing sill is one of the major environmental concerns in the world today. Strong colour imparted by synthetic dyes to the receiving aquatic ecosystems poses aesthetic and serious ecological problems such as inhibition of benthic photosynthesis and carcinogenicity. Textile industry uses and rejects high amounts of water, its wastewater being the main way by which dyes are discharged into the environment [8, 22]. Textile effluents are characterized by strong colour and high concentrations of organic and inorganic compounds caused by residual dyes that were not fixed to the fibers during the dyeing process [5, 25]. The serious environmental problems of public health concern related to coloured wastewaters containing synthetic dyes have diverted researchers promptly to look for eco-friendly products. Hence, there is a world's movement to return to the natural dyes [1, 3].

In this paper we have shown that the natural dye-stuffs of plant origins, grown in Beawar, Rajasthan, used as peanut pods systems can be developed scientifically and can be substituted for the textile dyes. These peanut pod dyes can be produced in large scale and could be prepared commercially and economically [20]. The practice of peanut pod systems for preparing dye-stuffs and the processes of dyeing has been developed using modern technological methods [6, 7].

Plant-based dyes such as indigo, saffron and madder were raised commercially and were important trade goods in the economies of Asia and Europe [16, 18]. The natural dye extracted from prickly pear for wool with various mordents. Jothi4 explained the method of extracting pigments from African marigold flower for textile application [4]. The cotton dyeing with natural dye extracted from pomegranate peel and the processing, stability and application of this pigment also have been analyzed. Indian textile exports have resorted to the use of natural dyes [11, 14]. Around 450 dye yielding plants are available in India. So far the green minded consumer, due to significant awareness of the people about the eco-friendly of various dyes and chemicals, it is essential to study the possibility of extent of application of natural dyes which can be used to a maximum extent to discharge our duties and responsibilities to build on eco-friendly. In this work, the dyed fabric linen has been treated using the natural dye which is botanically named as ‘Arachis hypogaea’, commercially named as Peanut pod [2, 16].

2. Material and Method:

2.1 Growing and Characterization of Peanut Pod:

The peanut is grown as an annual crop. It can grow up to 21/ 2 feet (75 centimeters) high and from 3 to 4 feet (90 to 120 centimeters) across. Peanut plants range in type from bunch plants to runner plants. Bunch plants grow upright. Runner plants spread out on or near the ground as they grow as shown in Figure 1.

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

2.2 Cultivation:

Peanut plant grows best in light, well-drained and sandy soil. They need much sunshine, warm temperature, moderate rainfall, and a frost-free growing period of four or five months. Farmers prepare the soil by plowing it deeply and thoroughly. Loose soil is important so that the pegs can penetrate the soil easily. Farmers plant peanut seeds 2" to 3" (5 to 8 centimeters) deep at intervals of 3" to 6" (8 to 15 centimeters), and in rows 24" to 36" (60 to 90 centimeters) apart [19].

2.3 Selection of Dye Source and Extraction Method:

The first part of this research work was to get the peanut pods. For this research work peanut pod were collected from local market of Beawar City and then classified it into two segments, dark and light color peanut pod then after this peanut pod were dried into non sunlight area.

After dried we grind them into mixer grinder. Preparation of the dye bath for dyeing using natural dye involves crushing, soaking and boiling are usually necessary to extract the dye from the vegetable matter. In general, the coarser the material, the longer it should be soaked and boiled. In the process of crushing, grinder is used to make it in the powder form. When the powder form is ready, it is mixed with water solvent and heated on gas burner to extract the dye [10, 19].

2.4 Pre-Treatment of Fabrics (Scouring):

Firstly, scouring treatment was given to linen fabric. The objective of scouring was to reduce the amount of impurities to obtain level and reproducible result in finishing operations "caustic soda boil" method was used for scouring [27] then fabrics were ready for dyeing as shown in Table 1.

Table 1: Linen fabric were scoured using recipe

Parameters	Value
Sodium carbonate	2% (O.W.F)
NaOH	3-6% (O.W.F)

Parameters	Value
Temperature	100°c
Time	30min
M.L.R	1:30

Scouring bath was made up by adding detergent and sodium carbonate and fabric was treated for 30 min at 100°c temperature. After scouring material was removed, rinsed thoroughly and squeezed gently. The scoured fabric was dried at room temperature [24].

3. Mordanting Methods:

A few dyes can be applied by any of 3 methods (pre, simultaneous and post) but generally one of the processes gives better results than the other in case of most of dyes [12, 23].

3.1 Premordanting:

The fabric is mordanted first, rinsed thoroughly with water and then it is dyed with dye solution. It's being a two bath process, consumes more time, water, steam. This method gives most level results.

3.2 Simultaneous Mordanting and Dyeing:

It is one bath process dyeing and mordanting is done together in same bath. The fabric to be mordanted and dyed must be covered with water, so that can be stirred easily and dye and mordant can circulate thoroughly and reach each part quickly. Fabric should be properly checked and conformed that; mordant should be well dissolved before dyeing mixed with fabric.

3.3 Post Mordanting:

It consists of simple dyeing and since the lake is not formed at this stage, perfect penetration of dye takes place. The subsequent mordanting fixed the dye through lake formation.

3.4 Natural Mordants:

In this present research work three mordanting agents are utilized. These are Alum (Al_2So_4), Copper Sulphate ($CuSo_4$) and Ferrous Sulphate ($FeSo_4$).

3.5 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.

4. Selection of Textile Substrate:

We have taken fabrics for this experimental work and that is linen fabric. Determination of preliminary data of fabric can be given in three steps listed below.

4.1 Thread Count:

One square cm was marked on the linen fabric and number of warp and weft thread were counted. Five readings were taken and then average was calculated [13].

4.2 Thickness of The Fabric:

Thickness tester was used to measure thickness. Fabric was ironed to remove wrinkles. The lever of pressure foot was raised and fabric was put on anvil. Pressure foot was released slowly and thickness of fabric was measured in mm from dial after 30 seconds. Thickness was determined at ten different places and mean was calculated [13].

4.3 Weight Per Unit Area:

Five specimen or samples of 5" ×4" were cut at random from fabric and weighted on electrical balances. The average of these five readings was taken. Weight/ Unit area was calculated as given below [15].

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

4.4 Depth of Shade (K/S Value):

The k/s value at 630 nm was determined by JAYPAK spectrophotometer. Peanut pod natural dye treated with different mordanting agents such as alum, copper sulphate and ferrous sulphate on linen fabric at different % such as 10% and 15% were determine by using digital potentiometer (DP001, pico make) at different time intervals [17].

$$K/S = \frac{(1 - \text{R})^2}{2R}$$

K/S value of dyed samples was assessed with the help of spectrophotometer. Only those samples which gave best results after dyeing with natural dyes and their combination was send to BHILWARA Laboratory for determination of K/S value [21, 28].

5. Result Analysis of Cotton Fabrics with Mordanting Agents:

Good colorfastness continues to be major concern of the consumers. Beauty of color on any fabric is of no value to consumer unless the dye is considered fast under conditions, it will be used, and that's why in this study colorfastness of different chemicals on different fabrics was assessed.

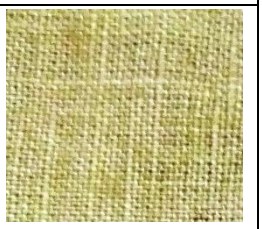
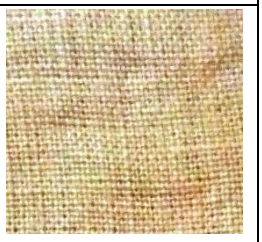
The fabric is like: Cotton. The above discussed points can be understood by different analysis with five-point gray scale, which is given by the six different tables [9, 26].

Table 2: Linen 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
Linen Fabric		Peanut Pods (pp)	-	-	-			
	1	PP+ Copper Sulphate	10%	Pre	4	4/5	4/5	4
	2	PP+ Copper Sulphate	15%	Pre	4/5	4/5	4/5	4
	3	PP+ Copper Sulphate	10%	Simultaneous	4	4	4/5	4/5
	4	PP+ Copper Sulphate	15%	Simultaneous	4	4	4/5	4
	5	PP+ Copper Sulphate	10%	Post	4/5	4/5	5	4
	6	PP+ Copper Sulphate	15%	Post	4	4/5	5	4/5

Table 3: Linen fabric using Copper Sulphate with K/S Analysis

Fabric	Specimen	Dye & Mordant	Dye %	Mordanting	K/S Value	Testing Results
Linen	1	PP+ Copper Sulphate	10%	Pre	7.82	

Fabric	Specimen	Dye & Mordant	Dye %	Mordanting	K/S Value	Testing Results
	2	PP+ Copper Sulphate	15%	Pre	7.95	
	3	PP+ Copper Sulphate	10%	Simultaneous	6.87	
	4	PP+ Copper Sulphate	15%	Simultaneous	7.37	
	5	PP+ Copper Sulphate	10%	Post	8.91	
	6	PP+ Copper Sulphate	15%	Post	9.46	

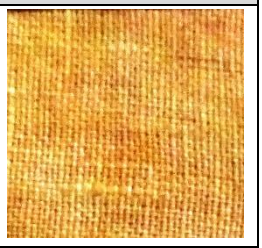
It can be observed from the table 2 and 3 that linen fabric is reacted with the copper sulphate mordanting agent with 10% and 15% dyed solution. Here we have worked on three different conditions as Pre, Simultaneous and Post mordanting.

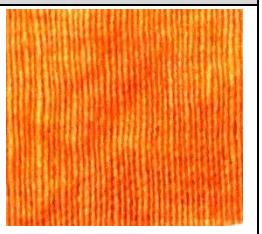
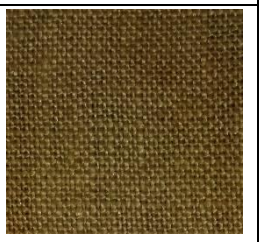
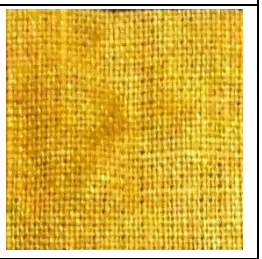
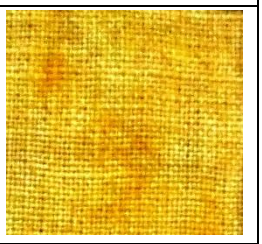
In this we have observed that linen fabric gives best result with the 10% and 15% in the post mordanting, 10% and 15% in pre and simultaneous mordanting condition gives good to very good results and 10% in simultaneous mordanting gives good k/s value.

Table 4: Linen fabric with Ferrous 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
Linen Fabric		Peanut Pods (pp)	-	-	-			
	1	PP+ Ferrous Sulphate	10%	Pre	4/5	4/5	5	4/5
	2	PP+ Ferrous Sulphate	15%	Pre	4	4/5	5	4
	3	PP+ Ferrous Sulphate	10%	Simultaneous	4	4	4/5	4/5
	4	PP+ Ferrous Sulphate	15%	Simultaneous	4/5	3/4	5	4
	5	PP+ Ferrous Sulphate	10%	Post	4/5	4	5	3/5
	6	PP+ Ferrous Sulphate	15%	Post	4	4	4	4

Table 5: Linen fabric using Ferrous Sulphate with K/S Analysis

Fabric	Specimen	Dye & Mordant	Dye %	Mordanting	K/S Value	Testing Results
Linen	1	PP+ Ferrous Sulphate	10%	Pre	5.69	

Fabric	Specimen	Dye & Mordant	Dye %	Mordanting	K/S Value	Testing Results
	2	PP+ Ferrous Sulphate	15%	Pre	5.87	
	3	PP+ Ferrous Sulphate	10%	Simultaneous	6.11	
	4	PP+ Ferrous Sulphate	15%	Simultaneous	6.38	
	5	PP+ Ferrous Sulphate	10%	Post	6.72	
	6	PP+ Ferrous Sulphate	15%	Post	7.01	

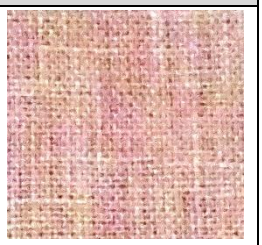
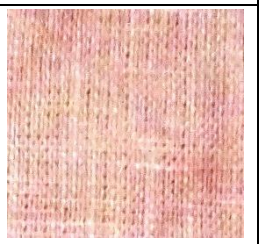
It can be observed from the table 4 and 5 that linen fabric is reacted with the ferrous sulphate mordanting agent with 10% and 15% dyed solution. Here we have worked on three different conditions as Pre, Simultaneous and Post mordanting.

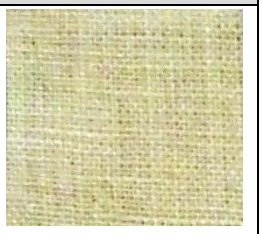
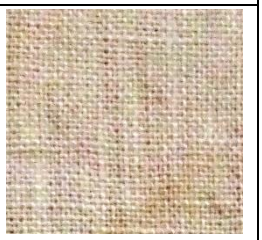
In this we have observed that linen fabric gives best result with the 10% and 15% in the pre, 10% and 15% in simultaneous and 10% in post mordanting condition at color change rubbing dry condition. As it is declared that Linen fabric in pre mordanting 10% and 15% gives the best result in all tests and 10 % in pre mordanting gives good results in k/s value test.

Table 6: Linen 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
Linen Fabric		Peanut Pods (pp)	-	-	-			
	1	PP+ alum	10%	Pre	4/5	4/5	4/5	4/5
	2	PP+ alum	15%	Pre	4/5	4	4	4
	3	PP+ alum	10%	Simultaneous	5	4/5	4/5	4/5
	4	PP+ alum	15%	Simultaneous	5	5	4/5	4/5
	5	PP+ alum	10%	Post	4/5	4/5	4/5	4
	6	PP+ alum	15%	Post	4/5	4	4	4

Table 7: Linen fabric using Alum with K/S Analysis

Fabric	Specimen	Dye & Mordant	Dye %	Mordanting	K/S Value	Testing Results
Linen	1	PP+ alum	10%	Pre	7.32	
	2	PP+ alum	15%	Pre	7.19	

Fabric	Specimen	Dye & Mordant	Dye %	Mordanting	K/S Value	Testing Results
	3	PP+ alum	10%	Simultaneous	9.43	
	4	PP+ alum	15%	Simultaneous	7.17	
	5	PP+ alum	10%	Post	8.79	
	6	PP+ alum	15%	Post	8.16	

It can be observed from the table 6 and 7 that linen 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 linen fabric gives best result with the 10% and 15% in the simultaneous mordanting and 15% in pre and simultaneous mordanting condition gives good results in k/s value test.

6. Conclusion:

From the study, it may be concluded that the selected dye sources namely peanut pod are highly suitable for Linen material with ferrous mordant. The pre-mordant with 10% & 15% of dye, techniques are mostly suitable for Linen material. These dyes are safe and eco-friendly. Therefore, their use will definitely minimize the health hazards caused by the use of synthetic dyes. These natural dyes give some medicinal properties also.

Acknowledgements:

One of the authors (Ms. Megha Kumari Chhipa) is thankful to the Department of Home Science, Swami Keshwanand Rajasthan Agriculture University (SKRAU), Bikaner, Rajasthan, INDIA for providing experimental and measurements facilities. The author would like also to thank to the Department of Textile Engineering, M.L.V. Textile & Engineering College, Pratap Nagar, Bhilwara (Raj.) India, for providing research facility for the measuring K/S value.

7. References:

1. AATCC Technical manual. American Association of Textile Chemists and Colorists, (AATCC), (2008), Vol 83.
2. Abdel-Halim, E. S., H. M. Fahmy, and Moustafa MG Fouda. "Bioscouring of linen fabric in comparison with conventional chemical treatment." Carbohydrate Polymers 74.3 (2008): 707-711.
3. Abou-Okeil, A., A. El-Shafie, and M. M. El Zawahry. "Ecofriendly laccase–hydrogen peroxide/ultrasound-assisted bleaching of linen fabrics and its influence on dyeing efficiency." Ultrasonics sonochemistry 17.2 (2010): 383-390.
4. Ahmed, N. S. E., R. M. El-Shishtawy, and M. M. Kamel. "Ultrasound assisted pre-treatment and dyeing of linen fibres with reactive dyes." Pigment & Resin Technology 36.6 (2007): 363-372.
5. Bechtold, Thomas, et al. "Natural dyes in modern textile dyehouses—how to combine experiences of two centuries to meet the demands of the future." Journal of Cleaner Production 11.5 (2003): 499-509.
6. Buschle-Diller, G., et al. "Enzymatic hydrolysis of cotton, linen, ramie, and viscose rayon fabrics." Textile Research Journal 64.5 (1994): 270-279.
7. Cardon Dominique. Natural Dyes, Our Global Heritage of Colors, Textile Society of America Symposium Proceedings, Textile Society of America, (2010).
8. Char, W.P. A revision of the Hawaiian species of Sesbania (Leguminosae). M.Sc. thesis, Univ. of Hawaii, Hawaii, USA (1983).
9. Chen, Zhao-hui, et al. "Application of degraded chitosan with quaternary ammonium salt to linen dyeing [J]." Dyeing & Finishing 17 (2009): 004.
10. Das, D., Bakshi, S., & Bhattacharya, P. "Dyeing of EDTA-modified cotton with reactive dyes". Clothing and Textiles Research Journal, (2016), 34(3), 196-206.
11. Grifoni, Daniele, et al. "Laboratory and outdoor assessment of UV protection offered by flax and hemp fabrics dyed with natural dyes." Photochemistry and photobiology 85.1 (2009): 313-320.
12. Ibrahim, N. A., et al. "Functionalization of linen/cotton pigment prints using inorganic nano structure materials." Carbohydrate polymers 97.2 (2013): 537-545.
13. Ibrahim, N. A., et al. "Novel pre-treatment processes to promote linen-containing fabrics properties." Carbohydrate Polymers 74.4 (2008): 880-891.
14. Ibrahim, N. A., et al. "Smart options for functional finishing of linen-containing fabrics." Journal of Industrial Textiles 39.3 (2010): 233-265.
15. Ibrahim, Nabil A., et al. "Eco-friendly plasma treatment of linen-containing fabrics." The Journal of the Textile Institute 101.12 (2010): 1035-1049.

16. Ibrahim, Saher Fawzy, E. S. El-Amoudy, and K. E. Shady. "Thermal analysis and characterization of some cellulosic fabrics dyed by a new natural dye and mordanted with different mordants." International Journal of Chemistry 3.2 (2011): 40.
17. Jiangping, Wang Xiaojuan HE. "Research on the Dyeing Behaviour of Qian Cao for Linen Fabrics [J]." Advanced Textile Technology 5 (2006): 000.
18. Jothi, D. Extraction of natural dyes from African Marigold flower (Tagetus Erecta) for Textile coloration, AUTEX journal, (2008), 8(2).
19. Liles, Jim N. The art and craft of natural dyeing: Traditional recipes for modern use. Univ. of Tennessee Press, (1990).
20. 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.
21. 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).
22. Mehta Pradip V. and Bhardwaj Satish K. "Managing Quality in the Apparel Industry", New Age International Publishers, (1998), 189-193.
23. Micheal, M. N., F. M. Tera, and E. M. Othman. "Degradation measurements of linen fabrics." Polymer-Plastics Technology and Engineering 43.5 (2005): 1377-1386.
24. Needles, Howard L., and Kimberly Claudia J. Nowak. "Heat-induced aging of linen." (1989) 159-167.
25. Samanta, A. K. and Agrawal, P. "Application of Natural Dyes on Textiles". Indian Journal of Fibre & Textile Research, (2009), 34: 384-389.
26. Shuzhen, Gao. "Ultrasonic Wave Applied in Linen Dyeing [J]." Dyeing and Finishing 12 (2000): 000.
27. Silva, Carla, et al. "Antimicrobial and antioxidant linen via laccase-assisted grafting." Reactive and Functional Polymers 71.7 (2011): 713-720.
28. Sloan, Frederick RW. "Preparation, bleaching, dyeing and finishing of linen." Review of Progress in Coloration and Related Topics 5.1 (1974): 12-16.