

Cotton Fabrics Treatment With Gallnut Extract (Terminalia Chebula) For Improving Color Fastness Of Alizarin Dye



Siva Jagadish Kumar, B. Venkatesh, Ch. Govardhana Rao, M. Ramesh Naidu

Abstract: Terminalia Chebula Powder also known as Haritaki powder, karakai powder is one of the herbs used in ayurvedic medicine and terminalia chebula plants are classified under medicinal plants and these are specially referred as the king of medicine in Tibet. terminalia chebula is one of the popular and proven herbs for various types of medicinal properties.

In the recent fashion of utilizing the natural and conventional techniques for modern-day usage, the karakai powder is also being used for textile applications, especially in the dyeing with natural coloring to textile goods.

In this present work, the karakai powder is used as one of the mordant along with alum and other mordants for treating cotton fabrics, and these fabrics are dyed with alizarin natural dye and studied with K/S values, color fastening to washing and rubbing were studied and found improvements by application of Terminalia Chebula Powder in both pre mordanting and meta mordanting methods.

Keywords : Terminalia Chebula Powder, Natural Dyes, Gallnut extract, natural mordanting.

I. INTRODUCTION

Dyeing industry is one of the industries which create a lot of pollution, with respect to all the industry segments of textiles and apparel sectors are considered. Many researchers have worked rigorously in the past few decades and eventually, it all led to more and more chemical usage. More chemical usage always leads to more pollution and toxicity, which may not be understood at that moment, but eventually, at later stage it will be understood the toxicity levels of that alternative routes are not eco friendly, that time we would have found a different solution. One of the best solutions for

this is replacing chemical substances or synthetic substances with natural materials[1], [2].

In the scope of cotton fabric dyeing, many attempts were made to utilize natural coloring matters to dye the cotton fabrics. The major issue with respect to natural dyeing is the affinity of the coloring particles to the fabric substrate. some researchers also probing with the enzymatic usage for improved dye uptake[3]. This study is also one of the attempts to reduce chemical usage and obtain better characteristics by optimizing and using different natural substances with other applications.

The powder of terminalia chebula is generally used for many ayurvedic medicinal benefits[4][5]. it is also being tested for application as a coloring agent for Ayurveda, in order to improve the color uptake the gallnut extract is tried with the application of chitosan on cotton fabrics[6]. woolen yarns were also dyed using gallnut extract and the colorfastness property seems satisfactory[7]. silk fabrics also were dyed with natural dyes with gallnut extract as a mordant[8] with woolen and silk being used, treated, dyed with this compound were studied mainly for protein fibers[9] and even leather[10]. Fabrics dyed with gallnut extract is naturally anti- microbial and having 40% anti microbial potency against *E.coli* bacteria and no anti microbial potency against *B.subtilis* [11]. In the present study, it is being supplemented as a part of the mordant along with other mordant, and studied its effect on colorfastness properties, K/S values.

II. MATERIALS AND METHODS

The cotton fabrics were sourced from one of the khadi bandaar and tested for any visual defects and the fabric is scoured and bleached as a single lot to avoid any impurities presence. the obtained fabric is found to be 100 x 66 EPI and PPI, warp count is 40s, weft count is 32s, GSM of fabric is found to be 101.

Three mordants selected for the present study and those are alum, FeSO₄, CuSO₄. The control samples are with 100 % of the mordant selected and the test samples are with 25% of the mordant and 75% of gallnut extract. Alizarin dye is obtained from Mangalagiri local market, which is famous for natural dyes. Lab grade chemicals were used for this study.

The study was conducted with both pre mordanting method and meta mordanting method, which in turn gave us 13 samples to produce and test the results. The details of the samples are in table.I.

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Table I: Details of the Samples

Sample	Dye	Mordant 1	Mordant 2	Type of mordanting
a.	Alizarin	None	--	None
b.	Alizarin	Alum	--	Pre
c.	Alizarin	FeSO ₄	--	Pre
d.	Alizarin	CuSO ₄	--	Pre
e.	Alizarin	ALUM	--	Meta
f.	Alizarin	FeSO ₄	--	Meta
g.	Alizarin	CuSO ₄	--	Meta
h.	Alizarin	Alum 25%	G. E 75%	Pre
i.	Alizarin	FeSO ₄ 25%	G. E 75%	Pre
j.	Alizarin	CuSO ₄ 25%	G. E 75%	Pre
k.	Alizarin	Alum 25%	G. E 75%	Meta
l.	Alizarin	FeSO ₄ 25%	G. E 75%	Meta
m.	Alizarin	CuSO ₄ 25%	G. E 75%	Meta

A. Mordanting

Mordanting was carried out on cotton fabric by using 25% concentration with Alum or feso4 or cuso4, using pre and simultaneous mordanting methods. This was performed at 85° c for 1 hour with material to liquor ratio is 1:20. pre mordanted sample was initially treated with mordant then squeezed and subjected to the dyeing process. In simultaneous mordanting both dye and mordant dissolved in a dye bath and then material added in the dye bath.

B. Dyeing

Dyeing was carried with and without mordants for alizarine dye using a digital controller water bath. Dyeing was performed using 10 % of alizarine to the textile material. Each mordanted and non-mordanted cotton sample was heated at a dye bath ratio of 1:20 at 85o c for 60 min. The cotton samples were then removed from the dye baths and rinsed for 10 min and then dried in oven.

C. Testing

Testing for color strength and L, a, b values were measured in Premier colorscan SS5100H Spectrophotometer. Colorfastness to washing was carried in laundro meter with the prescribed test method AATCC-61-2010. Colorfastness to rubbing was carried out with AATCC -08 test method.

III. RESULTS AND DISCUSSION

Change in the mordanting mix offers different color shade by adding gallnut extract and the same was evident by the K/S Values obtained from Premier colorscan SS5100H Spectrophotometer. Sample 'a, without any mordanting is with the lowest K/S value of 38.13. From table II it is also evident that the Meta mordanting is obtaining stronger K/S values than the Pre Mordanting. Use of G. E, reduced the color strength a bit, but it is much stronger than the sample a, which is without any mordanting. From these K/S values in Table II, we also can confer that the gallnut extract mordanting is much preferred for Light and Medium shades during dyeing. L, a, b values represent the location of color in the shade sphere. these L, a, b values also indicate that by

applying the gallnut extract, the shade card can be further enhanced and new shades also are possible with different combinations of known mordants and the combination of gallnut extract, however the prime objective of this study is to analyze the durability or colorfastness of the dyed samples rather than the shades obtained. Shades obtained range from light wheatish color to brownish colors.

Table II: color strength and L a b values of dyed samples

Sample	L	a	b	K/S values
a	61.32	35.48	39.44	38.13
b	50.77	34.17	11.31	85.45
c	68.26	4.22	1.14	134.80
d	67.45	13.92	-1.11	75.83
e	53.96	38.28	20.15	104.74
f	40.44	6.91	-1.49	151.98
g	67.50	17.72	-0.70	74.89
h	42.42	29.00	3.85	61.38
i	39.18	7.32	-9.59	56.88
j	41.63	20.52	3.24	59.39
k	38.13	35.53	11.99	70.07
l	31.75	9.33	-9.20	95.33
m	40.22	16.73	-2.07	115.11

The primary concern with natural dyes is colorfastness. Table III shows the results obtained by the 13 samples for colorfastness to washing for both staining and fading. The samples h, i, j, and m clearly show improvement in colorfastness property. The addition of gallnut extract and pre mordanting combination has improved colorfastness to washing, especially in the fading. Meta mordanting with Alum and FeSO₄ does not affect the colorfastness. Many types of apparel, home furnishings brands require the colorfastness above 4 for passing the quality tests and it is quite difficult for the natural dyes, but sample h, alum, and G. E combination is a 4/5 scale for both staining and fading, which is a notable improvement.

Table III: Colorfastness to washing; staining and fading

Sample	C.F. to washing STAINING	C.F. to washing FADING
a	3\4	3\4
b	3\4	3
c	3	3
d	3	3
e	3\4	3
f	4	3\4
g	3	3
h	4\5	4\5
i	4	4
j	3	3\4
k	3\4	3
l	4	3\4
m	3	4

The result for colorfastness is generally measured with grey scales for color changing and staining.

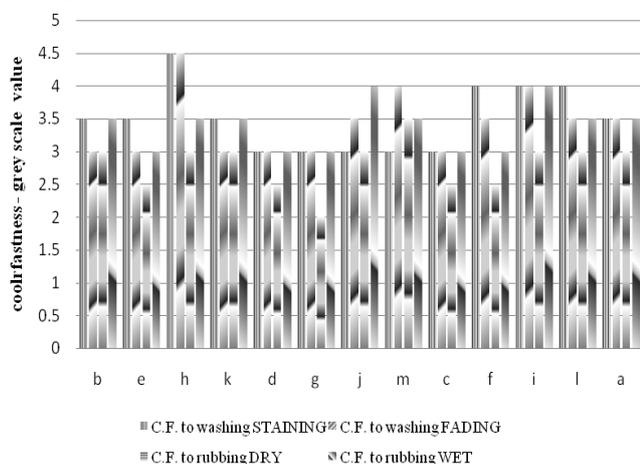
Results are in the range of 1 to 5, 1 is represented as very poor performance and 5 represents very good color fastness and no color bleeding happened. In the present study, to avoid the subjective assessment, the samples were tested with the premier colorsan SS5100H spectrophotometer as this equipment has the provision of giving the results instead of the manual greyscale comparison. Test results of colorfastness to rubbing using crock meter were tabulated in table IV.

Alum and gallnut extract combination in pre mordanting, shown no effect to colorfastness to rubbing. Alum and gallnut extract combination in Meta mordanting, shown a slight improvement in colorfastness. FeSO₄, CuSO₄ as mordant's combined with 75% of gallnut extract shown slight increment in colorfastness in both pre mordanting and Meta mordanting, increase in dry condition is about 0.5 of scale and in wet condition it is 0.5 to 1, which is a notable change. The improvement in the color fastness may be the chemical reaction of gallnut extract with the cellulosic materials.

Table IV: Colorfastness to rubbing; dry and wet

Sample	C.F. to rubbing DRY	C.F. to rubbing WET
a	3	3/4
b	3	3/4
c	2/3	3
d	2/3	3
e	2/3	3
f	2/3	3
g	2	3
h	3	3/4
i	3	4
j	3	4
k	3	3/4
l	3	3/4
m	3/4	3/4

Fig. 1 shows the chart drawn with the colorfastness values for washing and rubbing. the samples are arranged with mordant 1, pre mordanting, meta mordanting, gallnut extract mixed pre mordanting and meta mordanting, similar to all three mordant, alum, FeSO₄, CuSO₄. The sample 'a' results are also far from the other sample's results, the reason could be dye uptake is very less in the dyeing itself, so it does not have any dye particles, so, the loss of dye particles is also very less in the sample. 'a'.



IV. CONCLUSION

Our world is full of innovations, innovations often come with changes, changes sometimes good and sometimes ugly, but we would not know their effect immediately. Similarly, more chemical usage is not a good Innovation in the long run. In the present study, the use of gallnut extract, along with other mordant is resulting in improved results in some combinations and no change in other instances. K/S values were slightly compromised and colorfastness to washing, and rubbing were slightly improved. Alum and gallnut extract with pre mordanting shown improvement in the colorfastness to washing, where Meta mordanting shown improvement in the colorfastness to rubbing. FeSO₄ and gallnut extract combination shown same performance in colorfastness, but shown improved colorfastness to rubbing in both pre mordanting and Meta mordanting. CuSO₄ and gallnut extract shown same performance in colorfastness to washing –staining, but improved colorfastness to colorfastness to washing – in fading, colorfastness to rubbing in wet and dry conditions.

REFERENCES

1. J. Arora, P. Agarwal, and G. Gupta, "Rainbow of Natural Dyes on Textiles Using Plants Extracts: Sustainable and Eco-Friendly Processes," *Green Sustain. Chem.*, 2017.
2. P. R. Kumar, V. Madhusudhan Rao, B. Nageswararao, M. Venkateswarlu, and N. Satyanarayana, "Enhanced electrochemical performance of carbon-coated LiMPO 4 (M = Co and Ni) nanoparticles as cathodes for high-voltage lithium-ion battery," *J. Solid State Electrochem.*, 2016.
3. S. A. Jabasingh, P. Sahu, and A. Yimam, "Enviro-friendly biofinishing of cotton fibers using Aspergillus nidulans AJSU04 cellulases for enhanced uptake of Myrobalan dye from Terminalia chebula," *Dye. Pigment.*, vol. 129, pp. 129–140, Jun. 2016.
4. Koh and K. H. Hong, "Gallnut extract-treated wool and cotton for developing green functional textiles," *Dye. Pigment.*, vol. 103, no. April 2014, pp. 222–227, 2014.
5. Bag, S. K. Bhattacharyya, and R. R. Chattopadhyay, "The development of Terminalia chebula Retz. (Combretaceae) in clinical research," *Asian Pac. J. Trop. Biomed.*, vol. 3, no. 3, pp. 244–252, 2013.
6. Lalit Jajpura, S. Paul, and A. Rangi, "Dyeing of Cotton with Terminalia chebula natural dye with chitosan," *Asian Dye.*, vol. 14, no. 3, pp. 57–62, 2017.
7. M. Shabbir et al., "An eco-friendly dyeing of woolen yarn by Terminalia chebula extract with evaluations of kinetic and adsorption characteristics," *J. Adv. Res.*, vol. 7, no. 3, pp. 473–482, May 2016.
8. M. Srivastava, D. Mogra, and P. Gupta, "Dye extraction from Rheum emodi for colouring silk using natural mordants," *J. Appl. Nat. Sci.*, vol. 7, no. 1, pp. 182–186, Jun. 2015.
9. K. Y. Nam and J. S. Lee, "Dyeing Property and Antimicrobial activity of Protein Fiber Using Terminalia chebula Retzius Extract," *Fash. Text. Res. J.*, vol. 16, no. 3, pp. 476–484, Jun. 2014.
10. J. E. Song, S. M. Kim, and H. R. Kim, "Improvement of dye affinity in natural dyeing using Terminalia chebula retzius (T. chebula) applied to leather," *Int. J. Cloth. Sci. Technol.*, vol. 29, no. 5, pp. 610–626, 2017.
11. S. Datta, M. Uddin, K. Afreen, S. Akter, and A. Bandyopadhyay, "Assessment of antimicrobial effectiveness of natural dyed fabrics," *Bangladesh J. Sci. Ind. Res.*, vol. 48, no. 3, pp. 179–184, Dec. 2013.
12. Narsimulu, B.N. Rao, M. Venkateswarlu, E.S Srinadhu, N. Satyanarayana. "Electrical and electrochemical studies of nanocrystalline mesoporous MgFe₂O₄ as anode material for lithium battery applications", *Ceramics International*, 2016, vol. 42(15), pp 16789- 16797
13. K. Hari Prasad, N. Naresh, Nageswara Rao, M. Venkateswarlu, N. Satyanarayana. "Preparation of LiMn₂O₄ Nanorods and Nanoparticles for Lithium-ion Battery Applications", *2016 Materials Today: Proceedings*, vol. 3(10), pp 4040-4045

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14. M.S. Sudhir, P.M Mohan, R.V. Nadh. "Simple and validated ultraviolet spectrophotometric method for the estimation of Febuxostat in bulk and pharmaceutical dosage forms", *Oriental Journal of Chemistry*, 2013, vol. 29(1), pp 235-240
15. G. Suresh G., R. Venkata Nadh, N. Srinivasu N, K. Kaushal. "Novel coumarin isoxazoline derivatives: Synthesis and study of antibacterial activities", *Synthetic Communications*, 2016, 46(24), pp 1972-1980

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