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Extraction of natural dye from *Rhus parviflora* (Tung) and evaluation of colour fastness properties of weaved wool herbal dyed fabrics using mixture of bio and chemical mordants

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Abstract

Present research is an attempt to assess the fastness grades of colourant on weaved woolen fabrics which were dyed by herbal dye extracted by the leaves of Rhus parviflora has been investigated with a mixture of botanical and chemical colour fixing agents like lime extract + $CuSO_4$, lime extract + $K_2Cr_2O_7$, lime extract + $FeSO_4$ and lime extract + $SnCl_2$ with the ratio 3:1, 1:2 and 1:3 respectively. Here dyeing method was followed with some colour fixing agent methods like prechromic-colour fixing agent, metachromic colour fixing agent and after chromic-colour fixing agent. Fastness tests of dyed fabrics are also observed under this study. A wide range of colour shades were observed with altering colour fixing agent ratios and their mixture. The fastness grades of the dyed fabrics to wash, rub, light and perspiration have also been examined as fair to excellent fastness grades and this observation can also be helpful to textile industries.

Keywords: Herbal dye, Wool fabrics, *Rhus parviflora*, Bio and chemical mordants or colour fixing agents, Colour fastness properties.

Introduction

In ancient times, most of the people were depend on the natural sources for textile dyeing, such as flowers fruits, leaves, seeds bark, the root of plants etc. Plant colourants have been used for dyeing textiles like wool, silk, cotton and various bio-fibers across the globe. Due to its eco-friendly environment nature and extraordinary colour diversity, it creates a non-polluted environment and these colourants have been used for colouring textiles as wool and other bio-fibers across the globe by the various human societies[1,2] and their fastness grades vary with nature ofsoil and the weather[3-7]. The colour components responsible for dyeing were isolated and their chemical constituents were established based on chemical and spectroscopic investigations. Generally, colour fixing agents can be botanical (as an extract of leaves, flowers, stem and root etc.) and chemical (as a metal salts which can be responsible for creating chemistry between the fabrics and herbal dye). Lodhspecies is actively giving the herbal dyes properties and this species give us an excellent colour grades w.r.t. grey scale. In this research, the aqueous extract of tung is attempted to colouring of woolen fabric sat some refined dyeing stages which followed with the mixture of botanical and chemical colour fixing agents[8-11] and these dyed fabrics were examined with respect to fastness as wash, rub, perspiration and light[12-15]. There are many natural resources are responsible to dyeing for the industries. However, the common drawbacks of herbal dyes are their non-recreatable nature, multiform shades, moderate colour grades and lack of sufficient scientific information on the chemistry for colouring with respective finishing conditions. Review of literature about finishing of textiles with herbal dye revealed lots of information to the application of herbal dyes using bio and chemical colour fixing agents with different colour characteristics[16] followed by different colour fixing agent methods like prechromic-colour fixing agent, metachromic colour fixing agent and after chromic-colour fixing agent.

Status of eco-friendly natural dyes and dye bearing plants in India: According to literature, the main use of nature friendly has been show versatility to exploring the finishing of textiles or polishing of medicinal drugs and colouring of beauty products etc. Due to its non-toxic nature, herbal dyes are also responsible to colouring of food products. Literature revealed that In India, appearance of more than 450 plants can bear the dyes[17] but unfortunately there are not sufficient data resources to know about applicability or availability of natural dyes towards extracting and dyeing techniques as well as too much information among the society to utilization of natural dyes over synthetic dyes.

Materials and methods

Rhus parviflora (Tung) is commonly known as Tung or Tunn and found in various places of the Garhwal region of Uttarakhand. For this research, leaves of lodh plant were taken for dyeing which was followed by aqueous extraction and

bleached plain weaved woolen fabrics purchased from the district Chamoli, Uttarakhand. Chemical metal salts (analytical reagents (AR) grade) were used as chemicalcolour fixing agents such as $K_2Cr_2O_7$, $CuSO_4$, $SnCl_2$ and $FeSO_4$, Some laboratory reagents as acetic acid, common salt and sodium carbonate were also used as same and a bio-colour fixing agents 'lime extract' was used for this research respectively[8,10].

By using the aqueous extracted herbal dye for dyeing from the leaves of *Rhus parviflora*, various colour shades were observed by using the different metal salts as chemical colour fixing agents and these colour shades of dyed fabrics were intervene with lime extract when it mixed with a standard vol. of distilled water and heating at 80^0C for 30 min was followed by three colour fixing agent conditions and this solution was cooled and filtered, this filtrate was responsible for different conditions of colour fixing agent. Now took the shaded dried leaves of *Rhus parviflora* with a known quantity and soaked in lukewarm water entire night and then obtained extract was further boiling with distilled water and cooled, filtered and then finally dyeing to weave woolen fabrics.

Fabrics dyeing were occurred with some optimized conditions like extraction time for dye (60 min), M-L ratio as 1:20 and time for dyeing (50 min.). The herbal and chemical colour fixing agent mixtures viz. lime extract: $CuSO_4$, lime extract: $K_2Cr_2O_7$, lime extract: $FeSO_4$, lime extract: $SnCl_2$were used with the ratio 3:1, 1:2 and 1:3 respectively. Total quantity of each two colour fixing agent mixture was 5% on the weight of the woolen fabric i.e. 5g of the colour fixing agent /100 g of the fabric. These four colour fixing agent mixtures was under go with three different ratios as 3:1, 1:2 and 1:3for three colour fixing agent conditions such as prechromic colour fixing agent, met chromic colour fixing agent and after chromic colour fixing agent for dyeing. Hence after fabrics dyeing, the solution was cooled then dyed fabrics were taken out from the dye bath, wash with distilled water to minimize the excess dye colourant and were dried in shade.

Measurement of fastness grades towards light, washing, rubbing (dry and wet) and perspiration were occurred with the help of ultra-violet light in a Shirley MBTF Microsal fade-O-meter as per ISO: 2454-1984 and fade nature of fabrics were measured by comparing with blue wool standards (BS1006: BOI: 1978), Sasmira launder-O-meter followed by IS-3 wash fastness method as per ISO-05-A02 (loss of shade depth) and ISO-105-AO3 (proportion of staining)and staining was measured with Macbeth 2020 plus computer-ACM system, a manually operatable crock-meter and grey scale as per ISO-105-AO3 (proportion of staining) as per IS: 766-1984 method and perspiro-meter under load of 4.5 kgs (10 lbs) was responsible for measuring the perspiration fastness grades in the acidic and alkaline media with M-L ratio 1:50 for 30 min at 25^oC. At last, specimen were taken out and dried in the air with the temperature not more than 60^oC and colour staining and change was occurred using grey scale[8,10].

Results and discussion

Colour fixing agent mixture – Lime extract: stannous chloride: In this case, evaluated fastness to light was remain same for all the ratios of color fixing agent mixtures while observed fastness was excellent to good (4-5 to 4) for washing under metachromic and after chromic colour fixing agent methods. Change in colour for dry and wet rubbing fastness condition, it was excellent whereas under staining, was fluctuated from non-staining to negligible (5 to 4-5) in dry case. Except prechromic colour fixing agent condition, it was found that perspiration fastness grades fluctuated from excellent to good (4-5 to 4) for all in acidic and alkaline media under no colour staining in both media (Table-1).

Colour fixing agent mixture – Lime extract: copper sulphate: Under this condition, evaluated fastness grades were observed as fairly good (4) to light and fair (4 to 5) to wash under prechromic condition but it was excellent to good (4 - 5) for both metachromic and after chromic respectively. Fastness to rub with dry and wet condition, it was excellent for all cases. There is no observation for colour staining but change in colour to dry and wet was observed as an excellent (5) for all cases. Except for 1:3 colour fixing agent ratio in prechromic colour fixing agent condition, there fastness grades were fluctuated from good to excellent (4-5) for perspiration fastness in both media but there was no staining of colour for all observed samples (Table-2).

Cooler fixing agent mixture – Lime extract: potassium dichromate: In this case, observed fastness was fairly good (4) to light for all cases and like fastness to light, wash fastness was fluctuated from fair (3-4) to fairly good (4) for all conditions except 1:3 colour fixing agent mixture under prechromic condition where it was fair. For fastness grade to rubbing, change in colour to dry and wet was observed as an excellent (5) for all cases. Except 1:3 colour fixing agent ratio under prechromic condition where it was good (4-5) and there was no colour staining observed in both the media (Table-3).

Colour fixing agentmixture – Lime extract: ferrous sulphate: For this condition, it was observed that fastness grade to light was recorded as fairly good (4) in all cases whereas washing fastness grades were fluctuated from fair to good (3-4 to 4-5) almost for all. Under rubbing condition, it was observed as almost an excellent in all cases while fastness grades were almost excellent in the absence of staining (5) to perspiration in the respective media except after chromic method where it was observed as (4) Table-4.

Aqueous extracted eco-friendly herbal dye from leaves of *Rhus parviflora* was pale yellow in colour. By using different colour fixing agent condition with some chemical colour fixing agents like $K_2Cr_2O_7$, $CuSO_4$, $SnCl_2$ and $FeSO_4$, we observed beautiful colour shades than extracted herbal dye without any colour fixing agent as mentioned in Table-5.

Table-1: Colour fastness grades of dyed weaved woolen fabrics with *Rhus parviflora* dye at some refined conditions using herbal and chemical colour fixing agent mixture as LJ: SC under three colour fixing agent conditions.

Colour fixing agent method	Colour fixing agent proportions	Fastness grades to light	Fastness grades to washing		Fastness grades troubling			Fastness grades to Perspiration			
			CC	CS	Dry		Wet	Acidic		Alkaline	
					CC	CS	CC	CS	CC	CS	CC
Prechromic colour fixing agent	3:1	4	2-3	5	4-5	5	4	5	3	5	3
	1:2	4	2-3	5	5	4-5	5	5	4-5	5	4
	1:3	4	2-3	5	5	4-5	5	5	4-5	5	4
Metachromic colour fixing agent	3:1	4	4-5	5	5	5	5	5	4	5	4
	1:2	4	4	5	5	5	5	5	4	5	4
	1:3	4	4	5	5	5	5	5	4	5	4
Afterchromic colour fixing agent	3:1	4	4	5	5	4-5	5	5	4	5	4-5
	1:2	4	4-5	5	5	4-5	5	5	4-5	5	4-5
	1:3	4	4-5	5	5	4-5	5	5	4-5	5	4-5

LJ: SC– Lime extract: $SnCl_2$, CC –Change in colour, CS – Staining of colour.

Table-2: Colour fastness grades of dyed weaved woolen fabrics with *Rhus parviflora* dye at some refined conditions using herbal and chemical colour fixing agent mixture as LJ: CS under three colour fixing agent conditions.

Colour fixing agent method	Colour fixing agent proportions	Fastness grades to light	Fastness grades to washing		Fastness grades to rubbing			Fastness grades to Perspiration			
			CC	CS	Dry		Wet	Acidic		Alkaline	
					CC	CS	CC	CS	CC	CS	CC
Prechromic colour fixing agent	3:1	4	3-4	5	5	5	5	5	4	5	4
	1:2	4	4	5	5	5	5	5	3	5	4
	1:3	4	4	5	5	5	5	5	3	5	4
Metachromic colour fixing agent	3:1	4	4	5	5	5	5	5	3	5	4
	1:2	4	4	5	5	4-5	5	5	3	5	4
	1:3	4	4	4-5	5	4-5	5	5	4	5	4
Afterchromic colour fixing agent	3:1	4	4	4-5	5	4-5	5	5	4	5	4-5
	1:2	4	4	4-5	5	4-5	5	5	4	5	4-5
	1:3	3-4	4	4-5	5	4-5	5	5	4	5	4-5

LJ: CS– Lime extract: $CuSO_4$, CC –Change in colour, CS – Staining of colour.

Table-3: Colour fastness grades of dyed weaved woolen fabrics with *Rhus parviflora* dye at some refined conditions using herbal and chemical colour fixing agent mixture as LJ: PD under three colour fixing agent conditions.

Colour fixing agent method	Colour fixing agent proportions	Fastness grades to light	Fastness grades to washing		Fastness grades to rubbing			Fastness grades to Perspiration			
					Dry		Wet	Acidic		Alkaline	
			CC	CS	CC	CS	CC	CS	CC	CS	CC
Prechromic colour fixing agent	3:1	4	3	5	5	4-5	3-4	5	4-5	5	3
	1:2	3-4	2-3	5	5	4-5	5	5	3-4	5	4
	1:3	4	2-3	5	5	4-5	5	5	4-5	5	4
Metachromic colour fixing agent	3:1	4	2-3	5	5	5	5	5	4	5	4
	1:2	4	4	5	5	5	5	5	4	5	4
	1:3	4	4	5	5	5	5	5	4	5	4
Afterchromic colour fixing agent	3:1	3-4	3	5	5	5	5	5	4	5	4-5
	1:2	3-4	4-5	5	5	5	5	5	4-5	5	4
	1:3	3-4	4-5	5	4-5	5	5	5	4-5	4-5	4-5

LJ: PD– Lime extract: $K_2Cr_2O_7$, CC –Change in colour, CS – Staining of colour.

Table-4: Colour fastness grades of dyed weaved woolen fabrics with *Rhus parviflora* dye at some refined conditions using herbal and chemical colour fixing agent mixture as LJ: FS under three colour fixing agent conditions.

Colour fixing agent method	Colour fixing agent proportions	Fastness grades to light	Fastness grades to washing		Fastness grades to rubbing			Fastness grades to Perspiration			
					Dry		Wet	Acidic		Alkaline	
			CC	CS	CC	CS	CC	CS	CC	CS	CC
Prechromic colour fixing agent	3:1	4	3-4	4-5	5	5	5	5	5	5	4
	1:2	4	4	4-5	5	5	5	4-5	5	5	4-5
	1:3	4	3-4	4-5	5	5	5	5	5	5	5
Metachromic colour fixing agent	3:1	4	3-4	4-5	5	4-5	5	5	5	5	5
	1:2	4	3-4	4-5	5	5	5	5	5	5	5
	1:3	4	3-4	4-5	5	5	5	5	5	5	5
Afterchromic colour fixing agent	3:1	4	3-4	4-5	5	5	5	5	4	5	4-5
	1:2	4	3-4	4-5	5	5	5	5	4	5	4-5
	1:3	4	4	4-5	5	5	5	5	4	5	4-5

LJ: FS– Lime extract: $FeSO_4$, CC –Change in colour, CS – Staining of colour.

Table-5: Observed colour shades of dyed weaved woolen fabrics using mixture of chemical and bio-colour fixing agents (with and without colour fixing agent condition).

Colour fixing agent conditions Used	Dyeing (without colour fixing agents)	Dyeing with the mixture of chemical and bio-colour fixing agents (lime extract)
Prechromic Colour fixing agent		
Metachromic Colour fixing agent		
Afterchromic Colour fixing agent		

Conclusion

Under this section, it was observed from this study that *Rhus parviflora* plant is responsible to give best dyeing properties towards weaved wool fabrics or fibers including fastness grades expose to light , wash, rub and perspiration in which fairly good fastness to light, excellent grades to rubbing and washing excluding prechromic condition for both cases as lime extract: $K_2Cr_2O_7$ and lime extract: $SnCl_2$ while good to excellent grades to perspiration in both respective media with no colour staining.

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