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Extraction of natural dye from marigold flower (*Tageteserectal*.) and dyeing of fabric and yarns: A focus on colorimetric analysis and fastness properties

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ABSTRACT

India has a very rich diversity and plantkingdom is certainly a treasure house of diverse natural products. One such product from nature is the dye. In this study, natural colorants mainly flavonoids and carotenoids present in the Marigold flower (TageteserectaL.) were extracted using Soxhlet extraction method and other conventional techniques under different operating conditions. Spectrophotometric method based on the Aluminium complex formation was used for the determination of total flavonoids concentration in the extracts of different solvents used. The dye potential of the colorants obtained from the marigold was evaluated by coloring pure cotton fabrics and the yarns of pure cotton and wool. Various metal salts were used as mordants to set extracted dye on the fabrics and yarns. Study about fastness tests of dyed clothes was undertaken. The color shade differences, L, a*, b*, ΔE values and K/S values were estimated using CCM software (GretagMacbath 7000 A ° spectrophotometer). The maximum strength of the dye was found in the Ethanol-Water mixture (70:30 v/v) as a solvent. The surface color of the dyed fabrics and yarns was not affected by washing. The different color shades were obtained for various mordants used. Most of the mordants showed higher K/S value due to their ability to form coordination complexes. Good light fastness, wash fastness and rubbing fastness were observed in case of fabrics mordanted with ferrous sulphate. The relative colour strength of the dye was found to be more in case of cotton clothes mordanted with ferrous sulphate. These findings reveal that Tageteserecta L. can serve as a potential source of natural colorant which can be used in textile industry for dyeing purpose.A GC-MS analysis was done to identify the compounds present in the dye extract.*

Keywords: Natural colorants, dye potential, Tageteserecta.

INTRODUCTION

With the public enhanced cognizance to eco-safety and health concerns, eco-friendly and non-toxic bio-resource products are regaining popularity in different spheres of our lives. Natural dyes , obtained from different sources such as plants, animals, and minerals, are renewable and sustainable bio-resource products with minimum environmental impact and known since antiquity for their use, not only in coloration of textiles but also as food ingredients and cosmetics [1-3]. With the discovery of synthetic ,dye 'Mauve' by W.H. Perkin 1856 and subsequent upsurge in research, production and application of synthetic dyes, use of natural colorants declined sharply, however, the application of number ofsynthetic dyes has detrimental effects on environment and associated allergic, toxic, carcinogenic, harmful responses [4]. Amidst growing environmental and health concerns eco-friendly non-toxic natural dyes re-emerged as a potential viable '' Green chemistry' option as an alternative/co-partner to some extent to synthetic dyes [5]. Recent resurgence in research and development on natural dye production and application is observed due to increasing popularity of more natural lifestyle based on naturally sustainable goods. Natural flora/fauna is full of exquisite colors, fascinating and attracting human being towards a vast portfolio of possibilities. A large number of plant and animal/insect sources have been identified for extraction of color and their diversified use in textile dyeing and other disciplines [6- 8].

Nature has gifted us with more than 500 dye-yielding plants[9]. One such dye –yielding plant species is *Tageteserecta* L., commonly known as Mexican Marigold because of its origin. This research was performed with the explicit objective of extracting natural dye from the petals of Mexican marigold flower using different solvents such as Methanol, Ethanol, Hexane and Water, and to investigate its dyeing effects on different fabrics and yarn samples. The effects of various mordants on the stability of the dye as well as on the color shade were also analyzed. The color shade differences, L*, a*, b*, ΔE values and K/S values were estimated via CCM software analysis tool using GretagMacbath 7000 A º spectrophotometer. Light fastness, Wash fastness and Rubbing fastness were also evaluated for fabrics and yarn samples.

MATERIALS AND METHODS

Flower

A dark yellow variety of marigold flowers were purchased from Vellore flower market, Tamil nadu, India.

Substrates and Chemicals

Substrates such as cotton fabrics, yarns of wool and cotton were used for dyeing process.

Chemicals such asPotashAlum, Copper sulphate, Stannous chloride, Ferrous sulphate, Potassium dichromate, Cream of tartar, Sodium carbonate, Ethanol, Methanol, Formic acid and Sodium hydroxide

Equipments

Weighing balance, Water bath, Soxhlet apparatus, Hot air oven, UV-Vis Spectrophotometer, Gretag Macbath 7000 A º spectrophotometer

Conventional methods

Aqueous extraction method: In this method, dye from flowers were extracted by preparing an aqueous solution of the dried flowers (3.3 g in 100 mL distilled water) and the extraction process was carried out at a temperature range of 50ºC -95ºC for 2 hours. Colouring materials from the flowers were extracted for dyeing of the fabric and yarn samples. After the extraction procedure is complete, the flowers were taken out from the liquor and they were taken for extraction of dye for the second time [10].

Aqueous-Ethanol extraction method: Finely crushed dry flowers (powdered form) were taken in three different 250 ml conical flasks containing 60%, 70% and 100% Ethanol respectively. The flasks were incubated over a water bath for 4 hours at 68ºC. After the extraction process is complete, the dye solutions were left overnight in a hot air oven to obtain the dye extracts [11].

Soxhlet extraction method

This method was carried out in order to avoid the filtration of the solvent and residue and also to obtain better efficiency of separation. The organic solvents such as Ethanol, Methanol and Hexane were used for this extraction method. In this method, the weighed quantity of feed (F) or raw material and measured volume of solvent (S) were taken in certain F/S ratio. The raw material (finely crushed dry flower) was kept in thimble of Soxhlet extractor and the solvent was poured in the round bottom flask and a condenser with high flow rate of water is fitted over it. The extraction was carried for 4-5 hours and the volume of the solutions thus obtained was measured. For the evaporation of solvent, a rotary evaporator was used and the remaining dye extract is weighed [11].

Dyeing process

Scouring of cotton fabrics as well as the yarns of cotton and wool were done by washing it in a solution containing 0.5g/L Sodium carbonate and 2g/L non-ionic detergent (Triton-X) at 50°C for 25 minutes, keeping the material (M) to liquor (L) ratio of 1:40.The scoured fabrics and yarns were thoroughly washed with tap water and dried at room temperature. The scoured materials were soaked in clean water for 30 minutes prior to dyeing or mordanting[12].

Mordanting was carried out by accurately weighing cotton fabrics and yarns of cotton and wool and the same were treated with different metal salts as mordants. The mordants used were Ferrous sulfate, Copper Sulfate, Potassium dichromate, Potash alum and Stannous chloride.The mordant (2 %, 4% owf separately) was dissolved in distilled water to make a material to liquor ratio of 1:40. The samples were dipped into the mordant solution and incubatedfor 1/2 hour at temperature range of 80 -85 ºC. After mordanting, the fabric and yarn samples were taken out, squeezed and dried at room temperature. The mordanted samples were immediately used for dyeing.

The conventional dyeing technique was used for the dyeing of mordanted as well as for the non-mordanted fabrics and yarn samples. The cotton samples were dyed directly with the dye extract by keeping the M: L ratio as 1:40;

however in case of wool yarn, the pH ofthe dye extract was adjusted to 5 by adding Formic acid. The M: L ratio was kept as 1: 40 even in the case of wool dyeing. The dyeing process was carried out for 2 hours in a water bath at 85º.After the completion of dyeing; the samples were washed off with cold water and dried at the room temperature. The dyed samples were then dipped in a brine solution for dye fixing.

Color measurement

The color strength of the colored samples was analyzed using CCM software (GretagMacbath 7000 A º spectrophotometer). L*, a*, b* values were obtained. The maximum value for L* is 100 which represents a perfect reflecting diffuser. The minimum value for L* is 0 which represents black. Positive 'a' is red; negative 'a' is green. Positive 'b' is yellow and negative 'b' is blue. The color axis are based on the fact that colors cannot be both red and green, or both blue and yellow, because these colors oppose each other. The average color values for the samples were recorded and the total color difference ΔE* was calculated, which was single value that takes into account the differences between L*, a*, b* of the sample and the standard.

$$\Delta E = (\Delta L^2 + \Delta a^{*2} + \Delta b^{*2})^{1/2}$$

Three replicates were taken for all individual parameters and statistical analysis was conducted.This method also involves Kulbelka- Munk K/S equation, which indicates that the production of reflected light involves absorption and scattering. K/S value denotes the fabric color strength. Based on the % reflectance (R), K/S can be calculated by the following formula:

$$K/S = (1-R)^2 / 2R$$

where K is the absorption coefficient and S is the Scattering coefficient [12, 14].

Fastness tests

The dyed material was tested for wash fastness, light fastness, and rubbing fastness. The color is usually rated by loss of depth of color in original sample [7]. The required condition for the tests is specified in different standard including International Organization for standardization (ISO) and the American Association of Textile Chemists and Colorists (ATCC). ISO 105 B02:1994 Amd: 2000, AATCC TM 61-2010, ISO 105 X12:2001 were used for light fastness, wash fastness and rubbing fastness respectively.

Scores for wash fastness and rubbing fastness: 5-excellent; 4-Good, 3- Fair, 2-Poor, 1- Very Poor

Scores for light fastness: 1- Very Poor; 2-Poor; 3- Moderate; 4- Fairly good; 5-Good; 6- Very good; 7- Excellent; 8- Outstanding.

Total Flavonoid determination

Aluminium chloride colorimetric method was used for flavonoids determination. A known volume of extract (0.5 ml of 1:10g/ml in methanol) was placed in a test tube. Distilled water was added to make it 5ml, and 0.3ml of $NaNO_2$ (1:20) was added to it. After 5 min, 3ml of $AlCl_3$ (1:10) was added. 2ml (1mol/L) of NaOH was added after 6 min of incubation at room temperature. The total volume was made up to 10ml with distilled water. The solution was mixed well and the absorbance was measured against a blank at 423nm using UV-Vis spectrophotometer (Schimadzu) [15].Quercetin was used as the standard for a calibration curve (Fig. 1). The Flavonoid content was calculated using the following linear equation based on the calibration curve.

$$A = 0.0409C + 0.0575; R^2 = 0.9966$$

where 'A' is the absorbance and 'C' is the flavonoid content in µg g^{-1} (Quercetinequivalent).

GC-MS analysis

C-MS analysis of the dye extracts (Ethanol extract, Methanol extract and aqueous extract) obtained from the flowers of *Tageteserecta* L. was performed using a Perker- Elmer Clarus 680 system coupled with Clarus 600 (EI) Mass spectrometer (MS). The Acquisition parameters of the GC-MS system were as follows:

Oven: Initial temp 60°C for 2 min, ramp 10°C/min to 300°C, hold 6 min, InjAauto=250°C, Volume=0 µL, Split=10:1, Carrier Oven: Initial temp 60°C for 2 min, ramp 10°C/min to 300°C, hold 6 min, InjAauto=250°C, Volume=0 µL, Split=10:1, Carrier Gas=He, Solvent Delay=2.00 min, Transfer Temp=240°C, Source Temp=240°C, Scan: 50 to 600Da, Column 30.0m x 250µm.The results were analyzed using Library version NIST-2008 (software: Turbo Mass ver.5.4.2).

RESULTS AND DISCUSSION

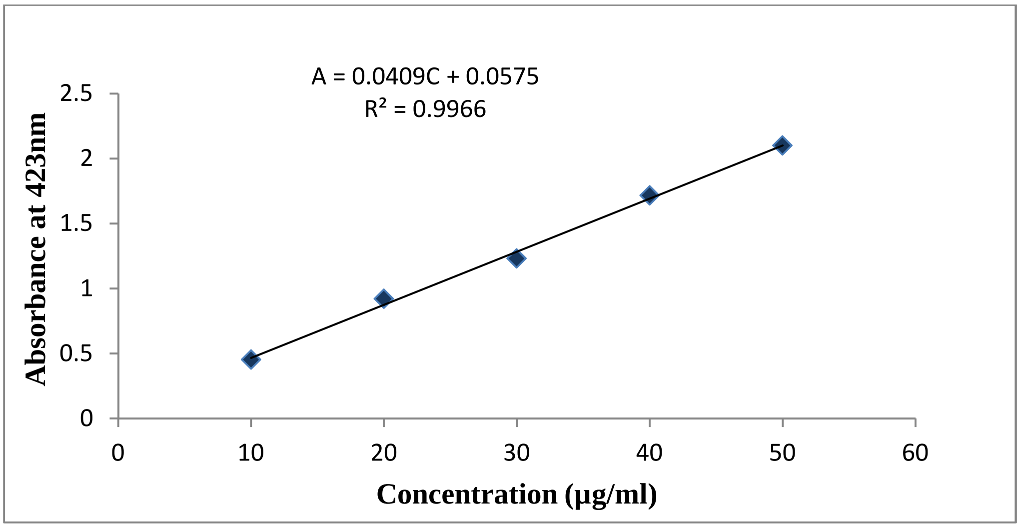

Fig.1. Standard curve of Quercetin

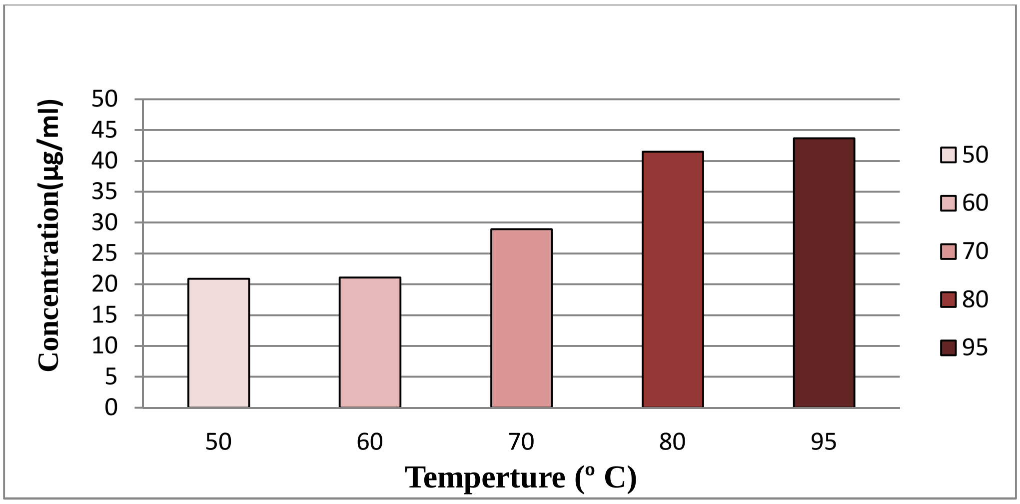

Fig.2. Dye concentration at different temperatures (Aqueous extraction)

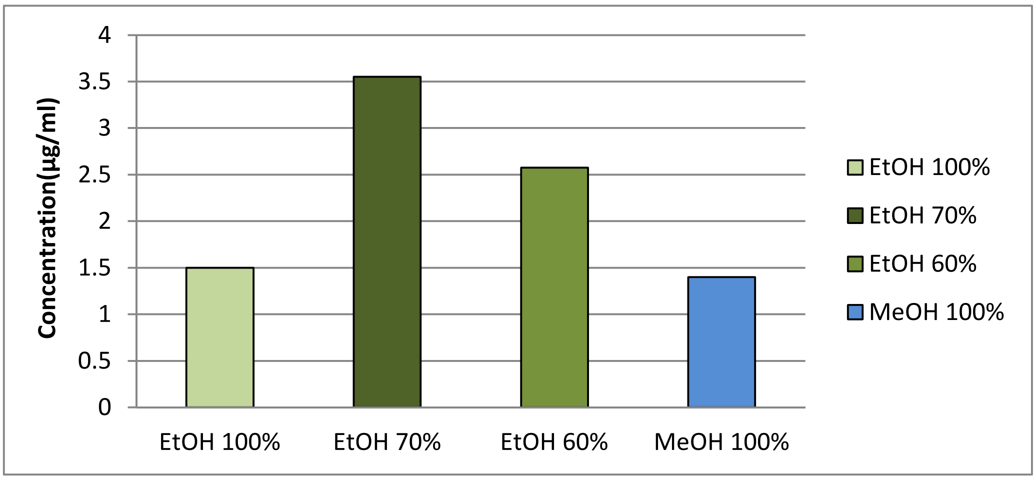

Fig.3.Dye concentration in different solvents

A dark yellownatural dye extract was obtained from *Tageteserecta* by using conventional methods and Soxhlet extraction method. In case of conventional methods, the extraction process was carried at different temperatures and

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with different solvents with an explicit objective of determining the optimum extraction conditions. The strength of the dye extracts increases with increasing temperature. Dye extracted from the marigold usually contains flavonoids and carotenoids. The major flavonoids present in the marigold flower are Quercetagin-7-methyl ether, Quercetagin-5-methyl ether, Quercetagin-5, 7-dimethyl ether and Quercetagin-3-O-glucoside [16]. Figure (2) shows the concentration of dye extracts obtained at different temperatures in aqueous extraction method. The maximum concentration of dye extract was obtained at 95ºC. Whereas figure (3) shows the concentration of dye extracts obtained using different solvents. The maximum concentration was obtained when 70% Ethanol was used as an organic solvent.

Colouring effect of extracted dye and mordants

Dark yellowextract was obtained from the flowers of *Tageteserecta*. Mordants play a very important role in imparting color to the fabric. The mordants used in combination in different ratios gave various shades to the fabrics and yarn samples. Better color strength results are dependent on the mordant used. The different shades were obtained from a single dye, using different mordants like Potassium dichromate, stannous chloride, Potash alum, Copper sulfate, and ferrous sulfate. The mordanted cotton and wool yarns were immediately used for dyeing because some mordants are light sensitive. Figure 4 shows the samples dyed with the extracted dye without using any mordant, whereas figures 5, 6, 7, 8 and 9 show the dyed samples pre-mordanted with Potassium dichromate, Stannous chloride, Potash alum, Copper sulfate and Ferrous sulphate respectively. The intensity of the color produced on cloth and yarns by dyeing without mordanting was found slightly less than that obtained for mordants and dye used successively. The application of natural dyes in textile industry for various purposes, viz. Dyeing of yarns, which are then woven into cloth, carpet or any other usable form; dyeing of cloths woven earlier and block printing, where the textile materials are printed with the help of printing blocks .Natural dyes are now as days in demand not only in textile industry but also in cosmetics, food, leather and pharmaceuticals. The rich diversity of our country has provided us plenty of raw materials, yet sustainable linkage must be developed between cultivation, collection, and their use.

Fig.4: Coloring effect of dye (no mordant)

Fig.5:Potassium dichromate as a mordant

Fig.6: Stannous chloride as a mordant

Fig.7: Potash alum as a mordant

Fig.8: Copper sulfate as a mordant

Fig.9: Ferrous sulfate as a mordant

Tab.1: Color measurement values for standard cotton sample

Sample	Illuminating sources	L*	a*	b*	% STR-WSUM
Standard for cotton samples	D65-10	76	-3.21	31.59	100
	A-10	77.46	3.88	30.39	100
	F02-10 (CWF)	77.01	-2.49	36.5	100

Tab.2: Color measurement values for standard wool yarn sample

Sample	Illuminating sources	L*	a*	b*	%STR-WSUM
Standard for wool yarn	D65-10	79.39	-1.65	24.97	100
	A-10	80.72	4.25	24.58	100
	F02-10 (CWF)	80.26	-1.24	28.11	100

Tab.3: Color measurement values for dyed cotton sample pre-mordanted with different metal Salts

Mordants	Illuminating sources	L*	a*	b*	ΔL*	Δa*	Δb*	%STR-WSUM	ΔE*
Potassium dichromate	D65-10	75.98	-3.45	31.32	-0.02	-0.25	-0.26	99.51	0.36
	A-10	77.4	3.63	30.06	-0.06	-0.25	-0.33	99.93	0.42
	F02-10 (CWF)	76.97	-2.66	36.21	-0.05	-0.17	-0.29	99.66	0.34
Stannous Chloride	D65-10	73.25	0.95	62.14	-2.75	4.16	30.58	333.09	30.96
	A-10	76.17	8.64	62.17	-1.29	4.76	31.78	274.1	32.16
	F02-10 (CWF)	75.59	-0.39	69	-1.42	2.1	32.5	322.93	32.6
Copper Sulfate	D65-10	79.39	-1.65	24.97	-16.88	4.36	14.65	450.82	22.75
	A-10	80.72	4.25	24.58	-15.98	3.48	16.14	450.02	22.98
	F02-10 (CWF)	80.26	-1.24	28.11	-16.01	2.61	15.1	454.21	22.16
Potash Alum	D65-10	76.41	-3.43	38.64	0.41	-0.22	7.05	122.07	7.07
	A-10	78.14	4.53	37.32	0.68	0.64	6.93	113.29	6.99
	F02-10 (CWF)	77.64	-2.64	44.22	0.62	-0.61	7.72	121.89	7.75
Ferrous sulfate	D65-10	16.76	5.33	8.56	-59.24	8.54	-23.03	513.63	64.13
	A-10	17.21	9.79	8.13	-60.25	5.91	-22.26	512.94	64.5
	F02-10 (CWF)	17.94	4.66	12.39	-59.07	7.15	-24.11	516.39	64.2

Colorometric parameters and color strength

The color yields of samples dyed without any mordant and the samples dyed with different mordants were evaluated using CCM software (GretagMacbath 7000 A ° spectrophotometer). The color strength (K/S value) was studied using Kubelka-Munk equation: $K/S = (1-R)^2/ 2R$ where R is the decimal fraction of the reflectance of the dyed fabrics and yarns. The fabrics and the yarn samples pre-mordanted with Potassium dichromate, Stannous chloride, Potash alum, Copper sulfate and Ferrous sulphate were dyed using the aqueous extract of *Tageteserecta*. The different mordants not only caused the differences in hue color and significant changes in K/S values but also L* values and brightness index values. Most of the metal salts exhibited the higher K/S values due to their ability to form coordination complexes with the dye molecules. The strong coordination tendency between the fibres and the dye results in high uptake of dye. Figures 10, 11 show the K/S values of the dyed cotton and the wool yarn respectively. The highest K/S value was found in dyed cotton pre-mordanted with Ferrous sulfate. Tables 1, 2 show the color measurement values for the standard samples of cotton and wool yarn respectively. For the measurement of L*, a*, b* and %STR-WSUM values, three illuminating sources such as D65-10, A-10 and F02-10 (CWF) were used. The values of % STR-WSUM gives the information about the color shade differences. Ferrous sulphate results in the highest increase in colour depth (ΔL* =-59.24), followed by Copper sulphate (ΔL* = -16.88), Stannous chloride (ΔL* = -2.75) and Potash alum (ΔL* = 0.41). Tables 3, 4 show the Color measurement values for dyed cotton and the wool yarn respectively with different mordants.

Tab.4: Color measurement values for dyed wool sample pre-mordanted with different metal salts

Mordants	Illuminating sources	L*	a*	b*	ΔL*	Δa*	Δb*	%STR-WSUM	ΔE*
Ferrous sulfate	D65-10	16.76	5.33	8.56	-59.24	8.54	-23.0	513.63	64.13
	A-10	17.21	9.79	8.13	-60.25	5.91	-22.2	512.94	64.5
	F02-10 (CWF)	17.94	4.66	12.3	-59.07	7.15	-24.1	516.39	64.2
Stannous Chloride	D65-10	79.14	-1.51	25.82	-0.25	0.13	0.85	105.38	0.89
	A-10	80.53	4.5	25.46	-0.19	0.25	0.88	104.11	0.93
	F02-10 (CWF)	80.05	-1.17	29.12	-0.21	0.07	1.01	105.19	1.04
Copper Sulfate	D65-10	69.26	1.94	29.02	10.35	3.58	4.05	232.62	11.68
	A-10	70.92	7.62	29.83	9.8	3.38	5.24	247.76	11.61
	F02-10 (CWF)	70.27	1.05	32.51	10	2.29	4.4	235.11	11.16

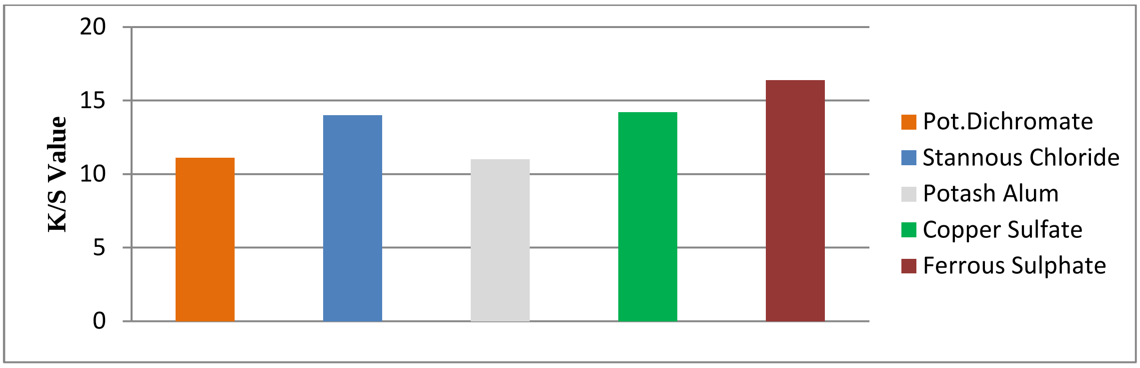

Fig. 10: Graph representing the K/S Value of cotton fabrics dyed along with different mordants

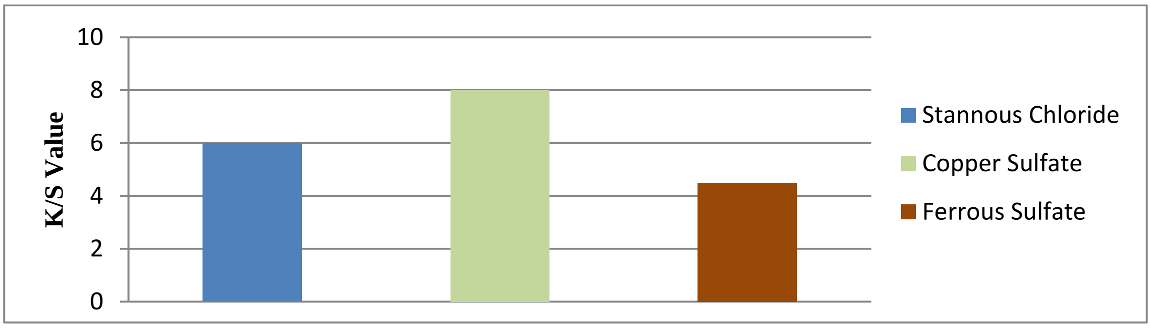

Fig.11: Graph representing the K/S Value of wool yarn dyed along with different mordants

Fastness properties of dyed samples

Color fastness test of dyed fabrics

Natural dyes have poor to moderate wash fastness as compared to synthetic dyes having moderate to excellent color fastness properties. Light fastness of many natural dyes, particularly which are extracted from flower parts are found to be poor to medium [7]. Poor light fastness of some natural dyes is attributable to photo oxidation of the chromophore. Such photo oxidation can be minimized by forming complex of the dye with transition metal. To improve the wash and light fastness of these dyed cotton fabrics, the dyed cotton fabrics should be further treated with selected cationic dye-fixing agents and also with an UV- absorber compound respectively. Natural dyes can be used on most types of material or fiber but the level of success in terms fastness and clarity of color varies considerably. It is found that natural dyeing of certain plant based textiles can be less successful than their animal equivalent. So, an extensive work has been carried out to improve the light fastness of different natural dyed textiles [7, 17-19]. To obtain varying color, to increase the dye uptake and to improve the color fastness behaviourof any natural dye for future line of work, it can be suggested that different types and selective mordants or their combination can be appliedon textile fabrics or some natural vegetable fixing agents can be used. Many investigations revealed that the use of combination of mordants in varying ratios give different shade anddifferent color fastness results [20]. Tables 6, 7show the effect of washing, rubbing and exposure to sunlight on the color fastness of marigold dyed samples. As expected, the mordanted specimen exhibited better color fastness compared to samples on which no mordant was applied.

Color fastness to washing

In case of dyed cotton samples, all the mordants except Alum showed good to excellent fastness (4-5) to washing. Alum offered fair to good (3-4) fastness. But in case of dyed wool yarn, Stannous chloride offered poor to fair (2-3) fastness, Potash alum offered fair to good fastness (3-4) and all the other mordants offered good to excellent (4-5) fastness.

Color fastness to light

Cotton samples dyed along with mordants such as Potassium dichromate and Stannous chloride exhibited moderate to fairly good fastness (3-4) against light whereas mordants such as Potash alum, Copper sulfate and Ferrous sulfate offered fairly good to good (4-5) fastness. Wool yarn dyed along with the mordants such as Potassium dichromate and Stannous chloride exhibited poor to moderate (2-3) fastness whereas mordants such as Copper sulfate and Ferrous sulfate exhibited fairly good to good (4-5) fastness.

Tab.5: Color fastness values for dyed cotton

S.No	Name of Mordant	Mordant Concentration	Light Fastness ISO 105 B02:1994 Amd :2000	Wash Fastness AATCC TM 61-2010	Rubbing Fastness ISO 105 X12:2001
	No Mordant		1-2	2	2
1.	**Potassium Dichromate**	2%	2-3	3-4	4
		4%	2-3	3-4	4
2.	**Stannous Chloride**	2%	2-3	2-3	4
		4%	4-3	2-3	4
3.	**Potash Alum**	2%	3	3-4	4
		4%	3	3-4	4
4.	**Copper Sulfate**	2%	4	4	4-5
		4%	4	4-5	4-5
5.	**Ferrous Sulfate**	2%	4-5	4	4
		4%	4-5	4	4

Tab.6: Color fastness values for dyed wool yarn

S.No	Name of Mordant	Mordant Concentration	Light Fastness ISO 105 B02:1994 Amd :2000	Wash Fastness AATCC TM 61-2010	Rubbing Fastness ISO 105 X12:2001
	No Mordant		2	2-3	3
1.	**Potassium Dichromate**	2%	2	2-3	3
		4%	3	4	4
2.	**Stannous Chloride**	2%	3	4	4
		4%	3-4	4	4
3.	**Potash Alum**	2%	4	3-4	4-5
		4%	4	3-4	4-5
4.	**Copper Sulfate**	2%	4	4	4
		4%	4	4	4
5.	**Ferrous Sulfate**	2%	4	4-5	4
		4%	4-5	4-5	4

Color fastness to rubbing

Color fastness was found be good to excellent (4-5) for all the cotton samples as well as for the wool yarn sample dyed along with all the mordants.

GC-MS analysis

GC-MS of dye extracts obtained from the flowers of *Tageteserecta* L. using solvents such as Ethanol, Methanol and water led to the identification of various compounds. The chromatogram of ethanol extract, methanol extract and aqueous extract are shown in the figures 9, 10 and 11. The various compounds detected by GC-MS in different extracts are shown along with their respective retention time and area percentage in tables 8, 9 and 10. The presence of various components with different retention (RT) times was confirmed by GC-MS spectra. The mass spectroscopy analyzes the components eluted at different times to identify the structure and the nature of the compounds. The fragmentation of large compound into small ones gives rise to appearance of peaks at different m/z ratios. These mass spectra act as a fingerprint of the very compound that can be identified from the library. The results of the GC-MS analysis showed the presence of various alkaloids, glycosides, flavonoidderivatives, phenols, reducing sugars, steroids and terpenoids and can be further analyzed for more specifications.

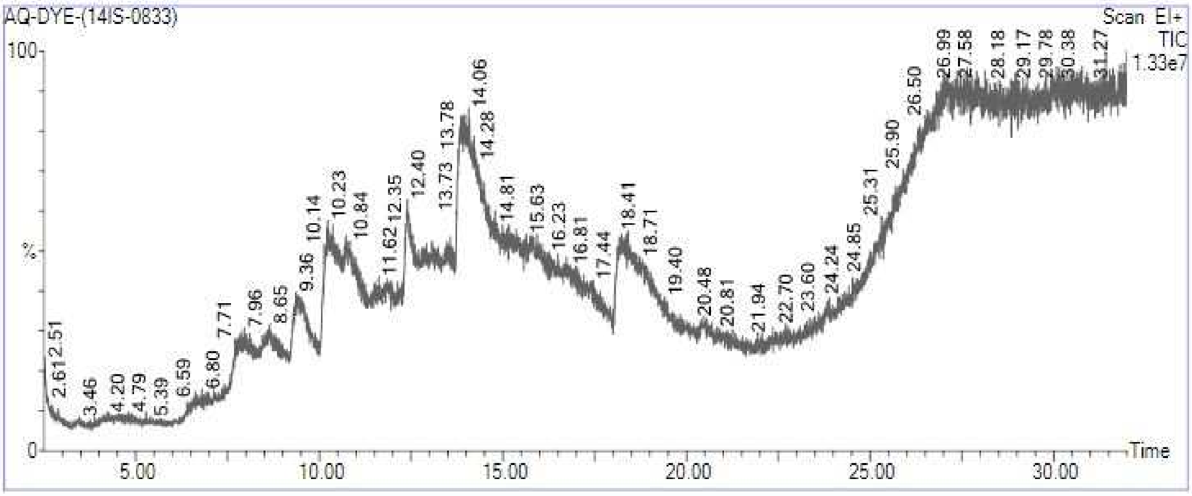

Fig.12: GC-MS chromatogram of *Tageteserecta* aqueous extract

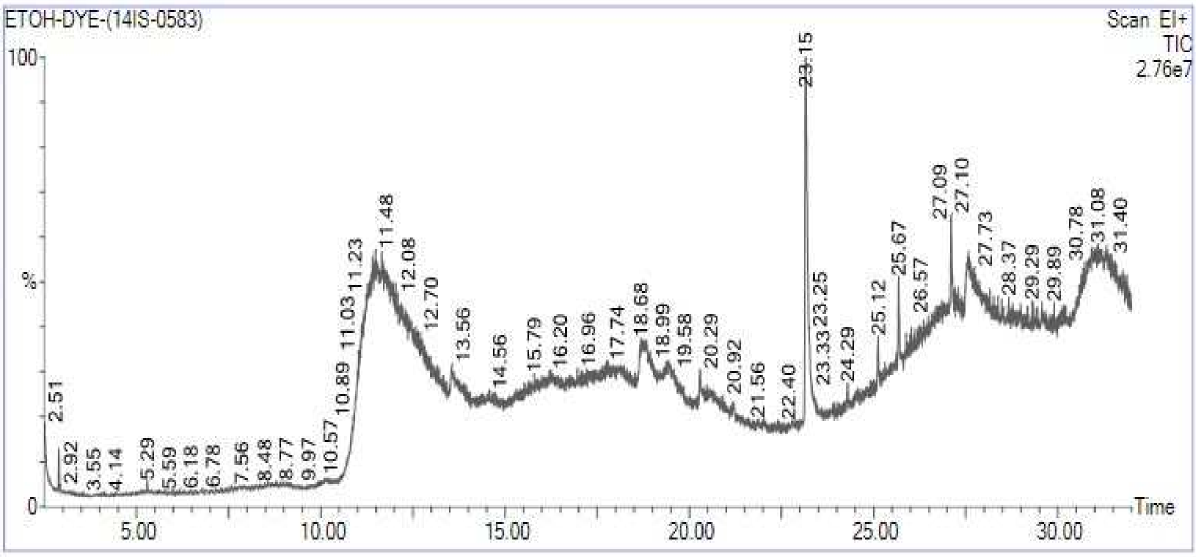

Fig.13: GC-MS chromatogram of *Tageteserecta* ethanolic extract

Tab.8: Compounds identified in aqueous extract of *Tageteserecta*

S.no	Name of the compound	Mol.Wt.	Molecular formula	RT(min)	Area %
1.	10,12-Dimethyl-1,4,7-trioxa-10,12-diazacyclotetradecan-11-one	246	$C_{11}H_{22}O_4N_2$	10.232	9.197
2.	2-oxo-2-(4-phenylphenyl)ethyl 2-hydroxy-3-methylbenzoate	346	$C_{22}H_{18}O_4$	10.732	8.219
3.	6-Tert-butyl-8-methyl-1H,2H,3H-cyclopenta[c]chromen-4-one	256	$C_{17}H_{20}O_2$	11.617	3.468
4.	2,2-Dimethyl-5-[2-(2-trimethylsilylethoxymethoxy)-propyl]-[1,3] dioxol	318	$C_{15}H_{30}O_5Si$	12.397	6.262
5.	2-n-Hexylthio-5-methyl-imidazoline	200	$C_{10}H_{20}N_2S$	12.923	3.575
6.	I-Propyl tricosanoate	396	$C_{26}H_{52}O_2$	13.563	4.172
7.	Alpha.-d-glucopyranoside, O-.alpha.-D-glucopyranosyl	504	$C_{18}H_{32}O_{16}$	14.063	30.370
8.	Beta-D-lyxofuranoside, thio-decyl	306	$C_{15}H_{30}O_4S$	15.158	4.557
9.	Benzoic acid, 4-hydroxy-3,5-dimethoxy	198	$C_9H_{10}O_5$	18.230	3.167
10.	Benzenemethanol, 3,4,5-trimethoxy	198	$C_{10}H_{14}O_4$	18.410	3.697

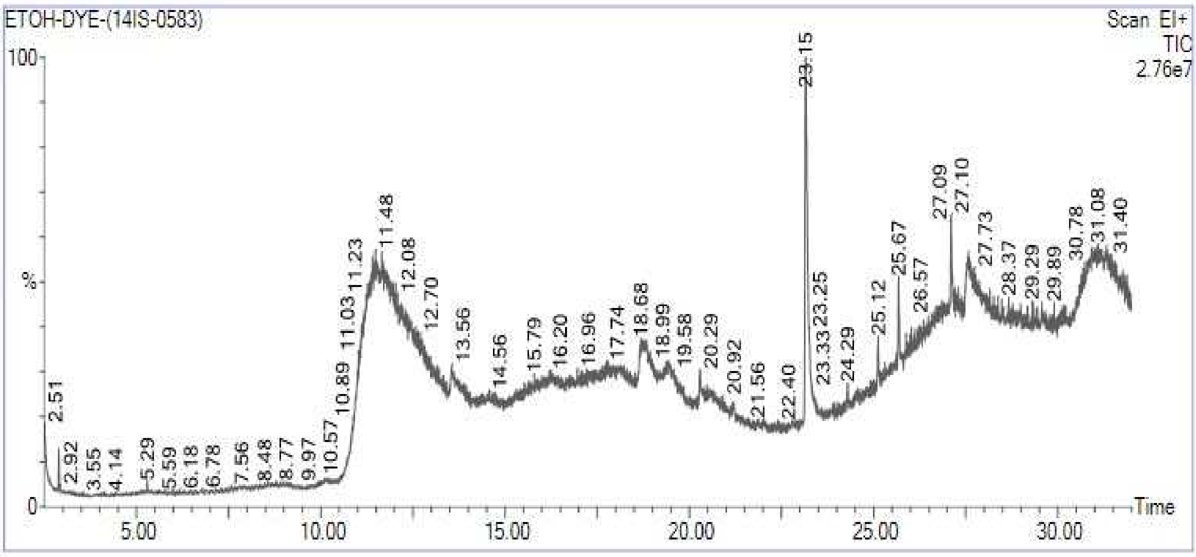

Fig.14: GC-MS chromatogram of *Tageteserecta* ethanolic extract

Tab.9: Compounds identified in ethanolic extract of *Tageteserecta*

S.no.	Name of the compound	Mol.Wt.	Molecular formula	RT(min)	Area %
1.	Acetic acid, 2-(5-nitro-2-benzimidazolyl) thio-, benzyl ester	343	$C_{16}H_{13}O_4N_3S$	11.657	79.011
2.	n-benzoyl-dl-phenylalanine	269	$C_{16}H_{15}O_3N$	13.563	2.845
3.	Beta.-d-mannofuranoside, 1-O-5-phenylpent-1-yl	326	$C_{17}H_{26}O_6$	18.685	4.625
4.	Alpha.-d-mannofuranose, 2,3-5,6-di-O-phenylboranediyl	352	$C_{18}H_{18}O_6B_2$	19.430	2.361
5.	1,2-benzenedicarboxylic acid, mono(2-ethylhexyl) ester	278	$C_{16}H_{22}O_4$	23.162	8.113
6.	Silane, trichlorooctadecyl	386	$C_{18}H_{37}Cl_3Si$	25.673	0.878
7.	Trimethyl[4-(1,1,3,3,-tetramethylbutyl)phenoxy] silane	278	$C_{17}H_{30}OSi$	27.098	1.189

Tab.10: Compounds identified in methanolic extract of *Tageteserecta*

S.no	Name of the compound	Mol.Wt.	Molecular formula	RT(min)	Area %
1.	2-Dimethyl(prop-2-enyl)silyloxydodecane	284	$C_{17}H_{36}OSi$	10.362	4.257
2.	5-Dimethyl(trimethylsilyl)silyloxytridecane	330	$C_{18}H_{42}OSi_2$	10.812	6.489
3.	2H-Pyran, tetrahydro-2-[(1-methyl-4-phenyl-2-butynyl)oxy]-	244	$C_{16}H_{20}O_2$	12.362	6.798
4.	Succinic acid, 2-methoxyethyl undecyl ester	330	$C_{18}H_{34}O_5$	13.913	20.809
5.	Diethylene glycol, O,O-di(pivaloyl)	274	$C_{14}H_{26}O_5$	15.058	4.833
6.	2-Ethoxycarbonylsyringic acid	270	$C_{12}H_{14}O_7$	16.124	4.107
7.	1-decanol, 9-[(trimethylsilyl)oxy]-, trifluoroacetate	342	$C_{15}H_{29}O_3F_3Si$	18.180	5.523
8.	Exo-2-[(2-trimethylsilyl) vinyl]bicyclo[2.2.1]hept-5-en-2-ol	208	$C_{12}H_{20}OSi$	18.590	5.146

CONCLUSION

The present study showed that natural dye can be successfully extracted from the flowers of *Tageteserecta*. The whole process of extraction is eco-friendly. The maximum dye extraction was observed at 95ºC using aqueous extraction method. The obtained results have shown that the dyeing potential of the marigold flower could be huge which can be used as a source of textile dyeing. The various color shades can be obtained using safe and eco-friendly mordants. Detailed scientific research with natural dyes has revealed that their properties are comparable to that of synthetic dyes. If natural dyes have to be commercialized, the traditional methods must be substituted by modern, more scientific approach in order to overcome to overcome some of the disadvantages of natural dye.

REFERENCES

[1] A.C. Dwek,*Int. J. Cosmet*, **2002**, 24, 287.
[2] D. Frick, *Rec. Prog. Color*,**2003**, 33, 15.
[3] S.J.F. Kadolph,*Delta Kappa Gamma Bull*. **2008**, 75, 74.
[4] T. Bechtold, A. Turcanu,E. Gangberger, S. Geissler,*J. Clean. Prod*,**2003**, 11, 499.
[5] Mrijalini, K. Nazarpoor, L. Karimi, *J. Clean. Prod*.**2011**, 19, 1045.
[6] T.L. Dawson, *Color. Technol*.**2009**, 125, 61.
[7] A.K. Samanta, P.Agarwal,*Indian J. Fibre.Text. Res*,**2009**, 34, 384.

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[8] M. Shahid, S. Ul-Islem, F. Mohammad,*J.Clean. Prod*,**2013**, 53, 310.
[9] D. Mahanta, S.C. Tiwari, *Curr. Sci*, **2005**, 88, 1474.
[10] N. Grover, V. Patni, **2011**, 2(4), 403.
[11] M.D. Luque de Castro, F. Priego-Capote, *J. Chromatogr. A*, **2010**, 1217, 2383.
[12] M. Toussirot, W. Nowik, E. Hnawia , N. Lebouvier , A.-E. Hay, A. de la Sayette, M.-G. Dijoux- Franca, D. Cardon , M. Nour,*Dyes Pigments*, **2014**, 102, 278.
[13] W. Haddar, M.B. Ticha, A. Guesmi, F. Khoffi, B. Durand, *J. Clean. Prod*,**2014**, 68, 114.
[14] K.Leon ,D. Mery, F. Pedreschi , J. Leon , Color measurement in L*a*b* units from RGB digital images,**2006**, 39, 1084.
[15] X.P. Zhuang, Y.Y. Lu, G.S. Yang,*Chinese Herbal Medicine*, **1992**, 23, 122.
[16] X. Li-wei, C. Juan, Q. Huan-yang, S. Yan-ping, *Chinese Herbal Medicines*, **2012**, 4(2), 103.
[17] S. Naz, I.A. Bhatti,S. Adeel, *Indian J.FibreTextile Res*, **2011**, 36, 132.
[18] C.C. Cook, *Rev.Prog.Colour*, **1982**, 12, 78.
[19] M.A. Salam, R.K. Sheik, F. Farouique, *J.Textile Apparel, Technol. Management*,**2006**, 5(3), 1.
[20] M. Kumaresan, P.N. Palanisamy, P.E. Kumar, *Eur. J. Sci. Res*, **2011**, 52(3), 306.