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Natural Dyeing Cotton Fabric with Marigold and Palash Flower Dye powder using different Mordant– their Colour fastness test and FTIR analysis

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Abstract

Tagetes is a genus of 50 species of annual or perennial, mostly herbaceous plants in the family Asteraceae. They are among several groups of plants known in English as marigolds. Tagetes erecta, the Aztec marigold, Mexican marigold, big marigold, cempaxochitl or cempasúchil, is a species of flowering plant in the genus Tagetes native to Mexico and Guatemala. It is widely cultivated commercially with many cultivars in use as ornamental plants, and for the cut-flower trade. The essential oil of the flower contains antioxidants. It may be added to perfumes to infuse an apple scent into them. It is used as a natural dye on textiles. Palash (Butea monosperma) is a species of Butea native to tropical and sub-tropical parts of South Asia and Southeast Asia. It is also known as flame of the forest, Bengal kino, dhak, palash, and bastard teak. The plant grows across Bangladesh, India, Nepal, Pakistan, Sri Lanka, Myanmar, Thailand, Laos, Cambodia, Vietnam, Malaysia, and western Indonesia. The plant is used to make timber, resin, fodder, medicine, and dye. The flowers are used to prepare a traditional Holi colour called "Kesari". It is also used as a dye for fabric. Butein, a vibrant yellow to deep orange-red dye made from the flowers, is used for dying silk and cotton. The chemical constituents of Palash are diverse and include flavonoids like quercetin and kaempferol, which exhibit antioxidant properties and contribute to its vibrant red color. Tannins, another group of compounds found in Palash, have astringent qualities and may have medicinal uses. The plant also contains sterols, which are essential components of plant cell membranes. Additionally, glycosides are present, which can have various biological activities. One notable compound in Palash is butein, responsible for its distinctive red hue and believed to possess antioxidant and anti-inflammatory properties. Present paper deals with natural dyeing cotton fabric mordanted with Alum, Alum and Cream of tartar, Copper sulphate and Cream of tartar, Ferrous sulphate and Cream of tartar, Potassium dichromate, Stannous chloride and Cream of tartar, Tannic acid using Marigold and Palash flower dye powder. This also includes their Colour Fastness test for Water Fastness and Light Fastness and FTIR analysis. Water fastness and light fastness test was performed by regular washing and drying fabric in sunlight. Gray Scales are used for assessing colour change and staining during colour fastness testing. Colour fastness test for water fastness and light fastness to Marigold and Palash flower dye powder using different mordant dyed fabric shows 4-5 range in gray scale method which indicates excellent to water fastness and light fastness. FTIR can be routinely used to identify the functional groups. FTIR spectra of Natural Dye made from Alkanet and Rhubarb Root dye powder are obtained at room temperature by using an FTIR Spectrophotometer - Shimadzu - IR Affinity – 1. The spectra are collected in range from 400 - 4500 cm-1.Interpretation of FTIR Spectra of Natural Dye made from Marigold and Palash flower dye powder shows presence of various functional groups such as

Keywords: Marigold, Palash, Alum, Cream of tartar, Copper sulphate, Ferrous sulphate, Potassium dichromate, Stannous chloride, Tannic acid, Colour Fastness Test, FTIR Analysis.

Introduction

Marigold (tagetes erecta): Tagetes is a genus[1] of 50 species of annual or perennial, mostly herbaceous plants in the family Asteraceae. They are among several groups of plants known in English as marigolds. Tagetes erecta, the Aztec marigold, Mexican marigold, big marigold, cempaxochitl or cempasúchil[2], is a species of flowering plant in the genus Tagetes native to Mexico and Guatemala. This plant reaches heights of between 20 and 90 cm. The Aztecs gathered the wild plant as well as cultivating it for medicinal, ceremonial and decorative purposes. It is widely cultivated commercially with many cultivars in use as ornamental plants, and for the cut-flower trade[3]. The essential oil of the flower contains antioxidants[4]. It may be added to perfumes to infuse an apple scent into them. It is used as a natural dye on textiles[5]. Natural colorants mainly flavonoids and carotenoids present in the Marigold flower (Tageteserecta L.) 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 (Gretag Macbath 7000 Aº

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[6].

Palash (butea monosperma): *Butea monosperma* is a species of Butea native to tropical and sub-tropical parts of South Asia and Southeast Asia. It is also known as flame of the forest, Bengal kino, dhak, palash, and bastard teak. The plant grows across Bangladesh, India, Nepal, Pakistan, Sri Lanka, Myanmar, Thailand, Laos, Cambodia, Vietnam, Malaysia, and western Indonesia. The plant is used to make timber, resin, fodder, medicine, and dye. The wood is dirty white and soft. Being durable under water, it is used for well curbs and water scoops. Good charcoal can be obtained from it. Farmers typically plant trees on field bunds and use them to reduce soil erosion. Young shoots are grazed by buffaloes as fodder. The leaves were once used to serve food where plastic plates would be used today. Consumption of Palash Sharbat (drink) gives strength to the body to bear the heat and keeps away from health related diseases. The body gets immunity power. Fixed oil in the seed and glucoside butrin of the flower sap are considered to be poisoned. Its consumption may cause dizziness, headache, and hypotension[7]. In India, the tree serves as a crucial host for the lac bug (Lacciferlacca), which creates shellac. It produces the most lac sticks per hectare of any lac tree. The bark produces a crimson exudate that, when dried, hardens into a substance called "Butea gum" or "Bengal kino". The gum is considered valuable by druggists because of its astringent qualities and by leather workers because of its tannin[8].

The gum from the tree is used in certain food dishes. It is prepared as a summer beverage out of tea of the flower which is considered to have medicinal benefits. This tree provides the leaves that are used either with many pieced together or singly (only in case of a banana leaf) to make a leaf-plate for serving a meal. The flowers are used to prepare a traditional Holi colour called "Kesari". It is also used as a dye for fabric. Butein, a vibrant yellow to deep orange-red dye made from the flowers, is used for dying silk and cotton.

The chemical constituents of Palash are diverse and include flavonoids like quercetin and kaempferol, which exhibit antioxidant properties and contribute to its vibrant red color. Tannins, another group of compounds found in Palash, have astringent qualities and may have medicinal uses. The plant also contains sterols, which are essential components of plant cell membranes. Additionally, glycosides are present, which can have various biological activities.

One notable compound in Palash is butein, responsible for its distinctive red hue and believed to possess antioxidant and anti-inflammatory properties. Palash (Butea monosperma) possesses pharmacological properties such as anti-inflammatory, antioxidant, antimicrobial, and analgesic effects. It is traditionally used in Ayurvedic medicine to treat various ailments, including skin disorders, pain, and inflammation. Its bioactive compounds contribute to these therapeutic actions, making it a valuable medicinal plant.

The uncontrolled discharge of synthetic dyes into the aquatic ecosystem is a global environmental concern due to their negative ecotoxicological effects. Dyes obtained from different natural sources have emerged as an important alternative to synthetic dyes. In this study, natural colorant from the petals of the Flame of forest (*Butea monosperma*) flower was extracted under different operating conditions such as extraction time (45–120 min), temperature (60–90°C) and mass of the petals (0.5–2 g) by conventional extraction technique. Response surface methodology (RSM) with the help of Design Expert Version 7.1.6 (STAT-EASE Inc., USA) was used for optimization of the extraction process and evaluation of interaction effects of different operating parameters.

The optimum conditions for dye extraction were found to be 153.65 min, 73.53°C and 1.47g for extraction time, temperature, and mass of the flower respectively.

The efficiency of extraction under these optimum conditions was found to be 8813.67 mg L^{-1}. Further, Fourier Transform Infrared Spectroscopy was used to identify the major chemical groups in the extracted dye[9].

Natural colorants are emerging globally as the safer and eco-friendly leaving synthetic colorant behind in the race. An attempt has been made to extract the dye from fresh, shade dried; field dropped and sun dried flowers of Butea monosperma (Palas).

A good quantity of crude dye was recovered to the extent of 4, 18 and 9 per cent respectively on weight basis. The compounds present in the flowers were analyzed through spectral means and identified as Chalcone, butein ($C_{15}H_{12}O_5$), orange yellow needles and a small quantities of colourless isomeric flavanone, butin ($C_{15}H_{12}O_5$), and its glycoside, butrin.

The crude dye after further purification and refining has tremendous scope as a medicine or ingredient for other medicine and can also serve as colouring material in soft drinks and other food products like ham/sausages, jam, chowmin noodles etc[10].

Present paper deals with natural dyeing cotton fabric mordanted with Alum, Alum and Cream of tartar, Copper sulphate and Cream of tartar, Ferrous sulphate and Cream of tartar, Potassium dichromate, Stannous chloride and Cream of tartar, Tannic acid using Marigold and Palash flower dye powder. This also includes their Colour Fastness test for Water Fastness and Light Fastness and FTIR analysis.

Methodology

Natural dyeing cotton fabric with Marigold and Palash flower dye powder using different mordant: Step 1: Cleaning Cotton Fabric for dyeing - Cotton Fabric is soaked in water and detergent (1 % weight of fabric) and heated for 30 minutes.

After cooling soaked cloth rinsed with cold water then excess water is squeezed out and fabric is dried. This helps dye to penetrate fabric better.

Step 2: Mordanting Cotton fabric: Mordanting Cotton Fabric with Alum - Alum (15 % weight of fabric) is dissolved in water. To it cleaned cotton fabric is soaked and heated for 1 hour. After cooling excess water is squeezed out and fabric is dried.

Mordanting Cotton Fabric with Alum and Cream of tartar - Alum (15 % weight of fabric) and Cream of tartar (10 % weight of fabric) is dissolved in water.

To it cleaned cotton fabric is soaked and heated for 1 hour. After cooling excess water is squeezed out and fabric is dried.

Mordanting Cotton Fabric with Copper and Cream of tartar – Copper sulphate (15 % weight of fabric) and Cream of tartar (10 % weight of fabric) is dissolved in water. To it cleaned cotton fabric is soaked and heated for 1 hour. After cooling excess water is squeezed out and fabric is dried.

Mordanting Cotton Fabric with Iron and Cream of tartar – Ferrous sulphate (15 % weight of fabric) and Cream of tartar (10 % weight of fabric) is dissolved in water.

To it cleaned cotton fabric is soaked and heated for 1 hour. After cooling excess water is squeezed out and fabric is dried.

Mordanting Cotton Fabric with Chrome– Potassium dichromate (15 % weight of fabric) is dissolved in water. To it cleaned cotton fabric is soaked and heated for 1 hour. After cooling excess water is squeezed out and fabric is dried.

Mordanting Cotton Fabric with Tin and Cream of tartar – Stannous chloride (15 % weight of fabric) and Cream of tartar (10% weight of fabric) is dissolved in water. To it cleaned cotton fabric is soaked and heated for 1 hour. After cooling excess water is squeezed out and fabric is dried.

Mordanting Cotton Fabric with Tannic acid – Tannic acid (15% weight of fabric) is dissolved in water. To it cleaned cotton fabric is soaked and heated for 1 hour. After cooling excess water is squeezed out and fabric is dried.

Step 3: Making Natural Dye: Making Natural Dye using Marigold and Palash flower dye powder - 5 % weight of fabric Rhubarb root dye powder is taken in separate Glass beakers to it water is added and boiled for 1 hour. Then kept overnight as it is and strained. Filtrate is used as dye bath.

Step 4: Dyeing Mordanted Cotton Fabric - Mordanted cotton fabric is kept in Dye bath and heated for 1 hour. Then it is removed from dye bath and rinsed with water and bit of detergent and dried.

Step 5: Dye fixing –10 gm sodium chloride was added to 500 ml water. Dyed fabric is dipped in sodium chloride solution for one hour and then fabric is washed with tap water and dried in the shade.

Step 6: Ironing Dyed Cotton Fabric – Dyed cotton fabric is ironed.

Step 7: Measurement of colour - The obtained colours were measured and matched with the names of RAL Color Chart.

Step 8: Colour fastness test - Then colour fastness test are performed.

Colour Fastness test for Water Fastness and Light Fastness to Marigold and Palash flower Dyed Fabric: Gray Scales are used for assessing colour change and staining during colour fastness testing. Both scales are used for visual assessment to enable us to specify a rating from 1 to 5, with 5 being 'good' and 1 being 'poor'.

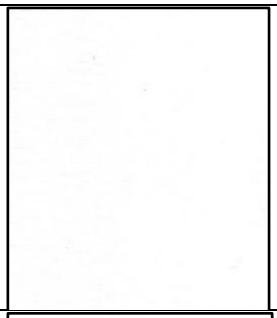
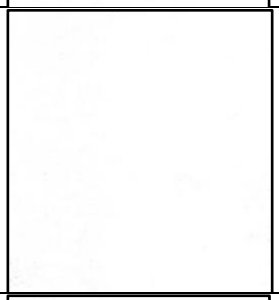
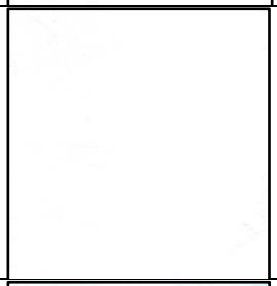
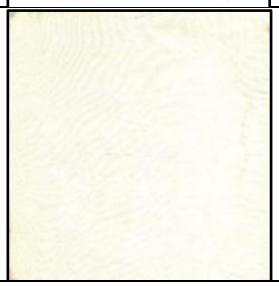
The colour change gray scale consists of nine pairs of grey coloured chips, from grades 1 to 5 in accordance with ISO 105-A02 and A03. Grade 5 represents no change and grade 1 shows large change. The staining scale consists of nine pairs of grey and white coloured chips from grades 1 to 5.

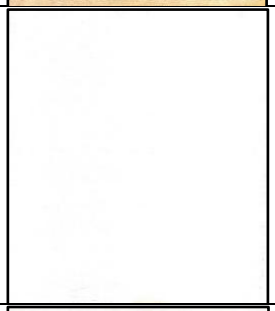
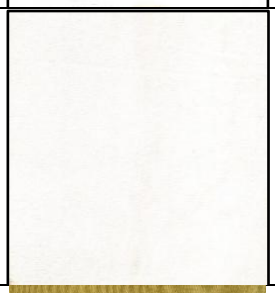
Water fastness and light fastness test was performed by regular washing and drying fabric in sunlight.

FTIR Analysis of Marigold and Palash flower Dye Extract: FTIR can be routinely used to identify the functional groups. FTIR spectra of Natural Dye made from Marigold and Palash flower dye powder are obtained at room temperature by using an FTIR Spectrophotometer - Shimadzu - IR Affinity – 1. The spectra is collected in range from 400 - 4500 cm^{-1}.

Results and Discussion

Table-1: Natural Dyeing Cotton Fabric using Marigold and Palash flower dye powder.

Code No. – Cotton Fabric	Colour obtained on Cotton Fabric	Color Model RGB				Color Model LAB		
		Red	Green	Blue	Hex # & Color Description	l	a	b
00 - Cotton Fabric Not Mordanted and Not Dyed		243	243	243	#F3F3F3 White Smoke	95.84	0	0
0 C - Cotton Fabric Mordanted with Alum and Not Dyed		243	243	243	#F3F3F3 White Smoke	95.84	0	0
0 D - Cotton Fabric Mordanted with Alum and Cream of tartar and Not Dyed		243	243	243	#F3F3F3 White Smoke	95.84	0	0
0 E - Cotton Fabric Mordanted with Copper sulphate and Cream of tartar and Not Dyed		243	253	255	#F3FDFF Azure	98.64	-2.91	-2.09
0 F - Cotton Fabric Mordanted with Ferrous sulphate and Cream of tartar and Not Dyed		238	230	222	#EEE6DF White Chocolate	91.71	1.34	4.85

0 G - Cotton Fabric Mordanted with Potassium dichromate and Not Dyed		222	182	162	#DEB6A2 Pale Chestnut	77.04	11.48	15.61
0 H - Cotton Fabric Mordanted with Stannous chloride and Cream of tartar and Not Dyed		243	243	243	#F3F3F3 White Smoke	95.84	0	0
0 I - Cotton Fabric Mordanted with Tannic acid and Not Dyed		238	238	238	#EEEEEE Bright Gray	94.1	0	0
19 C - Cotton Fabric Mordanted with Alum and Dyed with Marigold		179	153	71	#B39947 darkkhaki	64.02	-0.28	45.79
19 D - Cotton Fabric Mordanted with Alum and Cream of tartar and Dyed with Marigold		186	165	91	#BAA55B darkkhaki	68.1	-2.1	40.85
19 E - Cotton Fabric Mordanted with Copper sulphate and Cream of tartar and Dyed with Marigold		141	110	43	#8D6E2B peru	48.25	4.77	40.77

19 F – Cotton Fabric Mordanted with Ferrous sulphate and Cream of tartar and Dyed with Marigold		88	75	56	#584B38 dimgray	32.68	2.25	13.36
19 G - Cotton Fabric Mordanted with Potassium dichromate and Dyed with Marigold		210	166	98	#D2A662 burlywood	70.77	8.08	41.08
19 H - Cotton Fabric Mordanted with Stannous chloride and Cream of tartar and Dyed with Marigold		213	173	48	#D5AD30 goldenrod	72.39	2.59	65.04
19 I - Cotton Fabric Mordanted with Tannic acid and Dyed with Marigold		189	176	126	#BDB07E tan	71.81	-2.93	27.34
20 C - Cotton Fabric Mordanted with Alum and Dyed with Palash		247	224	157	#F7E09D palegoldenrod	89.64	-1.44	35.71

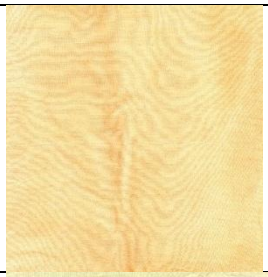
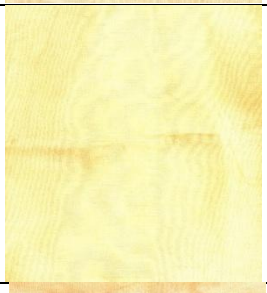
20 D - Cotton Fabric Mordanted with Alum and Cream of tartar and Dyed with Palash		247	222	157	#F7DE9D navajowhite	89.14	-0.43	35.05
20 E - Cotton Fabric Mordanted with Copper sulphate and Cream of tartar and Dyed with Palash		224	234	197	#E0EAC5 lightgoldenrodyellow	91.11	-9.63	16.87
20 F – Cotton Fabric Mordanted with Ferrous sulphate and Cream of tartar and Dyed with Palash		225	193	152	#E1C198 tan	79.85	5.49	24.88
20 G - Cotton Fabric Mordanted with Potassium dichromate and Dyed with Palash		247	231	187	#F7E7BB wheat	91.92	-1.27	23.43
20 H - Cotton Fabric Mordanted with Stannous chloride and Cream of tartar and Dyed with Palash		250	247	180	#FAF7B4 palegoldenrod	96.06	-9.1	32.67
20 I - Cotton Fabric Mordanted with Tannic acid and Dyed with Palash		246	221	165	#F6DDA5 navajowhite	88.93	0.64	30.68

Table-2: Colour Fastness test for Water Fastness and Light Fastness to Marigold and Palash flower Dyed Fabric.

Code No. - Cotton Fabric	Colour Fastness Test	
	Water Fastness	Light Fastness
00 - Cotton Fabric Not Mordanted and Not Dyed	5	5
0 C - Cotton Fabric Mordanted with Alum and Not Dyed	5	5
0 D - Cotton Fabric Mordanted with Alum and Cream of tartarand Not Dyed	5	5
0 E - Cotton Fabric Mordanted with Copper sulphate and Cream of tartar and Not Dyed	5	5
0 F - Cotton Fabric Mordanted with Ferrous sulphate and Cream of tartar and Not Dyed	5	5
0 G - Cotton Fabric Mordanted with Potassium dichromate and Not Dyed	5	5
0 H - Cotton Fabric Mordanted with Stannous chloride and Cream of tartar and Not Dyed	5	5
0 I - Cotton Fabric Mordanted with Tannic acid and Not Dyed	5	5
19 C - Cotton Fabric Mordanted with Alum and Dyed with Marigold	4-5	4-5
19 D - Cotton Fabric Mordanted with Alum and Cream of tartar and Dyed with Marigold	4-5	4-5
19 E - Cotton Fabric Mordanted with Copper sulphate and Cream of tartar and Dyed with Marigold	4-5	4-5
19 F – Cotton Fabric Mordanted with Ferrous sulphate and Cream of tartar and Dyed with Marigold	4-5	4-5
19 G - Cotton Fabric Mordanted with Potassium dichromate and Dyed with Marigold	4-5	4-5
19 H - Cotton Fabric Mordanted with Stannous chloride and Cream of tartar and Dyed with Marigold	4-5	4-5
19 I - Cotton Fabric Mordanted with Tannic acid and Dyed with Marigold	4-5	4-5
20 C - Cotton Fabric Mordanted with Alum and Dyed with Palash	4-5	4-5
20 D - Cotton Fabric Mordanted with Alum and Cream of tartar and Dyed with Palash	4-5	4-5
20 E - Cotton Fabric Mordanted with Copper sulphate and Cream of tartar and Dyed with Palash	4-5	4-5
20 F – Cotton Fabric Mordanted with Ferrous sulphate and Cream of tartar and Dyed with Palash	4-5	4-5
20 G - Cotton Fabric Mordanted with Potassium dichromate and Dyed with Palash	4-5	4-5
20 H - Cotton Fabric Mordanted with Stannous chloride and Cream of tartar and Dyed with Palash	4-5	4-5
20 I - Cotton Fabric Mordanted with Tannic acid and Dyed with Palash	4-5	4-5

Colour fastness test for water fastness and light fastness to Marigold and Palash flower dye powder using different mordant dyed fabric shows 4-5 range in gray scale method which indicates excellent to water fastness and light fastness.

Table-3: FTIR spectra of Natural Dye made from Marigold flower.

No.	Peak	Intensity	Corr. Inte	Base (H)	Base (L)	Area	Corr. Are
1	399.28	2.355	1.973	419.54	339.49	111.835	7.816
2	426.29	2.578	0.055	447.5	420.5	42.727	0.126
3	495.73	2.585	0.231	874.76	448.47	641.653	8.056
4	889.22	3.985	0.026	925.87	875.72	70.048	0.087
5	1071.5	2.479	1.021	1169.88	926.84	370.689	18.679
6	1211.35	3.053	0.086	1308.76	1170.84	207.884	0.882
7	1370.48	3.096	0.213	1523.83	1309.72	317.629	2.902
8	1606.77	2.967	1.178	1936.61	1524.79	555.149	17.597
9	2160.37	6.204	0.014	2180.62	1937.58	292.302	0.269
10	2930	3.546	0.485	3002.33	2181.58	1073.59	5.032
11	3371.71	2.683	2.548	3801.86	3003.3	1146.962	116.732
12	3864.55	6.829	0.021	3893.48	3802.82	105.581	0.073
13	3974.5	6.701	0.176	4174.14	3894.45	326.071	1.453
14	4335.2	6.857	0.116	4496.26	4175.1	372.62	1.183
15	4694.94	6.824	0.004	4700.73	4497.23	236.45	0.124

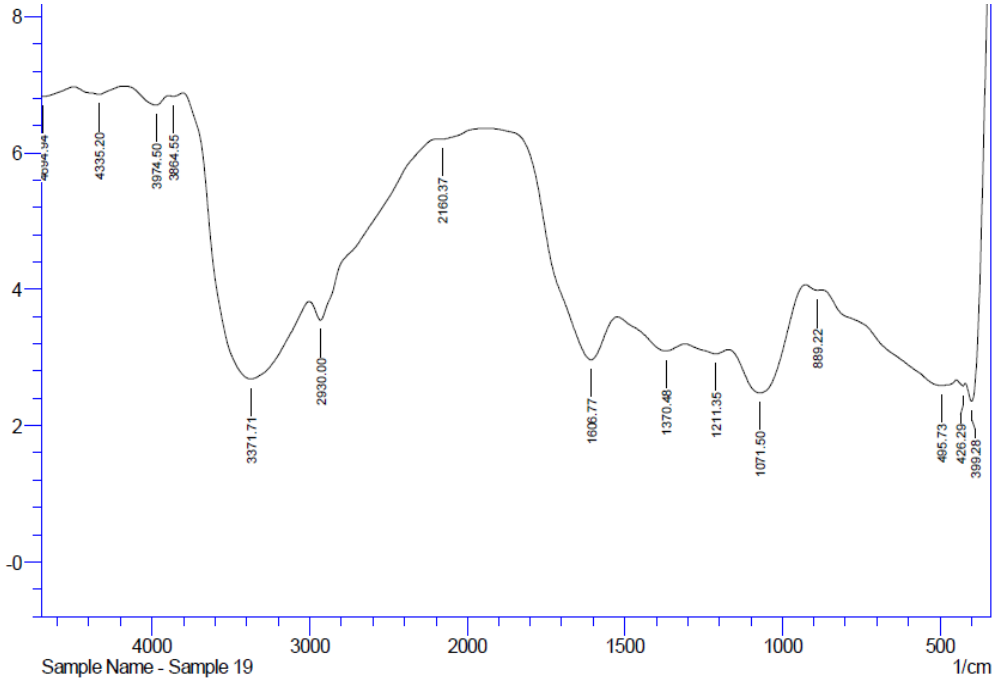


Figure-1: FTIR spectra of Natural Dye made from Marigold.

Table-4: Interpretation of IR spectra of Natural Dye made from Marigoldis done as follows.

Spectra region wave number cm^{-1}	Intensity and Pattern of peak	Bond causing Absorption	Compound Class
399.28	Weak	-	-
426.29	Weak	-	-
495.73	Weak	-	-
889.22	Weak	-	-
1071.5	Medium	C-N Stretching	Amine
1211.35	Weak	-	-
1370.48	Weak	-	-
1606.77	Strong	C=C Stretching	α, β-unsaturated Ketone
2160.37	Weak	-	-
2930	Weak	O-H Stretching	Alcohol
3371.71	Strong, Broad	O-H Stretching	Alcohol
3864.55	Weak	-	-
3974.5	Weak	-	-
4335.2	Weak	-	-
4694.94	Weak	-	-

Table-5: FTIR spectra of Natural Dye made from Palash flower.

No.	Peak	Intensity	Corr. Inte	Base (H)	Base (L)	Area	Corr. Are
1	393.5	3.669	0.43	398.32	339.49	75.405	2.415
2	408.93	3.565	0.129	434.97	399.28	51.296	0.244
3	475.47	3.669	0.232	926.84	435.93	657.663	2.795
4	1069.57	4.072	1.204	1219.06	927.8	388.603	15.903
5	1265.36	4.797	0.153	1318.4	1220.03	129.049	0.669
6	1391.7	4.886	0.25	1487.18	1319.37	218.505	2.324
7	1601.95	4.432	1.452	1858.49	1488.15	462.676	16.223
8	1869.1	7.275	0.003	1949.15	1859.46	102.021	0.01
9	1960.73	7.301	0	1963.62	1950.12	15.346	0
10	2080.32	7.246	0.001	2083.21	1964.58	135.032	0.016
11	2142.04	7.234	0.009	2176.76	2084.18	105.574	0.023
12	2358.08	7.084	0.009	2367.72	2177.73	217.433	0.019
13	2928.07	5.408	0.41	2997.51	2368.69	755.602	2.813
14	3398.72	4.417	2.041	3798	2998.47	1021.198	67.047
15	3848.15	7.195	0.054	3905.06	3798.97	121.097	0.186
16	3967.74	7.142	0.1	4119.16	3906.02	243.697	0.624
17	4147.13	7.224	0.002	4166.42	4120.13	52.827	0.004
18	4399.82	7.143	0	4400.78	4167.39	266.963	0.055
19	4444.18	7.137	0.01	4481.8	4401.75	91.754	0.024
20	4684.33	7.031	0.011	4700.73	4482.76	250.699	0.203

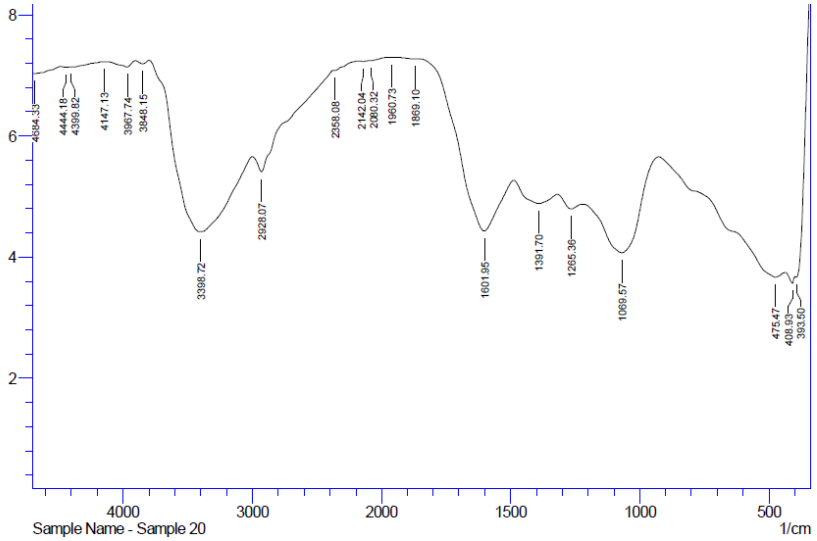


Figure-2: FTIR spectra of Natural Dye made from Palash.

Table-6: Interpretation of IR spectra of Natural Dye made from Palash is done as follows

Spectra region wave number cm^{-1}	Intensity and Pattern of peak	Bond causing Absorption	Compound Class
393.5	Weak	-	-
408.93	Weak	-	-
475.47	Weak	-	-
1069.57	Strong	C-O Stretching S=O Stretching	Primary alcohol Sulfoxide
1265.36	Weak	-	-
1391.7	Medium	O-H Bending	Phenol
1601.95	Medium	C=C stretching N-H Bending	Conjugated alkene, Cyclic alkene Amine
1869.1	Weak	C-H Bending	Aromatic compound
1960.73	Weak	-	-
2080.32	Weak	-	-
2142.04	Weak	C≡C Stretching	Alkyne
2358.08	Weak	-	-
2928.07	Medium	C-H Stretching	Alkane
3398.72	Strong, Broad	O-H Stretching	Alcohol
3848.15	Weak	-	-
3967.74	Weak	-	-
4147.13	Weak	-	-
4399.82	Weak	-	-
4444.18	Weak	-	-
4684.33	Weak	-	-

Conclusion

The study concludes that natural dyes extracted from marigold and palash flowers, when applied to cotton fabric using Alum, Alum and Cream of tartar, Copper sulphate and Cream of tartar, Ferrous sulphate and Cream of tartar, Potassium dichromate, Stannous chloride and Cream of tartar, Tannic acid mordants, produced bright and uniform yellow-to-orange hues with effective colour development, demonstrated good colour fastness ratings (4–5), and showed characteristic functional groups in FTIR analysis, thereby confirming their potential as efficient and eco-friendly textile dyes.

References

1. Soule, J. A. (1994). Infrageneric systematics of Tagetes. In Proceedings of the International Compositae Conference, Compositae: Systematics, Kew, UK (pp. 435-443).

2. Evbuomwan, S. A., Omotosho, O. E., & Akinola, O. O. (2023). A Mini Review on Some Known Medicinal Uses of Tridax procumbens. *Tropical Journal of Natural Product Research*, 7(8).

3. Garnai, M. G., Borda, D. D., Vizireanu, C., & Mihalcea, L. I. (2017). Temperature influence on the Tagetes Erecta L. Flowers dehytratation process. *Journal of Agroalimentary Processes and Technologies*, 23(1), 52-58

4. Pérez Gutierrez, R. O. S. A., Hernández Luna, H., & Hernández Garrido, S. (2006). Antioxidant activity of Tagetes erecta essential oil. *Journal of the Chilean chemical Society*, 51(2), 883-886.

5. Vastrad, J. V., Walmiki, L. N., & Goudar, G. (2017). Dyeing of cotton yarn with marigold (Tagetes erecta) petals: An emphasis on pre-treatments and mordants. *Journal of Applied and Natural Science*, (2), 1282-1286.

6. Jha C. K., Kumar R., Venkat K. S. and Devi R. V. (2015). Extraction of natural dye from marigold flower (Tageteserectal.) and dyeing of fabric and yarns: A focus on colorimetric analysis and fastness properties. *Der Pharmacia Lettre*, 7(1), 185-195

7. Abid, A., Ahmad, M., Zafar, M., Zafar, S., Ramadan, M. F., Althobaiti, A. T., ... & Majeed, S. (2023). Foliar epidermal and trichome micromorphological diversity among poisonous plants and their taxonomic significance. *Folia Horticulturae*, 35(2), 243-274.

8. Cowen, D. V. (1952). Flowering trees and shrubs in India.

9. Sinha, K., Saha, P. D., & Datta, S. (2012). Extraction of natural dye from petals of Flame of forest (Butea monosperma) flower: Process optimization using response surface methodology (RSM). *Dyes and Pigments*, 94(2), 212-216.

10. Srivastava, S., Ray, D. P., & Giri, S. K. (2013). Extraction of Palas dye for its use in Textile Coloration. International Journal of Agriculture. *Environment and Biotechnology*, 6(3), 497-502.