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Natural Dyeing Cotton Fabric with Annatto Seed and Heena Leaf Dye Powder Using Different Mordant– Their Colour Fastness Test & FTIR Analysis

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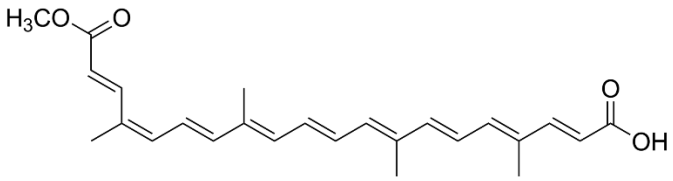
ABSTRACT

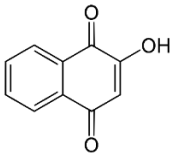
Annatto is an orange-red condiment and food coloring derived from the seeds of the achiote tree (*Bixa orellana*), native to tropical parts of the Americas. It is often used to impart a yellow to red-orange color to foods, but sometimes also for its flavor and aroma.The color of annatto comes from various carotenoid pigments, mainly bixin and norbixin, found in the reddish waxy coating of the seeds. The condiment is typically prepared by grinding the seeds to a powder or paste. Similar effects can be obtained by extracting some of the color and flavor principles from the seeds with hot water, oil, or lard, which are then added to the food. The fat-soluble color in the crude extract is called bixin, which can then be saponified into water-soluble norbixin. This dual solubility property of annatto is rare for carotenoids. The seeds contain 4.5–5.5% pigment, which consists of 70–80% bixin. The more norbixin in an annatto preparation, the more yellow it is; a higher level of bixin gives it a more orange hue.



Bixin, the major apocarotenoid of annatto

Lawsone (2-hydroxy-1,4-naphthoquinone), also known as hennotannic acid, is a red-orange dye present in the leaves of the henna plant (*Lawsonia inermis*). Humans have used henna extracts containing lawsone as hair and skin dyes for more than 5,000 years. Lawsone reacts chemically with the protein keratin in skin and hair via a Michael addition reaction, resulting in a strong permanent stain that lasts until the skin or hair is shed. Darker

colored staining is due to more lawsone–keratin interactions occurring, which evidently break down as the concentration of lawsone decreases and the tattoo fades. Lawsone strongly absorbs UV light, and aqueous extracts can be effective sunless tanning agents and sunscreens.



Lawsone

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 Annatto seed and Heena leaf dye powder. This also includes their Colour Fastness test for Water Fastness and Light Fastness and FTIR analysis.

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

I. INTRODUCTION

Annatto is an orange-red condiment and food coloring derived from the seeds of the achiote tree (*Bixa orellana*), native to tropical parts of the Americas.[1] It is often used to impart a yellow to red-orange color to foods, but sometimes also for its flavor and aroma.

The color of annatto comes from various carotenoid pigments, mainly bixin and norbixin, found in the reddish waxy coating of the seeds. The condiment is typically prepared by grinding the seeds to a powder or paste. Similar effects can be obtained by extracting some of the color and flavor principles from the seeds with hot water, oil, or lard, which are then added to the food.[2]

Annatto and its extracts are now widely used in an artisanal or industrial scale as a coloring agent in many processed food products, such as cheeses, dairy spreads, butter and margarine, custards, cakes and other baked goods, potatoes, snack foods, breakfast cereals, smoked fish, sausages, and more. In these uses, annatto is a natural alternative to synthetic food coloring compounds, but it has been linked to rare cases of food-related allergies. [3] Annatto is of particular commercial value in the United States because the Food and Drug Administration considers colorants derived from it to be "exempt of certification".

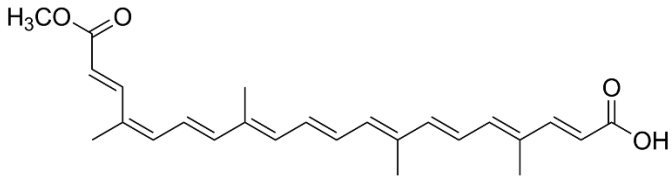
Open fruit of the achiote tree (*Bixa orellana*), showing the seeds from which annatto is extracted. [4]

Industrial food coloring

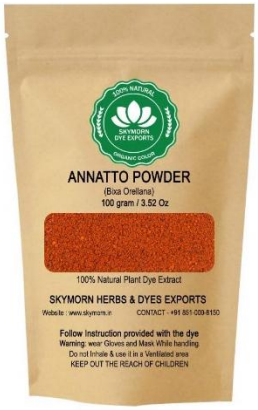
Annatto is commonly used to impart a yellow or orange color to many industrialized and semi-industrialized foods, including cheese, ice cream, bakery products, desserts, fruit fillings, yogurt, butter, oils, margarines, processed cheese, and fat-based products.[5] In the United States, annatto extract is listed as a color additive "exempt from certification"[6] and is informally considered to be a natural coloring. Foods colored with annatto may declare the coloring in the statement of ingredients as "colored with annatto" or "annatto color".[7] In the European Union, it is identified by the E number E160b.

Chemical composition

The yellow to orange color is produced by the chemical compounds bixin and norbixin, which are classified as carotenoids. The fat-soluble color in the crude extract is called bixin, which can then be saponified into water-soluble norbixin. This dual solubility property of annatto is rare for carotenoids.[8] The seeds contain 4.5–5.5% pigment, which consists of 70–80% bixin.[9] Unlike beta-carotene, another well-known carotenoid, annatto-based pigments are not vitamin A precursors.[10] The more norbixin in an annatto preparation, the more yellow it is; a higher level of bixin gives it a more orange hue.



Bixin, the major apocarotenoid of annatto[9]



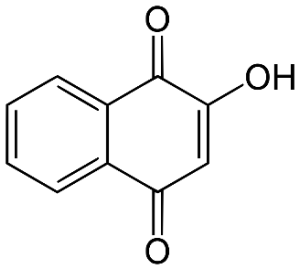
SkymornPureOrganic Powdered Annatto Natural Colorant|Natural dye for Fabric, Soap & Paper

HEENA

Lawsone (2-hydroxy-1,4-naphthoquinone), also known as hennotannic acid, is a red-orange dye present in the leaves of the henna plant (*Lawsonia inermis*), for which it is named, as well as in the common walnut (*Juglans regia*) [11] and water hyacinth (*Pontederia crassipes*). [12] Humans have used henna extracts containing lawsone as hair and skin dyes for more than 5,000 years. Lawsone reacts chemically with the protein keratin in skin and hair via a Michael addition reaction, resulting in a strong permanent stain that lasts until the skin or hair is shed. Darker colored staining is due to more lawsone–keratin interactions occurring, which evidently break down as the concentration of lawsone decreases and the tattoo fades. [13] Lawsone strongly absorbs UV light, and aqueous extracts can be effective sunless tanning agents and sunscreens. Lawsone is a 1,4-naphthoquinone derivative, an analog of hydroxyquinone containing one additional ring.

Heena Plant

Heena Flower



Lawsone

Lawsone isolation from *Lawsonia inermis* can be difficult due to its easily biodegradable nature. Isolation involves four steps:

1. extraction with an extraction solution, usually NaOH
2. column filtration using a macroporous adsorption resin
3. a rinse with ethanol to remove impurities, and finally
4. freeze the product to isolate the lawsone powder, usually a yellow colored dust. [14]

During the rinse, the lawsone will be the bottom as it has such a high density and the chlorophyll molecules will all be on the top of the mixture. [15]

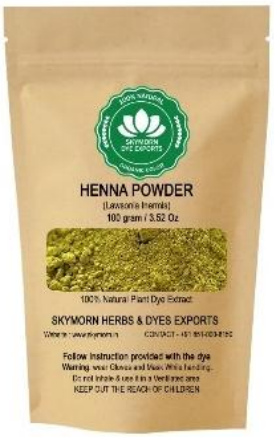
Lawsone is hypothesized to undergo a reaction similar to Strecker synthesis in reactions with amino acids. Recent research has been conducted on lawsone's potential applications in the forensic science field. Since lawsone shows many similarities with ninhydrin, the current reagent for latent fingerprint development, studies have been conducted to see if lawsone can be used in this field. As of now the research is inconclusive, but optimistic. Lawsone non-specifically targets primary amino acids, and displays photoluminescence with forensic light sources. [16] It has a characteristic purple/brown coloration as opposed to the purple/blue associated with ninhydrin. [17] Lawsone shows promise as a reagent for fingerprint detection because of its photoluminescence maximized at 640 nm, which is high enough that it avoids background interference common for ninhydrin. [18]

The natural dye henna usually being recognized as lawsone is a red-orange pigment that has long been used for the coloration of skin and hair as well as textile materials. This natural colorant garners the attention of researchers throughout the globe for the coloration of textile materials due to the fact that its color can easily be harmonized with nature besides its slight chemical reactivity without posing any environmental problems. So, a large number of studies were carried out on both extraction and application of henna dye in textile fibers along with the standardization and simplification of dyeing techniques. The contemporary research

works on henna dye highlighting the general characteristics alongside its chemical composition and chromatic properties has been focussed. A greater emphasis is also placed on the dyeing chemistry of the natural dye henna as well as its applications in the dyeing of cellulosic, protein and synthetic textile fibers including the effects of different mordants and mordanting methods on the dye uptake. Moreover, the scope of improvement in terms of dyeability and overall colorfastness properties through chemical modification of textile fibers has also been mentioned. [19]

The demand of natural colorants for the dyeing of textile fibers has been increasing gradually in recent years due to a growing global ecological awareness as well as a greater emphasis on a cleaner and greener production process. The eco-friendly dyeing of polyester fiber with natural dye henna is a novel approach that has extensively been studied. The dyeing of polyester fiber with henna dye was conducted at different temperatures without using hazardous metallic mordants. Then the dyeing performance was investigated in terms of depth of shade measurement, analysis of colorimetric properties of color and assessment of color fastness properties of henna dyed polyester fabric samples. The amount of dye absorption by fiber and the resulting depth of shade were found to increase with increasing dyeing temperature. In case of colorfastness properties, all dyed substrates demonstrated excellent fastness ratings against washing, rubbing and perspiration with little to no deterioration of color. The detailed morphological study revealed that surface structure of fiber remained unchanged after dyeing at an elevated temperature and pressure.[20]

Medicinal plants are a valuable source of supplementary remedies for the treatment of various ailments. *Lawsonia inermis* (belongs to family *Lythraceae*) or commonly known as Henna is a glabrous and branching small tree that is indigenous to the subtropical regions of Asia and North Africa. It has traditionally been used as a dandruff-fighting and antifungal agent when applied to the hair, hands, and feet. The staining properties of Henna are derived from the lawsone content, which is found primarily in the leaves. Review is to conducted to a literature search and critically review the relevant published articles on the phytochemical and pharmacological activities of *L. inermis*. The phytochemical screening reported that naphthoquinone derivatives, Henna essential oil, flavonoids, tannins, phenols, quinones, alkaloids, glycosides and saponins can be isolated from various parts of the Henna tree. The selection of appropriate solvents is critical in phytochemical screening, as different solvents resulted in different extraction yields. The pharmacological activities found in Henna are ameliorative activity, alleviating wound healing process, antifungal, antioxidant, antibacterial, hepatoprotective, nootropic, anti-ulcer, anti-inflammatory and anti-cancer activity. Phytochemical screening is critical for identification of plants constituents, and Henna possesses wide range of pharmacological properties. [21]



Skymorn Henna powder

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 Annatto seed and Heena leaf dye powder. This also includes their Colour Fastness test for Water Fastness and Light Fastness and FTIR analysis.

II. METHODOLOGY

1. Natural dyeing cotton fabric with Annatto seed and Heena leaf 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 Annatto seed and Heena leaf dye powder - 5 % weight of fabricAnnatto seed and Heena leaf dye powderis 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.

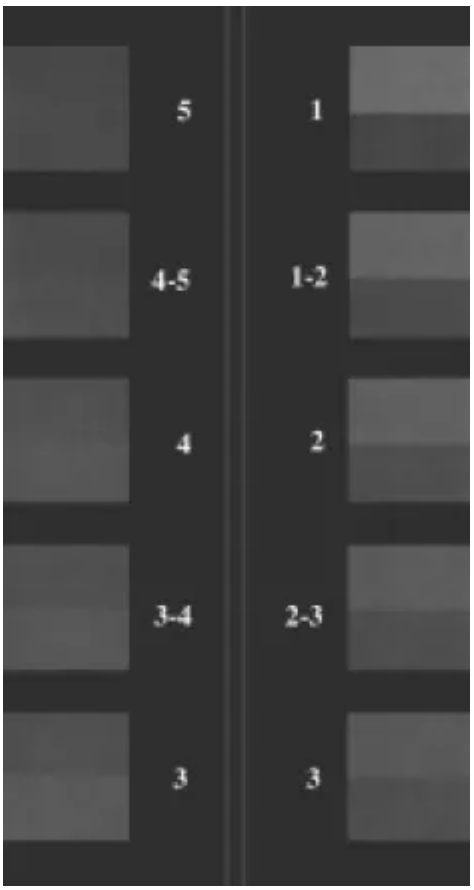
Step 6: Ironing Dyed Cotton Fabric – Dyed cotton fabric is ironed.

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

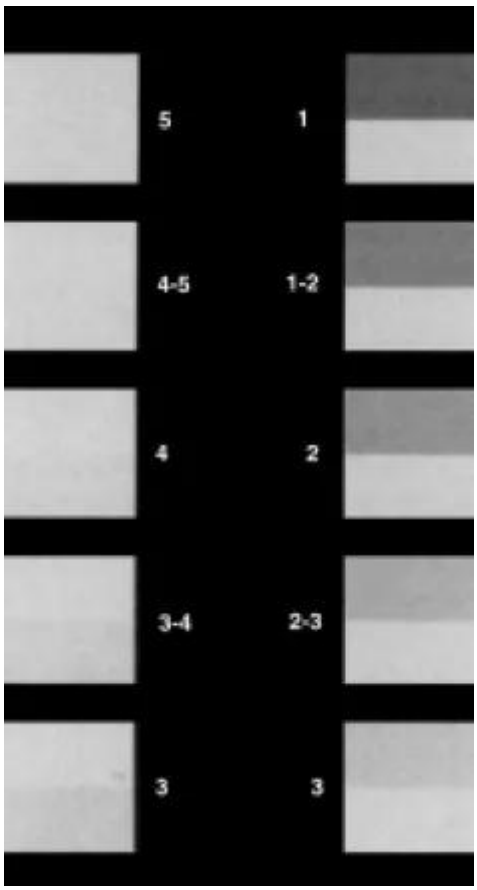
Step 8 : Colour fastness test - Then colour fastness test are performed.

2. Colour Fastness test for Water Fastness and Light Fastness to Annatto seed and Heena leaf 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.



Gray Scale for Color Change



Gray Scale for Color Staining

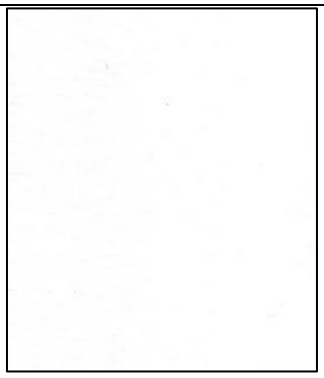
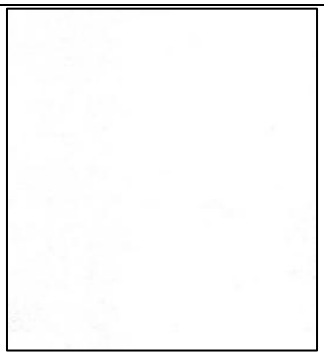
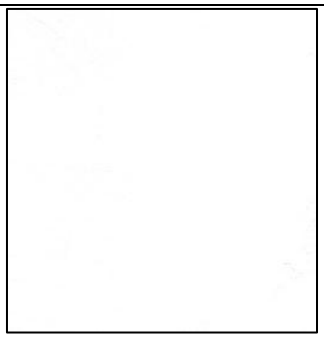
Water fastness and light fastness test was performed by regular washing and drying fabric in sunlight.

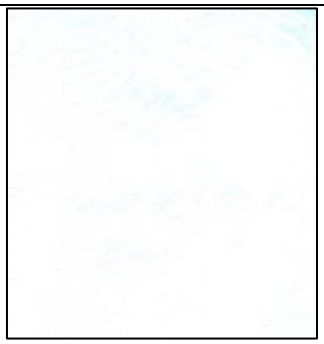
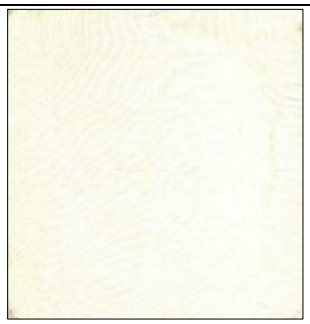
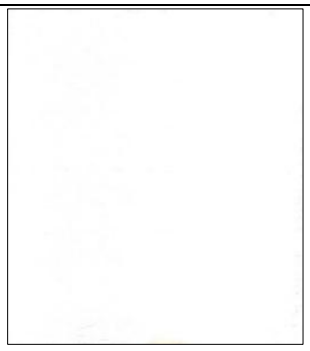
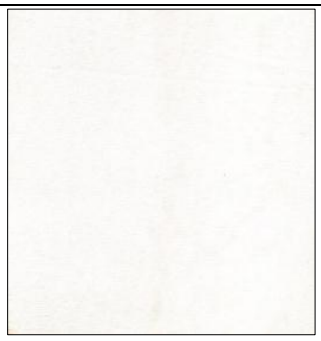
3. FTIR Analysis of Annatto seed and Heena leaf Dye Extract

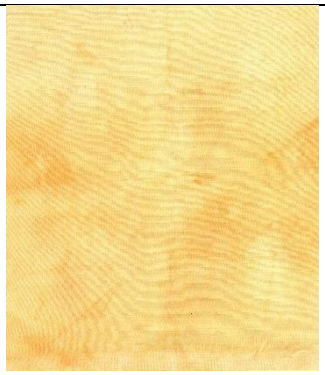
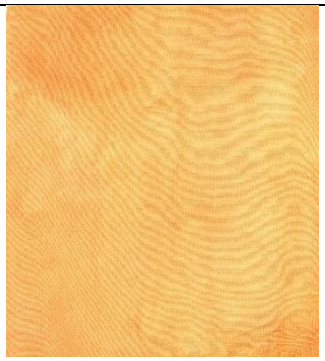
FTIR can be routinely used to identify the functional groups. FTIR spectra of Natural Dye made from Annatto seed and Heena leaf dye powderare obtained at room temperature by using an FTIR Spectrophotometer - Shimadzu - IR Affinity – 1. The spectra is collected in range from 400 - 4500 cm-1.

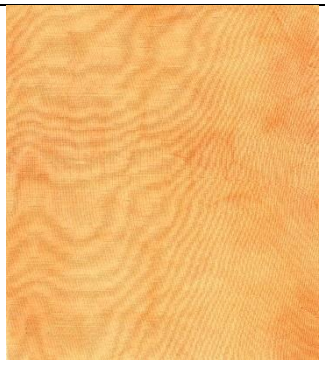
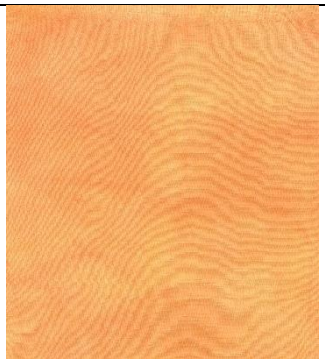
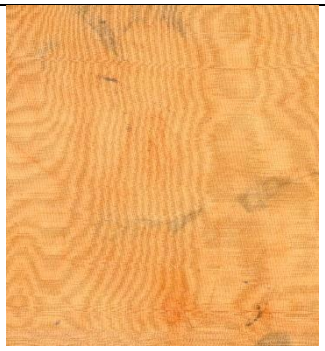
III.RESULTS AND DISCUSSION

1. Natural Dyeing Cotton Fabric using Annatto seed and Heena leaf 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

Code No. – Cotton Fabric	Colour obtained on Cotton Fabric	Color Model RGB				Color Model LAB		
		Red	Green	Blue	Hex # & Color Description	l	a	b
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

Code No. – Cotton Fabric	Colour obtained on Cotton Fabric	Color Model RGB				Color Model LAB		
		Red	Green	Blue	Hex # & Color Description	l	a	b
17 C - Cotton Fabric Mordanted with Alum and Dyed with Annatto		247	218	136	#F7DA88 Khaki	87.82	-0.59	43.92
17 D - Cotton Fabric Mordanted with Alum and Cream of tartar and Dyed with Annatto		246	192	108	#F6C06C Sandybrown	80.95	10	49.24
17 E - Cotton Fabric Mordanted with Copper sulphate and Cream of tartar and Dyed with Annatto		240	150	81	#F09651 Sandybrown	70.13	27.83	49.67
17 F – Cotton Fabric Mordanted with Ferrous sulphate and Cream of tartar and Dyed with Annatto		245	175	100	#F5AF64 Sandybrown	76.68	17.92	48.05

Code No. – Cotton Fabric	Colour obtained on Cotton Fabric	Color Model RGB				Color Model LAB		
		Red	Green	Blue	Hex # & Color Description	l	a	b
17 G - Cotton Fabric Mordanted with Potassium dichromate and Dyed with Annatto		245	182	105	#F5B669 Sandybrown	78.4	14.6	47.64
17 H - Cotton Fabric Mordanted with Stannous chloride and Cream of tartar and Dyed with Annatto		246	171	102	#F6AB66 Sandybrown	75.87	20.57	46.13
17 I - Cotton Fabric Mordanted with Tannic acid and Dyed with Annatto		241	172	96	#F1AC60 Sandybrown	75.49	17.58	48.51
18 C - Cotton Fabric Mordanted with Alum and Dyed with Heena		215	202	164	#D7CAA4 Wheat	81.49	-1.45	20.64

Code No. – Cotton Fabric	Colour obtained on Cotton Fabric	Color Model RGB				Color Model LAB		
		Red	Green	Blue	Hex # & Color Description	l	a	b
18 D - Cotton Fabric Mordanted with Alum and Cream of tartar and Dyed with Heena		220	205	175	#DCCDAF Wheat	82.9	0.43	16.84
18 E - Cotton Fabric Mordanted with Copper sulphate and Cream of tartar and Dyed with Heena		213	203	168	#D5CBA8 Wheat	81.67	-2.15	18.74
18 F – Cotton Fabric Mordanted with Ferrous sulphate and Cream of tartar and Dyed with Heena		162	150	140	#A2968C Darkgrey	62.83	2.66	6.86
18 G - Cotton Fabric Mordanted with Potassium dichromate and Dyed with Heena		220	202	167	#DCCAA7 Wheat	81.97	0.85	19.78

Code No. – Cotton Fabric	Colour obtained on Cotton Fabric	Color Model RGB				Color Model LAB		
		Red	Green	Blue	Hex # & Color Description	l	a	b
18 H - Cotton Fabric Mordanted with Stannous chloride and Cream of tartar and Dyed with Heena		221	204	162	#DDCCA2 Wheat	82.47	-0.5	23.12
18 I - Cotton Fabric Mordanted with Tannic acid and Dyed with Heena		221	215	194	#DDD7C2 Antiquewhite	85.94	-1.48	11.1

2. Colour Fastness test for Water Fastness and Light Fastness to Annatto seed and Heena leaf 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
17 C - Cotton Fabric Mordanted with Alum and Dyed with Annatto	4-5	4-5
17 D - Cotton Fabric Mordanted with Alum and Cream of tartar and Dyed with Annatto	4-5	4-5
17 E - Cotton Fabric Mordanted with Copper sulphate and Cream of tartar and Dyed with Annatto	4-5	4-5

Code No. - Cotton Fabric	Colour Fastness Test	
	Water Fastness	Light Fastness
17 F – Cotton Fabric Mordanted with Ferrous sulphate and Cream of tartar and Dyed with Annatto	4-5	4-5
17 G - Cotton Fabric Mordanted with Potassium dichromate and Dyed with Annatto	4-5	4-5
17 H - Cotton Fabric Mordanted with Stannous chloride and Cream of tartar and Dyed with Annatto	4-5	4-5
17 I - Cotton Fabric Mordanted with Tannic acid and Dyed with Annatto	4-5	4-5
18 C - Cotton Fabric Mordanted with Alum and Dyed with Heena	4-5	4-5
18 D - Cotton Fabric Mordanted with Alum and Cream of tartar and Dyed with Heena	4-5	4-5
18 E - Cotton Fabric Mordanted with Copper sulphate and Cream of tartar and Dyed with Heena	4-5	4-5
18 F – Cotton Fabric Mordanted with Ferrous sulphate and Cream of tartar and Dyed with Heena	4-5	4-5
18 G - Cotton Fabric Mordanted with Potassium dichromate and Dyed with Heena	4-5	4-5
18 H - Cotton Fabric Mordanted with Stannous chloride and Cream of tartar and Dyed with Heena	4-5	4-5
18 I - Cotton Fabric Mordanted with Tannic acid and Dyed with Heena	4-5	4-5

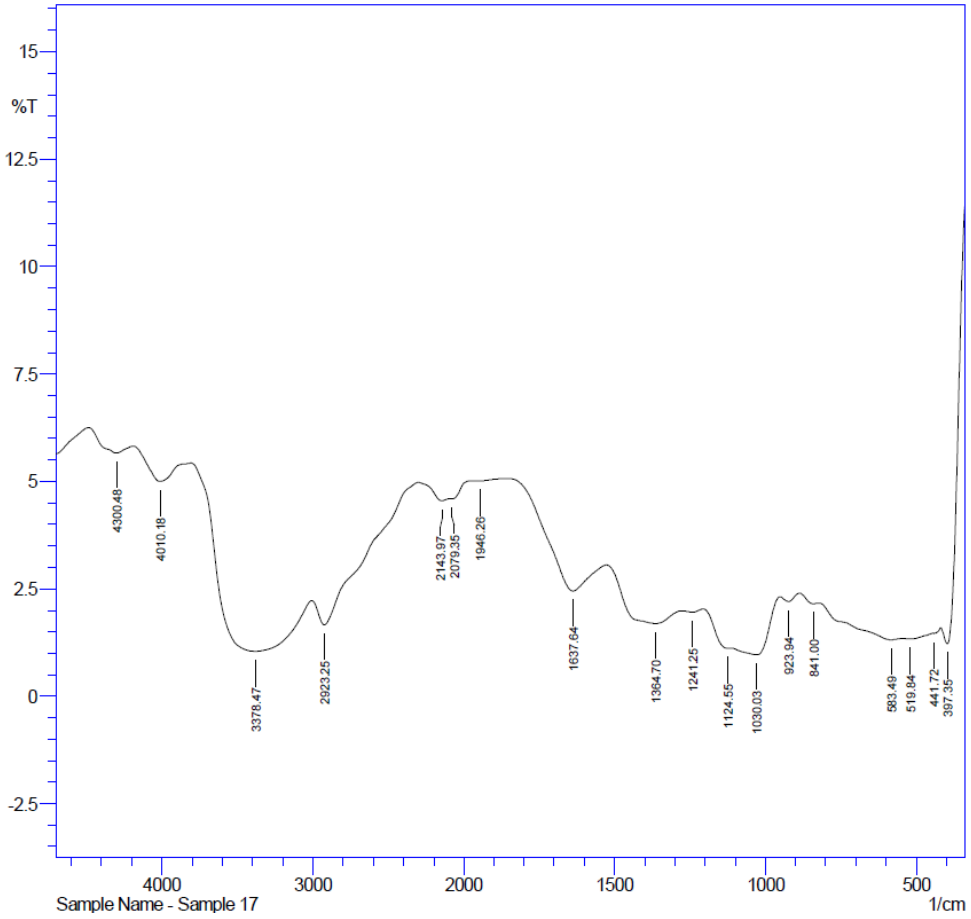
Colour fastness test for water fastness and light fastness to Annatto seed and Heena leafdye powder using different mordant dyed fabric shows 4-5 range in gray scale method which indicates excellent to water fastness and light fastness.

3. FTIR Analysis of Annatto seed and Heena leaf Dye Extract

FTIR spectra of Natural Dye made from Annatto seed

No.	Peak	Intensity	Corr. Inte	Base (H)	Base (L)	Area	Corr. Are
1	397.35	1.219	3.005	418.57	339.49	119.643	12.108
2	441.72	1.463	0.006	442.68	419.54	42.184	0.166
3	519.84	1.335	0.041	544.91	446.54	183.11	0.849
4	583.49	1.313	0.144	822.68	545.88	498.358	9.1
5	841	2.154	0.081	886.33	823.64	103.495	0.586
6	923.94	2.204	0.15	950.95	887.29	104.486	0.919
7	1030.03	0.963	0.78	1114.9	951.91	311.019	18.997
8	1124.55	1.117	0.089	1206.53	1115.87	166.545	1.94
9	1241.25	1.955	0.055	1275.97	1207.49	116.615	0.431
10	1364.7	1.691	0.671	1526.72	1276.93	424.649	22.831

No.	Peak	Intensity	Corr. Inte	Base (H)	Base (L)	Area	Corr. Are
11	1637.64	2.451	1.285	1852.71	1527.69	475.738	19.999
12	1946.26	5.016	0.014	1969.41	1853.67	150.177	0.054
13	2079.35	4.598	0.032	2088.03	1970.37	155.335	0.373
14	2143.97	4.551	0.147	2300.21	2089	279.638	0.996
15	2923.25	1.663	0.891	3006.19	2301.18	1061.95	24.331
16	3378.47	1.046	2.669	3806.68	3007.15	1397.447	231.511
17	4010.18	5	0.637	4189.57	3807.65	486.427	8.964
18	4300.48	5.658	0.324	4485.65	4190.53	364.159	4.258



FTIR spectra of Natural Dye made from Annatto seed

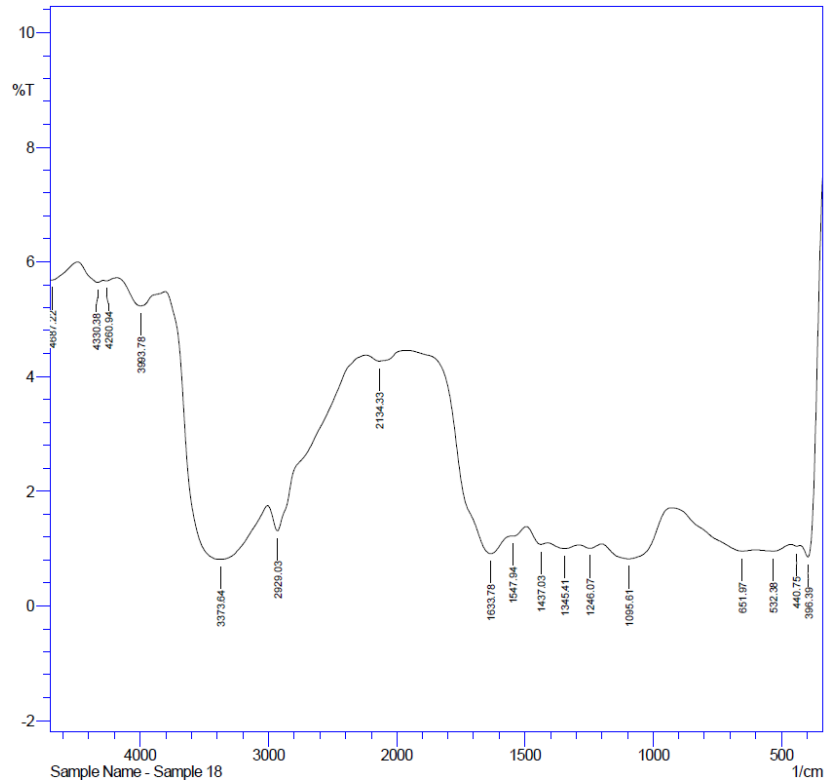
Interpretation of IR spectra of Natural Dye made from **Annatto seed**is done as follows

Spectra region wave number cm^{-1}	**Intensity and Pattern of peak**	**Bond causing Absorption**	**Compound Class**
397.35	Weak	-	-
441.72	Weak	-	-
519.84	Weak	-	-
583.49	Weak	-	-
841	Weak	-	-

Spectra region wave number cm^{-1}	Intensity and Pattern of peak	Bond causing Absorption	Compound Class
923.94	Weak	-	-
1030.03	Medium	-	-
1124.55	Medium	-	-
1241.25	Weak	-	-
1364.7	Medium	O-H Bending	Phenol
1637.64	Medium	C=C Stretching	Alkene
1946.26	Weak	C-H Bending	Aromatic compound
2079.35	Weak	-	-
2143.97	Weak	-	-
2923.25	Strong, Broad	O-H Stretching	Carboxylic acid
3378.47	Strong, Broad	O-H Stretching	Alcohol
4010.18	Weak	-	-
4300.48	Weak	-	-

FTIR spectra of Natural Dye made from Heena leaf

No.	Peak	Intensity	Corr.Inte	Base(H)	Base(L)	Area	Corr.Are
1	396.39	0.854	2.407	426.29	339.49	149.784	15.593
2	440.75	1.039	0.021	462.94	427.25	70.577	0.145
3	532.38	0.955	0.069	600.85	463.9	274.763	2.219
4	651.97	0.955	0.133	928.76	601.82	624.794	7.954
5	1095.61	0.822	0.502	1200.74	929.73	537.816	32.08
6	1246.07	1.004	0.068	1289.47	1201.7	174.164	1.276
7	1345.41	1	0.08	1410.02	1290.43	237.356	2.217
8	1437.03	1.072	0.115	1494.9	1410.99	162.068	1.878
9	1547.94	1.215	0.02	1554.69	1495.86	111.386	0.414
10	1633.78	0.91	0.93	1960.73	1555.66	666.802	25.435
11	2134.33	4.267	0.137	2239.45	1961.69	378.606	2.191
12	2929.03	1.308	0.701	3005.22	2240.42	1187.795	16.094
13	3373.64	0.809	2.66	3802.82	3006.19	1451.166	249.305
14	3993.78	5.234	0.368	4179.92	3803.79	476.004	5.138
15	4260.94	5.667	0.02	4286.98	4180.89	132.056	0.063
16	4330.38	5.642	0.103	4486.62	4287.94	246.122	0.962
17	4687.22	5.686	0.021	4700.73	4487.58	263.218	0.344



FTIR spectra of Natural Dye made from Heena leaf

Interpretation of IR spectra of Natural Dye made from Heena leaf is done as follows

Spectra region wave number cm^{-1}	Intensity and Pattern of peak	Bond causing Absorption	Compound Class
396.39	Weak	-	-
440.75	Weak	-	-
532.38	Weak	-	-
651.97	Weak	-	-
1095.61	Medium	-	-
1246.07	Weak	-	-
1345.41	Weak	-	-
1437.03	Weak	-	-
1547.94	Weak	-	-
1633.78	Strong	C=C Stretching	Alkene
2134.33	Weak	C≡C Stretching	Alkyne
2929.03	Medium	C-H Stretching	Alkane
3373.64	Strong, Broad	O-H Stretching	Alcohol
3993.78	Weak	-	-
4260.94	Weak	-	-
4330.38	Weak	-	-
4687.22	Weak	-	-

IV. CONCLUSION

Code No. - Cotton Fabric	Hex # &Colorobtained	Colour Fastness Test	
		Water Fastness	Light Fastness
00 - Cotton Fabric Not Mordanted and Not Dyed	#F3F3F3 White Smoke	5	5
0 C - Cotton Fabric Mordanted with Alum and Not Dyed	#F3F3F3 White Smoke	5	5
0 D - Cotton Fabric Mordanted with Alum and Cream of tartar and Not Dyed	#F3F3F3 White Smoke	5	5
0 E - Cotton Fabric Mordanted with Copper sulphate and Cream of tartar and Not Dyed	#F3FDFF Azure	5	5
0 F - Cotton Fabric Mordanted with Ferrous sulphate and Cream of tartar and Not Dyed	#EEE6DF White Chocolate	5	5
0 G - Cotton Fabric Mordanted with Potassium dichromate and Not Dyed	#DEB6A2 Pale Chestnut	5	5
0 H - Cotton Fabric Mordanted with Stannous chloride and Cream of tartar and Not Dyed	#F3F3F3 White Smoke	5	5
0 I - Cotton Fabric Mordanted with Tannic acid and Not Dyed	#EEEEEE Bright Gray	5	5
17 C - Cotton Fabric Mordanted with Alum and Dyed with Annatto	#F7DA88 Khaki	4-5	4-5
17 D - Cotton Fabric Mordanted with Alum and Cream of tartar and Dyed with Annatto	#F6C06C Sandybrown	4-5	4-5
17 E - Cotton Fabric Mordanted with Copper sulphate and Cream of tartar and Dyed with Annatto	#F09651 Sandybrown	4-5	4-5
17 F – Cotton Fabric Mordanted with Ferrous sulphate and Cream of tartar and Dyed with Annatto	#F5AF64 Sandybrown	4-5	4-5
17 G - Cotton Fabric Mordanted with Potassium dichromate and Dyed with Annatto	#F5B669 Sandybrown	4-5	4-5
17 H - Cotton Fabric Mordanted with Stannous chloride and Cream of tartar and Dyed with Annatto	#F6AB66 Sandybrown	4-5	4-5
17 I - Cotton Fabric Mordanted with Tannic acid and Dyed with Annatto	#F1AC60 Sandybrown	4-5	4-5
18 C - Cotton Fabric Mordanted with Alum and Dyed with Heena	#D7CAA4 Wheat	4-5	4-5
18 D - Cotton Fabric Mordanted with Alum and Cream of tartar and Dyed with Heena	#DCCDAF Wheat	4-5	4-5
18 E - Cotton Fabric Mordanted with Copper sulphate and Cream of tartar and Dyed with Heena	#D5CBA8 Wheat	4-5	4-5

Code No. - Cotton Fabric	Hex # &Colorobtained	Colour Fastness Test	
		Water Fastness	Light Fastness
18 F – Cotton Fabric Mordanted with Ferrous sulphate and Cream of tartar and Dyed with Heena	#A2968C Darkgrey	4-5	4-5
18 G - Cotton Fabric Mordanted with Potassium dichromate and Dyed with Heena	#DCCAA7 Wheat	4-5	4-5
18 H - Cotton Fabric Mordanted with Stannous chloride and Cream of tartar and Dyed with Heena	#DDCCA2 Wheat	4-5	4-5
18 I - Cotton Fabric Mordanted with Tannic acid and Dyed with Heena	#DDD7C2 Antiquewhite	4-5	4-5

Interpretation of FTIR Spectra of Natural Dye made from Annatto seed and Heena leaf dye powder shows presence of various functional groups such as

Bond causing Absorption	Compound Class	Bond causing Absorption	Compound Class
Natural Dye made from Annatto Seed		Natural Dye made from Heena Leaf	
C-H Bending	Aromatic compound	C-H Stretching	Alkane
O-H Stretching	Carboxylic acid, Alcohol	O-H Stretching	Alcohol
O-H Bending	Phenol	C=C Stretching	Alkene
C=C Stretching	Alkene	C≡C Stretching	Alkyne

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