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Dyeing Cotton Fabrics Using Eco-Friendly Green Dye Extracted from the Leaves of the Melia Azedarach Tree

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Abstract:
This research aimed to keep pace with the global approach to achieving environmentally friendly industries. Moreover, it sheds light on chlorophyll dye and the possibility of using it to dye textile fibres. The criteria for nations' progress will be measured by how far the environment is not polluted. Thus, competition has increased in using environment-friendly dyes, and scientific research has become interested in this industry and working on developing and improving it. So, this work used 100% Cotton fabric, Natural green dye extracted from the Melia Azedarach plant, and two types of mordants. The colour stability for washing, rubbing, and perspiration has shown that the greatest values were given when dying fabrics using the pre-mordanting process and the post-mordanting process, using both concentrations and mordants. As for light colour stability, the highest value was given when using a dying concentration of 20gm using the Ferrous Sulfate mordant; this was when using the pre-mordanting and post-mordanting processes. As for elongation, elongation was recorded in the direction of the weft using pre-mordanting at both concentrations and with both mordants to the standard sample and for the elongation in the direction of the wrap. In conclusion, using modern natural dyes extracted from plants and algae and their mixture is recommended to reach new colour degrees and shades that are environmentally safe and achieve product quality. Therefore, green dyes are the optimal choice for a safe environment.

Keywords: *Mordants, Cotton Fabric, Color Strength, Textile Tests, Color Fastness*

1. INTRODUCTION

Nature around us is a source for inspiration and a new era of color palettes that are modern and fresh. The term environment-friendly dying refers to the technique of dying fabrics using unpolluting natural dyes and materials and that also work with low power and water consumption.

Chlorophyll could be extracted from vegetables and plants leaves and branches.

Chlorophyll is a pigment which traps the solar energy in the photosynthesis process, so that it can be used to drive the production of carbohydrates from carbon dioxide and water.

During photosynthesis in plants, the chlorophyll molecules exist in two forms called chlorophyll a and b. [1,2].

Chlorophyll molecules consist of (a) a porphyrin head (four pyrrole rings containing Nitrogen arranged in a ring around a Magnesium ion) and (b) a long Hydrocarbon tail, which is soluble in fats and oils. There are four types of chlorophyll. One of them, chlorophyll b, can be extracted from green plants such as stinging nettles and spinach. It is used extensively as a colorant, but rarely to dye textiles. Commercial extraction from plant material involves many steps using solvents such as petroleum ether and propanone.[3].

2- Objectives

The present work aims to:

Extracting natural dyes from the Azedarach tree leaves

Eco-friendly dyeing cotton fibers by green dye extracted from Melia azderach plant

Knowing the best mordant used and the best mordanting methods used in order to improve the quality of naturally-dyed textiles.

Studying the factors that affect the brightness and purity of the color Study Importance:

Keeping pace with the global approach in achieving environmentally friendly industries.

The possibility of maximum economic utilization of the resources available to us in a scientific and environmentally friendly way.

Shed light on chlorophyll dye and the possibility of using it in dyeing textile fibers.

The research hypothesizes that we can:

*Have new colors degrees by the difference of (K/S) and (L*a*b) values using different (dye concentrations. mordants. mordant methods).*

Have high levels of color fastness to light, rubbing (wet, dry), washing, and perspiration (acidic, alkaline) using different (dye concentrations. mordants. mordant methods).

Have good effects in Textile tests {Tensile strength and elongation} using different (dye concentrations. mordants. mordant methods).

The study limits

1)100% natural bleached cotton fabric was used.

2) Natural green dye extracted from the Melia Azedarach tree leaves.

3) Two types of Eco- friendly mordants were used: Ferrous Sulfate,
Aluminum Sulfate.

4) Two concentrations of the dye (10-20) gm were used along with implementing experiments (Without mordanting- pre-mordanting- Simultaneous-mordanting).

5) The dyed samples were subjected to laboratory tests in terms of: - Strength of the color (k/s) and color Tolerancing (l*b*c*).

Color Fastness to {light, rubbing (wet, dry), washing, and perspiration (acidic, alkaline)}.

Physical characteristics, {Tensile strength and elongation}: (at the direction of the wrap and the weft).

The study curriculum

The research followed the analytical and experimental methods to verify the rightness of the research hypothesizes

The Previous Studies:

The study of Saher Abd Elmegeed (2012)[4]

The search used: - Blend fabric: cotton /polyester blend 65:35%.

- Natural dyes such: Phaephyta, Rhodophyta, Cyanophyta, and Chlorophyta.

The best values of Phaephyta dye by dye conc. 10gm, pH7 and (Al) mordant -The best values of Rhodophyta dye by dye conc. 5gm, pH 7 and (Cr) mordant - The best values of Cyanophyta dye by dye conc.10gm, (pH 7, pH 9) and (Cr) mordant - The best values of Chlorophyta dye by all dye conc., pH 9 and (Cu) and (Cr) mordants.

The study of B.H. PATEL (2014) [5]

The study deals with extraction of Azadirachta indica leaves using water and methanol. The extract was characterized by FT-IR and CIE L*a*b* colorimetric system for its group and color co-ordinate values. Parameters for dyeing Lycra filament were standardized by using exhaust method. The sample treated with the water extract exhibits pale brown color and pale to dark green color with methanolic extract without significant loss in strength. The novel feature of this study was the use of FT-IR spectroscopy to identify the major chemical groups in the extract as well as its attachment on Lycra.

The study of Ibrahim Hamed and others (2015). [6]

pepsin and trypsin enzymes behave towards natural fibers dyed with natural dyes. In this study, four natural fibers were used: cotton, linen, wool, and silk dyed with 14 natural dyes extracted from R.tinctoria L(madder), Humuluslupulus L(common hop), P.tormentillaneck (blood-root), A.cepa L(onion skin), Punicagranatum L(pomegranate skin), A.catechuwilld(catechu tree), Juniperuscommunis L(common juniper tree), R.coriaria L(dyer's sumac), Bongardiachysogonumboiss (golden rod), A.arabicawilld (Egyptian L(dog's fennel) and acacia), Bixaorellana L(annatto), S.officinalis L(common sage),A.cotula Dactylopiuscoccus (American cochineal). Alum was used as mordant to fixate dyes with fibers. The dyed samples were divided into three groups; the first group was treated with buffer solution to study the effect of buffer solution used with enzymes on the dye, the second group was treated with a slight concentration of enzymes and the last group was treated with high concentration of enzymes to study the effect of enzymes concentration on natural dyes. Each treatment continues for four hours at 40C° with stirring the solution. The strength of color and color difference were measured for each sample to show the effect of treatment on dyes, it concluded that the pepsin and trypsin enzymes have not any side effects on dyed samples, the side effects back to the buffer's solution

The study of Tamrat Tesfaye (2015). [7]

Dyes have been extracted from four different natural sources, namely, eucalyptus bark, eucalyptus leaves, mango leaves and mango pill. Dyes extracted from eucalyptus bark contain more coloring material than dyes extracted from the eucalyptus leaves, mango leaves and mango pills. Cotton fabric was successfully dyed with all dyes obtained from the various materials. Different shades of various depths were achieved with the use of five different mordants. Statistical analysis helped to ascertain the effects of type of mordant on the dyeability of cotton fabric with the different types of natural dyes studied. The dye extract from the eucalyptus bark produced deeper color shades than the other dye extracts irrespective of the type of mordant used. Pale yellow shades were exhibited by dyes obtained from eucalyptus and mango leaves. Thus, it can be concluded that lighter yellow, yellowish green or lighter red shades can be achieved with the use of different parts of eucalyptus and mango trees.

The study of Noha Mohamed Elsayd (2016). [8]

This research deals with the treatment of cellulosic clothes fabrics (Cotton-linen) with SLN PERIWET (fatty alcohol polyglycol ether and phosphoric acid ester) at four different concentrations (5, 10, 15, 25 g) before the dyeing process so that dyeing process procedures were conducted with a natural dye extracted from sumac under the following dyeing conditions: dye concentration of 2.5 g/l, temperature 100 ° ± 3 ° C and time of 60 minutes in the presence of a mixture of mineral stabilizers, a ferrous sulfate + potassium chromate as a concentration of 25 g / l.

At the end of the experiment, tests were performed on the dyed material, namely color depth test (K/S) and fastness to (light-washing friction). Grading of strong and bright colors was obtained and the results showed clear values to the impact of treatment material, where samples gave values of color depth and higher degrees of fastness than those samples that have not been treated. Therefore, the research recommends using natural dyes due to the recently proven serious damage of artificial dyes and their carcinogenic effect on human health and harmful impact on the environment. The researcher also recommends the necessity of environmentally safe treatment of the material to allow better permeability of natural dyes and get strong, bright and faster colors.

The study of Magda Ebrahim (2018) [9]

This study aimed to benefit from lemon peel-treated fabrics, which are environmentally friendly, in children's clothing. The study aimed to identify the best suitable conditions for treating fabrics with environmentally friendly materials to achieve the highest colorfastness. The samples were dyed at home, and laboratory testing (color fastness to washing, sweating, rubbing, and the strength and elongation of fabrics) was conducted at the National Institute of Standards. Five children's clothing pieces were produced, and the research found that the best samples were viscose fabric with a crepe weave and an alcohol solvent, while the samples with polyester fabric with a traditional mesh weave and untreated samples had the lowest quality.

The study of Huiyu Jiang (2022). [10]

cost-effective and eco-friendly natural dyeing and finishing have become an urgent demand. Herein, gardenia yellow, a natural dye, is extracted from Gardenia fructus seeds and used for the coloration of organic cotton fabrics (OCFs). In addition, silver nanoparticles (AgNPs) were synthesized in-situ on the surface of the OCFs, where gardenia yellow serves as a reducing and stabilizing agent. Optimization of the process parameters ($AgNO_3$ conc., gardenia yellow conc., solution pH, and reaction time) for the yield of AgNPs and subsequent fixation of nanoparticles on the OCFs surface were controlled by Taguchi design of experiments. All parameters were tested in a specified range at four levels on the color strength (K/S) and color difference (DE) value. Structural characterization of optimized samples revealed that the AgNPs are nanometer size, spherical shapes, evenly dispersed, and firmly attached to the fiber surfaces by molecular force or double networking capabilities of plant phytochemicals. Color properties demonstrate an even shade due to the surface plasmon resonance (SPR) of AgNPs with brilliant color strength. Functional properties exposed that the in-situ synthesis of AgNPs significantly enhanced the UV resistance and antibacterial activity.

The study of Jin Fang (2022). [11]

This work aims to verify the usability of Ipomoea batatas leaves for simultaneous dyeing and functional finishing.

Without the use of inorganic salts and metal mordants for the cleaner production.

The adsorption kinetics study showed that the adsorption behavior of the natural dye on silk fabric was more consistent with the pseudo-second-order. kinetic model and the Langmuir model. Meanwhile, the natural dye extracted from Ipomoea batatas leaves could be used for simultaneous salt-free dyeing and functional finishing of silk fabric and other fiber types with good color fastness, antibacterial properties and UV resistance with some durability, and the color strength in the order of wool, nylon, cotton, silk and polyester fabric.

Cotton fabric:

Cotton Fiber is defined as a natural material.

Cotton is a widely used fiber type that exhibits high absorbency, softness, and breathability.[12].

Cotton fiber is about 94 percent cellulose. The remaining 6 percent is made up of protein (1-1-5 percent), pectic materials (1 per cent), mineral substances (about 1 percent), wax (about 0-5 per cent) and small amounts of organic acids, sugars and pigments.

Chemical and Physical Properties of Cotton:

Effect of Acids: Cotton is damaged by dilute acids and cold concentrated acids which causes disintegration.

Effect of Alkalis: Cotton has an excellent resistance to alkalis. It swells in caustic alkalis like NaOH but it isn't damaged by alkalis. It can be washed repeatedly in soap solution without any problem

Effect of Organic Solvent: Cotton has a high resistance to normal cleaning solvents. Cotton is dissolved by copper complexes such as cuprammonium hydroxide… etc.

Effect of Micro-Organism: Cotton is attacked by fungi and bacteria. Mildews feed on cotton fiber, rotting and weakening the material. Mildews and bacteria will flourish on cotton under hot and humid conditions.

Effect of Moisture: Tensile strength of cotton fiber is increased with the absorption of moisture. Under normally humidity condition, cotton takes up about 6 – 8% moisture.

Effect of Heat: Cotton is very resistant to degradation by heat.

Conductor: Cotton is a very good conductor of heat and air. Cotton is a good conductor of electricity. [13,14,15]

Melia azedarach L:

The Chinaberry tree, Melia azedarach L. (Sapindales:Meliaceae), is a deciduous tree often grown for its medicinal uses and for shade or ornament on roadsides.[16]

Melia azedarach (M. azedarach) is a preferred tree species for afforestation in industrial and mining areas, and it is also one of the tree species used for artificial afforestation in abandoned.[17]

- Higher classification: Melia
- Scientific name: Melia azedarach
- Family: Meliaceae
- Order: Sapindales
- Kingdom: Plant
- Biological rank: Specie.[18]

Mordants:

Mordants are metal salts which produce an affinity between the fabric and the dye.[19]

Mordants play important role in dyeing with natural dyes as they bind the color molecules to the fabric via forming complex with dye particle and textile substrate.[20]

Few natural dyes are color-fast with fibers, therefore mordants used for textile dyeing are substances used to increase natural dyes' affinity for fabrics and colorfastness by chemically binding together.[21]

Mordants are used to fix the color in dyeing or fabric printing, The choice of mordant depends upon the fabric source.[22]

3. Materials and Methods:

Materials:

14 samples of bleached cotton fabric 100% natural were used to study the effect of different dyeing parameters. and its specifications are as follows:

* plain weave 1/1
* The number of prepared warp yarn is 63/inch.
* The number of prepared weft yarn is 57 / inch
* Weight per linear meter is 124 / g
* Weight per square meter is 136/g
* yarn number for both warp and weft 20/20 single "Misr El-Mahalla Spinning and Weaving Company".

Natural green dye:

Extracted from the leaves of Melia Azedarach tree .

The process of extracting chlorophyll dye from the used plant and dyeing the samples was carried out in the Textile consolidation Fund in Alexandria, Gamila Bouhred St. El-siouf.

Mordants:

Two types of Eco- friendly mordants were used: Ferrous Sulfate, Aluminum Sulfate.

Methods:

Preparation of natural dyes (green dye):

plants preparations

Choose highly green leaves that are free of stinging and abrasion

Wash the leaves well several times to get rid of dust

Dry the leaves in the sun for several days until they are completely dry

Grind the dried leaves well

The azedarach plant has been sifted well to obtain a fine powder free of veins

Extraction of Dye from Melia azderach plant:

According to the available method with minor modifications:

Do the extraction using ethanol were put 100 gm of dried plant at 400 ml ethanol at 60°c in Soxhlet at water path for one hour.

Filtrate the extract by filter paper.

Warm the solution to get the dye material at 50°c.[23,24,25,26]

Method of the fabric dyeing and mordanting:

Note: the laboratory standard atmospheric condition is T °C: 21 R.H %: 65.

Two concentrations of the dye (10-20) gm were used along with implementing experiments as follows:

Without mordanting:

Put 10 gm of fabric with the concentrate of dye in 200ml distilled water in a tube of machine at 90°C for two hours. Then wash by warm distilled water & detergent. after washing put the sample in air to dry. Note: (The scoured cotton fabrics were mordanted by different mordants. Three different processes of mordanting used were pre, simultaneous and post mordanting)

Pre-mordanting:

For each used mordant, (Ferrous Sulfate, Aluminum Sulfate), the mordant is dissolved in water and the cotton samples are heated in the mordant solution for 30 minutes at a temperature of 100°, then the samples are dried without being washed, afterwards the samples are put in the green dye solution and the temperature is gradually raised to 90°C for one hour and a half, then the samples are washed with warm distilled water and the cleanser. The samples are left in air to get dry.

Simultaneous-mordanting:

For each of the selected mordants (Ferrous Sulfate, Aluminum Sulfate), Put 10 gm of fabric with the concentration of the green dye and 6gm of the selected mordant in 200ml distilled water in a tube of machine at 90°C for one hour. Then wash by warm distilled water & detergent. After washing put the sample in the air to dry.

Post-mordanting:

For each of the selected mordants, put 10 gm of fabric with the concentration of the green dye bath, gradually raising the temperature to 90°C and allowed to boil gently for 60 minutes.

For preparing the samples, the dyed fabrics were dried without washing. For each of the selected mordants 6 gm of each mordant were dissolved in water, the dyed cotton fabric was mordanted in the solution at 90°C for 60 minutes. Then, wash by warm distilled water & detergent, after washing put the sample in the air to dry.

The research used the same method for dyeing each Dye concentration (10-20) g.

The study measurements:

(The tests were carried out in the processing, monitoring and quality laboratories of the Misr El-Mahalla Spinning and Weaving Company in El-Mahalla El-Kobra).

Color measurements {Color Strength (K/S), Color Tolerance (L*a*b*)}:

The dyed samples were evaluated by Hunter lab Ultra Scan PRO and expressed Several color measurements were carried out to evaluate the shades obtained on dyeing cotton with green natural dye extracted from the leaves of Melia Azedarach tree.

The color strength (K/S value) was assessed using the Kubelka – Munk Equation, K / S = (1- R) 2 / 2R where R is the decimal fraction of the reflectance of dyed fabric.[27]

The CIE L*a*b*, C, H values were ascertained for two mordants and three different mordanting conditions. Chroma (C) is a measure of intensity or saturation of color and Hue angle (H) is derived from the two coordinates a* and b*.

2- Color fastness (light, rubbing, washing and perspiration):

• Colorfastness to light was determined according to ISO test method105-B01 "The evaluation was carried out using the blue scale reference for color change.

• Color fastness to rubbing (wet, dry) was determined according to AATCC Crock Meter Method, 8-2007.

• Color fastness to washing was determined according AATCC Test Method, 61-2006.

Color fastness to perspiration (acidic, alkaline) was measured according to: AATCC Test Method, 15-2002.

3-Textile tests (Tensile strength and elongation):

Tensile strength and elongation (at the direction of the wrap - at the direction of the weft) were measured according to: Designation: D 5035 – 06 (Reapproved 2008), Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method).

• The weight of the square meter.

4. Results and Discussion:

The tabulation of the results and the use of applied statistics to find different relationships between the variables of research to show the final results are as the following:

Measurement of K/S, L* a* b*, C, H Values:

Table (1) The dyeing results, color Sum (K/S) and the colorimetric data (L*, a*, b*, C* and h*) for the dyed samples without metallic salts

NM	MELIA AZEDARACH 10% CONC						MELIA AZEDARACH 20% CONC					
	K/S	L*	a*	b*	C*	h*	K/S	L*	a*	b*	C*	h*
400-450	15.85	23.47	30.76	33.70	35.42	35.28	25.87	35.37	44.31	47.78	50.50	51.25
460-510	34.76	34.89	35.75	36.01	36.67	36.30	51.27	51.66	52.43	52.48	52.54	53.00
520-570	37.76	38.21	38.71	39.44	40.10	40.72	53.60	54.30	55.38	57.25	58.79	60.35
580-630	41.35	41.92	42.64	43.40	44.17	44.97	61.82	62.73	63.20	63.52	64.54	65.49
640-690	45.90	46.86	47.79	48.94	50.27	50.63	65.39	63.72	61.01	60.44	65.56	68.85
700	51.63						72.40					

*NM- nanometers

From table (1) The results revealed that: The higher the dye concentration the higher the value of k\s and a with increased wavelength, The k/s gave the highest value at a wavelength of 700.

Table (2) The dyeing results, color Sum (K/S) and the colorimetric data (L*, a*, b*, C* and h*) for the dyed samples with metallic salts, pre-mordanting method

	NM	MELIA AZEDARACH 10% CONC						MELIA AZEDARACH 20% CONC					
		K/S	L*	a*	b*	C*	h*	K/S	L*	a*	b*	C*	h*
ALUM	400-450	28.74	40.93	53.17	58.09	60.66	60.01	39.79	54.08	67.26	71.50	73.24	72.50
	460-510	58.36	58.13	58.84	59.06	59.69	60.94	71.81	72.35	73.95	73.98	74.10	74.29
	520-570	61.81	62.78	63.87	65.32	66.51	67.63	74.36	74.61	74.86	75.58	76.32	76.89
	580-630	68.74	69.60	70.51	71.39	72.22	73.01	77.56	77.71	77.89	77.90	78.14	78.33
	640-690	73.64	74.36	74.92	75.60	76.71	76.84	78.18	77.34	76.26	76.25	78.64	79.71
	700	77.37						81.58					
FERROUS SULFATE	400-450	40.10	50.30	54.30	59.50	61.05	63.12	66.38	72.18	74.04	74.66	76.85	77.25
	460-510	48.60	61.40	62.88	62.88	62.57	65.27	78.42	79.15	80.22	80.12	80.64	80.21
	520-570	58.34	74.55	76.06	76.33	68.33	73.22	79.97	79.72	79.57	80.06	80.15	80.86
	580-630	72.67	76.80	77.89	77.94	74.01	74.16	81.32	81.00	81.71	81.78	82.21	82.43
	640-690	79.15	77.10	79.02	79.15	78.22	78.40	82.44	82.15	82.71	83.01	83.38	83.73
	700	83.02						86.33					

*NM- nanometers

From table (2) The results revealed that: The higher the dye concentration the higher the value of k\s and a with increased wavelength, The k/s gave the highest value at a wavelength of 700 with metallic salts using.

Table (3) The dyeing results, color Sum (K/S) and the colorimetric data (L*, a*, b*, C* and h*) for the dyed samples with metallic salts, Simultaneous -mordanting method

	NM	MELIA AZEDARACH 10% CONC						MELIA AZEDARACH 20% CONC					
		K/S	L*	a*	b*	C*	h*	K/S	L*	a*	b*	C*	h*
ALUM	400-450	20.88	30.21	40.03	47.12	53.75	56.88	29.18	44.38	60.33	66.18	68.41	67.28
	460-510	57.96	59.22	61.43	61.39	60.79	60.58	66.31	67.19	69.53	70.14	71.01	71.56
	520-570	61.97	62.25	61.91	63.65	64.89	66.01	71.93	72.39	72.87	73.93	74.86	75.66
	580-630	67.13	66.96	66.01	64.42	64.87	65.62	76.53	76.93	77.21	77.35	77.72	78.16
	640-690	64.73	60.62	54.05	51.78	59.38	65.63	78.04	77.13	75.72	75.66	77.48	78.79
	700	72.28						80.79					
FERROUS SULFATE	400-450	32.01	44.54	56.13	60.44	63.09	63.54	21.10	33.60	46.32	50.82	53.08	52.89
	460-510	63.90	64.82	66.49	66.48	66.50	66.65	52.62	53.96	56.68	58.08	59.75	61.10
	520-570	66.85	67.18	67.47	68.73	69.69	70.67	62.27	63.39	64.48	66.09	67.39	68.68
	580-630	71.72	72.01	71.63	71.10	71.36	71.72	69.89	70.76	71.40	72.04	73.01	73.90
	640-690	71.15	68.77	65.67	65.28	69.51	71.78	73.83	73.24	72.08	72.63	76.32	77.71
	700	75.00						80.01					

*NM- nanometers

From table (3) The results revealed that: The higher the dye concentration the higher the value of k\s and a with increased wavelength, The k/s gave the highest value at a wavelength of 700 with metallic salts using.

Table (4) The dyeing results, color Sum (K/S) and the colorimetric data (L*, a*, b*, C* and h*) for the dyed samples with metallic salts, post -mordanting method

	NM	MELIA AZEDARACH 10% CONC						MELIA AZEDARACH 20% CONC					
		K/S	L*	a*	b*	C*	h*	K/S	L*	a*	b*	C*	h*
ALUM	400-450	16.38	29.18	49.04	64.36	73.85	77.52	20.70	31.28	45.58	56.71	63.59	67.75
	460-510	78.74	79.05	80.70	80.63	80.46	80.12	71.14	73.59	76.26	76.26	75.85	74.96
	520-570	79.79	79.74	79.75	80.06	80.51	80.88	74.80	74.65	74.66	75.29	76.18	77.09
	580-630	81.20	81.38	81.73	81.88	82.12	82.34	78.03	77.80	77.16	76.55	76.95	77.38
	640-690	82.41	82.59	82.73	83.03	83.83	83.71	76.66	73.69	69.96	96.54	74.09	76.18
	700	84.02						79.19					
FERROUS SULFATE	400-450	40.79	54.74	66.16	71.30	73.42	72.50	64.83	70.28	73.14	73.65	75.58	77.01
	460-510	70.08	70.35	72.95	73.89	74.12	74.27	76.24	77.25	80.21	80.08	80.56	79.36
	520-570	73.63	74.16	73.86	75.85	76.34	76.87	77.97	77.72	79.79	80.01	79.85	80.06
	580-630	75.65	77.17	75.17	77.91	78.12	78.35	80.33	79.01	81.23	81.68	81.72	81.93
	640-690	78.83	77.13	74.89	76.27	78.62	79.73	81.48	81.25	82.31	82.21	82.68	82.71
	700	82.58						85..06					

*NM- nanometers

From table (4) The results revealed that: The higher the dye concentration the higher the value of k\s and a with increased wavelength, The k/s gave the highest value at a wavelength of 700 with metallic salts using

Fastness of the Dyed Samples to light, rubbing, washing and perspiration:

* Melia azedarach 10% concentration:

Table (5) Fastness properties of cotton dyed with Melia azedarach 10% concentration

The mordant	Method of Mordanting	Color fastness to light	Wash fastness cc	Wash fastness CS	Perspiration Acidic cc	Perspiration Acidic cs	Perspiration Alkaline cc	Perspiration Alkaline cs	Rubbing dry	Rubbing wet
Without mordant	-	4-5	3	2-3	3	2	4	4	4	3
Alum	Pre- mordanting	6-7	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5
	Simultaneous	5-6	4	3-4	4	3	2	3	4	4
	Post- mordanting	6-7	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5
Ferrous Sulphate	Pre- mordanting	6-7	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5
	Simultaneous	6	4	4	4	4	3	2	4	4
	Post- mordanting	6-7	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5

*cc-color change, cs-color staining

From table (5) The results revealed that:1- Using mordants in dyeing is better than dyeing without mordants

2- pre-mordanting and post mordanting methods are Beter than Simultaneous mordanting during dyeing.

* Melia azedarach 20% concentration:

Table (6) Fastness properties of cotton dyed with Melia azedarach 20% concentration

The mordant	Method of Mordanting	Color fastness to light	Wash fastness cc	Wash fastness cs	Perspiration Acidic cc	Perspiration Acidic cs	Perspiration Alkaline cc	Perspiration Alkaline cs	Rubbing dry	Rubbing wet
	-	6	4	4	3	3	3	3	4	3
Alum	Pre- mordanting	6-7	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5
	Simultaneous	6-7	4	4	3-4	3-4	3-4	3-4	4	4
	Post- mordanting	6-7	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5
Ferrous Sulphate	Pre- mordanting	6-7	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5
	Simultaneous	6-7	4	4	4	4	4	4	4	3
	Post- mordanting	6-7	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5

*cc-color change, cs-color staining

From table (6) The results revealed that:1- Using mordants in dyeing is better than dyeing without mordants

2-pre-mordanting and post mordanting methods are better than Simultaneous mordanting during dyeing.

3-Textile tests and statistical calculation of the results

* Melia azedarach 10% concentration:

Table (7) textile tests of cotton dyed with Melia azedarach 10% concentration

	Methods: No mordanting	Alum Pre	Alum Simultaneous	Alum Post	Ferrous sulphate Pre	Ferrous sulphate Simultaneous	Ferrous sulphate Post	Standard
Weft Tensile Strength	43.5	43.5	45	46	44.5	44	45.5	47.5
Weft Elongation	22	20.5	21	22	23	22.5	22.5	24
Warp Tensile Strength	54.5	54	53	52	53	52	54	58
Warp Elongation	8	8	7	8	7	8	7	7

Table (8) textile tests of cotton dyed with Melia azedarach 20% concentration

Textile tests	No mordanting	Methods						Standard
		Alum			Ferrous sulphate			
		Pre	Simultaneous	Post	Pre	Simultaneous	Post	
Weft Tensile Strength	44	46	44	47	44.5	46	46.5	47.5
Weft Elongation	21	21	20.5	23	23	21	22	24
Warp Tensile Strength	56	56	56	57.5	53	54	55.5	58
Warp Elongation	8	8	7	7	7	9	7	7

Table (9) The weight of the square meter

Textile tests	No mordanting	Methods						Standard
		Melia azedarach 10% concentration						
		Alum			Ferrous sulphate			
		Pre	Simultaneous	Post	Pre	Simultaneous	Post	
The weight of the square meter	148	151	153	155	151	152	154	152
Melia azedarach 20% concentration								
The weight of the square meter	150	152	154	157	151	153	152	152

Results related to the third hypothesis and its interpretation: -

"There are statistically significant differences between the samples in Weft Tensile Strength after treatment".

To verify this hypothesis, the researcher followed the following steps:

1- Using one-way ANOVA to determine that there is a difference between samples in Weft Tensile Strength (kg) after treatment.

Calculating the mean and standard deviation for each sample to identify the best samples.

From the tables (10,11) it is shown that:

The value of (F) = 1.138 and the level of significance Not a function at (0.05) which is more than the level of (0.01), (0.05), and therefore "there aren't statistically significant differences at the level of significance (0.01), (0.05) between samples in Weft Tensile Strength after treatment.

Table (10) shows the differences between samples in Weft Tensile Strength (kg) after treatment.

Groups	Sum of Squares	DF	Mean Square	F	Sig.
Between Groups	69.714	13	5.363	1.138	Not a function at (0.05)
Within Groups	66.000	14	4.714		
Total	135.714	27			

Table (11) shows the arithmetic mean and standard deviation of the samples with respect to Weft Tensile Strength (kg)

The samples	Mean	Std. Deviation	The samples	Mean	Std. Deviation
1.00	43.00	4.24	8.00	43.00	1.41
2.00	43.50	.70711	9.00	45.00	1.41
3.00	45.00	4.24264	10.00	44.00	2.82
4.00	46.00	1.41421	11.00	45.50	0.70
5.00	46.50	3.53553	12.00	47.50	0.70
6.00	44.00	2.82843	13.00	46.00	1.41
7.00	47.00	2.82843	14.00	48.00	1.41

The best samples in terms of Weft Tensile Strength are sample No. (12,14), which is (concentrate level, 20%, type of treated material, Ferrous Sulphate, condition of the substance, post and pre), and therefore there is a difference between the samples in the Weft Tensile Strength after treatment and the best sample are (12,14) with mean (47.5,48) compared to standard results (47.5).

The differences between samples in Weft Elongation

Table (12) shows the differences between samples in Weft Elongation (kg) after treatment.

Groups	Sum of Squares	DF	Mean Square	F	Sig.
Between Groups	76.607	13	5.893	.668	Not a function at (0.05)
Within Groups	123.500	14	8.821		
Total	200.107	27			

Table (13) shows the arithmetic mean and standard deviation of the samples with respect to Weft Elongation (kg)

The samples	Mean	Std. Deviation	The samples	Mean	Std. Deviation
1.00	22.00	2.82843	8.00	21.00	1.41421
2.00	20.50	.70711	9.00	21.00	1.41421
3.00	21.00	1.41421	10.00	20.50	.70711
4.00	22.00	2.82843	11.00	23.00	1.41421
5.00	23.00	4.24264	12.00	26.00	5.65685
6.00	22.50	3.53553	13.00	21.00	1.41421
7.00	24.00	5.65685	14.00	25.00	1.41421

From the tables (12,13) it is clear that:

The value of (F) = .668 and the level of significance Not a function at (0.05) which is more than the level of (0.01), (0.05), and therefore "there aren't statistically significant differences at the level of significance (0.01), (0.05) between samples in Weft Elongation after treatment, The best samples in terms of Weft Elongation are sample No. (12,14), which is (concentrate level, 20%, type of treated material, Ferrous Sulphate, condition of the substance, post and pre), and therefore there is a difference between the samples in the Weft Elongation after treatment and the best sample are (12,14) with mean (25,26) compared to standard results (24).

The differences between samples in Warp Tensile Strength (kg) after treatment.

Table (14) shows the differences between samples in Warp Tensile Strength (kg) after treatment.

Groups	Sum of Squares	DF	Mean Square	F	Sig.
Between Groups	891.429	13	68.57	2.79	function at (0.01)
Within Groups	344.000	14	24.57		
Total	1235.42	27			

Table (15) shows the arithmetic mean and standard deviation of the samples with respect to Warp Tensile Strength (kg)

The samples	Mean	Std. Deviation	The samples	Mean	Std. Deviation
1.00	54.50	3.53553	8.00	56.00	8.48528
3.00	53.00	2.82843	10.00	56.00	8.48528
4.00	52.00	2.82843	11.00	59.50	.70711
5.00	57.00	1.41421	12.00	75.50	7.77817
6.00	52.00	2.82843	13.00	54.00	4.24264
7.00	57.50	.70711	14.00	59.00	1.41421

From the tables (14,15) it is clear that:

The value of (F) = 2.791 and the level of significance is (0.000), which is less than the level of (0.01), (0.05), and therefore there are statistically significant differences at the level of significance (0.01), (0.05) between samples in Warp Tensile Strength after treatment, The best samples in terms of Warp Tensile Strength are samples No. (12,14), which is (concentration level, 20%, type of treatment material, Ferrous Sulphate, condition of the substance, post and pre mordanting), and therefore there is a difference between the samples in the Warp Tensile Strength after treatment and the best samples are (12,14) with mean (75.5,59) compared to standard result (58).

The differences between samples in Warp Elongation (kg) after treatment.

Table (16) shows the differences between samples in Warp Elongation (kg) after treatment.

Groups	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	15.000	13	1.154	.305	Not a function at (0.05)
Within Groups	53.000	14	3.786		
Total	68.000	27			

Table (17) shows the arithmetic mean and standard deviation of the samples with respect to Warp Elongation (kg)

The samples	Mean	Std. Deviation	The samples	Mean	Std. Deviation
1.00	7.00	1.41421	8.00	7.00	1.41421
2.00	7.00	1.41421	9.00	7.00	1.41421
3.00	6.00	1.41421	10.00	6.00	2.82843
4.00	6.50	.70711	11.00	7.00	1.41421
5.00	7.00	2.82843	12.00	9.00	4.24264
6.00	6.50	.70711	13.00	7.00	1.41421
7.00	7.00	1.41421	14.00	8.00	1.41421

From tables (16,17) it is clear that:

The value of (F) = 0.305 and the level of significance Not a function at (0.05) which is more than the level of (0.01), (0.05), and therefore "there aren't statistically significant differences at the level of significance (0.01), (0.05) between samples in Warp Elongation after treatment, The best samples in terms Warp Elongation are sample No. (12,14), which are at concentration level, 20%, type of treated material, Ferrous Sulphate, condition of the substance, post and pre), and therefore there is a difference between the samples in the Warp Elongation after treatment and the best sample are (14) with mean (9,8) compared to standard result (7).

Comment on the results

The cotton material was successfully dyed without defects or color spots, and laboratory results have shown that:

Measurement of K/S, L* a* b*, C, H Values:

*The different dying processes made various color shades.

* The difference of coloring measurements in according with the difference in the used dye concentration.

*The more the dye concentration is the more the k/s value is.

*The k/s gave the highest value at a wavelength of 700.

* The highest k/s values using mordants were achieved using the Ferrous Sulfate mordant.

* The k/s gave the highest value when using pre-mordanting and post-mordanting dying method.

2- Fastness of the Dyed Samples to light, rubbing, washing and perspiration:

*Colorfastness to light, washing, rubbing, and perspiration has shown that the greatest values were given when dying fabrics using the pre-mordanting process, as well as the post-mordanting process; using both concentrations and both mordants.

3-Textile tests:

As for the textile tests, the results were as follows

The best samples in terms of tensile strength, and elongation tests are the samples that used the concentration level, 20%, the type of treated material, ferrous sulfate, in the two cases of mordanting pre-Mordanting and post-mordanting.

Which is consistent with the studies of Saher Abd Elmegeed, Noha Mohamed Elsayd and Magda Ebrahim.

The study recommends

The study recommends directing to modern natural dyes to reach new shades and colors that are environmentally safe and achieve product quality.

5. Conclusion

Since the new global direction is towards using environmentally safe dyes.

In this study, a natural green dye was extracted from the leaves of the Melia azedarach tree using ethanol. Two concentrations of the extracted dye were used (10% and 20% conc) also two types of mordants were used; "ALUM, FERROUS SULFATE", and four different methods were followed in the dyeing process; "Without mordanting, Pre-Mordanting, Simultaneous, and post-mordanting.

The dyed samples were subjected to laboratory tests in the terms of: -

- Strength of the color (k/s) and color Tolerancing (l*b*c*).
- Color Fastness to {light, rubbing (wet, dry), washing, and perspiration (acidic, alkaline)}.
- Physical characteristics, {Tensile strength and elongation}: (at the direction of the wrap - at the direction of the weft)

The cotton material was successfully dyed without defects or color spots, and laboratory results have shown that: The different dying processes made various color shades.

Colorfastness to light, washing, rubbing, and perspiration has shown that the greatest values were given when dying fabrics using the pre-mordanting process, as well as the post-mordanting process; using both concentrations and both mordants

As for the textile tests, the results were as follows

The best samples in terms of tensile strength, and elongation tests are the samples that used the concentration level, 20%, the type of treated material, ferrous sulfate, in the two cases of mordanting pre-Mordanting and post-mordanting.

The study recommends directing to modern natural dyes to reach new shades and colors that are environmentally safe and achieve product quality.

6. References

1. Baker, N.R. and Webber, A.N.. Interactions between Photosystems. Advances in Botanical Research, 13, 1-66. (1987).
2. Briantais, J.M., Vernotte, C., Krause, G.H. and Weiss, E.. Light Emission by Plants and Bacteria. Academic Press, New York. (1986).
3. https://pdf4pro.com/view/14-extracting-natural-plant-dye-nuffield-foundation-4c84d.html.(2008).

4. Saher Abd Elmegeed Abd Elmegeed Mohamed Dyeing (cotton/ polyester) blended fabrics using dyes stuffs extracted from some hydrophytes. PhD thesis. Clothing and Textiles Dept., Faculty of Home Economics, Menoufia University. (2012).

5. . B.H. PATEL, A.A. MANDOT and P. K. JHA. Extraction, Characterization and application of Azadirachta Indica Leaves for Development of Hygienic Lycra Filaments, Journal Of International Academic Research For Multidisciplinary volume 1, Issue 12. (2014).

6. Ibrahim Hamed and others Effect Of Pepsin and Trypsin Enzymes Used in Textile Conservation on Natural Dyed textiles Samples., Journal of Home Economics, Volume 25, Number (1) (2015).

7. Tamrat Tesfaye Dyeing Cotton with Dyes Extracted from Eucalyptus and Mango Trees. The International Journal of Science & Techno ledge (ISSN 2321 – 919X). (2015).

8. Noha Mohamed Elsayd, Ahmed Ramzy The Effect of Treatment of Cellulosic Household Clothes Fabrics with Environmentally Safe Materials on The Properties of Fastness to Natural Dyes. Journal of Home Economics, Volume 26, Number (1). (2016).

9. Magda Ebrahim, Eman Raafat. Benefiting From Processing Multifunctional Fabrics With Eco-Friendly Materials In The Implementation Of Children's Cloths. Journal of Home Economics, Volume 28, Number(4). (2018).

10. Huiyu Jiang . Rui Guo . Rony Mia . and others. others Eco-friendly dyeing and finishing of organic cotton fabric using natural dye (gardenia yellow) reduced-stabilized nanosilver: full factorial design. Cellulose 29:2663–2679. Springer Sci. (2022).

11. Jin Fang, Chen Meng, Guangzhi Zhang. Agricultural waste of Ipomoea batatas leaves as a source of natural dye for green coloration and bio-functional finishing for textile fabrics. Industrial Crops & Products Journal 177 114440. .(2022)

12. Yetisen, A. K., Qu, H., Manbachi, A., Butt, H., Dokmeci, M. R., Hinestroza, J. P., Skorobogatiy, M., Khademhosseini, A., & Yun, S. H. Nanotechnology in Textiles. ACS Nano, 10(3), 3042-3068. (2016). https://doi.org/10.1021/acsnano.5b08176.

13. B P Saville. Physical Testing of Textiles 1st Edition - ISBN: 9781855733671. (1999).

14. J. Gordon Cook. Handbook of Textile Fibers: Volume 1: Natural fibers ISBN:9781855734845 (ISBN10: 1855734842. (1984).

15. Ivana Markova. Textile Fiber Microscopy: A Practical Approach. ISBN: 978-1-119-32007-4 New York, J. Wiley & Sons. (2019).

16. Efat bou-Fakhr Hammad E, McAuslane H Effect of Melia azedarach L. Extract on Liriomyza sativae (Diptera:

Agromyzidae) and its Biocontrol Agent Diglyphusisaea (Hymenoptera: Eulophidae). Journal of Food Agriculture and Environment, 8(3):1247-1252. . (2010).

17. Manzoor Iqbal and Rukhsana Jabeen. Detection of heavy metals in leaves of Melia azedarach and Eucalyptus citriodoraas biomonitring tools in the region of Quetta valley. Pak. J. Bot., 44(2): 675-681. (2012).

18. Nelson, Gil "Meliaceae - Mahogany Family". The Shrubs and Woody Vines of Florida – A Reference and Field Guide. Pineapple Press Inc. p. 213. ISBN 9781561641109. (1996).

19. Vanker P. S., Shankar R., Dixit S., and Mahanta D. Sonicator dyeing of cotton, wool and silk with leaves extract, J. Textile Apparel, Technol. Manag., 6(1), 296-305"., (2009).

20. Pooja Kumari, Dr. Lalit Jajpura and Neetu Rani Application Of Kalanchoe-Pinnata And Sida-Cordifoliaherbs In Colouration Of Textiles. International Journal of Engineering Sciences & Management Research Impact Factor (PIF): 2.243. (2015).

21. Tiedemann, E. J., and Yang, Y., Fiber-safe extraction of red mordant dyes from hair fibers, Journal of the American Institute for Conservation, 34(3), 195-206. (1995).

22. S. Keka and P. Das Textiles and Light Industrial Science and Technology. Vol. 1. (2012).

23. B. H. Patel Dyeing and antimicrobial finishing of polyurethane fiber with neem leaves extract . Man-Made Textiles in India 52(4):112-116. (2009).

24. Meilana Dharma Putra, Agus Darmawan, Ilham Wahdini And Ahmed E. Abasaeed Extraction of chlorophyll from pandan leaves using ethanol and mass transfer study. J. Serb. Chem. Soc. 82 (0) 1–12 JSCS–4219. (2017).

25. Norazlina Hashim and Lili Hassan A study of neem leaves: Identification of method and solvent in Extraction. Materials Today: Proceedings 42 217–221. (2021).

26. Isam Kamal, Dr.Ahmed Jawad, Ali Khalid Khudair Al-JomailyExtraction of Chlorophyll from Alfalfa Plant. Al-Khwarizmi Engineering Journal, Vol.2, No.1, pp 85-97. (2006).

27. Alfred, A.C., Olav, M.K. and Rance, A.VQuantitative Analysis in Diffuse Reflectance Spectrometry: A Modified Kubelka-Munk Equation. Vibrational Spectroscopy, 9, 19-27. (1995).

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الملابس والنسيج

صباغة الأقمشة القطنية باستخدام الصبغة الخضراء صديقة للبيئة المستخرجة من أوراق شجرة ميليا أزدراخت

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الملخص العربي:

يهدف هذا البحث إلى مواكبة التوجه العالمي لتحقيق صناعات صديقة للبيئة. وتسليط الضوء على صبغة الكلوروفيل وإمكانية استخدامها في صباغة ألياف النسيج. إن معيار تقدم الأمم يقاس بمدى عدم تلوث البيئة فيها. ومن هنا زادت المنافسة في استخدام الأصباغ الصديقة للبيئة وأصبح البحث العلمي يهتم بهذه الصناعة ويعمل على تطويرها وتحسينها. لذلك، تم استخدام في هذا العمل: نسيج قطني 100%، صبغة خضراء طبيعية مستخرجة من نبات ميليا أزدراخت؛ نوعين من المثبتات. أظهر ثبات اللون للغسيل والاحتكاك والتعرق أن القيم الأعلى تم الحصول عليها عند صبغ الأقمشة باستخدام عملية التثبيت قبل الصباغة، وكذلك عملية التثبيت بعد الصباغة؛ باستخدام كلا التركيزين و كلا المثبتين أما بالنسبة للقياسات اللونية، فقد أعطيت أعلى قيمة عند استخدام تركيز صباغة قدره 20 جم باستخدام مادة كبريتات الحديدوز، وكان ذلك عند استخدام عملية التثبيت قبل الصباغة، وكذلك عملية التثبيت بعد الصباغة. أما بالنسبة للاستطالة، فقد تم تسجيل الاستطالة في اتجاه اللحمة باستخدام التثبيت قبل الصباغة في كلا التركيزين ومع كل من المواد المثبتة للعينة القياسية، وللاستطالة في اتجاه السداء. ويوصي البحث بما يلي: يجب أن ننتقل مباشرة إلى استخدام الأصباغ الطبيعية الحديثة المستخرجة من النباتات والطحالب والخلط بينها للوصول إلى درجات لونية وظلال جديدة آمنة بيئيا وتحقق جودة المنتج

الكلمات المفتاحية: المثبتات، خامة القطن، قوة اللون، اختبارات النسيج، ثبات اللون.