J. Egypt. Acad. Soc. Environ. Develop., 22 (1):33--46 (2021) **(D-Environmental Studies)**
E.mail: easedjournal_egypt@yahoo.com **ISSN 1110-8770**
www.jades.journals.ekb.eg **eISSN 2314-5471 (online)**

Efficient Synthesis of TiO_2 nanoparticles and its application in natural fabrics printed with Turmeric dyes

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Received : August 2, 2021
Accepted: August 25, 2021

ABSTRACT

Special photocatalytic activity, extreme availability, non-toxicity, biocompatibility, and low cost make TiO_2 nanoparticles mainly attractive for industrial of different high value-added produces. The present work aims of harnessing nanotechnology as one of the most important frontier sciences to develop the printing of natural fibers using the most ecologically friendly dyes, namely turmeric dye to confirm the sustainability of the environment for upcoming generations, decrease pollution resultant from textile printing, overcome the harms of using synthetic colorants, synthetic thickeners, and synthetic fibers on environmental balance and human healthiness.

Environmental natural dye (turmeric dye) and the natural thickener (tamarind thickener) are used to produce a natural printing paste with a proper viscosity for printing natural fabrics by the flat silk screen printing. In this work, three diverse methods of treating fabrics were used, which are pre-treatment, simultaneous treatment, and post-treatment with TiO_2 nanoparticles at varying concentrations (0.5%, 1%, 1.5%, and 2% W.O.F). TiO_2 nanoparticles were prepared using sol-gel technique. The prepared nanoparticles were analyzed using Scanning electronic microscope(SEM), and transmission, electronic microscope(TEM), tensile strength and elongation, microbial protection, Color strength K/S values, fastness properties, and Ultraviolet protection factor (UPF were measured on fabric samples.

Results presented that the K/S values of treated samples are higher than the original samples. All treated fabrics have excessive fastness values for washing, perspiration, and rubbing. But all treated fabric printed with curcuma show low light fastness properties. Rise in the tensile strength of fabrics. The combination of these nanoparticles in the structure of the natural fabrics creates the ending product antimicrobial. The UPF values of all the treated printed fabric samples are upper than those of the blank ones.

Development of the function and health properties and value of the resultant fabrics while keeping the ecological balance. By overcoming the lowly shadow and fastness properties of natural colorants by treating fabrics with green materials. Rise the durability of treated natural fabrics and the default service life. The printed fabrics obtained advance an antibacterial agent for Staphylococcus aureus, and Escherichia coli , and ultraviolet protective.

Keywords: TiO_2 Nanoparticles, UV Protective, Antibacterial Agent , Turmeric Dye, Green Treatment.

INTRODUCTION

The main challenge facing the textile printing today is to adjust production methods, so they are more ecologically friendly at a viable price, by using safer colorants and thickeners. It is therefore imperative to use treatment strategies (Ortset *et al*., 2018), which aim to ensure the sustainability of the environment for future generations (Jordão *et al*., 2018) through physical, chemical and biological techniques or a combination thereof (Setiadi et al., 2006). It has been observed that physical and chemical methods, although successful, have high electricity and operating input costs (Imran *et al*., 2015). Therefore, current work is directed towards the use of natural dyes, because it is is biodegradable, non-toxic, easy to prepare, antibacterial, anti-mite, anti-allergic, anti-UV, obtained from cheap renewable resources, does not produce hazardous wastewater upon decomposition in the environment, therefore does not need to treat wastewater I (Samanta and Konar, 2011), and have no side effects on the human body (Kasiri. and Safapour, 2013). Therefore, the researcher used the natural printing paste that contains a natural dye, namely the turmeric dye .

Turmeric is a natural yellow coloring agent. It is a phytopolylphenol pigment isolated from the plant Curcuma longa, commonly known as curcuma(Saxena and Raja, 2014), and a natural thickener, namely a tamarind thickener, which have been prepared from tamarind gum. Tamarind gum made of glucose, xylose, and galactose in a 3: 2: 1 ratio isolated from the tamarind seeds (Goyal *et al*., 2008). Without using mordant for printing natural fabrics. Due to the weakness of the color and the stability of natural colorant, it becomes necessary to need stabilizers that are done by environmentally friendly treatments such as biopolymers are used instead of chemical treatments to remove chemical pollutants and their residues resulting from chemical processes5.

Recent advances in nanoscience and nanotechnology have an enormous impact on almost all industries and many sectors of daily life. Despite the tremendous progress already being made in this field, nanotechnology continues to pose many questions and challenges including its implementation on an industrial scale that would enable commercial manufacturing of nanomaterials and corresponding products, environmental concerns, safety and health, etc .

Nanotechnology is the science and technology of designing, building, and creating a new structure at the nanoscale, with a size of 1 nanometer to 100 nanometers, with greater quality, new performance characteristics, as well as fewer defects compared to existing ones In bulk materials (Qian and Hinestroza, 2004). It can provide high durability for fabrics because nanoparticles have a large surface area to volume ratio and high surface energy, which leads to a better affinity for fabrics and leads to an increase in functional durability (Wong et al., 2006). When the particle size is reduced, the surface area of the material increases. As a result, a higher percentage of the atoms can react with another substance. Nanoparticles must be closely regulated so that their properties do not change (Ragheb et al., 2017).

Metal and metal oxide nanoparticlesTiO_2 because of their semiconductor nature have been used extensively as photocatalysts under UV irradiation and are responsible for self-cleaning by eradicating the organic compounds from polluted water and air. They are also effective for the bacterial colonization reduction. Redox reaction induced by generation of electron-hole pair upon exposure to UV light equal or more than bad gap energy of photocatalysts produces reactive oxygen species (ROS) like singlet oxygen (O2) (Kamat 2002), superoxide ion (O2 •-), and hydroxyl radicals(•OH) which are responsible for organic degradation .

In the current study TiO_2nanoparticles were synthesis and application by three treatment method (pre, simultaneous, and post treatment) on natural fabrics (cotton, wool, silk) printed with turmeric. Comparative studies have been conducted for K / S, overall stability properties, tensile strength, antimicrobial activity, etc.

MATERIALS AND METHODS

Materials:

Fabrics: Cotton100% fabric was supplied from Opera Textiles Co., Cairo, Egypt, wool 100% fabrics were supplied from Elkammah Company, and silk100% fabrics were supplied from The Egyptian Natural Silk Company (Debag), Ismailia, Egypt. All fabrics washed with a solution containing 2g / liter non-ionic detergent (TERGITOLTM NP-9 Surfactant), at 60 °C for cotton and 50° C for wool and silk fabrics for 30 minutes, then rinsed thoroughly with water and dried with air at room temperature.

Dye: Natural dye substance turmeric that was purchased from local market Harraz natural market, Cairo, Egypt. The color matter curcumin is shown in Figure (1)

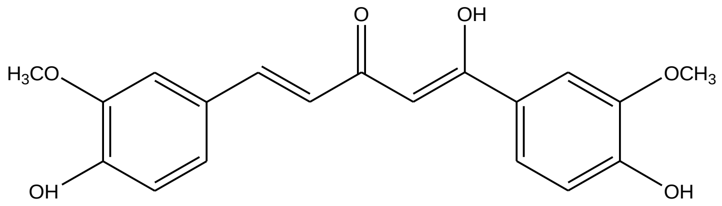


Fig. 1. Chemical structure of curcumin (Saxena and Raja, 2014)

Thickeners: Natural Gum ST 80 is an anionic thickener from (ADGUMS private limited, an exporter of thickener for textile printing). The viscosity 8%, and pH was adjusted to 9-11(Goyal *et al.,* 2008). Its structure is shown in Figure (2)

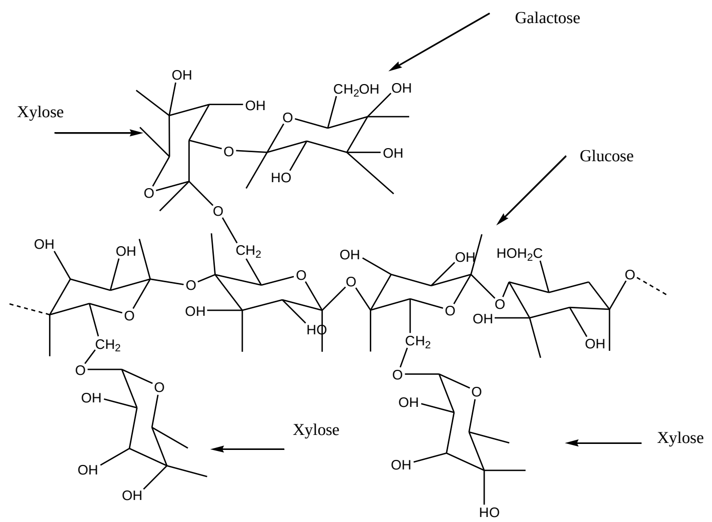


Fig.2. Structure of tamarind seed polysaccharide [TSP] (Gupta *et al.,* 2015)

Other Chemicals: Urea, Diammonium hydrogen orthophosphate, and all chemicals used in this study were of laboratory grade, and were purchased from El Gamhoria Company, Cairo, Egypt.

Methods:

Fabrics treatment methods: Natural fabrics were treated in three different methods: pretreatment, concurrent treatment and post-treatment with different materials.

Pretreatment method: Samples of natural wool fabrics were treated with different concentrations(0.5%, 1%, 1.5%, and 2% W.O.F). TiO_2 nanoparticles, squeezed, and were dried at room temperature then were printed with the natural dyes mentioned above.

Simultaneous treatment method (single stage): In this method of printing and treatment, the materials were made in one step by adding them to the printing paste.

Post- treatment method:
In this method, the specimens of natural fabric were first printed with natural dyes, and then the printed fabrics obtained were treated with TiO_2 nanoparticles.

- **Treatment of the natural fabrics with TiO2 nanoparticles:**

Synthesis of TiO_2 nanoparticles:

Adding 3.5 ml of titanium tetrachloride ($TiCl_4$) to 50 ml of deionized water in an ice bath and the process was carried out under a fume hood. Then add 35 ml of ethanol with vigorous stirring for 30 minutes at room temperature. After that adding drops of ammonium hydroxide to a solution of titanium tetrachloride ($TiCl_4$), and obtaining ethanol and deionized water for its neutralization and precipitation. After stirring vigorously, the solution was made to settle for twelve hours. After that, the precipitate was centrifuged. The resulting precipitate was washed with deionized water until the chloride ion was removed and separated by centrifugation. The precipitate was dried at 200 ° C using an oven to remove part of the absorbed water for 4 hours, and thus amorphous TiO_2 was obtained.
Finally, the obtained amorphous TiO_2 is calcinated at temperatures of 400 ° C for four hours to obtain TiO_2 nanoparticles (Abd El-Thalouth and Mashaly, 2016).
Preparation of Sol-Gel TiO_2-nanoparticles can be represented as follows:

≡Ti (OR) + H2O → ≡TiOH + ROH Hydrolys ≡ Tis (1)

≡TiOH+ ≡ TiOH → ≡ Ti-O- Ti ≡ + H_2O Condensation and/or (2)

≡TiOH+ ≡ Ti (OR) → ≡ Ti-O-Ti ≡ + ROH CondensaVon (3)

Where R is an organic group, and,
Ti-O-Ti is a colloidal oxide network in the sol form.

TiO_2 –nano sol network $\xrightarrow{heat}$ gel formation (4)

Treatment method with TiO_2 nanoparticles:

The aforementioned fabrics were treated with TiO2 nanoparticles by exhaustion method with 4 different percentages of TiO2 nanoparticles (0.5% - 2%W.O.F) at 80 °C for 20 minutes in the presence of a wetting agent in the beaker. The liquor ratio of the bath was 120. After 20 minutes. The treated fabrics were fixed at 140 °C for 10 minutes. Finally, the treated fabrics were washed at 60 °C for 20 minutes, followed by drying (Abd El-Thalouth and Mashaly, 2016).

- **Dye Extraction:**

The colorant was extracted by adding 100g turmeric to 1,000 ml. H_2O. Water was boiled for 30 minutes.The solution was cooled and filtered.

- **Preparation of the printing pastes:**

The printing paste was prepared according to the following:

Natural dye (turmeric)	100.0 g
Thickener (Tamarind)	67.8 g

Di-ammonium phosphate 12.5 g
Urea 40.0 g
Then complete with 100 ml water

Printing technique:

The three fabrics cotton, wool and silk, were printed by flat screen printing, then the printed fabrics were steamed to 120°C for 20 min. After fixation, all printed samples were washed to remove excess material from the surface of the fabric and to provide stability to the printed material.

Washing process: It was done as follows:

1- Samples were rinsed in cold water, then washed with warm water.
2- Samples were soaped with a solution containing 2 g/l (TERGITOLTM NP-9 Surfactant) (non-ionic detergent) for 15 min at 50◦C for wool and silk fabrics and 15 min at 60◦C for cotton fabric.
3- Samples were washed using hot and cold water.
4- The washed samples were allowed to dry at room temperature.

Finally, fabrics were evaluated to measure color strength (K/S), and all fastness properties, antimicrobial properties and tensile strength.

Measurements:

Morphological study of TiO_2 nanoparticles :

a- Scanning electron microscope (SEM):

SEM **(**JSMT-20, JEOL-Japan) was used to scan the surface morphology of printed fabrics treated with silver nanoparticles.

b-Transmission Electron microscope (TEM):

TEM (JTEM-1230, JEOL Japan) was used to analyze the size, morphology, crystalline structure, and chemical composition of a wide range of nanometers.

Measurement of tensile strength and elongation:

Tensile strength and elongation tests were carried out on a Tinius Olsen machine (H5KT/130-500) in the context of the ASTM D5035 (Strip Method).

Determination of antibacterial activity of colonyforming unit:

Antibacterial activities of fabrics treated with TiO_2 nanoparticles at a concentration of (0.5% - 2%W.O.F) were investigated using the colony-forming technique (CFU) for *Staphylococcus aureus*, and *Escherichia coli*. The number of viable bacterial colonies on the agar plate for both treated and untreated products was counted and the results of bacterial reduction(Lellis *et al.,* 2019) were reported as per the equation. R (%) = B-A / B x 100
Where A corresponds to CFU/ml of the treated sample after 16 hours of incubation and B corresponds to CFU/ml of the non-treated sample after the same incubation period (Abdel-Wareth *et al*., 2019).

Measurements of color strength (K/S):

The color strength (K/S) of the specimens was evaluated by the light reflectance technique using the Shimadzu UV/Visible spectrophotometer (De Santis *et al.,* 2017). K/S in which K and S correspond to the absorption and diffusion coefficients, respectively

Measurements of Fastness properties:

The printed specimens were subjected to friction, washing, perspiration and light according to ISO standard methods, ISO 105-X12 (1987), ISO 105-co4 (1989), ISO105-EO4 (1989), ISO 105-BO2 (1988).

UV-protecting properties of printed tissues treated with TiO_2 nanoparticles:

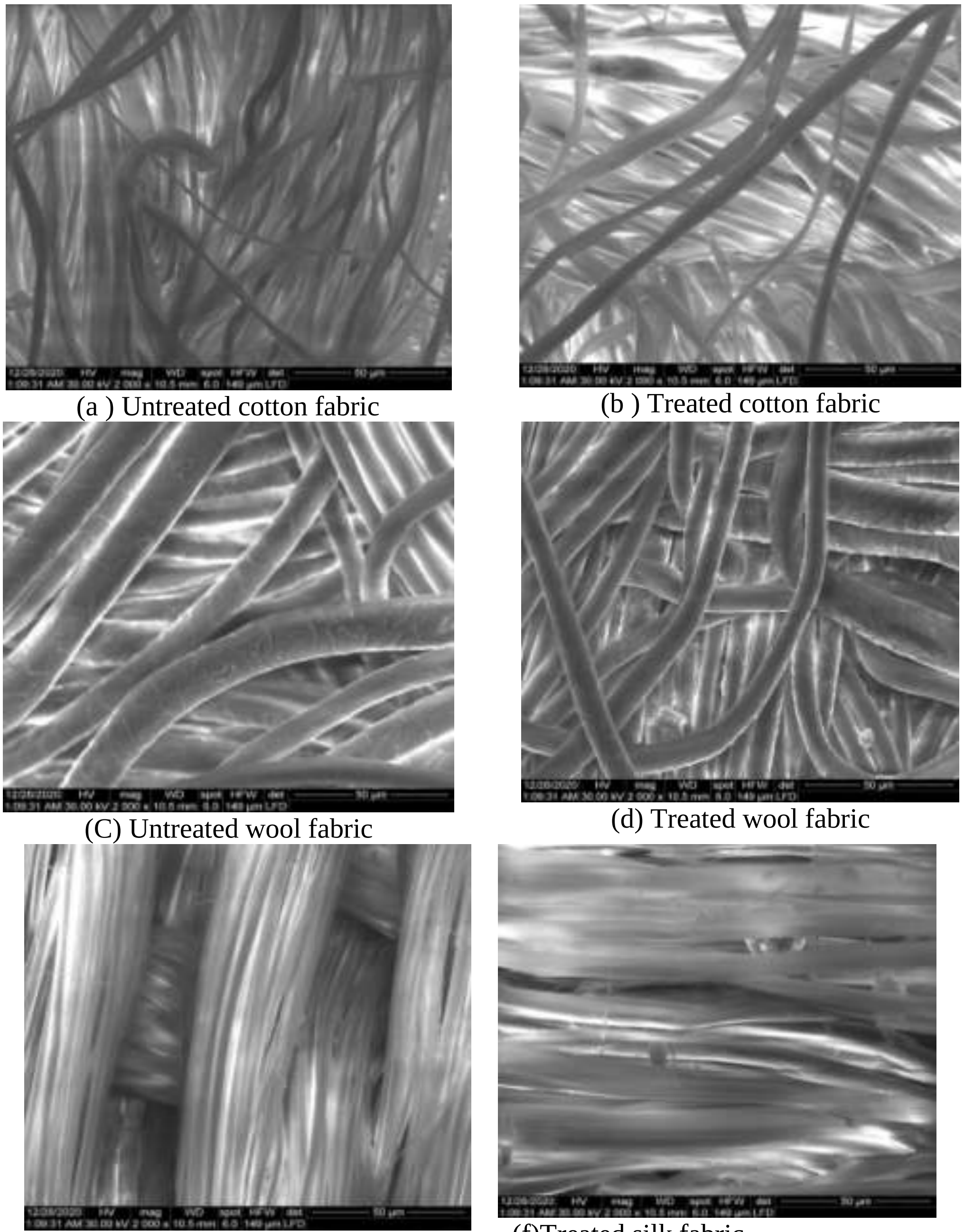
The trial was conducted in accordance with AATCC TM 183-2010.

RESULTS AND DISCUSSION

Morphological study of TiO_2 nanoparticles:

Scanning electron microscopy (SEM) analysis for sample treatment

The SEM images of untreated fabrics are shown in Figure (3a & c). Images of fabrics treated with TiO_2 nanoparticles at the concentration 2% W.O.F are shown n Figure (3 b & d).



(a) Untreated cotton fabric

(b) Treated cotton fabric

(C) Untreated wool fabric

(d) Treated wool fabric

(e) Untreated silk fabric

(f)Treated silk fabric

Fig.3. SEM images of untreated and treated fabrics with TiO_2 nanoparticles

Images of SEM for treated fabrics showed that TiO_2 nanoparticles have been distributed on the surface of the fiber and that the smoothness of the surface has improved. TiO_2 nanoparticles binds well to fibers and not only adheres to the surface, but also penetrates textile deficiencies.

Transmitting electron microscopy (TEM) for silver nanoparticles

TEM analysis of TiO_2 nanoparticles revealed that the size of the nanoparticles ranged between 9to 94nm (Fig. 4).

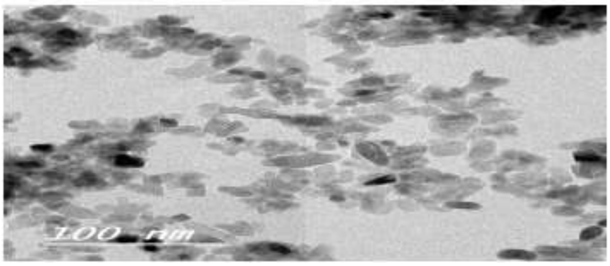


Fig.4. TEM images showing TiO_2 nanoparticles

Tensile strength and elongation measurement

The tensile strength test is one of the major sustainability tests of the fabric. The test was carried out on all fabrics treated with TiO_2 nanoparticles at concentration 2% W.O.F and compared with untreated tissues. Table (1) gives a summary of the results of the tensile strength and elongation tests for untreated and treated tissues. The result shows that the tensile strength and elongation of treated wool fabrics with TiO_2 nanoparticles are higher than that of untreated fabrics due to the presence of a high degree of cross-sulfide on wool fabrics (87) as mentioned previously. Also the treated cotton fabrics with TiO_2 nanoparticles showed a significant decrease compared to the untreated fabrics. Silk fabrics treated with TiO_2 nanoparticles show the same tensile strength as untreated fabrics, and the elongation of all treated fabrics showed a decrease with TiO_2 nanoparticles can be attributed to those spaces between fibers after treating decreases.

Table 1. Tensile strength and Elongation of natural fabrics treated with 2% W.O.F.TiO_2 nanoparticles

Types of fabrics	Materials used			
	Tensile strength @ break Kg		Elongation @ break %	
	Blank	Treated	Blank	Treated
Cotton	43	42	15	10
Wool	62	80	35	40
Silk	88	88	28	25

Determination of antibacterial activity by colony-forming unit

The antibacterial activities of treated fabrics at 2% W.O.F of TiO_2 nanoparticles were studied using a colony-forming technique (CFU) against *Staphylococcus aureus*, and *Escherichia coli* (Fig. 5). The results revealed that TiO_2 nanoparticles have exllent antibacterial activity with all fabrics, because nano-TiO_2 has a photo catalytic effect and when exposed to light, photons with energy equal to or greater than the bonding gap of titanium dioxide excite the electrons up to the conduction band. The excited electrons within the crystal structure interact with the oxygen atoms in the air, producing free oxygen. These oxygen atoms are powerful oxidizing agents, which can break down the cell wall of microorganisms through an oxidation-reduction reaction(Samal *et al.*, 2010).

Table 2. Antibacterial activity of natural fabrics treated byTiO_2 nanoparticles

Treatment material	Type of fabrics	Sample Test	Gram+ vebacteria	Gram– vebacteria
			Staphylococcus aureus	Escherichia coli
TiO_2 Nanoparticles	cotton	control	0	0
		treated	100	97.59
	wool	control	0	0
		treated	100	96.39
	silk	control	0	0
		treated	99.48	100

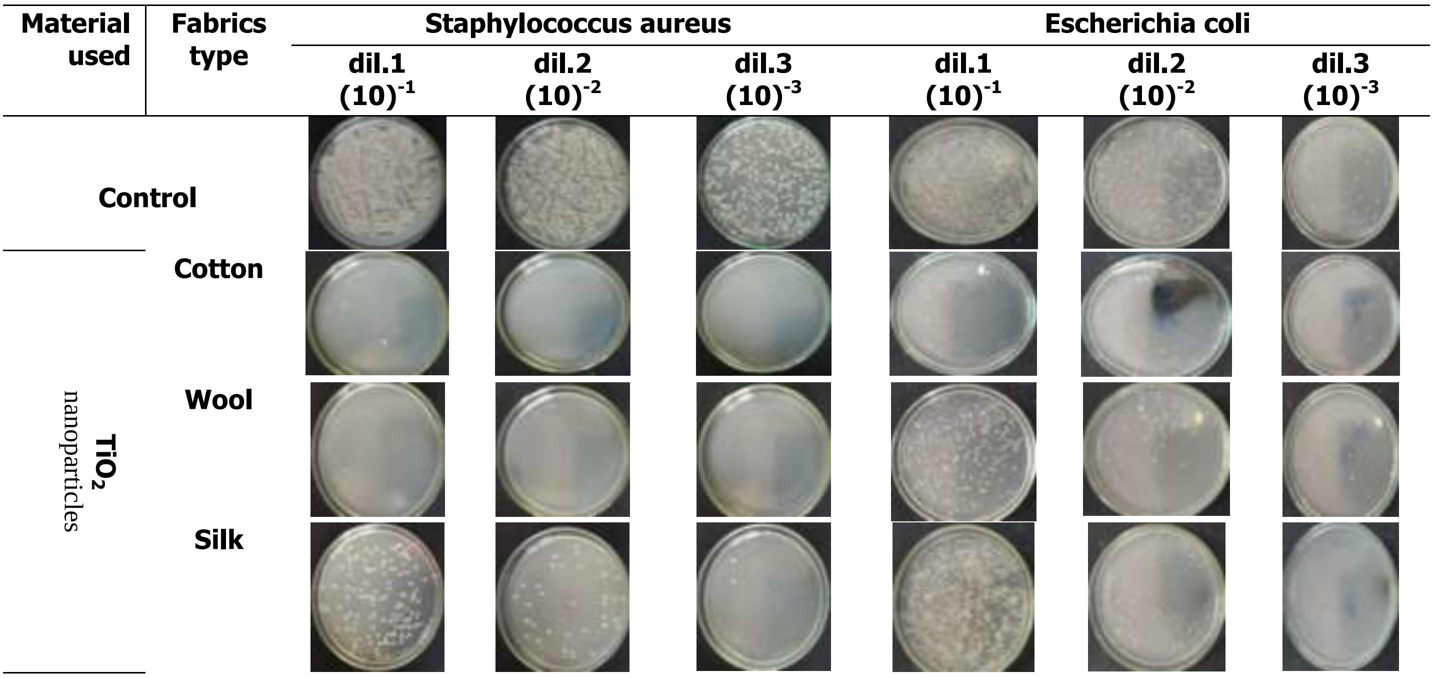


Fig.4. Antibacterial activity of natural fabrics by TiO_2 nanoparticles

Effect of biotreatment on Color strength (K/S value) of fabrics:

The results of the effects of TiO_2 nanoparticles pretreatment, simultaneous and post treatment process on K/S samples of cotton, wool, and silk printed with turmeric dye were given in Tables (3, 4 & 5) respectively.

Table 3. Effect of pretreatment of natural fabrics treated byTiO_2 nanoparticleswith turmeric dye

NO	Types of fabrics	Materials used	
		TiO_2Nano particles	
		Conc.%	**K/S**
1	**Cotton 100%**	Without	2.38
		0.5%	2.47
		1%	2.24
		1.5%	3.72
		2%	3.87
2	**Wool 100%**	Without	2.52
		0.5%	4.89
		1%	5.22
		1.5%	3.16
		2%	2.79
3	**Silk 100%**	Without	2.75
		0.5%	2.76
		1%	2.76
		1.5%	3.12
		2%	2.98

Table 4. Effect of simultaneous treatment of natural fabrics treated byTiO_2 nanoparticles with turmeric dye

NO	Types of fabrics	Materials used	
		TiO_2 Nano particles	
		Conc.%	**K/S**
1	**Cotton 100%**	Without	2.38
		0.5%	3.06
		1%	2.89
		1.5%	2.47
		2%	2.98
2	**Wool 100%**	Without	2.52
		0.5%	2.66
		1%	2.16
		1.5%	2.14
		2%	1.91
3	**Silk 100%**	Without	2.75
		0.5%	3.61
		1%	3.03
		1.5%	3.35
		2%	3.32

Table 5. Effect of post treatment of natural fabrics treated byTiO_2 nanoparticles with turmeric dye

NO	Types of fabrics	Materials used	
		TiO_2 Nano particles	
		Conc.%	K/S
1	Cotton 100%	Without	2.38
		0.5%	2.09
		1%	2.73
		1.5%	2.01
		2%	2.18
2	Wool 100%	Without	2.52
		0.5%	2.49
		1%	2.38
		1.5%	2.33
		2%	1.82
3	Silk 100%	Without	2.75
		0.5%	2.43
		1%	1.81
		1.5%	2.18
		2%	1.98

The highest K / S were achieved when pretreated wool fabrics with TiO_2 NPs at a concentration of TiO_2 NPs(1 % W.O.F) it achieves 5.22 values compared with 2.52 of the untreated sample, While increasing the concentration more or less than that has no noticeable effect. It is also clear from the data that the color strength of pretreated cotton, wool, and silk fibers have high value of color strength which demonstrates that pre-treatment is effective in increasing the absorption of curcuma dye, as the positive polymers transfer a positive charge to the surface of the fibers, providing active sites for anionic moieties such as phenolic compounds in the turmeric dye. TiO_2 NPs can easily achieve an improvement in the cellulosic surface by introducing a + charged surface, which in one sense creates a similar condition to protein fabrics that ended with an increase in the printability of these fabrics (Xin *et al.*, 2004)

Titania OH + Cell.OH $\xrightarrow{\text{heat}}$ Nano-TiO_2- Loaded cotton fabric

Titania OH + H2N.CHR.COOH $\xrightarrow{\text{heat}}$ Nano-TiO_2- Loaded protein fabric

Effect of biotreatment on Color fastness of fabrics:

The printed samples treated with TiO_2 nanoparticles by turmeric dyes for all treatment method which acquire the highest K/S were chosen and subjected to overall color fastness measurements.

Color Fastness to Washing

Table (6) shows the various fastness categories (washing, rubbing, alkali perspiration, acid perspiration, and light fastness) of treated printing fabrics using TiO2 nanoparticles with turmeric natural dye. The results showed that the printed cotton fabrics show increase in wash fastness with TiO2 nano particles. The printed wool and silk fabrics show good wash fastness where the color change was found from 3-4 to 4-5 and from 3-4 to 4for TiO2 nanoparticles

Color Fastness to Perspiration

The colorfastness to Perspiration of printed samples treated with TiO_2 nanoparticles showed more stability of acidic perspiration than alkaline in discoloration of printed fabrics that’s due to Curcuma is stable at an acidic pH but unstable at an alkaline pH and in the presence of light, and under these conditions the main hydrolysis product of curcuma is via 6- (40-Hydroxy-30-methoxyphenyl) -2,4-dioxo-s-hex, in While the minor degradation products are vanillin, ferulic acid, and feruloyl methane (Zhu, 2009). Also showed excellent stability against staining on cotton, and wool fabrics (Table 6).

Color Fastness to Rubbing

The results in Table (6) indicated high color fastness of rubbing for all printed fabrics treated with TiO_2 nano particles. This shows that the majority of the dye molecules are well anchored to the fibers and that the remaining surface dye molecules are minimal. The result may also be that the dye molecules formed bonds between the molecules with the treated material and fabrics as mentioned before.

Color Light fastness.

The light fastness of the samples printed with turmeric and treated with TiO_2 nano particles in (Table 6) showed poor light stability, That’s due to curcuma is unstable the presence of light where it is degraded to ferulic acid and feruloyl methane (Mondal and Soumen, 2012), with regard to photocatalytic dye degradation, the dye removal and degradation are attributed to both the dye's interaction with the positive active sites and ROS, the TiO_2 NPs are cationic in nature and the curcuma dyes are anionic in nature that facilitate NPs and the dye reaction. On contact, the ROS generated causes the degradation of the organic dye (Majid and Samaneh, 2012).

Table 6.Effect of TiO_2 Nano particles on color fastness values of natural fabrics printed with curcuma dye

Type of fabric	Material	Treatment method	*Con.*	Washing fastness			Perspiration fastness						Rubbing fastness		Light fastness
				Alt.	St. (C)	St. (W)	acidic			alkaline			dry	wet	
							Alt.	St. (C)	St. (W)	Alt.	St. (C)	St. (W)			
TiO_2 Nano particles	Cotton 100%	*without*	0	4	4-5	4	4	4	4-5	4	4	4	4-5	3	1
		Pretreatment	2%	4	4	3-4	5	5	5	4	4	4	4	3-4	2
		Simultaneous Treatment	0.5%	4	4	4	5	5	5	4	4	4	4-5	4	1
		Post treatment	1%	4	4	4-5	4	4	4-5	4-5	4	5	5	4-5	1
	Wool 100%	without	0	3-4	4	3-4	4	4	4	5	5	5	3-4	2-3	1
		Pretreatment	1%	4	4-5	3-4	5	5	5	4-5	4-5	4-5	4	3	1
		simultaneous treatment	0.5%	4	4-5	3-4	5	5	5	5	5	5	5	4	1
		post treatment	0.5%	4	4	3-4	5	5	5	4-5	4-5	4-5	5	4	2
	Silk 100%	without	0	4	4	3-4	4	4	4	4	4	4-5	4	3	1
		Pretreatment	1.5%	4	4	4	4	3-4	4-5	3-4	3-4	4-5	3-4	4	1
		simultaneous treatment	0.5%	3	3-4	3	4	4	4-5	4-5	4-5	4-5	3-4	4	1
		post treatment	0.5%	4	4	3-4	4	5	4	4	4-5	4	5	4-5	1

Measurement of UPF Printed Fabrics:

It is clear from the data that printed cotton showed poor UV protection degree after treatment with TiO_2 NPs. Treated printed wool with TiO_2 NPs showed slightly decrease protection by AS/NZ S43991996 and Test Method 1832010 respectively. This could be due to blocking of interstices of fabric. Treated silk showed decrease in UV protection by AS/NZ S43991996 and Test Method 1832010 by TiO_2 nano particles.

Table 7.Effect of TiO_2 Nano particles on UPF of natural fabrics printed with curcuma dye

Treatment material	Type of fabric	Sample test	UPF	
			AS/NZ S43991996	Test Method 1832010
TiO_2 Nano particles	Cotton 100%	control	4.0	4.0
		Pretreated 2%	4.4	4.4
	Wool 100%	control	124.9	119.1
		Pretreated 1%	117.1	112.1
	Silk 100%	control	5.7	5.7
		Simultaneous treated 0.5%	5.6	5.6

Conclusion

The K/S value of the treated printed fabrics with TiO_2 NPs give higher results with curcuma dyes. All treated fabrics have high fastness values for washing, perspiration, and rubbing. All treated fabric printed with curcuma show low light fastness properties. Treated printed cotton fabrics showed a significant decrease in UV protection with TiO_2 NPs. Also, Treated wool fabrics are more tensile strength and elongation than cotton and silk fabrics with TiO_2 NPS.The turmeric dye was suitable as an antibacterial agent for E. coli and S. aureus microorganisms.

Acknowledgments

The authors are grateful to the anonymous reviewers for providing constructive comments and suggestions to improve this article. All the respect and thanks to my supervisor to read the manuscript.

REFERENCES

Abd El-Thalouth, J.I. and Mashaly, H.M. (2016). Imparting multi-functional performance on cellulosic fabrics via nanotechnology. Int. J. Innov. Appl. Stud., 18(1): 140-153.

Abdel-Wareth, M.T.; El-Hagrassi, A.M.; Abdel-Aziz, M.S.; Nasr, S.M. and Ghareeb, M.A. (2019). Biological activities of endozoic fungi isolated from *Biomphalaria alexandrina* snails maintained in different environmental conditions. Int. J. Environ. Stud., 76(5):780-799.

De Santis, D. and Moresi, M. (2017). Production of alizarin extracts from *Rubia tinctorum* and assessment of their dyeing properties. Industrial Crops and Products, 26(2): 151-162.

Goyal, P.; Kumar, V. and Sharma, P. (2008). Cyanoethylation of tamarind kernel powder. Starch-Stärke, 60(1):41-47.

Gupta, N.R.; Wadgaonkar, P.P.; Rajamohanan, P.R.; Ducouret, G.; Hourdet, D.; Creton, C. and Badiger, M.V. (2015). Synthesis and characterization of PEPO grafted carboxymethyl guar and carboxymethyl tamarind as new thermo-associating polymers. Carbohydrate Polymers, 117:331-338.

Imran, M.; Crowley, D.E.; Khalid, A.; Hussain, S.; Mumtaz, M.W. and Arshad, M. (2015). Microbial biotechnology for decolorizationof textile wastewaters. Rev. Environ. Sci. Biotechnol., 14(1):73-92.

Jordão, C.; Puppim, R. and Broega, A.C. (2018). Solutions notes on clean textile waste. Int. Conference on innovation, engineering and entrepreneurship, Cham., Springer, pp. 682-689.

Kamat, P.V. (2002). Photophysical, photochemical and photocatalytic aspects of metal nanoparticles. J. Phys. Chem., B, 106(32):7729-7744.

Kasiri, M.B. and Safapour, S. (2013). Natural dyes and antimicrobials for textiles. In: Green Materials for Energy, Products and Depollution , Springer, Dordrecht, pp. 229-286.

Lellis, B.; Fávaro-Polonio, C.Z.; Pamphile, J.A. and Polonio, J.C. (2019). Effects of textile dyes on health and the environment and bioremediation potential of living organisms, Biotechnol. Res. Innov., 3(2):275-290.

Majid, M. and Samaneh, H. (2012). Textile with immobilised nano titanium dioxide for repeated discoloration of CI Reactive Black 5 under UV-A. Coloration Technol., 128(5): 403-409.

Mondal, S. and Soumen, G. (2012). Role of curcumin on the determination of the critical micellar concentration by absorbance, fluorescence and fluorescence anisotropy techniques. J. Photochem. Photobiol., B Biology, 115 :9-15.

Orts, F.; del Río, A.I.; Molina, J.; Bonastre, J. and Cases, F. (2018). Electrochemical treatment of real textile wastewater:Trichromy Procion HEXL®". J. Electroanalyt. Chem., 808:387-394.

Qian, L. and Hinestroza, J.P. (2004). Application of nanotechnology for high performance textiles. J. Text. Apparel, Technol. Manag., 4(1):1-7.

Ragheb, A.A.; Tawfik, S.; Abd-El Thalouth, J.I. and Mosaad, M.M. (2017). Development of printing natural fabrics with curcuma natural dye via nanotechnology. Int. J. Pharmaceut. Sci. Res., 8(2):611-620.

Samal, S.S.; P. Jeyaraman, and Vinita, V. (2010). Sonochemical coating of Ag-TiO_2 nanoparticles on textile fabrics for stain repellency and self-cleaning-the indian scenario a review. J. Minerals and Materials Characterization and Engin., 9(06) : 519.

Samanta, A.K. and Konar, A. (2011). Dyeing of textiles with natural dyes. Natural dyes, 3: 30-56.

Saxena, S. and Raja, A.S.M., 2014. Natural dyes: sources, chemistry, application and sustainability issues. In: Roadmap to sustainable textiles and clothing (pp. 37-80). Springer, Singapore.

Setiadi, T.; Andriani, Y. and Erlania, M. (2006). Treatment of textile wastewater by a combination of anaerobic and aerobic processes: A denim processing plant case. In: S. Ohgaki; K. Fukushi; H. Katayama; S. Takizawa and C. Polprasert (Eds.), Southeast AsianWater environment 1, Oxford: IWA Publishing, , Bangkok, Thailand, pp. 159-166.

Wong, Y.W.H.; Yuen, C.W.M.; Leung, M.Y.S.; Ku, S.K.A. and Lam, H.L.I.(2006). Selected applications of nanotechnology in textiles. AUTEX Rese. J., 6(1):1-8.

Xin, J.H.; Daoud, W.A. and Kong, Y.Y. (2004). A new approach to UV-blocking treatment for cotton fabrics. Textile Res. J., 74(2):97-100.

Zhu, Q.G. (2009). Studies on prospect of curcumin as an analytical reagent for aluminium. Unpublished master's thesis, Universiti Sains Malaysia, Pulau Pinang

تخليق فعال لجسيمات ثانى اكسيد التيتانيوم النانوية وتطبيقاته على الأقمشة الطبيعية المطبوعة بصبغة الكركم

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المستخلص

النشاط التحفيزي الضوئي ، وعدم السمية ، والتوافق الحيوي ، والتكلفة المنخفضة تجعل جسيمات ثانى اكسيدد التيتانيوم النانوية جذابة بشكل أساسي للصناعات المختلفة ذات القيمة المضافة العالية. تهدف هذه الدراسة إلى استخدام تقنية جسيمات ثانى اكسيد التيتانيوم النانوية فى طباعة الألياف الطبيعية باستخدام صبغة الكركم لتحقيق استدامة البيئة للأجيال القادمة ، وتقليل التلوث الناتج عن طباعة المنسوجات ، التغلب على أضرار استخدام الملونات الاصطناعية والمكثفات الاصطناعية والألياف الاصطناعية على التوازن البيئي وصحة الإنسان الى جانب التكلفة المنخفضة لهذه التقنية. تستخدم الصبغة الطبيعية البيئية (صبغة الكركم) والمكثف الطبيعي (مثخن التمر الهندي) لإنتاج معجون طباعة طبيعي مع لزوجة مناسبة لطباعة الأقمشة الطبيعية عن طريق طباعة الشاشة الحريرية المسطحة. تم في هذا البحث استخدام ثلاث طرق متنوعة لمعالجة الأقمشة ، وهي المعالجة المسبقة والمعالجة المتزامنة والمعالجة اللاحقة بجزيئات النشاط التحفيزي الضوئي ، وعدم السمية ، والتوافق الحيوي. تم استخدام جسيمات ثانى اكسيد التيتانيوم النانوية بتركيزات متفاوتة (0.5٪ ، 1٪ ، 1.5٪ ، و 2٪ من وزن الخامة). تم تحضير الجزيئات النانوية باستخدام تقنية sol-gel. وتم تحليل الجسيمات النانوية المحضرة باستخدام المجهر الماسح الإلكتروني (SEM) ، والمجهر الإلكتروني (TEM) ، و قياس قوة الشد والاستطالة ، والحماية البكتيرية ، وقيم قوة اللون K / S ، وخصائص الثبات ، وعامل الحماية من الأشعة فوق البنفسجية .

أظهرت النتائج أن قيم قوة اللون للعينات المعالجة أعلى من العينات الأصلية ، وان جميع الأقمشة المعالجة تحتوى على قيم ثبات مفرطة للغسيل والتعرق والاحتكاك لكن جميع الأقمشة المُطبوعة بالكركم تُظهر خصائص ثبات منخفضة للضوء وارتفاع في مقاومة الشد للأقمشة. كما إن الجمع بين هذه الجسيمات النانوية في بنية الأقمشة الطبيعية يخلق منتجًا نهائيًا مضادًا للبكتيريا. وقد وجد ان قيم UPF لجميع عينات الأقمشة المطبوعة المعالجة أعلى من تلك الفارغة. وقد خلص البحث الى هذه التقنية النانوية قد أدت الى تحسين الخصائص الوظيفية والخصائص الصحية وقيمة الأقمشة الناتجة مع الحفاظ على التوازن البيئي من خلال التغلب على خصائص الثبات المنخفضة ومن خلال معالجة الأقمشة بمواد خضراء. كما أدت الى زيادة متانة الأقمشة الطبيعية المعالجة وعمر الخامة الافتراضي. كما ان الأقمشة المطبوعة التي تم الحصول عليها تقدم عاملًا مضادًا لبكتيريا المكورات العنقودية الذهبية والإشريكية القولونية مع امكانية الحماية من الأشعة فوق البنفسجية.