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IMPROVING THE DYEABILITY AND THE ANTI MICROBIAL ACTIVITY OF WOOL FABRICS PRETREATED WITH NATURAL PRODUCTS AND DYED WITH TURMERIC NATURAL DYE USING NANOCHITOSAN

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Abstract

Textile processing offers a method by which defects in textiles can be introduce certain properties. Antimicrobial treatments have gained in an importance for the textile material. Woolen fabrics have been dyed with natural dye obtained from turmeric using a traditional process. The fastness properties including light and washing of colored fabrics were evaluated. The color strength (K / S) of woolen fabrics show that pretreatment with nanochitosan is more effective than untreated. The pH values, temperature and duration of the dye bath for woolen fabrics were investigated. The antimicrobial activity of curcumin obtained from Curcuma long a can serve as a suitable alternative natural product as an environmentally friendly antimicrobial finishing agent and used as medical herb with different pharmacological applications. It is used in woolen fabrics in lieu of harmful chemicals. The investigation of the antimicrobial activity of curcum in showed the ability to inhibit gram-positive and gram-negative and exhibited a remarkable effectiveness against *Staphylococcus aure us* and *Escherichia coli* as well as an isolate of the pathogenic fungus *As pergillus niger.*
Therefore, the present study was carried out with the aim of extracting and applying environmentally and eco-friendly natural dyes from fresh and dry curcumin to woolen fabrics. In addition, the study deals with the effect of the staining and coloring properties of curcumin on woolen fabrics.

Keywords: Curcumin, nanochitosan, wool fabrics, finishing agent, antimicrobial activity.

1. Introduction

Textile dyeing can be summarized as the relatively simple application of dyes to a substrate for various textile materials. The dyeing process encompasses a number of processes, includes dyeing, pigmenting, and printing, and is used in various textile finishing applications. Natural dyeing is practiced today by hand, weavers and knitters use natural dyes as a special element in their work [1,2]

Natural dyes have a good durability and color. Some of the benefits are that they are antiallergic and have been shown to be safe to use in physical contact. The most

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natural colored materials are non-toxic. Natural dyes include all dyes from plants, insects, and minerals that are used in various types of textiles. Most natural dyes are safe to the environment for humans around the world [3,4].

The structure of wool contains a covalently bound layer of fat, which increases the hydrophobicity of the wool. It also contains protease, which catalyzes the breakdown of various components in wool fabrics and is the most common antimicrobial used in fabrics. Nowadays textile process prefers environmentally friendly chemicals to give textiles an antimicrobial finishing agent [5].

Natural colors are global because most environmentally friendly sources should see their application as a better alternative that is comparable to the synthetic dyes. Curcumin plants as natural substances that are used in the dyeing of textiles and are known as versatile medicinal plants have an antibacterial effect against various microorganism [6,7].

In addition, chitosan [poly-1 (1-4) -d-glucosamine] is a cationic polysaccharide compound. Chitosan has many uses in medicine, cosmetics, agriculture, biomaterials, and drug-controlled release systems. Several studies show that chitosan also has many clinical uses [8-10]. It has been used as an antibacterial agent against various strains of bacteria and fungi due to the presence of ionic bonds on the cell surface. Because chitosan and its derivatives are the most effective antibacterial agents and are used as finishing agents for antibacterial textiles as finishing agents [11,12].

Chitosan is a natural compound extracted from the chitin in the shells of crustaceans. The beneficial properties of chitosan are non-toxicity, biocompatibility, biodegradability, antimicrobial activity and chemical reactivity. Chitosan and nanochitosan are therefore polymeric compounds which, due to their functional groups, enable surfaces with high antibacterial properties and which could be used as a potential source for the textile industry [13-15].

In the present work we investigate the activity of curcumin for the treatment of wool fabrics in order to investigate the antimicrobial properties of curcumin for the treatment of wool fabrics as an important active ingredient. The benefits of curcumin are a simple process and an environmentally friendly product for dyeing textiles.

2.Materials and Methods

2.1. Wool fibers**:** Wool fibers10/2, supplied by El Mahalla company-Egypt.

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2. 2. Chemicals:
Chitosan high molecular weight (210,000), Poly (D-glucose amine).Tannic acid are laboratory grade chemical, non-ionic detergent (hostapal CV. ET, Hochest)

2.3. Extraction of natural coloring matter:
Curcuma Longa (turmeric) was ground and crushed into a light yellow powder form. The dye was then boiled using (20-100 g of the powder in 1000 ml of water) then , boiled for two hours. Finally the solution was filtered off and allowed to cool.

Extraction conditions: Dye conc.: 20/40/60/80 g/L-
Time: 2 hours
Temp.: 100 ^{O}C
Dyeing conditions: Time: 60 min.-
Temp.: 100 ^{O}C

2.4. Dyeing method:
Dyeing of wool fabrics:
Wool fabric samples (2 g each) were dyed with the natural dye from Curcuma Longa (turmeric) in a liquor ratio of 1:50. Dyeing was carried out at 100 ° C for 60 minutes. The wool samples were placed in the dye solution in a water bath at 40 ° C and then heated to 100 ° C. The fabrics were dyed for 60 minutes and the dyed samples were rinsed with cold water and washed in a 3g / L nonionic detergent bath at 30 ° C for 15 minutes. Finally the fabrics were rinsed and air dried.

3.Antimicrobial activity measurements
The antimicrobial activity was performed on several types of bacteria strains as *Staphylococcus aureus* and *Escherichia coli*as well as one isolate of pathogenic fungi such as *As per gillusnige*r using disk diffusion assay.

3.1.Serial dilution method:

1gm of each fiber sample was added to 99ml sterile distilled water to form the stock solution (blank) at conc.10^{-1} from which serial dilutions(10^{-1} to 10^{-5})were prepared. To investigate and counting the bacterial strains Nutrient Peptone Agar (NPA) media was used. Testing of the fungal strains potato dextrose agar (PDA) media was selected. 0.1 ml from each dilution (10^{-1}- 10^{-5}) was spread on previously sterilized petri-plates and used in triplicates according to the standard spread plate technique, for both bacterial and fungal strains. The (NPA) plates were then incubated at 37 °C for 24 hf and the PDA plates were incubated at 27 °C for 72 h. After successful growth of microorganisms, characteristics of each distinct colony, e.g., shapes, color,

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transparency, etc. were determined. Gram stain was performed to observe the cellular morphology and gram reaction of the bacteria. The number of bacterial and fungal colonies in the fiber samples was counted and the density was expressed as Colony Forming Units (CFU). The antimicrobial activity was estimated and expressed as reduction in total count of fungi and bacteria in each treatment. Two isolates of pathogenic bacteria, *Staphylococcus aureus* and *Escherichia coli*as well as one isolate of pathogenic fungi *Aspergillus niger*[16,17].

4.Results and discussion:

4.1.Effect of extraction temperature of natural coloring matter extracted from Curcuma Longa (turmeric):

The results in Table 1 and Figure 1 show that the color strength of pretreated wool fabrics with nano-chitosan is higher than that of untreated ones. The color strength increases with increasing extraction temperature, both in the case of treated and untreated substances fabrics. The colorimetric data also improved as the extraction temperature increased, as shown in Table 1.

Table 1*: Effect of extraction temperature of natural coloring matter extracted from Curcuma Longa (turmeric)on color strength and colorimetric data of untreated and treated dyed wool fabrics using nanochitosan.*

Samples	***extraction temperature(^oC)***	***K/S***	***L****	***a****	***b****	***∆E***
Blank (undyed wool fabrics)		***1.07***	***86.25***	***0.61***	***14.34***	***0***
Untreated dyed wool fabrics	***60***	***13.58***	***64.30***	***7.13***	***36.45***	***34.02***
	70	14.80	64.41	7.53	39.79	36.37
	80	14.51	63.07	7.55	39.06	36.76
	90	15.05	62.25	7.98	39.03	37.41
	100	20.04	57.32	8.50	42.05	42.2
Dyed wool fabrics Pre-treated with nanochitosan	60	13.20	58.34	7.39	36.18	38.31
	70	13.40	57.17	7.03	38.39	40.48
	80	14.04	55.69	8.13	38.06	41.64
	90	15.53	59.77	6.05	40.92	40.05
	100	25.22	50.66	12.2	53.22	47.63

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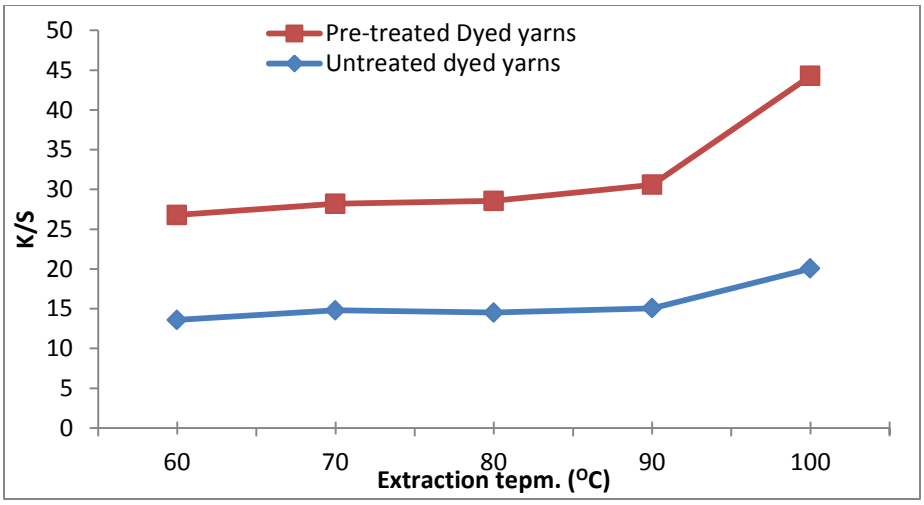

Fig. 1: Effect of extraction temperature of natural coloring matter extracted from Curcuma Longa (turmeric)on color strength of untreated and treated dyed wool fabrics using nanochitosan**.**

4.2.Effect of extraction time of natural coloring matter extracted from Curcuma Longa (turmeric) :

The results in Table 2 exhibited that the color strength of pretreated wool fabrics with nano-chitosan is higher than that of the untreated. The color strength value at 120 minutes is the highest value for treated and untreated fabrics. The colorimetric data are also improved by the treatment.

Table 2: ***Effect of extraction time of natural coloring matter extracted from Curcuma Longa (turmeric)on color strength and colorimetric data of untreated and treated dyed wool fabrics using nanochitosan.***

Samples	extraction time (min.)	K/S	L*	a*	b*	ΔE
Blank (undyed wool fabrics)		1.07	86.25	0.61	14.34	0
Untreated dyed wool fabrics	30	25	45	15	22	50
	60	14	44	14	21	49
	90	16	60	11	20	50
	120	20.04	57.32	8.20	42.05	42.2
Dyedwool fabrics Pre-treated with nanochitosan	30	18	55	8	45	40
	60	22	45	11	50	47.4
	90	23	49	12	52	48.5
	120	24.2	50.66	12.2	53.22	49.6

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4.3.Effect of concentration of natural coloring matter extracted from Curcuma Longa (turmeric):

The results in Figure 1 showed that the color strength of pretreated wool fabrics with nano-chitosan is higher than that of untreated woolen fabrics. The color strength value at concentration 80g/ L is the higher value for both treated and untreated fabrics.

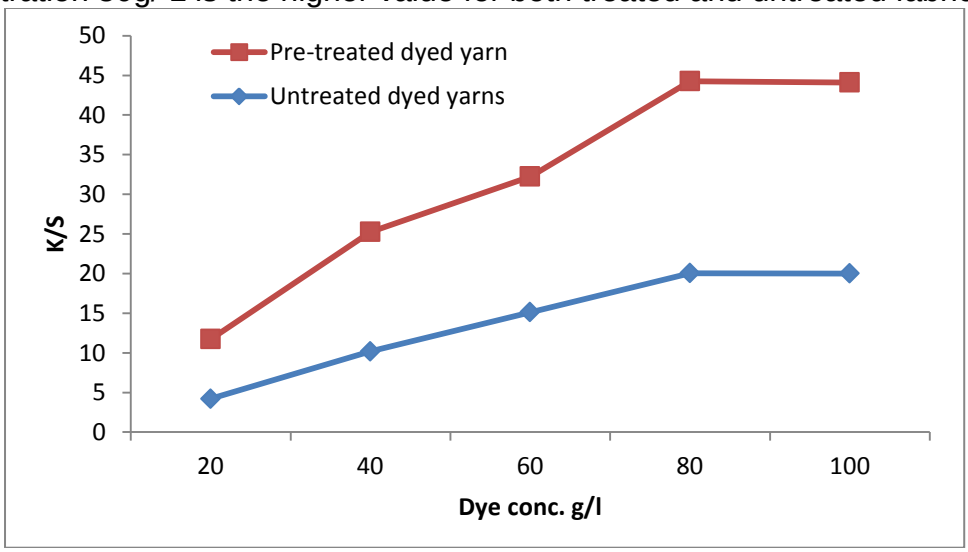

Fig. 2: Effect of concentration of natural coloring matter extracted from Curcuma Longa (turmeric) on color strength of untreated and treated dyed wool fabrics with nanochitosan.

4.4.Effect of concentration of Turmeric natural dyeand colorimetric data:.

It is clear from Table 1 that the effect of the treatment increases the color difference in wool fabrics dyed with natural turmeric dye.

Table 3:*Effect of concentration of turmeric natural dye colorimetric data of untreated and treated dyed wool fabrics with nanochitosan.*

The lightness (L*) decrease from 85 0f blank to 58.93 for dyed fabric by increasing concentration of dye till 100g/L and 50.09 for dyed wool fabrics Pre-treated with nanochitosan . .

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Samples	Dye conc. g/L	L*	a*	b*	ΔE
Blank (undyed wool fabrics)		85.	0.64	14.4	0
Untreated dyed wool fabrics	20	72.6	2.91	26.73	18.5
	40	63.9	5.4	34.66	32.76
	60	62.01	7.04	40.14	38.13
	80	58.3	9.20	42.05	42.25
	100	58.93	7.93	41.20	41.33
Dyed wool fabrics Pre-treated with nanochitosan	20	60.48	5.2	30.0	31.8
	40	58.67	7.35	43.10	42.55
	60	52.04	9.25	48.49	45.61
	80	50.66	12.2	53.22	49.63
	100	50.09	13.93	52.77	48.9

4.5.Effect of pH of turmeric natural dye and colorimetric data:

The result in Table 4 and Figure 3 shows that the pH value 5 is the best value for both treated and untreated wool fabrics. It should also be noted that the K / S value for treated fabrics is higher than for untreated fabrics at the same pH value. The colorimetric data are also improved as a result of the treatment and gave the highest values at acidic pH.

Table 4: ***Effect of pH of untreated and treated dyed wool fabrics using nanochitosan with natural coloring matter extracted from Curcuma Longa (turmeric)on color strength and colorimetric data***

Samples	pH	K/S	L*	a*	b*	ΔE
Blank (undyedwool fabrics)		1.07	86.2	0.61	14.3	0
Untreated dyed wool fabrics	3	28.2	46.91	15.1	52.45	57.02
	5	34.9	44.63	15.40	48.67	57.7
	9	11.05	60.61	8.76	3.05	32.56
Dyedwool fabrics Pre-treated with nanochitosan	3	32.89	48.23	14.24	54.41	56.56
	5	39.92	45.61	15.39	49.32	55.97
	9	23.06	48.91	9.4	34.93	43.8

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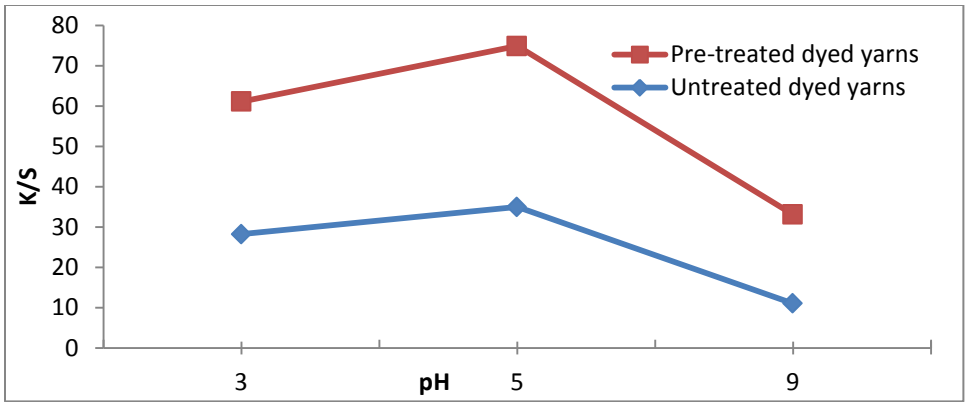

Fig. 3: Effect of pH of untreated and treated dyed wool fabrics using nanochitosan with natural coloring matter extracted from Curcuma Longa (turmeric)on color strength

4.6.Effect of time of dyeing of untreated and treated dyed wool fabrics:

Despite the color strength is higher when 90 and 120 minutes are used, but the color changes from bright yellow to a dull greenish-yellow color as shown in Table 5. The results in Figure 4 indicated that the color strength of pretreated wool fabrics with nano-chitos an is higher than that of untreated wool fabrics. The color strength value at 120 minutes is the highest value for treated than untreated fabrics.

Table 5:*Effect of time of dyeing of untreated and treated dyed wool fabrics using nanochitosan with natural coloring matter extracted from Curcuma Longa (turmeric)on color strength and colorimetric data*

Samples	Time (min.)	K/S	L*	a*	b*	ΔE
Blank (undyedwool fabrics)		1.08	86.2	0.61	14.3	0
Untreated dyed wool fabrics	30	18.0	59.04	9.2	48.49	46.61
	60	23.04	58.32	8.20	42.05	40.25
	90	27.88	41.06	10.64	34.36	51.84
	120	30.5	39.66	10.50	32.3	52.45
Dyedwool fabrics Pre-treated with nanochitosan	30	19.05	62.46	16.74	71.71	63.27
	60	24.22	50.66	12.23	53.22	49.63
	90	29.64	38.50	10.80	32.51	53.59
	120	34.04	40.3	10.09	33.5	52.10

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Effect of time of dyeing of untreated and treated dyed wool fabrics using nanochitosan with natural coloring matter extracted from Curcuma Longa (turmeric):

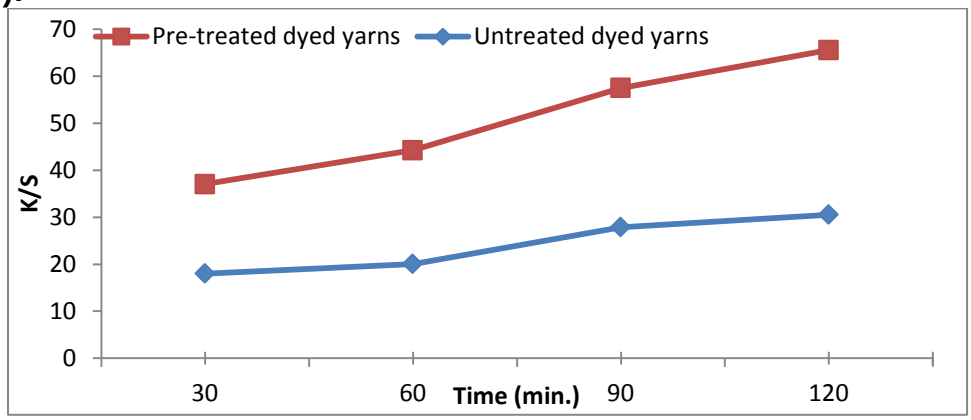

Fig. 4: Effect of time of dyeing of untreated and treated dyed wool fabricsusingnanochitosan with natural coloring matter extracted from Curcuma Longa (turmeric)on color strength

4.7.Effect of dyeing temperature of Turmeric natural dye and colorimetric data:
The results in Table 6 and Figure 5 show that the color strength of pretreated wool fabrics with nano-chitosan is higher than that of untreated. The color strength increases with increasing dyeing temperature, both for treated and untreated fabrics up to 100 ° C. The colorimetric data also improved as the dyeing temperature increased, as shown in Table 5.

Table 6: ***Effect of temperature of dyeing of untreated and treated dyed wool fabrics using nanochitosan with natural coloring matter extracted from Curcuma Longa (turmeric)on color strength and colorimetric data***

Samples	Temperature (C^o)	K/S	L*	a*	b*	ΔE
Blank (undyedwool fabrics)		1.07	86.25	0.61	14.34	0
Untreated dyed wool fabrics	40	9.92	66.82	5.92	51.39	44.04
	70	18.16	61.77	14.00	68.50	60.08
	100	20.04	55.32	8.20	42.05	42.2
Dyedwool fabrics Pre-treated with nanochitosan	40	12.74	63.26	6.93	41.06	19.16
	70	20.12	58.67	7.3	43.10	42.5
	100	25.22	50.66	12.2	53.22	49.6

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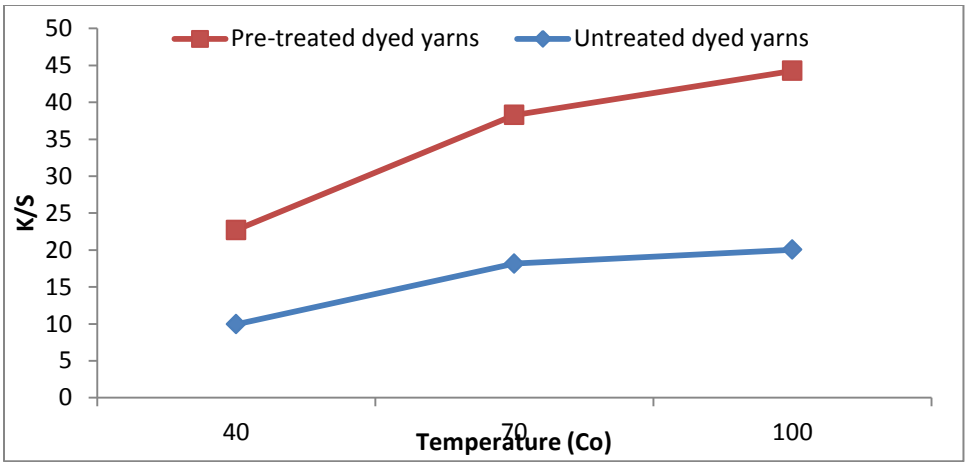

Fig. 5: Effect of temperature of dyeing of untreated and treated dyed wool fabrics using nanochitosan with natural coloring matter extracted from Curcuma Longa (turmeric)on color strength

5.Antimicrobial activities of wool fabrics

The effect of the concentration of natural colorings from Curcuma Longa (turmeric) was studied. In the present study, we used curcumin as a naturally occurring compound that showed promising good antibacterial activity against multiple strains of bacteria. The main goal of the work is to extract and purify the curcumin as a natural coloring agent from the Curcuma Longa L. As a natural plant, it was used to dye the woolen fabric. The application of curcumin has been successfully carried out on woolen fabrics by the exhaustion method. The antibacterial activity of the curcumin treatment of wool fabric was examined by calling up the effectiveness on the finishing after different concentrations. The extraction of natural dyes and their use may be of great importance for commercial and domestic dyeing in the future. The cost of dye processing is certainly lower than other synthetic dyes used in textiles. Antimicrobial agents are protective agents which, as bacteriostatic, bactericidal, fungi static and fungicidal, offer special protection against the various types of textile [18-20].

The antimicrobial activity was applied to woolen fabrics with curcumin extract in different concentrations. The wool fabrics have been refined. The antimicrobial activity of the control and finished samples was determined using the test method AATCC-100-2004. In order to determine the bacterial count of treated and untreated samples, the bacterial growth in inoculated and incubated samples was determined by serial dilution. The antimicrobial activity on the curcumin treated wool fabric samples showed good activity and improved the properties of the wool fabrics. As the concentration of the extracted color of curcumin increases, bacteria reduction has also increased and the curcumin has been used as an antimicrobial agent in addition using nano-chitosan as an antimicrobial agent. The antimicrobial finish was given to wool fabrics by applying the

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nano-chitosan. Several test methods have been developed to determine the effectiveness of antimicrobial textiles. The tests for evaluating the antimicrobial properties can generally be divided into two categories: dynamic shaking test (quantitative method such as serial dilution and plate counting method) and agar diffusion test (qualitative method such as Halo method) [21-24] The antimicrobial activities of fibers stained with a natural dye such as curcumin and nanochitosan were assessed using two standard methods 1 - serial dilution and plate counting method 2-halo method (zone of inhibition).

Table 7 : ***Antimicrobial activities of wool fibres treated with nanochitosan and dyed with curcumin natural dye.***

Samples	Total fungi count cell x 104	Reduction %	Total bacteria count cell x 106	Reduction %
Untreated	7.4	7.5	5.4	16.5
Treated with 20%	3.8	52.5	3.5	37
Treated with 30%	1.2	82.5	2.6	67.
Treated with 40%	0.4	95.0	13	82
Treated with 50%	0.0	100	0.0	100
Wool fabrics undyed (control)	8.0	0.0	6.2	0.0

It was concluded from the above results as shown in table 7. That increasing the extract concentration progressively increased the percentage bacterial reduction. These findings are in agreement with the results that the inhibition zone increases up to 50% of the extract concentration with increasing concentration of the curcumin extract. It was also observed that the exhaust process was more effective for dyeing two isolates of pathogenic bacteria as,*Staphylococcus aureus* and *Escherichia coli*as well as one isolate of pathogenic fungi *Aspergillusniger*[25-28].

Conclusion

The antimicrobial agents are used to prevent serious adverse effects on textile materials such as dye degradation. We have concentrated on researching the antibacterial and antifungal modifications of wool fabrics through the use of natural substances such as curcumin and nanotechnology as environmentally friendly processing in wool textile dyeing and finishing with natural dyes. From the present study, the following conclusions were drawn as follows:

1. When the concentration of the extracted color compound of curcumin increases the bacterial reduction was increased.

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2. The effect of curcumin on wool fabric treated with theextract shows good antimicrobial activity than untreated wool fabric.
3. The antimicrobial activity on the *curcumin*treated wool fabric samples was good activity and was improved the properties of the wool fabrics.
4- Curcumin is used as antibacterial agent has attracted increasing interest for futures work for wool fabric depends on concentration.
5- Curcumin is probable biological applications as an efficient antimicrobial agent for finishing wool fabric for future work for textiles.
6-The antimicrobial show good bacteriostatic reduction rate.
7-The result indicate revolutionary results of antibacterial on wool fabrics as ecofriendly application.
8-The antimicrobial finishing have been imparted on wool fabrics by using nano-chitosan.

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Conflict of interest: the author declares no conflict of interest.

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