Functional Properties for Double Layers Garment Affected by Nano Technology Treatment

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Abstract:

For the body to remain comfortable, the surface moisture must be transferred away from the skin, or it will lead to a buildup of sweat on the skin's surface and interfere with the body's natural cooling mechanism and cause composition of bacteria. The growth of microbes on textiles during use and storage negatively affects the wearer as well as the textile itself. The detrimental effects can be controlled by durable antimicrobial finishing of the textile as nano zinc oxide and bulk titanium dioxide, which also affect the problem of UV radiation to the body skin and prevent degradation of the natural leather due to the exposure to solar UVR.

This article shows the experimental results for antimicrobial finishing, ultra violet protection efficacy before and after washing, and the results were analyzed by using Fourier transform infra-red spectroscopy to shows the alterations on the treatments of natural goat leather and blended woven fabric 50%cotton, 50% polyester using nano zinc oxide and bulk titanium dioxide separately by using Pad –Dry –Cure method under tension.

Keywords:

Nano Zinc Oxide
Titanium Dioxide
FTIR
Textile,
Antimicrobial
Antibacterial
Ultra Violet Protection
Natural Goat Leather
Blended 50% Cotton
50% Polyester Fabric

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1. Introduction:

Layered clothing is particularly relevant in cold climates, where clothing must at the same time transfer moisture, provide warmth, and protect from wind and rain. In a hot and dry climate, clothes have very different functional requirements: they must block the radiation from the Sun, and allow for sufficient air circulation. Outdoor and sportswear manufacturers favor layered clothing because, among other reasons, it allows them to offer so-called "technical" or "functional" clothes which are optimized for the particular demands of a specific layer.(1)

Here we discuss a garment contains two layers are identified as follows:

- **Inner layer** (represent as blended 50%cotton, 50% polyester woven fabric) provides comfort by keeping the skin dry. Also called *base layer* or *first layer*.
- **Outer layer** (represent as natural goat leather) provide protection from wind, water and works as protection from sun harmful ultra violet rays. Also called *shell layer*.

Antibacterial treatment of textiles is usually marketed with the function of preventing odours. Antibacterial substances are substances which are intended to kill or inhibit bacteria. Substances which shall prevent harmful effects of organism on human beings, animals or material are called biocides. Usually, these substances are poisonous and can be associated with health or environmental risks. In garment textiles, there exists a space between the skin and the textile, where it is warm and humid. This is a perfect environment for microorganisms to grow and flourish, given the moisture from sweat and the growing medium of the textile substrate. The textile often harbors food for the microbes in the form of dirt and processing chemicals. Starch warp size especially encourages microbe growth, and thus any greige good which was sized with a starch based size must be treated with an antimicrobial finish if it is going to be transported or stored in relatively high humidity, high temperature conditions. (2,3)

Zinc Oxide and titanium dioxide have recently achieved special attention regarding potential electronic application due to its unique optical, electrical and chemical properties. The advantage of using these inorganic oxide as antimicrobial agent and ultra violet protection is that they contain environmentally safe mineral elements essential to humans. As zinc oxide and titanium dioxide are non-toxic to the consumer and to the environment were selected for this research to provide anti-bacterial and ultra violet ray's protection to the materials for both layers.(4)

Textiles and garments, are treated with

antibacterial substances to avoid unpleasant odors. Smells are built up when sweat and other excretions are metabolized by bacteria. Therefor the garments should breath to keep dry as Bacteria do not grow on dry surfaces and odor-causing bacteria are inhibited, as they cannot metabolize anymore and the garment does not smell. Producers of anti-odor treated materials claim an advantage for the environment, because such textiles need less washing. (5)

Sunshine is good for us as it makes us feel good and chases away the blues. The negative and painful effects, such as sunburn, wrinkles and the risk of developing skin cancer, are the other side sun exposure. It is true that the skin produces the essential, bone-building vitamin D3 with the aid of UVB rays, but no more than a small dose of just 20-30 minutes of sunshine a day is needed. Further exposure to UV radiation is mainly harmful. It can do permanent damage to the skin's local immune system and the skin cells' genetic material (DNA). This is true both of the short-wave UVB rays and also the long-wave UVA rays. The most important natural source of ultraviolet (UV) rays is the sun. Whereas its aggressive UVC rays are almost completely absorbed by the ozone layer, the UVA and UVB rays invisible to the human eye reach the earth and reach everything that lives there. UV radiation can produce varying effects in the human skin depending on its wavelength and intensity. UV-protective garment whose manufacturer claims that it protects from sunlight, including harmful UV light, claims the reduction of risk of skin injury associated with UV exposure, or uses a rating system that quantifies the amount of sun protection afforded and prevent garment material degradation, especially outer layer which influence natural leather ageing. (6)

UV irradiation cause collagen structural degradation as shown below

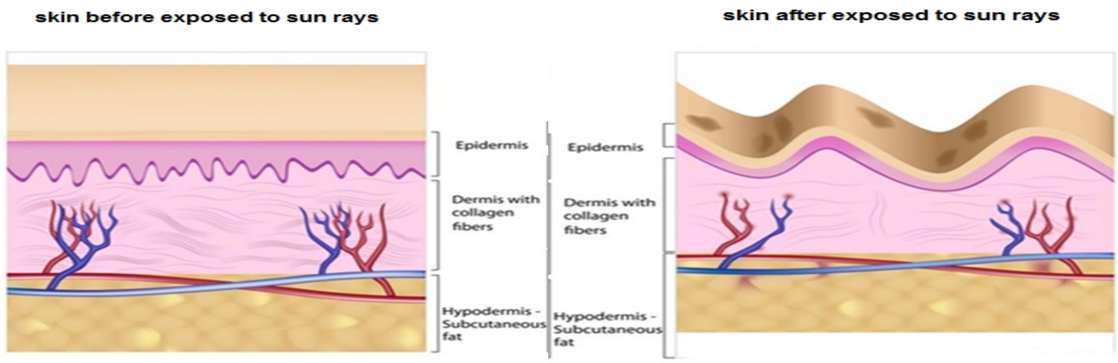

Figure (1)

Collagen Based biomaterials subject to UV Irradiation from sunshine or from artificial sources. Prolonged Exposure to UV Irradiation will cause excessive molecular fragmentation and denaturation which influence the mechanical properties

Different chemical reactions happen in collagen macromolecules during UV irradiation. Short time irradiation results mainly in crosslink within and between collagen chains. Long time irradiation may result in chain scission. The tensile strength, tensile fracture energy and water vapor permeability are slightly increased at the beginning of irradiation, and then followed by a drastic decrease. The hydrothermal stability is impaired due to UV irradiation. The plant extract can endow the collagen with better capability against UV due to the phenolic structure. The number of double bonds of fatliquoring agent influences the UV-resistance Properties of physical modified collagen matrices.(7, 8, 9)

In this work an attempt has been made to apply ZnO nano particles and bulk titanium dioxide to natural goat leather as outer layer and blended cotton/ polyester fabric as inner layer by pad-dry-cure technique. The chemical transformations have been analyzed using Infra-Red (IR).

The changes in functional properties as anti-bacterial and ultra violet protection are tested before and after washing and IR analysis which used to study the surface morphology and structural compositions.

Washing test:

The U.S. Environmental Protection Agency (EPA) has received many inquiries recently about garment cleaners (traditionally known as "dry cleaners") that offer "wet cleaning" services. Wet cleaning is a professional, nontoxic method of cleaning clothes. Unlike conventional dry cleaning, which uses chemical solvents to clean clothes, wet cleaning technologies are water-based. Consumer demand for nontoxic garment cleaning alternatives like wet cleaning is on the rise. This increase is evidenced by the growing number of manufacturers of wet cleaning and other alternative technologies, and by the increasing number of facilities offering wet cleaning services

Wet cleaning is a professional garment cleaning technique that uses detergents and water. Professional cleaners in the 1930s and 1940s wet cleaned about one-fourth of all the garments that came through their shops. Back then, wet cleaning was used mostly on natural fiber garments, trained cleaners are now able to wet clean many garments that have typically been dry cleaned, such as silks, woolens, linens, suedes, and leathers. By concerns about the toxicity of dry cleaning solvents, recent advances in both wet cleaning technology and garment care have revived wet cleaning as a safe alternative to dry cleaning. (10, 11, 12, 13)

2. Materials and Methods:

2.1 Materials

2.1.1 Fabric

The specifications of leather and blended woven fabric are given in table 1. The fabric was procured from local textile market. **Table 1 below shows the** Fabric specifications

Table (1) the material weight and thickness

Sample	Material Specification		
	Weave	Weight GSM	Thickness (mm)
50%Cotton,50%Polyester	Plain	115	0.03
Goat Leather	natural	281.3	0.08

2.1.2 Chemicals

Zinc oxide nano particles with average size less than 100 nm, poly-ethylene glycol and acrylic binder and Bulk titanium dioxide.

2.2 Experimental Methods

2.2.1 Application of Nano zinc oxide on natural goat leather and blended 50%cotton, 50%polyester woven Fabric

Application of zinc oxide nano particles and bulk titanium dioxide were done on natural goat leather, and blended 50%cotton, 50%polyester woven fabric by pad dry cure method under tension.

a) Preparation of

1. **zinc oxide nano padding liquor:** Nano zinc oxide solution was prepared using 3% concentrations was added with 0.25% Polyethylene glycol surfactant and 1% acrylic binder. The mixture was then stirred using magnetic stirrer for 60minutes at 65ºC temperature.
2. **Titanium dioxide padding liquor:** Titanium dioxide solution was prepared using 3% concentrations was added with 1% acrylic binder at room temperature.

b) Application to samples by pad dry cure method:

natural goat leather and 50% cotton, 50% polyester woven fabric were immerged in padding liquor at room temperature for 15 minutes and then passed through a two bowl laboratory padding mangle, which was running at a speed of 15 rpm with a pressure of 1.75 Kg/cm2, then the sample padded again for 1 min the squeezed, using 2-dip 2-nip padding sequence at 70% expression. The padded substrate was dried at 110ºC for 5 minutes and thermosetting at 160ºC temperature for 3 minutes under tension.

2.2.2 Testing and Analysis

a) Analysis of functional properties:

1) For testing antimicrobial functional properties antimicrobial for both (leather and blended woven fabric) **- Quantitative test Assessment of antibacterial activity**

The determination of Percentage Reduction is done according to Test (AATCC 100-2004) and ISO 20743:2007 (14, 15)

Specimens of the test material were shaken in a known concentration of bacterial suspension and the reduction in bacterial activity in standard time was measured. The efficiency of the antimicrobial treatment was determined by comparing the reduction in bacterial concentration of the treated sample with that of control sample expressed as a percentage reduction in standard time.

$$\text{Reduction\%} = [(A-B)/B] \times 100$$

Where A and B are the surviving cells (CFU/ml) for the flasks containing the control (blank cotton fabric) and test samples (natural dye treated cotton fabric), respectively, after 18 hrs of contact time.(16,17)

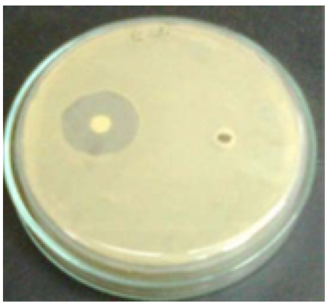

Figure 2. Anti-bacterial activity

2) For testing ultra-violet protection functional properties for the leather as outer layer

Standard Practice for Preparation of Textiles Prior to Ultraviolet (UV) Transmission Testing according to Standard ASTM D6544 (18)

The significance of this practice is that cloth, labeled as UV-protective, which will ultimately be submitted for UV transmittance testing will be in a state that simulates their condition at the end of two years of normal seasonal use. Therefore, the UV-protection level ultimately placed on a label estimates the maximum UV transmittance of the garment fabric during a two-year life cycle.

This practice leads to measurement of the residual level of UV-protection in fabrics or garments labeled as sun- or UV-protective, after exposure to conditions that relate to about two years of seasonal use. The UV transmission measurements may be done in accordance with AATCC Test Method 183 using fabrics prepared in accordance with this practice.(19) This measurement may be used in support of a label statement regarding UV protection.

Below is the ASTM Standard for Sun Protective Clothing: (20)

UPF Rating	Protection Category	% UV radiation Blocked
UPF 15 – 24	Good	93.3 – 95.9
UPF 25 – 39	Very Good	96.0 – 97.4
UPF 40 – 50+	Excellent	97.5 – 98+

b) Evaluation of surface morphology and structural compositions:

Infra-Red (IR) used to study the surface morphology and structural compositions for both (leather and blended woven fabric).

An important observation made by early researchers is that many functional group absorb infrared radiation at about the same wavenumber, regardless of the structure of the rest of the molecule. For example, C-H stretching vibrations usually appear between 3200 and 2800cm^{-1} and carbonyl(C=O) stretching vibrations usually appear between 1800 and 1600cm^{-1}. This makes these bands diagnostic markers for the presence of a functional group in a sample. These types of infrared bands are called group frequencies because they tell us about the presence or absence of specific functional groups in a sample.

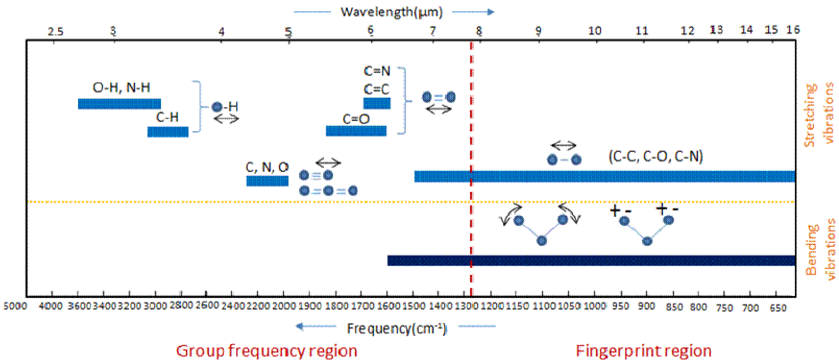

Figure 3. Group frequency and fingerprint regions of the mid-infrared spectrum

The region of the infrared spectrum from 1200 to 700 cm^{-1} is called the fingerprint region. This region is notable for the large number of infrared bands that are found there. Many different vibrations, including C-O, C-C and C-N single bond stretches, C-H bending vibrations, and some bands due to benzene rings are found in this region. The fingerprint region is often the most complex and confusing region to interpret, and is usually the last section of a spectrum to be interpreted. However, the utility of the fingerprint region is that the many bands there provide a fingerprint for a molecule.

3. Results and Discussion:

3.1Effect of the treatment on natural goat leather

3.1.a) Analysis of functional properties:

1) For testing antimicrobial functional properties antimicrobial

Table (2) natural goat leather comparison between (untreated, nano zinc oxide, bulk titanium dioxide) samples anti-bacterial treatment by padding methods

natural goat leather treatment type	Inhibition zone diameter (mm/1cm sample)			
	escherichia coli (G$^-$) before washing	escherichia coli (G$^-$) after washing	Staphylococcus aureus (G$^+$) before washing	Staphylococcus aureus (G$^+$) after washing
untreated	0.0	0.0	0.0	0.0
Padded nano zinc oxide	16	15	19	18
Padded bulk titanium dioxide	14	12	20	15

Sample antibacterial, is the ability to kill off bacteria and prevent its growth.

Table 2 gives antibacterial zone of (untreated, nano zinc oxide, bulk titanium dioxide) samples anti-bacterial treatment for natural un-dyed goat leather by pad – dry – cure method. The untreated samples did not give any anti bacterial activity toward escherichia coli **(G^-)** neither Staphylococcus aureus **(G^+).**

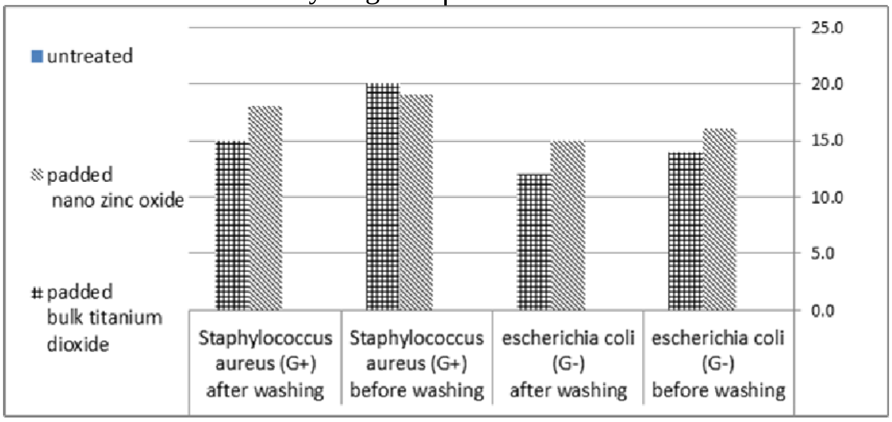

Figure (4) natural goat leather comparison between (untreated, nano zinc oxide, bulk titanium dioxide) samples anti-bacterial treatment by padding methods

Before washing, Antibacterial treatment by nano zinc oxide particle padding method led to increased bacterial resistance and increasing diameter free region from bacterial activity area for Staphylococcus aureus **(G^+)** to 19 and increasing diameter free region of the bacterial activity for escherichia coli **(G^-)** to 16. And antibacterial treatment by bulk titanium dioxide padding method led to increased bacterial resistance and increasing diameter free region from bacterial activity area for Staphylococcus aureus **(G^+)** to 20 and increasing diameter free region of the bacterial activity for escherichia coli **(G^-)** to 14, both treatment cause the increasing of antibacterial protection compared to that of the untreated sample which shows no antibacterial protection at all.

After washing, Antibacterial treatment by nano zinc oxide padding method led to decreased bacterial resistance and decreasing diameter free region from bacterial activity area for Staphylococcus aureus **(G^+)** to 18 and decreasing diameter free region of the bacterial activity for escherichia coli **(G^-)** to 15. Antibacterial treatment by bulk titanium dioxide padding method led to decreased bacterial resistance and decreasing diameter free region from bacterial activity area for Staphylococcus aureus **(G^+)** to 15 and decreasing diameter free region of the bacterial activity for escherichia coli **(G^-)** to 12, both treatment cause the increasing of antibacterial protection compared to that of the untreated sample which shows no antibacterial protection at all. The results would imply that nano zinc oxide finished leather by padding method and after washing test shows the more increasing antibacterial protection as it reduce the Staphylococcus aureus **(G^+)** and escherichia coli **(G^-)** infections, and more durable treatment. (Sheila Shahidi et al)

2) For testing ultra-violet protection functional properties antimicrobial

Table (3) natural goat leather comparison between (untreated, nano zinc oxide, bulk titanium dioxide) samples uv protection treatment by padding methods

natural goat leather treatment type	Ultra Violet Protection UPF before washing	Ultra Violet Protection UPF after washing
untreated	41397.9	41397.9
Padded nano zinc oxide	49332.23	48752.52
Padded bulk titanium dioxide	54325	4743

Ultra violet protection is a numerical rating given to clothing to indicate how effectively the leather blocks ultraviolet (UV) radiation. Table 3 gives ultra violet protection of (untreated, padded and sprayed) for natural un-dyed goat leather.

Before washing, Ultra violet protection of bulk titanium dioxide finished natural leather samples shows sample increased ultra violet protection to be 54325 more than the nano zinc oxide padded sample to be 49332.23, both treatment cause the increasing of ultra violet protection compared to that of the untreated sample which has 41397.9.

After washing, Ultra violet protection of nano zinc oxide finished natural leather samples shows increased ultra violet protection to be 48752.52 more than the bulk titanium dioxide padded

sample to be 4743, both treatment cause the increasing of ultra violet protection compared to that of the untreated sample
.

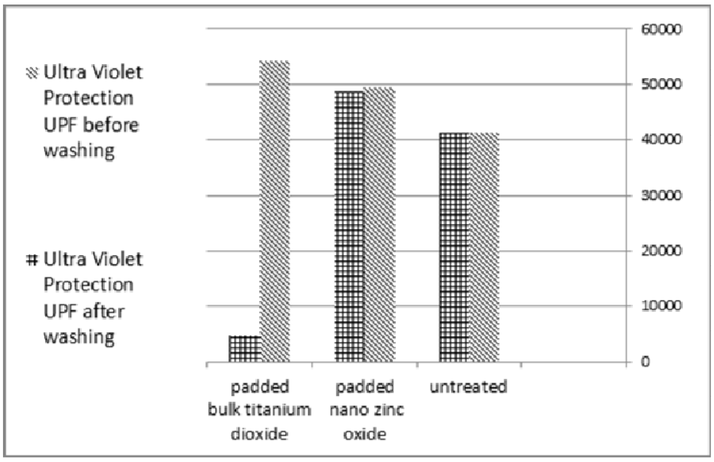

Figure (5) natural goat leather comparison between (untreated, nano zinc oxide, bulk titanium dioxide) samples uv treatment by padding methods

Nano zinc oxide padded treatment method after washing cause the increasing of ultra violet protection compared to both, the untreated sample and the bulk titanium dioxide treated sample this is because nano zinc oxide particles have covalently bonded to the natural goat leather giving a stable structure and avoiding deformation of leather, as high absorbance of ultra violet rays can break chemical bonds causing generating free radicals which induce further reaction leading to a continuous disintegration of natural goat leather, therefore the UV protection can positive influence on the natural goat leather ageing. Also the stability of leather to UV exposure, will consider being very good property as leather will play a significant role in obtaining a good cool effect. This would imply that nano zinc oxide finished leather by padding method shows the more increasing ultra violet protection and durable treatment. (Sheila Shahidi et al)

3.1.b) Infra-Red (IR) used to study the surface morphology and structural compositions.

FT-IR spectrum analysis of natural goat leather (Un-treated, treated zinc oxide nanoparticles and treated with bulk titanium dioxide)

The three leather samples (un-treated, treated zinc oxide nanoparticles and treated with bulk titanium dioxide) were subjected to IR analysis to detect the various characteristic functional group associated with the zinc oxide nanoparticles and titanium dioxide.

(a) Un treated leather sample FTIR showed the following:

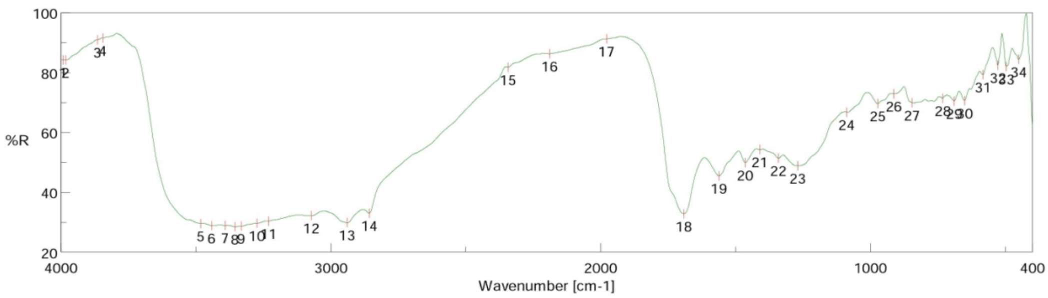

Figure (6) IR spectrum of natural goat leather (a) untreated sample

The peak 1087.66 cm^{-1} is ascribed to (C-O-C=O in tanning ester),
The peak at 1410.67 cm^{-1} is ascribed to (C-OH);
The peak at 1463.71 - 1341.25 cm^{1} due to bending modes of CH2, CH3.
The peaks at 1562.06, 1269.9 cm^{-1} is ascribed to (amide bands I, II, III, correspondingly)
The peak at 1691.27 cm^{-1} is ascribed to (galloyl ester carbonyls),
The peak at 1978.61 cm^{-1} is ascribed to (ester carbonyls possibly due to tanning).
The peaks at 2857.99 (wax),
The peaks at 2939.95 (oil impurities)
The peak at 3073.01 cm^{-1} is ascribed to be (NH2),
The peaks at 3332.39 cm^{-1} is ascribed to be (due to N-H) which detected protein material exist.
The peaks at 3482.81, 3441.35, 3392.17 and 3354.57 cm^{-1} is ascribed to (OH) from tanning

agents,
(b)Leather sample treated with nano zinc oxide particles showed Different peak indicates the characteristics functional group present of zinc oxide nanoparticles which indicate that the Zn–NP have absorption peaks in the range of the following:

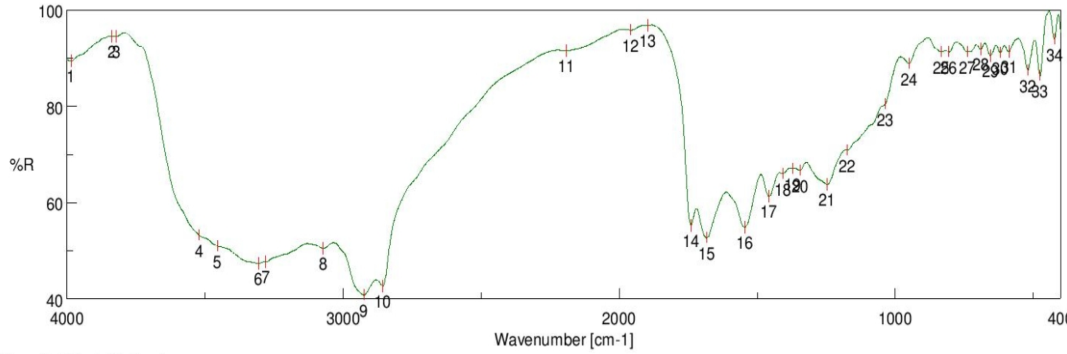

Fig. (7) IR spectrum of natural goat leather (b) treated sample with zinc oxide nanoparticles

The peak at 588.182 cm^{-1} may correspond to vibrational mode of metal–oxygen (zinc-oxide).
The peak at 1035.59 cm^{-1} is ascribed to aliphatic fluoro compounds, primary amine C–N stretch.
The peak at 1174.44 cm^{-1} is ascribed to secondary amine N–H stretch.
The peak at 1246.75 and 1372.1 cm^{-1} are ascribed to aromatic phosphates and nitrate ion, tri-methyl or "tert-butyl" group.
The peak at 1407.78 cm^{-1} is ascribed to phenol or tertiary alcohol and carboxylate group.
The peak at 1545.67 cm^{-1} is ascribed to aliphatic and aromatic nitro compounds.
The peak at 1683.55 cm^{-1} is ascribed to amide group and open chain imino (–C=N–).
The peak at 2925.48 cm^{-1} is ascribed to methylene C–H asym./sym. stretch.
The peak at 3454.85 cm^{-1} is ascribed to hydroxyl group, H– bonded O–H stretch.
The peak at 3280.32 cm^{-1} is ascribed to hydroxyl group, H– bonded O–H stretch.

(c) Leather sample treated with TiO2 showed Several peaks related to TiO2 are observed in all samples as the following:.

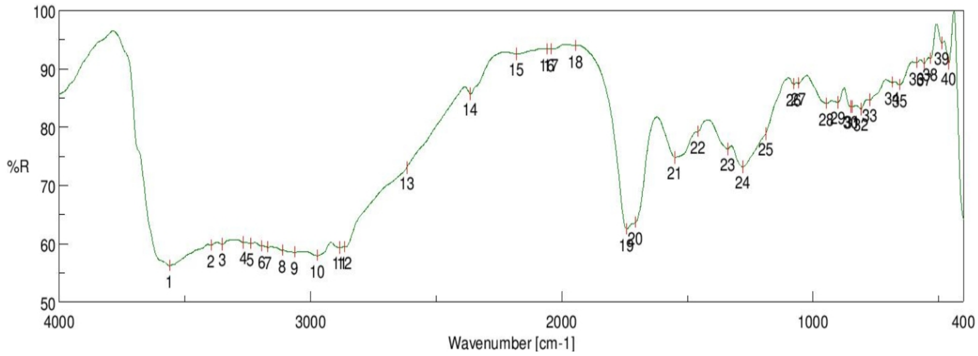

Fig. (8) IR spectrum of natural goat leather (c) treated sample with bulk titanium dioxide

The peaks at 500-600 cm^{-1} is likely due to the vibration of the Ti–O bonds in the TiO_2 lattice.
The peaks at 1706.69-1056 cm^{-1} ascribed to c=c
The peaks appearing at 3111.58–3560.91 cm^{-1} are assigned to vibrations of hydroxyl groups.
The peaks at 2059.6 cm^{-1} are assumed to be due to the species containing CN bonds, such as cyanamide, carbodiimide, cyanuric acid.
The peaks at 1188.9-1550 cm^{-1} ascribed to nitrogen oxide species

3.2 Effect of the treatment on blended 50%cotton, 50%polyester woven fabric

3.2.a) Analysis of functional properties:

1) For testing antimicrobial functional properties antimicrobial

Table (4) blended 50%cotton, 50% polyester woven fabric comparison between (untreated, nano zinc oxide, bulk titanium dioxide) samples anti-bacterial treatment by padding methods

50%cotton, 50%polyester treatment type	Inhibition zone diameter (mm/1cm sample)			
	escherichia coli (G-) before washing	escherichia coli (G-) after washing	Staphylococcus aureus (G+) before washing	Staphylococcus aureus (G+) after washing
padded nano zincoxide	16	13	16	14
Padded bulk titanium dioxide	14	12	15	13

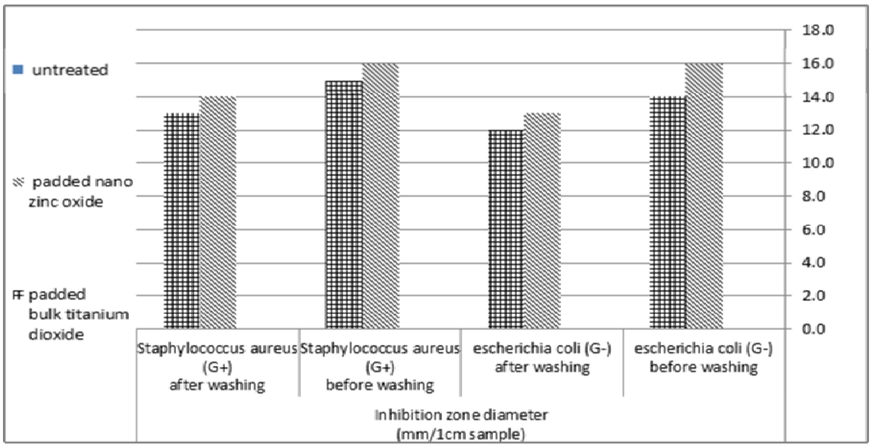

Figure (9) blended 50%cotton, 50% polyester woven fabric comparison between (untreated, nano zinc oxide, bulk titanium dioxide) samples anti-bacterial treatment by padding methods

Sample antibacterial, is the ability to kill off bacteria and prevent its growth.

Table 4 gives antibacterial zone of (untreated, nano zinc oxide, bulk titanium dioxide) samples anti-bacterial treatment for blended 50%cotton, 50% polyester woven fabric by pad – dry – cure method.

The untreated samples did not give any anti bacterial activity toward escherichia coli **(G^-)** neither Staphylococcus aureus **(G^+).**

Before washing, Antibacterial treatment by nano zinc oxide particle padding method led to increased bacterial resistance and increasing diameter free region from bacterial activity area for Staphylococcus aureus **(G^+)** to 16 and increasing diameter free region of the bacterial activity for escherichia coli **(G^-)** to 16. And antibacterial treatment by bulk titanium dioxide padding method led to increased bacterial resistance and increasing diameter free region from bacterial activity area for Staphylococcus aureus **(G^+)** to 13 and increasing diameter free region of the bacterial activity for escherichia coli **(G^-)** to 14, both treatment cause the increasing of antibacterial protection compared to that of the untreated sample which shows no antibacterial protection at all.

After washing, Antibacterial treatment by nano zinc oxide padding method led to decreased bacterial resistance and decreasing diameter free region from bacterial activity area for Staphylococcus aureus **(G^+)** to 14 and increasing diameter free region of the bacterial activity for escherichia coli **(G^-)** to 13 compared to before washing results. Antibacterial treatment by bulk titanium dioxide padding method led to decreased bacterial resistance and decreasing diameter free region from bacterial activity area for Staphylococcus aureus **(G^+)** to 13 and increasing diameter free region of the bacterial activity for escherichia coli **(G^-)** to 12, compared to before washing results. Both treatments cause the increasing of antibacterial protection compared to that of the untreated sample which shows no antibacterial protection at all. The results would imply that nano zinc oxide finished leather by padding method and after washing test shows the more increasing antibacterial protection as it reduce the Staphylococcus aureus **(G^+)** and escherichia coli **(G^-)** infections, and more durable treatment.(Sheila Shahidi et al)

3.2.b) Infra-Red (IR) used to study the surface morphology and structural compositions.

FT-IR spectrum analysis of blended 50%cotton, 50% polyester woven fabric (Un-treated, treated zinc oxide nanoparticles and treated with bulk titanium dioxide)

(a)Un treated 50% cotton, 50% polyester woven fabric sample FTIR showed the following:

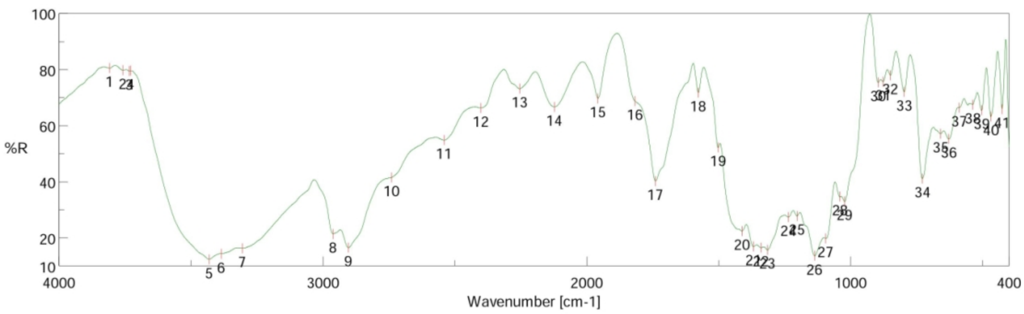

Fig. (10) IR spectrum of natural goat leather (a) Un treated sample

The details of an infrared technique standardized to analyze cotton–polyester blends of different compositions are reported. FT-IR spectra for O-H group based cotton fiber and ester group based polyester. It is observed that particle size plays a very important role in the peak intensity of a broad peak at 1730 - 1725 cm^{-1} band (C=O stretching) in polyester, is characteristic of carbonyl stretching of unsaturated ester the absorption band recommended for analysis of cotton–polyester blends

The bands represent cellulose can be seen at

The peaks at 538.042 - 426.191 cm^{-1} is ascribed to (skeletal C-O-C, C-C-C, O-C-C and O-C-O bend).

The peaks at 797.421 and 849.49 cm^{-1} is ascribed to be accounted for out-of -plane bending of aromatic ring system.

The peak at 895.773 cm^{-1} is ascribed to (C-O-C in plane, symmetric),

The peaks between the regions 1094.4– 1136.83 cm^{-1} is ascribed to be due to cellulosic component of the fiber materials

The peaks at 1136.83 – 1094.4 cm^{-1} is ascribed to (C-C and C-O stretch) due to cellulosic component of the fiber materials,

The peaks at 1236.15 and 1339.32 cm^{-1} is ascribed to be due to C-O stretching of the polymer back bone.

The peaks at 1368.25, 1339.32 cm^{-1} is ascribed to (H-C-C, H-C-O, and H-O-C bend),

The peaks at 1411.64 – 1502.28 cm^{-1} is ascribed to (H-C-H and H-O-C bend),

The peak at 2401.91 cm^{-1} is ascribed to methylene C–H stretching.

The peak at 2903.31 cm^{-1} is ascribed to (CH, CH2 stretch),

The peak at 3304.43 cm^{-1} is ascribed to C-H stretching of aromatic ring.

An interesting feature in the above discussed spectrum was that an additional small peak observed at around 3600 cm^{-1} is ascribed to free -OH groups of cellulose component indicating that the treatment had increased the extent of amorphous region in the cotton component of the material

Types of bonds present in the chemical structure of polyester, has made execution of absorbency peaks and intensity totally different than cotton. This is purely influenced by the presence of ester group in its structure.

(b) 50% cotton, 50% polyester woven fabric treated with nano zinc oxide particles showed the following:

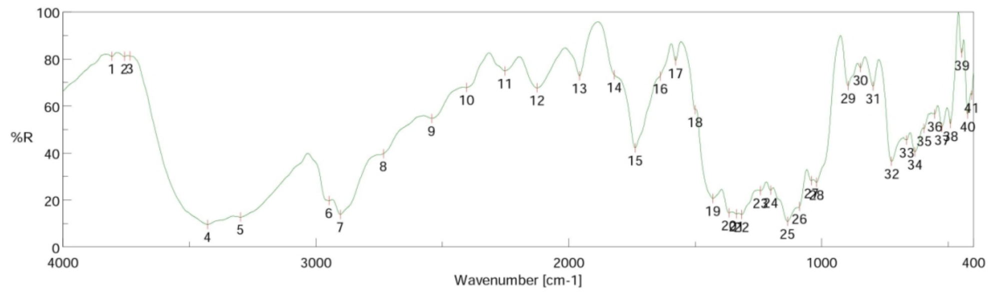

Fig. (11) IR spectrum of natural goat leather (b) treated sample with nano zinc oxide in polyester

The peak at 525.507 – 553.47 – 595.896 – 632.537 cm^{-1} may correspond to vibrational mode of metal–oxygen (zinc-oxide).

The peak at 1021.12 – 1041.37 cm^{-1} is ascribed to aliphatic fluoro compounds, primary amine C–N stretch.

The peak at 1135.87 cm^{-1} is ascribed to secondary amine N–H stretch.

The peak at 1202.4 – 1241.37 - 1316.18 – 1337.39 – 1366.32 cm^{-1} are ascribed to aromatic phosphates and nitrate ion, tri-methyl or “tert-butyl” group.

The peak at 1429.96 cm^{-1} is ascribed to phenol or tertiary alcohol and carboxylate group.

The peak at1501.31 - 1577.49 cm^{-1} is ascribed to aliphatic and aromatic nitro compounds.

The peak at 1639.2 cm^{-1} is ascribed to amide group and open chain imino (–C=N–).

The peak at 1737.55 cm^{-1} band (C=O stretching) in polyester

The peak at 2903.31 – 2948.63 cm^{-1} is ascribed to methylene C–H asym./sym. stretch.

The peak at 3428.81 – 3297.68 cm^{-1} is ascribed to hydroxyl group, H– bonded O–H stretch.

The peak at 3297.68 – 3428.81 cm-1 can be correlated to C-H stretching of aromatic ring for cellulose.

(c) 50% cotton, 50% polyester woven fabric treated with TiO2 showed the following:.

The peaks 526.471 -544.792 – 590.111 – 630.509 – 654.715 cm^{-1} is likely due to the vibration of the Ti–O bonds in the TiO_2 lattice.

The peaks at 1500.35 – 1576.52 – 1738.51 cm^{-1} and the broad peaks appearing at 2961.16 – 3297.68 – 3399.89 -3428.81 cm^{-1} are assigned to vibrations of hydroxyl groups.

In modified samples these peaks overlap with broad bands of the stretching and deformation

modes of NH groups.
The peaks at 1145.51 – 1239.04 – 1311.36 – 1343.18 – 1370.18 – 1429.96- 1500.35 – 1576.52 – 1738.51 – 1817.58 – 1957.39cm^{-1} and the peaks at 2123.24 cm^{-1} are assumed to be due to the species containing CN bonds, such as cyanamide, carbodiimide, cyanuric acid.

Alternatively, the peaks at 1145.51-1576.52 cm^{-1} could be also ascribed to nitrogen oxide species
The peak at 1738.51 cm^{-1} band (C═O stretching) in polyester
The peak at 3297.68 – 3428.81 cm-1 can be correlated to C-H stretching of aromatic ring for cellulose.

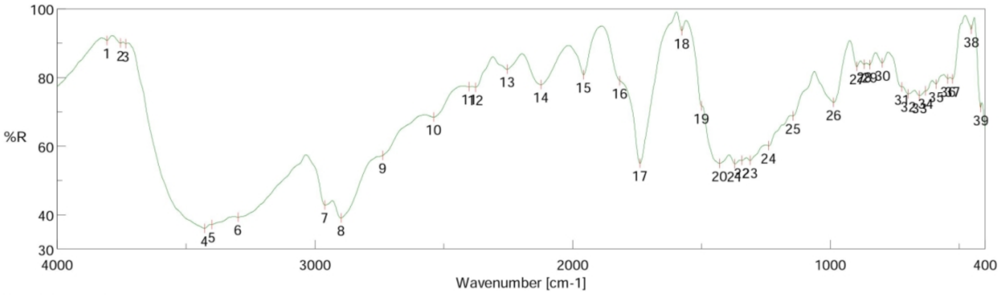

Fig. (12) IR spectrum of natural goat leather (c) treated sample with bulk titanium dioxide

4. Conclusion:

This study shows that the zinc oxide nano particles gives the best results for anti-bacterial and ultra violet treatment for both natural goat leather and the blended 50% cotton, 50% polyester woven fabric, and more durable than the bulk titanium dioxide, therefore nano zinc oxide particles are more safer for the consumer, economical and environment.
From the IR analysis we could observe different absorption peaks for zinc oxide nanoparticles. Presence of different functional groups is due to the conjugation of collagen to the zinc oxide nanoparticles. This is due to The molecular weight distribution of modified and cross-linked of collagen samples was greatly changed which was detected that the diameters of collagen fibers become thicker and the intervals of fibers are increased, causing durable treatment. IR has the potential to be used in the textile industry for the prediction of the composition of cotton-polyester blends and the peaks proved the presence of zno nano particles, as From the results we found that ZnO has better antibacterial activity since the decrease of molecular weight of ZnO increases the antibacterial activity, and this phenomenon due to the decrease of ZnO molecular weight in the fabric porosity improves the movement of the chains.
Thus, the nano-ZnO treatment for natural leather and blended 50% cotton 50% polyester woven fabric is proved to have better durable anti-bacterial and UV protection property.

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