International Journal of Engineering and Information Systems (IJEAIS)
ISSN: 2000-000X
Vol. 3 Issue 4, April – 2019, Pages: 34-39

Preparation of an Anti- microbial Cotton Fabric Using Synthesize Zinc Nano particles stabilizing by Alovera Gel

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Abstract: *By used Aloe Vera as a capping agent Zinc oxide (ZnO) nanostructures were synthesized on the surface of cotton fabric via a simple wet chemical method for providing antimicrobial activity. Surface morphology and surface chemistry were characterized by scanning electron microscopy (SEM) coupled with energy-dispersive X-ray spectroscopy. Antibacterial and (FTIR) Spectroscopy. Activity was evaluated against Gram-negative Ecoli and Gram-positive Staphylococcus aureus bacteria. Nanostructures were homogenously formed on the fibers' surface in case of used alovera capping agent, most of them are bundle like particles having different sizes. Antibacterial tests showed that the ZnO-coated fabric possesses good bacteriostatic activity against to staphylococcus and Ecoli with alovera. Representative bacteria, demonstrated by the zone of inhibition. However, there was no reduction in the number of bacteria, proving the lack of bactericidal activity. Demonstrate its excellent ability to block the UV radiation. The washing durability was also confirmed by performing repeated home laundering*

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Keywords— Anti- microbial; Zinc Nano particles; Alovera Gel

1. INTRODUCTION

Due to the rabidly progress of nanotechnology in the manufacturing of fibers/yarns (nano spinning) including the development of fabric finishes, the applications and disciplines of nano technology are pervasive in the area of textiles for the last few decades. Fabric finishes is greatly contributed to the advancement in the area of nanotechnology. By combining the nanoparticles with the organic and inorganic compounds, the surfaces of the fabrics modified to hydrophobic, abrasion resistant, ultraviolet (UV), electromagnetic and infrared protection finishes can be significantly modified e.g Titanium-dioxide (TiO2) nanoparticles have been utilized for the UV protection. The usage of nanoengineered cross-linking agents during finishing process enhances the wrinkle resistance of cotton fabrics [1]. The recent developed micro encapsulation technique is being used in textile industry for flame or fire retardant agents and bactericidal [2], e.g. Microcapsules of silver nano particles have been used for providing anti-microbial effects and for odor control. Nanoscale fibrous materials, Nanotextiles, are materials that can be functionalized with a vast array of novel properties, including antibiotic activity, self-cleaning and the ability to increase reaction rates by providing large surface areas to potential reactants.

In Addition, nanoparticle synthesis can be possible via liquid (chemical method), solid, and gaseous media , but due to several advantages over the other methods, chemical methods are the most popular methods due to their low cost, reliability, and environmentally friendly synthetic routes, and this method provides rigorous control of the size and shape of the nanoparticles.

As nanoparticles, ZnO and TiO2 have been widely used in textile finishing due to their super properties such as Uv resistant, abrasion resistant, thermal comfortable, electrical-static, and antimicrobial. to meet different application. Rezwan Mahmud and Farhatun Nabi[3, 4]were investigated the cotton fabrics treated with bulk-ZnO or nano-ZnO showed different physical and mechanical properties. This reflects the improved properties of nano-sized particles with respect to conventional materials. The result showed that air permeability was reduced when the coating process was carried out with bulk-ZnO, while it was improved when nano-ZnO was used. In another work done by Skathirvelu and et all [5] ZnO has shown a good protected against Uv radiation. they applied uv test on cotton fabric ,cotton /polyester fabric before and after washing and found significant improvement in the uv absorbing activity when the Zno nanoparticles was applied.

Yadav and et al [6] were proved air permeability and uv blocking were improved when the nanoparticles with average size of 40 nm were coated on bleached cotton fabric (75%) UV blocking was recorded for the cotton fabrics treated with (2%) ZnO nanoparticles and the result shown that air permeability of the Nano-ZnO coated fabrics was significantly increased compered to control, hence the increased breathability.

Nano finishing in textile finishing showed excellent properties but unfortunately the aggregate of Nano particles during syntheses make the attachment and cross linking between them and textile surface weaker and released during home washing after short

time so the durability properties of Nano particles it should be achieved. To overcome this problem stabilizers and capping agents have used as chemical modifiers during the synthesis and coating. Alovera was commonly used as stabilizer to stop aggregate of nano particles and keep it in homogenous distribution these promote homogenous innovated properties in each point on surface area, also make across linker to enhance stability, abrasion resistant and durability against wash.
The aim of this work is to treating textiles fabric with ZnO by using natural extract from (alovera plant) act as stabilizer, instated of chemical agents to eliminate the nanoparticles aggregation during synthesis. In general, nanoparticles with high surface-to-volume ratio were needed, but the agglomeration of small particles precipitated in the solution is the main concern in the absence of any stabilizer.

2. MATERIALS AND METHODS

2.1 Materials

Plain weave (1/1) 100% cotton fabric with 150 GSM, 20 Ne warp and weft count, 75 ends/inch and 54 picks/inch was used in this research work.
2.2 Fabric modification with Alovera and ZnO (Fabric- Alovera –ZnO):
30 ml of alovera gel diluted by 70 ml of methanol 1 g of fabric impeded in solution for 24 h then separate the fabric and dried at room temperature 0.5 g was suspended in 150 ml of deionized water and mixed with 0.5 g of Zn(Ac)2.2H2O pre-dissolved in 5 ml methanol (5% w/v). A concentrated sodium hydroxide solution (2 M) was added drop-wise to the mixture to keep the pH above 10 during the reaction. The mixture heated to 70°C under vigorous stirring until a milky white solution was obtained. Thereafter the solution was heated for a further (2 h) under the same temperature. After then fabric was removed, squeezed and washed by distilled water, and dried at room temperature.

3. METHODS

3.1 **Characterization**:
3.1.1 FTIR
FT-IR stands for Fourier Transform Infra- Red, the preferred method of infrared spectroscopy. In infrared spectroscopy, IR radiation is passed through a sample. Some of the infrared radiation is absorbed by the sample and some of it is passed through (transmitted). The resulting spectrum represents the molecular absorption and transmission, creating a molecular fingerprint of the sample. Of this makes infrared spectroscopy useful for several types of analysis Results.
3.1.2 SEM
Scanning Electron Microscope – SEM – is based on the scanning of the specimen surface by an electron fascicle and the analysis of the signal (electromagnetic particles and waves) resulting from the interaction between the primary fascicle and the specimen The depth at which information on the specimen is obtained ranges between 1 nm (Auger electrons) and 5 μm (characteristic X radiation). With SEM the contrast may be of the following types: topographic contrast, atomic number contrast, magnetic contrast, etc.

3.1.3 EDS

EDS makes use of the X-ray spectrum emitted by a solid sample bombarded with a focused beam of electrons to obtain a localized chemical analysis. All elements from atomic number 4 (Be) to 92 (U) can be detected in principle, though not all instruments are equipped for 'light' elements ($Z < 10$). Qualitative analysis involves the identification of the lines in the spectrum and is straightforward owing to the simplicity of X-ray spectra. Quantitative analysis (determination of the concentrations of the elements present) entails measuring line intensities for each element in the sample and for the same elements in calibration Standards of known composition. By scanning the beam in a television-like raster and displaying the intensity of a selected X-ray line, element distribution images or 'maps' can be produced. In addition, images produced by electrons collected from the sample reveal surface topography or mean atomic number differences according to the mode selected. The scanning electron microscope (SEM), which is closely related to the electron probe, is designed primarily for producing electron images, but can also be used for element mapping, and even point analysis, if an X-ray spectrometer is added. There is thus a considerable overlap in the functions of this instrument.

Figure 1: SEM and EDS Instrument

3.1.4 Antimicrobial Test

Antimicrobial activity of the ZnO-coated fabrics was studied with standard methods: AATC using tC 100-2004 (modified colony counting method). The former method shows bactericidal activity. (E.coli, ATCC 10031, Gram-negative bacterium) and Staphylococcus aureus (S. aureus, ATCC 25923, Gram-positive bacterium) were used as model challenge microorganisms. Nutran agar was prepared as a solid media, modified fabrics was fixed on surface of media at 37°C for 24 h. [7] Then, a single colony was moved with an inoculation loop from the culture media to the MH media and cultured at 37°C until the desired concentration was reached. The suspension of bacteria must be cultured to (0.5 Maxwell turbidity units).

3.1.5 Abrasion

The crock meter is a relatively simple rub tester commonly used to determine the amount of color transferred from textile materials to other surfaces by rubbing. This instrument has also been utilized to conduct smear or abrasion resistance tests on images produced by a printer or copier. For paints and coatings, the crock meter is useful when evaluating the change in gloss due to rubbing, scuffing or marring. A test sample is clamped to the instrument base and a square of standard crocking cloth is fixed to a 16mm diameter, acrylic-rubbing finger. The finger rests on the sample with a pressure of 900 grams force and traverses a straight path approximately 100mm long with each stroke of the arm.

Figure 2: Crock meter Instrument

4. Result and Discussion

4.1 FTIR

In this work (FTIR-8400S) SHIMADAZU – JAPAN instrument, was used to investigate chemical compositions of sample. Investigation result of sample (F-A-ZnO) was showed, the absorption peaks at 1400, 1500 and 3000 cm-1 which are characteristic

of peaks in alovera and are due individually, to the C=O stretching of carboxylic ester (–COOCH3) and the asymmetrical and symmetrical –COO- of carboxylic acid (–COOH) groups [8].

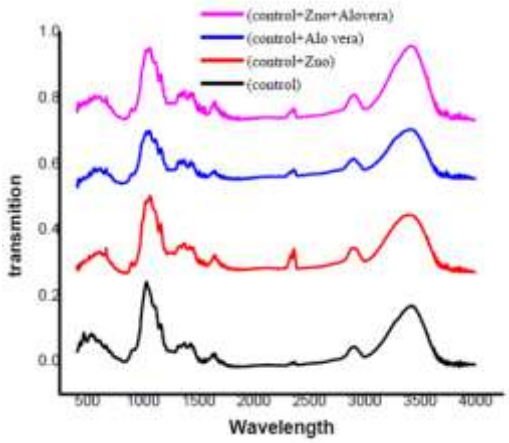

Figure 3: FTIR of (Control, Control + ZnO, Control +Alovera and Control + ZnO +Alovera)

4.2 SEM:

(F-A-ZnO) at magnification (2micro), the results was showed, huge amounts of ZnO nano particles aggregated on the surface of the fabric, and a few amount dispersed randomly at whole fibers surfaces area, this due to non-homogenous hydroxlics groups, presented by alovera which led to catch a huge amounts of ZnO nanoparticles in some positions and few amount in other positions. a unique Alovera structure tend to catch whole amount of ZnO nano particles were synthesis inreactor approximately all amount of ZnO nano particles were holded on fabric surface, which it mean alovera structure acts as good crosslink between fiber and nanoparticles , confirmed the stability during repeated laundry.

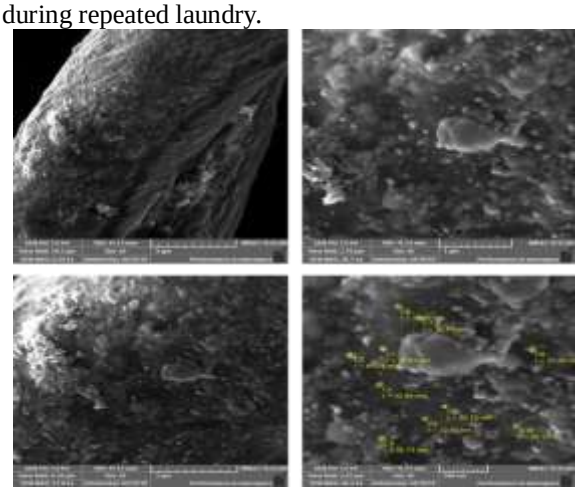

Figure 4: SEM of modified fabric with Alovera at magnification (5µm, 1µm, 2µm, 500nm)

4.3 EDS

EDS measurements were carried out for element detection of the fabric surface. The representative EDS patterns are shown in Figure (4.7). Peaks at about 9.5 keV are characteristic for O, Na and Zn signals are located at about 0.4,1.0,1.0, 8.6, and 9.6 keV [7]. The peaks of Si and Ca were observed at about 1.8, 1.0 and 3.9 keV, which are from the lap environment. The EDS results reveal that the prepared nanostructures are certainly composed of Zn and O. The concentration of Zn element was 3.3 wt. % and the ZnO quantity was 0.5 g/g, when was treated samples (F-ZnO), (F-A-ZnO) and (F-CI-ZnO) It should be noted that the ZnO content determined by EDS is always different from the actual amounts on materials. This discrepancy is experienced because although the penetration depth of EDS is about 500 nm, most ZnO particles are localized on the fiber's surface of cotton fibers.

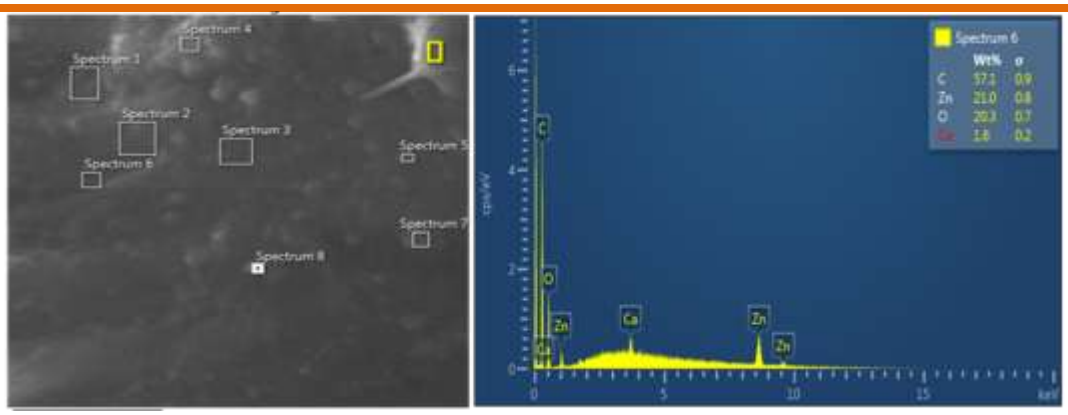

Figure 5: EDS of fabric modified with ZnO and alovera (F-A-ZnO)

4.4 Anti-bacterial

Huge and organized zoon formative around the fabric (F- A –ZnO) before washed which present a higher bactericidal effect against staphylococcus, small and non-organized zone formative against *E.coli*. This present a good anti-bacterial result of ZnO nano particles against staphylococcus (gram-positive bacteria) and acceptable result with *E.coli* (gram-negative bacteria). After washing 5 times the zone, turn to non- organized shape but still huge dimensions with staphylococcus and small with *E.coli*.

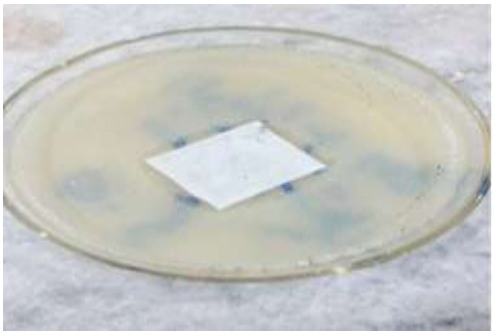

Fig (6.1) :(A-ZnO) Treated fabric with (St- before washing)

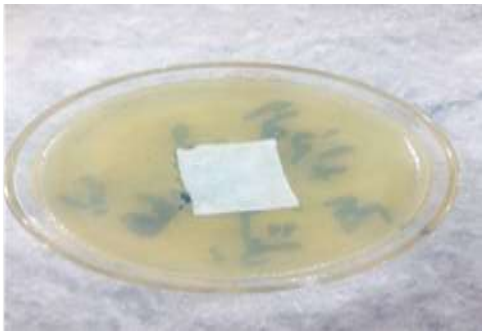

Fig (6.2): (A-ZnO) treated fabric with (E.coli before washing)

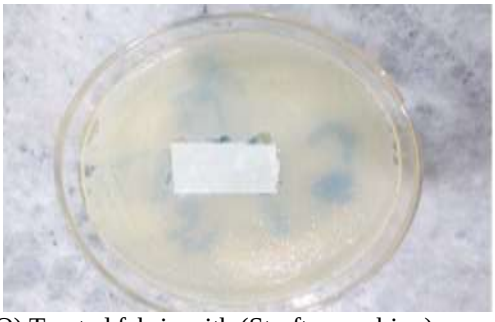

Fig (6.3) :(A-ZnO) Treated fabric with (St-after washing)

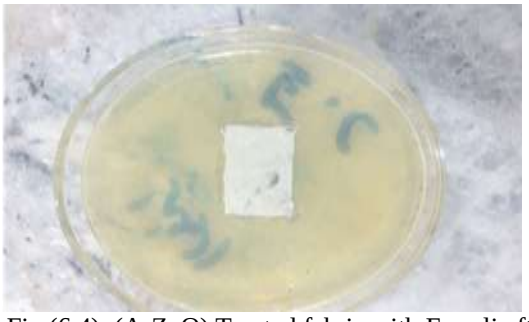

Fig (6.4): (A-ZnO) Treated fabric with E- coli after washing

4.5 Abrasion

Crokometer is used to investigate the abrasion of the treated fabric. The sample (F-A-ZnO) was rubbed for 15 second instead of 10 second (ISO and ASTM) to insure of stability limit of ZnO nanoparticles on surface of fabric. Two samples of fabric were tested via crokometer instrument to study abrasion behavior, one on top(treated sample) and second on the bottom (untreated sample) , After rubbing the sample at the bottom was checked under SEM and EDS to investigate if there is any nanoparticles were released

of the top sample and stable on bottom fabric surface. The result showed there is no ZnO nanoparticles removed for treated sample. The result of EDS bellow showed that.

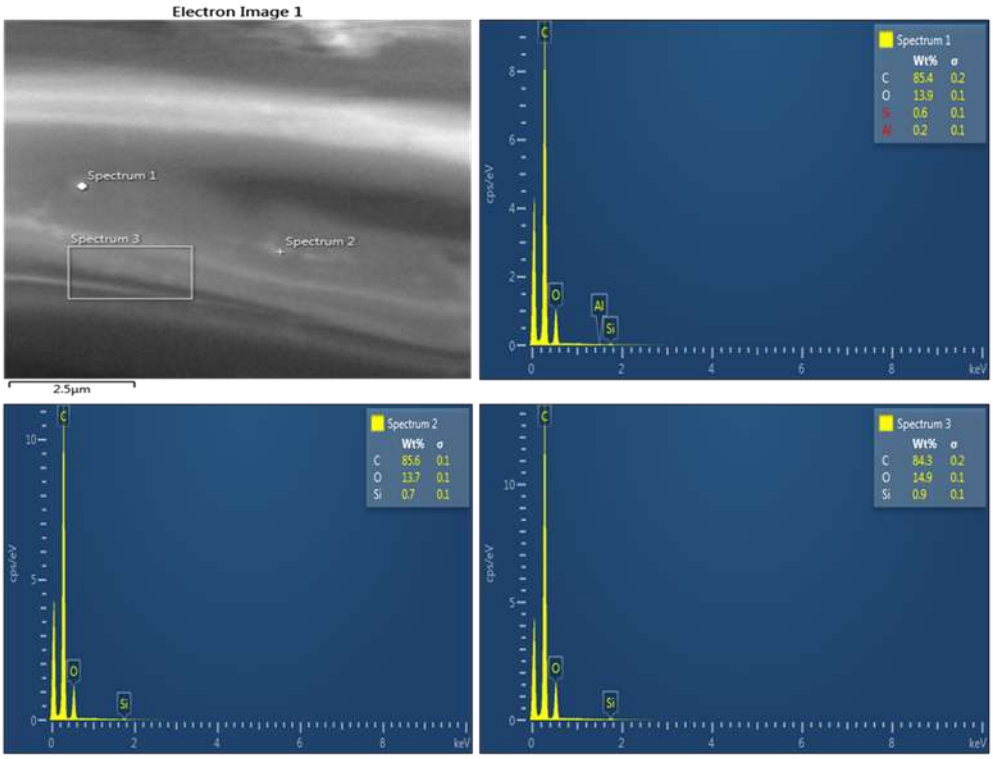

Figure 7: The treated fabric with ZnO and Alovera after rubbing

5. CONCLUSION:

To increase the stability of nanoparticles and stop release of it of surface fabric natural crosslinking agents was used in this study, to synthesize ZnO nanoparticles by solution method. In this study the results showed good stability of ZnO Nanoparticles when alovera gel was used as cross-linking agent (natural capping agent). From characterization of ZnO nanoparticle when alovera gel used as crosslinking agent the SEM, results showed homogeneous and non–homogenous distribution of nanoparticles.

EDS results confirmed presence of ZnO nanoparticle in chemical composition of treated samples and this confirmed of successfully synthesis of nanoparticles. Also FTIR results verified the (EDS) results.

Finally, abrasion test was a doubted no ZnO Nano particles removed from treated samples. The innovation of this study natural extract as crosslinking agent it was showed good results for all tests, from this results natural extract preferable than chemicals crosslinking agent in textile finishing.

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