

**SYNTHESIS AND CHARACTERIZATIONS OF ZINC OXIDE
NANOPARTICLES FOR THE APPLICATIONS OF UV PROTECTION
AND ANTIBACTERIAL ACTIVITIES IN COTTON TEXTILES**

BY

MELAKU MEKURIA



**A THESIS SUBMITTED TO THE DEPARTMENT OF APPLIED PHYSICS
SCHOOL OF APPLIED NATURAL SCIENCE**

**THE PARTIAL FULFILLMENT OF THE REQUIREMENTS OF
THE DEGREE OF MASTER OF SCIENCE IN PHYSICS**

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ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY

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APPLIED PHYSICS PROGRAM

As thesis research advisor, I hereby certify that I have read and evaluated this thesis entitled: **“Synthesis and Characterizations of Zinc Oxide Nanoparticles for The Applications Of UV Protection And Antibacterial Activities In Cotton Textiles”** prepared under my guidance by Melaku Mekuria I recommend that it can be submitted as fulfilling the thesis requirement.

Dr. Abebe Belay

Advisor

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As members of the Board of Examiners of the M.Sc. thesis Open Defense Examination, we certify that we have read and evaluated the thesis work prepared by **Melaku Mekuria** and examined the candidate. We recommended that the thesis be accepted as fulfilling the thesis requirement for the Degree of Master of Science in Physics.

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Date

Declaration and Statement of the Candidate

This thesis has been submitted in partial fulfillment of the requirements for M.Sc. degree in Physics at the ASTU. I solemnly declare that this thesis work is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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Name of candidate: Melaku Mekuria Signature: _____

Place: Adama Science and Technology University, Adama

Date of Submission:

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This work dedicated to my Family, especially to my sisters.

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List of Abbreviation

XRD	X-ray power diffraction
SEM	Scanning Electron Microscopy
UV-	Ultra Violet
UPF	Ultra Viloet Protection Factor
ZnO	Zinc Oxide
NPs	Nanoparticles
FWHM	Full Width at Half Maxim
E. coli	Escherichia Coli
S. aureus	Staphylococcus aureus

Abstract

In this research study synthesize, characterization of zinc oxide (ZnO) nanoparticles and its applications on cotton textiles for UV protection and antibacterial activities were investigated. The nanoparticles were synthesized at different temperature (90° or 150°C) and reaction medium (water or 1,2-ethanediol) using precipitation method. Scanning electron microscopy, X-ray powder diffractometry and UV-vis were used to characterize shape, size and optical properties of the NPs. The average crystallite size of the ZnO NPs estimated from XRD spectra using Debye Scherrer formula was found to be 19.19 and 19.21 nm respectively. The morphology of ZnO NPs characterized by SEM shows flower and spherical shape on treated cotton textiles. UV protection ability of ZnO NPs coated and uncoated for local and factory prepared cotton textiles were investigated using UV-vis spectroscopy by measuring the ultraviolet protection factor (UPF) values in the range 280-400 nm. Higher Values of UPF were obtained when ZnO NPs prepared using in situ method. The Antibacterial activities of ZnO-coated on fabric possess good bacteriostatic activity against *S. aureus* and *E. coli* bacteria using agar disc diffusion method.

Key words. Antibacterial. Nanoparticles. Cotton. UV. In situ, Zinc Oxide

1. Introduction

1.1. Background of the study

Nanotechnology is defined as the understanding and manipulating of matter at dimensions between 1 and 100 nm where unique phenomena enable novel applications. Although human exposure to nanoparticles has occurred throughout human history, it dramatically increased during the industrial revolution. The study of nanoparticles is not new. The concept of a “nanometer” was first proposed by Richard Zsigmondy, the 1925 Nobel Prize Laureate in chemistry. He coined the term nanometer explicitly for characterizing particle size and he was the first to measure the size of particles such as gold colloids using a microscope(Hulla, Sahu, & Hayes, 2015; Krukemeyer, Krenn, Huebner, Wagner, & Resch, 2015)

Modern nanotechnology was the brain child of Richard Feynman, the 1965 Nobel Prize Laureate in physics. During the 1959 American Physical Society meeting at Caltech, he presented a lecture titled, “There’s Plenty of Room at the Bottom”, in which he introduced the concept of manipulating matter at the atomic level. This novel idea demonstrated new ways of thinking and Feynman’s hypotheses have since been proven correct. It is for these reasons that he is considered the father of modern nanotechnology(Faraday; Melnik & Shagalina, 2011; Stylios, 2013)

A bulk material should have constant physical properties regardless of its size, but at the nanoparticles not in the same case. The properties of materials change as their size approaches the nanoscale because of Nanoparticles have a very high surface area to volume ratio, make

nanoparticles to be applicable on different area(Buzea, Pacheco, & Robbie, 2007; Mishra et al., 2014; Sirelkhatim et al., 2015)

Nanoparticles have a nanoscale dimension, and they are very small sized particles with enhanced catalytic reactivity, thermal conductivity, non-linear optical performance and chemical steadiness owing to its large surface area to volume ratio, Surface area to volume ratio in nanoparticles have a significant effect on the nanoparticle's properties. The application of nanoparticles have been used in different industry, health, food, space, chemical and cosmetics industry depending on the nano scale dimension of the nanomaterial(Agarwal, Kumar, & Rajeshkumar, 2017) The bulk particles have different properties from those of nanoparticles that have the same chemical substance(Foss Hansen, Larsen, Olsen, & Baun, 2007).

This technology is rapidly attracting worldwide attention because it is widely perceived as offering huge potential in a wide range of end uses. The unique and new properties of due to their huge economical potential, nanomaterials have attracted not only scientists and researchers but also businesses.(Wong, Yuen, Leung, Ku, & Lam, 2006).

Nanoparticles basically change their properties of substance when their size is reduced to the nanometer range. When a bulk material is reduced into small size particles with one or more dimension (length, width, or thickness) in the nanometer range or even smaller, the individual particles show unexpected properties different from those of the bulk materials(Qian & Hinestroza, 2004).

The textile industry is one of the most important industries for consumer goods worldwide generating fabrics for clothing, household goods, furnishing and technical purposes. Textile garments are aimed to protect the body against environmental factors, such as UV radiation,

humidity, extreme temperature, bacterial and stain action(Broasca, Borcia, Dumitrascu, & Vrinceanu, 2013).

Nanoparticles have variety applications in the textile industry and can be added to the textiles either during the fiber production or during the finishing, meaning being directly applied to the fiber surface or incorporated into fiber coatings (e.g. polymers). It is also possible to produce nanotextiles without nanoparticles by creating nanosized porosity in the textile's structure. They can beneficially replace the classical micronized particles used in finishing for obtaining soil release, stain resistance, flame retardation, wrinkle resistance, moisture management, antibacterial and antistatic effects, UV protection, improvement of dyeability, etc Incorporating nanoparticles into a textile can also affect a host of physical properties, including shrinkage, strength, electrical and thermal conductivity(Lee, Yeo, & Jeong, 2003).

Recently, many researches are working on coating of nanoparticles in textiles. Nanoparticles coating may affect other fabric properties like dyeing capacity, tensile strength, bursting strength, bending rigidity, air permeability (comfort) and fabric friction that play a crucial role in textile industries. Textiles treated with bulk-particles or nanoparticles show different physical and mechanical properties. This reflects the improved properties of nano-sized particles with respect to conventional materials. Air permeability of the textile is reduced when the coating process is carried out with bulk-particles, while it is improved when nanoparticles is used. This basic difference has great consequences on the garment's breathability, and eventually on the comfort of the treated fabrics. As opposed to bulk-particle coating, in the case of nanoparticles treated fabric, the small size and uniform distribution of the particles results in a significant lowering of the friction(Yadav et al., 2006)

The impact of nanoparticles in the textile finishing area has brought up innovative finishes as well as new application technique. Particular great attention has been paid in making chemical finishing more controllable and more thorough. preferably, discrete molecules or nanoparticles of finishes can be brought individually to designated sites on textile materials in a specific orientation and trajectory through thermodynamic, electrostatic or other technical approaches(Anita, Ramachandran, Rajendran, Koushik, & Mahalakshmi, 2011; Kaounides, Yu, & Harper, 2007).

Fabrics impregnated with nanoparticles may thus offer enhanced UV protection, and also other advantages. The protection provided by fabrics depends on several parameters: fiber type, color, the presence of UV absorbers and additives, the porosity, thickness, mass per unit surface, other finishing processes and laundering, and the wearing conditions(Gambichler, Hatch, Avermaete, Altmeyer, & Hoffmann, 2002). Products made from synthetic yarn have excellent strength properties, dimensional stability and good color fastness to washing, dry-cleaning and light exposure. Nonetheless, there is much interest in designing synthetic fabrics combining these excellent mechanical properties with new features, as combined UV protection and increased hydrophobicity. Such materials are envisaged in many fields of applications, as technical, industrial, medical, military, as well as everyday life use(PATRA & Gouda, 2013).

Several types of nanoparticles have received great attention for their potential antimicrobial effects. Among them, zinc oxide nanoparticles (ZnONPs) has been found highly preferable. ZnO NPs have some advantages, compared to silver nanoparticles, such as lower cost and white appearance. Moreover, antimicrobial activity of ZnO NPs is light-independent, while in other cases, like TiO₂ nanoparticles, light irradiation is required for achieving good antibacterial activity(S. Chen et al., 2012). Due to their antimicrobial properties, ZnO NPs, have been

extensively used in fabric finishing's, because they are considered as a viable solution for fighting a broad spectrum of bacteria and fungi. The high specific surface area of this material provides a great opportunity for a reaction with microorganisms. Some authors have reported antibacterial finishing of ZnO NPs coated fabrics(Pulit-Prociak, Chwastowski, Kucharski, & Banach, 2016). Different factors can play an essential role in the interactions between nanoparticles and microorganisms. These factors include the shape, size, type and concentration of nanoparticles, the intrinsic properties and the bacterial strain, among others(Khan, Musarrat, & Al-Khedhairy, 2016)

Overexposure of human skin to ultraviolet radiation (UV) from the sun is a major risk factor for sunburn and the development of skin and also cancer microbial colonization of fabrics can cause undesirable effects, not only to the textile material, but also to the user himself. Microbial growth on these materials could lead to the formation of spots with color alteration, fabric discoloration or formation of unpleasant odors. Moreover, this growth could also decrease fabric resistance and promote the development of skin infections. However, coating of zinc oxide nanoparticles will bring new functionalities, and if so, to help prevent bacterial and to protect UV radiation.

zinc oxide nanoparticles (ZnONPs) attractive metal oxide because of its remarkable application potential, sun-screens as UV-blocking and due to the fact that nanoparticles have a larger surface area per unit mass and volume than the conventional materials, leading to increased effectiveness in blocking UV radiation and antibacterial activities. Therefore, in this research it is intended to synthesis, characterize and apply the zinc oxide nanoparticles for UV radiation protection and antibacterial activity in different textiles.

1.2. Statement of The Problem

Overexposure of human skin to ultraviolet radiation (UV) from the sun is a major risk factor for sunburn and the development of skin and also cancer microbial colonization of fabrics can cause undesirable effects, not only to the textile material, but also to the user himself. Microbial growth on these materials could lead to the formation of spots with color alteration, fabric discoloration or formation of unpleasant odors. Moreover, this growth could also decrease fabric resistance and promote the development of skin infections. However, coating of zinc oxide nanoparticles will bring new functionalities, and if so, to help prevent bacterial and to protect UV radiation. zinc oxide nanoparticles (ZnO NPs) is attractive metal oxide because of its remarkable application potential, sun-screens as UV-blocking and due to the fact that nanoparticles have a larger surface area per unit mass and volume than the conventional materials, leading to increased effectiveness in blocking UV radiation and antibacterial activities. Therefore, in this research it is intended to synthesis, characterize and apply the zinc oxide nanoparticles for UV radiation protection and antibacterial activity in different textiles.

1.3. Objectives of The Study

1.4. General Objective

The general objective of this study is to synthesis, characterize zinc oxide nanoparticles and to apply on different cotton textiles for UV radiation protection and antibacterial activities.

1.5. Specific Objectives

The specific objectives of this study are:

- To synthesis zinc oxide nanoparticles on cotton fabrics.
- To characterize the synthesized zinc oxide nanoparticles using UV-Vis, FTIR, SEM, and XRD.
- To apply the ZnO nanoparticles for UV light protection.
- To apply the ZnO nanoparticles for antibacterial activities

1.6. Significance of The Study

Textile garments are designed to protect the body against environmental factors, such as UV radiation, humidity, extreme temperature, bacterial and stain action, etc. In this respect, the textile industry aims to create fabrics adapted to severe environmental conditions, as to improve the human physiological comfort, by simple and low-cost finishing operations.

The synthesis method of zinc oxide nanoparticles on the cotton textiles is cost effective, simple and efficient. Therefore, this research will contribute to the improvement of UV protection and antibacterial activity of cotton textile.

2. Literature Review

2.1. Zinc Oxide Nanoparticles

In recent years zinc oxide has promoted itself as an interesting metal oxide material because of its unique physical and chemical properties, such as high chemical stability, high electrochemical coupling coefficient, broad range of radiation absorption and high photostability, is a multifunctional material (Lou, Shen, & Shen, 1991; Segets, Gradl, Taylor, Vassilev, & Peukert, 2009)

Zinc oxide is classified as a semiconductor in group II-VI, with a broad energy band (3.37 eV), high bond energy (60 meV) and high thermal and mechanical stability at room temperature make it preferable for potential use in electronics, optoelectronics and laser technology (Bacaksiz et al., 2008; Wang, Xin, & Tao, 2005). Zinc oxide (ZnO) powders occur in a variety of structures, widely used due to their unique properties, such as photocatalytic, electrical, optical, dermatological and antibacterial (Anitha, Brabu, Thiruvadigal, Gopalakrishnan, & Natarajan, 2012). Moreover, ZnO is bio-safe and biocompatible for applications in medicine (Asif, Elinder, & Willander, 2011). ZnO is known as a UV-blocking material, especially in the UV-A region. For the applications of ZnO as UV-absorbing system, it has to be incorporated into different matrices, and various strategies have been developed to increase the stability of ZnO in different dispersion media and to prevent particles agglomeration (Sirelkhatim et al., 2015)

Mechanical, physical and chemical processes are employed to synthesis zinc oxide nanoparticles, coatings, dispersions or composites. Zinc oxide Nanoparticles characteristics can be controlled by temperature, pH value, concentration, chemical composition, surface modifications and the process of preparation. Basically, two approaches have been suggested for zinc oxide nanoparticles synthesis: Bottom up and top down approach. The top-down approach involves milling or attrition of large macroscopic particle. It involves synthesizing large-scale patterns initially and then reducing it to nanoscale level through plastic deformation. This technique cannot be employed for large scale production of nanoparticles because it is a costly and slow process. The bottom up approach involves that the nanostructures are synthesized onto the substrate by stacking atoms onto each other, which gives rise to crystal planes, crystal planes further stack onto each other, resulting in the synthesis of the nanostructures. A bottom-up approach can thus be viewed as a synthesis approach where the building blocks are added onto the substrate to form the nanostructures(Agarwal et al., 2017; Mishra et al., 2014).

2.2. Methods for Synthesis of Zinc Oxide Nanoparticles

Two main approaches are used in synthesis of ZnO NPs that is, the bottom up approach and the top-down approach as shown in figure 1. The bottom up synthesis carries out by forming Zinc Oxide nanoparticles relatively from simpler substance. The approach also called building up approach. The sol-gel, green synthesis and biochemical synthesis are example of bottom up synthesis method and the top down synthesis method involves by starting with large molecule then decompose into smaller units. Examples of top down methods are grinding (milling), physical vapor deposition and decomposition techniques. The challenging issue in the synthesis of nanoparticles is over range of chemical compositions, size, and high monodispersity (Thirumalai Arasu, Prabhu, & Soniya, 2010).

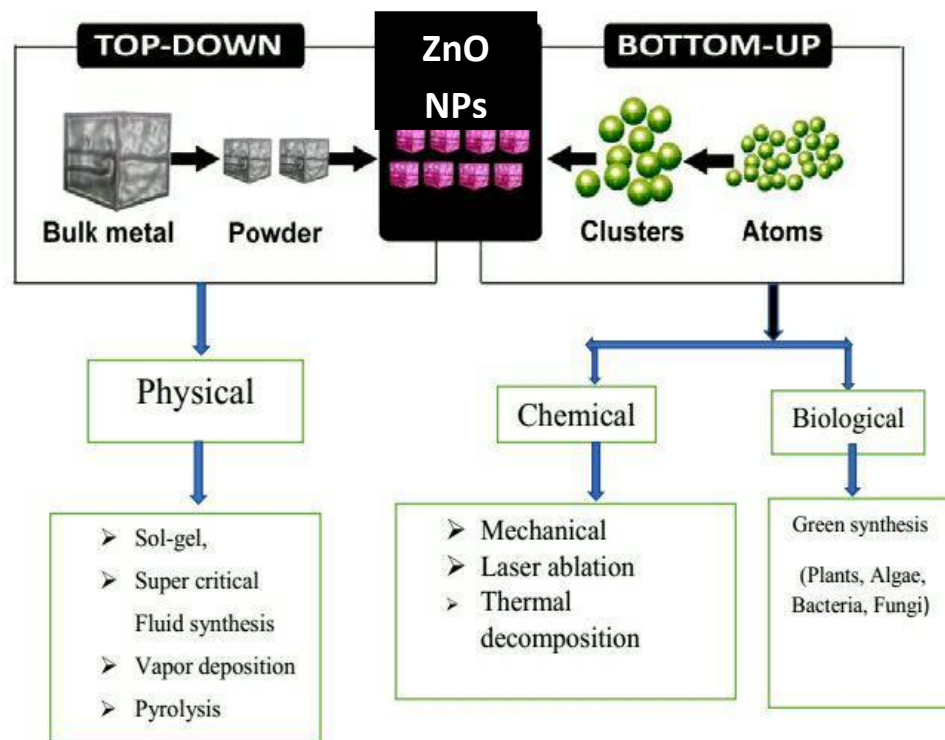


Figure 1 General synthesis methods of zinc oxide nanoparticles

Zinc oxide nanoparticles is synthesized in variety methods, such as green synthesis, sol-gel, thermal decomposition and precipitation methods, makes it possible to obtain products with particles differing in shape, size and spatial structure.

2.2.1. Biosynthesis

Biosynthesis of ZnO nanoparticles is a method of synthesizing nanoparticles using microorganisms and plants. Biosynthesis of nanoparticles is a method of synthesizing nanoparticles using microorganisms and plants having biomedical applications. This approach is an environment-friendly, cost effective, biocompatible, safe, green approach(Salam, Sivaraj, & Venckatesh, 2014). Green synthesis includes synthesis through plants, bacteria, fungi, algae etc. They large scale production of ZnO NPs free of additional impurities(Yuvakkumar, Suresh,

Nathanael, Sundrarajan, & Hong, 2014). NPs synthesized from biomimetic approach show more catalytic activity and limit the use of expensive and toxic chemicals.

Plant parts like leaf, stem, root, fruit, and seed have been used for ZnO NPs synthesis because of the exclusive phytochemicals that they produce. Using natural extracts of plant parts is a very ecofriendly, cheap process and it does not involve usage of any intermediate base groups. It takes very less time, does not involve usage of costly equipment and precursor and gives a highly pure and quantity enriched product free of impurities(Heinlaan, Ivask, Blinova, Dubourguier, & Kahru, 2008). Plants are most preferred source of NPs synthesis because they lead to largescale production and production of stable, different in shape and size nanoparticles(Qu, Yuan, Wang, & Shao, 2011).

Bio-reduction involves reducing metal ions or metal oxides to 0 valence metal NPs with the help of phytochemicals like polysaccharides, polyphenolic compounds, vitamins, amino acids, alkaloids, terpenoids secreted from the plant(Heinlaan et al., 2008; Qu et al., 2011).so The green synthesized nanoparticle can have huge application in the field of food, pharmaceutical, and cosmetic industries and thus become a major area of research.

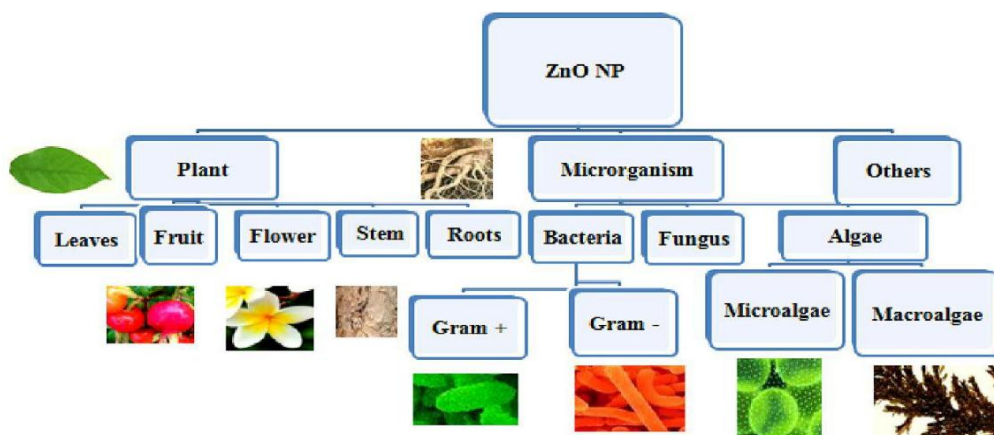


Figure 2 Green synthesis of Zinc oxide nanoparticles by using different sources

2.2.2. Sol-gel Methods

In the sol–gel processing method, there are two types of words, ‘sol’ which is a colloidal suspension of solid particles in a liquid and ‘gel’ which are polymers containing liquid. Thus, this process includes the creation of ‘sols’ in the liquid that lead to the formation of a network of discrete particles or network polymers by the connection of sol particles(Binker & Scherer, 1990). Hydrolysis and condensation are the typical steps of sol–gel process, in which the former uses water to disintegrate the bonds of the precursor that is also the first 4 step in formation of the gel phase. This process is then followed by condensation that leads to the formation of nanomaterials after which excess water is removed to determine the Final structure of the material Zinc oxide's (ZnO) physical and chemical properties make it preferable compound to us.

The sol-gel process, involves the evolution of inorganic networks through the formation of a colloidal suspension (sol) and gelation of the sol to form a network in a continuous liquid phase (gel). The precursors for synthesizing these colloids consist usually of a metal or metalloid element surrounded by various reactive ligands. The starting material is processed to form a dispersible oxide and forms a sol in contact with water or dilute acid. Removal of the liquid from the sol yields the gel, and the sol/gel transition controls the particle size and shape. Calcination of the gel produces the oxide. The figure below shows the sol-gel method for synthesis of ZnO NPS.

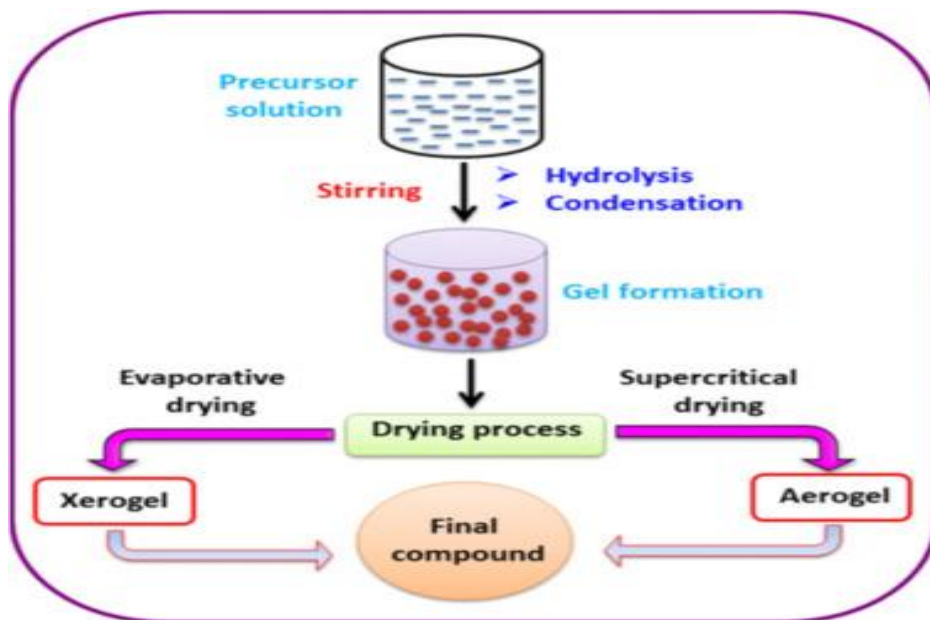


Figure 3 Sol-gel synthesis method of ZnO NPs

2.2.3. Thermal Decomposition

Thermal decomposition, or thermolysis, is a chemical decomposition caused by heat. The decomposition temperature of a substance is the temperature at which the substance chemically decomposes. Many oxides nanoparticles have been prepared by thermal decomposition, Likewise, zinc oxide nanoparticles prepared by thermal decomposition.

2.2.4. Precipitation Methods

Precipitation is the creation of a solid from a solution. so, this method in particular has been successfully used to design different structures of zinc nanoparticles. The synthesized ZnO nanoparticles using a simple solution route without assistance of base, surfactant, template etc., at relatively very low temperature, by a single-step process. They reported that the ZnO crystal growths are more sensitive to the mixture of solvents, which depends on the miscibility, polarity, and homogeneity of precursor in the reaction medium (Sepulveda-Guzman et al., 2009).

A variety of methods have been used to synthesis pure ZnO nanoparticles, it still needs a great deal of work to explore simple and new approach with low cost to synthesis ZnO nanoparticles. In this work, ZnO nanoparticles have been synthesized by annealing the ZnO precursor at different temperatures. The precursor is obtained by a direct precipitation method through the reaction between zinc nitrate ($\text{Zn}(\text{NO}_3)_2$) and ammonium carbonate ($(\text{NH}_4)_2\text{CO}_3$) in aqueous solutions, which belongs to the solution phase. The precipitation method has its own advantages, such as low-processing cost, high quality, relatively low temperature and high manufacture yield. The effects of different calcinating temperatures especially on microstructural properties of the ZnO nanoparticle (Raoufi, 2013).

Zinc oxide nanoparticles have also been synthesized by dissolving $\text{ZnCl}_2(5.5\text{g})$ in 200 mL of water at 90°C or 1,2- ethanediol at 150° and after some filtering, washing, filtering, peptizing and calcinating process zinc oxide nanoparticles is prepared(Becheri, 2008)

2.3. Characterization of ZnO NPS

The size, shape, size distribution, degree of aggregation, surface charge surfactant coatings and surface area, of the synthesized nanoparticles of zinc oxide nanoparticles is obtained using different spectroscopic and charactering technique. The techniques are X-ray Power Diffractometry (XRD), UV-vis spectroscopy, Scanning Electron Microscopy (SEM) and Fourier transformed infrared spectroscopy (FTIR).

2.3.1. X-ray Diffraction Characterization

X-ray powder diffraction (XRD) is the most widely used techniques for the characterization of nanoparticles. basically, XRD provides information regarding the crystalline structure, nature of the phase, lattice parameters and crystalline grain size. The latter parameter is estimated by using

the Scherrer equation using the broadening of the most intense peak of an XRD measurement for a specific sample of the synthesized nanoparticles.

X-ray diffraction is performed with the intention of substantiate various phases of ZnO nanoparticles. The phase identification of ZnO NPs is evaluated using the X-ray powder diffraction (XRD) with 2θ ranges from 20° to 80° with Cu $K\alpha$ radiation of 0.1540 nm, with scan rate 1.5o/min. The mean particle size (D) from XRD analysis is calculated by using Debye-Scherrer's formula.

(2.1)

$$D = \frac{0.89 \lambda}{\Delta w \cos \theta}$$

where λ is the wave length of the incident X-ray beam ($\lambda=1.54^\circ\text{A}$ for Cu $k\alpha$), θ is the bragg's diffraction angle and Δw is the width of the X-ray pattern line at half peak height in radiance.

2.3.2. UV-vis Spectroscopy

UV-visible spectrometers can be used to measure the absorbance of ultra violet or visible light by a sample, either at a single wavelength or perform a scan over a range in the spectrum. The UV region ranges from 190 to 400 nm and the visible region from 400 to 800 nm. The technique can be used both quantitatively and qualitatively. Ultraviolet-visible (UV-Vis) spectroscopy is one of the most popular analytical techniques because it is very versatile and able to detect nearly every molecule. With UV-Vis spectroscopy, the UV-Vis light is passed through a sample and the transmittance of light by a sample is measured. From the transmittance (T), the absorbance can be calculated as $A=-\log (T)$. An absorbance spectrum is obtained that shows the absorbance of a compound at different wavelengths. The amount of absorbance at any wavelength is due to the chemical structure of the molecule.

UV-Vis can be used in a qualitative manner, to identify functional groups or confirm the identity of a compound by matching the absorbance spectrum. It can also be used in a quantitative manner, as concentration of the analyte is related to the absorbance using Beer's Law. UV-Vis spectroscopy is used to quantify the amount of DNA or protein in a sample, for water analysis, and as a detector for many types of chromatography. Kinetics of chemical reactions are also measured with UV-Vis spectroscopy by taking repeated UV-Vis measurements over time. UV-Vis measurements are generally taken with a spectrophotometer. UV-Vis is also a very popular detector for other analytical techniques, such as chromatography, because it can detect many compounds.

Typically, UV-Vis is not the most sensitive spectroscopy technique, because not a lot of light is absorbed over a short path length. Other spectroscopy techniques such as fluorescence have higher sensitivity, but they are not as generally applicable, as most molecules are not fluorescent. UV-Vis has a similar sensitivity to other absorbance measurements, such as infrared spectroscopy.

UV-vis spectroscopy can also use to characterize the nanoparticles such ZnO NPs. It measures the absorption peaks of ZnO Nanoparticles, which occurred due to transition of scanning of electron from the valance band to conduction band.

Generally, as it was reported in several literatures, the UV-Vis absorption peaks of ZnO NPs are found between 350-380 nm(Seetawan et al., 2011). The width of energy gap of ZnO NPs calculated based on effective mass approximation using Brus Equation(Spanhel, 2006).

$$E_g^n = E_g^b + \left(\frac{h^2}{8R^2} \right) \left(\frac{1}{m_e} + \frac{1}{m_h} \right) - \left(\frac{1.8e^2}{4\pi\epsilon_0 \epsilon R} \right) \quad (2.2)$$

Where E_g^n and E_g^b are the band gap energies of nanoparticle and bulk solid respectively, R is the radius of the quantum dot, m_e is the effective mass of electron in solid ($m_e = 9.11 \times 10^{-31}$ kg), e is elementary charge of electron ($e = 1.6 \times 10^{-19}$), h is planks constant (6.626×10^{-34} J.S), m_h is the effective mass of hole (1.62×10^{-27} kg) in solid, ϵ is the dielectric constant of the solid.

2.3.3. Fourier transformed Infrared Spectroscopy

Fourier transformed infrared spectroscopy (FTIR) is a technique used to get the information about the chemical bonding in a material. It is used to identify the elemental constituents of a material and it helps to get Structural identification and quantitative information about the synthesized nanoparticle.(Muthukumaran & Gopalakrishnan, 2012).

2.3.4. Scanning Electron Microscopy

Scanning electron microscopy (SEM) is a microscopic instrument which gives a detail information about size, external morphology (texture), microstructure of ZnO NPs. Electrons are thermionically emitted from a tungsten or lanthanum hexa boride cathode and are accelerated towards an anode; alternatively, electrons can be emitted via field emission. The electron beam, which has an energy ranging from a few hundred eV to 100 KeV, is focused by one or two condenser lenses into a beam. Characteristic X-rays are emitted when the primary beam causes the ejection of inner shell electrons from the sample and are used to determine the elemental composition of the sample.

As most biological specimens are made up of non-dense material the number of secondary electrons produced is too low to be of much use in creating an image and therefore, they are usually coated with a very fine layer of a metal which readily produces secondary electrons. The back scattered electrons emitted from the sample can be used. These signals are monitored by

photomultiplier tubes and magnified. An image of the investigated microscopic region of the specimen is observed in cathode ray tube and is photographed (Cullity, 2001).

2.4. Application of Zinc Oxide Nanoparticles

Zinc oxide's (ZnO) physical and chemical properties make it a different and extremely attractive compound to use in a variety of nanotechnology applications. Some of these applications include biomedical, energy, sensors, and optics. Unique properties of ZnO NPs plays relevant role in a very wide range of applications, ranging from tires to ceramics, from pharmaceuticals to agriculture, and from paints to chemicals(Gomez & Tigli, 2013). The figure below shows the general and different application of zinc oxide nanoparticles

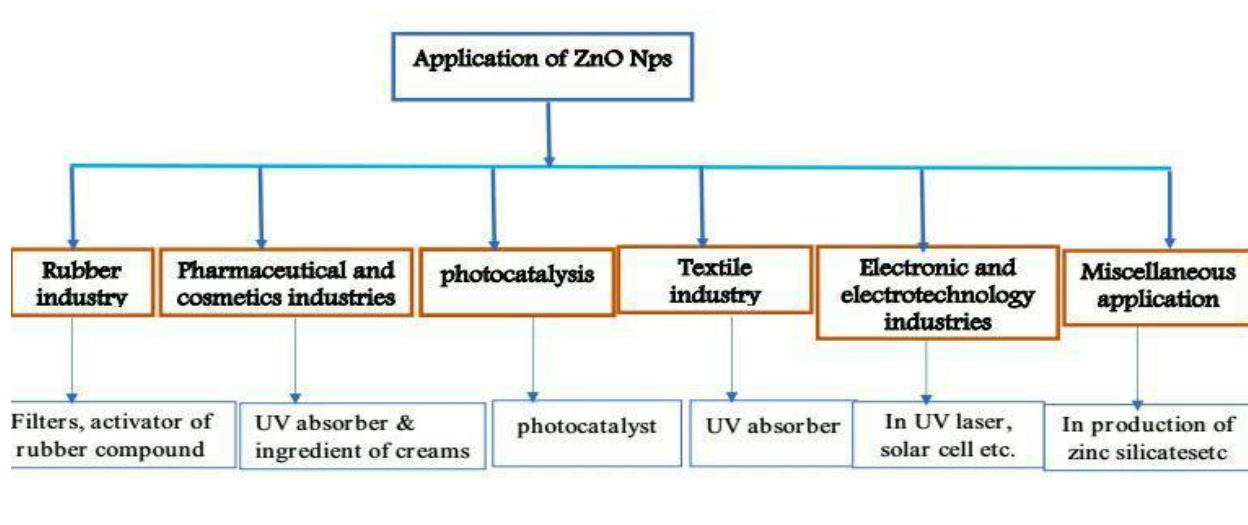


Figure 4: General application of zinc oxide nanoparticles

2.5. Application of Zinc Oxide Nanoparticle on Textiles

Zinc oxides nanoparticles used in textile finishing to alter surface properties and impart desirable textile functions. Nanosized particles have a larger surface area and their use can therefore result in higher efficiency of the treatment agent than larger size particles. Besides, nanosized particles

are transparent, and do not affect the color and brightness of the textile substrates. fabrics treated with nanoparticles of ZnO, may replace fabrics treated with active carbon, previously used for chemical and biological protection(Sawhney et al., 2008).

The use of Zinc oxide nanoparticles in the textile industry has increased rapidly. This is mainly due to the fact that conventional methods used to impart different properties to fabrics often do not lead to permanent effects, and will lose their functions after laundering or wearing. Zinc oxide nanoparticles can provide high durability for treated fabrics, with respect to conventional materials, because they possess large surface area and high surface energy that ensure better affinity for fabrics and lead to an increase in durability of the textile functions. washfastness is a particular requirement for textile and it is strongly correlated with the nanoparticles adhesion to the fibers. In order to increase the washfastness, the nanoparticles can be applied by dipping the fabrics in a solution containing a specific binder(Becheri, Dürr, Nostro, & Baglioni, 2008; C.-C. Chen, Wang, & Yeh, 2010; Roe & Zhang, 2009; Vigneshwaran, Kumar, Kathe, Varadarajan, & Prasad, 2006)

Textile materials coated with these zinc oxide nanoparticles have proven to be useful for many applications, such as hydrophobicity, antimicrobial, ultraviolet (UV) protection and self-cleaning. substrates. However, more interesting and progressive works in the field of textile finishes are the construction of bifunctional or multifunctional fabrics using various nanostructured materials. The finished fabrics can offer multiple innovative characteristics (antimicrobial, water repellent, self-cleaning, UV blocking, electrical conductivity, etc.) simultaneously, which broadens the practical areas of the final product(Shateri-Khalilabad & Yazdanshenas, 2013)

2.6. Zinc Oxide Nanoparticles for Antibacterial in Textiles

Bacteria are mostly characterized by a cell membrane, cell wall, and cytoplasm. The cell wall found outside the cell membrane and is composed mostly of a homogeneous peptidoglycan layer (which consists of amino acids and sugars). The cell wall maintains the osmotic pressure of the cytoplasm as well the characteristic cell shape. Gram-positive bacteria have one cytoplasmic membrane with multilayer of peptidoglycan polymer, and a thicker cell wall (20–80 nm). Whereas gram-negative bacteria have two cell membranes, an outer membrane and a plasma membrane with a thin layer of peptidoglycan with a thickness of 7–8 nm. NPs size within such ranges can readily pass through the peptidoglycan and hence are highly susceptible to damage or kill. The cytoplasm, a jelly-like fluid that fills a cell, involves all the cellular components except the nucleus. The functions of this organelle include growth, metabolism, and replication. Consequently, the cytoplasm contains proteins, carbohydrates, nucleic acids, salts, ions, and water (~80 %). This composition contributes in the electrical conductivity of the cellular structure. The overall charge of bacterial cell walls is negative.(Sirelkhatim et al., 2015)

Due to the intrinsic properties, fabrics can provide a particularly suitable environment for growth and proliferation of microorganisms, such as bacteria and fungi, commonly found almost everywhere in the environment that cause harm in human health(Gao & Cranston, 2008). Concerning these issues significant efforts have been made in the development of new strategies for incorporating antimicrobial agents in fabrics and in the manufacture of new products with antimicrobial properties that could efficiently prevent the growth and spreading of bacterial infections(Petkova, Francesko, Perelshtein, Gedanken, & Tzanov, 2016).

The shape of ZnO NPs can influence their mechanism of internalization such as rods and wires penetrating into cell walls of bacteria more easily than spherical ZnO-NPs. Whereas, flower-

shaped have revealed higher biocidal activity against *S. aureus*, and *E. coli* than spherical and rod-shaped ZnO NPs(Ma et al., 2013)

Although there are several hypotheses concerning the mechanisms responsible for the antimicrobial activity of ZnO NPs, these have not yet been completely understood and more studies should be done to clarify this matter. The most common mechanisms including the release of antimicrobial ions, mainly Zn^{2+} ions, interaction between nanoparticles and microorganisms, which leads to damage to the integrity of the cell wall and the formation of reactive oxygen species (ROS). Species such as superoxide anion (O_2^-), hydrogen peroxide (H_2O_2) and hydroxyl radical (OH^\cdot) can interact and cause damage to cellular components, important cause for ZnO NPs antimicrobial effects, suggests that the antibacterial effect of ZnO NPs is due to membrane lipid oxidation caused by ROS produced during interaction of ZnO *E. Coli*. A significant effort by demonstrating the presence of hydroxyl radicals in aqueous suspensions of small ZnO NPs and also demonstrated that an exposure of *E. coli* and *S. aureus* to the ZnO NPs leads to bacterial cell damage(Kalpana et al., 2018).

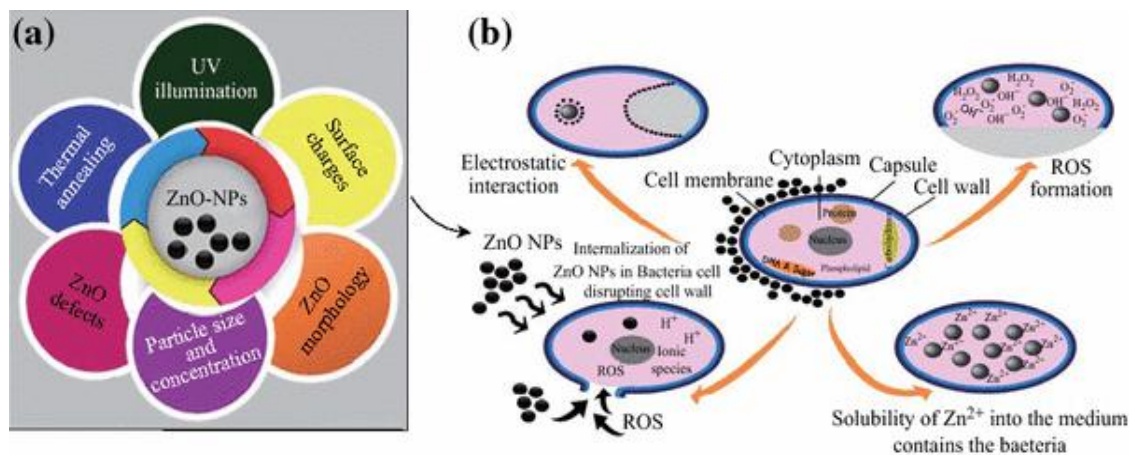


Figure 5: a) Influence of essential ZnO-NPs parameters on the antibacterial response and the B) different possible mechanisms of ZnO-NPs antibacterial activity, including: ROS formation, Zn²⁺ release, internalization of ZnO-NPs into bacteria, and electro interact

2.7. Zinc Oxide Nanoparticles for UV-Protection Textiles

High exposure to UV radiation can result in skin damage such as sunburn, premature skin ageing, allergies, and even skin cancer, particularly in white-skinned people. However, zinc oxide nanoparticles coated textiles can provide effective protection against such damage. Sun protection textiles are common choices to protect against UV radiation although UV radiation also weathers and degrades textiles. So many UV blocking agents are being developed to add or to enhance the UV protection function of the textiles(Reinert, Fuso, Hilfiker, & Schmidt, 1997). There are both organic and inorganic UV blockers. The organic blockers are also known as UV absorbers as they absorb the UV radiation, whereas the inorganic blockers such as TiO₂ and ZnO efficiently scatter both UVA and UVB, the main cause of skin cancer. Compared with organic UV absorbers, inorganic blockers are now preferred due to their properties such as nontoxicity and chemical stability under UV radiation(Mishra et al., 2014).

3. Materials and Methods

3.1. Chemicals

The chemicals ZnCl₂, 1,2- ethanediol), 2-propanol, NaCl, zinc nitrate (Zn(NO₃)₂·6H₂O), ammonium chloride (NH₄Cl), urea, ammonia solution, , distilled water, and ethanol were used in synthesis of zinc oxide nanoparticles.

3.2. Apparatus and Instruments

The apparatus which were used in the experiments are:, centrifuge, hot plate, electronic balance, whatman filter paper, oven, beakers(different size), scissors, local and factory cotton.

The instrument used to measure the absorbance, shape and crystallites were UV-Spectroscopy (Perkin-elemnary, Germany) Scanning Electron Microscopy (SEM), and X-ray Powder Diffusion (XRD) (Cu-K α 1 radiation ($\lambda=1.5406 \text{ \AA}$) operating at 45 KV and 30 mA).

3.3. Synthesis Methods

Synthesis one, ZnO nanoparticle was prepared by precipitation method and the synthesis was carried out at a high degree of supersaturation. 5.5 g of ZnCl₂ was dissolved in 200 mL deionized water in beaker and vigorously stirred by magnetic stirrer at 90°C and 16 mL of 5 M NaOH aqueous solution were added dropwise to the zinc chloride solution, with a gentle stirring over a period of 10 min at 90°C. After the complete reaction, the solution was allowed to settle and the supernatant solution was removed and the remaining suspension washed 5 times with distilled water. The particles were then peptized with 2-propanol at room temperature. The particles were then collected by centrifugation at 4000 rpm for 10 min. The prepared particles were thermally treated in oven for 5 hrs. at 250 °C leads to the formation of Zinc oxide nanoparticle. The synthesis 2 in 1,2- ethanediol (ED) was carried out in the same way, but at 150 °C.

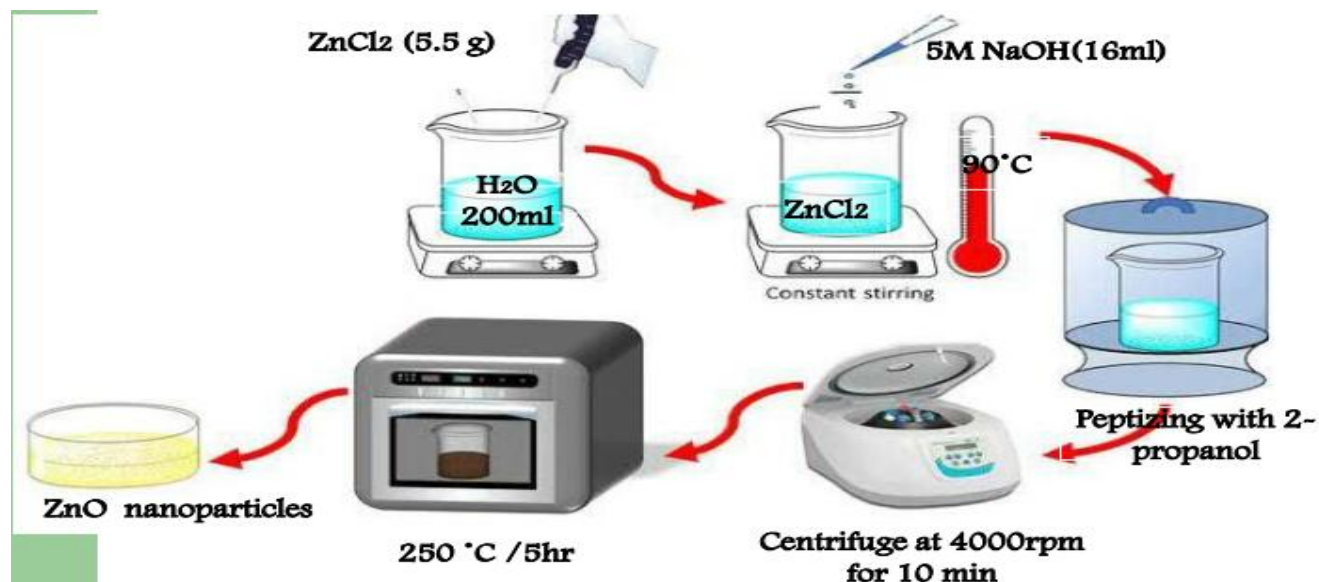


Figure 6: Synthesis of Zinc Oxide nanoparticles

In Synthesis Three, Zinc oxide nanoparticles were prepared by in situ methods on cotton Fabrics. Before being used, the fabric was washed in warm water using a non-ionic detergent to ensure removal of residual chemicals. After washing, the fabric was rinsed with warm water two times, thoroughly with cold water and then oven dried at 75°C for 60 min. The cotton textile was transferred in the 100mL of aqueous solution which contain 0.005 mol $\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$. after 15min, 0.02 mol NH_4Cl , 0.01 mol urea and 5 mL ammonia solution added to the reaction vessel. The system was rapidly heated (10°C/ min) to 90°C and kept for 60 min. The reaction carried out under magnetic stirrer (300 rpm). After reaction, the fabric was removed, rinsed by distilled water several times, then air-dried for 60 min and finally oven cured at 150°C for 10 min to ensure particles' adhesion to the fibers' surface

3.4. Fabric Treatment

For synthesis one and two samples, the cotton fibers samples (253g/ m²) and (10 cm × 10 cm) were soaked for 10 min in 2-propanol dispersion of ZnO nanoparticles (5% w/w) under gentle magnetic stirring. The cotton fibers were then squeezed to remove the excess dispersion and dried in oven at 130°C for 15 min under atmospheric pressure (dry heat). In order to evaluate the nanoparticles adhesion to the cotton fibers, the treated fabrics were washed two times.

Zinc oxide nanoparticles in situ synthesized on the surface of the cotton rinsed by distilled water several times, then air-dried for 60 min and finally oven cured at 150°C for 10 min to ensure particles' adhesion to the fibers' surface.

3.5. Antibacterial Activity Test

The antibacterial activity of the zinc oxide nanoparticles from synthesis 2 on gram positive (*S. aureus*) and gram-negative (*E. coli*) bacteria were tested by agar disc diffusion method. Microbial strains were grown aerobically in nutrient broth for 24 h at 37°C until the turbidity of bacterial suspensions was achieved to 1.3×10^8 CFU mL⁻¹(0.5 McFarland Standard.). Sterile standard filter paper discs (6mm in diameter) were impregnated with sterile aqueous suspensions of ZnO NPs at 126 µg/mL, 252 µg/mL, and 504 µg/mL were prepared by dissolving in dimethyl sulfoxide (DMSO) and placed onto the inoculated plates using sterile forceps. The standard antibiotic drug Ciprofloxacin was used as control positive. Then the plates were incubated at 37°C for 24 hrs. All measurements were performed in triplicate. Finally, the zone of inhibition formed around the discs was measured in millimeters (mm) and recorded.

Antibacterial activity of cotton fabrics was assayed against both Gram-negative (*Escherichia coli*) and Gram-positive bacteria (*Staphylococcus aureus*), First the antibacterial activity was assayed by the agar diffusion method. The cotton fabrics with 20 mm of diameter were uniformly pressed on the agar and incubated for 24 h at 37. After incubation, the antibacterial effect of the fabrics was investigated by evaluating different parameters: the growth of the bacteria underneath and the presence of at least 1 mm of inhibition zone around the specimen. Ideally, no bacterial growth should be observed on the fabric. Thus a “no growth” category represents “ideal” antibacterial efficacy; that is, no bactericide elutes into the bulk of the agar with no bacterial growth on the cotton

3.6. UV Absorption Properties

The solar UV radiation is actually composed of UV-A (400–315 nm), UV-B (315–290 nm) and UV-C (290–200 nm). UV transmittance through a fabric is the decisive factor determining the UV protection of cotton fabrics. The application of ZnO NPS on the cotton fabrics increases the absorption of UV light. UV spectra were performed on the untreated and treated fabrics and cotton textiles, by measuring the absorbance,

The UV-screen properties of the treated cotton fabrics were studied by absorption spectroscopy using a UV-Vis spectrometer. The effectiveness in shielding UV radiation was evaluated by measuring the UV Absorption, Transmission and reflection (Gambichler et al., 2002). The transmission data were used to calculate the ultraviolet protection factor (UPF), The UPF rating system measures the UV protection provided by fabric. The UPF is defined as the ratio of the average effective irradiance calculated for skin to the average UV irradiance calculated for skin protected by the test fabric and The UPF was calculated using mean percentage transmission in the UVA region (315–400 nm) and mean percentage transmission in the UVB region (280–315nm) according to the following equation. (Gambichler, 2002)

$$UPF = \int_{\lambda_1}^{\lambda_2} \frac{E(\lambda) \cdot S(\lambda) d\lambda}{E(\lambda) \cdot S(\lambda) \cdot T(\lambda) d\lambda} \quad 3.1$$

$$\text{Percent UV transmission} = \frac{\sum_{\lambda_1}^{\lambda_2} T(\lambda)}{(\lambda_2 - \lambda_1)} \quad 3.2$$

Where $E(\lambda)$ is the relative erythermal spectral effectiveness, $S(\lambda)$ is the solar spectral irradiance in $\text{Wm}^{-2}\text{nm}^{-1}$ and $T(\lambda)$ is the spectral transmission specimen obtained from UV spectrometric

experiments. $E(\lambda)$ and $S(\lambda)$ will obtain from the national oceanic and atmospheric administration data base (NOAA).

4. Results and Discussion

4.1. XRD Patterns of ZnO Nanoparticles

Figure a and b shows the XRD pattern of ZnO nanoparticles synthesized using water and 1,2-ethanediol ($\text{CH}_2\text{OHCH}_2\text{OH}$) as solvent respectively. The diffraction peaks of ZnO NPs correspond to (100), (002), (101), (102), (110), (103), (112) and (201) planes. The samples (101) peak is the most intense peak. The average crystallite size of the ZnO NPs calculated using

Debye Scherer formula or using equation 2.1. The calculated average size were about 19.2 nm and 19 nm for synthesis one (water) and synthesis two (1,2-ethanediol) respectively.

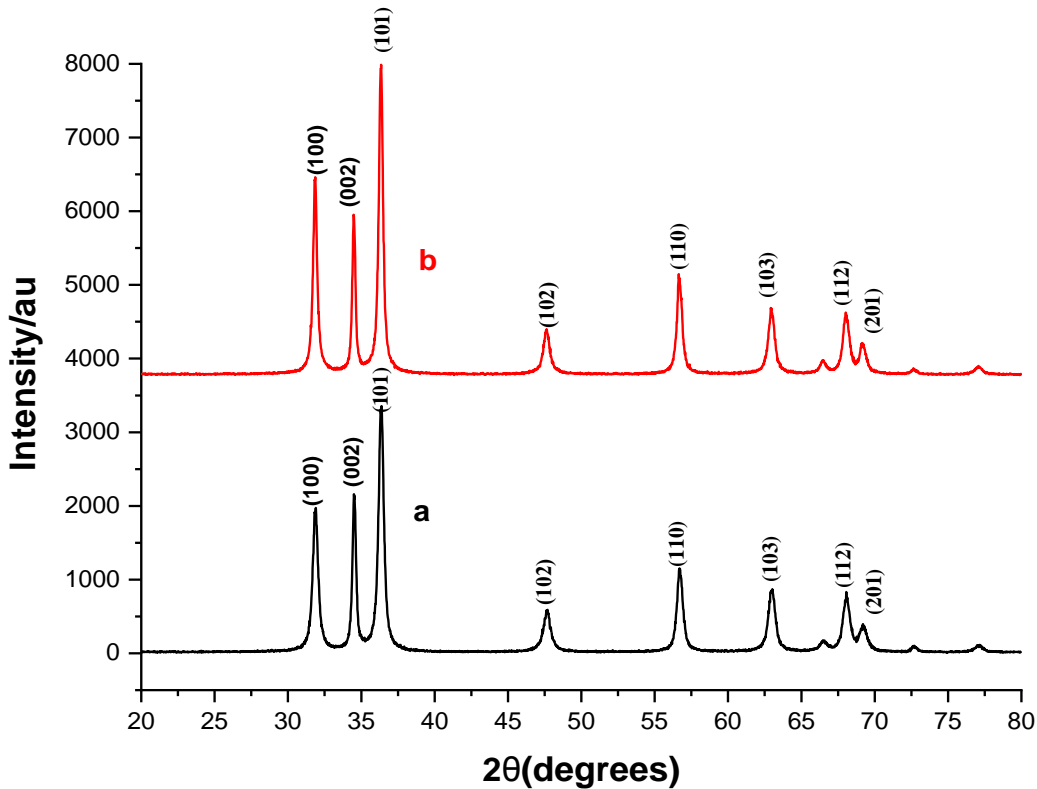


Figure 7: a) XRD patterns of the ZnO NPS obtained from (a) synthesis 1 and (b) synthesis 2

(A)				
hkl	2θ(degree)	FWHM(degree)	Crystallite size(nm)	D(nm)
100	31.8892	0.43490	20.35	19.19
002	34.5312	0.32170	25.58	
101	36.3632	0.41910	19.72	
102	47.6436	0.53130	16	

110	56.6946	0.43280	20.53	
103	62.9578	0.51510	17.5	
112	66.4783	0.52800	17.8	
201	68.0345	0.51200	18.5	
(B)				
hkl	2 θ (degree)	FWHM(degree)	Crystallite size(nm)	D(nm)
100	31.7340	0.38300	21.3	19.21
002	34.3932	0.43820	21.4	
101	36.2148	0.42290	19.54	
102	47.4978	0.48590	17.54	
110	56.5363	0.44620	17.65	
103	62.8168	0.51490	19.96	
112	66.3083	0.42800	17.85	
201	67.8909	0.51670	21.5	

Table 1: The X-ray diffraction parameters and crystallite size of ZnO nanoparticles synthesized using a) synthesis one and b) synthesis two

4.2. SEM Analysis

The chemical composition determined by SEM analysis also confirmed the uniform and dense deposition of ZnONPs on the fabric (Figure 8 b to d). The nanoparticles are well dispersed on the fiber surface in three cases, although some aggregated nanoparticles are still visible.

Nanoparticles because of the small dimension properties, high surface activity and large specific surface area, have a tendency to be agglomerated easily. The morphology of ZnO NPs characterized by SEM shows flower and spherical for ZnO NPs were on treated cotton textiles.

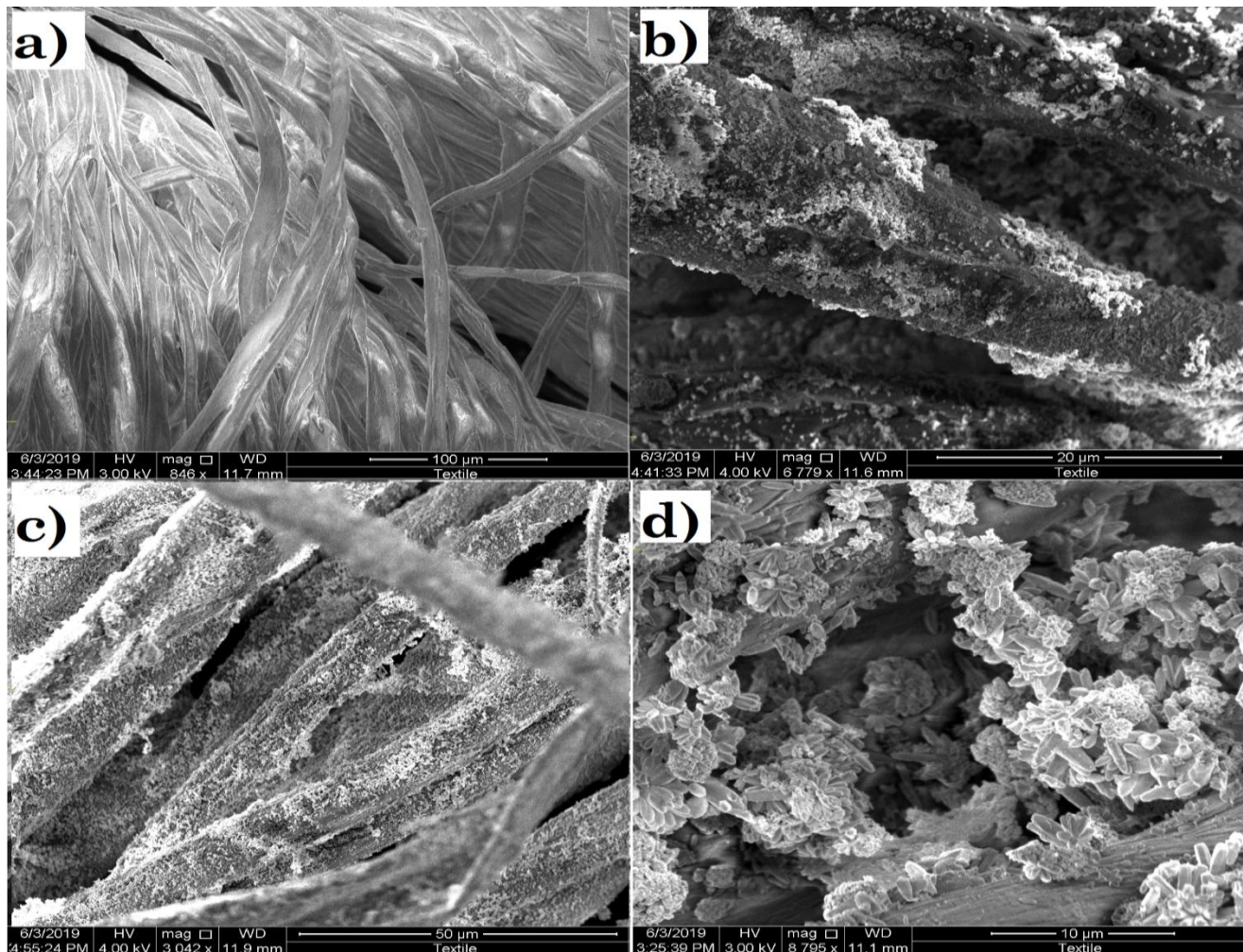


Figure 8 SEM image of cotton Textiles (a) uncoated, (b) ZnO NPs coated from synthesis one(water as a solvent, (c) ZnO NPs coated from synthesis two(ethylene glycol as a solvent), (d) ZnO NPs from in situ synthesized on the Alemeda cotton textiles

ZnO powder from synthesis one and synthesis two are observed under scanning electron microscope to decide about morphology of the particle. SEM images taken at different fields of the powder are presented in the figure. 9a and 9b are spherical and both figures are observed that

nanoparticles remain aggregated form due to high surface energy and high surface area to the volume ratio,

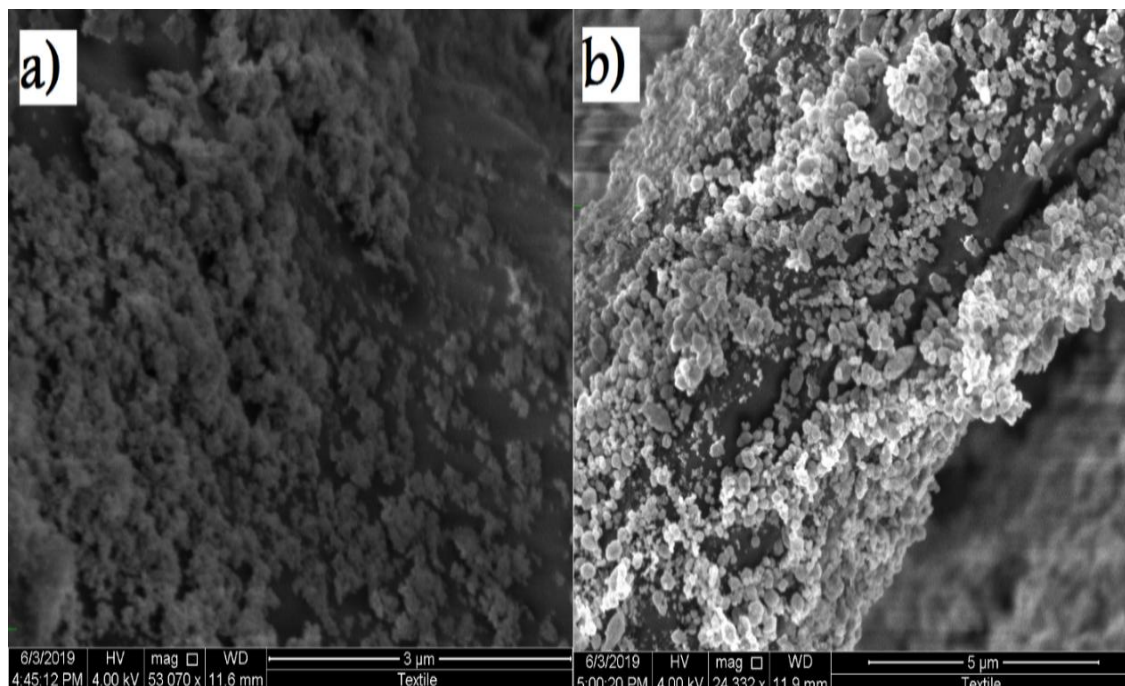


Figure 9 SEM images of ZnO powder synthesized using a) synthesis one and b) synthesis two

4.3. UV Protection of Cotton Textiles

The protective effect of textiles, the UPF was determined. The UPF is the ratio of the potential erythemal effect to the actual erythemal effect transmitted through the fabric by the radiation. The larger the UPF, the more protective the fabric is to UV radiation., UPF measured for both UVA and UVB radiation absorbance using a laboratory instrument (UV-

vis) and an artificial light source and translate these results using a mathematical expression based upon the sunburn action spectrum (Erythema action spectrum) integrated over the UV spectrum. Typically, a fabric with an UPF of >40 is considered to provide excellent protection against UV radiation and higher Values of UV absorbance were obtained when ZnO NPs in situ synthesized for local and fabric cotton textiles. (see figure 10 (B) and figure 11 (C)). similarly, The ZnO NPs obtained from Synthesis one and synthesis 2 shows good protection of UV lights for local and fabric cotton textiles. See fig 10(A), and 11(A), (B). respectively,

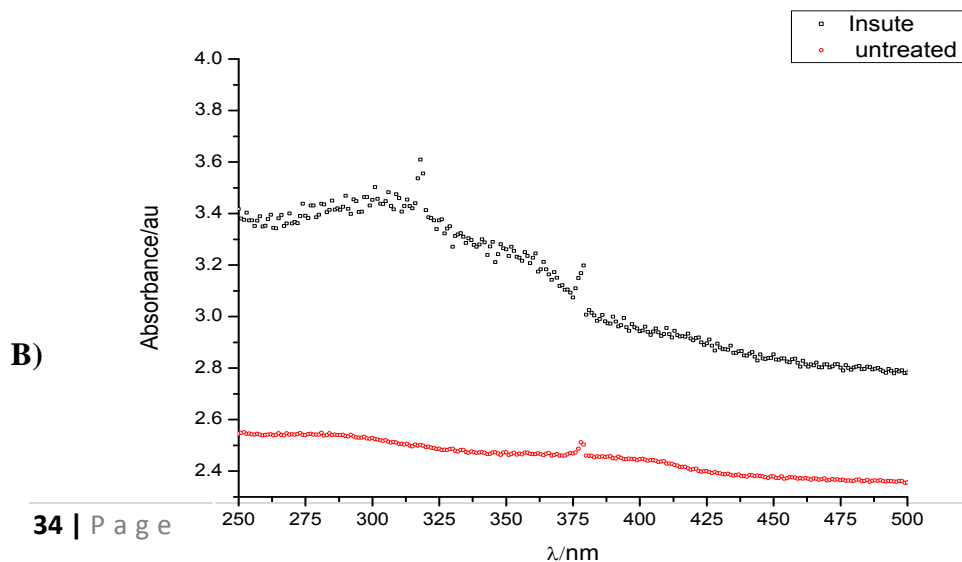
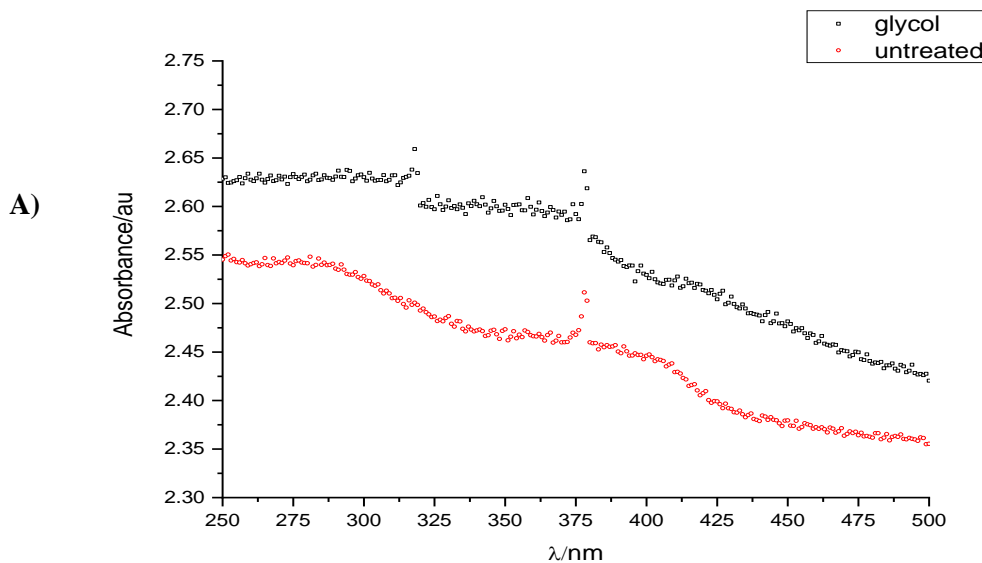


Figure 10 A) Absorption spectra for treated fabric cotton + synthesis two (ethylene glycol as a solvent) (B) Absorption spectra for treated fabric cotton from in situ method

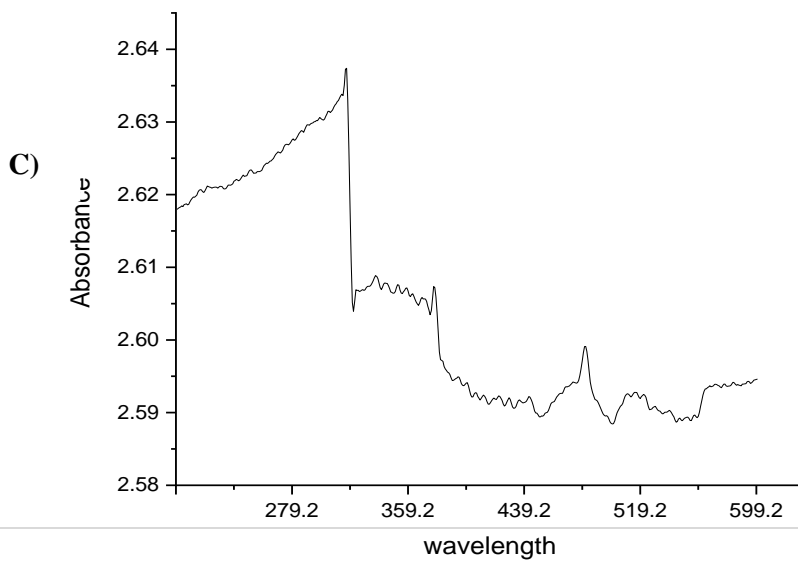
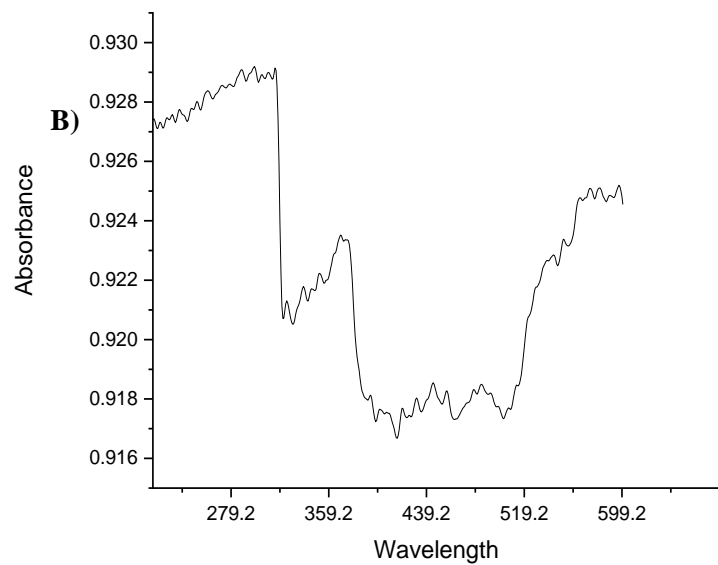
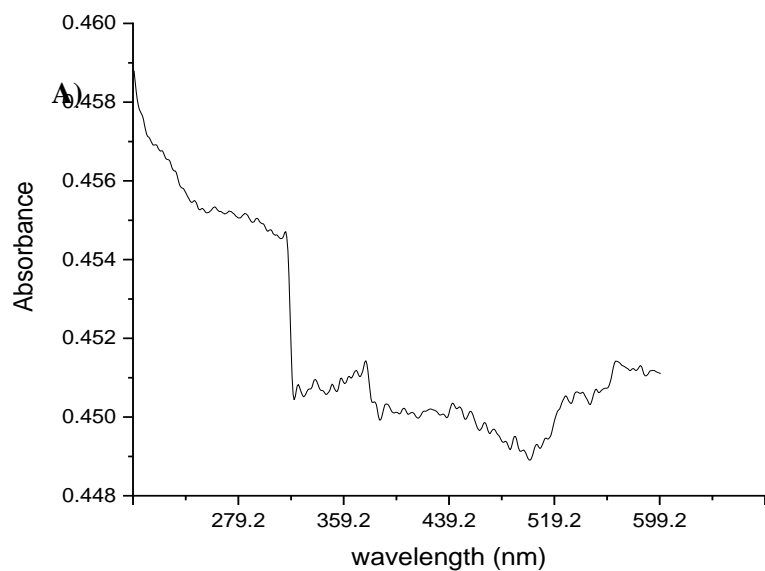


Figure 11 A) Absorption spectra for untreated local cotton (B) Absorption spectra for treated local cotton + synthesis one (C) Absorption spectra for treated local cotton from in situ method

The results of the UPF and the percent of UV transmission in the ranges of UV (UVB, UVA) for the uncoated and the ZnO-coated were calculated according to equation 3.1 and 3.2, respectively, and are presented below in Table 2. Initial investigations regarding the UV protection property of the untreated both local and fabric cotton textiles showed that poor protection against UV radiation. The UPF value of the ZnO NPs untreated and treated cotton textiles was under 3. An UPF value <15 indicates no protection against transmittance of UV radiation through fabric and onto skin. ZnO NPs significantly improved the UV-protection property of both local and fabric cotton textiles. The UV absorbance decreased significantly (UPF in the UVA is lower than UVB). The UPF value increased to 320 for the ZnO-coated

Sample	UPF		UV transmission (%)		
	UV-A	UV-B	UV-A	UV-B	UV-A/UV-B

fabric using in situ method for fabric cotton textile.

Fabric Cotton					
Untreated	17.6	19	5.9	5.4	1.1
Synthesis 1	118	209	0.9	0.8	1.13
Synthesis 2	196	213	0.26	0.215	1.21
In situ	226	320	0.067	0.0371	1.8
Local Cotton					
Untreated	2.85	2.97	35	34.6	1.01
Synthesis 1	8.5	10.7	12	11.8	1.01
Synthesis 2	12.83	15.28	7.8	7.6	1.02
In situ	42.7	44.6	0.24	0.23	1.04

Table 2: UPF and percent UV transmission for local and fabric cotton textiles

4.4. Antibacterial activity of the ZnO nanoparticles

Figure 12a, b: shows the presence of an inhibition zone which clearly indicate the synthesized ZnO NPs have antibacterial effect by disrupt the cell membranes probably by the production of reactive oxygen species, such as superoxide, hydroxyl radicles and the ZnO NPs could be attributed to the damage of the bacterial cell membrane and extrusion of the cytoplasmic contents there by resulting in the death of the microbial.

Antibacterial activity results showed that the ZnO nanoparticle synthesized using $ZnCl_2$ has exhibited strong antibacterial activity against both gram-positive (*S. aureus*) and gram-negative (*E. coli*) bacteria. Moreover, ZnO nanoparticles performed better antibacterial activity on gram-positive (*S. aureus*) than the gram-negative (*E. coli*) bacteria in comparison to standard antibiotics.

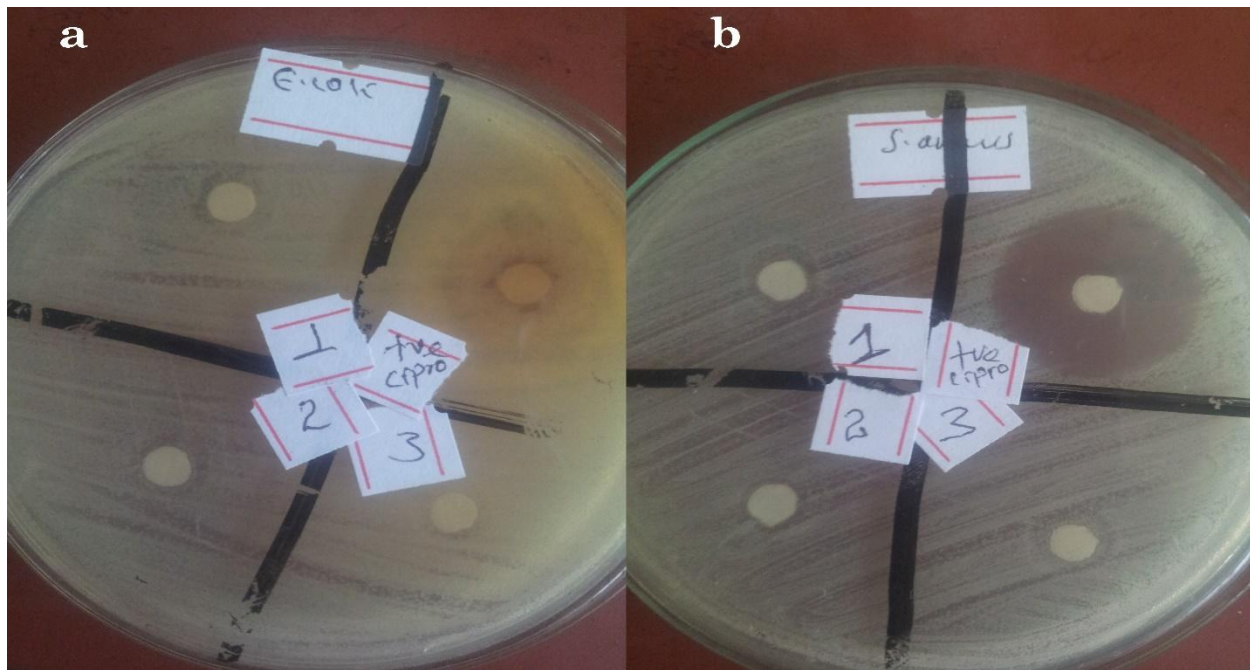


Figure 12 Antibacterial activity of ZnO NPs synthesized using zinc chloride on, a) *E. coli*. and b) *S. aureus*

Figure 13 shows the size of inhibition zone was different according to the type of bacteria. The antibacterial activity of was depend on the concentration of ZnO NPs, particle size also ply important roles in the antimicrobial activities. This discussion points out the importance of understanding the mechanism of ZnO NPs antimicrobial activity. Generally, the growth inhibition of *E. coli* and *S. aureus* has been increased by increasing the concentration of ZnO nanoparticles in discs.

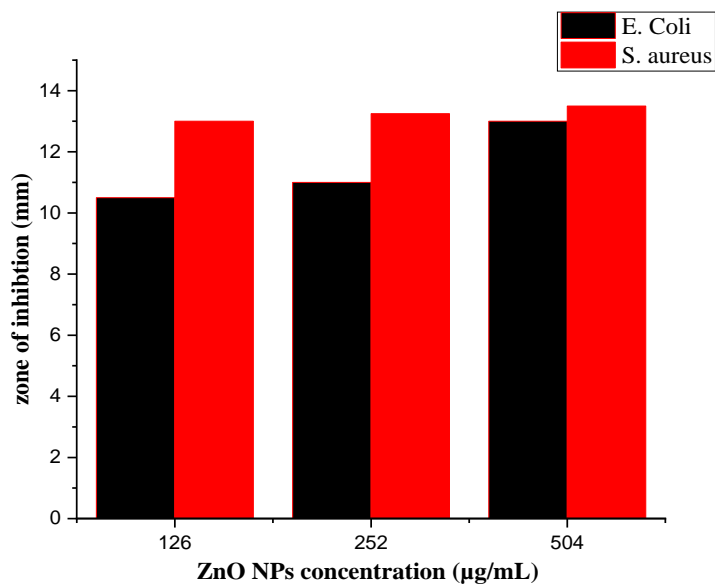


Figure 13 The comparison of antibacterial activity of ZnO NPs from synthesis 2 on *S. aureus* and *E. coli*.

The excellent dispersion of nanoparticles on cotton fibers, suggests the existence of a good adhesion between the ZnO NPs and fibre matrix this is due to the in situ synthesis that favors zinc ions interaction with the fabric prior to ZnO nanoparticles formation. The ZnO-coated fabric showed bacteriostatic activity against both Gram-positive *S. aureus* Gram-negative *E. coli* bacteria, as demonstrated by the zone of inhibition formed around the cotton fabric surface as shown in figure 14. Therefore, the investigated ZnONPs treated fabrics are promising materials for use in hospital applications namely as raw material for curtains, disposable bedding linen or uniforms for health professionals, in order to contribute to the prevention of bacterial infections.

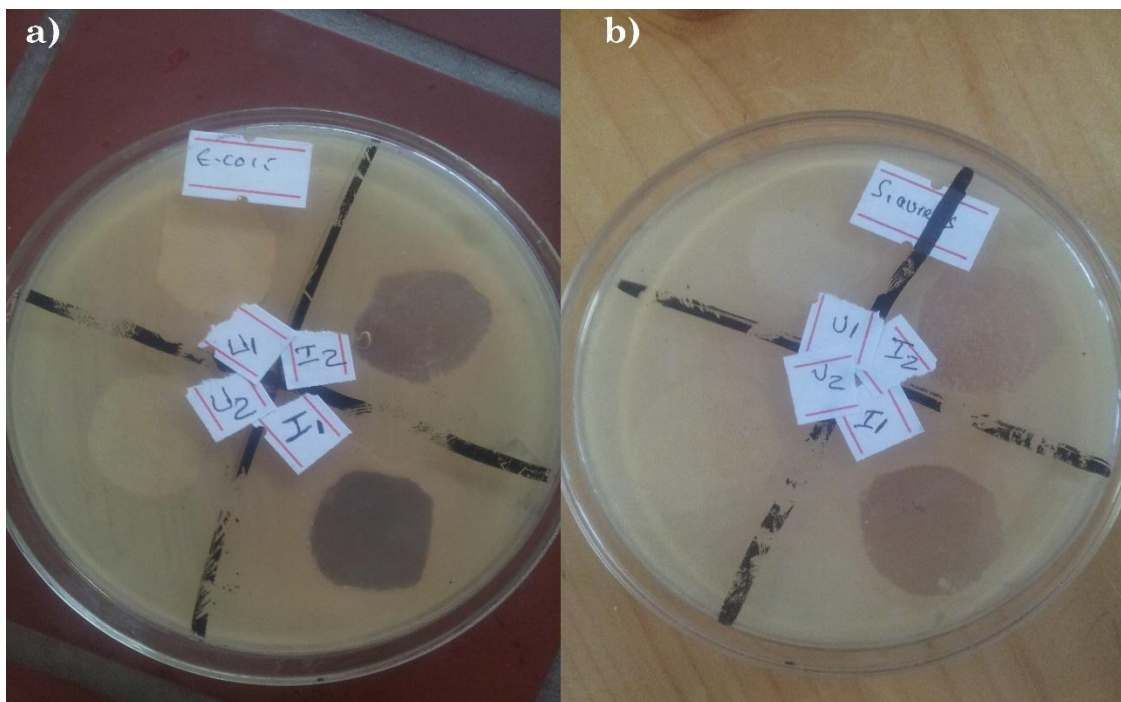


Figure 14 Antibacterial activities of ZnO-coated cotton fabrics a) E. coli. and b) S. aureus.

5. CONCLUSION

In this study, ZnONPs were synthesized using three different synthesis methods and used for ultraviolet (UV) protection and antibacterial activities. ZnO NPs were synthesized by precipitation method through homogeneous phase reaction using zinc chloride as a precursor with sodium hydroxide at high temperature in water and in 1,2- ethanediol at 90 °C and 150 °C.

respectively, and also ZnO NPs were in situ synthesized on the surface of cotton textiles via a simple wet chemical route. The synthesized and coated ZnO NPs were investigated by using different spectroscopic techniques such as X-ray powder diffractometry (XRD), Scanning electron microscopy (SEM) and UV-vis spectroscopy. The average crystallite size of the ZnO NPs using XRD was 19.19 and 19.21 for synthesis one and two respectively. The morphology of ZnO NPs characterized by SEM shows flower shape for ZnO on treated cotton textiles and spherical for nanoparticles synthesized using water and ethylene glycol as a solvent. UV protection ability of ZnO NPs coated and uncoated for local and fabric cotton textiles were investigated using UV-vis spectroscopy by measuring the ultraviolet protection factor (UPF) values in the range 280-400 nm. The value of ultraviolet protection factor for ZnO coated fabrics using in situ methods were 320. The synthesized ZnO NPs and ZnONPs treated fabrics showed good antibacterial activity against *E. coli.* and *S. aureus.* The zone of inhibition were 13 and 13.25 mm for *E. coli.* and *S. aureus* bacteria respectively.

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