Asian Journal of Biomaterial Research 2018; 4(4):1-7

Research Article

Textile Application And Antimicrobial Activity Ofbiosynthesizedzinc Oxide Nanoparticles from *Nypafrutican* Seeds' Starch

Stephanie Celeste C. Pamintuan[1]* Karina Milagros C. Lim[1, 2]
[1]Department of Physical Sciences, College of Science, Philippines 6400
[2]University Research and Development Services, University of Eastern Philippines, University Town, Northern Samar, Philippines 6400

Received: 08 July 2018 Revised: 14 July 2018 Accepted: 18 July 2018

ABSTRACT

Objective: An endemic palm specie abundant in Northern Samar was the subject for this study. With its few known uses, *Nypafruticans* was subjected for more experimentation and further uses. On the other hand, nanotechnology, one of science's greatest break hrough, making greatest innovations in almost every field. **Materials and methods:** Textiles treated with Zinc Oxide Nanoparticles has been tested against *E. coli* and *S. aureus*. Bacterial effects of the textile were determined using the zone of inhibition. Also, water repellency was tested, being one of the important factors in the textile industry. ***Results and conclusion***: Results showed that, the textile treated with ZnONps exhibited a good antimicrobial property to the bacteria sample and showed great water repellency ability.

KEYWORDS: Zinc Oxide Nanoparticles (ZnONps), Nypafruticans, textile, antimicrobial property.

Introduction

The use of nanotechnology in the field of textiles has received much attention with the current broad interest in nanomaterials and nanotechnology (*Lee, 2009)*. According to the National Nanotechnology Initiative (NNI), nanotechnology is defined as utilization of structure with at least one dimension of nanometer size for the construction of materials, devices or systems with novel or significantly improved properties due to their nano-size (*Yadav, A. et al., 2006).* The wide range of applications is possible as ZnO has key advantages. It is bio-safe, biocompatible and can be used for biomedical applications without coating.

* **Corresponding author,**
University of Eastern Philippines,
University Town, Northern Samar,
Philippines 6400.
karina_cui@yahoo.com

With these unique characteristics, ZnO could be one of the most important nanomaterials in future research and applications (Kathirvelu, *et. al*, 2008).

The surface of Zinc oxide nanoparticles reacts with water to produce reactive oxygen species that destroy the bacteria cell membranes. And, if the nanoparticles are made small enough, the bacteria will actually internalize the nanoparticles, resulting in even higher killing efficiency as the cells are attacked from the inside too (Anita and Ramachandran, *et. al*, 2012).

As stated by the "European Technological Platform for Textiles and Fashion", the textile industry to thrive must improve and reduce the costs of the processes, offer innovative products for traditional markets, develop new products for new markets. Nanotechnology has an important role to achieve these goals aimed at applications in the textiles sector (*Rajendran, 2010).* With this development, the industries are developing textiles with multiple functions or improved properties which they call 'multifunctional textiles'. This is not an ordinary textile but with improved functionalities like improved durability, water repellency and others.

With growth in world population and the spread of disease, the number of antibiotic resistant microorganisms is rising along with the occurrence of infections from these microorganisms. With the increase in health awareness, many people focused their attention on educating and protecting themselves against harmful pathogens. It soon became more important for antimicrobial finished textiles to protect the wearer from bacteria that it was to simply protect the garment from garment degradation (*Rajendran et al., 2006)*. Now, the need for antimicrobial finished textiles could lessen the problem on common diseases brought about by these pathogenic microorganisms like *Staphylococcus aureus* which is a common cause of skin infections, respiratory infections and food poisoning. Also, regarding the antibiotic resistant microorganisms like *Methicillin-resistant S. aureus* (MRSA) that is a worldwide problem in clinical medicine because there is no approved vaccine for *S. aureus.* Another is the *Escherichia coli* which could be one of the causes of Urinary Tract Infection (UTI).

This study focused on the application of zinc oxide nanoparticles synthesized from *Nypafruticans*in the antimicrobial analysis of*Escherichia coli*and *Staphylococcus aureus.* Also, tested the textile's characteristics in terms of its water repellency.

Materials and Methods

Isolation of Starch

The collected fresh fruits of *Nypafruticans* were washed to remove the dirt and were dehulled manually to get the mature seeds. One kilogram up to more than five kilograms of fresh seeds was weighed and soaked in one liter (for every kilogram of the seeds) of 1% of Sodium Metabisulfate solution was added into it and was soaked for one hour. After an hour, the seeds were put in a juicer. It was juiced into paste and was filtered using cheesecloth. The filtrate was then soaked with 1% Sodium Metabisulfate and allowed to settle. Supernatant was discarded and then the starch mucilage will be washed four times with 1% Sodium Metabisulfate and allowed to stand for 90 mins. After each wash, the washed starch mucilage was dried at 60°C in a drying oven for twelve hours. The dried starch was then pulverized and kept for analysis.

Preparation of Zinc Oxide from Zinc Nitrate

The preparation was done with the procedure of Subhankar Paul (2014) with some modification made. Zinc oxide nanoparticles was prepared by using Zinc nitrate and sodium hydroxides precursors and starch as a stabilizing agent. Starch isolated from *Nypafruticans* seeds, about 0.1g was dissolved in 500 mL of lukewarm distilled water. Zinc nitrate, 14.874 grams (0.1 mol), was added in the above solution, and then followed by constant stirring for 1 hour using magnetic stirrer to completely dissolve the zinc nitrate. After complete dissolution of zinc nitrate, 0.2 M of NaOH solution was added drop by drop under constant stirring. The reaction was allowed to proceed for 2 hours. After the completion of reaction, the solution was kept overnight and the supernatant solution was kept overnight and the supernatant solution was discarded carefully. Rest of the solution was centrifuged at 10,000 g for 10 min and the supernatant was discarded. Thus, the nanoparticles were obtained and washed thrice using distilled water. Washing was carried out to remove the by-products and the excessive starch bound with the nanoparticles. After washing, the nanoparticles were dried at 80^0C overnight.

Preparation of the Textile

A procedure from the study conducted by S Anita was adapted with a little modification.

PET Cloth was used for the purpose, or 'Katrina' in local terms. Zinc oxide nanoparticles were applied to the textile by pad-dry-cure method (with a little modification). The PET cloth, cut to a size of 30 x 30 cm, was immersed in a solution of 2% zinc oxide nanoparticles for 5 minutes. A 100% wet-pick up was maintained for all the treatments. After soaking, the textile was air-dried and then cured for 3 mins. at 140℃. The coated fabric was immersed for 5 mins in 2g/L Sodium Lauryl Sulphate to remove any unbound nanoparticles. The fabric was next rinsed 10 times to completely remove any traces of soap. The fabric was finally dried in ambient air. After drying, the textile was kept for future analysis.

The Antimicrobial Properties of Textile Treated with Zinc Oxide Nanoparticles

Antimicrobial analysis was carried out using the procedure used by Ariap (2017) but some modifications were made. All the equipment was placed in an autoclave for sterilization. R. Rachendran et al (2010) antimicrobial test was used to determine the antimicrobial activity of the treated textile against *E. coli* and*S. aureus*. Each of the subculture pure isolates of the bacteria were aseptically harvested into the surface of the cultured plates by using sterile cotton swab. A plain textile for the control was soaked with the solution of Chloramphenicol (1:10). The textiles and the soaked control was aseptically and carefully impregnated into the surface of nutrient agar using a sterile pick up forceps. The disc was placed with a distance from each other. The inoculated plates were incubated at 37℃ for 18-24 hours. After the inoculation, the plates were inspected for the presence of any clear zone of the inhibition around the sample discs.

Results and Discussion

Once the ZnO kills/captures the cell membrane, the ZnONps presumably remain tightly adsorbed on the surface of the dead bacteria preventing further bacterial action. However, ZnO nanoparticles continue to release peroxides into the medium even after the surface of the dead bacteria are completely covered by ZnO nanoparticles, thereby showing high bactericidal efficacy (Padmavathy and Vijayaraghavan, 2008).

Antimicrobial analysis was done measuring the zone of inhibition created by the discs (positive, negative, and sample).Following the standard protocol, results were collected after 24 hours of incubations of the dishes.

Escherichia coli

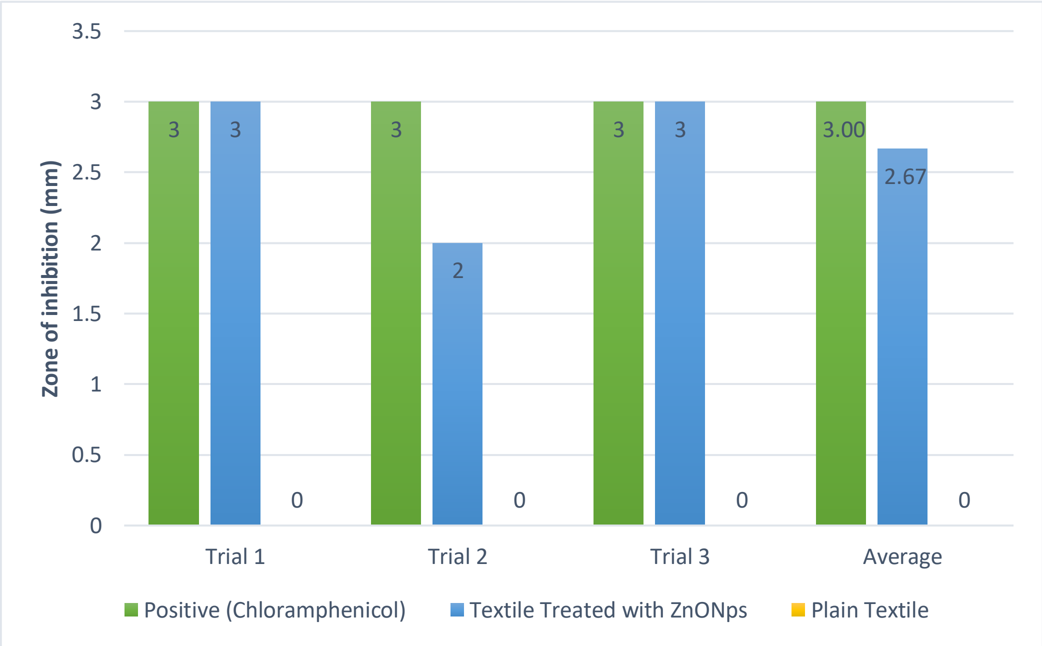

Figure 1. Comparative Chart on the Zone of Inhibition for *Escherichia coli*

In line with the results obtained by Subhankar Paul and Deependra K. Ban (2010), the figure above displays that the textile treated with ZnONps has a good inhibitory effect comparable to the control, Chloramphenicol – a standard antibacterial medicine. A statistical test showed that there was no significant difference between the obtained results. With this findings, textiles with good inhibitory effect against *E.coli*will be a breakthrough in the textile industry.

Staphylococcus aureus

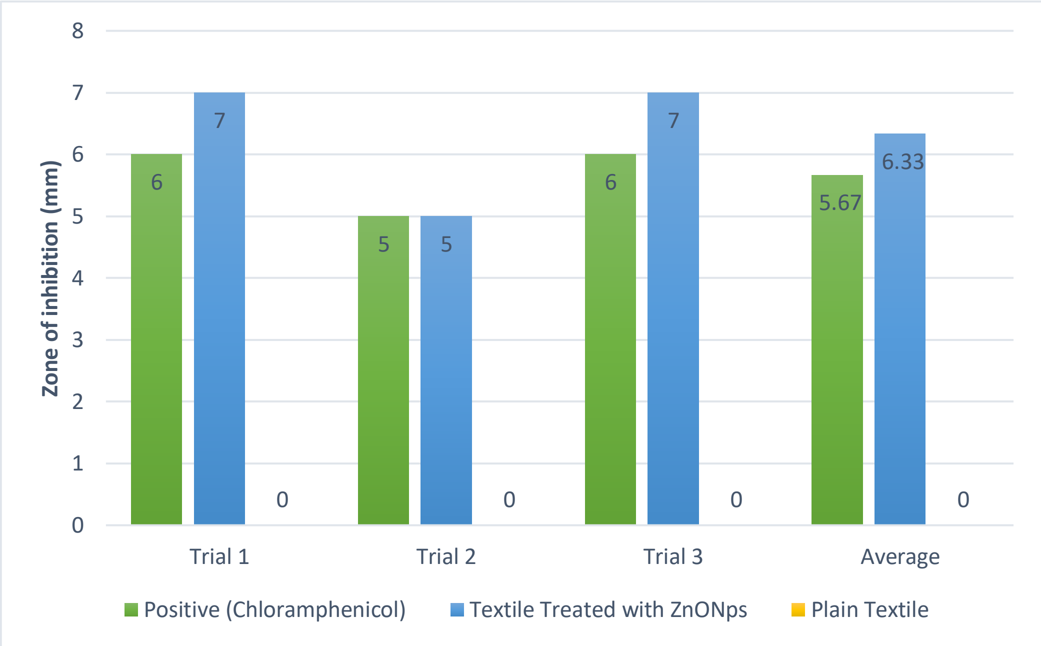

Figure 2. Comparative Chart on the Zone of Inhibition for *Staphylococcus aureus*

Results from the study of V. Parthasarathi et al (2011) showing that ZnONps and their application onto textile imparts antimicrobial property is 97% against *S. aureus*. Figure 2 shows that the textile treated with ZnONps has a better inhibitory effect comparable to the control, Chloramphenicol – a standard antibacterial medicine. A statistical test showed that there was no significant difference between the obtained results.

Water Repellency of the Textile

In this study, the water repellency test was conducted at the Philippine Textile Research Institute, Taguig City, Philippines. Textile samples were sent to their respective laboratory.

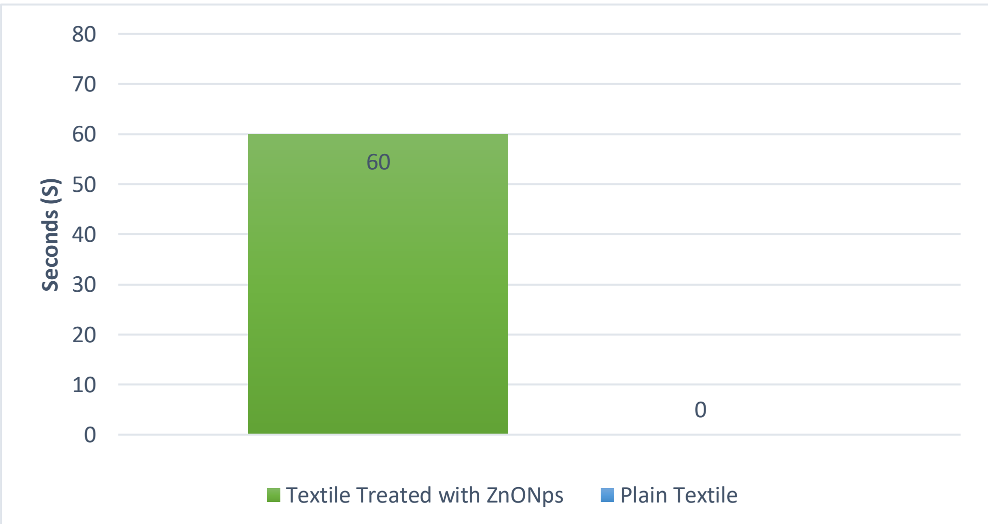

Figure 3. Comparative Chart on the Results of the Water Repellency Test

The figures present the data that the textile treated with ZnONps shows great water repellency ability. This means that the treated textile could repel water for about sixty seconds, enough time to wipe of the liquid that could possibly soak or damage the textile. The liquid repellence and transport properties of fabrics are critical not only to the success of wet processes such as dyeing, printing and finishing, but also to the performance of products such as sports clothes, performance clothing, disposable hygiene materials and medical products (Maggie Tang *et al.*, 2014).

Table 1. Relative Data of the Sample Textiles

Test Organisms	**Plain Textile**	**Textile Treated with ZnONps**
E. coli	No zone of inhibition	2.67 mm, zone of inhibition
Staphylococcus aureus	No zone of inhibition	6.33 mm, zone of inhibition

Textile treated with ZnONps showed excellent antibacterial activity against two representative bacteria, *Escherichia coli* and *Staphylococcus aureus.* ZnO treated woven and knitted fabric showed excellent antibacterialactivity. Hence it is most suitable for defense clothing like bed linens, gloves and T-shirts to avoid cross infections (V. Parthasarathi, *et al* 2011*).*

Results showed that ZnONps at low concentrations enhanced the $\beta -$ glucosidase expression level, but when applied at higher concentrations of ZnONps, it showed antimicrobial property with different bacteria (Subhankar Paul, *et al* 2014).

Table 2. Relative Data of the Sample Textiles during the Water Repellency Test

Test	**Treated textile**	Not treated textile
Water Repellency (Absorbency)	**60+ seconds**	0 seconds

Table 2 shows the comparison between the Treated Textile and Plain Textile during the Absorbency test. This shows that the Treated Textile exhibited great repellence. Avoiding unwanted drenching due to some accidents. Waterproof materials have an extraordinarily high use, with products for everyday clothing, sportswear and protective clothing for industrial or technical applications (Loghin, *et al, 2018)*

Conclusions

The textile treated with Zinc Oxide Nanoparticles exhibited good inhibitory effect against Escherichia coli and Staphylococcus aureus. With this, it could result to antimicrobial textiles that would help the textile industry in making clothes that will protect the wearer from harmful bacteria, odor causing bacteria and others. Also, the water repellency was improved upon the treatment with ZnONps. With this findings, the textile that will be treated will be very helpful in the sports and medical industries.

References

Anita S, Ramachandran T. 2012. "Preparation, Characterization and Functional Analysis of Zinc Oxide Nanoparticles Coated Single Jersey Cotton Fabric." Textile Science and Engineering. Tamil Nadu India.

Ariap, Nashyl Mae A, Gatongay, Julita A, 2017. Antimicrobial Potential of Ligustrum spp. (Polipog) Root Extract, Unpublished Thesis, College of Science, University of Eastern Philippines.

Carmen L, Ciobanu L, Ionesi D, Loghin E, Cristian I. 2018. Waterproof and Water Repellent Textiles and Clothing. The Textile Institute Book Series, pp. 3-24

Kathirvelu S, D'Souza, Louis, Dhurai, Bhaarathi, 2009, "UV protection finishing of textiles using ZnO nanoparticles", Indian Journal of Fibre and textile Research, 34, 267-273.

Lee S. 2009. Developing UV-protective Textiles Based on Electrospun Zinc Oxide Nanocomposite Fibers". Fibers and Polymers. Vol 10, No.3, 259 – 301.

Padmavathy N, Vijayaraghavan R. 2008. "Enhanced bioactivity of ZnO nanoparticles- an antimicrobial study" Sci. Technol. Adv. Mater. 9, 1-7.

Paul S, Ban, DK. 2014. Synthesis, Characterization and the Application of ZnO Nanoparticles in Biotechnology, International Journal of Advance in Chemical Engineering, 1, 1.

Rajendran R, Balakumar C, Mohammed-Ahammed, Hasabo A, Jayakumar S, Videki K, Rajesh EM. 2010, Use of zinc oxide nano particles for production of antimicrobial textiles. International Journal of Engineering, Science and Technology, 2 (1): 202-208.

Tang KPM, Kan CW, Fan JT. 2014. Evaluation of Water Absorption and Transport Property of Fabrics. Textile Progress Journal, 46(1).

Yadav A, Prasad V, Kathe AA, Raj S, Yadav D, Sundaramoorthy C, Vigneshwaran N. 2006. Functional Finishing in Cotton Fabrics Using Zinc Oxide Nanoparticles. Bull. Mater. Sci., 29(6) : 641 – 645.