International Journal of Advanced Biotechnology and Research
ISSN 0976-2612, Online ISSN 2278–599X,
Vol 3, Issue 3, 2012, pp 621-624
http://www.bipublication.com

ANTIBACTERIAL EFFECT OF TiO2 NANOPARTICLES ON PATHOGENIC STRAIN OF *E. coli*

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[Received-21/07/2012, Accepted-01/08/2012]

ABSTRACT

In recent years, nanotechnology has been flourishing. Nano-structured materials are attracting a great deal of attention because of their potential for achieving specific processes and selectivity, especially in biological and pharmaceutical applications. Nanotechnology has become one of the most practical technologies, because of unique physical and chemical properties of nanomaterials. Nanomaterials such as TiO 2 nanoparticles (TiO 2 -NPs), less than 100 nm in diameter, have become a new generation of advanced materials due to their brilliant and interesting optical, dielectric, and photo-catalytic characteristics from size quantization. Resistant strains fail to develop if we apply Nanoparticle-based formulations in their media. The antibacterial activities of some nanoparticles, makes them attractive as a new agents against pathogenic bacteria. Liquid and agar nutrient medium used for E.coli culture and different antibiotics used for Disk diffusion technique to evaluate antibiotic resistance pattern of E.coli. Antibacterial effect of 0.01, 0.5, 1 and 1.5% of nano-TiO2 evaluated via optical density (OD) and Kirby-Bauer disc diffusion test.This strain was resistant to all antibiotics used in this study. Optical density decrease was observed with nano-TiO2 concentration increase (0.225, 0.218, 0.158, 0.075, 0.031respectively). Inhibition zone measurement showed the similar results. The maximum inhibition zone (5mm) was observed in 1.5% of nano-TiO2. Nano materials are known to inactivate cellular enzymes and DNA by binding to electron-donating groups such as Carboxylates, Amides, Indoles, Hydroxyls, Thiols, and etc. They cause little pores in bacterial cell walls, leading to increased permeability and cell death. Based on this study, nano-TiO2 has efficient antibacterial effect and can be used as an antibacterial agent for different purposes.

Key Words: TiO2 nanoparticles, Escherichia coli, Antibacterial effect ,Disk diffusion technique

INTRODUCTION

In recent years, nanotechnology has been flourishing. The development of Nano materials is a foundation for the development of nanotechnology. Nano materials refer to materials with special properties, whose geometric dimension reaches Nano scale. Among Nano- materials, great importance has been attached to Nano oxide [1, 2, 3].

Nano-structured materials are attracting a great deal of attention because of their potential for achieving specific processes and selectivity, specially in biological and pharmaceutical applications [4, 5, 6].

Nano-Materials are called a wonder of modern medicine. It's stated that antibiotics kill perhaps a half dozen different diseases-causing organisms but Nano-materials can kill some 650 cell (7).

Resistant strains fail to develop if we apply Nanoparticle-based formulations in their media. In laboratory tests with Nanoparticles, the bacteria, viruses, and fungi are killed within minutes of contact. The effect of nanoparticles on bacteria is very important, since they constitute the lowest level and hence enter the food chain of ecosystem [8, 9].

Tio2 nanoparticles (Tio2-NPs), approximately less than 100 nm in diameter, have become a new generation of advanced materials due to their novel and interesting optical, dielectric, and photo-catalytic properties from size quantization [10]

Titanium dioxide (Tio2) is a photo catalyst and widely utilized as a self-cleaning and self-disinfecting material for surface coating in many applications, titanium dioxide has a more helpful role in our environmental purification due to its nontoxicity, photo induced super-hydrophobicity and antifogging effect [11].

These properties have been applied in removing bacteria and harmful organic materials from water and air, as well as in self-cleaning or self-sterilizing surfaces for places such as medical centers [12-15].

MATERIALS AND METHODS

The Antibiotic resistant strain of E.coli isolated from hospital environment was used in this study. Tio2 Nanoparticles with particle size of 60 nm purchased from Dr. Reddy Corporation was suspended in distilled water and sonicated for 15 minutes before use(7).concentrations ranging from 0.01, 0.5, 1.0 to 1.5% were prepared.

Antibiotic resistance pattern of E.coli

The Muller-Hinton Media used to culture the bacteria and the Tetracycline (TE), Penicillin (G), Amoxicillin (AMY), Ceftriaxone (CRO), Chloramphenicol (C) and Tobramycin (Tob) antibiotics were used to study for their resistance pattern according to Kirby-Bauer Disk Diffusion Technique.

Antimicrobial Effect of Tio2 in Liquid media

Overnight Culture of the E.coli was added to 100 ml of nutrient broth with and without 0.01%, 0.5%, 1%, 1.5% Tio2 respectively and incubated at 37°C for 24 hours.

To study the bacterial concentration, The O.D. values were taken at 600 nm.

Antimicrobial effect of the Tio2 in solid Media

The Bacteria were cultured in Muller-Hinton Medium and Antibiogram disks of 0.01, 0.5, 1.0 and 1.5 % of Tio2 were prepared according to Kirby Bauer disk diffusion Technique. The disks were placed over the media and incubated at 37°C for 18 hours.

RESULTS

E. Coli was resistant to all of the antibiotics used in this study. Decrease in Optical density (OD), was observed with nano-Tio2 concentration increase (0.225, 0.218, 0.158, 0.075, 0.031) respectively. (Figure 1)

Inhibition zone measurements show that by increasing the concentration of Tio2, the inhibition zone also increased . (0, 0.2, 2.5, 3.0, 5.0) respectively. (figure 2)

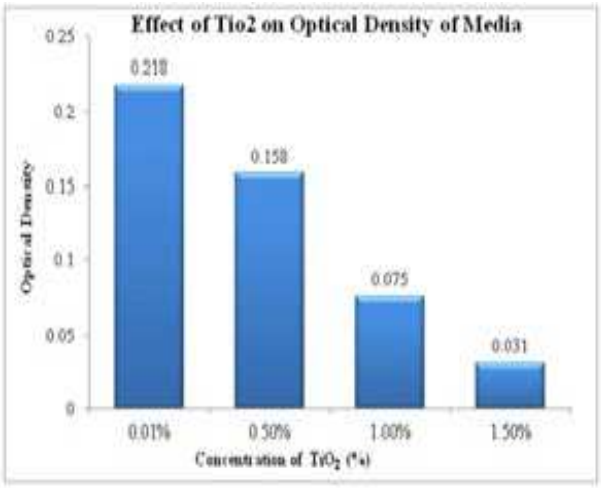

Fig. 1: E. coli Density in different Tio2 concentrations.

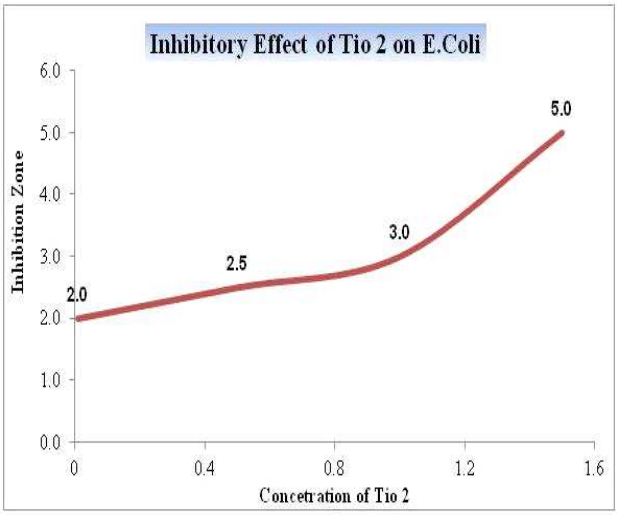

Fig. 2 Inhibition Zone of different concentrations of Tio2

DISCUSSION

In this study, Antibacterial effect of different concentrations of Tio2 were studied. E. Coli is one of the most important causative agents of nosocomial infections and resistant to most of the broad spectrum Antibiotics . Due to over using of the antibiotics, Antibiotic resistance of microbes are highly increased.(16)

Introducing the new antibacterial agents can control the mortality and morbidity rate of the infectious diseases.

It has been known that Nano-Materials exhibit strong inhibiting effects towards a broadened spectrum of bacterial strains.

According to several studies, it's believed that the metal oxides carry the positive charge while the microorganisms carry negative charges; this causes electromagnetic attraction between microorganisms and the metal oxides which leads to oxidization and finally death of microorganisms (17) Nano materials also could deactivate the cellular enzymes and DNA by coordinating to electron-donating groups, such as: Thiols, Carbohydrates, Amides, Indoles, Hydroxyls and etc.

They cause pits in bacterial cell walls, leading to increased permeability and cell death. (18)

In present study, we showed that the different concentrations of Tio2 could inhibit the growth of Antibiotic resistant strain of E.Coli.

In hospital environments, where resistant strains could be transmitted easily and cause infection in surgical wounds and burnt patients; Tio2 could be used as the suitable disinfectant in hospitals.

In textile industry, by using the Nano materials, such as Tio2, cotton fabrics with antibacterial effect are developed(19), therefore, it could be possible to manufacture the suture or wound bands by those cotton fabrics to decrease the rate of infection in patients.

REFERENCES

1. Xu GC, et al. Nanocomposite. Beijing: Chemical Industry Press, 2002.
2. Cermenati L, Dondi. DL. Maurizio Fagnoni and Angelo Albini. Titanium dioxide photocatalysis of adamantine. Tetrahedron, 2003; 59: 6409-6414.
3. Liu JP, et al. Nanotechnology in textile Science. Beijing: China Textile Press, 2003.
4. Wu X, Liu H, Liu J, haley KN, Treadway JA, Larson JP, et al. Immunofluorscent labeling of cancer marker Her2 and other cellular targets with semiconductor quantum dots. Nat Biotechnol 2003;21(1):41-6.
5. Fortner JD, Lyon DY, Sayes CM, Boyd AM, Falkner JC, Hotze EM, Alemany et al. C-60 in water:

Nanocrystal formation and microbial response Environ Sci Technol 2005;39(11):4307-16.
6. Li P, Li J, Wu C, Wu Q, Li J. Synergistic antibacterial effects of lactam antibiotic combined with silver nanoparticles. Nanotechnol 2005;16(9):1912-17
7. Sungkaworn T, Triampo W, nalakarn P, Triampo D, tang IM, Lenbury Y, et al. The effects of Tio2 nanoparticles on tumor cells colonies: fractal dimension and morphological properties, Int J biomed Sci 2007;2(1):67-74
8. Forther JD, Lyon DY, Sayes CM, Boyd AM, Falkner JC, Hotze EM, Alemany et al. C-60 in water: Nanocrystal formation and microbial response. Environ Sci Technol 2005;39(11):430716.
9. Herrera M. Carrion P, Baca P, Liebana J, Castillo A. In vitro antibacterial activity of glass-ionomer cements Microbios 2001;104(409): 141-48
10. Alivisatos A. Semiconductor Clustors, Nanocrystals and Quantum Dots Science of the Total Environment 271(5251): 933-937, 1996.
11. A. Fujishima, K Honda, Nature 238, 37 (1972).
12. H. Sun, Y. Bai, Y. Cheng. W. Jin, N. Xu, Ind. Eng. Chem. Res 45, 4971 (2006).
13. S. Tojo, T. Tachikawa, M. Fujitsuka, T. Majima, J. Phys. Chem. C 112, 14948 (2008).
14. M. S. Wong, S. W. Hsu, K. K. Rao, C. P. Kumar, J. Mol. Catal. A: Chem. 279, 20 (2008)
15. H. Kato, A. Kudo, J. Phys. Chem. B 106, 5029 (2002)
16. M.Haghi , H.Maadi1,2 Vol. 2. No. 6. November,(2010), Part II
17. Zhang H, Chen G. Potent antibacterial activities of Ag/Tio2 nanocomposite powders synthesized by a one-potsol-gel method. Environ Sci Technol 2009;34(8):2905-10.
18. Holt KB, Bard AJ. Interaction of silver (1) ions with the respiratory chain of Escherichia coli: An electrochemical and scanning electrochemical microscopy of micromolar Ag. Biochemistry 2005; 44(39): 13214-23.
19. Qin WT, Shen Y, Zhang HF, et al. Application and Research of Modified nano Oxide in Antibacterial Finishing of Fabric. Dyeing, 2005; 31 (21): 4-6.