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THE ANTIBACTERIAL PROPERTIES OF PAINT WITH THE ADDITION OF ZNO NANOPARTICELS

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ABSTRACT

The purpose of this study was to see how the antibacterial characteristics of ZnO nanoparticles were applied to wall paint to determine the effectiveness of ZnO nanoparticles in killing bacteria. Where ZnO is one of the metal oxides with good anti-bacterial properties through the formation of ROS. By modifying the percentage of ZnO nanoparticles used, namely 3%, 5%, 10%, and 15%, and 0% as a blank or comparison. Antibacterial properties were obtained through evaluation using the TPC method which stands for Total Plate Count. ZnO nanoparticles were obtained by synthesizing using the precipitation method. ZnO nanoparticles were characterized using XRD Instruments to analyze the morphological structure.

Keywords: TPC; Wall Paint; ZnO

1. INTRODUCTION

Wall surfaces with antimicrobials are urgently needed as an efficient method to avoid surface contamination. Antibacterial paint itself is a promising strategy towards a cleaner indoor and outdoor environment by preventing the colonization of walls with microorganisms such as bacteria[1-3]. There are various ways that can be done to prevent the development of bacterial cells on the surface by utilizing metal oxide nanoparticles, the most effective of which is the formation of reactive oxygen species (ROS), namely, the ability of metal oxide nanoparticles to kill bacteria by forming reactive oxygen species (ROS). or oxygen free radicals. Oxygen free radicals in question such as hydrogen peroxide (H2O2) and superoxide anion. With the formation of ROS, it can cause high oxidative stress and trigger the formation of holes in the bacterial membrane which will cause bacterial cell lysis[4-6]. Broadly speaking, nanotechnology provides new hope in various fields. Nanotechnology is able to create materials with nanometer dimensions, and their applications and new properties arise from the created nanoparticles. Some nanoparticles are considered as antibacterial agents, this is due to their very small size and has highly tested properties as antibacterial agents[7].

Tuning of the crystallite and particle sizes of ZnO nanocrystalline materials in solvothermal synthesis and their photocatalytic activity for dye degradation[8]. The powder diffractometer method is used to look at the diffraction of polycrystalline samples. The sample is in the form of powder/powder with flat surface and has the right thickness to absorb X-ray beams going up. Geiger counter and are used scintillation to produce diffraction peaks. Sample is set on 2Θ angle to the incident groove so that the monitor can surround the sample. The monitors are aligned so that their axis is always through and at right angles to the axis of rotation of the sample. The X-ray intensity diffraction as a function of the angle 2Θ[9]. As explained in the table above, the basic content of wall paint consists of 5% additives, 15% solvents, 35% binders and 45% pigments [10-12]. The percentage of ingredients contained in Wall Paint is in Table 1.

Table 1. Materials contained in Wall Paint

Chemical material	Percentage (%)
Additive	5
Solvent	15
Binder	35
Pigment	45

Figure 1. Wall Paint (www.google.com)

Wall paint or wall paint is one of the industrial products that has an important role in finishing or finishing a building. Paint is used to coat the surface of walls and other surface layers of objects with the aim of adding aesthetic value, strengthening and protecting the surface of buildings and objects that are coated with the paint. In general, the paint manufacturing process uses technology related to the application of polymer chemistry technology and organic chemistry. Where in the process it utilizes surface chemistry, colloids, electrochemistry and petrochemicals[13]. Paint is defined as a material which if at room temperature will be a liquid liquid and if applied to a surface will dry and form a solid layer. In wall paints that use water-based solvents, they usually use the principle of emulsion polymerization in which the dispersion phase is water, while the dispersed phase is a hydrophilic extender. The main composition of the paint is 45% pigment, 35% binder, 15% solvent and 5% additive[14].

ZnO (Zinc Oxide) is a white inorganic compound, has no odor and is difficult to dissolve in water solvents. At room temperature, this compound has a solid phase with a density of 5.61 g/cm3, a melting point of 1975oC and a molecular weight of ZnO of 81.38 g/mol. Zinc oxide (ZnO) is a semi-conductor with a large band gap of approx. 3.37 eV and high exciton binding energy (60 meV). It is a multifunctional compound with unique optics, luminescent 58 S.N.A[15-17]. When exposed to light, electron pairs of holes are formed on the surface of ZnO, which in turn this hole will split and will cause the formation of reactive oxygen species (ROS), especially O2, H2O2 and OH-[18]. ZnO is usually synthesized in powder form which is commonly used as an additive to various materials and products such as ceramics, plastics, glass, rubber, cement, lubricants and paints, but ZnO is mostly produced synthetically for commercial purposes, besides that scientists are developing ZnO to be an efficient semiconductor photocatalyst because of its non-toxicity and physical stability. [19].

Escherichia coli is a bacterium that has pathogenic properties, is one of the main causes of morbidity and mortality in the world. Escherichia coli is the predominant facultative anaerobe of the human colonic flora. These organisms usually colonize the infant's gastrointestinal tract within a few hours of life, Escherichia coli is usually harmless if limited to the intestinal lumen. However, in humans who are immunocompromised or immunosuppressed, or in conditions where gastrointestinal obstruction occurs, pathogenic Escherichia coli can cause infection. Moreover, even the most vigorous members of this species may be susceptible to infection by one of several Escherichia coli clones that have adapted to develop the ability to cause a broad spectrum of human disease groups[20]. Escherichia coli is a gram-negative, rod-shaped bacterium, and is classified into a member of the Enterobacteriaceae family with the Gammaproteobacteria class. Escherichia coli is one of the bacteria that has been studied in depth and well. Escherichia coli can grow rapidly under optimal developmental conditions, replicating within 20 minutes. Many methods for gene manipulation have been developed using Escherichia coli as the host bacterium that produces countless enzymes and other industrial products. Infections due to pathogenic Escherichia coli may be confined to mucosal surfaces or may spread throughout the body[21-23].

X-ray diffractometer (XRD) is an instrument commonly used for the analysis of the size (Fierascu et al., 2019), structure, and crystallinity of synthesized ZnO nanoparticles (Akintelu et al., 2020). X-ray diffraction by crystals is explained by Bragg's law which relates the wavelength of the X-ray emission, the angle of the diffraction beam to the distance between atoms in the crystal structure of the sample can be obtained[24]. The working principle of X-Ray Fluorescence is a characterization by means of a non-destructive analysis that serves to determine the elemental composition in the material, where the sample being tested is in the form of solid, powder, or liquid. For X-Ray Fluorescence analysis using X-rays that have high energy to be able to fight the electrons contained in the low energy of a sample so that the electrons can make changes in completing the position of the excited electrons, and accompanied by retransmission of the characteristic X-rays with the lowest energy[25].

In this research, antibacterial properties were obtained through evaluation using the TPC method which stands for Total Plate Count. ZnO nanoparticles were obtained by synthesizing using the precipitation method. ZnO nanoparticles were characterized using XRD Instruments to analyze the morphological structure. The purpose of this study was to see how the antibacterial characteristics of ZnO nanoparticles were applied to wall paint to determine the effectiveness of ZnO nanoparticles in killing bacteria.

2. EXPERIMENTAL SECTION

2.1. ZnO Syntesis

To incorporate powdered ZnO nanoparticles, follow the previous methodology with adjustments. A total of 7 grams of [Zn(NO3)2 6H2O,(Brand, 99.0%)] was dissolved in 117 ml of the arrangement, then 4 M NaOH solution was added dropwise with consistent stirring until it reached pH 12 from whichever precipitation was achieved. In addition, sieving, after the separation system, the pusher form was washed several times with distilled water and followed by a few drops of CH3)2CO then framed white powder. Then the white powder was dried in a broiler at a temperature of 110°C for 5 hours [26-29].

2.2. Antibacterial Paint Manufacturer

To make the wall paint that will be used in this study, mix 121 grams of CaCO3 with 60 grams of kaolin then stir until evenly distributed, then add 12 grams of TiO2 powder and mix again until well blended. Then added 91 g of PVAC, 182 ml of Aquades and 34 ml of pine oil and stirred until mixed[30-33].

2.3. Antibacterial Activity Test

Prior to the bacterial test, Nutrient Agar media was prepared by weighing 2.8 g of NA medium and dissolved in 100 mL of distilled water, then heated on an attractive stirrer until homogeneous, then sterilized in an autoclave at 121°C for 60 minutes. to prevent the growth of unwanted microorganisms. After sanitizing, the media can be aseptically emptied into sterile petri dishes for use. Before pouring the media, let it sit until it is warm (± 40˚C) then let it sit at room temperature until the media is completely attached. Followed by a bacterial test where the blended samples were ready and weighed with a weight of 0.2 g each, then a 0.2 gram ZnO-cat sample was put into a bird of prey tube followed by 1 ml of Escherichia coli microorganisms. The sample was then vortexed for several minutes. minutes with the aim of directly reaching microbes with ZnO-paint[34].

Combined:

$$(\frac{\text{cfu}}{\text{ml}}) = \frac{(\text{no of colonies})\text{x total dilution factor}}{\text{volume of cultur plated}}$$

2.4. XRD Instrument Sample Characterization

The consequence of ZnO imaging is solved by the way it works, in particular, 2 X-rays radiate with indistinguishable frequencies and stages on a strong sample, in this way forming a point with the nuclear plane. These X-rays are diffracted by various particles, then, at that time, the diffraction beam interfered. In certain subjects the impedance is conductive, in this study the XRD tool plans to determine the type of precious stone in the form of ZnO and obtain gem size information on ZnO using the conditions

$$\frac{k\lambda}{\beta.cos\theta}$$

where d is the gem size in nanometers, K is the Scherrer steady, is the frequency of the occurrence of the X-beam bar, and e full width at a portion of the greatest power of the reflection top[35-36].

2.5. XRF Instrumen Sample Characterization

Analysis using this XRF (X-Ray Fluorescence) instrument aims to identify the chemical composition of theZnO nanoparticle samples. For X-Ray Fluorescence analysis using X-rays that are have high energy to be able to fight electrons at the low energy of a sample so that electrons can make change in the complete position of the excited electron, and is accompanied by retransmission of characteristic X-rays with the lowest energy[37].

3. RESULTS AND DISCUSSION

3.1 ZnO Syntesis

To obtain ZnO nanoparticles, a synthesis was carried out using the coprecipitation method or the recording method follow research from (Muñoz-Echeverri,et.al-2021). The precipitate formed is a material, namely ZnO, the main factor being the influence of several factors, namely pH, temperature, and the type of solvent used. In this coprecipitation method the basic materials will be deposited stoichiometrically using certain reactants Unadulterated ZnO powder is created from a combination of ZnO nitrate hexahydrate with 0.2 M NaOH, the expansion of NaOH with a kept up with pH of 12.

The expansion of NaOH intends to isolate ZnO from nitrate to shape Zinc Hydroxide and Sodium Nitrate, then the arrangement is separated for cleaning. or on the other hand detachment of strong particles from an answer/liquid by going them through a separating medium or septum that holds the solids set up. The strong shaped was dropped by drop acetone which intends to eliminate nitrate in ZnO, and was every so often given aquabides to clean the contaminations, and was prepared for 5 hours with the accompanying. response:

$$Zn(NO_3)_2.6H_2O + 2NaOH \longrightarrow Zn(OH)_2 \downarrow + 2NaNO_3 + 8H_2O$$

$$Zn(OH)_2 + 2OH^- \longrightarrow [Zn(OH)_2]^{2-} + 2H^+ \xrightarrow[\text{Heat}]{} ZnO \downarrow + 3H_2O$$

Subsequent to separating and washing the accelerate a few times with refined water, trailed by acetone, a white powder was gotten, so that an unadulterated ZnO powder with a load of 3.2 grams was acquired. The occurrence of precipitation is influenced by several factors including pH control, temperature, type of solvent used and speed in stirring. In this coprecipitation method, the basic materials will be deposited stoichiometrically using certain reactants. This coprecipitation method was chosen because the process is simple and the cost is relatively cheap and the results are satisfactory[38-41].

3.2 Application of Paint-ZnO Against Escherichia Coli Bakteria With UV

After forming a composite between Paint-ZnO which has previously been varied with variations of 0%, 1%, 3% and 5%, then the resulting product is applied to bacteria, which aims to see the effectiveness of the product in evaluating bacteria, the following table presents the results of bacterial evaluation to the sample[42].

Table 2. Result of antibacterial application with UV

No.	Paint-ZnO variation (%)	No of Colonies	(CFU/ml)(x10^6)

1.	0	320	3.20
2.	1	278	2.78
3.	3	190	1.90
4.	5	83	8.3

From the table, it very well may be reasoned that the degree of bacterial life in settlement framing units per volume (CFU/ml) of Escherichia coli with varieties in ZnO with the assistance of UV light. With the additional variety of ZnO, the endurance pace of microscopic organisms diminished. from the littlest variety of 0% to the biggest variety of 5% encountered a huge abatement. If done without using UV light, the bacteria will not change because there is no ROS formation.

3.3 Characterization Nanoparticles ZnO With XRD

Characteristic tests using XRD instruments were carried out with the aim of seeing how the structure and size of the nanoparticles formed :

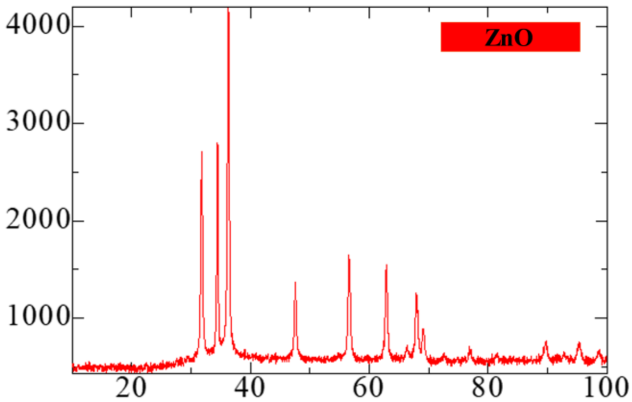

Figure 2. XRD Spectrogram for ZnO

On the XRD results, the structure of the ZnO precious stone is hexagonal wurtzite shown by the field, confirming the high purity properties of the integrated powder, and the design results are practically equivalent to previous investigations, where the highest peak is located at 36,389°. The sharpness of the XRD range diagram is related to its crystallinity properties. The peak sharpness is also related to the bend width which is usually referred to as the full width in the largest half of the FWHM (the most extreme half full width). The FWHM value is associated with the size of the gem width, the larger the FWHM, the smaller the gem width obtained. It is known that based on estimation results using the Debye-Scherrer equation, the size of ZnO glass powder with normal nanoparticle size is 20.49 nm.

3.4 Characterization Nanoparticles ZnO With XRF

The results of the synthesis of ZnO nanoparticles were characterized using X-Ray Fluorescence instrument to determine the content of a elements and their percentages in a material The table below is the result of the analysis that obtained :

Table 3.. Result of the analysis that XRF Characterization

Compound	Qonc(%)
Al_2O_3	0.00
P_2O_5	1.26
ZnO	97.68
CaO	0.22
Fe_2O_3	0.02
Ag_2O	0.02
CO_3O_4	0.00
HFO_2	0.12
Yb_2O_3	0.08
CdO	0.11
NiO	0.00

Based on the test results of the chemical composition contained in sample of ZnO nanoparticles where the highest composition is owned by the compound Pure zinc oxside (ZnO) was 97.683%. This concentration can be said to be quite large and good and can be used in tests on paint-zno according to the journal of (Erane Dio, et., al 2021).

4. CONCLUSION

The results showed that the addition of ZnO to wall paint with the help of UV light was effective and caused a critical decrease in bacterial resistance, in blanks without the addition of ZnO nanoparticles, a large number of bacterial colonies were found and when nanoparticles were added, the effect of decreasing bacterial growth was seen. This means that ZnO nanoparticles have a good ability as an antibacterial agent in wall paint. The results of XRD nanoparticles showed the formation of the desired ZnO at a peak of 36.389 ° *according to research that has been done by* (Sagadevan et al., 2017) which where the peaks are found at angles of 32.769°, 34.2976°, 36.0389°, 39.417°, 41.3164°, and 43.1495° with hkl values (1 0 0), (0 0 2), (1 0 1), (1 0 3), (11 2), and (2 0 1).

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