Influence of *Aloe vera* and Pluronic F127 on the enhancement of Photocatalytic degradation and Antibacterial activity of ZnO by sol-gel synthesis method

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Abstract: The development of plant-based photocatalyst with a minimum time of irradiation for water-soluble dye disposal from industries is a great significance to unravel water pollution. In the present work, the sol-gel synthesis method was employed for the synthesis of zinc oxide nanoparticles using Pluronic F127 and *Aloe vera* as dispersing media. A hexagonal wurtzite structure and surface morphology confirmed by XRD and FE-SEM analysis. The infrared study was applied to substantiate the acceptable compounds within the nanoparticles and phytochemicals presence within the extract. From the DRS spectra, Bandgap energy of ZnO nanoparticles (3.22eV) was decreased to 2.89eV by blending of *Aloe vera* and Pluronic F127 into ZnO. The photocatalytic action of different combinations of ZnO was examined against malachite green dye under UV light and visible light irradiation. Upto 95% degradation was achieved for ZnO/Aloe/PF127 with a minimum time of UV light exposure. All combinations of ZnO showed effective bactericidal activity against multi-drug resistance of *E.coli, S.aureus, B.subtilis, and P.aeruginosa*. These findings proved the overwhelming photocatalytic and antibacterial activity of ZnO samples, which might be used as effective remediation to treat textile dye wastewater.
1. Introduction:
Water pollution has become the main problem everywhere within the globe. Water pollution may occur from different wastes such as phenolic compounds, pharmaceutical wastes, resins, and textile dyes. Annually, 0.7 Million load of synthetic dyes are employed by textile, leather, food, cosmetic, and paint industries. These industries release a higher amount of dyes into the water, which causes serious environmental issues because of the non-biodegradability.
compared to other pollutants. Various physical and chemical treatments were developed to treat the wastewater such as reverse osmosis, electrochemical oxidation, ultrafiltration, activated carbon, ion exchange, and so on[1, 2]. According to the recent reports, the most important problems related to these methods result in the generation of secondary pollution, lower efficiency of water treatment and high cost. Therefore, the semiconductor-assisted photocatalyst among advanced oxidation processes has been analyzed to convert harmful organic compounds into water (H₂O) and carbon dioxide (CO₂) by the oxidation process. The section of metal oxides for the photocatalytic process influences the photocatalytic activity. The photocatalytic process is mainly related to the catalyst, electron-hole recombination, inclusion of dopants, light energy, and wavelength. Many kinds of semiconductor materials have been explored as photocatalysts such as TiO₂, CdS, ZnO, CuO, and WO₃. Compared to other photocatalysts, ZnO had much attention because of its excellent chemical and photochemical stability, biological activity, non-toxicity, low cost, and enormous exciton separation energy [3].

Due to the non-toxic behavior of ZnO nanoparticles, it is often used as antimicrobial agents towards several disease causing pathogens. The synthesis of nanoparticles using plant extract may be the cleanest and safest method compared to other physical and chemical synthesis methods [4, 5]. Among various syntheses of nanoparticles from plant extract, Aloe vera contains plenty of flavonoids, terpenoids, amino acids, enzymes, vitamins, and polysaccharides. The presence of these compounds in Aloe vera can give non-toxic behavior with excellent reducing agent property. The green fuel of Aloe vera was chosen according to this direction for the preparation of ZnO nanoparticles. Several numbers of metal oxides synthesized from plant extracts have been reported [6-9]. Besides of surfactants for the synthesis process may increase their optical and biological activities. Pluronic F127 based TiO₂ mesoporous was prepared by
Emy Merlina Sumsudin et al. in 2015 and revealed that the physicochemical properties changed due to the addition of Pluronic F127 and ends up in an enhanced photocatalytic activity [10]. Glenna. L et al. 2012 have been reported the photocatalytic activity of macro and mesoporous Titania monoliths using Pluronic F127 [11]. Many of the researchers were reported the enhancement of photocatalytic and antimicrobial activity using metal oxide with a pluronic combination [12-17].

The present work focused on the synthesis of different combinations of ZnO using Pluronic F127 and Aloe vera to evaluate the photocatalytic degradation of malachite green dye. In addition, antibacterial activities have been studied with several disease causing Gram-negative and Gram-positive pathogens.

2. Experimental Methods

2.1 Materials

Zinc acetate (C\textsubscript{2}H\textsubscript{6}O\textsubscript{4} Zn.2H\textsubscript{2}O), triblock copolymer Pluronic F127 (EO\textsubscript{100}PO\textsubscript{65}EO\textsubscript{100}), Aloe vera (L. Burm. F. (=Aloe barbadensis Mill.) - LILIACEAE identified by Botanical Survey of India, Southern regional center, Coimbatore, Malachite Green (C\textsubscript{23}H\textsubscript{25}N\textsubscript{2}) dye, and textile dye wastewater.

2.2 Preparation of Aloe vera gel powder

Fresh and matured Aloe vera leaf was washed several times with DI water to get rid of dust particles; gels were separated and dried at 40°C using hot-air oven for two days. The prepared gel powders with the help of mortar and pestle were stirred with DI water for four hours, filtered, and stored for the further synthesis process.
2.3 Synthesis of different combinations of ZnO

The aqueous solution of Pluronic F127 (EO\textsubscript{100}PO\textsubscript{65}EO\textsubscript{100}) was prepared with 1:4 ratios at the continuous stirring of an hour to obtain a homogeneous solution. Both \textit{Aloe vera} gel powder and Pluronic F127 solutions were drop-wisely added into 1M of zinc acetate under continuous shaking for six hours at 70°C. The obtained ZnO/\textit{Aloe}/PF127 precipitate was washed three-five times with DI water and annealed at 350°C for an hour in a muffle furnace. For ZnO and ZnO/PF127, NaOH was added for the synthesizing process.

2.4 Characterization Methods

The structure and size of different combinations of ZnO was characterized by X-ray diffraction (XRD) analysis (PANalytical X’PERT PRO) in a continuous scanning mode of 2θ=10°-80° at room temperature. The functional groups present in the synthesized nanoparticles were determined by Fourier Transform Infrared Spectrometer (FTIR) (Shimadzu). The morphologies were examined by FESEM (MIRA3 TESCAN). The optical properties were studied by UV-DRS (SHIMADZU) and Spectrophotoflurometer- RF 5301PC instrument.

2.5 Photocatalytic experiments of MG dye and textile dye wastewater

The photocatalytic activity of MG dye aqueous solution was tested by different combinations of ZnO. In this process, 0.04g of the catalyst is added into 250 ml of MG dye-containing aqueous solutions and sonicated for 30 minutes in dark condition to ascertain the adsorption-desorption equilibrium of MG and ZnO. In the next step, the suspension is exposed to UV light and visible light (50 W halogen light-H) irradiation for 20 minutes under constant stirring. At a usual period of 5 minutes, the 5 ml of test sample is taken and centrifuged (3,000 rpm, 2 min) and supernatant liquid (dye) is analyzed using a UV-Vis spectrophotometer (JASCO
The following equation is used to calculate the degradation percentage of dye in presence of the catalyst,

$$\eta = \left[ \frac{C_0 - C_t}{C_0} \right] \times 100 = \left[ \frac{A_0 - A_t}{A_0} \right] \times 100 \quad \ldots \ldots \quad (1)$$

Where the percentage of degradation is denoted as $\eta$, the initial and after irradiation of selected time interval of concentration of dye ($\frac{mg}{L}$) is denoted as $C_0$ and $C_t$. To inspect the reusability and photo-stability, the cycling experiment of MG aqueous solution was conducted using an oven drying method under UV light irradiation.

2.6 Antibacterial activity

The effect of antibacterial activities of different combinations of ZnO was evaluated with Gram-ve ($Bacillus subtilis$, $Escherichia coli$) and Gram+ve ($Pseudomonas aeruginosa$, $Bacillus subtilis$) bacterial cells by agar-well diffusion method proposed by Clinical and Laboratory Standards Institute (CLSI 2009a). A lawn culture of individual bacterial strains ($10^6$ CFU/ml) was prepared by using a sterile cotton swab on Muller-Hinton agar. The media was punctured by making a well of 6 mm in diameter and filled with 10 µl of all combinations of ZnO samples by DMSO (100µg/ml). The standard antibiotic Chloramphenicol (30 mcg, HiMedia, India) was used as a positive control. Further, the Petri plates were placed inversely for complete diffusion and inhibition zones were examined by measuring the diameter (mm) formed around the well after 24 hrs incubation at 37°C. The zones were measured by using a standard (Hi-Media) scale [18, 19].
3. Results and Discussion

3.1 Size and structural analysis

Powder X-ray diffraction was performed to analyze the crystalline phase of different combinations of ZnO nanoparticles. The average crystallite size was calculated by following Debye Scherer’s equation.

\[ D = \frac{k\lambda}{\beta \cos \theta} \] \hspace{1cm} (2)

To determine the defect concentration within the specimen, the dislocation density (\( \delta \)) is calculated by following equation.

\[ \delta = \frac{1}{D^2} \] \hspace{1cm} (3)

Where \( D \) represents the average crystallite size, \( \lambda \) represents the wavelength of X-ray (1.5418Å for Cu Kα), \( \beta \) is the full width of half maximum of 2θ peak and \( k \) represents the shape factor (0.9). All combinations of ZnO exhibited hexagonal wurtzite structure with diffraction planes of (100), (002), (101), (012), (110), (013), (200), (112), and (201). Besides, no significant difference observed between XRD patterns of ZnO, ZnO/PF127, and ZnO/Aloe/PF127 nanoparticles, which is confirmed by JCPDS card no (36-1451) [18] with lattice constant \( a=b=3.25\text{Å}, c=5.20\text{Å} \), and P63mc space group, as shown in Fig. 1a. The stiff and narrow diffraction peaks showed good crystalline structure and purity of the nanoparticles and no other secondary peaks were observed [20]. However, the peak intensity was different for all combinations of ZnO. The zoomed view of the XRD pattern was shown in Fig.1b. Compared to all XRD pattern, drastic peak broadening (101) was observed from FWHM of 0.1178 to 0.2142, and 0.2676 for ZnO, ZnO/PF127, and ZnO/Aloe/PF127 respectively, shown in Tab.1. The average crystallite size of the ZnO, ZnO/PF127, and ZnO/Aloe/PF127 combinations were found to be 78 nm, 52 nm, and 48 nm, respectively. This could imply that the combination of Pluronic
F127 and *Aloe vera* extract into ZnO gives a major impact on the crystallite size and it does not change the final crystal composition of the synthesized ZnO.

**Table. 1** Corresponding FWHM, Phase composition, Crystallite size, and Dislocation density of ZnO, ZnO/PF127, and ZnO/*Aloe*/PF127 nanoparticles

| Structural parameters | Plane & Corresponding FWHM | Crystallite size (D) nm | Inter-planar spacing, d (Å) | Dislocation density, δ (nm⁻²) |
|-----------------------|-----------------------------|-------------------------|----------------------------|--------------------------------|
|                       | (100) (002) (101)           |                         | (100) (002) (101)          |                                |
| ZnO                   | 0.1224 0.2007 0.1178        | 78                      | 2.7858 2.3828 2.6376       | 0.000164                       |
| ZnO/PF127             | 0.2342 0.2676 0.2142        | 59                      | 2.8093 2.4718 2.3987       | 0.000284                       |
| ZnO/*Aloe*/PF127      | 0.2175 0.2673 0.2676        | 48                      | 2.7940 2.6133 1.9039       | 0.000434                       |

(a)  
(b)
Fig. 1 (a) X-ray diffraction pattern, (b) Zoomed view of XRD pattern of ZnO, ZnO/PF127, and ZnO/Aloe/PF127 nanoparticles and (c, d) FESEM image of ZnO and ZnO/Aloe/PF127 nanoparticles

The surface morphology of synthesized ZnO, and ZnO/Aloe/PF127 were determined by FESEM analysis. The Fig 1c showed hexagonal structure for pristine ZnO, while Fig. 1d. showed low agglomerated hexagonal and rectangular structure because of the Aloe vera and PF127 surfactant incorporation within the sample of the synthesized ZnO/Aloe/PF127.

3.2 Vibrational Studies- FTIR

To ascertain the formation of zinc oxide in ZnO/PF127, and ZnO/Aloe/PF127 and their interaction with PF127 and Aloe vera, the samples were analyzed by FTIR spectroscopy within the range of 400-4000 cm\(^{-1}\) at room temperature, as shown in Fig. 2. Metal oxides generally give their peak between 400 cm\(^{-1}\) to 600 cm\(^{-1}\). In this stance, the lower wavelength vibration peak of 462 cm\(^{-1}\) in all combinations of ZnO strongly attributed to the ZnO vibration mode [21]. The 1458 cm\(^{-1}\) and 1519 cm\(^{-1}\) peaks were represents the symmetric and asymmetric stretching vibration of the C=O group and it corresponds to the zinc acetate used for the
synthesis process [22]. ZnO peaks observed in all spectra with their wavelength slightly shifted and the new peaks were also observed because of the blending of PF127 and Aloe vera into ZnO. The vibrational peaks at 1111 cm$^{-1}$, 1342 cm$^{-1}$, 1280 cm$^{-1}$ and 2885 cm$^{-1}$ were attributed to the C-O stretching, C-H bending, -CH$_2$ twist, and C-H stretching vibration, which confirms the presence of PF127 in both ZnO/PF127 and ZnO/Aloe/PF127 spectra [23-25]. For ZnO/Aloe/PF127, 1242 cm$^{-1}$, 1743 cm$^{-1}$, 2978 cm$^{-1}$ peak correspond to the C-O-C stretching of -COCH$_3$ groups, and presence of carbonyl group in the Aloe vera. The interaction of phytochemicals such as alcohols, phenols, amines, and carboxylic acids with zinc surface and aid in the stabilization of ZnO was confirmed by the above peaks [7, 26]. The presence of hydroxyl groups and bending vibration of absorbed water on the photocatalyst surface was confirmed by the vibration bands at 1558 cm$^{-1}$ and 3417 cm$^{-1}$ in all spectra which could help to capture the holes in the valence band and helps to increase the number of hydroxyl radicals [22]. The presence of water molecules in all combinations of ZnO were confirmed by 3000 cm$^{-1}$ - 3650 cm$^{-1}$ peak.

![FTIR spectra of ZnO, ZnO/PF127, and ZnO/Aloe/PF127 nanoparticles](image)

Fig. 2 FTIR spectra of ZnO, ZnO/PF127, and ZnO/Aloe/PF127 nanoparticles
3.3 Optical study

ZnO samples were analyzed by UV-DRS spectroscopy for identifying the respective reflectance. The tauc’s plot between \( [F(R)\hbar\gamma]^2 \) and \( (\hbar\gamma) \) were provide optical bandgap of 3.22 eV, 3.02 eV, and 2.89eV for ZnO, ZnO/PF127, and ZnO/Aloe/PF127 respectively, illustrated in Fig. 3 (a, b, and c) inset shows reflectance, which attributed to the smaller crystallite size quantum confinement effects [7, 17]. The surface to volume ratio was increased with decrease in crystallite size, which increases the defect distribution of nanomaterials surface and exhibited strong absorption bands. The blending of PF127 and Aloe vera into the ZnO shifting the photocatalytic action from the UV region to the visible region due to the bandgap energy decrease, thus red-shift occurs [23-27].

The photoluminescence emission spectra of ZnO samples (excitation wavelength of 380 nm) were carried out to determine the separation and recombination of photo-generated electrons and holes in the catalyst. Generally, semiconductor materials have two photoluminescence emissions (excitonic and trapped). The sharp and near absorption edge peak is called excitonic emission while broad peaks are called trapped emission which is found at a longer wavelength [28]. In Fig. 3 (d), three characteristic excitonic peaks around 423 nm, 438 nm, and 467 nm (Blue emission) were observed in every sample [25, 27] which was mainly due to the surface defects and oxygen vacancies of ZnO. In another, the broad peak at ~ 517 nm (Green emission) was assigned to the defect-related emission because of the recombination of photo-generated holes with singly ionized oxygen vacancies of ZnO. The decrease in PL emission intensity value indicate longer lifetime of photo-generated \( e_{CB}^- - h_{VB}^+ \) efficiency and weaker recombination, which result in the higher photocatalytic performance [19, 29, 30].
Fig. 3 The plot drawn between \([F(R)h\gamma]^2\) and \(h\gamma\) of (a) ZnO, (b) ZnO/PF127, (c) ZnO/Aloe/PF127 nanoparticles (inset shows corresponding reflectance), and (d) Photoluminescence spectra of ZnO, ZnO/PF127, and ZnO/Aloe/PF127 nanoparticles
3.4 Photocatalytic degradation of Malachite Green dye

The photocatalytic performance of all combinations of ZnO was investigated for the degradation of MG dye by the reduction in absorption peak at $\lambda_{\text{max}} = 617 \text{ nm}$ under UV light and visible light of irradiations. Malachite green dye (MG) is the most commonly used water-soluble dye in industrial sectors such as leather, printing, textile, and pharmaceuticals. Fig. S1 shows the time-dependent absorption spectra of ZnO, ZnO/PF127, and ZnO/Aloe/PF127 nanoparticles. As the irradiation time increased from 0-20 min, the absorption band of all combinations of ZnO was observed to be decreased. In a photocatalytic process of all combinations of ZnO, the electrons in the conduction band (CB) and holes in the valence band (CB) are formed by the UV light and visible light illumination. In this process, the conduction band electrons produced less toxic superoxide anion radical ($\text{O}_2^-$) by reduction process with oxygen molecules. The valence band holes can attract water molecules or hydroxyl ions to generate reactive hydroxyl radicals by the oxidation process [31, 32]. The least degradation was occurred for pure ZnO because of the wide bandgap energy. The big jump in the absorption intensity confirmed that both samples are capped with PF127. Both the blended samples illustrated better photocatalytic activity toward Malachite green (MG) dye compared to the pure ZnO because of the bandgap energy reduction and promotion of electron-hole separation. The surface hydroxyl groups of ZnO/Aloe/PF127 nanoparticles facilitated the trapping of photo-induced e$^-$s and h$^+$, which resulted in the increased efficiency of photocatalytic degradation [323 34]. The degradation efficiency of ZnO, ZnO/PF127, and ZnO/Aloe/PF127 nanoparticles were observed as 66%, 78%, and 95% under UV light and 63%, 74%, and 90% under visible light irradiation for 20 minutes of light exposure, was shown in Fig. 4 (a, b). This demonstrates that the ZnO/Aloe/PF127 exhibits excellent photocatalytic activity because of the lower crystallite
size, active surface area, bandgap energy, and structure. [35]. In the same way, V.K Patel et al., in 2017 have been reported the synthesis process of ZnO nanorods using Aloe vera and PEG (8000) and investigate their catalytic effect by thermal decomposition of potassium perchlorate under the sono-emulsion route method. The results reported that the synthesized ZnO nanorods using Aloe vera with PEG exhibited higher catalytic activity compared to ZnO nanorods from PEG (8000) because of the large number of surface hydroxyl groups, amino acids, and phenolic compounds presence [36]. And another report, Nikhil Chauhan (2019) described the synthesis of different doped ZnO nanoparticles by hydrothermal method and their photocatalytic performance. They investigated crystallinity, bandgap energy, structure, and surface area of the nanoparticles to obtain higher degradation efficiency. The 80% of photocatalytic efficiency toward Methylene blue (MB) dye was achieved at 120 min because of the highest concentration of dopant [27].

Based on the photocatalytic experiment result, the ZnO/Aloe/PF127 was selected to inspect the reusability and photo-stability. For every cyclic experiment, the samples were dried at 100ºC before the irradiation of UV light. The degradation efficiency was slightly reduced from 94.8% to 91.4% for all five cycles. Fig. 4c indicates that the catalyst is considerably stable during the five cyclic photocatalytic experiments. The reusability and better durability of MG dye are achieved using ZnO/Aloe/PF127 nanoparticles. Visual image of degradation of MG dye using ZnO/Aloe/PF127 combination under UV light illumination was shown in Fig. 4d. A similar photocatalytic performance was carried out by Adeel Ahmad et al. in 2019, Fe NPs synthesized using an aqueous extract of Actinidia chinensis fruit extract and evaluated photocatalytic activity against alizarin yellow R. The prepared FeNPs exhibits 93.7% of photodegradation efficiency.
with 42 hrs of sunlight irradiation and it maintained stability and reusability for five times with the minimum loss of degradation efficiency [37].

Fig. 4 (a, b) $C_t/C_0$ plot and degradation efficiency $\eta(\%)$ of different combinations of ZnO, (c, d) reusability test report for five photo-cyclic experiments and visual image of MG
dye degradation under UV light irradiation using ZnO/Aloe/PF127 nanoparticles [UV-UV light and H-visible light]

3.5 Antibacterial screening

The relative bactericidal activity of different combinations of ZnO nanoparticles was evaluated towards Gram-positive and Gram-negative bacteria of *Pseudomonas aeruginosa*, *E.coli*, *S.aureus*, and *Bacillus subtilis*. Most of the polluted water causes of bacterial infections such as urinary tract infection, gastrointestinal disease, diarrhea, runny nose and sometimes it can cause lung infection or asthma. The antibacterial activities of ZnO have several mechanisms such as (i) Reactive oxygen species (ROS) generation under illumination process can degrade the microbes as well the pollutants present in the water bodies. The removal of both chemical contaminants and bacteria in polluted water has attracted much attention because of increasing the demand of water consumption. The produced ROS does not penetrate the cell membrane of the microbes but nucleic acid, lipids, and DNA present in the cell membrane are damaged. Due to this damaged cell membrane reaction, the growth of bacterial cells was stopped. The higher generation of reactive oxygen species value depends on the crystallite size, high surface area, and increase of oxygen vacancy. In the same manner, the analysis report of Piyali Mitra et al. 2018 revealed that the ZnO nanoconjugate effectively kills the bacteria through ROS method. The other antibacterial mechanisms are (ii) uneven surface texture produced by rough edges and (iii) Zn$^{2+}$ ion release in a suspension containing the nanoparticles [40-45]. R. Suganya et al. in 2015 have reported the synthesis of ZnO nanoparticles by chemical and biological methods. It showed that the biologically synthesized ZnO nanoparticles using *Aloe vera* exhibited higher optical and biological activity compared to chemically synthesized ZnO nanoparticles [46]. All combinations of ZnO exhibited effective bactericidal activity against both gram-positive and
gram-negative bacteria, shown in Fig.6. Our antibacterial report showed that, metal oxides can effectively inhibit bacterial pathogens. The Zn$^{2+}$ ion penetrates the cell membrane due to the electrostatic attraction between the ZnO surface and cell membrane attracting a thiol group of proteins present in the outer surface of the bacteria which inactivate proteins and decrease the membrane permeability. The ZnO/PF127 and ZnO/Aloe/PF127 exhibited higher antibacterial activity compared to ZnO. Easy functionalization of ZnO nanoparticles can be achieved by blending of polymers. The polymer chain links were compressed and forced for the higher energy conformation shift because the human cells adhered to the PF127 modified particles surface. The attractive force between the human cell and surface was balanced by the created opposing repulsive force [47-55]. Interestingly in the present study, ZnO/Aloe/PF127 is most prominent in cell inhibition of *B. subtilis* (24mm), *E. coli* (20mm), *S. aureus* (24mm), and *P. aeruginosa* (29mm) compared to standard antibiotic Chloramphenicol which may due to the phytochemicals and PF127 present in the ZnO/Aloe/PF127 combination. Tab.2 shows antibacterial result of different combinations of ZnO nanoparticles.
Fig. 6 Photographic image of antibacterial activity of ZnO [A], ZnO/PF127 [B], and ZnO/Aloe/PF127 [C] against selected microorganisms

Table. 2 Zone inhibition (mm) values of bacterial organisms

| Name of the sample     | Zone of Inhibition (mm) 100µg/ml |
|------------------------|----------------------------------|
|                        | B.subtilis | S.aureus | E.coli | P.aeruginosa |
| ZnO                    | 18         | 20       | 16     | 19           |
| ZnO/PF127              | 19         | 22       | 18     | 22           |
| ZnO/Aloe/PF127         | 24         | 24       | 20     | 29           |
| Standard               | 22         | 24       | 23     | 25           |

4. Conclusions

The different combinations of ZnO nanoparticles were synthesized employing sol-gel synthesis method. The synthesized samples were characterized by XRD, FESEM, UV-DRS, FTIR, Photocatalytic and Antibacterial activity to investigate the structural, morphological, optical, and biological properties. The increase in degradation level might be due to the bandgap energy value and crystallite size of ZnO nanoparticles. The lower crystallite size value will give a higher surface to volume ratio, which results an enhancement of photocatalytic degradation efficiency. The photocatalytic degradation efficiency of 95% was achieved for ZnO/Aloe/PF127
at a minimum time (20 min) of UV light irradiation. Furthermore, the antibacterial investigation of all combinations of ZnO showed effective antibacterial activity against various disease causing microbes. The above characterization results prove that the ZnO/Aloe/PF127 can be used to degrade several effective dyes. This can be also used for water purification of textile industry.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author contributions:

Seifunnisha.O: Experiments conducting, Characterization, and Preparation of draft.

Shanthi.J: Supervision, and Manuscript editing.

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