



***Acalypha Indica* and *Curcuma Longa* Plant Extracts Mediated ZnS Nanoparticels**

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Abstract

The development of biomedical electronics, biosynthesis of ZnS nanoparticles (NPs) much attracted researchers, due to an eco-friendly and cost effective routes for synthesis ZnS nanoparticles. In this present work ZnS NPs was synthesized by using *acalypha indica* and curcuma longa plant extract using chemical co-precipitation method. The structural, morphological, element composition of biosynthesis ZnS NPs was characterized by XRD, SEM and EDAX respectively. Optical and photoluminescence (PL) properties was evaluated by UV Visible spectroscopy. The formation of inhibition zone diameter against human pathogenic microorganisms was screened by in vitro disc diffusion method. From this investigation formation of inhibition zones clearly shows biosynthesized ZnS NPs have high antimicrobial activity against tested organisms, especially curcuma longa plant extract mediated ZnS NPs was formed maximum inhibition against all the tested microorganism.



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Introduction

In the last two decades, fabrication of inorganic semiconductor materials widely attracted researchers because of their excellent chemical and physical properties. Among all II-VI group semiconductors, ZnS having cubic and hexagonal crystal structure with large band gap (~3.63 eV) and high refractive index in the visible range.¹⁻⁴ The various synthesized method has been used to fabricate ZnS such as thermal decomposition, sol-gel technique,

microemulsion method hydrothermal method, CVD, CBD, Microwave assisted, sonochemical method, soft chemistry method, etc.⁵⁻¹² The bio-fabricated nanoparticles were used various applications like solar cells, field emitters, ultraviolet light-injection lasers, emitting diodes, electroluminescent devices, infrared windows, spintronics, flat-panel displays, optoelectronics, sensors, photocatalysis and antimicrobial activity.¹³⁻²² *acalypha indica* and *curcuma longa* is good medicinal plant and widely

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used novel drug medicine, green pharmacy due to the antimicrobial activity²³ In the recent time, biosynthesis of ZnS NPs using different biological extracts were reported.²⁴⁻²⁵ Biosynthesized ZnS NPs from various plant extracts has been already reported by our earliest reports. Biosynthesized ZnS NPs exhibits rapid generation of electron-hole pairs by photo-excitation and the highly negative reduction potentials of excited electrons have been generated high electron-hole pair when treated under UV visible light, and it increases antimicrobial properties.²⁶⁻²⁷ In this present investigation we reported structural optical and antimicrobial activity of ZnS NPs using *acalypha indica* and *curcuma longa* plants extract.

Experimental Procedure

Plant Extracts Preparation

acalypha indica and *curcuma longa* plants are collected from Herbal garden Coimbatore. For remove soils and dusts, the collected plants are washed in-deionized water followed by under running tab water. Then it's treated shadow drying for 10 days

at room temperature. The dried plant materials are crushed to coarsely powdered by grinder and 250 g of plant powder extracted by 250 ml of methanol solvent using soxhlet apparatus²⁸ the prepared plant extracts has been used for further investigation.

Biofabrication of ZnS

The bio-fabrication of ZnS nanoparticles were prepared by using 20 ml plant extract and 1:1 molar ratio of $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ (zinc sulfate) and NH_2CSNH_2 (thiourea) as a source materials. The both $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ and NH_2CSNH_2 were dissolved in 50 ml of deionized water in two different beakers and the mixtures was stirred 30 min by using magnetic stirrer. While continuous stirring, NH_2CSNH_2 and 20 ml of plant extract solution were added drop by drop into $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ solution and the mixture was kept 60 min stirring. The resultant nono-colloidal was formed and it was centrifuged at 2000 rpm for 20 min further it's heated in air furnace at 100 °C for 12 hours for obtain fine nanoparticles. Pure ZnS nanoparticles were prepared by same

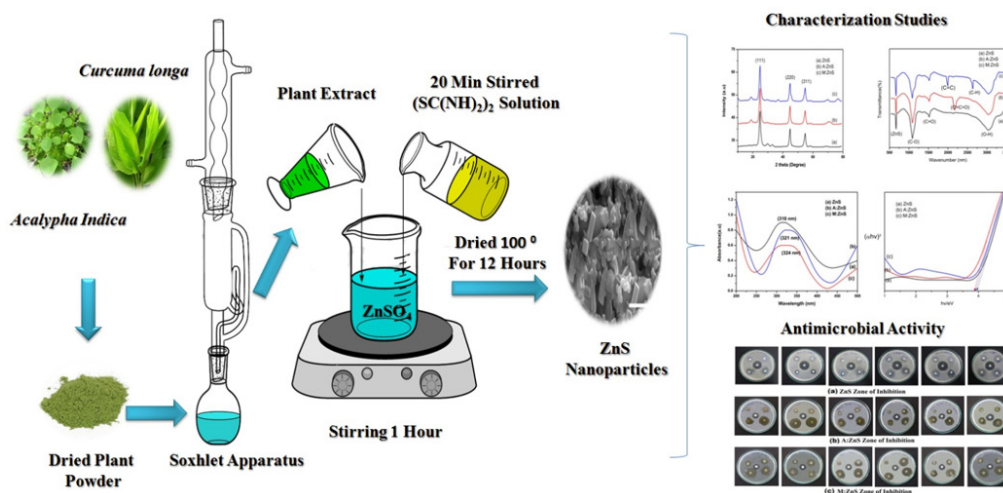


Fig. 1: Schematic representation of pure and bio fabricated ZnS synthesis process

Table.1. Show the structural properties of pure and bio fabricated ZnS NPs

Sample	2θ (hkl)	FWHM (Radian)	D Spacing	Average Crystalline size (nm)	Band gap energy(eV)
ZnS	28.9 (111)	0.4795	3.13	17.87	3.89
A:ZnS	28.9 (111)	0.4799	3.15	17.84	3.86
C:ZnS	28.9 (111)	0.5056	3.28	16.94	3.82

experimental procedure presented above but plant extracts could not be used for synthesis ZnS, for comparative evaluation, prepared ZnS nanoparticles was abbreviated following namely, pure ZnS as ZnS, *acalypha indica* and *curcuma longa* plant extract as A:ZnS and C:ZnS respectively. Schematic representation for the preparation and antimicrobial activity of Biosynthesized ZnS showed in figure 1.

Characterization Method

The Biosynthesized ZnS samples were characterized by XRD technique in the 2θ range of 10° - 80° with 0.1° step size using Cu-K α radiation (X'per PRO model- $\lambda = 1.54056 \text{ \AA}$) to determine crystal structure. Surface morphology and element compound presence in the ZnS was found by scanning electron microscopy

with element analyzer (Hitachi S-4500). The optical absorbance and photoluminescence properties were found by Perkin Elmer UV/VIS/ NIR and JASCO FT/IR-6600 instrument respectively.

Susceptibility Test Preparation

Antimicrobial activity of prepared ZnS nanoparticles has been determined by the diameter formation of inhibition zone, *In vitro* disc diffusion method has been used to investigate antimicrobial activity of human pathogenic microorganism's i.e: *B.substils*, *S.aures*, *E.coli*, *P.aeruginosa*, *C.albicans* and *A.niger*. Microorganisms were maintained 4°C on the slopes nutrient agar, MHA plates and the stock cultures were incubated for 24 hours at 37°C and 25°C respectively. Before transfer culture on the MHA plates, 15 ml of molten media pouring into MHA plates and solidify for 5 min. The minimum amount of stock culture (0.1%) were swapped on the MHA plates surface and 6 mm of sterile disc which have 60 μl concentration were placed on the MHA plate surface. The prepared ZnS samples were loaded on the sterile disc surface and allowed 5 min to diffuse samples into disc, and the loaded MHA plates are kept 24 hours in incubation at 37°C , finally during the incubation inhibition zone was formed around the disc it has been calculated by transparent millimeter ruler.²⁹⁻³⁰

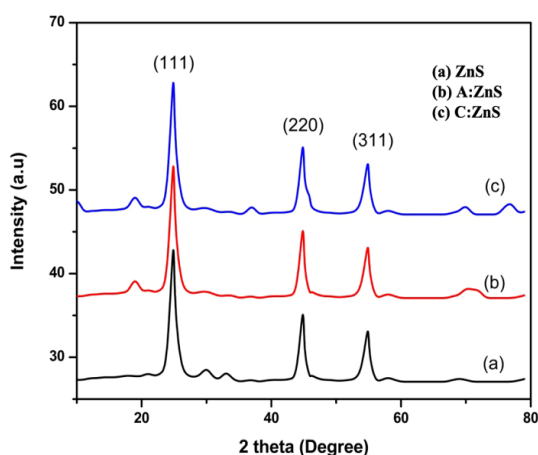


Fig. 2: XRD patterns of (a) ZnS, (b) A:ZnS, (c) C:ZnS

Result and Discussion

Structural analysis

XRD pattern of the prepared ZnS, A: ZnS and C: ZnS samples shown in Fig. 2. All the prepared samples

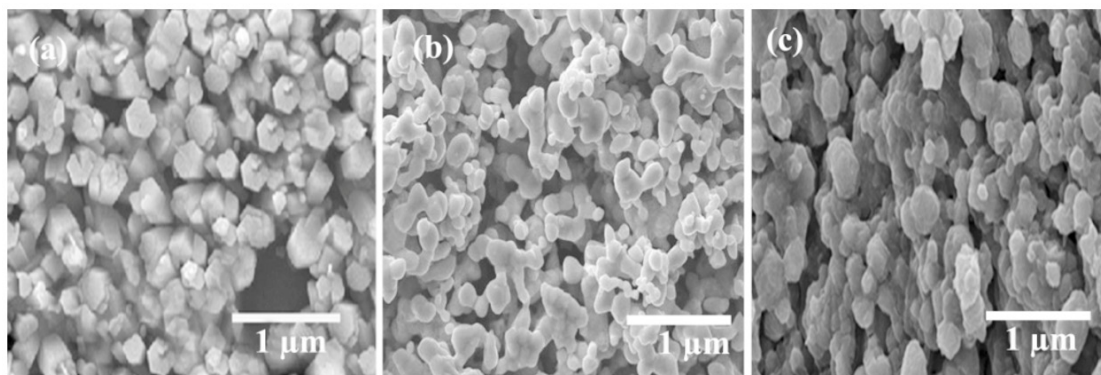


Fig. 3: SEM Image of (a) ZnS, (b) A:ZnS, (c) C:ZnS

exhibits three diffraction peaks well matched with zinc blended cubic structure³¹ From this XRD results shows any other impurity peaks are not detected and its conformed well formation of ZnS NPs. Figure 2 shows the XRD pattern of prepared samples diffraction peaks indicates the presence of prominent peaks 2 θ at 28.9°, 48.1° and 57.7° corresponding to the miller indices planes to (111), (220) and (311) reflection of ZnS cubic structure which well matched with JCPDS card no.80-0020.³² The XRD pattern of A:ZnS and C:ZnS NPs shows high intensity diffraction peak at (111) plane so it was the evidence bioactive compound of plant extract helps to improve the crystal growth of ZnS nanoparticles. Table 1 shows the calculated average crystalline size of ZnS

nanoparticles using Debye Scherer formula

$$D = \frac{0.9\lambda}{\beta \cos \theta} \quad \dots(1)$$

Where, D is the mean crystallite size, β is the full width at half maximum of the diffraction line, θ is diffraction angle, λ is the wavelength of X ray radiation and 0.9 is the constant shape factor.

Morphological and Element Composition Analysis

The morphological and element composition of prepared ZnS NPs was investigated by using SEM and EDAX. The SEM images of synthesized ZnS

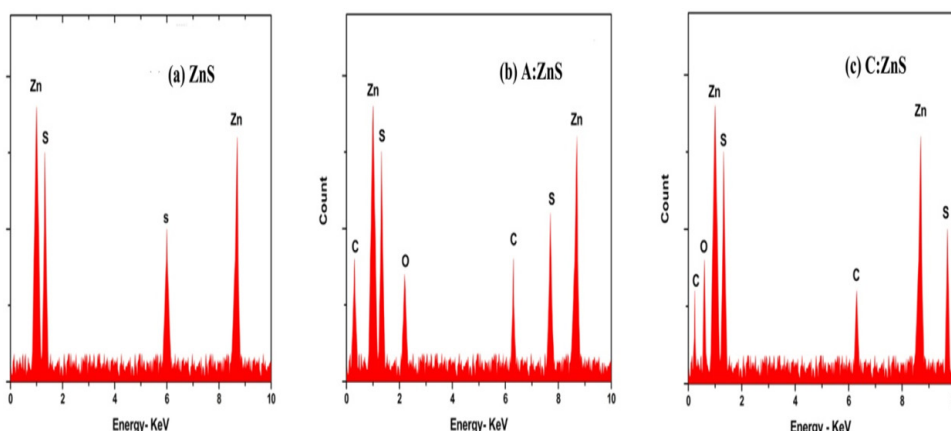


Fig. 4: EDAX Image of (a) ZnS, (b) A:ZnS, (c) C:ZnS

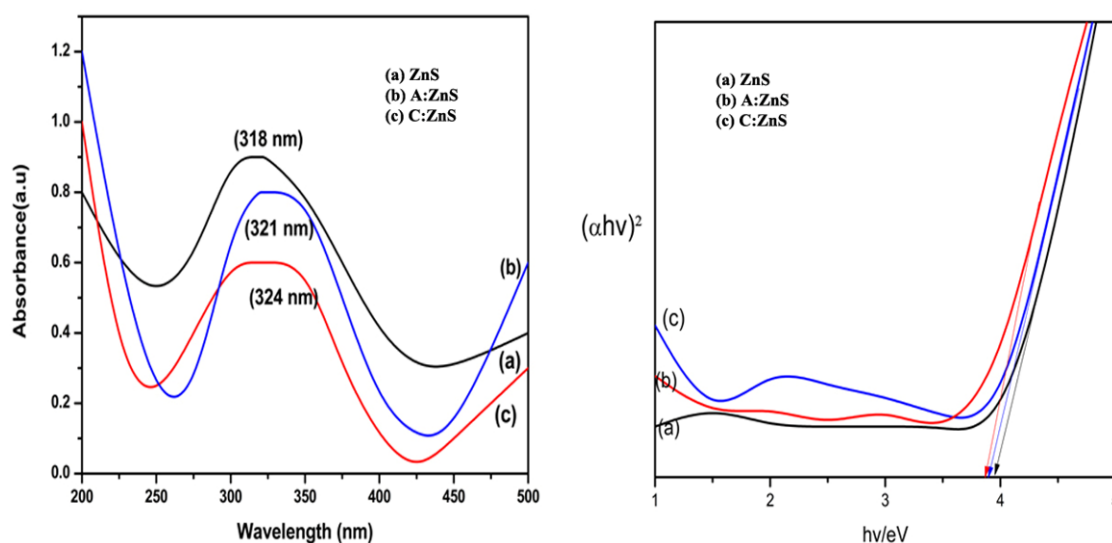


Fig. 5: Optical Absorbance of (a) ZnS, (b) A:ZnS, (c) C:ZnS

NPs are having narrow particle size with spherical shape as shown in Fig. 3(a-c). Surface morphology of the ZnS nanoparticles was varied by the plant extract; from this SEM image revealed bio-fabricated ZnS having uniform distribution of plant extract and improve the crystalline structure of ZnS NPs as shown in Fig. 3 (b-c). The C: ZnS nanoparticle is smaller than ZnS and A: ZnS and diameter of the prepared samples was varied depends on the plant extracts. Fig. 4(a-c) shows the EDAX image of pure and biological synthesized ZnS NPs, from this result Zn and S elements were presence in pure ZnS NPs and the Zn (63.59%) composition element was found

higher than S (36.41%) element in ZnS NPs and no other impurities observed in the spectrum it was clearly shown in Fig. 4 (a). In the EDAX image, A:ZnS NPs composition was confirmed with presence of Zn, S, Carbon, Oxygen elements in the atomic ratio of 41.23%, 31.94% 16.21% and 10.62% respectively from this spectrum biomolecules of plant extract was influence to composite the carbon and oxygen element as shown in Fig. 4 (b). The Zn, S, Carbon, Oxygen elements also presence in C:ZnS in the atomic ratio of 46.24%, 31.93% 15.20% and 06.63% respectively it is shown in Fig. 4(c).

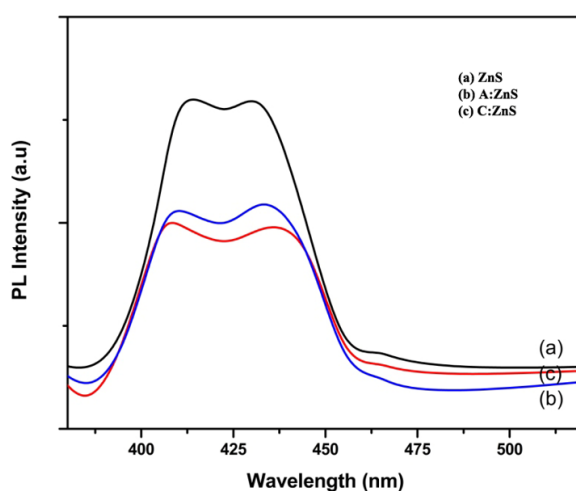


Fig.6. Photoluminescence spectrum of (a) ZnS, (b) A:ZnS, (c) C:ZnS

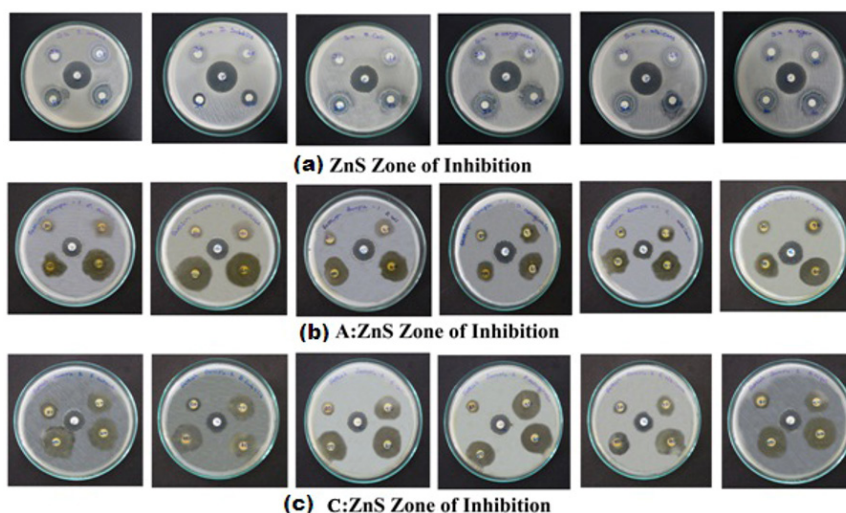


Fig. 7: Show the Zoi for (a) ZnS, (b) A:ZnS, (c) C:ZnS NPs against different microorganisms

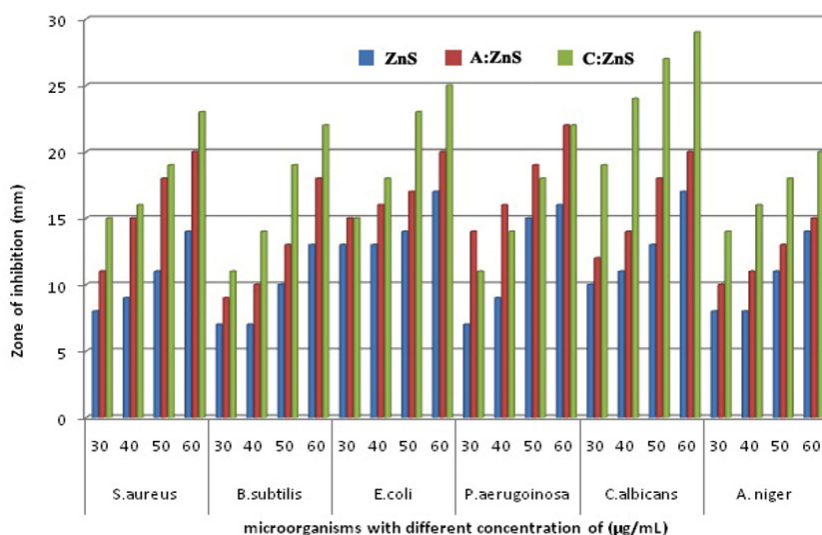


Fig. 8: The bar diagram for (a) ZnS, (b) A:ZnS, (c) C:ZnS NPs against different microorganisms

observed against *E. coli* and *C. albicans* followed by *S. aureus*, *P. aeruginosa*, *A. niger* and *B. subtilis* of 17 mm followed by 16 mm, 14 mm, 14 mm, 13 mm at 60 µl of concentration respectively, its clearly indicate when concentration is increased the inhibition zone also increased due high surface absorption of bacteria cell.

For A:ZnS NPs was found highest inhibition zone against *P. aeruginosa* followed by *E. coli*, *C. albicans*, *S. aureus*, *B. subtilis* and *A. niger* of 22 mm, 20 mm, 20 mm, 14 mm, 18 mm and 15 mm at 60 µl of concentration respectively, *P. aeruginosa* has higher inhibition zone at starting concentration when compared to other microorganisms due to presence of bioactive compound of plant extract such as phenolic, saponin, terpenoids, etc. The maximum inhibition zone of C:ZnS NPs was found against *C. albicans* followed by *E. coli*, *S. aureus*, *B. subtilis*, *P. aeruginosa* and *A. niger* of 29 mm, 25 mm, 23 mm, 22 mm, 22 mm and 20 mm at 60 µl of concentration respectively, from this investigation since at starting concentration *C. albicans* lead to form high inhibition zone.

From this investigation we found maximum inhibition zone against gram negative bacteria followed by gram positive and fungus culture for bio-fabricated ZnS, this may happen due to presence of bioactive compounds like saponin, phenols, terpenoids, proteins and carbohydrates which may help to

formation of large surface area nanoparticle penetrate into bacteria cell wall and causes cell death.³⁴⁻³⁵

Conclusion

In summary, we reported the bio fabricated ZnS NPs were prepared by using plant extracts of *acalypha indica* and *curcuma longa*. The cubic crystalline structure was confirmed for all the ZnS NPs and the average particle was found to be 15-18 nm. The smaller crystalline size was found to bio-fabricated ZnS nanoparticles compare to ZnS NPs and morphology was found the spherical shape like structure. The band gap energy was calculated from 3.89 eV to 3.82 eV and the purity of different element composition of plant extract was reveals from EDAX. The antimicrobial activity was investigated against different human pathogens, maximum zone of inhibition was formed for plant extract mediated ZnS when compared pure ZnS nanoparticles due to influence of smaller crystal size and presence of bimolecular from plant extracts.

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Conflict of Interest

The author(s) declare(s) that there is no conflict of interests regarding the publication of this article

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