International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.9, pp 443-449, 2017

Green synthesis, Characterization and Antimicrobial activity of ZnS using Syzygium aromaticum extracts

M.Sathishkumar[1,2]*, M.Saroja[1], M.Venkatachalam[1].

[1]Thin Film R&D centre, Department of Electronics, Erode Arts and Science College, Erode-638009, Tamilnadu, India.
[2]Department of Electronics and Communication Systems, Nehru Arts and Science College, Coimbatore-641105, Tamilnadu, India.

Abstract : This present work reported biosynthesized ZnS nanoparticles using methanol extract Syzygium aromaticum as an antimicrobial agent. The soxhlet apparatus was used to extract Syzygium aromaticum and As-biosynthesized ZnS nanoparticles were characterized by using different analysis techniques. The nanoparticles structural properties and surface morphology formation were investigated using X-Ray diffraction (XRD), Scanning Electron Microscopy (SEM) and average grain size also calculated. The optical absorption and different functional group of biosynthesized ZnS studied by UV-Visible spectroscopy (UV-Vis) and Fourier transform infrared spectroscopy (FTIR). The antimicrobial activity was evaluated by agar well disc diffusion method against various microorganisms.
Keyword : ZnS, Syzygium aromaticum, Antimicrobial Activity, XRD, SEM, UV-Vis, FTIR.

1. Introduction

ZnS is one of the promising semiconductor materials in II-VI group because of their wide band gap energy (3.7 eV), Dielectric constant, Refractive index (2.35) [1-3]. In photovoltaic and optoelectronics devices ZnS is resolvable material because of their Nano and polycrystalline structure [4]. ZnS have to different zinc blende and wurtizite crystalline structure [5] there is different methods are used to synthesis ZnS, chemical bath deposition[6]spray pyrolyis, vacuum evaporation and pulsed laser deposition [7] in health and food industries silver, titanium gold nanoparticles are widely used because of their antimicrobial properties [8]synthesized ZnS and other sulphide metals are broadly compared and determined their antibacterial, Fungal and viral activity [9-10]Syzygium aromaticum is good medicinal plant its commonly known clove and widely used novel drug medicine, green pharmacy due to the antimicrobial activity [11] Syzygium aromaticum (clove) have excellent antimicrobial activity against food spoilage bacteria [12] methanol extract Syzygium aromaticum (clove) increase zone of inhibition to compare ethanol extract [13] Syzygium aromaticum (clove) is family of myrtaceae and it's a unopened puds of flower in plant [14-15] the objective of the study is biosynthesis of ZnS NP's using Syzygium aromaticum (clove) methanol extract and investigate their characterization and Antimicrobial activity.

2. Materials and Methods

2.1 Plant Extract

Syzygium aromaticum(clove) buds are purchased from agriculture university, Coimbatore and well growth Syzygium aromaticum (clove) was conform by Mr.R.Gokulavasan, seed certificate officer, Tharapuram

02. The obtained Syzygium aromaticum (clove) were washed running tab water followed DI water five times for removing soil and dusts, Washed material treated shadow dried, open air dried at room temperature more than ten days and grinder used to crushed powder form of dried plant Syzygium aromaticum. The soxhlet apparatus used to extract plant, 25 g of coursed powder was treated 250 ml of methanol to extract successful solvent and stored, used for further investigations.

2.2 BIOSYNTHESIS OF ZnS

Biosynthesis of ZnS used from Syzygium aromaticum extract, zinc sulphate obtained from merck industries in analytical grade used for without purification, 14.4 g zinc sulphate was dissolved in 100 ml DI water and 20 ml of Syzygium aromaticum extract was treated in 20 min stirred. Than 20 ml of stirred extract was added drop by drop in 80 ml (1 mM) of aqueous ZnS solution were kept from continuous stirring at 2 hours. The formation of nanocolloid solution was formed at result and dried for 60^0C at 5 hours.

2.3 Preparation of Inoculums and Antimicrobial Test

One of the best antimicrobial susceptibility tests is disc diffusion method and Muller Hinton Agar (MHA) plates are obtained from Hi-Media Mumbai used to screening In vitro antimicrobial activity all the stock culture was maintained 4^0 C, The loopful process were used transfer stock culture into MHA plates and all stocks cultures were kept 24 hours at 24^0 C to 35^0C in incubator

Before transfer the cultures the MHA plates are treated different process for purification, 15 ml pouring of molten media use to prepare MHA plates and allow 5 min for solidify platesand the minimum amount 0.1% of stock cultures inoculums were swapped in MHA plate surface and allowed 5 min to dry, The 60 mg/disc concentration of disc are placed MHA plate surface each disc have 6mm width. The prepared biosynthesized ZnS solution were loaded all disc surface with different concentration and allow 5 min to diffuse extracts and diffused MHA plates are kept Incubation at 37^0C for 24 hrs during the incubator zone of inhibition (ZoI) was formed around the disc, transparent millimeter ruler use to measure ZoI.

2.4 Characterization Techniques

Biosynthesized zinc sulphide nanoparticles were investigated different techniques for analysis the characterization, X-ray diffractometer(XPERT-PRO)used to analysis crystalline structure of ZnS and average grain size, Hitachi S-4500 scanning electron microscope (SEM) help study surface morphology and formation of nanoparticles, The optical absorbance was determine using UV-Visible spectrometer, JASCO FT/1 IR-6600 instrument was use to measure different function group of synthesized ZnS.

3. Result and Discussion

3.1 Structural Analysis

Synthesized ZnS nanoparticles using Syzygium aromaticum extract crystalline structure characterization was carried out by using X-Ray powder diffractionanalysis.figure 1 show the different intensity peaks(2Θ= 28.55,33.08,47.51,56.28,59.13) for corresponding reflective plane (111, 200, 220, 311, 222)it conform ZnS cubic zinc blende structure because the major peak were absorve at (2Θ= 28.55 and 47.51) for (111,220) plane (JCPDS 05-0566)[16], Average crystalline size (D) calculated by using scherrer's formula.

$$D = 0.9\lambda / \beta \text{Cos}\ \theta \quad \text{----------} \quad \textbf{(1)}$$

Here 0.9 is the shape factor constant value, λ=1.5405Å wave length of the incident beam CuKa1, Full width half maximum is β, diffraction angle Θ in radian, average grain size of ZnS is ~46 nm

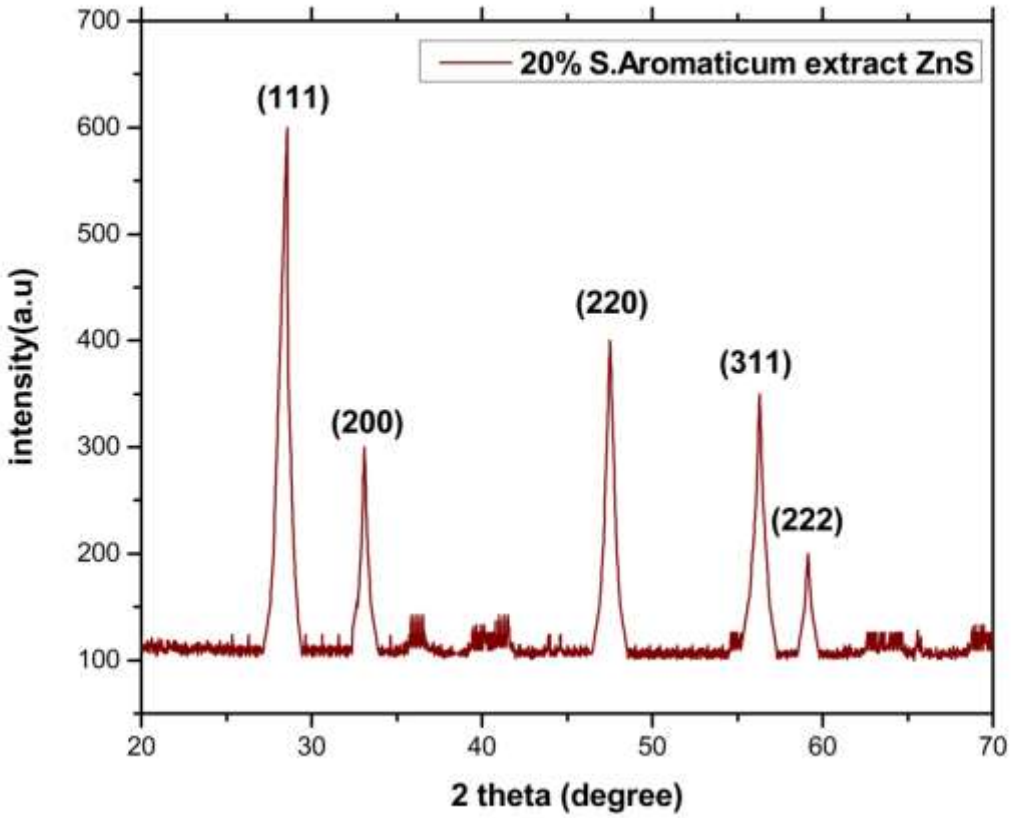

Figure 1: XRD pattern of ZnS using Syzygium aromaticum extract

3.2 Morphology Analysis

Surface morphology of synthesized ZnS nanoparticles using Syzygium aromaticum extract, powder sample were analysis by using SEM, Figure 2 clearly show the different particle size and zinc blend and spherical microstructure on the surface and estimate size was found less than 2 µm.

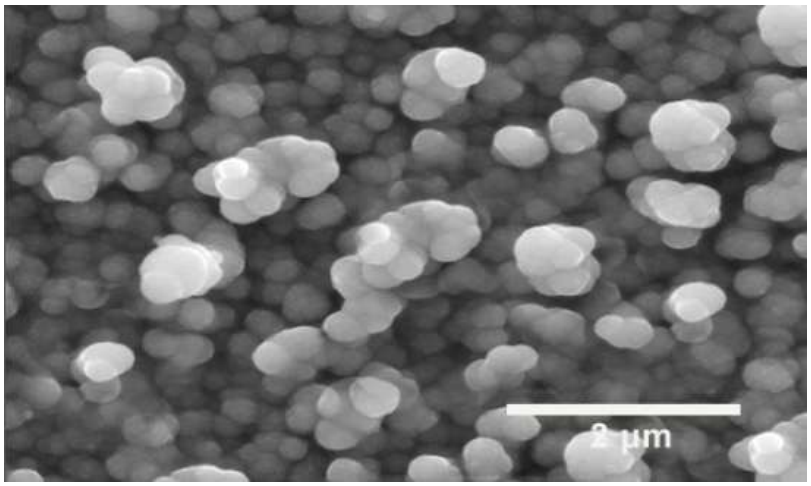

Figure 2: SEM analysis of ZnS using Syzygium aromaticum extract

3.3 UV-Visible Analysis

Figure 3 show the UV-Visible spectrum of synthesized ZnS nanoparticle using Syzygium aromaticum extract, The ZnS nanocolloidal solutions optical absorbance examined from 400-600 nm range. The sharp absorbance of UV-Vis region at 492 nm and decrease up to 600 nm during the absorbance green ZnS nanocolloidal solution transition in to white color.

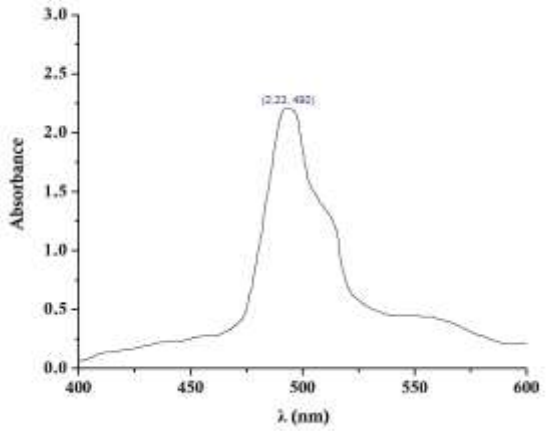

Figure 3: UV-Visible spectrum of ZnS using Syzygium aromaticum extract

3.4 Functional Group Analysis

FTIR analysis use to evaluate different functional group of biosynthesized ZnS nanoparticles using Syzygium aromaticum extract. Figure 4 shows various IR spectra of biosynthesized ZnS sharp peaks, all functional group exhibit range from 500 to 4000 cm^{-1}absorption.

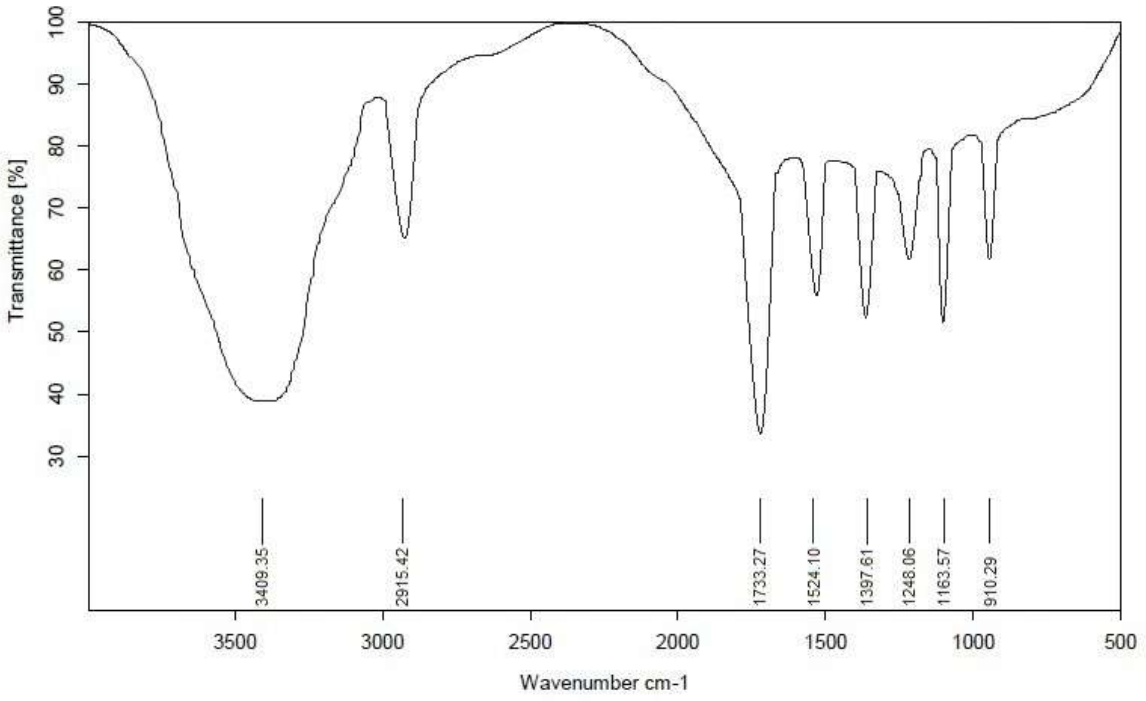

Figure 4: FTIR spectrum of ZnS using Syzygium aromaticum extract

Broad absorption range in 3409 cm^{-1} exhibit O-H alcohol bonding due to high stretching of Zinc, capping agent of Syzygium aromaticum extract were low exhibit stretching at 2915 cm^{-1}due to C-H methyl and methylene group, capping agent of sulphide high stretching exhibit at 1733 cm^{-1} C=O carbonyls, 1524 cm^{-1} is C=C aromatic of extract 1397 cm^{-1} is C-H Cellulose ,hemicelluloses of extract , again zinc stretching at 1248 cm^{-1}O-H Phenolic and 1163 cm^{-1} O-H Alcohols (Primary and secondary) of sulphide exhibits, at 910 cm^{-1} is C=C alkanes indicate water stretching of nanocolloidal ZnS solution

3.5 Antimicrobial Activity Analysis

Biosynthesized ZnS using Syzygium aromaticum extract antimicrobial activity were examined by in vitro disc diffusion method using MHA plates, during the incubation zone of inhibition(ZoI)was formed around the disc, figure 5 and table 1 clearly show their formation. Here both gram positive, gram negative bacteria and fungus are tested. Staphylococcus aureus and Basicillus subtilis are gram positive, Escherichia coli and Psedomonas aerugoinosa are gram negative bacterial, only cell membranes differ for both bacteria's and Candida albicans, Aspergillus niger are fungus culture. The 30 µl to 60 µl different four concentration was tested in MHA plate surface.

Table 1: Antimicrobial activity of ZnS using Syzygium aromaticum extract

Organism	C	30 µl	40 µl	50 µl	60 µl
Staphylococcus aureus	16	12	14	22	24
Basicillus subtilis	13	11	16	20	21
Escherichia coli	15	9	14	18	20
Psedomonas aerugoinosa	15	10	16	18	22
Candida albicans	14	11	15	23	25
Aspergillus niger	12	9	18	20	21

At 30 µl concentration ZoI were formed against all tested microorganisms Staphylococcus aureus (12 mm) lead at this concentration followed by Basicillus subtilis, Candida albicans (11 mm), Psedomonas aerugoinosa (10 mm), Escherichia coli and Aspergillusniger (9 mm) but 40 µl concentration Aspergillus niger (18 mm) lead and 50 µl concentration Candida albicans (23 mm) formed high ZoI.

Finally at 60 µl concentration fungus culture of Candida albicans (25 mm) formed high zone of inhibition followed by Staphylococcus aureus (24 mm), Psedomonas aerugoinosa (22 mm), Basicillus subtilis and Aspergillus niger (21 mm) minimum zone was formed Escherichia coli (20 mm) because ZnS and Syzygium aromaticum extract damaged cell membrane of bacteria and fungus basicallycell membrane of microorganisms affect by iron source [15] and sulphide source. So the biosynthesized ZnS nanoparticles using Syzygium aromaticum extract have excellent antimicrobial activity against entire tested microorganism.

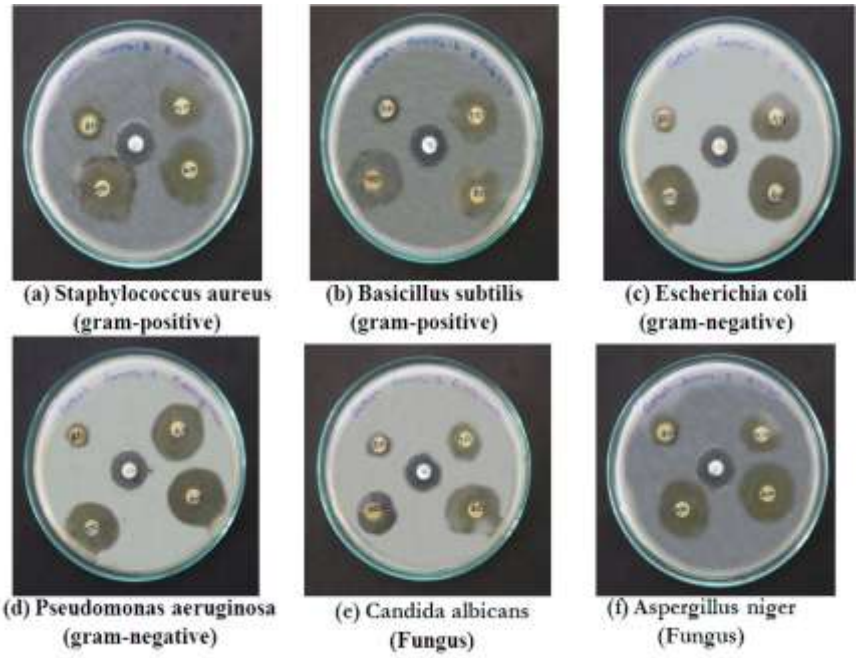

Figure 5: Antimicrobial activity of ZnS using Syzygium aromaticum extract

4. Conclusion

Biosynthesized ZnS nanoparticles using Syzygium aromaticum extract in first time we reported, characterization of ZnS nanoparticles were analyzed by using XRD,SEM,UV-Visible and FTIR The antimicrobial activity of ZnS tested in vitro disc diffusion method using MHA plates obtained from Hi-Media Mumbai. Biosynthesized ZnS nanoparticles using Syzygium aromaticum are cubic zinc blende structure and average grain size was calculated ~ 46 nm using XRD analysis. Surface morphology of synthesized ZnS was found different zinc blende shapes of surface, size less than 2 µm by using SEM analysis, the sharpoptical absorbance at 492 nm and different functional group of Syzygium aromaticum extract were found by using UV-Visible and FTIR spectrum. The antimicrobial activity of biosynthesized znS nanoparticles are tested different microorganisms like bacteria and fungus the maximum ZoI was formed Candida albicans (25 mm), minimum ZoI formed Escherichia coli (20 mm) at concentration 60 µl. it was the evident biosynthesized ZnS have an excellent antimicrobial activity against all tested microorganisms

Reference

1. Seyyed ZR, Hamid RD, Mohammad HE. Study ofstructural and optical properties of ZnS zigzag nanostructured thin films.J Applied Surface Science .,2015, 356; 1096-1104.
2. Inamdar AI, Sangeun Cho, Yongcheol Jo, Jongmin Kim, Jaeseok Han, Pawar SM, Hyeonseok Woo,Kalubarme RS, ChanJinPark, Hyungsang Kim, HyunsikIm. Optical properties in Mn-doped ZnS thinfilms Photoluminescence quenching. J Materials Letters., 2016, 163; 126-129.
3. Daniela E, Ortíz-Ramos, Luis A González, Rafael Ramirez-Bon.P-Type transparent Cu doped ZnSthin films by the chemical bath deposition method. J Materials Letters., 2014, 124; 267-270.
4. Jie Cheng, DongBo Fan, Hao Wang, BingWei Liu, YongCai Zhang and Hui. Chemical bath deposition of crystalline ZnS thin films. J Sci. Technol., 2003, 18; 676-679.
5. Jyoti PB, Barman J, Sarma KC.structural and optical properties of zns nanoparticles. Jof materialsLetters., 2008, 5; 201- 208.
6. S Tec-Yam, Rojas J,Rejón V, Oliva AI.High quality antireflective ZnS thin films prepared by chemical bath deposition, Materials Chemistry and Physics.,2012, 136; 386-393.
7. Patil JS, Dhasade SS, Thombare JV,Fulari VJ. Structural, Morphological and Optical Studies of ZnS Thin Films Produced by Electrodeposition Method, Journal of Shivaji University (Science & Technology)., 2014, 41 (2); 2014-2020.

8. Bokare A, Sanap A, Pai M, Sabharwal S, Athawale AA. 2013. Antibacterial activities of Nd doped and Ag coated TiO2 nanoparticles under solar light irradiation. J Colloids Surface.,2013, 102; 273–280.
9. Malarkodi C, Annadurai G. A novel biological approach on extracellular synthesis and characterization of semiconductor zinc sulfide nanoparticles, J Applied Nanoscience., **3(**5); 389–395.
10. Vanaja M, Rajeshkumar S, Paulkumar K, Gnanajobitha G, Malarkodi C, Annadurai G.Phytosynthesis and characterization of silver nanoparticles using stem extract of Coleus aromaticus, International Journal of Materials and Biomaterials Applications, 2013,3(1); 1–4.
11. Ayoola GA, Lawore FM, Adelowotan T, Aibinu IE, Adenipekun E, Coker HAB, and Odugbemi TO. Chemical analysis and antimicrobial activity of the essential oil of Syzigium aromaticum(clove),Afr. J. Micro. Res., 2008, 2; 162-166.
12. Muhammad Saeed, Muhammad Nadeem, Moazzam Rafiq Khan.Antimicrobial activity of Syzygium aromaticum extracts against food spoilage bacteria,aferica journal of microbial research., 2009, 7(41); 4848-4856.
13. AmitPandey, Paru Singh. Antibacterial activity of Syzygium aromaticum(clove) with metal ion effect against food borne pathogens, Asian Journal of Plant Science and Research., 2011, 1 (2);69-80.
14. Shyamala MP, Venukumar MR and Latha MS. Antioxidant potential of this Syzygium aromaticum(Gaertn.) Linn. (Cloves) in rats fed with high fat diet,Ind. J. Pharmacol., 200335; 99-103.
15. S Burt. Essential oils: their antibacterial properties and potential applications in foods a review, International Journalof Food Microbiology., 2004, 94(3); 223–253.
16. JCPDS card 05-0566.

*****