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SYNTHESIS, CHARACTERIZATION, AND ANTI-BACTERIAL ACTIVITY OF COLLOIDAL SUPPORTED COBALT NANOPARTICLES

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Abstract: In this examination, we have incorporated polyvinyl pyrrolidine (PVP) capped cobalt nanoparticles (Co NPs) was combined by reduction strategy, Silica (Si) colloid was synthesised by Stober's technique and it was functionalized with thiol by 3-mercaptopropyl trimethoxy silane. Silica supported Co NPs was combined by blending of Si colloid and Co NPs. The integrated product characterized by various methods like XRD, SEM, EDX. The phase purity and crystallinity of Cobalt nanoparticles was confirmed by X-ray diffraction examines the normal molecule size of Co and Si supported CoNPS, was evaluated utilizing Scherrer's and observed to be in the range nano extend. PXRD revels that all the diffraction peaks were all around filed to cubic Co (JCPDS document: 89-7093). Assist the antibacterial impact of Silica, Cobalt nanoparticles, Colloidal Silica upheld Co nanoparticles was assessed against antibacterial movement for two-gram positive cultures Staphylococcus aureus, Bacillus cereus and two-gram negative cultures Klebsiella, Pseudomonas. which demonstrated that the nanoparticles have direct antibacterial action in contradiction of both Gram positive and Gram negative pathogenic bacterial strains and holds potential application in pharmaceutical and biomedical businesses.

1. Introduction:

In nanotechnology the nanoparticles are the building pieces and they are alluded to a characteristic accidental or produced material, the molecule in measure circulation at least one outside measurements is in the range 1nm-100nm [1] Nanoparticles are the nano-sized particles [2], [3]. Nanotechnology can be characterized as the control of issue through certain compound or potentially physical procedures to make materials with particular properties, which can be utilized as a part of specific applications [4] Metal nanoparticles are exceptionally appealing impetuses contrasted with mass materials because of their high surface-to-volume proportion. A few kinds of conventional nanocatalysts incorporate change metal nanoparticles in colloidal suspension those adsorbed onto mass backings and lithographically manufactured varieties of nanocatalysts [5],[6].which have discovered different applications in the fields of solution [7],[8], science [9],[10] and so on.

There are physical, compound or organic strategy to integrate the nanoparticles. Cobalt nanoparticles (CoNPs) can be blended by different methodologies like ultrasonic shower pyrolysis, DC magnetron sputtering [11], warm structure [12], electrochemical [13] and Liquid-Phase Reduction [14] process and furthermore by organic techniques, for example, microbial amalgamation [15] of nanoparticles. Progress metal nanoparticles in colloidal suspension have integrated by utilizing wide assortment of decreasing specialists, for example, hydrogen, sodium borohydride and ethanol [16]. Various sorts of stabilizers have been utilized as topping operators to settle the nanoparticles, for example, surfactants, polymers, dendrimers and additionally extraordinary kinds of ligands [17]-[19]. On account of metal nanoparticles adsorbed onto mass backings, a wide assortment of help materials have utilized, for example, carbon, mesoporous silica, titania, alumina, zeolites and pitches [20]-[25] .Arrays nanocatalysts have been created by utilizing electron shaft lithography and colloidal lithographic techniques[26].

Significant consideration has been given from the previous couple of years, to the combination middle of the road nanocatalysts that we term as colloidal-upheld metal nanoparticles (CSMNs). They have potential focal points of CSMNs as middle of the road nanocatalysts being suspended in arrangement amid fluid stage synergist responses, having high metal loadings on the silica colloid surface bringing about a high surface zone, and simple partition of the response blend from the CSMNs. The CSMNs join the benefits of heterogeneous impetuses in a close homogeneous organization [27]. These favorable circumstances make utilizing CSMNs especially appealing nanocatalysts for fluid stage responses contrasted with their colloidal partners and those adsorbed onto mass backings [27]. CoNPs could be productive nanoparticles as they have great synergist [28],[29] and elite perpetual attractive properties [30],[31]and additionally have biomedical [32] and cytotoxic action [33],

In this proposed work, incorporating the cobalt nanoparticles (Co NPs) connected to silica colloids by three stages. The three stages in this procedure incorporate blending the silica colloids, functionalizing the silica colloids, PVP-topped Co NPs and appending the PVP-topped Co NPs to the silica colloids. Orchestrated items were described by different systems. The antibacterial exercises of the blended silica colloids, PVP-topped Co NPs and appending the PVP-topped Co NPs to the silica colloids have been examined against two gram positive societies Staphylococcus aureus, Bacillus cereus and two gram negative societies Klebsiella, Pseudomonas Results demonstrate that the detailed CoNPs are having bactericidal exercises.

2. Materials and methods:

Tetraethylorthosilicate, ammonium hydroxide, cobalt chloride and 3-mercaptopropyl trimethoxysilane were obtained from Sigma Aldrich and Merck compound Pvt Ltd. Every one of the reagents were acquired diagnostic review and arranged utilizing doubly refined water.

2.1. Synthesis of Silica Colloids and its functionalization:

The silica colloids were orchestrated by utilizing the Stoeber union strategy [30 mL of ethanol and 2.4 mL of ammonium hydroxide was added to an Erlenmeyer flagon and blended for 5 minutes. At that point, 1.2 mL of Tetraethylorthosilicate was added to the above arrangement and mixed for around 24 h. The last arrangement is extremely turbid and comprises of a suspension of the silica colloids. Functionalized silica colloid was set up by including 100 µL of 3-mercaptopropyl to the silica colloid suspension and this arrangement was blended overnight [34]

2.2. Synthesis of PVP Stabilized Cobalt Nanoparticles:

In a common combination process, 1 g of polyvinyl pyrrolidone (PVP) was broken up in 40 mL deionized (DI) water under attractive blending, trailed by the expansion of 2 mmol cobalt chloride to shape a red arrangement. 30 mL containing ethanol and water (1:1) and 1mM NaBH4 were added to the blend. The blend was mixing energetically for around 24 h within the sight of nitrogen environment at room temperature. The subsequent dim dark powder was recovered by centrifugation. The item was washed with refined water took after by ethanol lastly dried at 80 0C for 2 h in an electric oven.

2.3. Synthesis of Colloidal Supported Cobalt Nanoparticles:

The functionalized silica colloids were first centrifuged four times at 13,500 rpm for 3 minutes each time. Amid the initial two-centrifugation cycles, the functionalized silica colloids were redispersed in ethanol and amid the last two centrifugation cycles, they were redispersed in doubly deionized water. 2 mL of the centrifuged functionalized silica colloids and 4mL of the PVP topped cobalt nanoparticles are set into a sparkle vial and this suspension is blended for 24 hours to permit the cobalt nanoparticles to tie to the functionalized silica colloids [27].

2.4 Antibacterial Activity:

The antibacterial exercises of the Silica, Cobalt nanoparticles, Colloidal Silica upheld Co nanoparticles was assessed against antibacterial movement for two-gram positive societies Staphylococcus aureus, Bacillus cereus and two-gram negative societies Klebsiella, Pseudomonas.) Two gram positive societies Staphylococcus aureus, Bacillus cereus and two gram negative societies Klebsiella, Pseudomonas were vaccinated into 20ml Luria bertini juices and hatched in a shaker hatchery at 37^{o}C and 150 rpm overnight.3 tests were considered for the antimicrobial examination. 100 µl of the examples were serially weakened in 900 µl of DMSO three times and utilized for the investigation. For the antimicrobial action, 400 ml of Muller hinton agar was cleaned and filled sterile petri plates in the laminar chamber and let to set. 100µl of the previously mentioned societies were spread onto the plates utilizing a spreader. 5 wells were punched into each plate utilizing a 8mm megabore and 100µl of the examples of various weakening's taken above were stacked in each well. The well in the inside was stacked with 100µl DMSO which filled in as a control and the plates were brooded at 37^{o}C overnight. The zone of hindrance was watched and the width of the zone was recorded.

3. Results and Analysis:

3.1 Powder X-ray diffraction study:

The stage immaculateness and crystallinity of Cobalt nanoparticles was affirmed by X-beam diffraction contemplates. Fig. 1 (an) and (b) demonstrates the XRD example of PVP topped Co NPs and silica upheld Co NPs. The wide diffraction crests at 2θ of 44.6°, 4.92° and 76.3° compare to (111), (200) and (220), individually as precious stone planes for the cubic Co (JCPDS document: 89-7093) as appeared in Fig.1 (an) and also the new pinnacle was seen at 23.3° relate to (100) planes of was watched for silica colloid (Fig.1 (b)) which shows that Co NPs on surface of mass Si material. The normal crystallite measure computed from the Debye-Scherer condition [25] were observed to be 28 nm and 23 nm for Co and Si upheld Co NPs, individually.

3.2 SEM and EDX analysis:

The surface morphology of silica colloids, functionalized silica colloids and colloids upheld cobalt nanoparticles were researched by SEM, as appeared in Fig. 2 (a). SEM micrograph has uncovered the development of round shape with uniform molecule estimate appropriation. The molecule size of silica colloids, functionalized silica colloids, PVP topped cobalt nanoparticles and colloids bolstered cobalt nanoparticles were resolved and it was found in the scope of 200-250 nm. The essential organization and immaculateness of silica colloids, functionalized silica colloids, PVP topped cobalt nanoparticles and colloids upheld cobalt nanoparticles were researched by EDX examination as found in Fig. 2 (b).

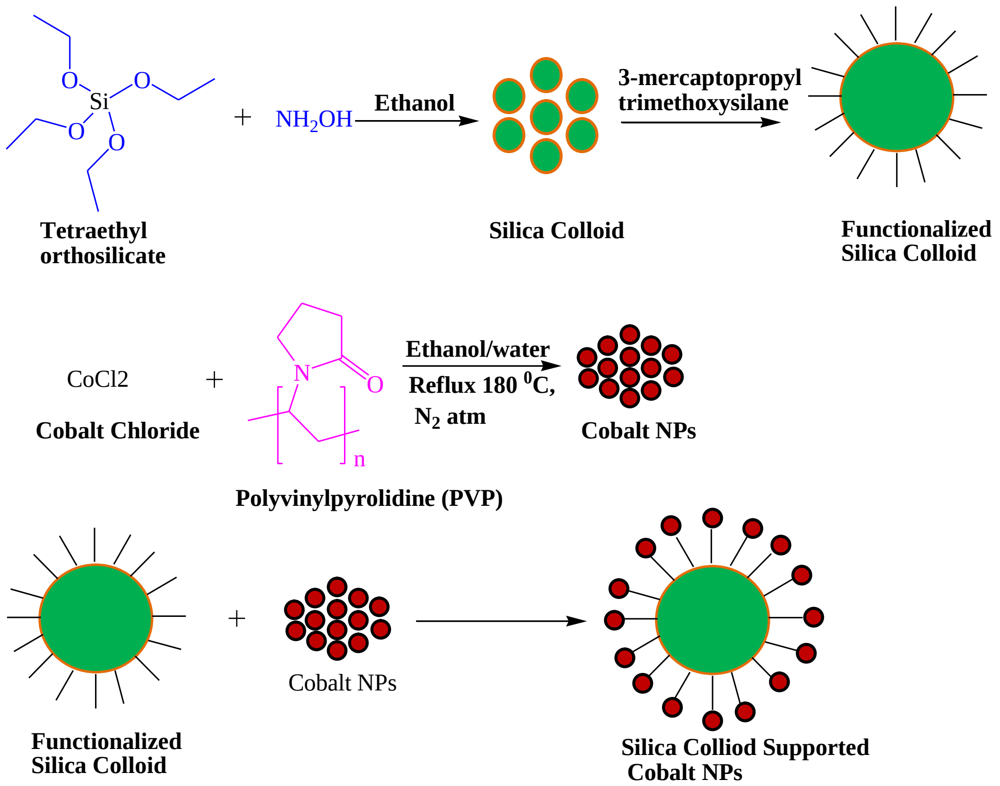
3.3 Antibacterial Activity:

The antibacterial exercises of the Silica, Cobalt nanoparticles, Colloidal Silica bolstered Co nanoparticles was assessed against antibacterial movement for two-gram positive societies Staphylococcus aureus, Bacillus cereus and two-gram negative societies Klebsiella, Pseudomonas.) are displayed in (Table 1 to 4 and Figure 3 to 5). The antibacterial exercises of the Silica, Cobalt nanoparticles, Colloidal Silica upheld Co nanoparticles was assessed against for two gram positive societies Staphylococcus aureus, Bacillus cereus and two gram negative societies Klebsiella, Pseudomonas.) are introduced in (Table 1 and Figure 6). The consequence of antibacterial movement demonstrated greater action of Silica colloidal near to the Co nanoparticles, no critical action towards the Colloidal Silica Cobalt nanoparticle because of soundness of Co nanoparticles, joined to the silica, it might due to the to the help of silica to the Cobalt nanoparticles in the colloidal arrangement, the action appeared, it won't much powerful as the exposed colloidal Silica or Co nanoparticles.it may enable further investigations to ease back medication to discharge conveyance in future. From table 4. result demonstrates the help to the Cobalt nanoparticles in the colloidal, it won't much powerful as the uncovered colloidal Silica or Co nanoparticles. peroxide (H2O2) and super-oxide (O2–) created from the surface of nanoparticles [37], [38].

The infiltration rate of a dynamic through the microscopic organism's cell divider may have an influence in the executing rate of nanoparticles against microbes. Hydrogen peroxide produced from the surface of cobalt nanopowders can without much of a stretch enter the cell mass of microscopic organisms and cause cell demolition. Consequently, we may guess that the little size of the nanoparticles which brings about the expansive arrival of dynamic oxygen species possibly assuming an essential part in the bacterial development hindering character of the cobalt nanoparticles. In this way, the above investigations exhibit that the cobalt nanoparticles and silica have huge antibacterial impact on an extensive variety of microorganisms. In any case, cytotoxicity contemplates must be led on this nanocomposite material before thinking about it for pragmatic applications. In this way, the attractive properties of the cobalt nanoparticle and, colloidal Silica particles, and Silica upheld colloidal cobalt nanoparticles joined with the development inhibitory limit against organisms can prompt its conceivable applications as antimicrobials in the field of prescription.

4. Conclusion:

Effortless and stable silica colloidal-bolstered Co NPs were incorporated and it was described by different methods. The nanoparticles are 28 nm affirmed by XRD, SEM, and examination of aggregate substance Cobalt nanoparticles by EDAX instrument. Promote the antibacterial impact of Silica, Cobalt nanoparticles, Colloidal Silica underpins Co nanoparticles was assessed against antibacterial action for two gram positive societies Staphylococcus aureus, Bacillus cereus and two gram negative societies Klebsiella, Pseudomonas. which demonstrated that the nanoparticles have direct antibacterial movement against both Gram positive and Gram negative pathogenic bacterial strains and holds potential application in pharmaceutical and biomedical businesses.



Scheme 1: *Schematic representation of synthesis of colloidal silica supported Co NPs.*

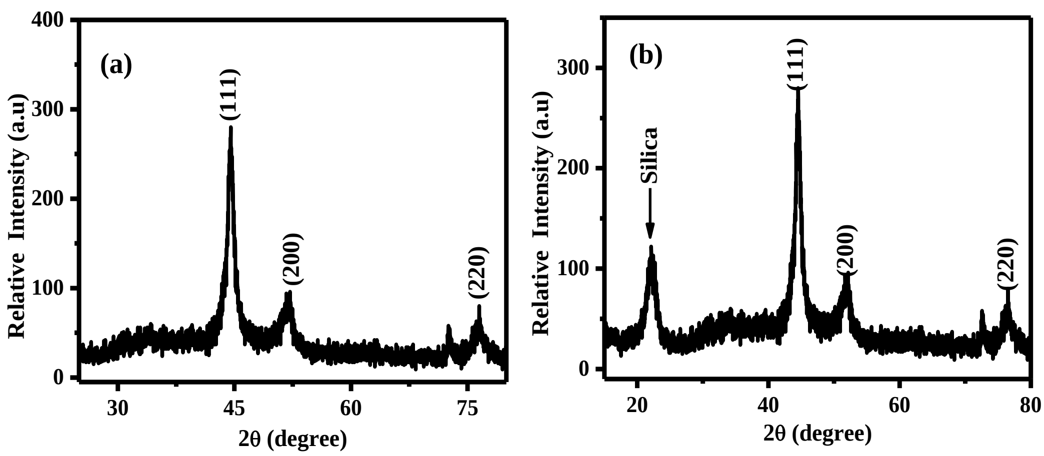


Figure 1. Powder XRD pattern of Co NPs ***(a)*** *and Silica supported Co NPs* ***(b).***

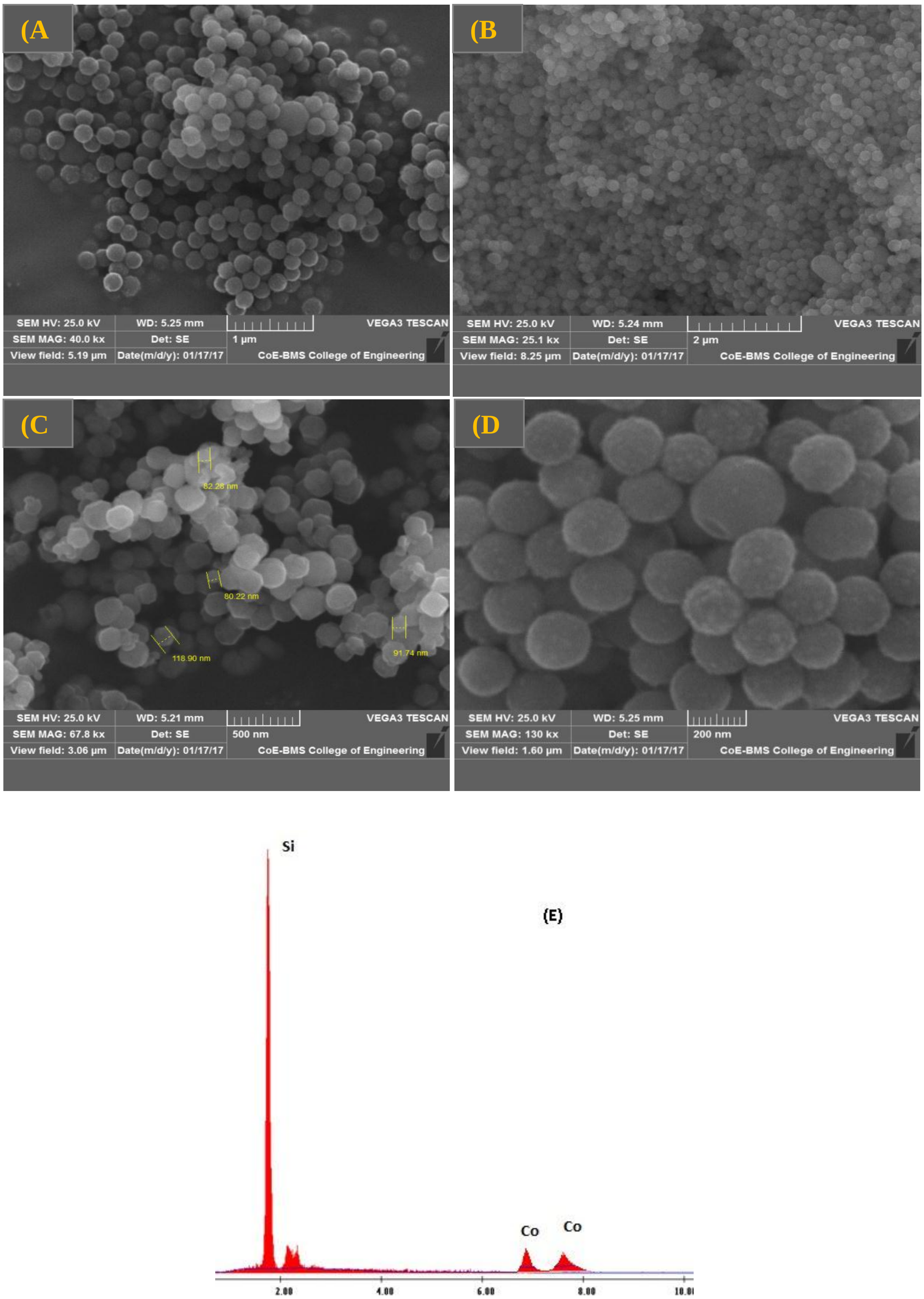


Figure 2:(a) SEM images of (A) Si Colloid, (B) Thiol capped Si Colloid and (C) Co NPs, (D) Silica supported Co NPs and (E) EDX pattern of silica supported Co NPs.

3.3.1 Silica Colloidal Antibacterial Activity:

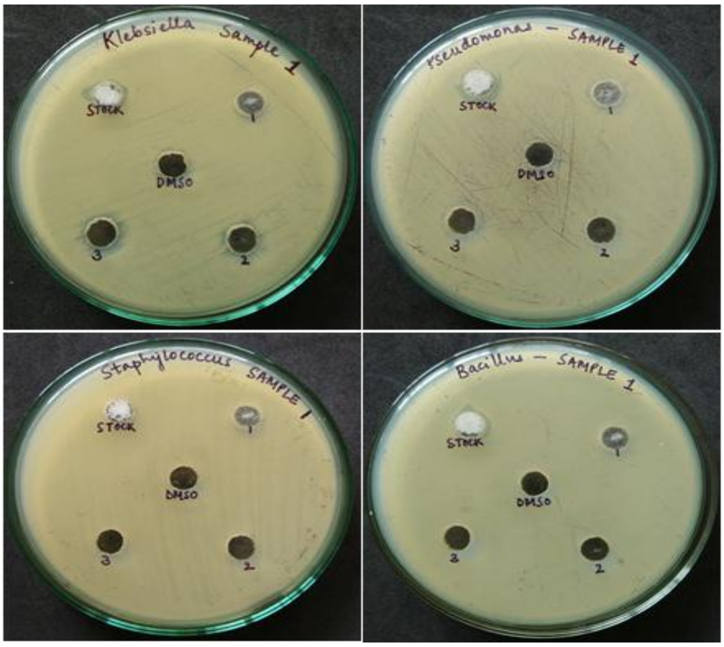


Figure 3. Antibacterial action of the silica colloidal a zone of inhibition.

Table :1

Cultures	**Stock**	**1st Dilution**	**2nd Dilution**	**3rd Dilution**
Staphylococcus	1.05 cm	-	-	-
Bacillus	1.15 cm	-	-	-
Pseudomonas	1.2 cm	-	-	-
Klebsiella	125 cm	-	-	-

3.3.2Cobalt Nanoparticles Antibacterial Activity

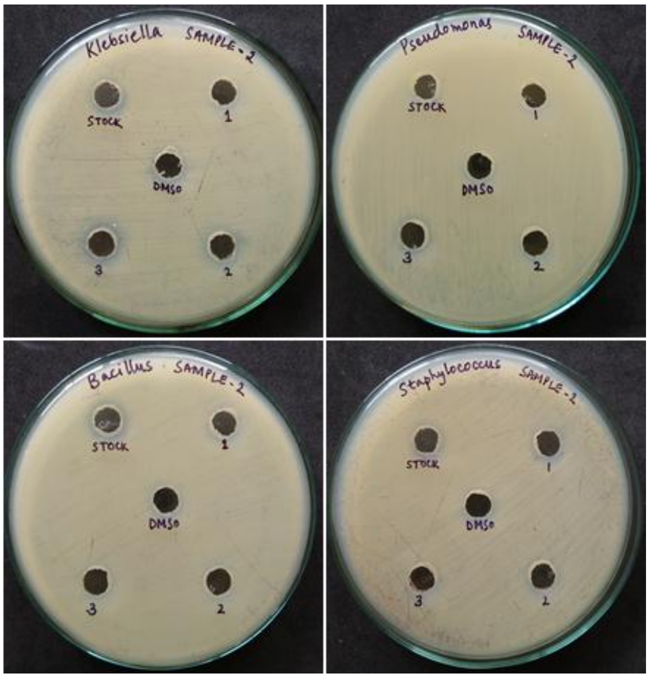


Figure 4. Antibacterial action of the cobalt nanoparticles producing a zone of inhibition.

Table:2

Cultures	**Stock**	**1st Dilution**	**2nd Dilution**	**3rd Dilution**
Staphylococcus	1.15 cm	-	-	-
Bacillus	1.325	-	-	-
Pseudomonas	-	-	-	-
Klebsiella	1.25	Very light	Very light	Very light

3.4. Colloidal Silica supports Co nanoparticles Antibacterial Activity:

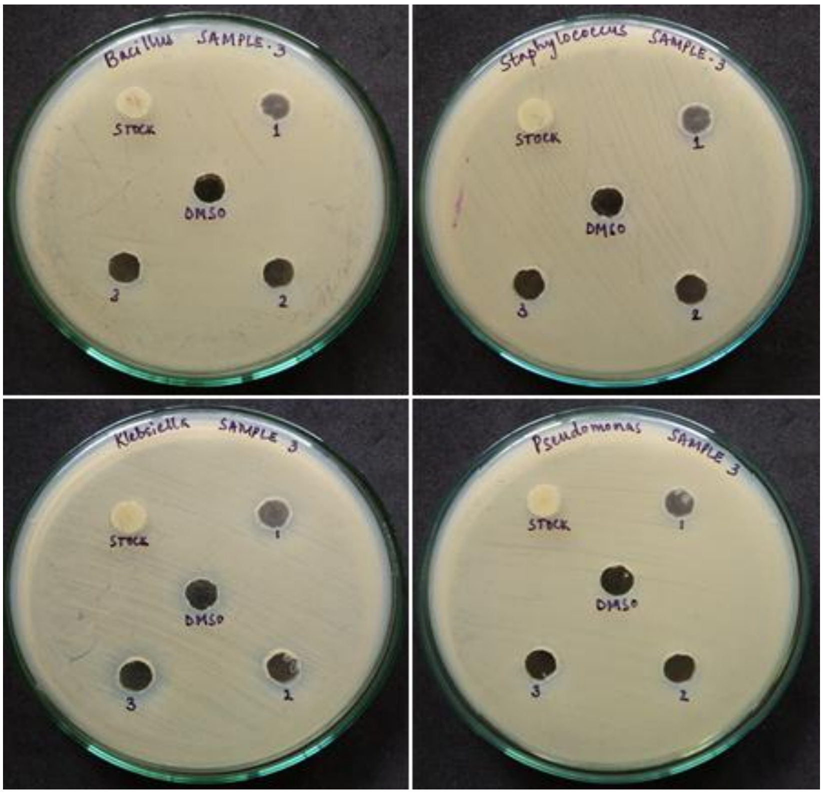


Figure 5. Antibacterial action of the Colloidal Silica supports Co nanoparticles.

Table:3

Cultures	Stock	1st Dilution	2nd Dilution	3rd Dilution
Staphylococcus	-	-	-	-
Bacillus	-	-	-	-
Pseudomonas	-	-	-	-
Klebsiella	Very light	Very light	Very light	Very light

Table:4

Cultures	Silica collidal	Co nanoparticle	Collodial Silica supports Co nanoparticles
Staphylococcus	1.05 cm	1.15 cm	-
Bacillus	1.15 cm	1.325	-
Pseudomonas	1.2 cm	-	-
Klebsiella	125 cm	1.25	Very light

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References :

[1] Monalisha, T.Muralikrishnan &P.Nayak, "Green synthesis of Gold nanoparticle using Daucuscarotaaqu eous extract", World journal of Nanoscience & technology, 3(2) 52-58 (2014)

[2] L. J. Jongh (1994). Physics and Chemistry of Metal Clusters Compounds. Kluwer Academic Publishers, Dordrecht. doi:10.1007/978-94-015-1294-7

[3] G. B. Budkevich, I. B. Slinyakova and I. E. Neimark (1996). Reducing Properties of Xerogel of Hydridepolysiloxane. Colloid Journal, 28 (1): 21-25.

[4] Environmental Protection Agency, "Nanotechnology white paper", USEPA 100/B - 07/001 (2007)

[5] R. Narayanan, M. A. El-Sayed, J. Phys. Chem. B, 109 (2005) 12663.

[6] F. T. Starzyk, M. Daturi, P. Bazin, O. Marie, Nanopart. Catal. (2008) 505–528.

[7] Tan W. B, Jiang S, Zhang Y (2007). Quantum-Dot Based Nanoparticles for Targeted Silencing of HER2/neu Gene via RNA Interference. Biomaterials, 28: 1565–1571.

[8] Su J, Zhang J, Liu L, Huang Y, Mason R. P (2008). Exploring Feasibility of Multicoloured CdTe Quantum Dots for In Vitro and In Vivo Fluorescent Imaging. J. Nanosci. Nanotechnol, 8: 1174–1177

[9] Matsumura Y, Yoshikata K, Kunisaki S, Tsuchido T (2003). Mode of bactericidal action of Silver zeolite and its comparison with that of silver nitrate. Appl. Environ. Microbio. 69: 4278-4281.

[10] Ingle A, Gade A, Pierrat S, Sönnichsen C, Rai M (2008). Mycosynthesis of silver nanoparticles using the fungus Fusarium acuminatumand its activity against some human pathogenic bacteria. CurrNanosci, 4:141-4.

[11] . Chao Lin, Kai Tao, Dayin Hua, Zhen Ma and Shenghu Zhou (2013). Size Effect of Gold Nanoparticles in Catalytic Reduction of p-Nitrophenol with NaBH4. Molecules, 10(18): 12609-12620.

[12] Bing-Xian Chung, Chuan-Pu Liu. DC magnetron sputtering (2004). Synthesis of cobalt nanoparticles by DC magnetron sputtering and the effects of electron bombardment. Materials Letters, 58: 1437–1440.

[13] Sowka E., M. Leonowicz B. Andrzejewski A. D. Pomogailo G. I. Dzhardimalieva (2006). Cobalt nanoparticles processed by thermal decomposition of metal-containing monomers. Materials Science Pratap Rudra Manthur Padigya et al /Int.J. PharmTech Res. 2016,9(3), pp 466-472. 472poland, 24(2).

[14] Ledo-Suárez L. Rodríguez-Sánchez M. C. Blanco,andM A. López-Quintela (2006).

Electrochemical synthesis and stabilization of cobalt nanoparticles. phys. stat. sol, 203(6):1234 – 1240.

[15] Mary donna Bellel Balela (2008). Liquid-phase reduction and synthesis and characterization of cobalt

[16] C. Burda, X. Chen, R. Narayanan, M. A. El-Sayed, Chem. Rev. (Washington, DC, U.S.) 105 (2005) 1025.

[17] D. Astruc, F. Lu, J. R. Aranzaes, Ange. Chem., 44 (2005) 7852.

[18] Q. Wang, A. E. Ostafin, Encycl. Nanosci. Nanotechnol, 5 (2004) 475.

[19] C. Mueller, M. G. Nijkamp, D. Vogt, Eur. J. Inorg. Chem. (2005) 4011.

[20] K. Y Chan, J. Ding, J. Ren, S. Cheng, K. Y. Tsang, J. Mater. Chem., 14 (2004) 505.

[21] J. S. Chang, J. S. Hwang, S. E Park, Res. Chem. Intermed., 29 (2003) 921.

[22] M. Chen, D. W. Goodman, Chem. Soc. Rev. 37 (2008) 1860.

[23] G. D. Yadav, Catal. Surv. Asia, 9 (2005) 117.

[24] K. Sun, J. Liu, N. K. Nag, N. D. Browning, Recent Res. Dev. Mater. Sci., 4 (2003) 521.

[25] B. Corain, P. Centomo, S. Lora, M. Kralik, J. Mol. Catal. A: Chem., 204-205 (2003) 755.

[26] M. A. Wood, J. R. Soc., Interface, 4 (2007) 1.

[27] K. Gude, R. Narayanan, J. Phys. Chem. C, 114 (2010) 6356.

[28] DUAN Hongzhen, LIN Xiang yang, LIU Guanpeng, XU Lei and LI Fengsheng (2006). Synthesis of Co Nanoparticles and Their Catalytic Effect on the Decomposition of Ammonium Perchlorate. J. Chem. Sci, 118(2):179–184.

[29] R Venkat Narayan, Vinod kanniah and Aruna Dhathathreyan (2013). Tuning size and catalytic activity of nano-clusters of cobalt oxide. Chem Sci Trans, 2(1):47-50.

[30] *Saeed Farhadi, Jalil Safabakhsh and Parisa Zaringhadam (2013). Synthesis, characterization, and investigation of optical and magnetic properties of cobalt oxide (Co3O4) nanoparticles. Journal Of Nanostructure in Chemistry 3(69).*

[31] *H. T. Yang, Y. K. Su,1, C. M. Shen, T. Z. Yang and H. J. Gao (2004) Synthesis and magnetic properties of e-cobalt nanoparticles. Surface and Interface Analysis Surf. Interface Anal 36: 155–160*

[32] *C. Osorio-Cantillo A. N, Santiago-Miranda O, Perales-Perez and Y. Xin (2012). Biomedical applications, Size-and phase-controlled synthesis of cobalt nanoparticles for potential biomedical applications. Journal of Applied Physics 111.*

[33] *Elena Papi, Federica Rossi, Mario Raspanti, Isabella Dalle-Donne, Graziano Colomb, Aldo Milzani, Giovanni Bernardini, Rosalba Gornati (2009). Engineered cobalt oxide nanoparticles readily enter cells. Toxicology Letters, 189:253–259.*

[34] *H. Flaschs bart, W. J. Stoeber, Colloid Interface Sci., 30 (1969) 568.*

[35] *M. Moritz, M. G. Moritz, Chemical Engineering Journal 228 (2013)596 – 613.*

[36] *O. Yamamoto, E. J. Sawai, B. Chem. Soc. Jpn, 74 (9) (2001) 1761 – 1765.*

[37] *M. Hashim, Alimuddin, S.E. Shirsath, S. S. Meena, R. K. Kotnala et al, J. Magn. Magn. Mater. 341 (2013) 148 – 157.*

[38] *J. Sawai, J. Microbiol Method 54(2) (2003) 177 – 182.*