The 2nd International Conference on Biotechnology and Global Development

Biosynthesis of cobalt oxide nanoparticles using bacteria

Fateme Momen Eslamieh-ei[1], Mansour Mashreghi[2,3], Maryam M. Matin[2,3]*

[1] Master student of Microbial Biotechnology, Department of Biology, Faculty of Science, Ferdowsi University of Mashhad, Mashhad, Iran

[2] Professor, Department of Biology, Faculty of Science, Ferdowsi University of Mashhad, Mashhad, Iran

[3] Professor, Novel Diagnostics and Therapeutics Research Group, Institute of Biotechnology, Ferdowsi University of Mashhad, Mashhad, Iran

Introduction

Nowadays, more specific methods for cancer treatment, including gene therapy and the application of nanoscience and drug-nanoparticle compounds which usually lead to a better outcome, have attracted a considerable attention (1). Nanotechnology is used to diagnose cancer at early stages, design a drug delivery system by targeting the nano-drug combination to cancer cells, and thus reducing the cytotoxicity to normal cells (2, 3). Cobalt oxide is one of the most potent natural antioxidants which exists in two forms: Co_3O_4 and CoO. Various applications of these nanoparticles in medicine, such as drug delivery systems, toxicity to cancer cells, and antibacterial properties, have been studied and analyzed (4, 5, 6). Synthesis of cobalt oxide nanoparticles can be done by various methods, including chemical, physical, physicochemical, and biosynthetic methods. So far, the synthesis of green cobalt oxide nanoparticles has been done using plant extracts, fungi, and bacteria (4, 6, 7, 8, 9).

Biosynthesis of cobalt oxide nanoparticles using bacteria was investigated in this study.

Methods

In brief, luminescent *Vibrio* bacteria were grown in Sea Water Complete (SWC) medium at 28°C for 2 days. After centrifugation of cultured bacteria, 100 ml of sonicated culture was mixed with 50 ml of 25 mM aqueous cobalt nitrate hexahydrate filtrates in a 250 ml container and incubated at 90°C for two hours. The successful synthesis of cobalt oxide nanoparticles (Co_3O_4 NPs) was determined based on the color change to purple. At next step, biosynthesized cobalt oxide nanoparticles were annealed at 500°C for 2 hours. X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), Scanning electron microscopy (SEM), and energy dispersive spectroscopy (EDS) were carried out for nanoparticles characterization.

Results

The XRD results illustrated the success in biosynthesis of Co_3O_4 NPs and the diffraction peaks at 2θ values of 19° and 36°. The FTIR spectra characterized the functional groups in Co_3O_4 NPs; the peaks were observed at 3445, 2924, 1010, 605, and 561 cm^{-1}. The 3445 and 2924 cm^{-1} peaks could be due to –OH stretching from polysaccharides and C–H stretching of alkanes, respectively. The peaks at 1010 and 605 cm^{-1} could be assigned to (C–O) of the alkoxy and CH_2 groups, respectively. 561 cm^{-1} peak might be due to cobalt oxide NPs. The results of SEM indicated that the biologically synthesized cobalt oxide nanoparticles are spherical and cubic with about 70 nm diameter. The results of EDS analysis indicated that the main elements refer to the peaks of cobalt and oxygen to be 38 and 36%, respectively, in the biosynthesized Co_3O_4 NPs.

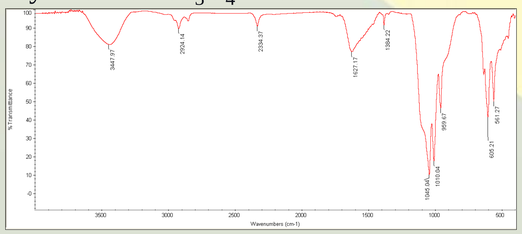

Figure1; FTIR results before annealing at 500°C.

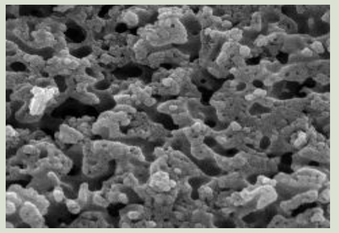

Figure2; FE-SEM image of cobalt oxide nanoparticles

Conclusions

This study investigates a biological method to synthesize cobalt oxide nanoparticles using a luminescent *Vibrio* bacterium. The properties of Co3O4 NPs were characterized by XRD, FTIR, SEM, and EDS. This method is cheaper, easier and faster than other biological methods. Biosynthesis of cobalt oxide nanoparticles from luminescent *Vibrio* is considered as a novel and ecofriendly method. It is comparable to those of chemical methods and can potentially be used in various applications such as drug delivery and treatment of cancer.

1-Bajpai, S. *et al.* (2021) 'Recent Advances in Nanoparticle-Based Cancer Treatment: A Review'.

2-Woodman, C. *et al.* (2021) 'Applications and strategies in nanodiagnosis and nanotherapy in lung cancer', *Seminars in Cancer Biology*, 69, pp. 349–364.

3-Schroeder, A., Heller, D. A., Winslow, M. M., Dahlman, J. E., Pratt, G. W., Langer, R., Jacks, T., & Anderson, D. G. (2012). Treating metastatic cancer with nanotechnology. *Nature Reviews Cancer*, *12*(1), 39–50.

4-Zola, A. S., Ribeiro, R. U., Bueno, J. M. C., Zanchet, D., & Arroyo, P. A. (2014). Cobalt nanoparticles prepared by three different methods. *Journal of Experimental Nanoscience*, *9*(4), 398–405.

5-Javed, K. R., Ahmad, M., Ali, S., Butt, M. Z., Nafees, M., Butt, A. R., Nadeem, M., & Shahid, A. (2015). Comparison of doxorubicin anticancer drug loading on different metal oxide nanoparticles. *Journal of medicine*, *94*(11), 1–6.

6-Iravani, S., & Varma, R. s. (2020). Sustainable synthesis of cobalt and cobalt oxide nanoparticles and their catalytic and biomedical applications. *Green Chemistry*, *22*.

7-Yang, H., Hu, Y., Zhang, X., & Qiu, G. (2004). Mechanochemical synthesis of cobalt oxide nanoparticles. *Materials Letters*, *58*, 387–389.

8-Omran, B. A., Nassar, H. N., Younis, S. A., El-Salamony, R. A., Fatthallah, N. A., Hamdy, A., El-Shatoury, E. H., & Nour, S. E.-G. (2020). Novel mycosynthesis of cobalt oxide nanoparticles using *Aspergillus brasiliensis ATCC 16404* - optimization, characterization and antimicrobial activity. *Journal of Applied Microbiology*, *128*.

9-Bibi, I., Nazar, N., Iqbal, M., Kamal, S., Nawaz, H., Nouren, S., Safa, Y., Jilani, K., Sultan, M., Ata, S., Rehman, F., & Abbas, M. (2017). Green and eco-friendly synthesis of cobalt-oxide nanoparticle: characterization and photo-catalytic activity. *Advanced Powder Technology*, *28*(9), 2035–2043.