

## Behavior of *Staphylococcus epidermidis* in biosynthesis of silver and cadmium sulfide nanoparticles

Microorganism biosynthesizes nanoparticles using its enzymes and biomolecules which can act as reducing and capping agents. In fact, the nanoparticle is a produce of detoxification pathways. These pathways neutralize the toxicity of metal ions and trap them although the reduction mechanisms of metal ions still are not understood completely. The biosynthesis of the nanoparticles using microorganisms usually divided into intracellular and extracellular methods. Culture medium containing microorganism is mixed with metal salt for intracellular biosynthesis. The nanoparticles graft to the cell components and its membrane in intracellular method and this is a limitation for intracellular biosynthesis. Recovery procedures of these nanoparticles are more expensive and longer than extracellular biosynthesis. The obtained nanoparticles in this method, were not always characterized completely. In extracellular biosynthesis, the microorganism cells are separated from culture medium and the cell-free extract is added to metal salt. Nanoparticles can be synthesized using the supernatant of culture medium (extracellular method), but size distribution and shape of the nanoparticles always did not control in extracellular biosynthesis. In some reports, the size distribution of the nanoparticles was reported between 10 nm to 6  $\mu\text{m}$  with various shapes.

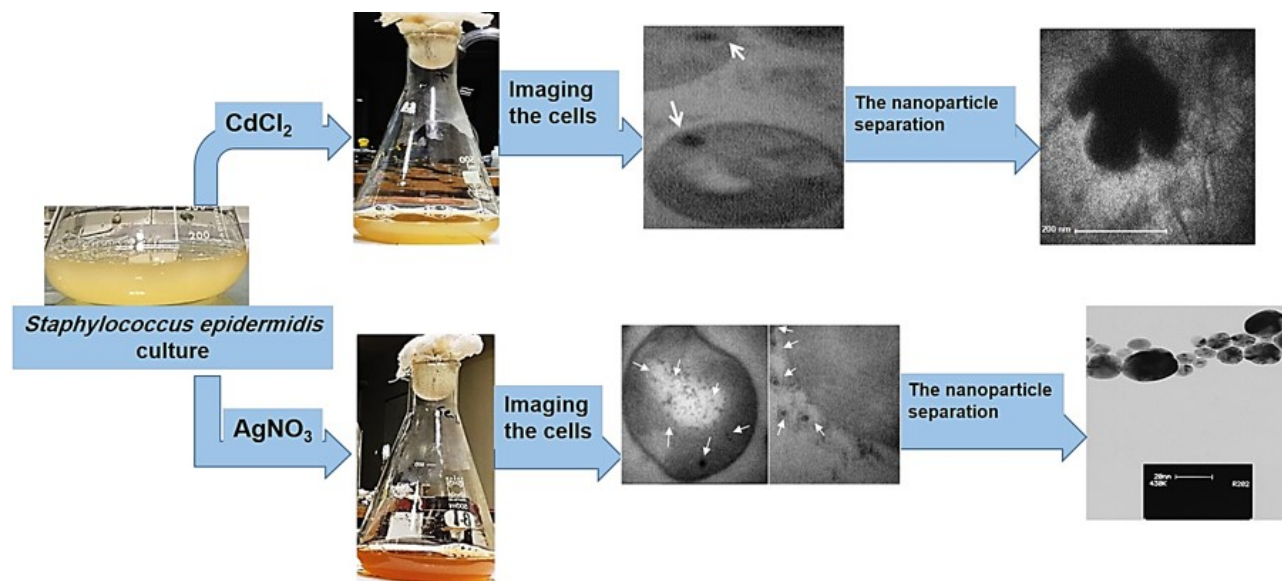


Fig. 1. The procedures of the nanoparticle biosynthesis and imaging the cells.

We studied behavior of *Staphylococcus epidermidis* (*S. epidermidis*) (ATCC 12228) for biosynthesis of silver nanoparticles (Ag-NPs) and cadmium sulfide nanoparticles (CdS-NPs) by TEM images. Both intra- and extracellular methods were investigated using TEM images. Then,

nanoparticle separation and purification were performed using a new method and the pure nanoparticles were characterized by XRD, FT-IR, and UV-VIS. TEM images of the cell cultures before and after exposing to the metal salt solutions, displayed Ag-NPs were spread throughout the cells (cytoplasm and outside surface of cell wall) and have size distribution less than 40 nm, the size distribution of these nanoparticle on the cell wall and in the cytoplasm are nearly the same, (Fig. 1) and CdS-NPs were only formed in cytoplasm, near the cell wall with size distribution between 200-250 nm. TEM images, which were prepared from recovered nanoparticles, indicated CdS-NPs were agglomerated (Fig. 1). CdS-NPs are only formed in one location and no CdS-NP was observed on the cell wall. However, there is a report that cadmium at concentration of 1 mM was precipitated by cultures of *Clostridium thermoaceticum* at the surfaces of the cells as well as in the surrounding medium.

It is possible that *S. epidermidis* (ATCC 12228) produces CdS-NPs by activity of sulfate adenyltransferase. TEM images of the supernatant in extracellular method, showed no nanoparticle. *S. epidermidis* only biosynthesized the nanoparticles (Ag-NPs and CdS-NPs) intracellularly.

FT-IR spectra confirmed, biomolecules exist on surface of the nanoparticles. In fact, the interactions of biomolecules to nanoparticles affect size and modify the surface of nanoparticles to enhance solubility, biocompatibility, and toxicity reduction. Remarkable stability of biosynthetic Ag-NPs and low toxicity of these nanoparticles may be dependent on the nature of protective layer on surface of biosynthetic nanoparticles.

**Zohreh Rezvani Amin, Bibi Sedigheh Fazly Bazzaz**

*Biotechnology Research Center, Mashhad University of Medical Sciences (MUMS), Mashhad, Iran*

## **Publication**

[Different behavior of \*Staphylococcus epidermidis\* in intracellular biosynthesis of silver and cadmium sulfide nanoparticles: more stability and lower toxicity of extracted nanoparticles.](#)

Rezvani Amin Z, Khashyarmansh Z, Fazly Bazzaz BS

*World J Microbiol Biotechnol.* 2016 Sep