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Bacterial Diversity in Oil Field Environments and Evaluation of Their Ability to Biosynthesize Silver Nanoparticles (AgNPs)

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ABSTRACT

Bacteria isolated from oil reservoir environments possess unique enzymes that allow them to adapt to extreme environments, making them ideal candidates for producing high-value nanomaterials that can be used in various fields. In the present study, eight samples were collected from Badra and Ahdab oil fields in Iraq, the bacteria isolated and identified based on the *16SrRNA* gene, and the isolates were screened for the synthesis of silver nanoparticles (AgNPs). The characteristics of the AgNPs were analyzed using UV-Vis spectroscopy, FTIR, XRD, FE-SEM, zeta potential measurements, and dynamic light scattering (DLS). The results indicated the dominance of Gram-positive bacteria, with a percentage of 18 (72%). Genetic identification revealed that the bacteria were under 6 genera and 16 species; these genera include *Enterococcus*, *Priestia*, *Enterobacter*, *Acinetobacter*, *Flavobacterium*, and *Bacillus*. Seven new strains have been deposited in GenBank. The results of screening isolates for synthesized AgNPs showed high efficiency of a novel strain, *Bacillus halotolerans* strain AhWM4, with the maximum absorption peak at 430 nm. The average size of AgNPs using XRD, FE-SEM, and TEM was (31.3, 27.0, and 42.1) nm, respectively. Dynamic light scattering (DLS) measurements showed a wide dispersion with an effective diameter of 57.1 nm; the X-ray diffraction (XRD) spectrum matched the crystalline nature of the AgNPs. It also showed high stability, with a zeta potential of -42.3 mV. AgNPs have attracted considerable attention due to their staggering potential for a wide range of commercial and environmental applications.

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INTRODUCTION

The biosynthesis of silver nanoparticles (AgNPs) has been explored in various environments, but using bacteria isolated from harsh conditions such as oil reservoirs-characterised by a lack of oxygen, high temperatures, and extreme pressures-represents a significant innovation. These extreme environments challenge most forms of life and provide new insights into how microorganisms may enhance industrial processes, particularly in nanotechnology production. In 1926, Bastin discovered sulphur-reducing bacteria such as Desulfoplanes, Desulfovermiculus, and Desulfotignum within harsh environments (Kadnikov et al. 2023). The study of microbial communities in oil reservoir environments has since opened a new chapter in our understanding of these ecosystems. Subsequent research has revealed diverse microorganisms inhabiting oil reservoirs, including those found in crude oil, formation water, rocks, and organic matter, particularly in the oil–water transition zone (OWTZ), which is conducive to microbial growth and oil decomposition (Rajbongshi and Gogoi 2021).

The positive effects of these microbial communities can be harnessed by investigating their activities, metabolic processes, and capacity to produce bioproducts such as surfactants, biopolymers, solvents, acids, and gases (Augustine 2023). Much current research focuses on oil-contaminated environments, where