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جامعة الملك سعود
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Differential Macrophage Response to Zinc and Nickel Oxide Nanoparticle Toxicity

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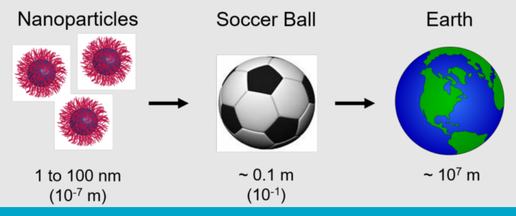
INTRODUCTION

Engineered nanomaterials (ENM) have wide range of biomedical applications. It has a small size that ranges between 1-100 nanometers. In consequence of its growth in use, it has raised serious considerations on its impact on the immune system. The immune system act in a defense mechanism against invading pathogens, it typically initiates the immune response through immune cells such as macrophage. Zinc oxide (ZnO) and nickel oxide (NiO) nanoparticles have some interesting biomedical applications in particular as anti-cancer, anti-bacterial, cosmetics, and in drug delivery. However, adverse effects of ZnO and NiO on the immune system are still lacking.



OBJECTIVES

Previous literatures have directed their efforts to study the overall toxicity of these nanoparticles at unrealistically high concentrations. Furthermore, only little is known about their toxicity to the immune system. Thus, our objective in this project was to assess the toxicity of ZnO and NiO nanoparticles on the macrophage including its function at subtoxic concentrations.

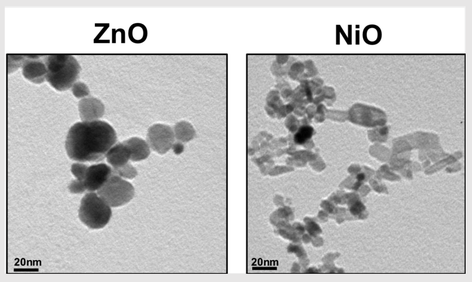
METHODS

In our study we have investigated the effects of ZnO and NiO nanoparticles on Raw 264.7 cells, a well-established macrophage model. MTT assay was used as an indicator for cell viability. H2DCFDA was used to measure reactive oxygen species (ROS) generation. FITC-labeled latex beads were used to measure cell phagocytosis.

RESULTS

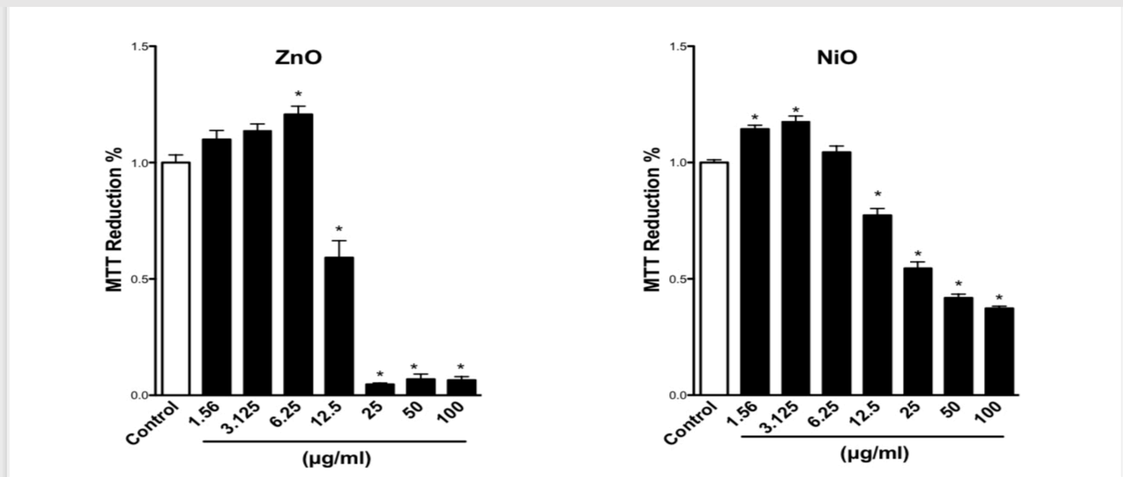
Nanoparticle characterization

	Hydrodynamic size (nm)	Charge (mV)
ZnO		
Water	336.8±25.5	-17.9±2.1
Cell culture media	427.7.8±18.9	-1.5±0.2
NiO		
Water	217.6±11.3	-36.3±1.4
Cell culture media	384.7±21.3	-14.9±1.9



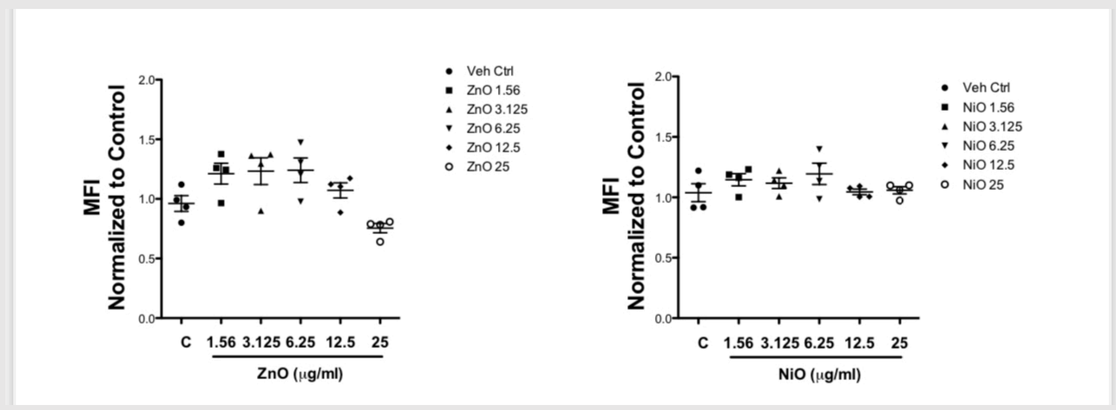
ZnO and NiO were characterized for their size, shape and charge and Transmission Electron Microcopy (TEM) image was used to demonstrate ZnO and NiO shape and size. N ≥ 3

Cell viability



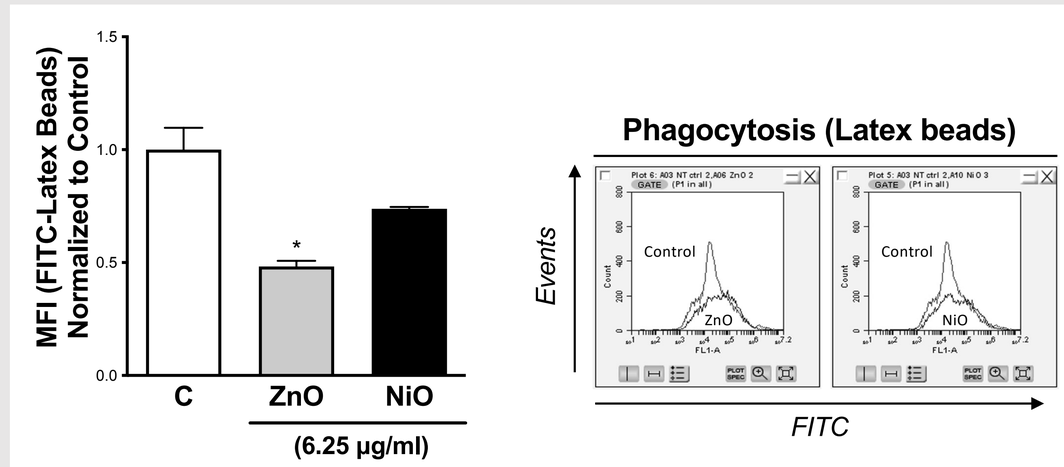
Cell viability was measured following the exposure to ZnO and NiO for 24 hours at different concentrations. *Indicates significant difference from controll group (p≤0.05). N ≥ 3

Reactive species



ROS generation was measured following the exposure to ZnO and NiO for 24 hours at different concentrations using 2',7'–dichlorofluorescin diacetate (H2DCFA) test. *Indicates significant difference from controll group (p≤0.05). N ≥ 3

Cell phagocytosis



Cell phagocytosis was measured following the exposure to ZnO and NiO for 24 hours at different concentrations using latex beads. *Indicates significant difference from controll group (p≤0.05). N ≥ 3

RESULTS

Our findings revealed that the cell viability was reduced in a dose-dependent manner as we can see that the cells started to die at (12.5 µg/ml) for both ZnO and NiO and there was complete death at (25 µg/ml) for ZnO treated cells. Exposure of Raw 264.7 cells to ZnO and NiO nanoparticles was associated with ROS generation even at low concentrations, which was more prominent with NiO nanoparticles. Importantly, our studies demonstrated that exposure to ZnO and NiO nanoparticles at subtoxic concentrations results in reduced capacity for phagocytosis.

DISCUSSION AND CONCLUSIONS

In conclusion these findings showed that exposure to ZnO and NiO nanoparticles is associated with cellular toxicity at higher concentrations as evidenced by reduced viability and increased ROS generation. Most importantly, exposure to ZnO and NiO nanoparticles at subtoxic concentrations was associated with a reduction in the cell function emphasizing the importance of assessing immune function even at subtoxic exposure levels of ENM.

REFERENCES

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