Role of Reactive Oxygen Species Production in Antimicrobial Action of Zinc Oxide

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Background

Staphylococcus aureus is the causative agent of many skin infections and the leading cause of death due to infectious disease in the United States. Additionally, *S. aureus* is known to rapidly gain antibiotic resistance, as seen with methicillin resistant *Staphylococcus aureus* (MRSA). Zinc oxide (ZnO), a nontraditional antibiotic, demonstrates antimicrobial action against *S. aureus.* While the exact mechanism of ZnO antibacterial action is currently unknown, production of reactive oxygen species (ROS) is a commonly proposed mechanism and the mechanism that will be examined. Previous work has also concluded that internalization is not the antimicrobial action of ZnO as well.

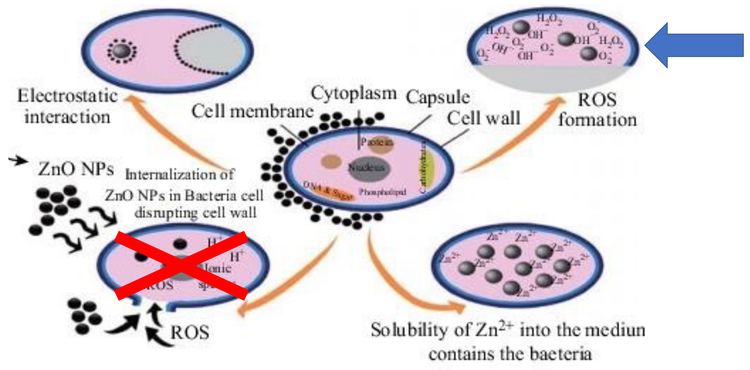
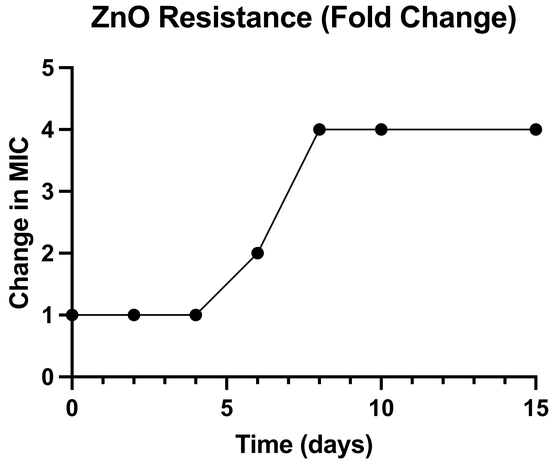


Figure modified from Sirelkhatim et al. Nano-Micro Lett. 2015

ZnO Resistance

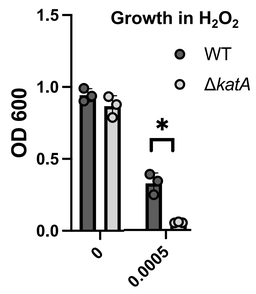


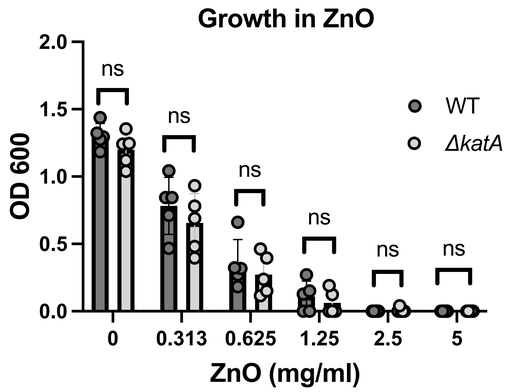
At day 0, the MIC of ZnO was 1.25 mg/ml. After 8 days, of passing the *S. aureus* at sublethal conditions, we observed a 4-fold increase in the MIC (from 1.25 mg/ml to 5 mg/ml).

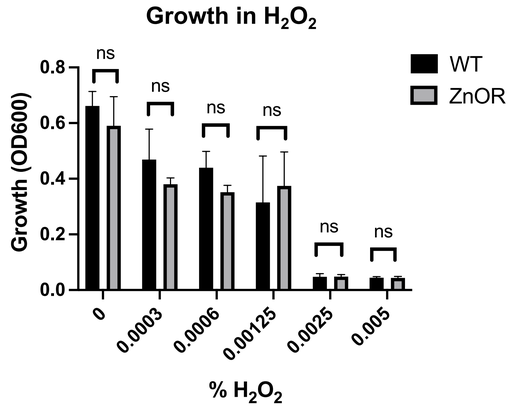
H_2O_2 production does not play a role

Catalase
$2H_2O_2 \rightarrow 2H_2O + O_2$

ΔkatA: $2H_2O_2 \not\rightarrow 2H_2O + O_2$





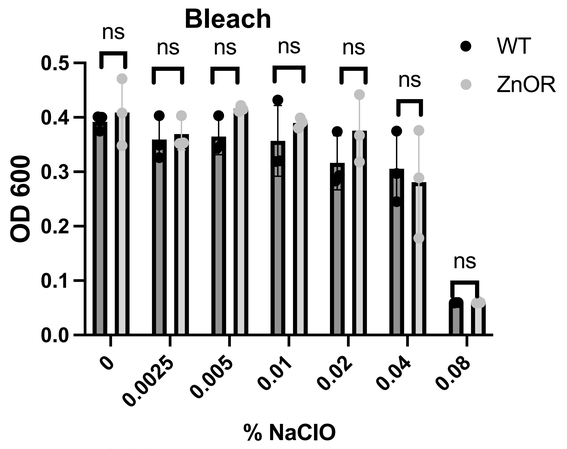


∗<0.05 as determined by unpaired t-test.

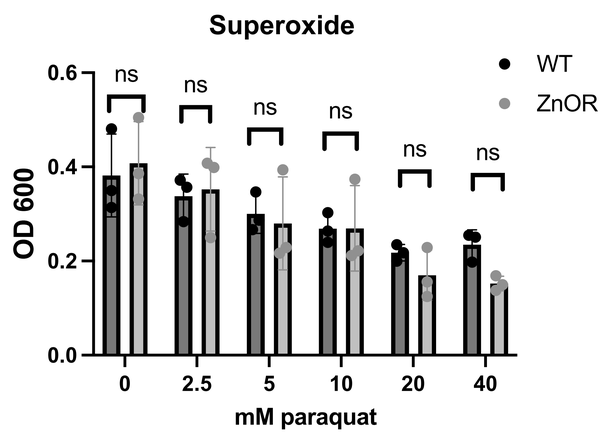
ns >0.05 as determined by unpaired t-test.

ns >0.05 as determined by unpaired t-test.

Other Reactive Oxygen Species



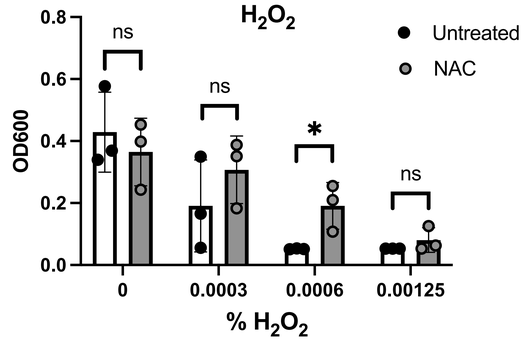
ns >0.05 as determined by unpaired t-test.



ns >0.05 as determined by unpaired t-test.

Future directions

N-Acetyl-L- Cysteine (NAC) stimulates production of antioxidants



∗<0.05 as determined by unpaired t-test.

Hypothesis:
Treatment with NAC will not affect ZnO resistance

Conclusions

Production of reactive oxygen species is likely not the primary mechanism of antimicrobial action by ZnO

References

Sirelkhatim A, Mahmud S, Seeni A, Kaus NHM, Ann LC, Bakhori SKM, Hasan H, Mohamad D. Review on Zinc Oxide Nanoparticles: Antibacterial Activity and Toxicity Mechanism. Nanomicro Lett. 2015;7(3):219-242.

Reeks, J.M., Ali, I., Moss, W.J., Davis, E., Mcgillivray, S.M., Strzhemechny, Y.M., 2021. Microscale ZnO with controllable crystal morphology as a platform to study antibacterial action on Staphylococcus aureus. Biointerphases 16, 031003.

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