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Effects of TiO_2 and ZnO nanoparticles on intestinal cells: An *in vitro* approach

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INTRODUCTION & AIM

The rapid advancement of nanotechnology has revolutionized food-related industries, introducing innovations such as smart packaging and nanosensors. Among the nanoparticles widely used in these applications are titanium dioxide (TiO_2) and zinc oxide (ZnO). However, their potential impact on human health, particularly through ingestion, remains a critical area of study. This research investigates the interactions of TiO_2 and ZnO nanoparticles with intestinal cells, focusing on cytotoxicity and its implications for their safe application in food production processes.

MATERIALS and METHOD

1.Nanoparticle Synthesis and Characterization

- TiO_2-NPs: Commercially acquired nanoparticles.
- ZnO-NPs: Synthesized in the laboratory.

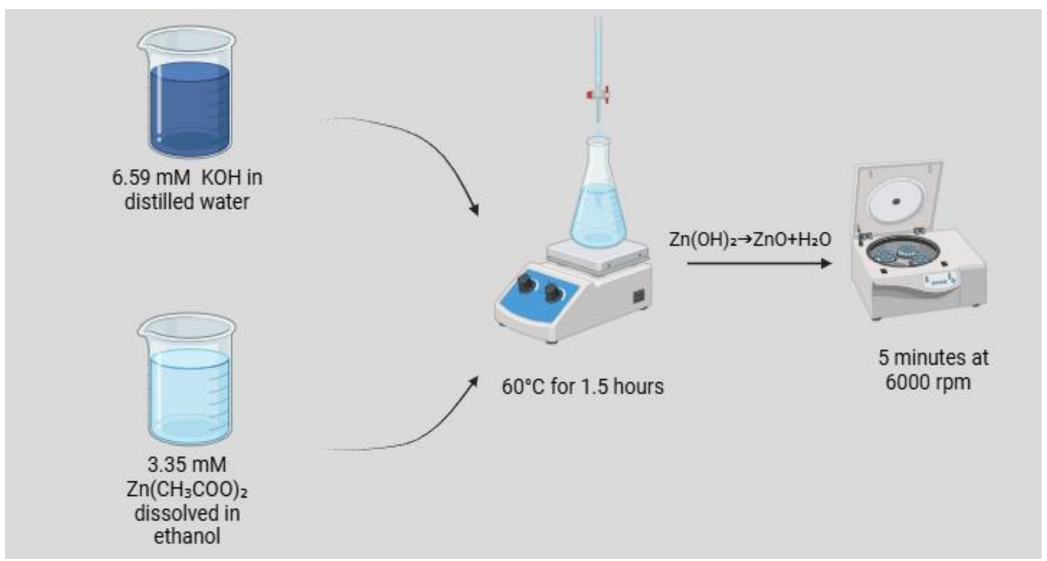

Figure 1- Experimental setup for ZnO synthesis [1].

Characterization:

- Scanning Electron Microscopy (SEM): Surface morphology and particle shape.
- Dynamic Light Scattering (DLS): Particle hydrodynamic size and zeta potential.

2. Cytotoxicity Assessment

- Cell Line: Human colon cancer cells (HCT116) were used to assess the effects of nanoparticles.
- MTT Assay: Cell viability was determined by measuring metabolic activity at 24, 48, and 72 hours after exposure to nanoparticles at concentrations of 0.39, 0.78, 1.56, 3.125, 6.25,12.5, 25, and 50 mg/L.

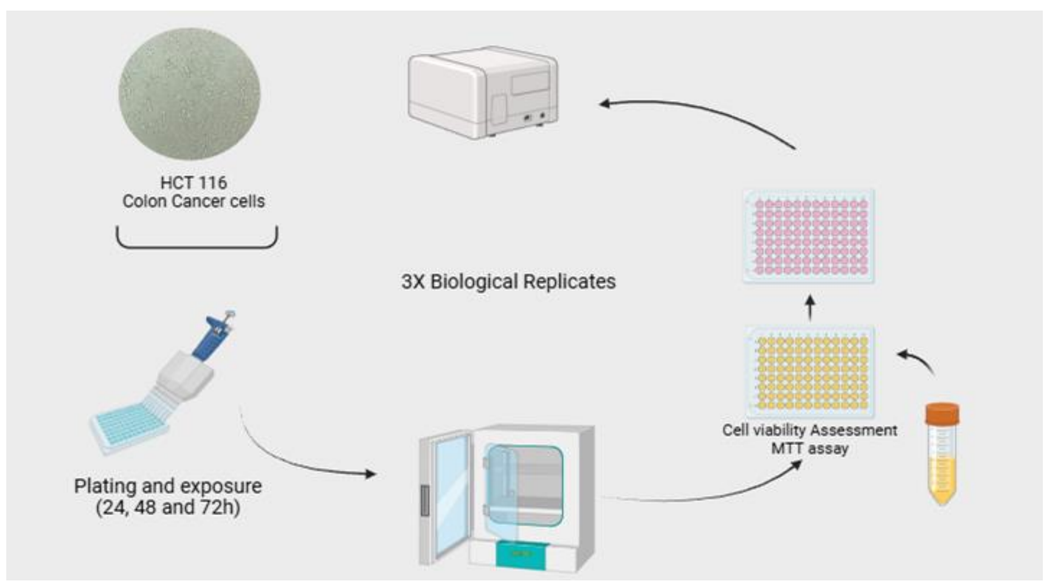

Figure 2 - Experimental setup for cell viability assay MTT [2].

RESULTS & DISCUSSION

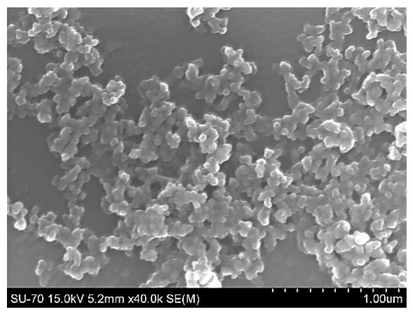

Figure 3 – SEM image of ZnO NPs. Average size 45 ± 6 nm.

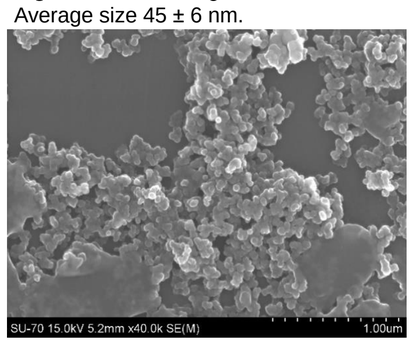

Figure 4 – SEM image of TiO_2 NPs. Average size 44 ± 8 nm.

Table 1 - Hydrodynamic size, polydispersity index (PDI), and zeta potential of ZnO NPs.

ZnO NPs		
Hydrodynamic Size (nm)	PDI	Zeta Potential (mV)
340	0.25	41

Table 2 - Hydrodynamic size, PDI, and zeta potential of TiO_2 NPs.

TiO_2 NPs		
Hydrodynamic Size (nm)	PDI	Zeta Potential (mV)
300	0.6	26

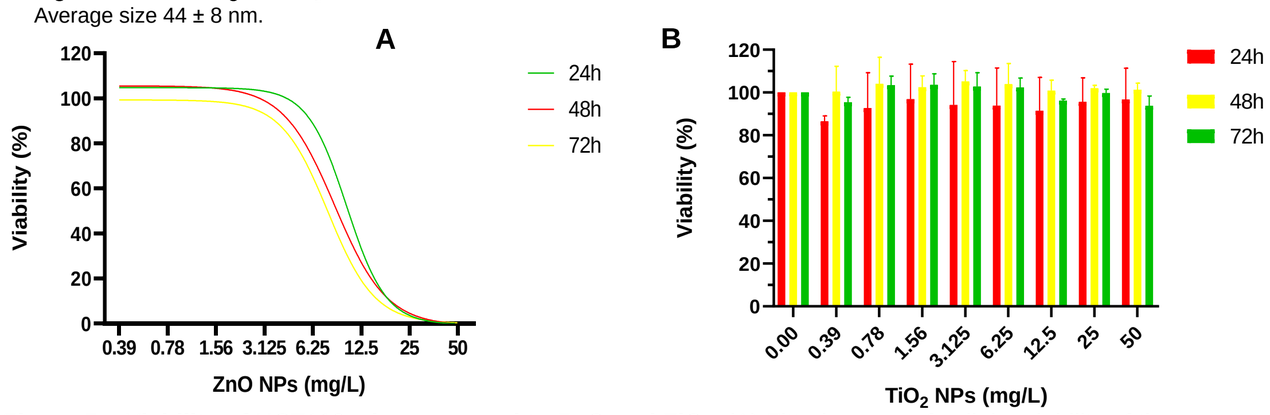

Figure 5 – Viability of HCT116 when exposed to ZnO and TiO_2. (A) Fitted curves of cellular viability of the HCT116 colon cancer cell line following exposure to ZnO NPs; (B) Histogram of cellular viability of HCT116 colon cancer cell line following exposure to TiO_2 NPs.

ZnO	24 h	48 h	72 h
$LC_{10\ (mg/L)}$	6.086	4.442	3.622
$LC_{25\ (mg/L)}$	7.802	6.103	5.314
$LC_{50\ (mg/L)}$	10.372	8.835	7.717

Table 3 - Lethal concentrations (LC) for ZnO NPs in HCT116 cell line at 24, 48, and 72h time points.

ZnO-NPs:

- SEM and DLS results confirm a well-defined, spherical morphology with consistent particle size, indicative of high stability.
- Observed concentration-dependent cytotoxic effects on HCT116 cells suggest potential risks of ZnO-NP exposure, particularly at higher concentrations, highlighting the need for regulations and controlled use of ZnO NPs, in applications involving direct contact with food or ingestion.

TiO_2-NPs:

- SEM and DLS highlight agglomeration of nanoparticles and irregular structures.
- Lack of significant cytotoxic effects suggests a relatively safer profile under the tested conditions, making TiO_2-NPs potentially more suitable for food-related applications.

CONCLUSION

These findings highlight the differential cytotoxicity of ZnO-NPs and TiO_2-NPs on colon cancer cells, emphasizing the need for careful consideration of ZnO-NPs in food applications due to potential health risks. TiO_2-NPs exhibit lower cytotoxicity compared to ZnO-NPs, suggesting they may pose a lower health risk in food-related applications. However, further studies are essential to confirm their safety and fully understand their potential effects.

FUTURE WORK / REFERENCES

- Further investigate size influence of ZnO and TiO_2 NPs on cell viability.
- Explore the cellular mechanisms driving the cytotoxicity of ZnO-NPs.

[1]. Chen, Z. Y., Yang, Y. C., Wang, B. J., Cheng, F. Y., Lee, Y. L., Lee, Y. H., & Wang, Y. J. (2022). Comparing different surface modifications of zinc oxide NPs in the developmental toxicity of zebrafish embryos and larvae. Ecotoxicology and Environmental Safety, 243. https://doi.org/10.1016/j.ecoenv.2022.113967

[2]. Präbst K, Engelhardt H, Ringgeler S, Hübner H. Basic Colorimetric Proliferation Assays: MTT, WST, and Resazurin. Methods Mol Biol. 2017;1601:1-17. doi: 10.1007/978-1-4939-6960-9_1. PMID: 28470513.

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