Zinc oxide and silver nanoparticles influence the antioxidative status in a higher aquatic plant, *Spirodela punctata*.

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7th ICEENN 2012, BANFF CENTRE, CANADA, 11 SEPTEMBER 2012

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MINTEK

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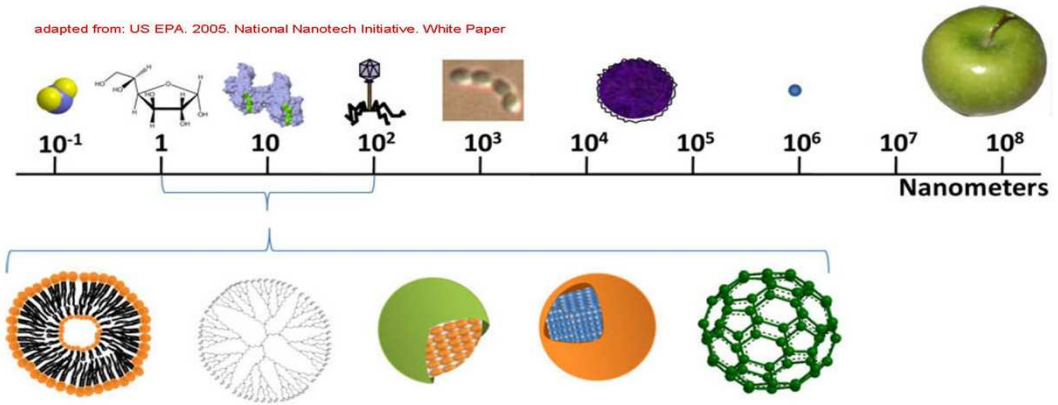


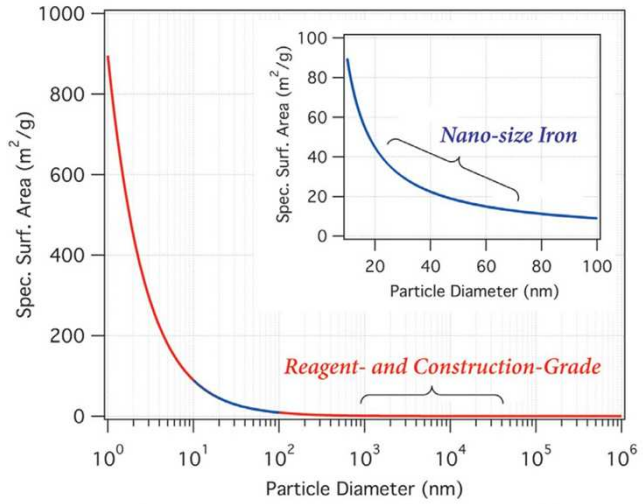


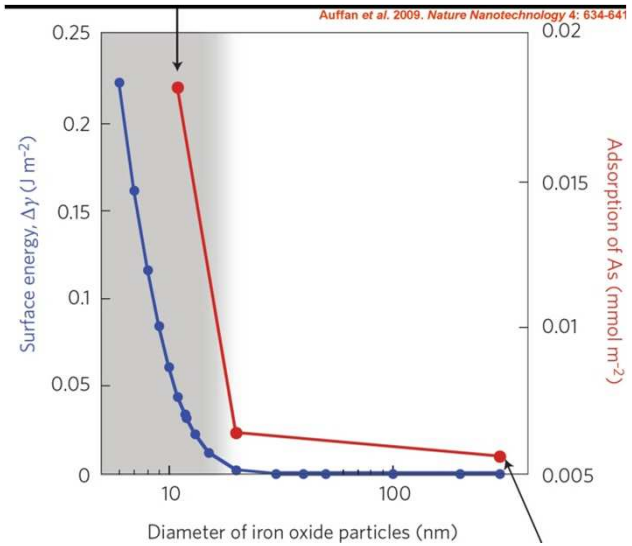
Fig. 2 Particle surface area calculated from diameter assuming spherical geometry and density 6.7 g/cm³ (based on the average of densities for pure Fe^0 and Fe_3O_4). Tratnyek and Johnson. 2006. *NanoToday* 1(2): 44-48

reactivity

solubility

conductivity

strength

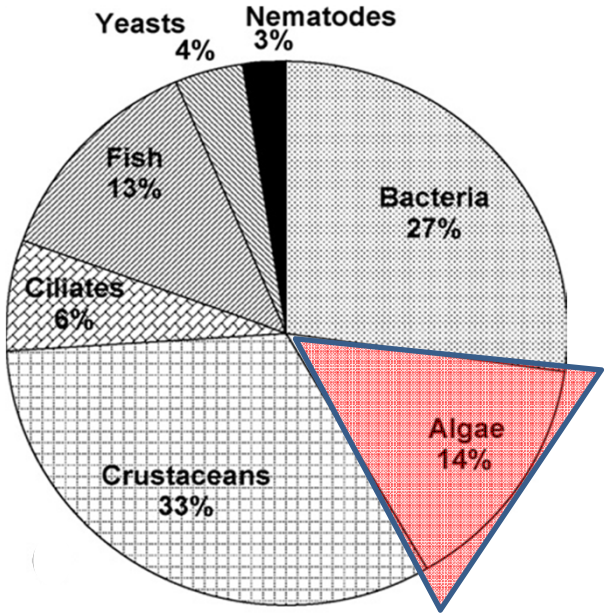


SOME FUNDAMENTAL COMPLEXITIES

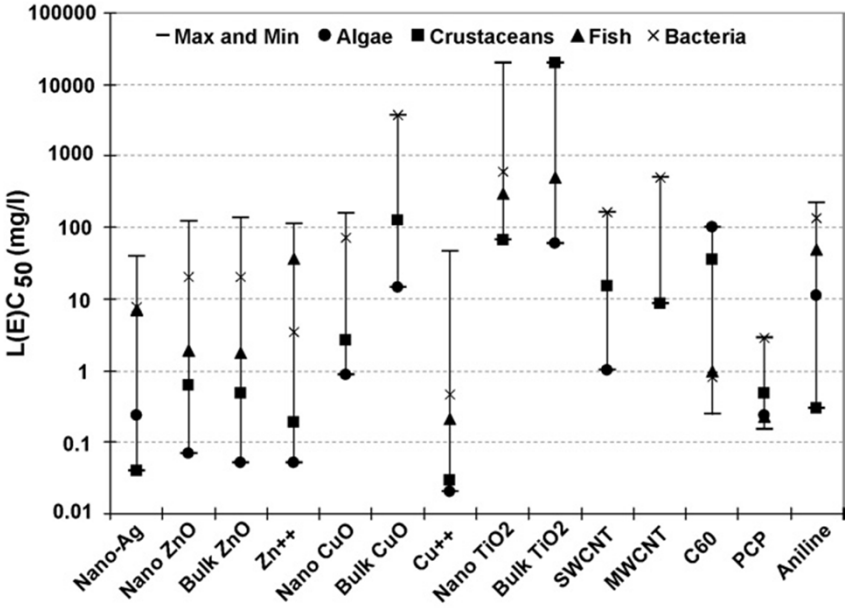
- Interaction with biological matter?
- Uptake routes: Do NM parameters influence uptake, how?
- Basis for biological response? Molecular definition
- Inducive level of dosage: environmentally relevant?
- Biomarkers of exposure: nano vs bulk

OLD SCIENCE SOLUTIONS FOR NEW TECHNOLOGY PROBLEMS

LOOK AT WHAT HAD BEEN DONE



The distribution of nanoecotoxicological data between organism groups. Kahru and Dubourgier . 2010. *Toxicology* 269: 105-119.



The distribution of L(C)50 values if nanoparticles to different groups of organisms. Kahru and Dubourgier . 2010. *Toxicology* 269: 105-119

Production of nanoparticles from different sources and respective applications.

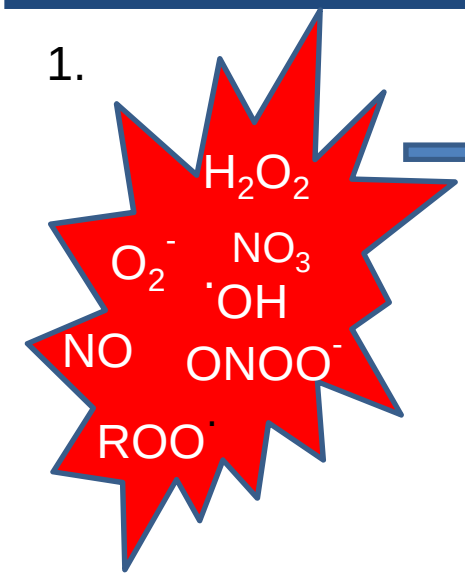
Source	Type of nanoparticle	Quantity used in terms of tons	Application/uses
Metals and alkaline earth metals	Ag	High	Antimicrobials, paints, coatings, medical use, food packaging
	Fe	High	Water treatment
Metal oxides	TiO_2	High	Cosmetics, paints, coatings
	ZnO	Low	Cosmetics, paints, coatings

<http://www.oecd.org/dataoecd/37/19/37770473.pdf>.

OVERALL APPROACH

THE OXIDATIVE STRESS HYPOTHESIS

1.



2.

$$2\,O_2^{\cdot-} + 2\,H^+ \xrightarrow{\text{superoxide dismutase}} H_2O_2 + O_2$$

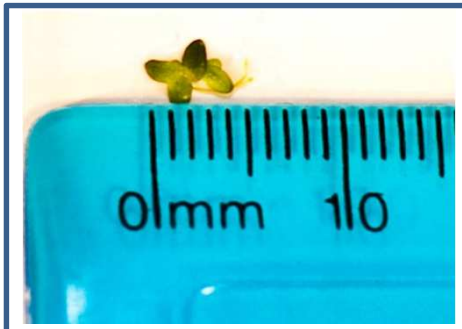
$$H_2O_2 + 2\,GSH \longrightarrow 2\,H_2O + GSSG$$

$$2\,OH^- + 2\,GSH \longrightarrow H_2O + GSSG$$

3. Oxidative damage

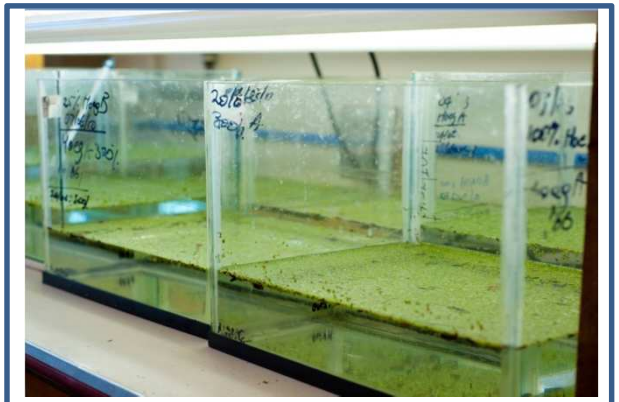
4. Physiological alteration

LABORATORY MAINTANANCE and TESTING



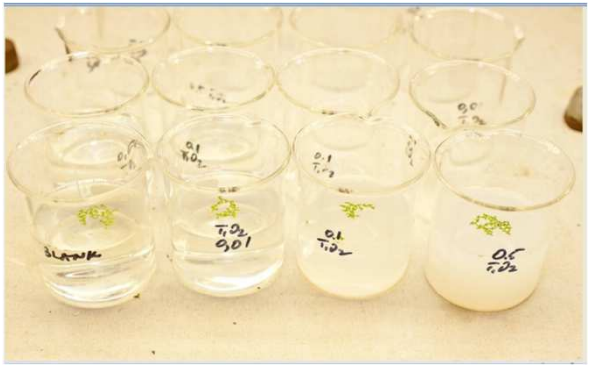
Free floating higher aquatic plant,

- easy laboratory maintenance,
- higher protein content,
- rapid growth.



Holding conditions:

- 22^{o}C±2
- cool-white fluorescent
- light:dark/8:16hrs
- weekly water renewal.



- Exposure period:

4 days-static and 14 days- static renewal

- Hoegland's Medium
- 5 replicates- 30 plants/replicate

Free radical activity

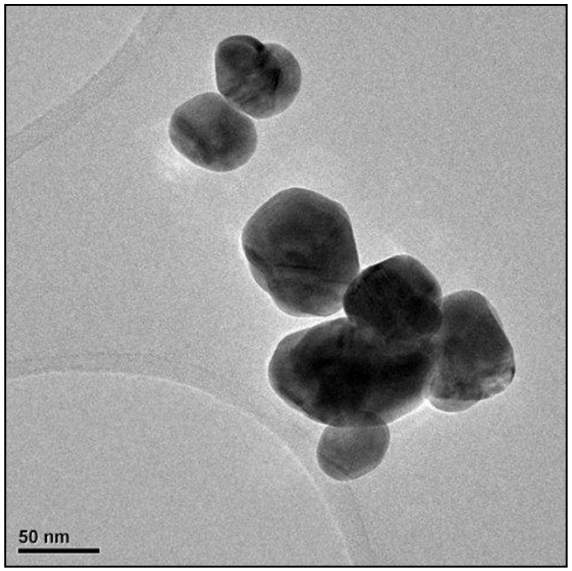
- ROS/RNS
- H_2O_2, $ROO^{\cdot}$, NO, $ONOO^{-}$
- DCFH-DiOxyQ probe

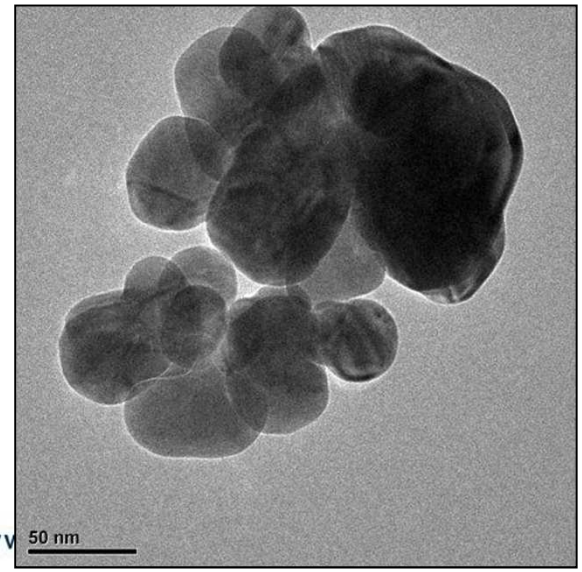
Enzymatic scavengers

- Catalase
- Superoxide dismutase
- Total antioxidant capacity

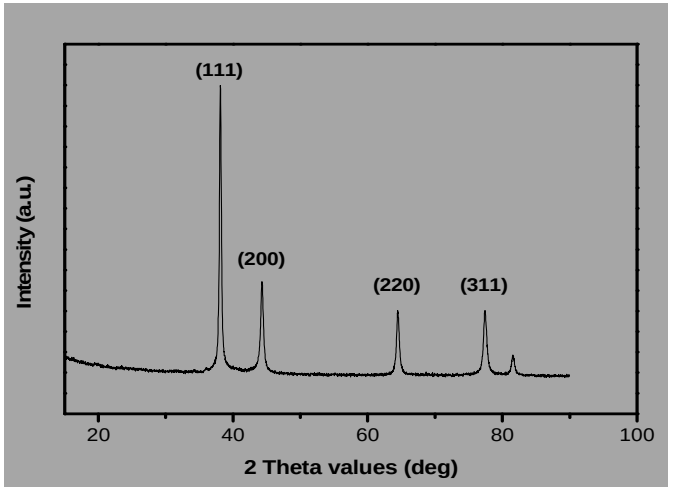
Size	Morphology	Surface area
• TEM	• TEM	• BET
• DLS	• XRD	

Ag nanoparticles





Sample	SA_{BET} (m^2/g)	Pore Volume (cm^3/g)	Particle size (nm)	Z-potential (mV)
nAg	3.399	0.01509	40-60	-16.3



Morphology
- Spherical nanoparticles.

Surface area
- Small relative to size.

XRD pattern
- Few crystal particles also detected.
- Pure phase: no impurities peaks detected.

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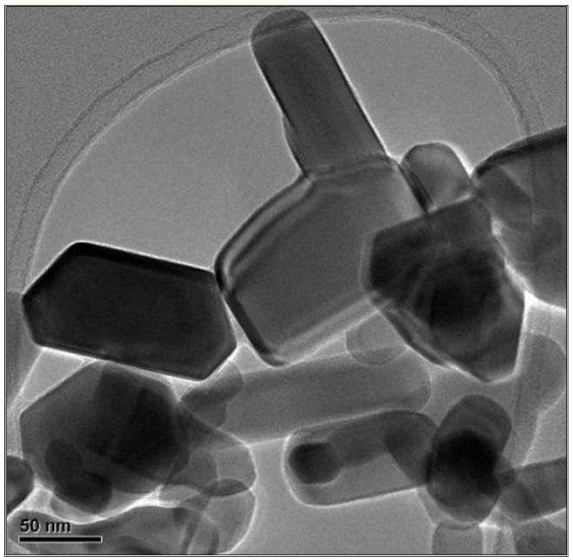
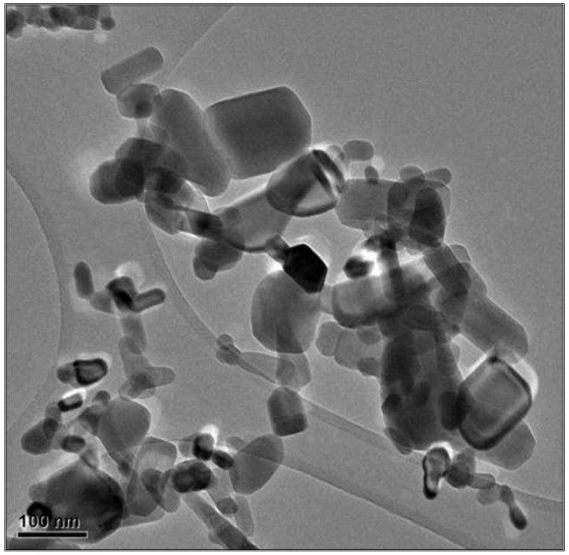
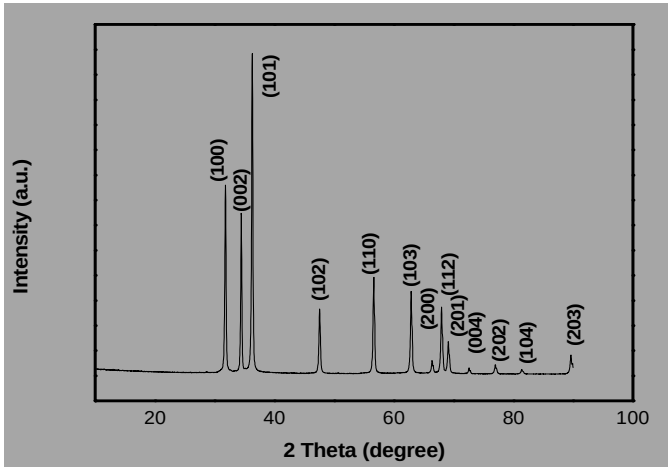
ZnO nanoparticles





Sample	SA_{BET} (m^2/g)	Pore Volume (cm^3/g)	Particle size (nm)	Z-potential (mV)
nZnO	11.44	0.03020	10-130	22.7
nAg	3.399	0.01509	40-60	-16.3

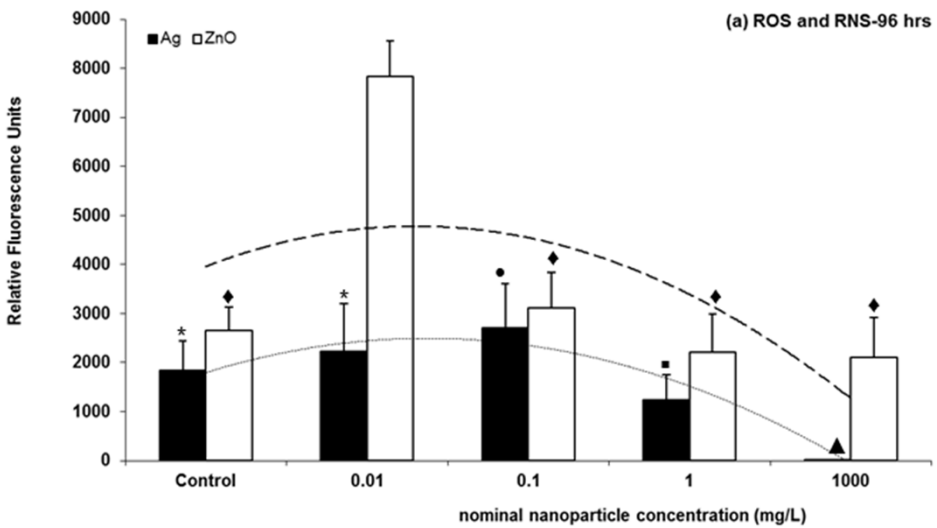


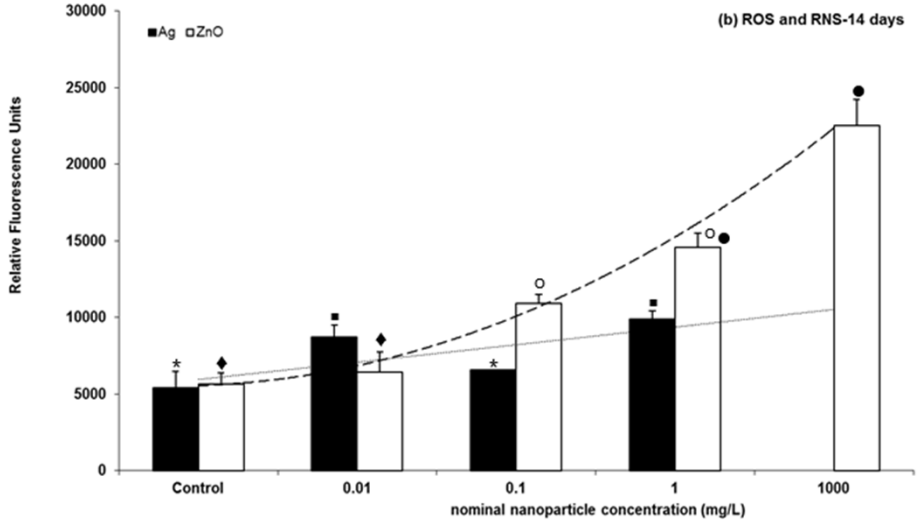
Morphology
- regular (20-50 nm) and irregular spheres (80-120 nm), rods (15-45 nm), cubes (10-130 nm) and hexagonal platelets (60-80 nm).

Surface area
- Higher than nAg although bigger sized.

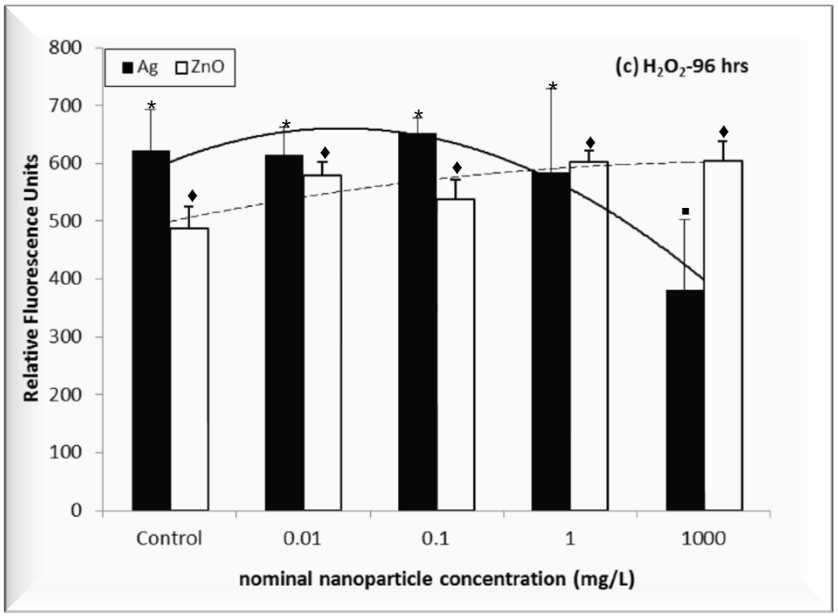
XRD pattern
- High crystallisation: hexagonal crystal system.
- Pure phase: no impurities peaks detected.

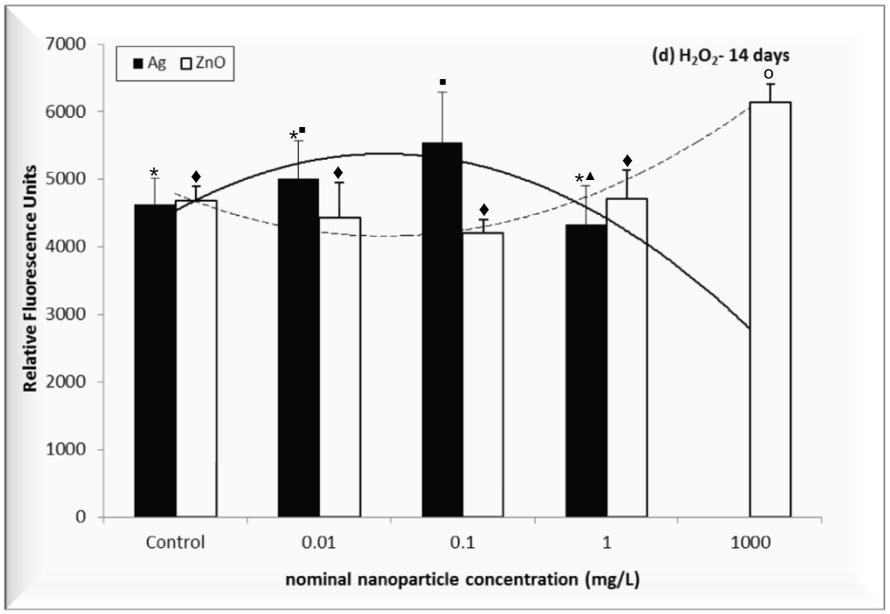
ROS/RNS



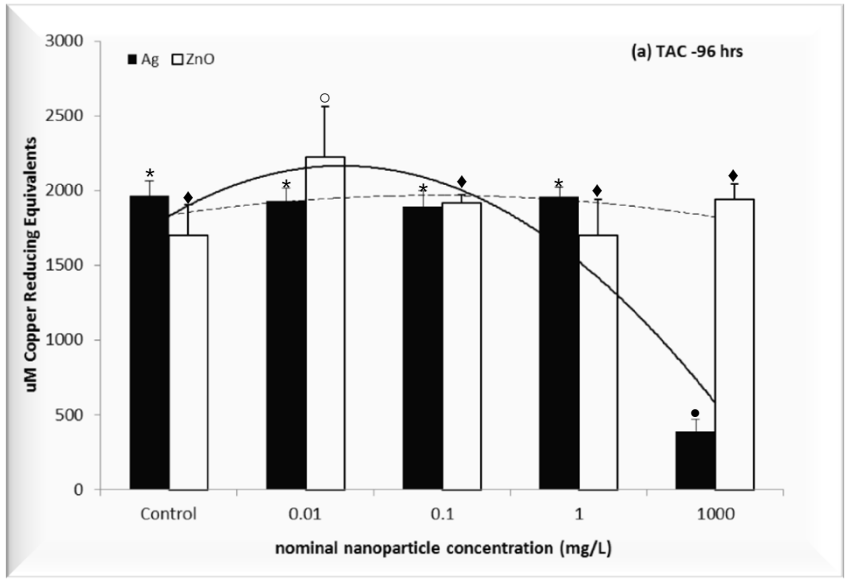


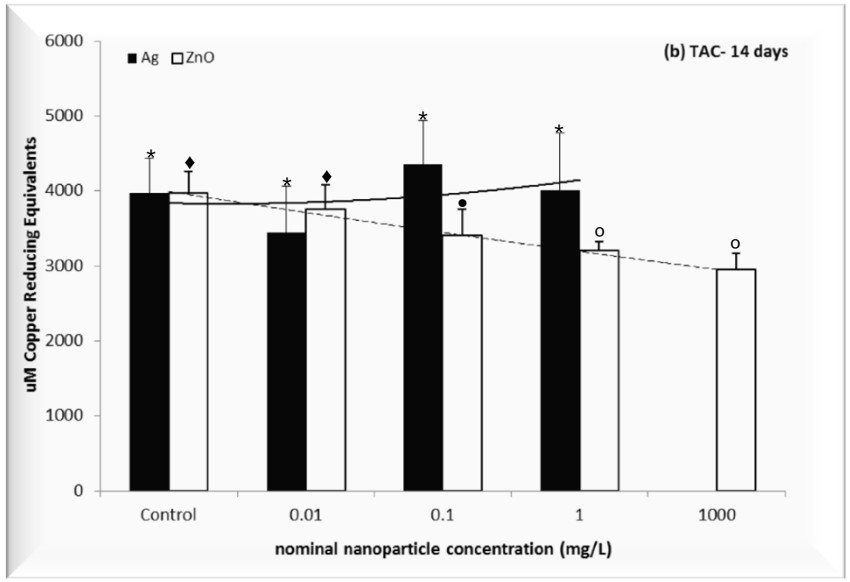
H_2O_2



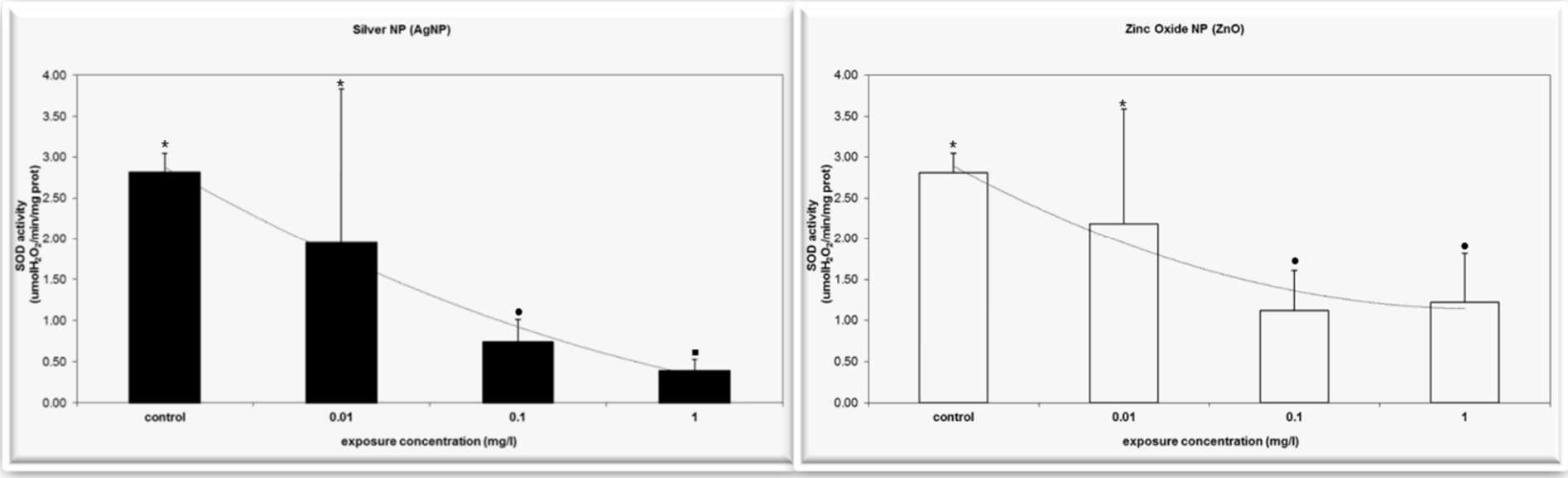


Total Antioxidant Capacity

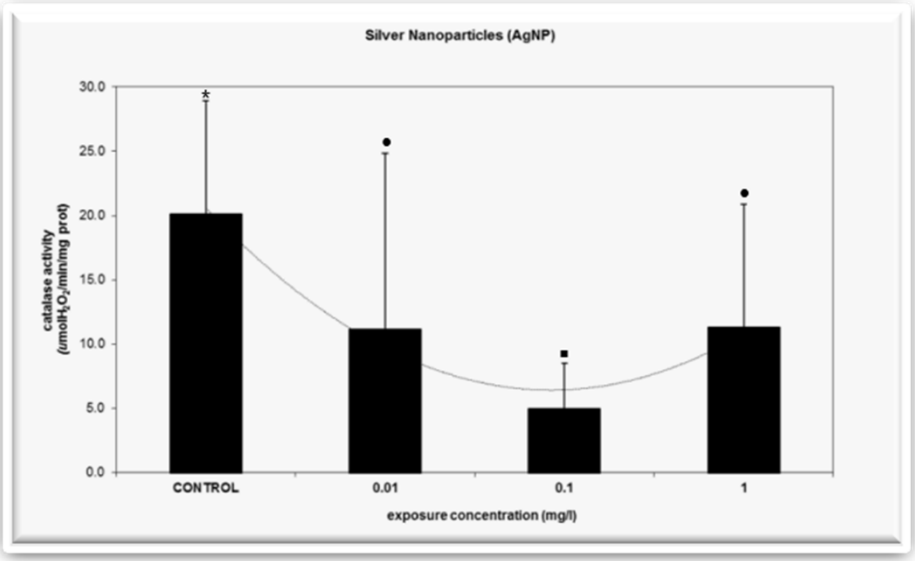


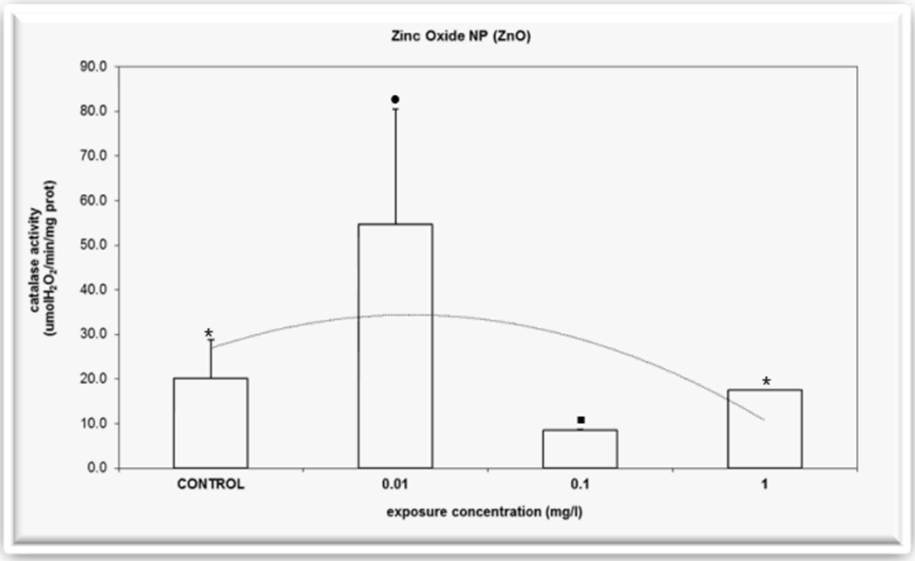


Superoxide dismutase – 96 hrs



Catalase – 96 hrs





CONCLUSIONS and THE FUTURE

- Significant bottom settling of particles → nano tracking analysis.
  →Generally, what are actual environmental implications?
- Exposure period as significant parameter on toxicity
- Clear evidence of significant oxidative offence due nZnO and nAg exposure.
- Suggestion of toxicity influence by nanoparticle parameters
  → further investigate this phenomena (morphologies and z-potential)
  → how does such influence uptake dynamics

CURRENT WORK

- Investigate protein damage and lipid peroxidation.

FUTURE

- DNA damage →focus on oxidative linked DNA damage.
- Physiological pathways integrity – photosynthetic and energy metabolism parameters.

THANK YOU

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