**Abstract No: BO-15**

# Assessing neurotoxic potential of titanium dioxide nanoparticles and bulk form using the fish model, Nile tilapia (*Oreochromis niloticus*)

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Titanium dioxide nanoparticles (nano $TiO_2$) and bulk $TiO_2$ are widely used worldwide in various sectors. Hence they can be released inevitably into the inland water bodies posing health threats to the aquatic ecosystems. Cholinesterase (ChE) activity can be used as a biomarker for screening neurotoxicity in organisms exposed to the environmental contaminants. The objective of the present study was to evaluate the neurotoxic potential of environmentally relevant concentrations of nano and bulk $TiO_2$ using Nile tilapia as the tropical fish model. Groups of fish which had been acclimated to the laboratory conditions for two weeks were exposed continuously to relatively low concentrations (50 and 100 µg/L) of nano or bulk $TiO_2$ for 7 or 14 days (n= 7). The control fish were exposed only to aged tap water. The experimental design also included 7 day nano or bulk $TiO_2$ exposure groups which had been transferred to aged tap water for another 7 days to evaluate potential recovery of the toxicity. Neurotoxic potential was assessed using ChE activity measurements in the brain, gill and liver tissues by a standard spectrophotometric method. ChE activities (mean±SEM in nmol/min/mg protein) in gills were elevated significantly($P < 0.05$) in the fish exposed to 50 and 100 µg/L bulk $TiO_2$ for 7 days (102±9 and 105±7 respectively) compared to those of the control fish (71 ± 5) whereas brain ChE activities were not affected. Liver ChE activities were significantly elevated at 100 µg/L continuous exposure to bulk $TiO_2$ for 7 and 14 days (279±15 and 315±15 nmol/min/mg protein respectively) compared to those of the control fish (155±12) and were not restored to normal levels after 7 days post exposure. A consistent ChE activity stimulation pattern was not evident with respect to bulk and nano$TiO_2$ exposures. In the fish exposed to both concentrations of nano $TiO_2$, ChE activities in brain and gill tissues were not significantly different from those of the control fish. However ChE activity in liver tissues of the fish exposed to 100 µg/L of nano $TiO_2$ was elevated significantly ($P < 0.05$) at 7 days exposure and post exposure periods. The results revealed that environmentally relevant concentrations of nano and bulk $TiO_2$ may pose neurotoxic risks to the fish populations inhabiting the contaminated water bodies and the bulk form of $TiO_2$ is not ecotoxicologically inert as previously assumed.

**Keywords:** Neurotoxicity, Cholinesterase, Nano$TiO_2$, Bulk $TiO_2$, Fish