# $Y_2O_3$ and $ZrO_2$ nanoparticles as modulators of embryo development, redox status, transcriptomic profile, and histopathology in chicken embryos

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Yttrium oxide ($Y_2O_3$) nanoparticles (NPs) have attracted increasing attention because of their favourable physicochemical properties, including high electrical conductivity, strong mechanical performance, a high melting point, and excellent chemical stability [1]. Despite their insolubility in water, $Y_2O_3$ NPs have been reported to exhibit antibacterial activity, which may be relevant for biological applications. Similarly, zirconium oxide ($ZrO_2$) nanoparticles are characterised by water insolubility, high hardness, mechanical strength, and chemical stability, making them useful in ceramic dental applications [2]. Nevertheless, the embryotoxic potential of both insoluble nanomaterials, $Y_2O_3$ and $ZrO_2$, has not yet been investigated.

The aim of this study is to evaluate the impact of $Y_2O_3$ and $ZrO_2$ nanoparticles on embryonic development. Using the chicken embryo as an experimental model, we investigated the influence of nanoparticle type and dose on embryo development. The nanoparticles were administered as suspensions into the fertilised egg on the first day of incubation at doses of 10 and 100 μg/mL. Their potential effects on the embryonic redox status were assessed by measuring superoxide dismutase activity, the level of lipid peroxidation, and the content of carbonylated proteins. To determine whether the tested nanoparticles affected programmed cell death in developing embryos, immunohistochemical staining was performed. Moreover, histopathological examination and transcriptomic profiling based on microarray analysis were conducted.

For both $Y_2O_3$ and $ZrO_2$ nanoparticles, a significant upward trend was observed for all examined oxidative stress markers over the course of the experiment, suggesting a cumulative effect of the nanoparticles used. Immunohistochemical analysis also revealed significant changes in the levels of proteins associated with pro-apoptotic potential following exposure to both $Y_2O_3$ and $ZrO_2$ nanoparticles.

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