Assessment of the *in vitro* biocompatibility of graphene quantum dots

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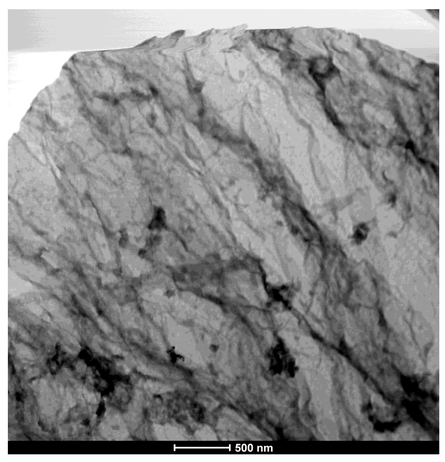
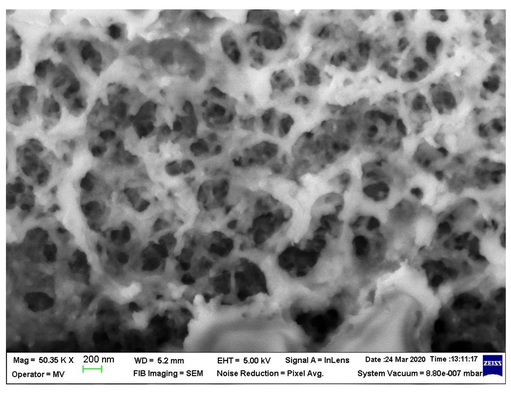
INTRODUCTION

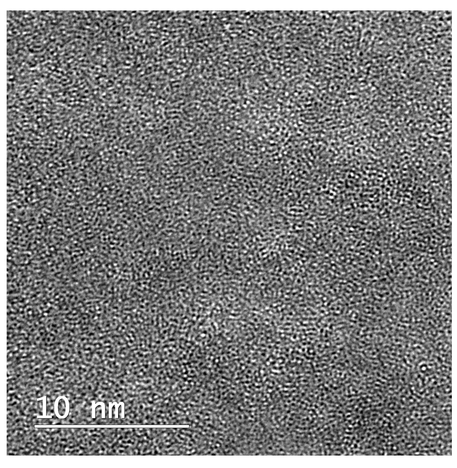
- ✓ The special physicochemical properties of graphene quantum dots (GQDs) make them very promising tools for nanomedicine, energy and environmental applications.
- ✓ Taking into account that these particles can be harmful for humans and environment, a toxicological evaluation is absolutely necessary before their use.

EXPERIMENTAL PROCEDURE

- ✓ Transmission and scanning electron microscopy (TEM and SEM), and energy dispersive X-ray spectroscopy (EDX) were used to characterize the morphology and elemental composition of GQDs.
- ✓ The hydrodynamic size and zeta potential were measured.
- ✓ Their biocompatibility was investigated on human fibroblast lung cells (MRC-5 cell line) after 24 and 72 hours of incubation with concentrations up to 200 μg/mL of GQDs.
- ✓ The interactions between GQDs and human white blood were assessed using the FagoFlowEx® kit. The phagocytic activity of neutrophil granulocytes on flow cytometry was assessed by measuring the oxidative burst after their stimulation with Escherichia coli or phorbol 12-myristate13-acetate.







TEM and SEM images of GQDs. EDX analysis of GQDs

TEM images showed graphene sheets with few wrinkle structures, the dots having uniform diameter in the range between 1.0 and 5.0 nm. SEM examination revealed the three-dimensional structure with a sponge-like aspect and pores of various sizes.
Their tendency to aggregate provided the formation of aggregates with sizes of hundreds of nanometers, as it was revealed by the hydrodynamic diameter of about 270 nm. A negative zeta potential of -16 mV confirmed the anionic character of GQDs.

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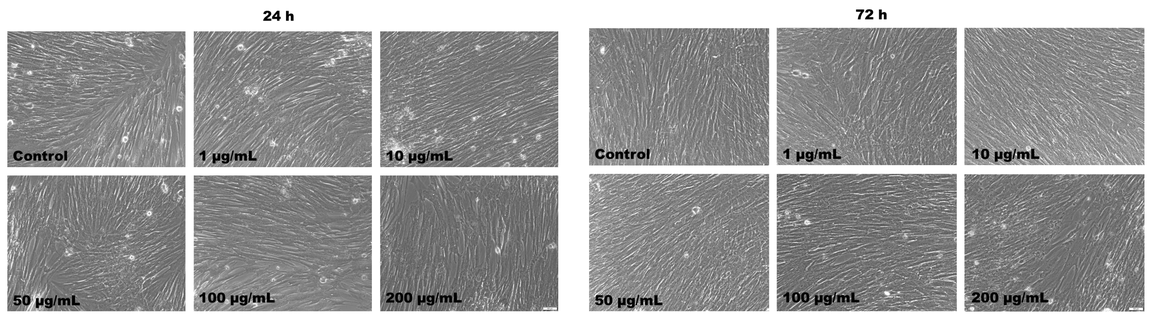
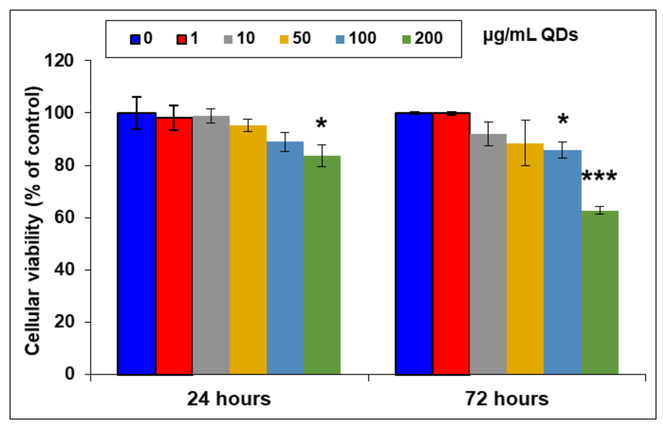
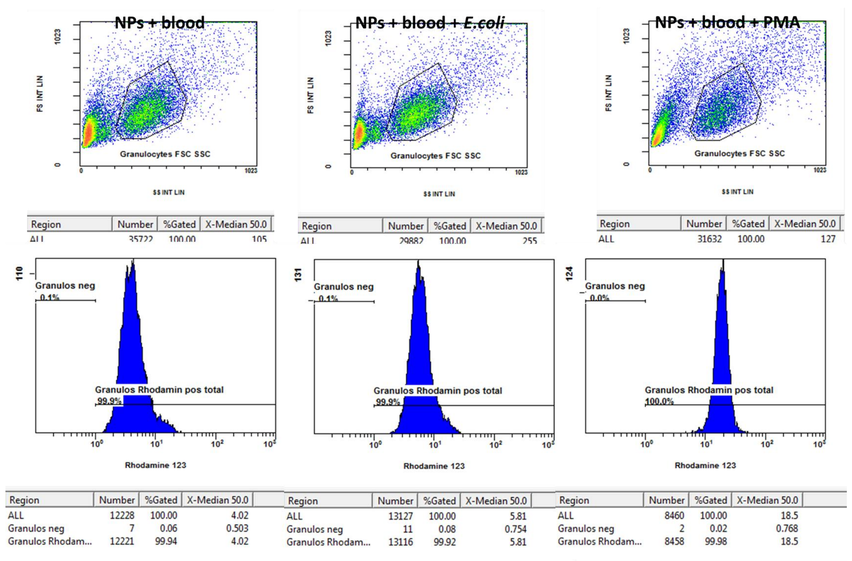
RESULTS

Concentrations up to 50 μg/mL exhibited a low toxicity in lung cells as revealed by MTT assay after both time intervals, confirming a potential further testing on animals for clinical purposes.



Phase contrast images of MRC-5 cells incubated with GQDs





GQDs did not significantly stimulate phagocytes to activate their NADPH oxidase for generating free radicals.

CONCLUSION

The high doses of GQDs induced cell death and must be avoided in future. These GQDs could become valuable components of future biocompatible nano-devices for nanomedicine and biotechnology.