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Synthesis, characterization and cytotoxicity of graphene oxide

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INTRODUCTION

Graphene oxide (GO) has many properties to be used in improved materials[1], but it is important to know the potential toxic effects derived from its use in this application. In this sense, the European Food Safety Authority had published a Guidance of the risk assessment of nanoscience and nanotechnology applications in the food and feed chain[2]. Appropriate characterization and toxicological studies should be undertaken before the potential application of GO as food contact material.

MATERIALS AND METHODS

GO was synthetized from graphite by using the Modified Hummers Method[3]. The samples were sonicated for 1 hour and diluted at different concentrations for:

Characterization:

- Fourier-Transform Infrared Spectroscopy
- X-ray photoelectron spectroscopy
- ζ potential
- X-Ray diffraction
- Scanning electron microscopy
- Transmission electron microscopy

Toxicity assays:

Toxicological effects were evaluated on CaCo-2 cells after 24-48h of exposure by:

- MTS reduction
- Protein Content (PC)

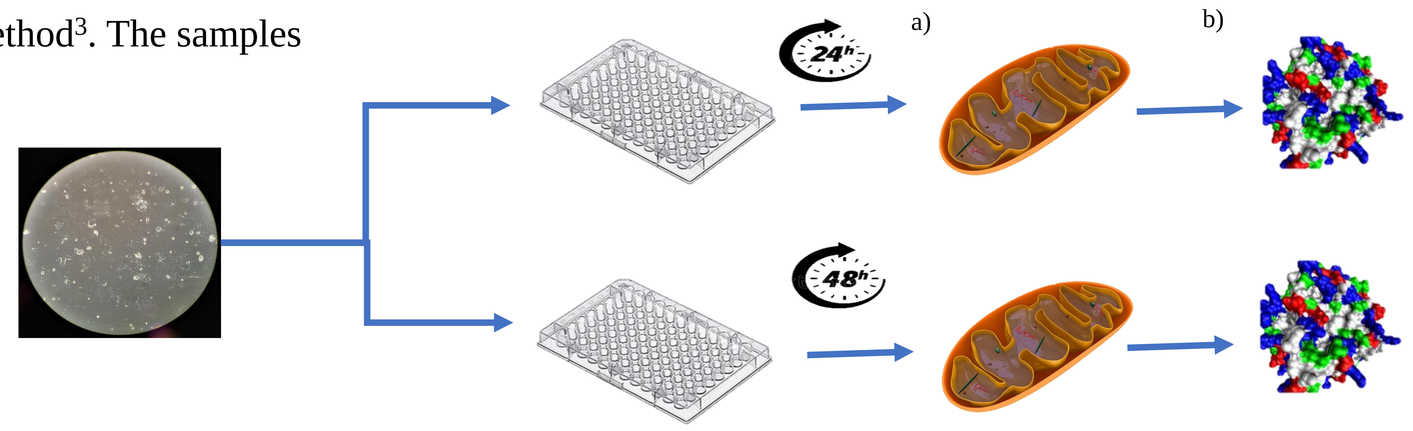

Fig.1: Scheme of MTS (a) and PC (b) assays on CaCo-2 cells

RESULTS

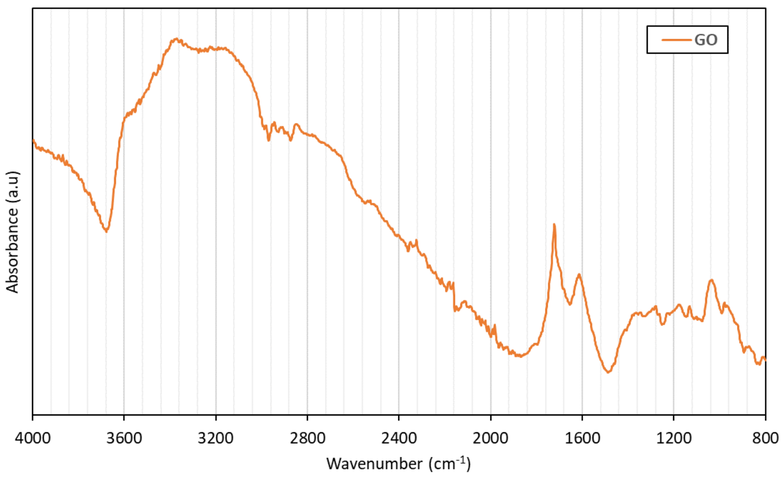

Fig.2: Image of FTIR spesctrum of graphene oxide (GO)

- FTIR showed the characteristic bands of the GO, a strong broad-band at 3430 cm^{-1} due to hydroxyl groups, a band around 1730 cm^{-1} arising from the carboxylic acid groups, the band at 1620 cm^{-1} assigned to the aromatic C-C groups, and about 1044 cm^{-1},a band corresponding to the C-O groups. (Fig.2)
- XPS revealed carbon content (66.29 At%), oxygen content (33.16 At%) and traces of nitrogen (0.55 At%).
- The ζ potential results demonstrated less aqueous dispersity of GO in cell culture medium (-10.9 ± 0.3) than in Milli-Q water (-30.3 ± 0.6).
- GO showed two diffraction peaks at 2Θ = 12.6 and 2Θ = 42.5.
- GO are visualized as agglomerated nanosheets in aqueous suspension (Fig.3)
- Caco-2 cells showed no significant changes in the endpoints considered after 24 and 48h of exposure at any concentration assayed (0-250 µg/mL). (Fig.4)

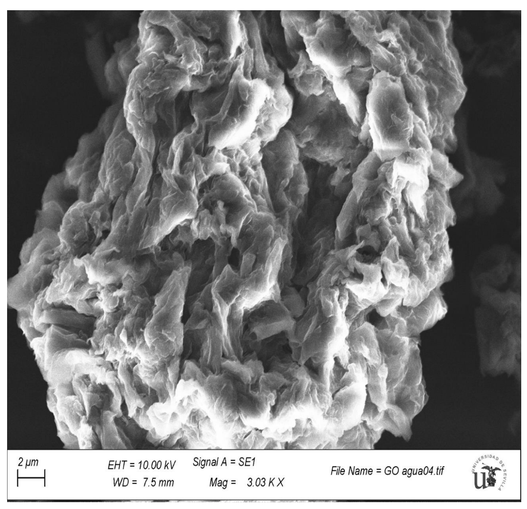

Fig.3: Image of graphene oxide obtained by scanning electron microscopy

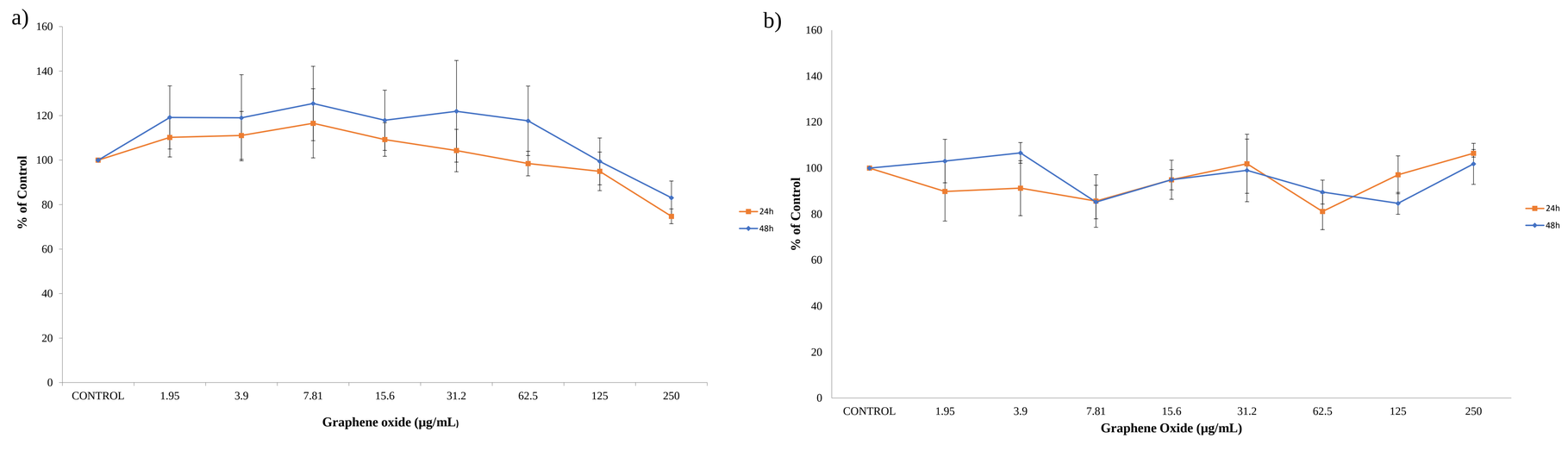

Fig.4: Reduction of the tetrazolium salt (a) and protein content on Caco-2 cells after 24 h and 48 h of exposure to 0–250 µg ml^{-1} Graphene oxide. All values are expressed as mean ± SD.

CONCLUSION

GO was characterized and cytotoxicity studies showed not relevant changes. However, further toxicological tests are required before the potential application of GO as food contact material.

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