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Sustainable nanotechnology and scientific literacy: an integrated approach to ovarian cancer theranostics

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ABSTRACT

Introduction: Ovarian cancer remains one of the most lethal gynaecological malignancies, with limited clinical progress despite conventional therapeutic advances. Its multifactorial complexity highlights the need for innovative strategies that integrate pharmacological efficacy, sustainability and social responsibility principles.
Objectives: Within an ongoing framework, this work aims to apply sustainable nanotechnology to ovarian cancer theranostics by converting viticulture byproducts into high-performance nanocarriers, while promoting scientific literacy and supporting circular economy.
Methodology: In this preliminary phase, nanometric graphene oxide was chemically synthesized, characterized, and functionalized. Conjugates with doxorubicin (NGO@DOX) were developed to enable pH-responsive controlled release. Concurrently, a citizen science strategy is under development, integrating co-design activities and discussions on sustainability, nanotechnology and oncological health. This strategy aims to evolve into a co-creation model with wine growers and rural communities to characterise wine-making bioresidues and assess their socioeconomic impact as pharmaceutical raw material.
Results: NGO@DOX exhibited stable drug binding at pH 7.4, while efficient release occurred under acid conditions at pH 5.5 (99±1 % over 24 hours), supporting targeted and controlled delivery. Nanometric graphene oxide showed tunable optical properties suitable for bioimaging and photothermal applications. These findings support future "Green-Graphene" synthesis from

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Douro vineyard biowaste, conjugated with paclitaxel and resveratrol, to develop multifunctional nanoconjugates with synergistic effects. Meanwhile, this participatory framework lays the groundwork to enhance scientific literacy and sustainable territorial innovation.
Conclusion: Nanometric graphene oxide-based conjugates demonstrate effective drug release and bioimaging potential. These preliminary results establish the technological and social foundations for sustainable synthesis using vineyard waste, while promoting health education and resource valorisation.