Calcium Carbonate Nanoparticles' Toxicological Profile for Use in Industry

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Abstract

The CO_2-derived calcium carbonate nanoparticles (CaCO3NPs) are promising materials for a variety of industrial

Keywords: Calcium carbonate; Nanoparticles; Environment toxicity

Introduction

e use of various nanomaterials to enhance the capabilities and mechanical qualities of cement is currently generating a lot of scienti c attention [1]. Numerous nanoparticles, such as carbon nanotubes (CNTs) titanium dioxide nanoparticles (TiO_2 NPs), silica nanoparticles (SiO_2 NPs), alumina nanoparticles (Al_2O_3 NPs), and silica nanoparticles (SiO_2 NPs) have been added to cement-based materials, each of which has potential advantages and disadvantages. In this context, calcium carbonate nanoparticles (CaCO3NPs) made from CO_2 are being researched as possible nanomaterials to be used in these industrial applications, with the aim of assisting in CO_2 capture and utilisation directly in the industrial site in which CO_2 is available or produced. As one of the main sources of anthropogenic CO_2 emissions in this regard, the cement industry raises the possibility [2].

Synthesis of CaCO3NPs

Slurry made with analytical-grade CaO (Merck, purity 99%), deionized water, and CO_2 (quality: 99.9%, supplied by SIAD, Italy) was used to create $CaCO_3$. e CaCO3NPs were created by carbonating a CaO slurry with only pure CO_2. Raschig rings were packed randomly in a Packed Bed Reactor (PBR) as part of the experimental setup, which is depicted in Fig. 1. e slurry is pumped into the PBR using a peristaltic pump, where it comes into touch with the CO_2 and precipitates. e vessel, which is kept at a constant stirring speed, received the precipitated particles right away. In this fashion, two zones are distinguished: the crystallisation zone, which is located inside the PBR. the stabilisation process, which takes place inside the feed tank where the pH is kept high enough to create a stable environment for the $CaCO_3$ particles because the growth and agglomeration processes of the CCnP are not favoured by alkaline circumstances. e CO_2 supply was halted once the pH fell below 10.5, which, in accordance with the carbonate equilibria, discourages CO_3-formation and lowers the $CaCO_3$ saturation. A er the procedure was complete, the synthesised particles were quickly ltered by vacuum (pore size = 0.45 m), and the excess ions were then removed by repeatedly washing the particles in deionized water. e $CaCO_3$ powder was ultimately ready for assessment of their size, shape, and crystal a er being dried at 60 °C for an overnight period [3, 4].

Due to their special characteristics, such as a high surface area to volume ratio and high porosity, calcium carbonate nanoparticles are thought to strengthen cement. e kinematic of the C single bond is accelerated by $CaCO_3$. Since they serve as the initial building blocks for the cement's hydration, which the $CaCO_3$ turns out to speed up, single bondH bonds form. us the early age compressive and exural strengths of the cement are increased. $CaCO_3$ also improves mechanical properties due to its lling qualities [5].

An urgent need for a thorough toxicological examination of these nanoparticles' e ects on ecosystems and human health arises from the massive increase in the manufacture and use of CaCO3NPs, exposure of industry workers to them, and the e ects of their discharge. In order to solve this problem, we tested the toxicity of CaCO3NPs on two di erent cell lines, a human breast cancer cell line and a mouse embryonic broblast cell line (NIH 3T3) (MCF7). By measuring survivability, reactive oxygen species (ROS) production, and DNA damage in vitro and a er treatment with various concentrations of CaCO3NPs, the cytotoxic assessment was carried out. Our ndings showed that CaCO3NPs were not harmful to either NIH 3T3 or MCF7 cells, showing that they did not promote cell mortality, reactive oxygen species, or oxidative DNA damage [6, 7, 8].

Conclusion

e creation of calcium carbonate nanoparticles from CO_2 and tests of their toxicity on cultured cells and more sophisticated biological systems are described in this paper. We have demonstrated that CaCO3NPs may be produced quickly and easily from CaO slurry. Additionally, we have shown that both normal and cancer cell lines exhibit high cyto-biocompatibility for our CaCO3NPs. On the two separate cell lines, the cell viability showed high values and there was no evidence of cell death, an increase in reactive oxygen species levels, or DNA damage. We looked at the precise interactions of the nanoparticles with zebra sh, which are vertebrate models, to determine the safety of CaCO3NPs with regard to human exposure. We showed that CaCO3NPs are very biocompatible with zebra sh at the early. [9, 10].

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Received: 03-Jan-2023, Manuscript No: tyoa-23-85616; **Editor assigned:**

Citation:

Acknowledgement

None