Ultrasonic-assisted synthesis and biological evaluation of a nano-rod diorganotin phosphonic diamide: Precursor for the fabrication of SnP$_2$O$_7$ nano-structure

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Nanorods of a diorganotin phosphonic diamide with formula [Sn(CH$_3$)$_2$(Cl)$_2$(L)$_2$] \( \{L = C_6H_5(O)P(NHC$_6$H$_5$)$_2}\) have been synthesized by sonochemical processes at different concentrations without any surfactant or capping agent. The structure and morphology of the prepared complex were investigated by using SEM-EDAX, XRD, DLS, UV–Vis and FT-IR spectroscopy. Nanoparticles with well-defined rod shapes and sizes in the range 30–40 nm have been obtained. Also bulk form of the titled complex was synthesized and characterized by $^1$H, $^{13}$C, $^{31}$P, $^{119}$Sn NMR, UV–Vis and FT-IR spectroscopy and compared with its nano-size. The thermal stabilities at bulk and nano-size scale have been studied by thermal gravimetric (TG) and differential thermal analysis (DTA). Further, SnP$_2$O$_7$ nanoparticles were synthesized by direct calcination at 730 °C under air atmosphere and characterized using XRD, SEM, and TEM. From XRD measurements, we determined the mean size of the crystallites about 27.4 nm. It is found that the size and morphology of the tin pyrophosphate nano-structures are dependent upon the particles size of precursor compound as well. Two different forms of metal coordination compound (1a, 1b) and the corresponding ligand (L) were screened for their antibacterial activity against the selected Gram-positive and Gram-negative bacteria, showing bactericidal activity for complexes 1a and 1b. In vitro cytotoxicity of compounds was studied against human carcinoma cell lines, A2780 (ovarian cancer) and PC-3 (prostate cancer). Results indicated that 1a and 1b possess relatively strong cytotoxic activity against cancer cells with IC$_{50}$ values ranging from 93.2 to 376.2 μM for two exposure time (24 and 48 h).

KEYWORDS
antibacterial, anticancer, diorganotin phosphonic diamide, nanorod, tin pyrophosphate

1 | INTRODUCTION

Nowadays, phosphoramidate complexes have received considerable attention due to their diverse chemical structures$^{[1–3]}$ and wide applications in biomedical, magnetic, catalysis, and theoretical studies.$^{[4–7]}$ The coordination chemistry of organotin compounds has become of great interest because of their important applications as anticancer agents.$^{[8,9]}$ Agrochemical fungicides and biocides$^{[10,11]}$ as well as catalysts.$^{[12]}$ Synthesis of organotin with phosphoramidate ligands by the reaction of Sn(R)$_2$Cl$_4$$_n$ \( (n = 1–3) (R = Cl, CH$_3$, C$_6$H$_5$) \) with various phosphoramides, as well as evaluation of their cytotoxicity against some human cell lines and microbial strains have