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Article

Biosynthesis of novel ascorbic acid esters and their encapsulation in lignin nanoparticles as carriers and stabilizing systems

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SI 1. Morphological analysis by FE-SEM images of biocatalyst **I**

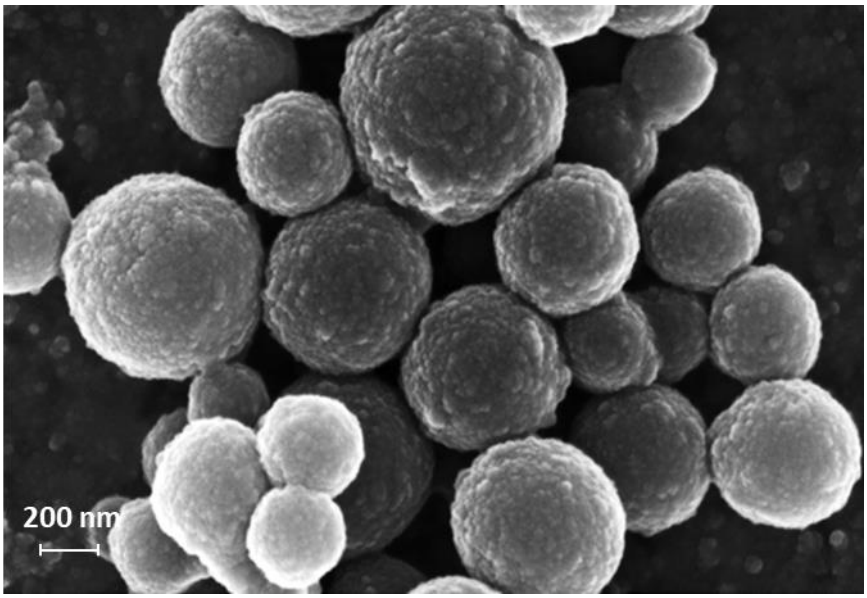


Figure S1. FE-SEM images of biocatalyst **I.**

SI 2. Synthesis protocol of ester **4** and **5**

The Mitsunobu synthesis of esters **4** and **5** was carried out via standard procedure in order to prepare reference samples. Briefly, a solution of the appropriate compound (1.0 eq.) in anhydrous THF (5.0 mL) and TPP (280 mg, 1.1 eq.) was cooled (0 °C) followed by addition of DIAD (1.0 eq.). After stirring for 48h at room temperature, the solvent was removed and the residue suspended in ethyl acetate. The organic phase was washed with saturated $NaHCO_3$ (15 mL x3), brine (15 mL x3), and dried by anhydrous Na_2SO_4.

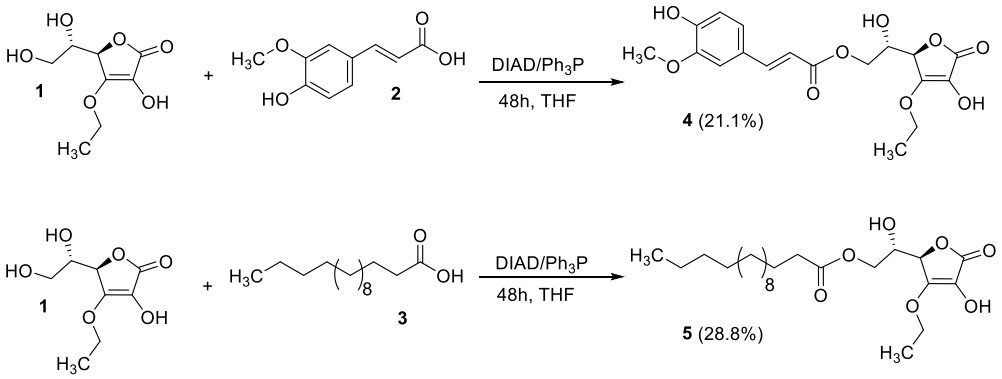
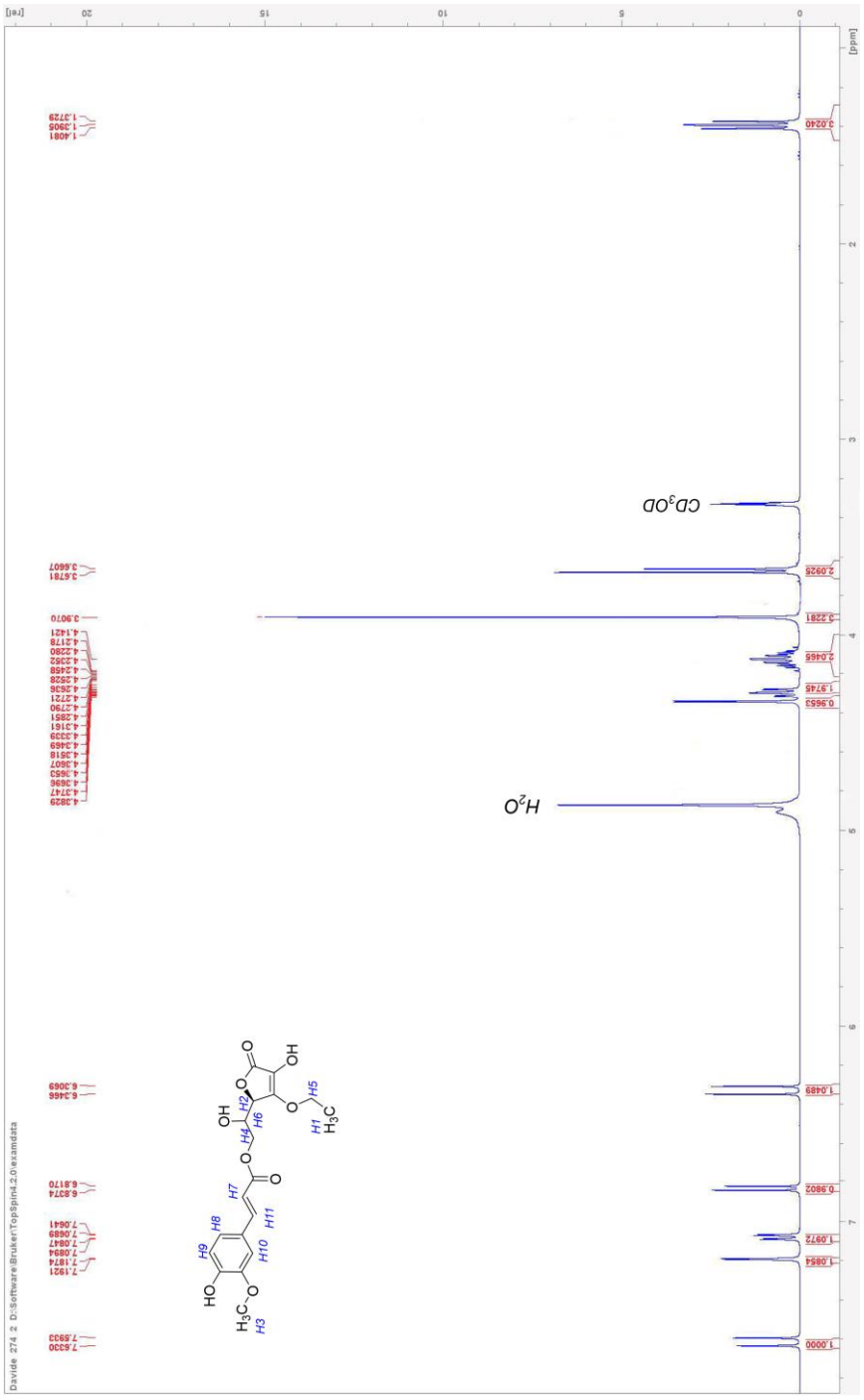


Figure S2. Synthesis ester **4** and **5** by Mitsunobu reaction.

SI 3. 1H and 13C NMR spectra of ester **4**



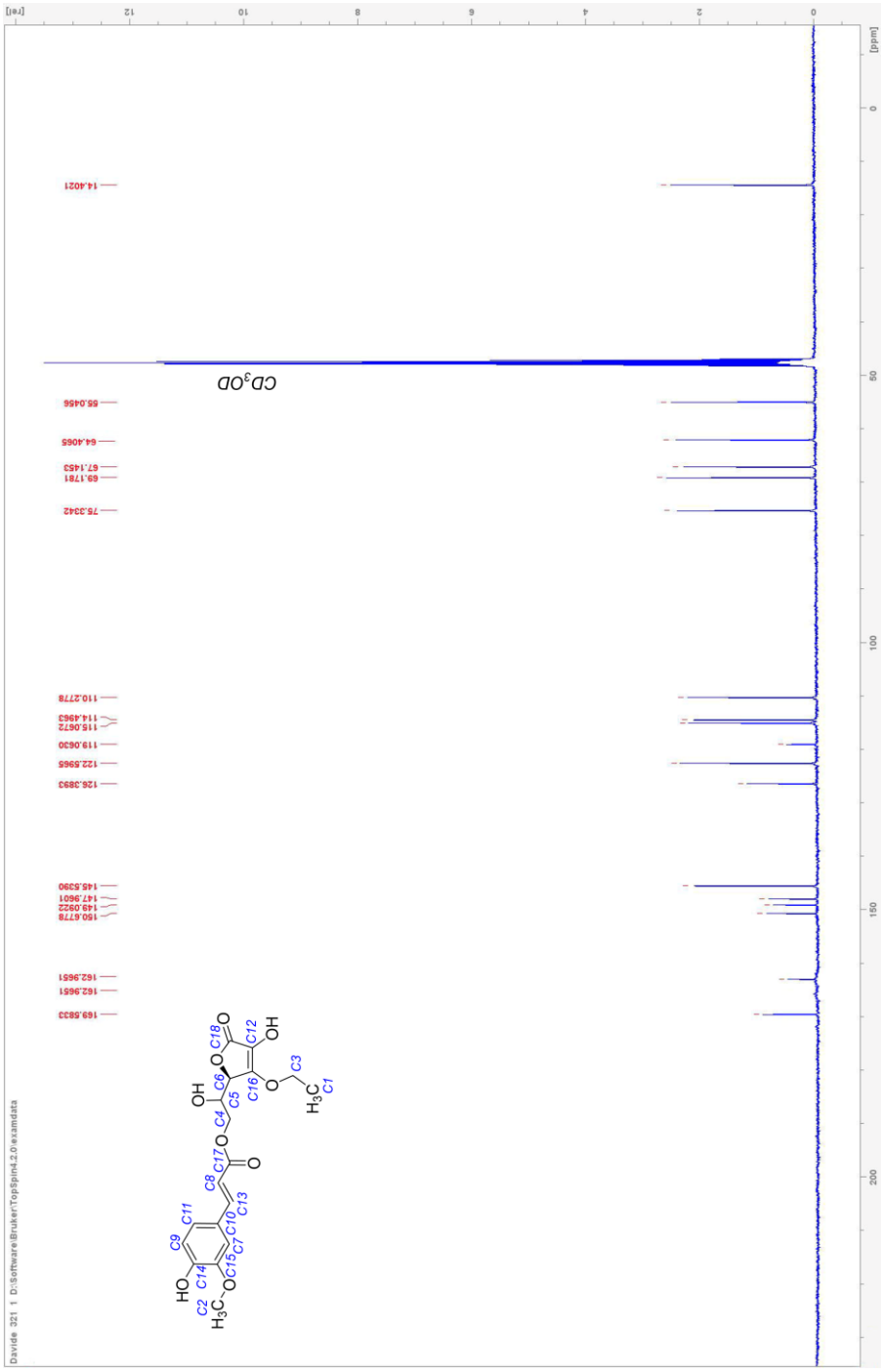
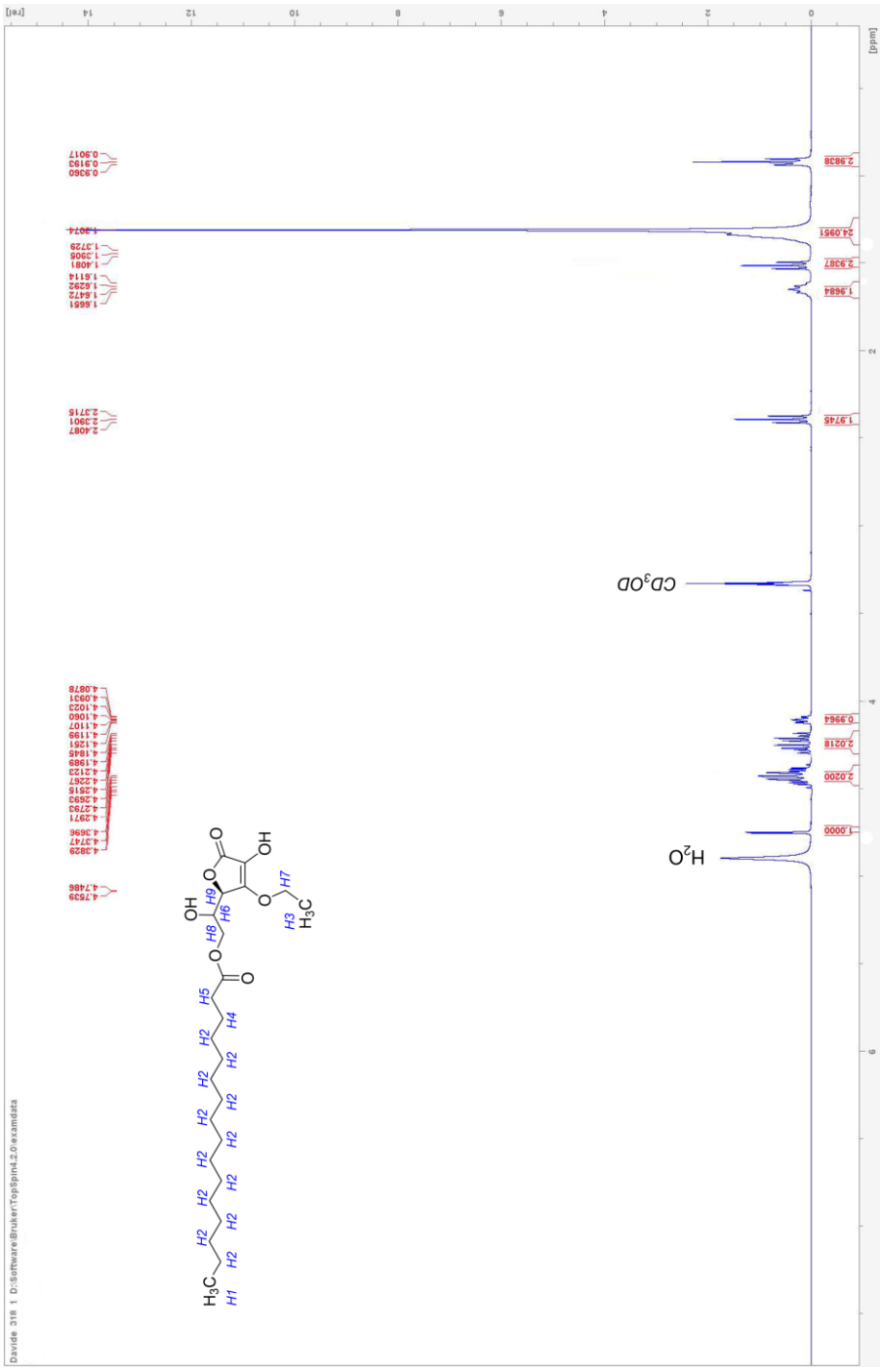


Figure S3. 1H and 13C NMR spectra of ester **4.**

SI 4. 1H and 13C NMR spectra of ester **5**



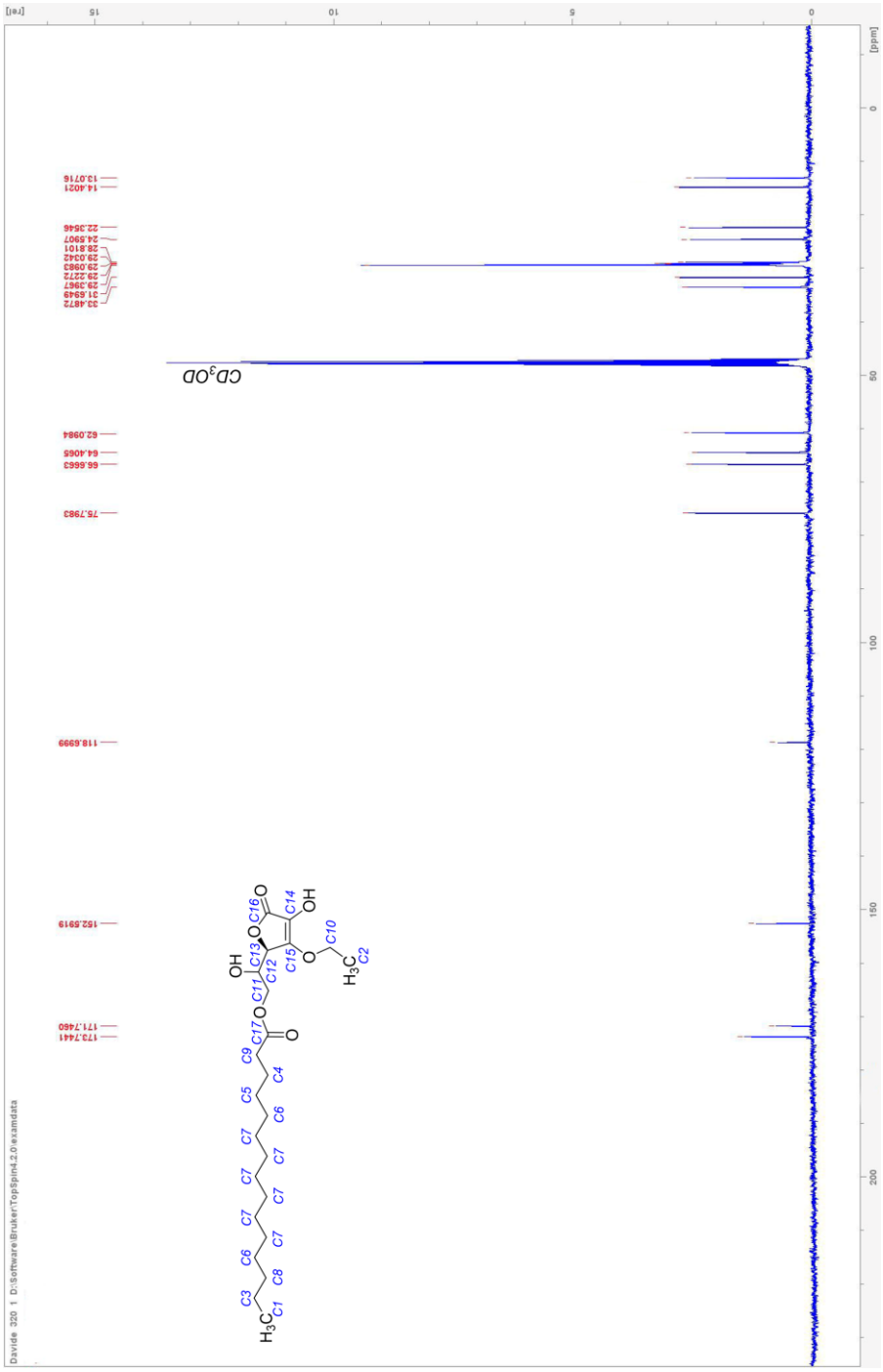


Figure S4. 1H and 13C NMR spectra of ester **5.**

SI 5. UV-vis analysis

The appropriate compound (1.0 µmol) was dissolved in milliQ water (2.8 mL) in the presence of MeOH (0.2 mL) and analyzed using quartz cuvette (3.0 mL, 1 cm path length) by Varian Cary UV 60 scan (Crawley, UK) in the range between 250 nm and 800 nm, with a scan speed of 400 nm/min and band width of 5 nm at 25°C under gentle stirring. The analysis was elaborated by the UV-Vis scan software.

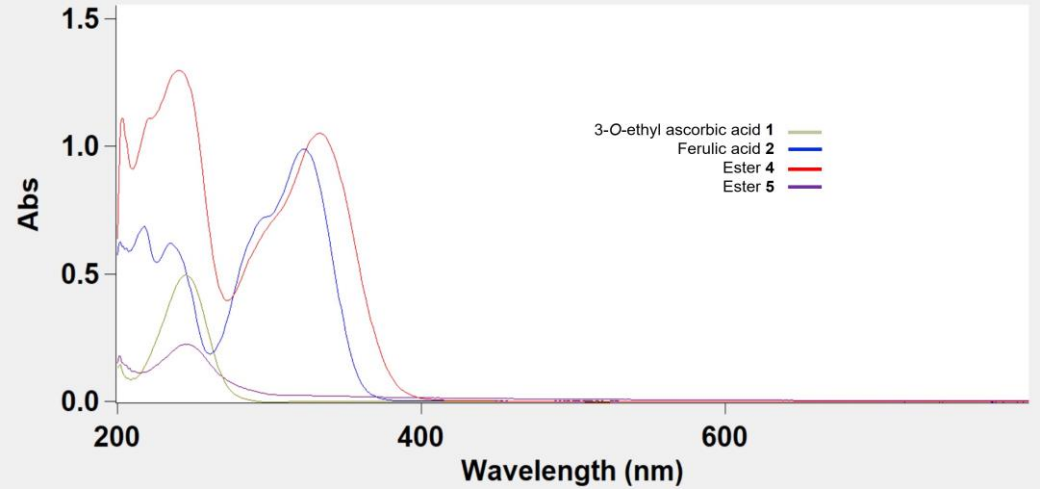
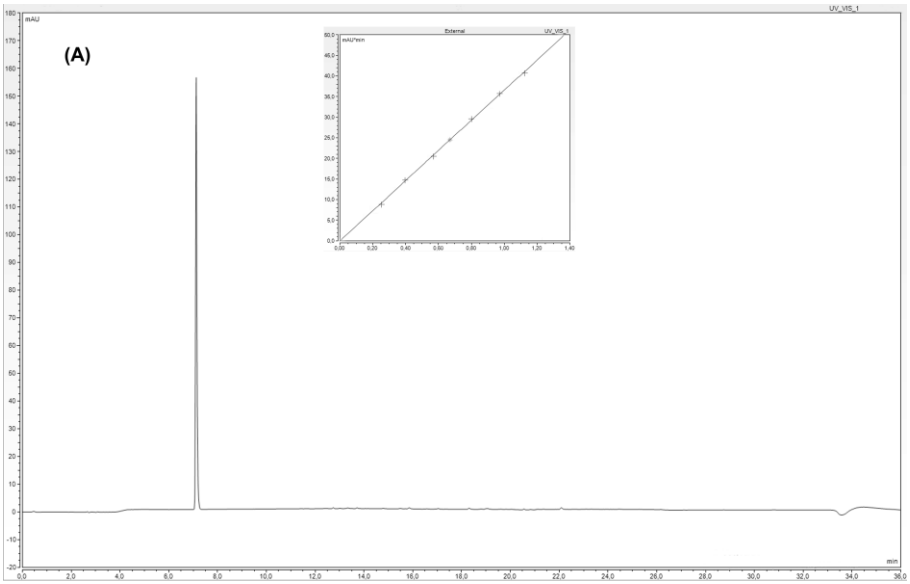


Figure S5. UV-vis scan of esters **4** and **5** compared with reference compounds (**1** and **2**).

SI 6. HPLC analysis



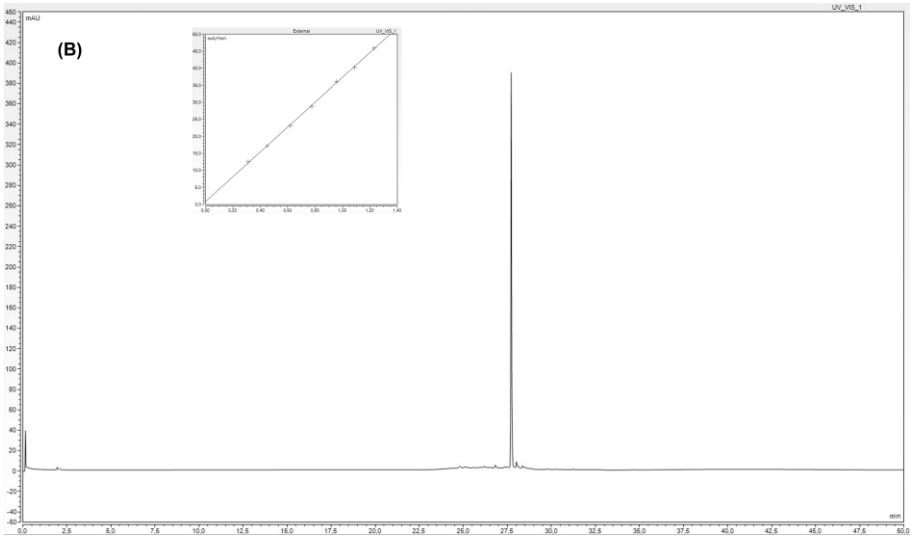


Figure S6. HPLC chromatograms of ester **4** (A) and **5** (B).