

A facile synthesis of $\text{ZrO}_x\text{-MnCO}_3$ /graphene oxide (GRO) nanocomposites for the oxidation of alcohols using molecular oxygen under base free conditions.

Syed Farooq Adil ^{1,*}, Mohamed E. Assal ¹, Mohammed Rafi Shaik ¹, Mufsir Kuniyil ², Nawaf M. AlOtaibi ¹, Mujeeb Khan ¹, Muhammad Sharif ³, M. Mujahid Alam ⁴, Abdulrahman Al-Warthan ¹, Jabair Ali Mohammed ⁵ and Mohammed Rafiq H Siddiqui ^{1,*} Muhammad Nawaz Tahir ^{3,*}

¹ Department of Chemistry, College of Science, King Saud University, P.O. 2455, Riyadh 11451, Kingdom of Saudi Arabia.

² Department of Chemistry, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Guntur 522502, Andhra Pradesh, India.

³ Chemistry Department, King Fahd University of Petroleum and Materials, Dhahran 31261, Kingdom of Saudi Arabia.

⁴ Department of Chemistry, College of Science, King Khalid University, Abha, Kingdom of Saudi Arabia.

⁵ Center of Excellence for Research in Engineering Materials (CEREM), King Saud University, P. O. Box 800, Al-Riyadh 11421, Kingdom of Saudi Arabia

* Correspondence: rafiqs@ksu.edu.sa (M.R.H.S.), sfadil@ksu.edu.sa (S.F.A.), muhammad.tahir@kfupm.edu.sa (M.N.T.)

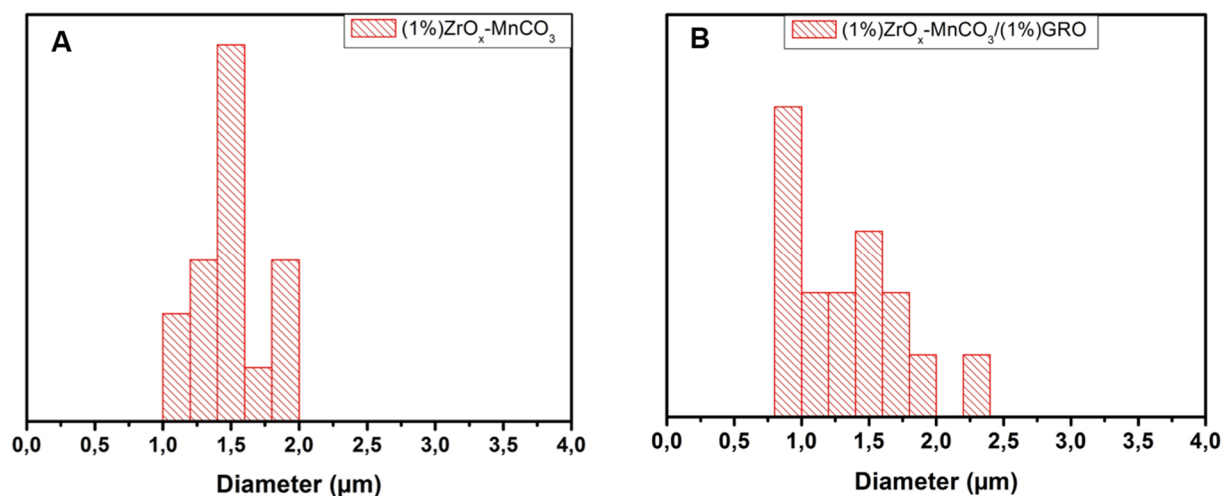


Figure S1: The corresponding histograms indicating the particles size and size distribution; **A)** as synthesized (1%)ZrO_x-MnCO₃ and **B)** (1%)ZrO_x-MnCO₃/(1%)GRO Nanocomposites.

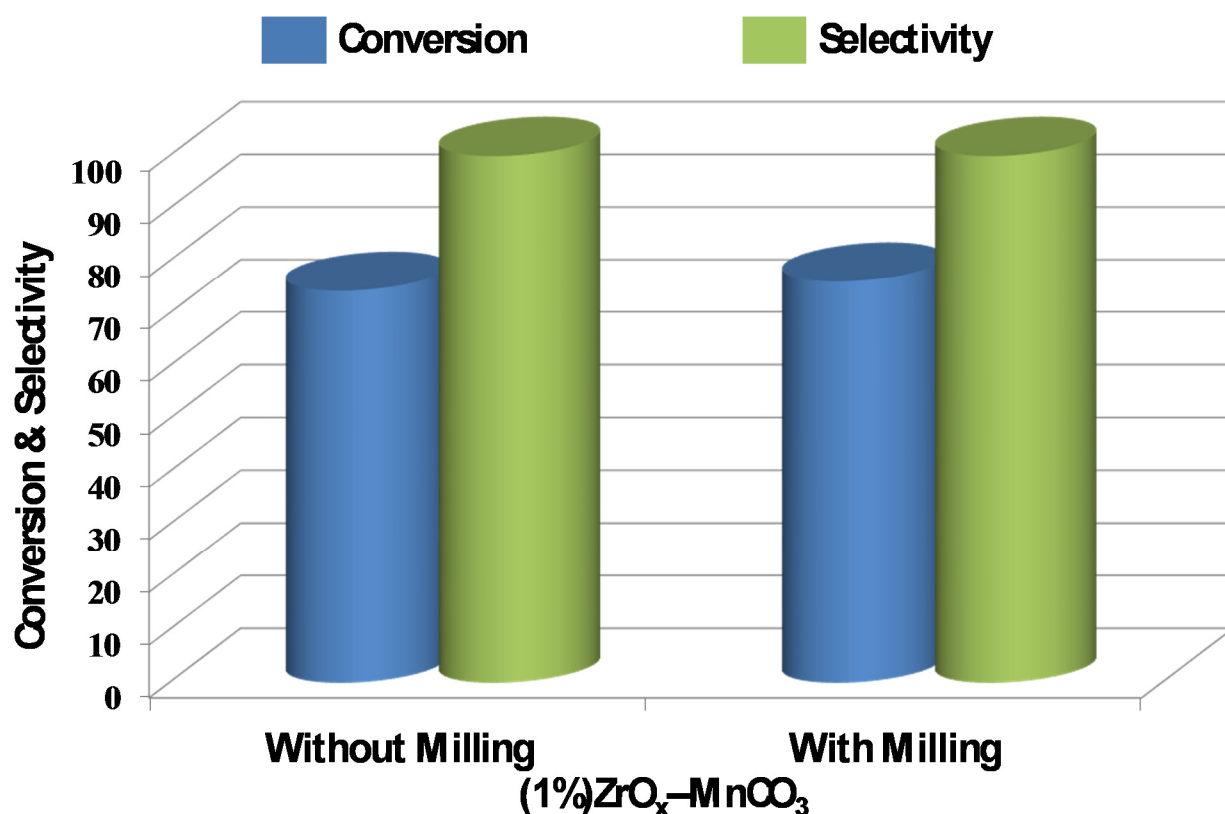


Figure S2: The graphical representation comparing the selectivity and conversion of benzyl alcohol to benzaldehyde for the catalyst (1%)ZrO_x-MnCO₃ with and without milling. Conditions: 2 mmol BzOH, 0.1 g catalyst amount, 20 mL/min O₂ flow rate, 100 °C; 7 minutes.

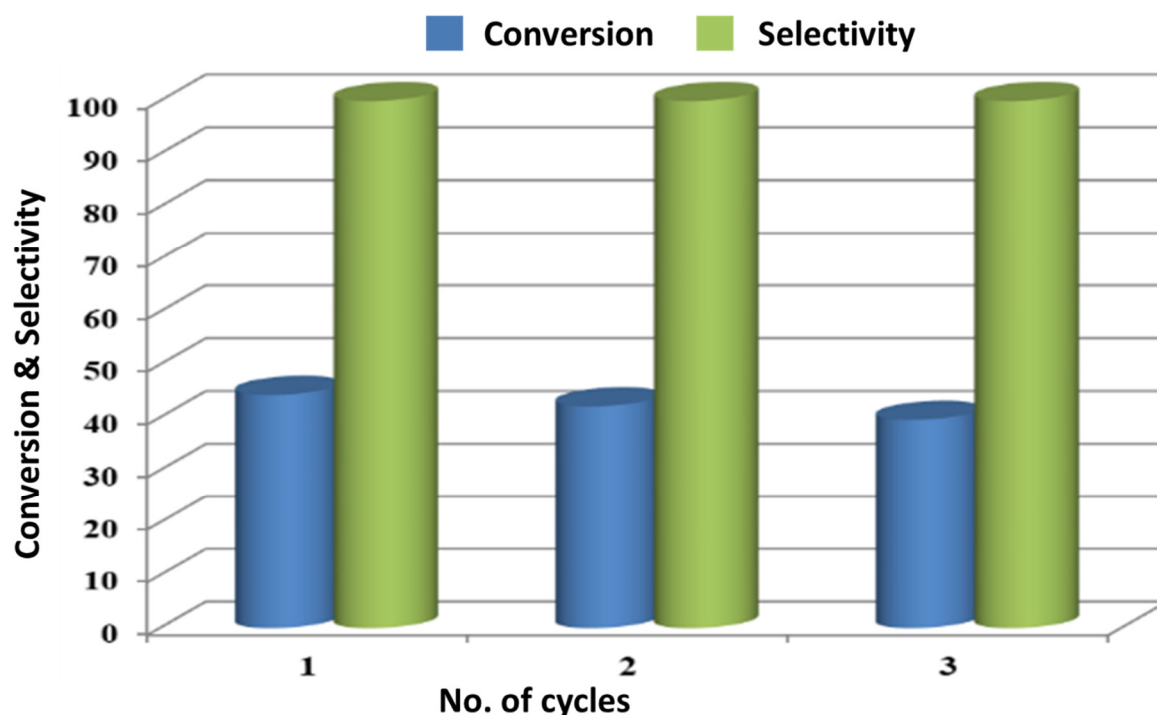


Figure S3: Reusability results of (1%)ZrO_x–MnCO₃/(1%)GRO nanocomposite. Conditions: 2 mmol BzOH, 0.1 g catalyst amount, 20 mL/min O₂ flow rate, 100 °C; 7 minutes.

Ball Milling Details

Ball Type: Fritsch pulverisette 7-planetary ball mill Stainless steel ball 5mm diameter

Mill type: Stainless steel container 300 rpm speed and 16 hours milling

Procedure of Milling: The graphite oxide powder was milled using Fritsch Pulverisette P7 planetary ball mill. The Graphite Oxide Powder and Stainless Steel balls (5mm Diameter) with ball to powder weight ratio of 11:1 were introduced into the Stainless steel Container. The milling of the powder was performed for 16 hours. And in order to maintain the temperature inside the container, the milling process was paused at regular intervals).

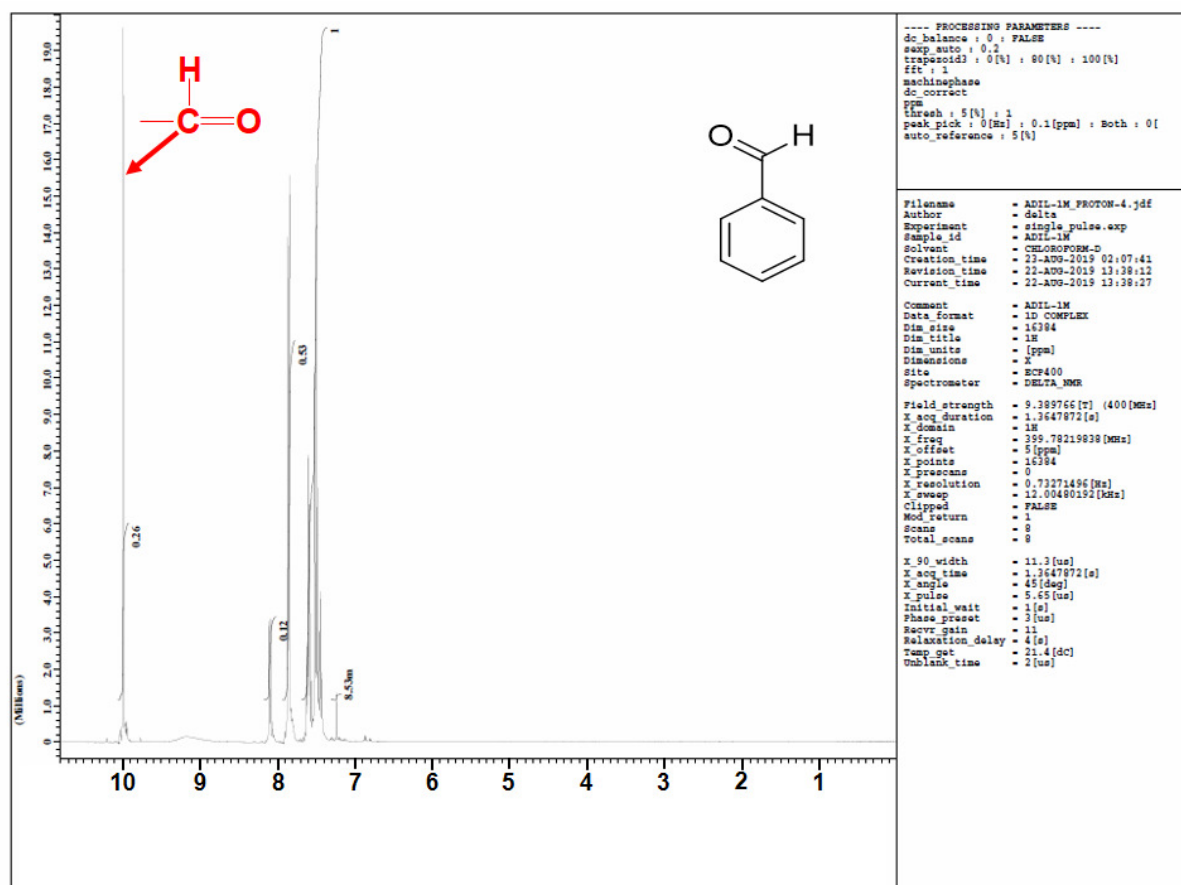


Figure S4: ^1H NMR spectra for the product (benzaldehyde) obtained after selective oxidation of benzyl alcohol

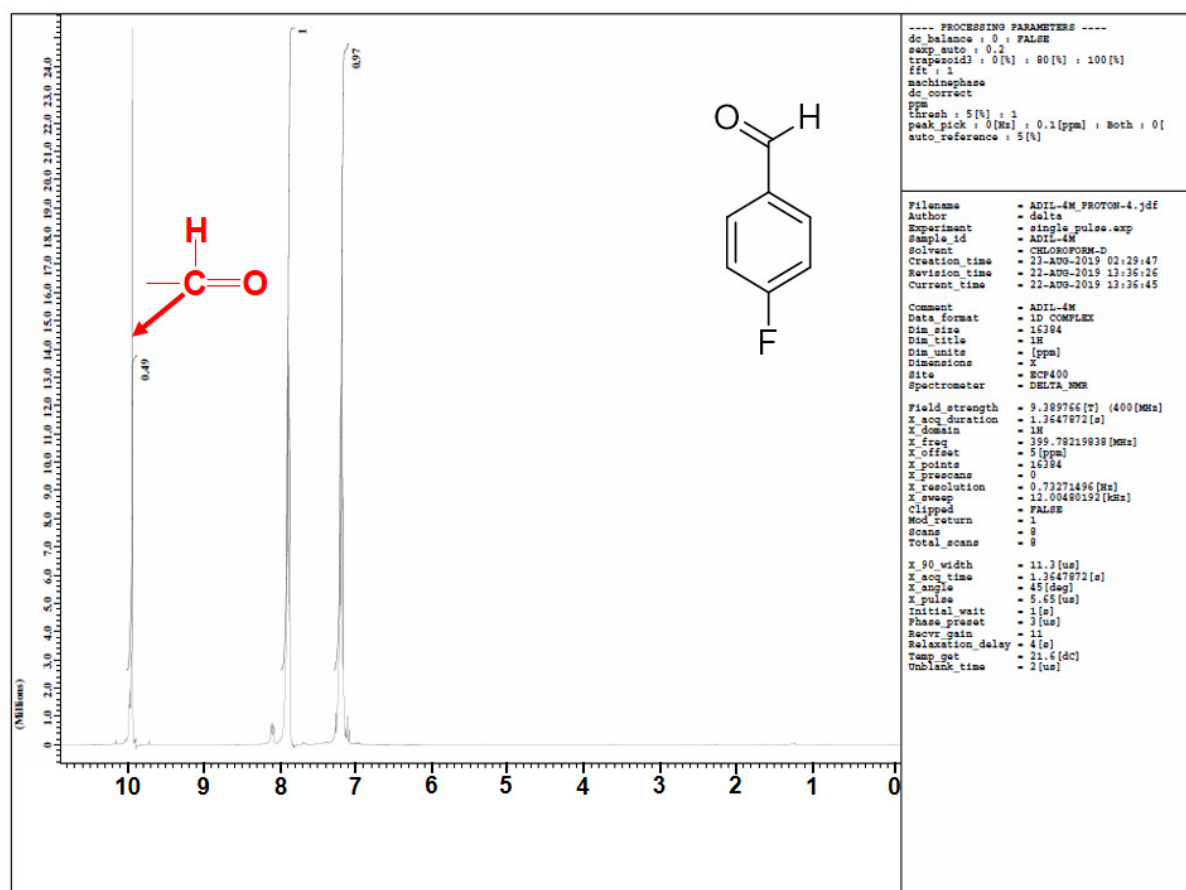


Figure S5: ^1H NMR spectra for the product (4-fluorobenzaldehyde) obtained after selective oxidation of 4-fluorobenzyl alcohol

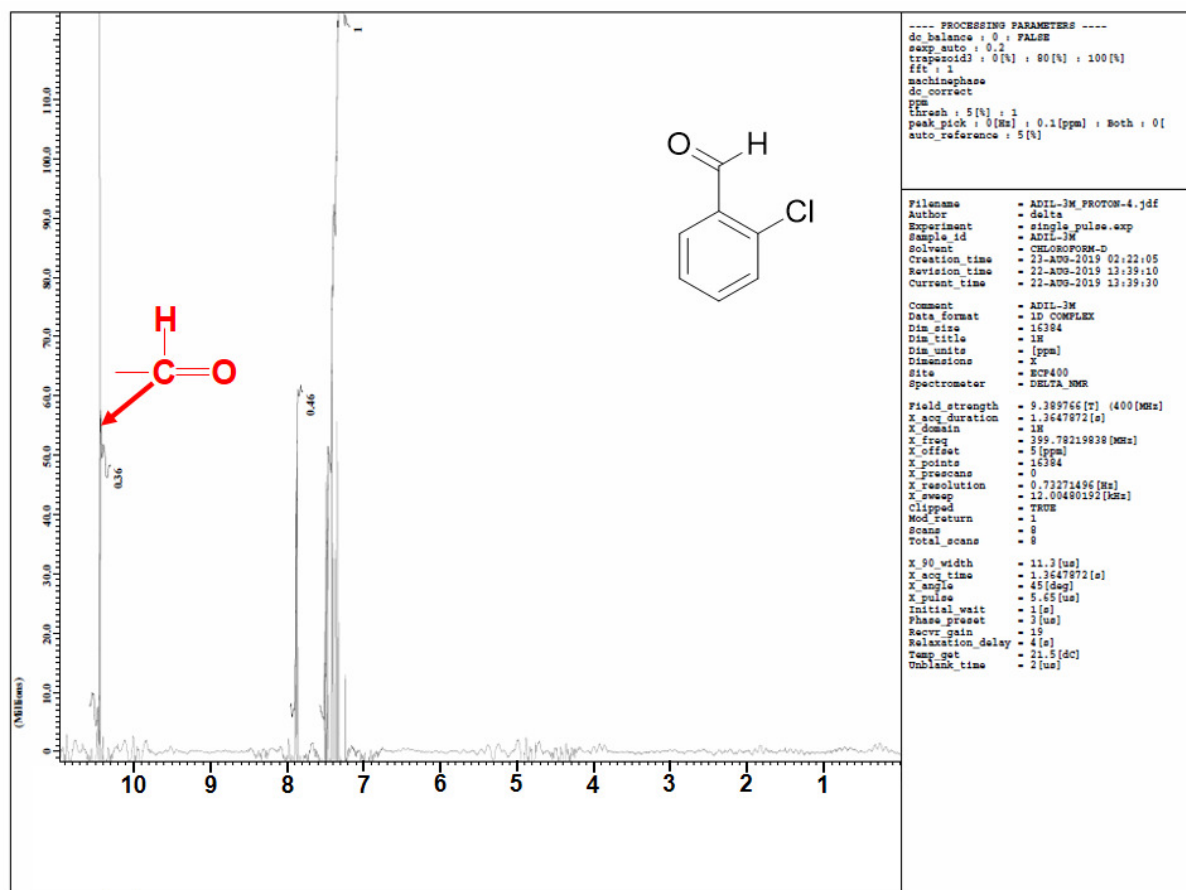


Figure S6: ^1H NMR spectra for the product (2-chlorobenzaldehyde) obtained after selective oxidation of 2-chlorobenzyl alcohol

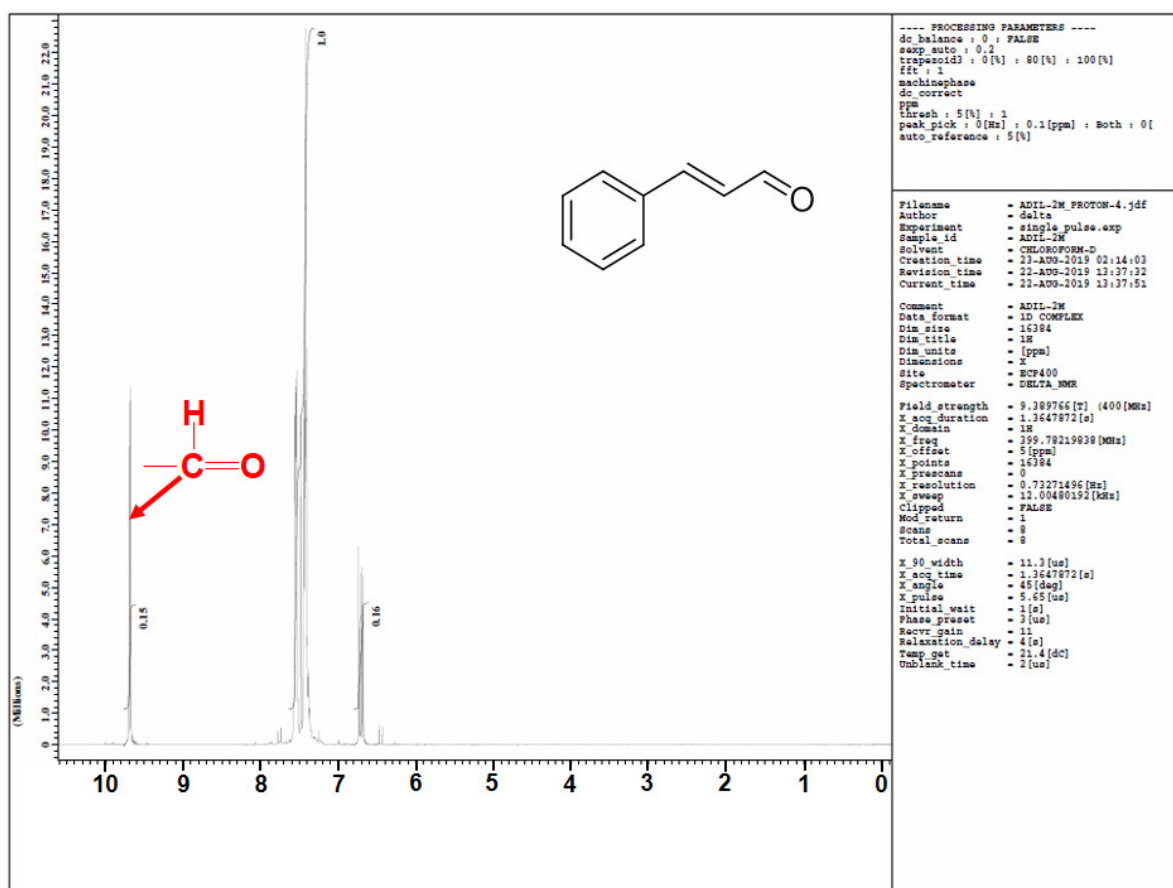


Figure S7: ^1H NMR spectra for the product (cinnamaldehyde) obtained after selective oxidation of cinnamyl alcohol

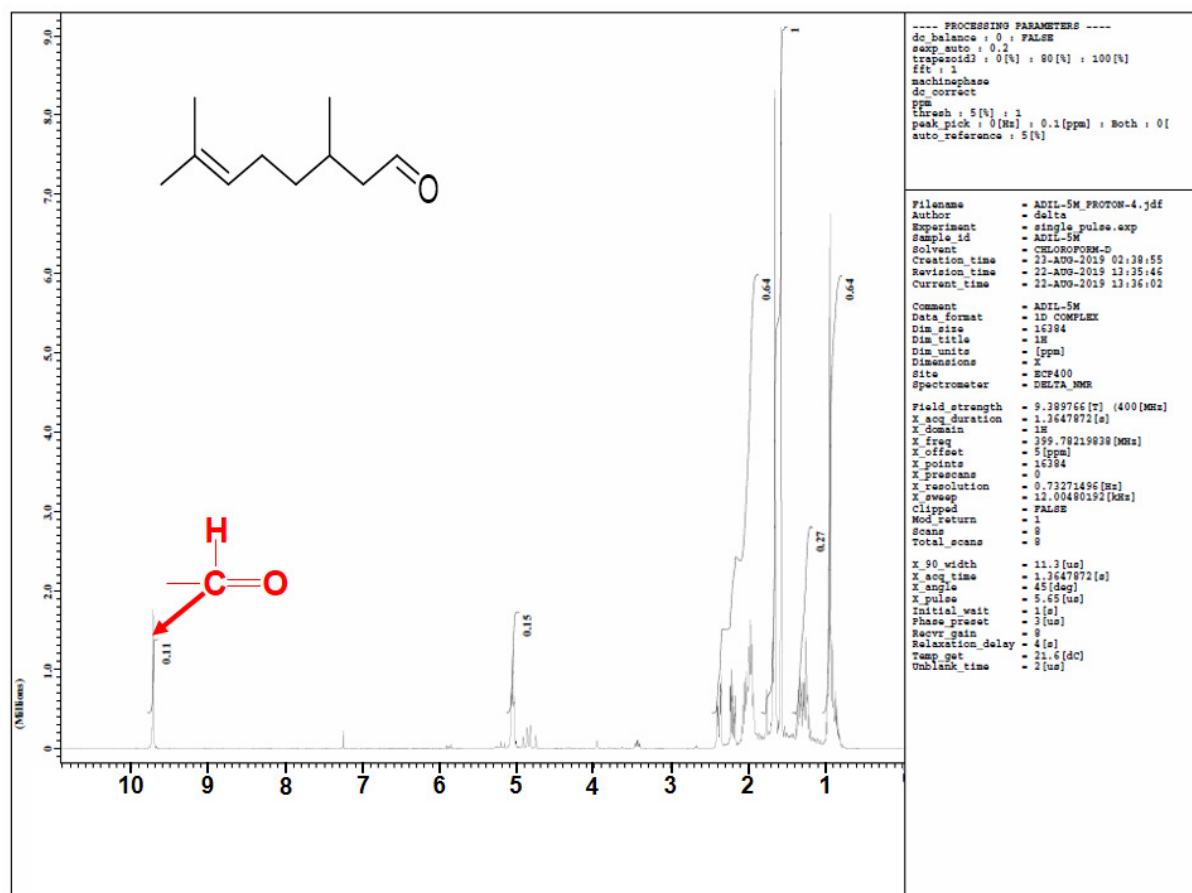


Figure S8: ¹H NMR spectra for the product (citronellal) obtained after selective oxidation of citronellol