Continuous flow vortex fluidic production of biodiesel

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Supplementary Information

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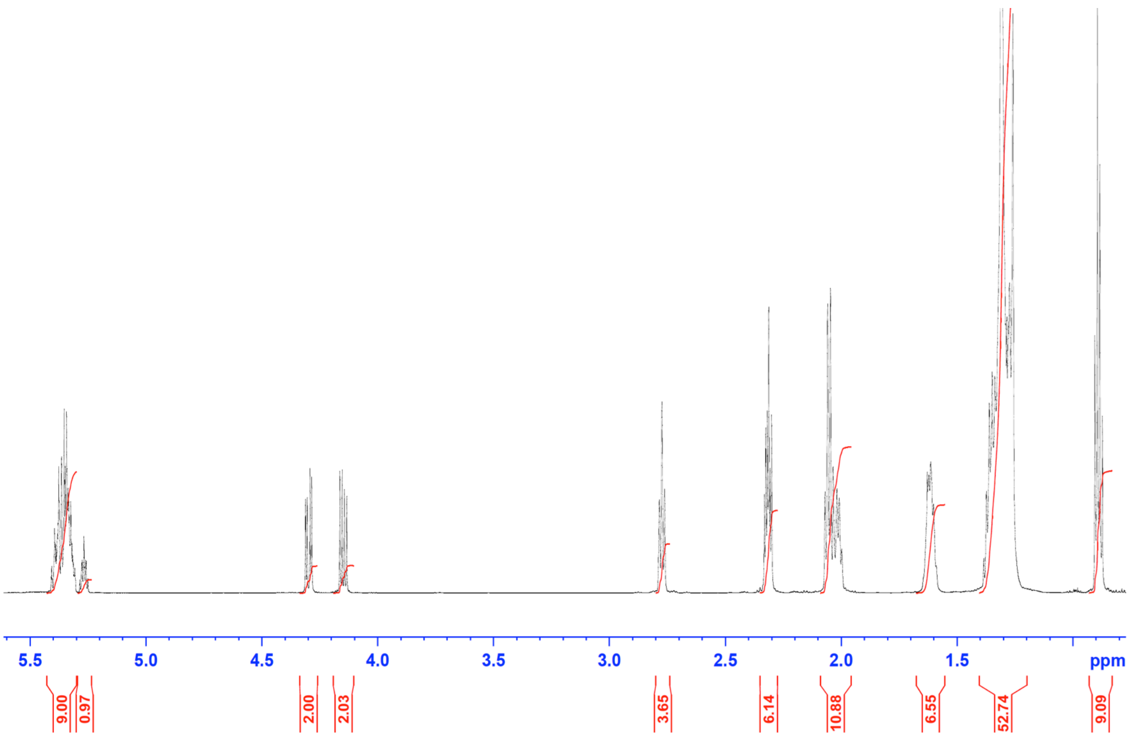
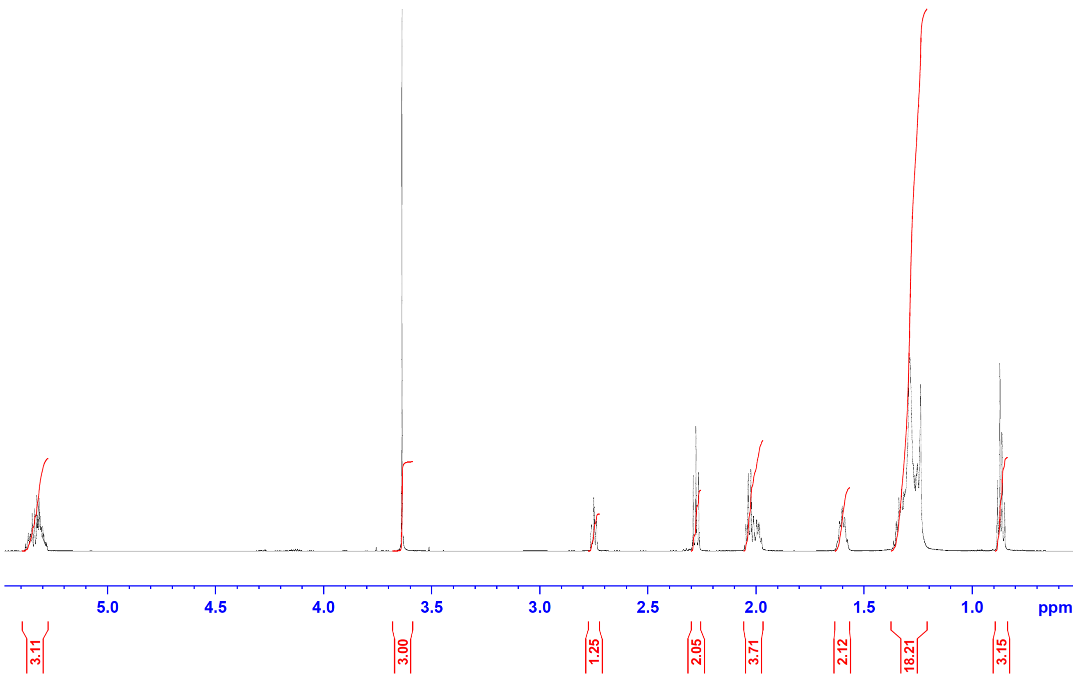
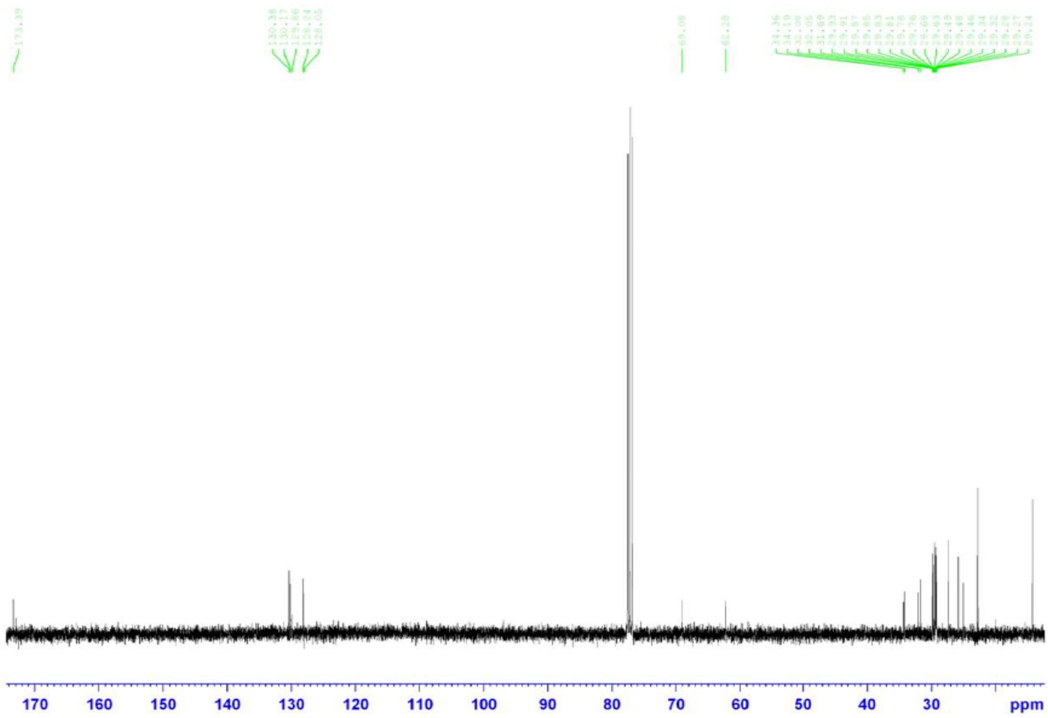
^{1}H and ^{13}C NMR



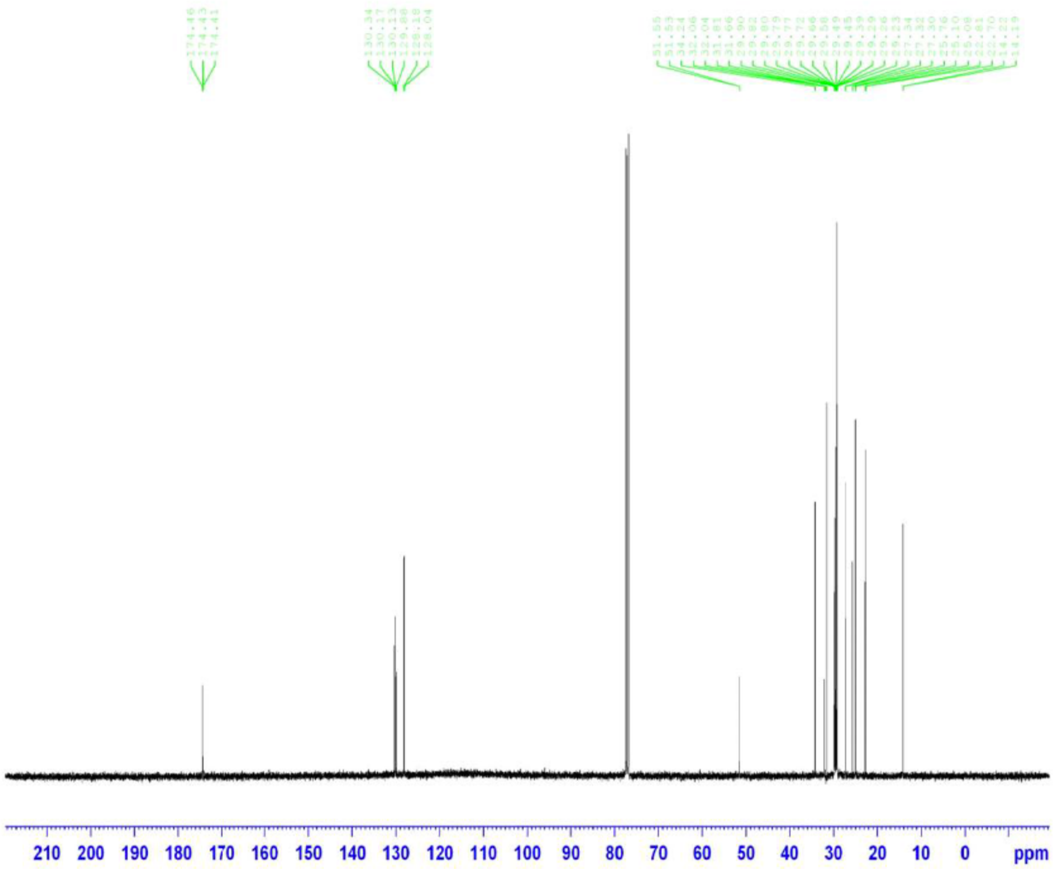
(A) ^{1}H NMR ($CDCl_3$) of pure sunflower oil as received, showing the glycerol peaks between 4.0 ppm – 4.5 ppm, and the quintet at 5.3 ppm.



(B) ^{1}H NMR ($CDCl_3$) of the VFD generated biodiesel, with no peaks present for glycerol peaks, and showing the installment of a singlet ($-CH_3$) at 3.655 ppm.

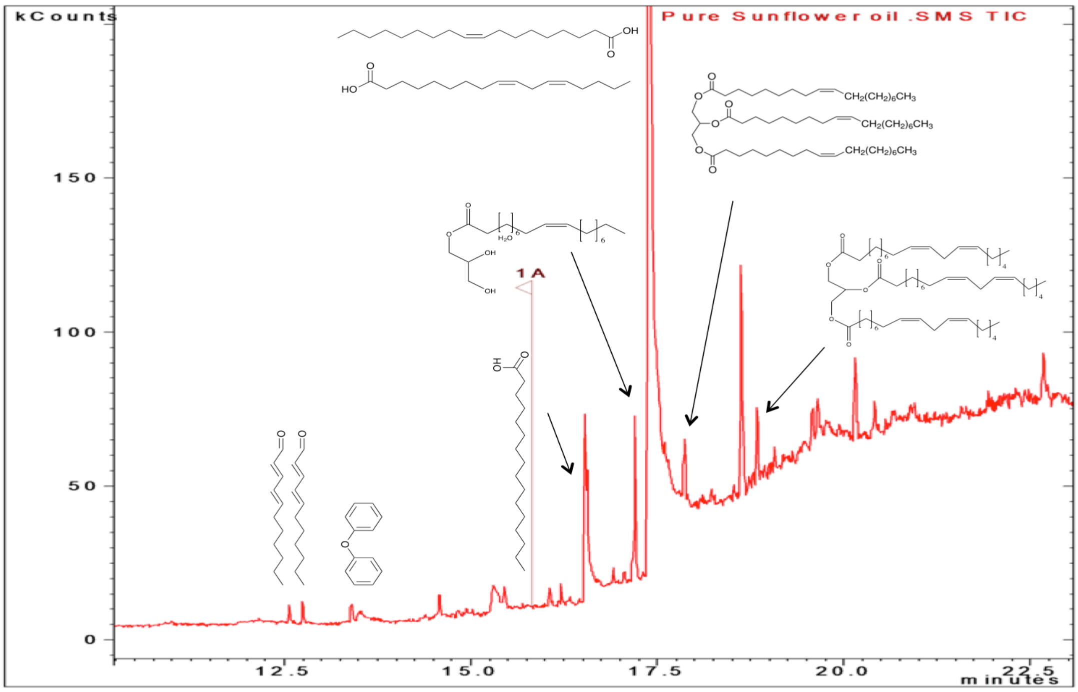


(C) ^{13}C NMR ($CDCl_3$) of as received sunflower oil showing the glycerol peaks at 69 and 62 ppm.

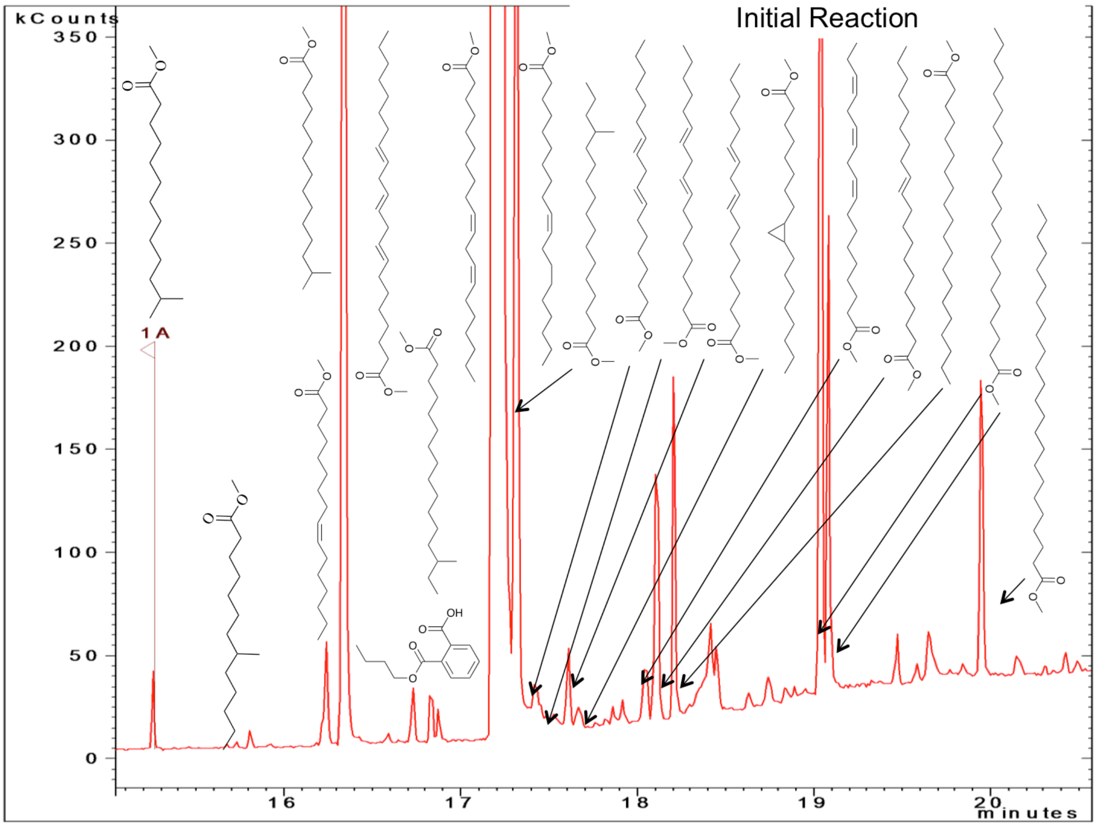


(D) ^{13}C NMR ($CDCl_3$) of the VFD produced biodiesel, with no peaks corresponding to glycerol at 69 and 62 ppm, and showing the installment of a methyl peak at 51 ppm. The carbonyl peak is at 174 ppm (from 173 ppm).

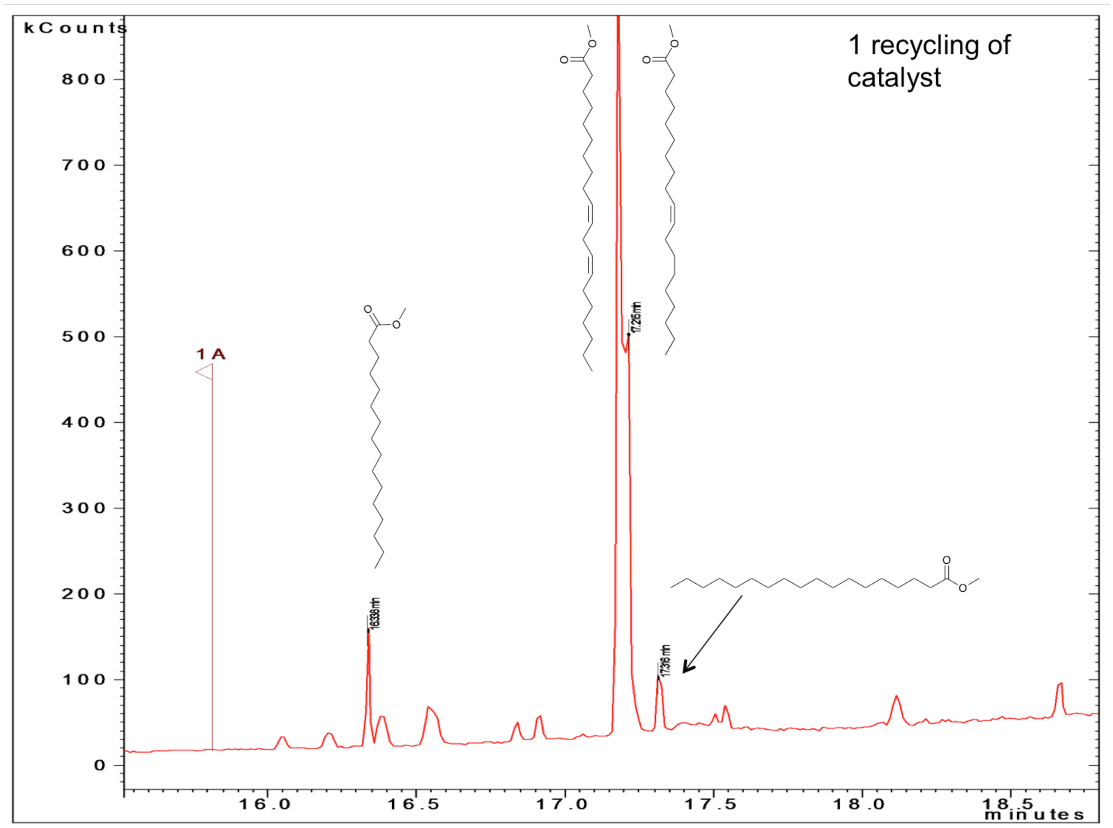
<u>GC-MS traces</u>



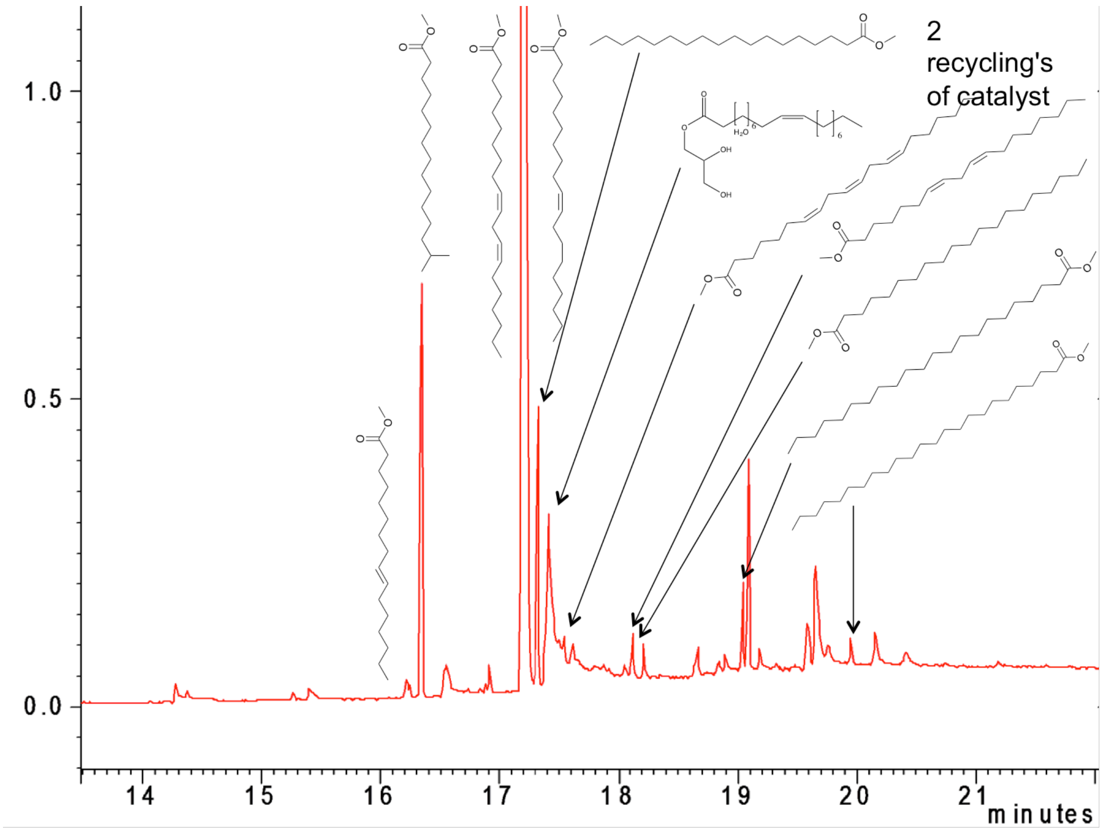
a) Pure sunflower oil



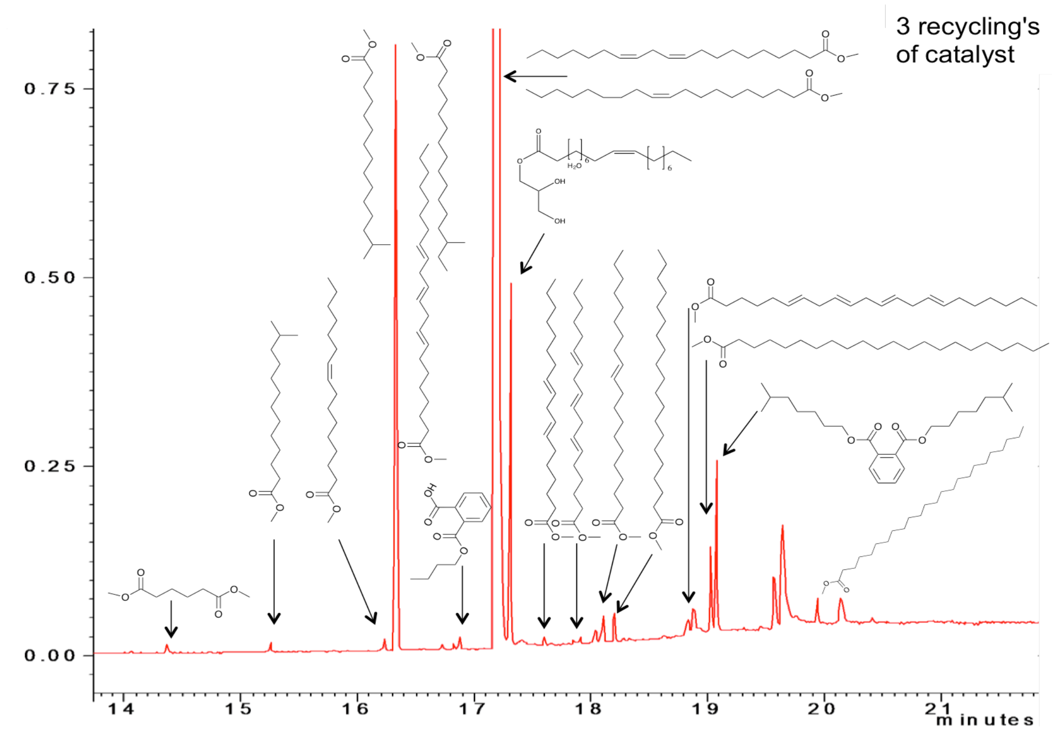
(B) GCMS of the biodiesel after the initial use of the catalyst solution (first cycle), showing a dominance of the esters.



(C) GCMS after the first recycling of the catalyst.

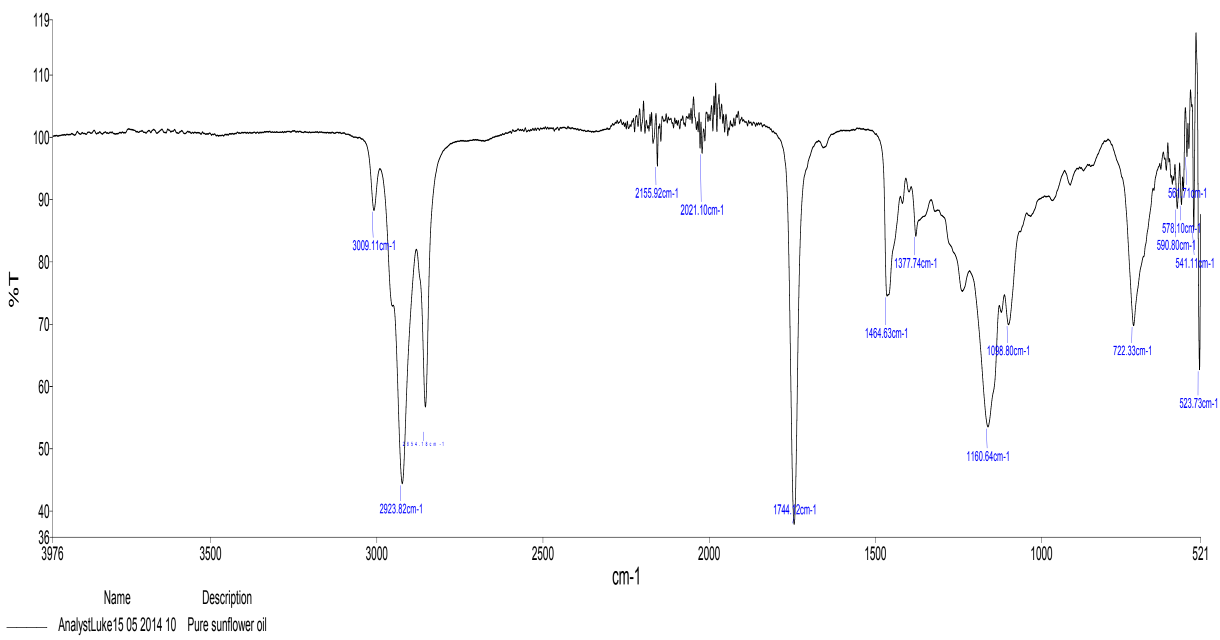


(D) GCMS after the second recycling of the catalyst, revealing the emergence of mono-glyceride, which accounts for the 5 % decrease in biodiesel purity.

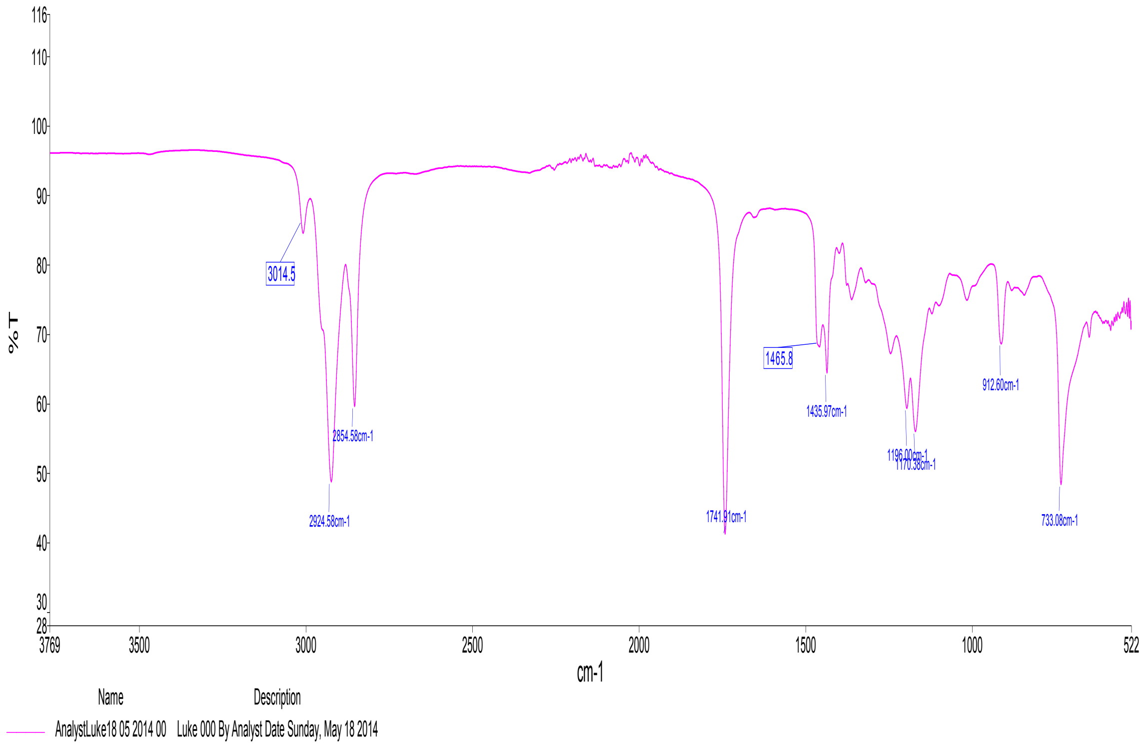


(E) GCMS after the third recycling of the catalyst, showing a larger MS peak for mono-glyceride, as the purity of the oil drops.

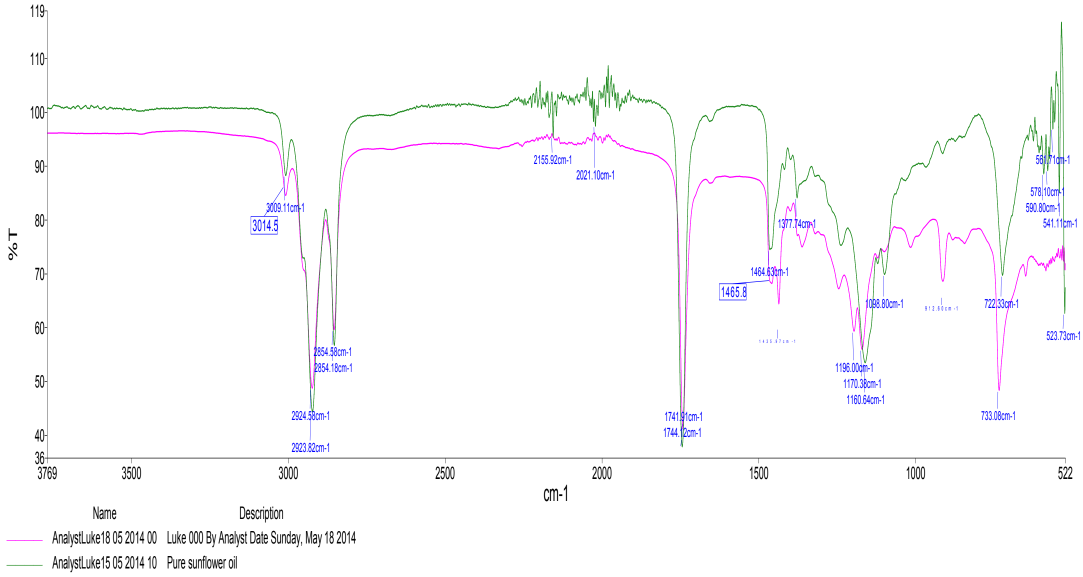
IR Analysis



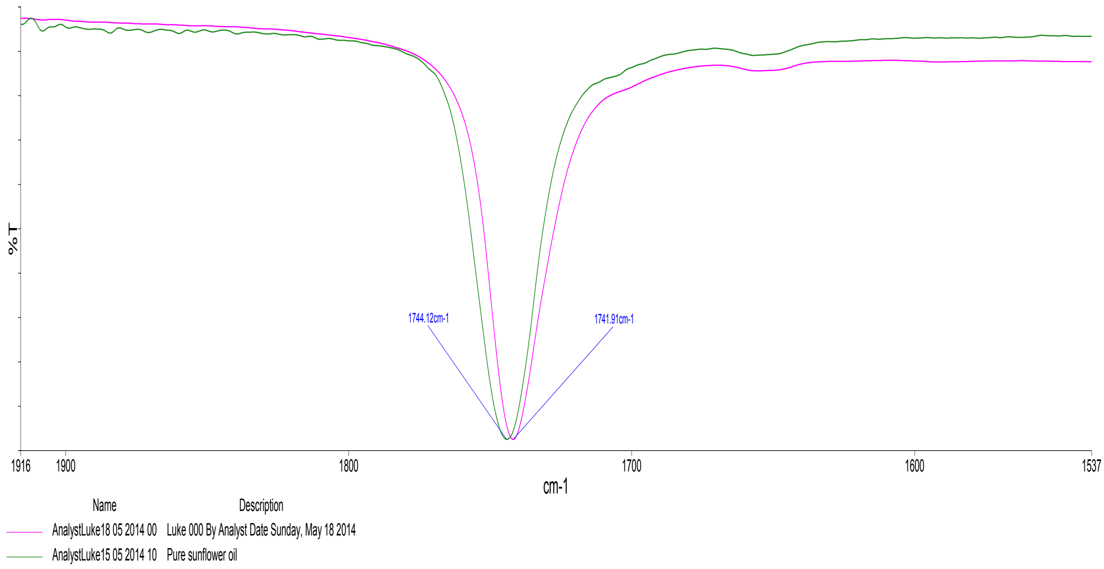
(a) FTIR of as received sunflower oil.



(b) FTIR of biodiesel, showing the expected change in the carbonyl peak shift.



(c) FTIR comparison between sunflower oil (green) and biodiesel (pink).



(d) Comparison between the carbonyl peak for pure sunflower oil (green) and biodiesel (pink).