Supporting Information

Green and Efficient Acquirement of Unsaturated Ether from Direct and Selective Hydrogenation Coupling Unsaturated Aldehyde with Alcohol by Bi-functional Al-Ni-P Heterogeneous Catalysts

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Figure S1. (a) GC conversion of the phenylpropanal from the reaction of 1 mmol of cinnamaldehyde and n-hexane at 120 ℃ under 0.1MPa H_2 pressure and GC-MS spectra and its fragmentation pattern of (b) Cinnamaldehyde (starting compound); (c)Dodecane (internal standard); (d) Phenylpropanal.

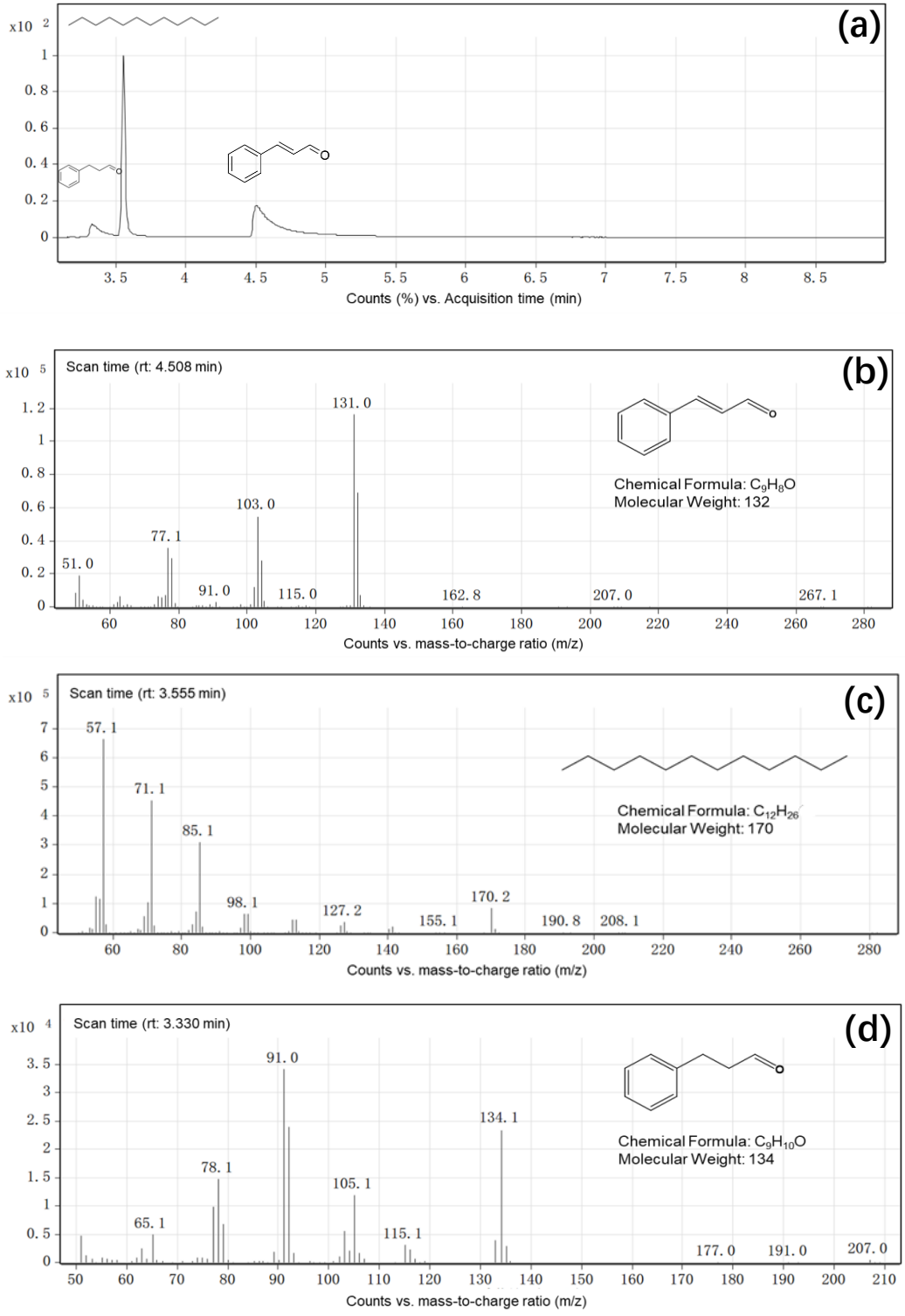


Figure S2. (a) GC conversion of the phenylpropanol from the reaction of 1 mmol of cinnamaldehyde and water at 120 ℃ under 2 MPa H_2 pressure; (b) GC-MS spectra and its fragmentation pattern of phenylpropanol.

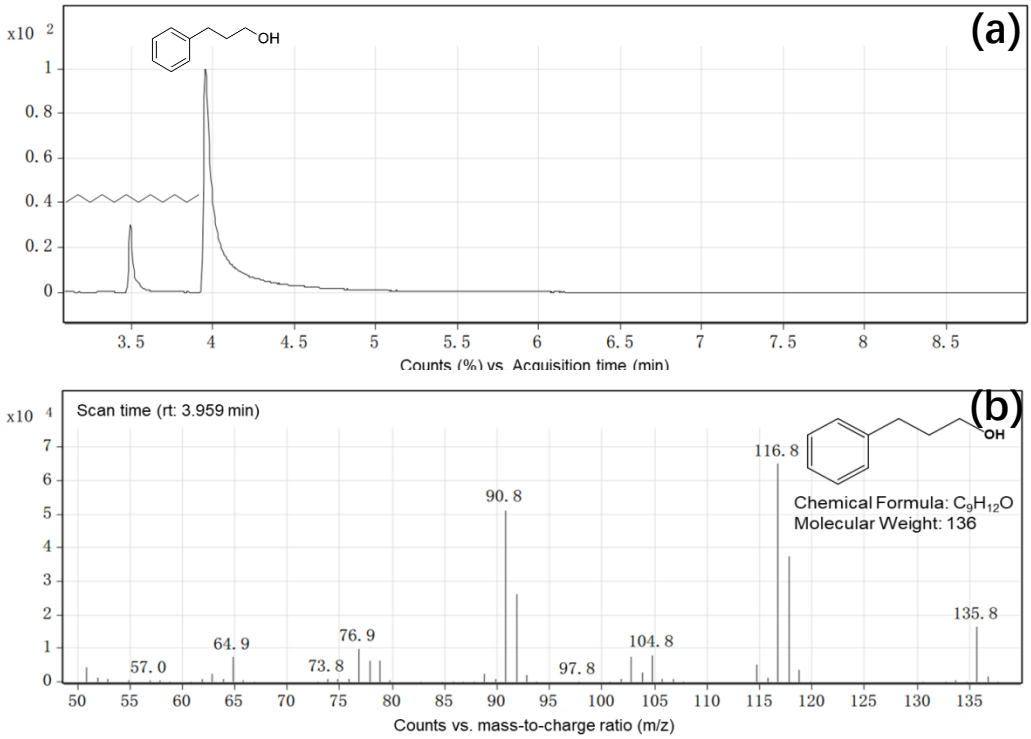


Figure S3. (a) GC conversion of the (4,4-dimethoxybutyl) benzene from the reaction of 1 mmol of cinnamaldehyde and methanol at 120 ℃ under 0.1 MPa H_2 pressure; (b) GC-MS spectra and its fragmentation pattern of (4,4-dimethoxybutyl) benzene.

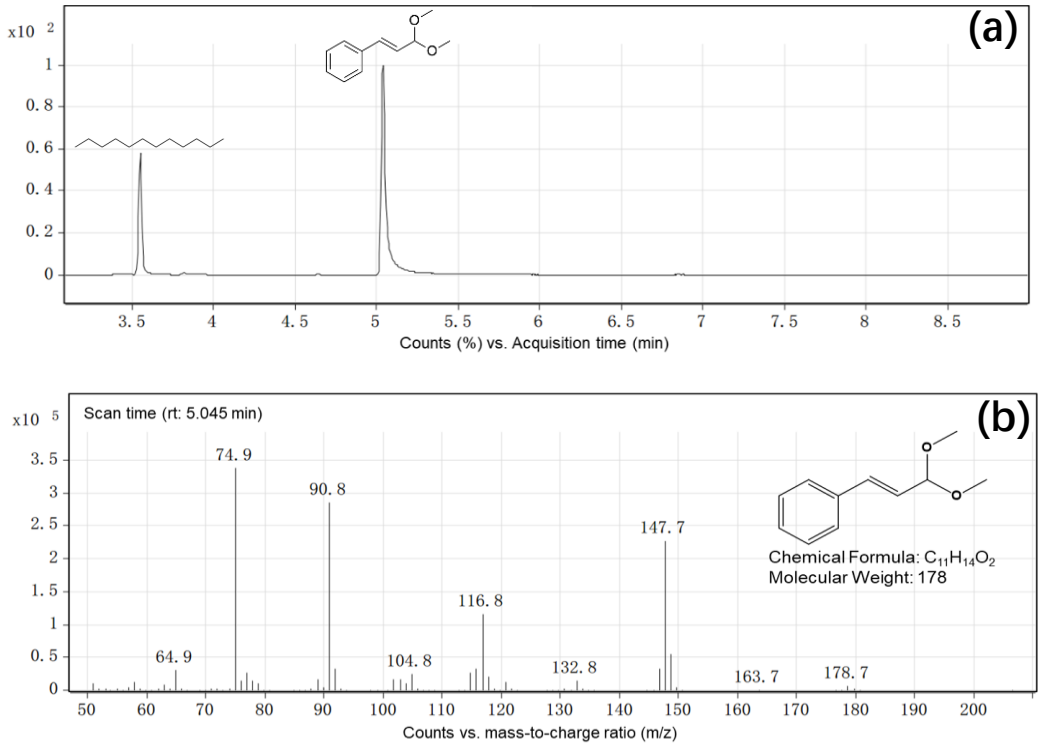


Figure S4. (a) GC conversion of the unsaturated ether from the reaction of 1 mmol of cinnamaldehyde and ethanol at 120 ℃ under 0.1 MPa H_2 pressure; (b) GC-MS spectra and its fragmentation pattern of unsaturated ether.

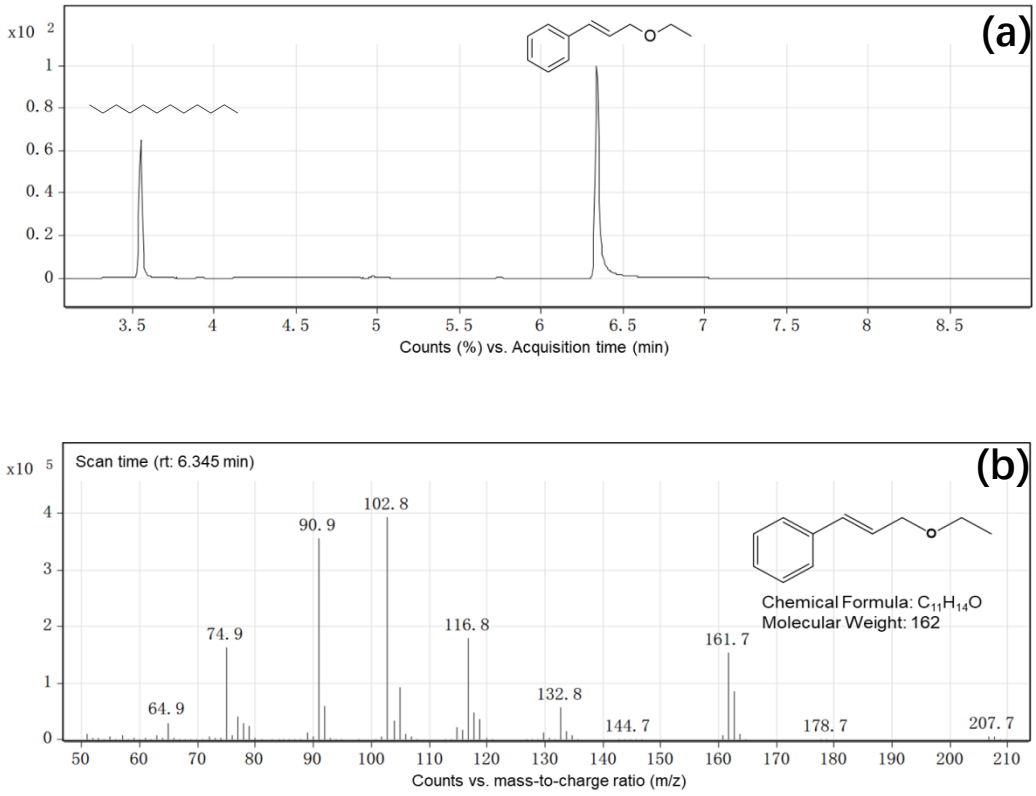


Figure S5. (a) GC conversion of the unsaturated ether from the reaction of 1 mmol of cinnamaldehyde and n-propanol at 120 ℃ under 0.1 MPa H_2 pressure; (b) GC-MS spectra and its fragmentation pattern of unsaturated ether.

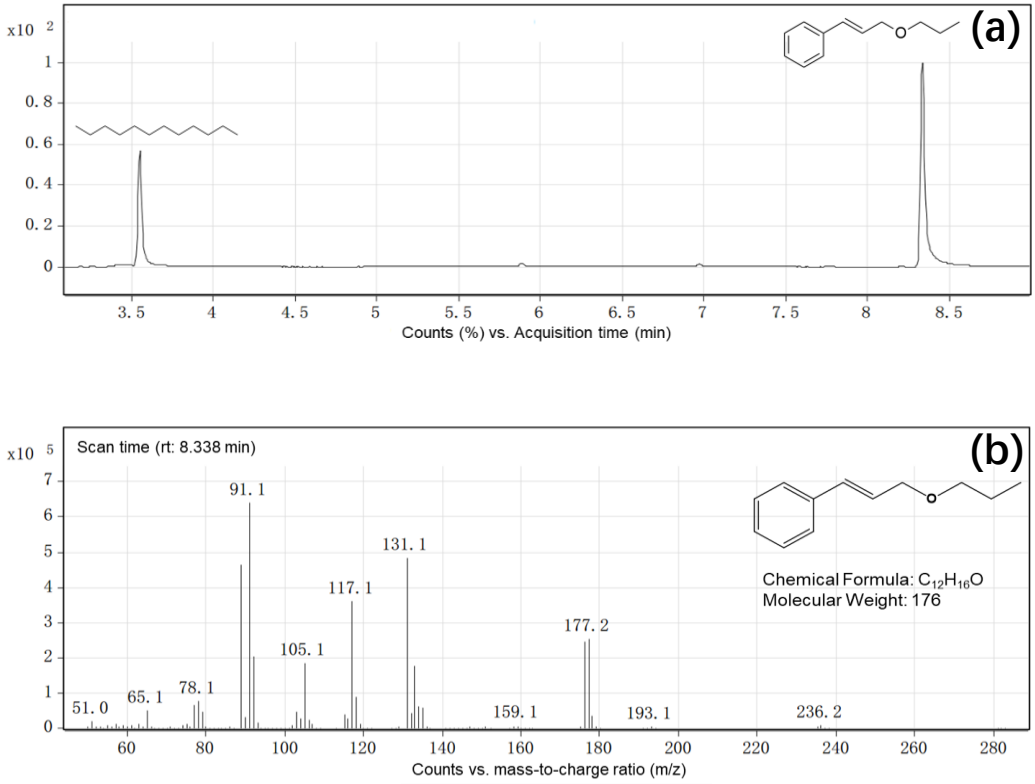
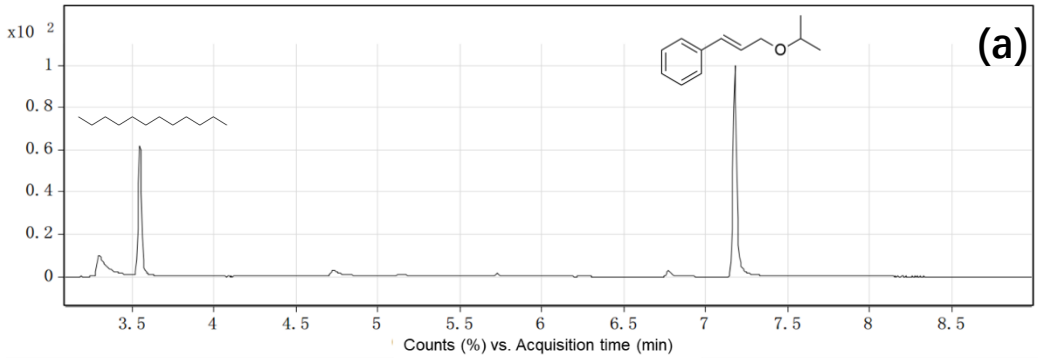


Figure S6. (a) GC conversion of the unsaturated ether from the reaction of 1 mmol of cinnamaldehyde and isopropyl alcohol at 120 ℃ under 0.1 MPa H_2 pressure; (b) GC-MS spectra and its fragmentation pattern of unsaturated ether.



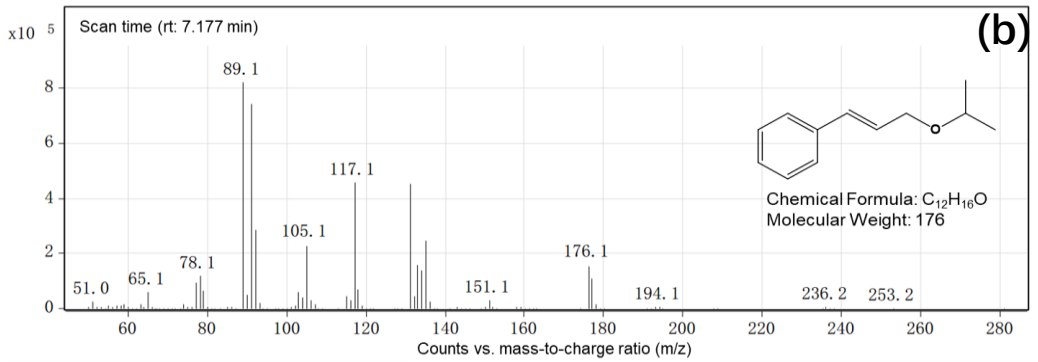


Figure S7. (a) GC conversion of the unsaturated ether from the reaction of 1 mmol of cinnamaldehyde and n-butanol at 120 ℃ under 0.1 MPa H_2 pressure; (b) GC-MS spectra and its fragmentation pattern of unsaturated ether.

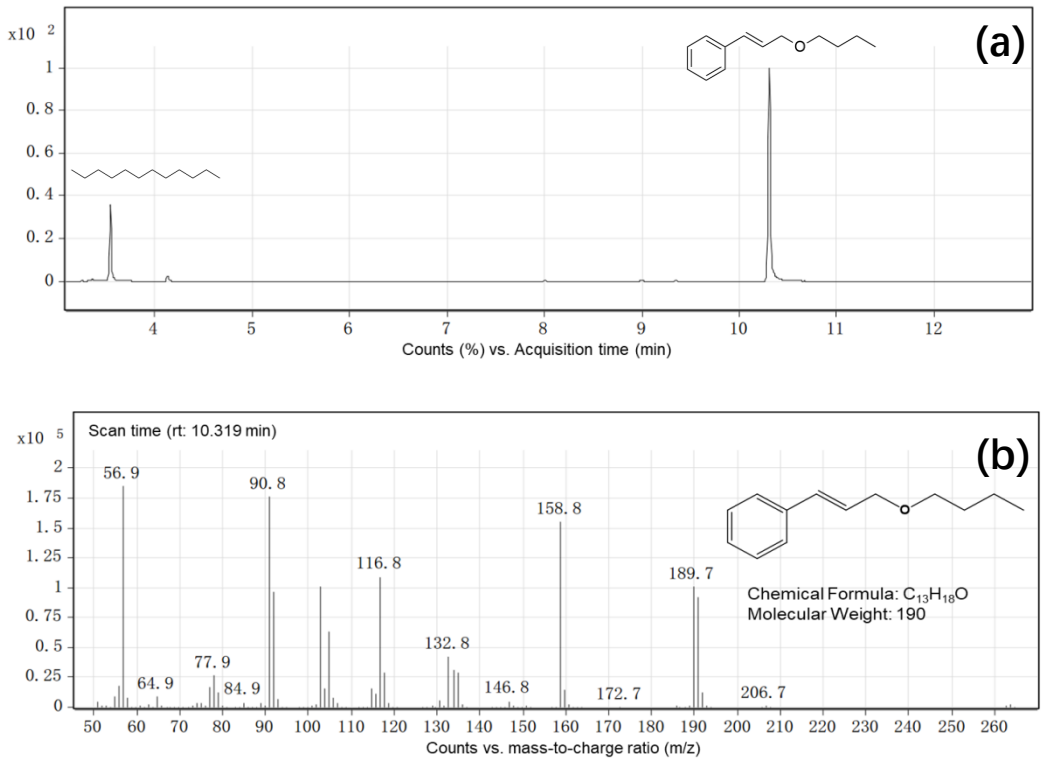


Figure S8. (a) GC conversion of the unsaturated ether from the reaction of 1 mmol of cinnamaldehyde and sec-butanol at 120 ℃ under 0.1 MPa H_2 pressure; (b) GC-MS spectra and its fragmentation pattern of unsaturated ether.

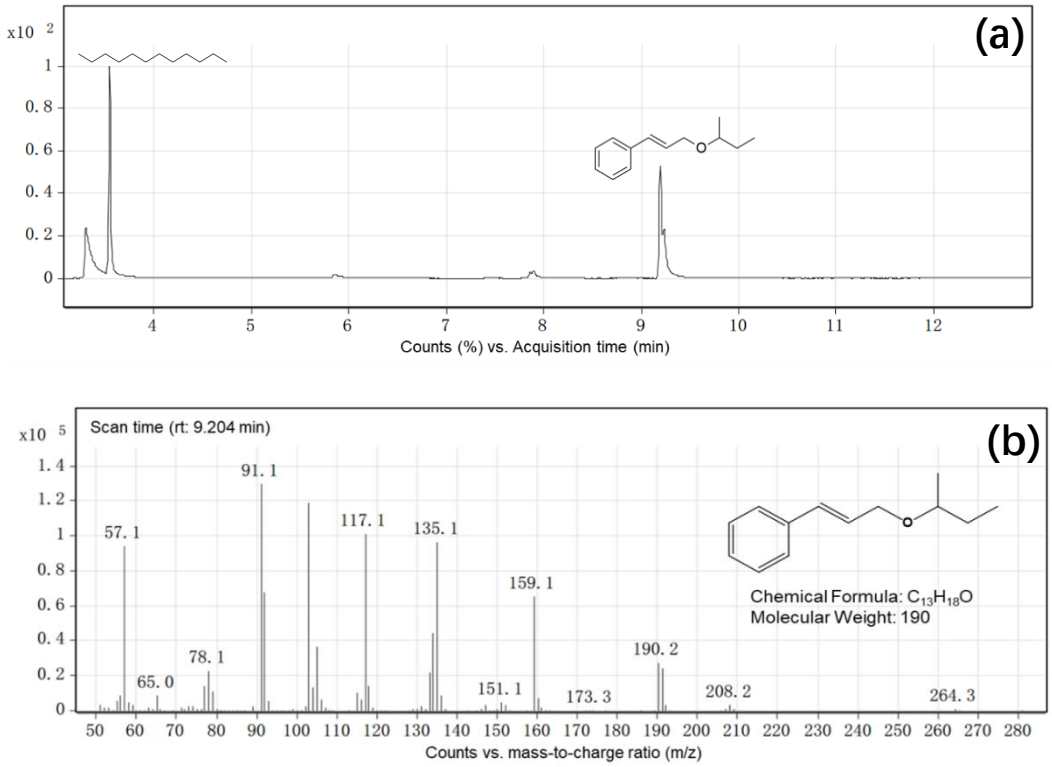


Figure S9. (a) GC conversion of the unsaturated ether from the reaction of 1 mmol of cinnamaldehyde and n-pentanol at 120 ℃ under 0.1 MPa H_2 pressure; (b) GC-MS spectra and its fragmentation pattern of unsaturated ether.

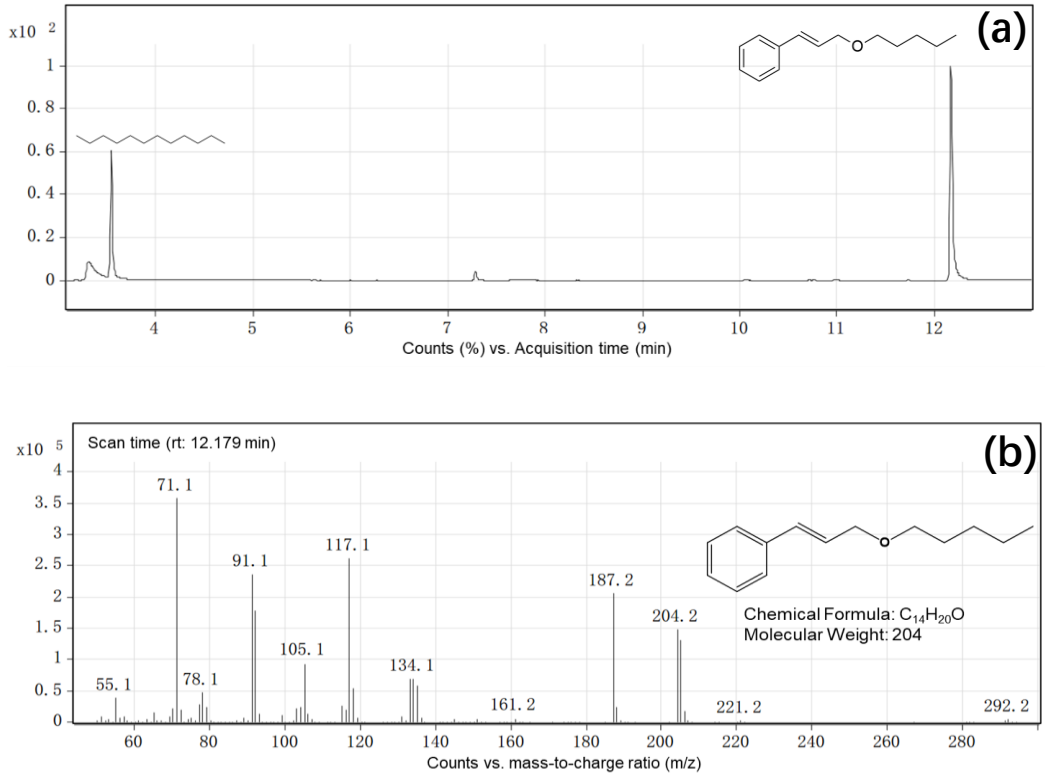


Figure S10. (a) GC conversion of the unsaturated ether from the reaction of 1 mmol of cinnamaldehyde and 2-pentanol at 120 ℃ under 0.1 MPa H_2 pressure; (b) GC-MS spectra and its fragmentation pattern of unsaturated ether.

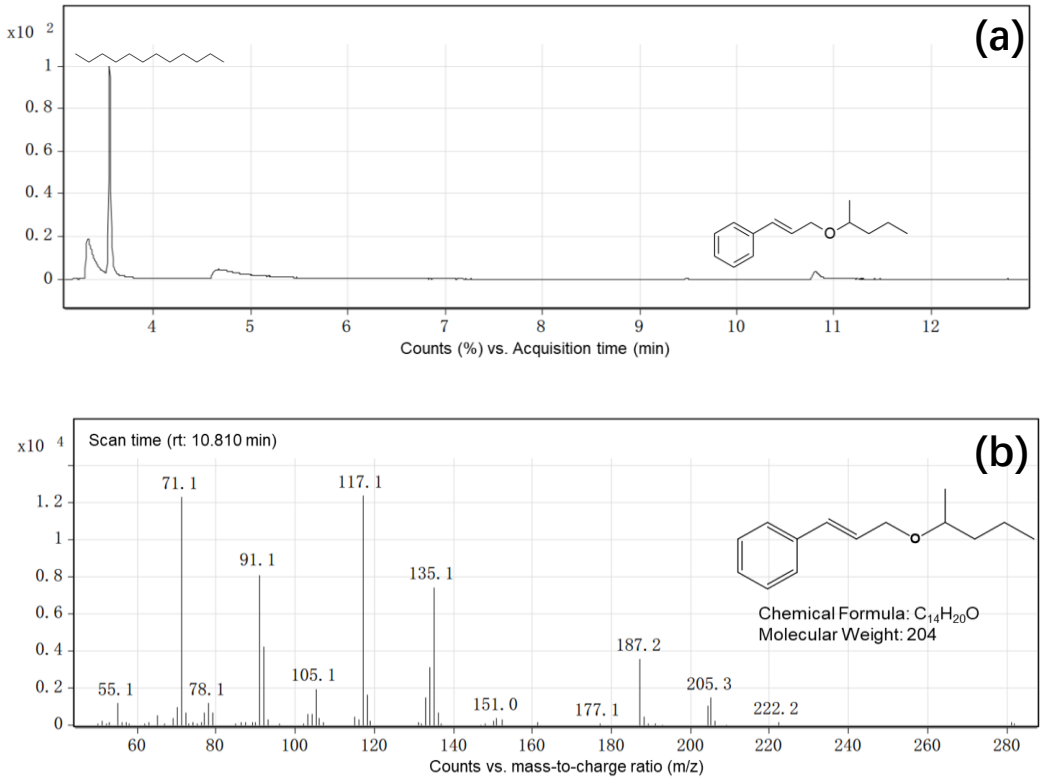


Figure S11. (a) GC conversion of the unsaturated ether from the reaction of 1 mmol of citral and methanol at 120 ℃ under 0.1 MPa H_2 pressure; (b) GC-MS spectra and its fragmentation pattern of unsaturated ether.

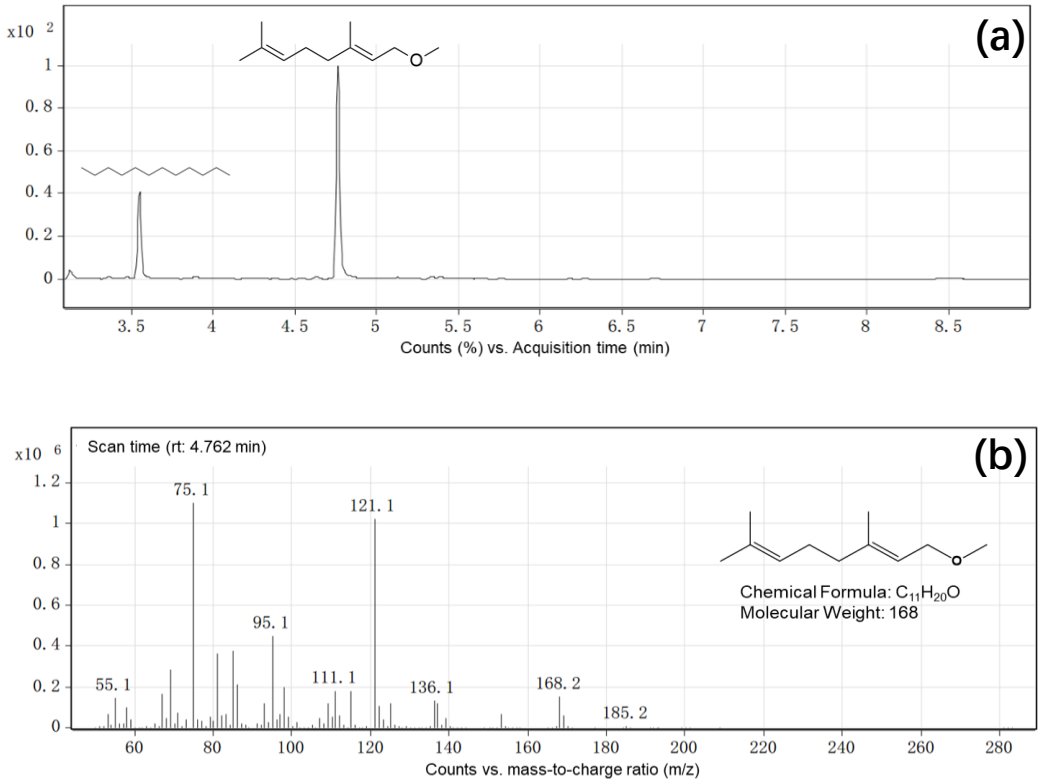


Figure S12. (a) GC conversion of the unsaturated ether from the reaction of 1 mmol of citral and ethanol at 120 ℃ under 0.1 MPa H_2 pressure; (b) GC-MS spectra and its fragmentation pattern of unsaturated ether.

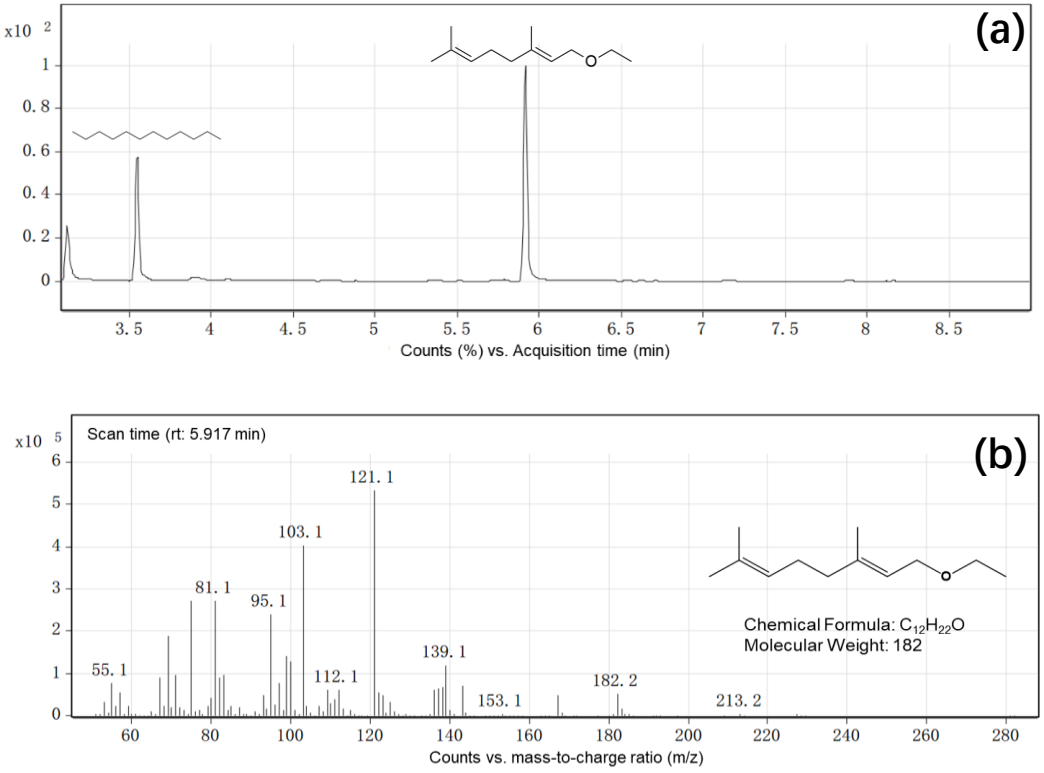


Figure S13. (a) GC conversion of the unsaturated ether from the reaction of 1 mmol of citral and n-propanol at 120 ℃ under 0.1 MPa H_2 pressure; (b) GC-MS spectra and its fragmentation pattern of unsaturated ether.

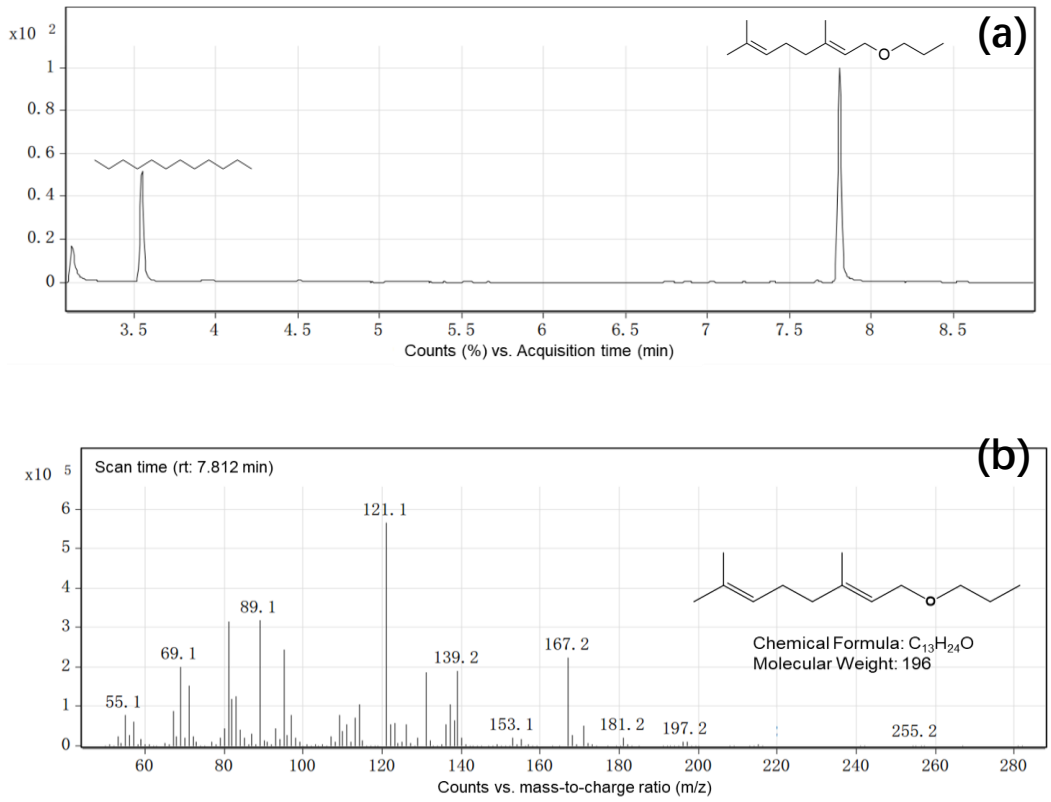


Figure S14. (a) GC conversion of the unsaturated ether from the reaction of 1 mmol of citral and isopropyl alcohol at 120 ℃ under 0.1 MPa H_2 pressure; (b) GC-MS spectra and its fragmentation pattern of unsaturated ether.

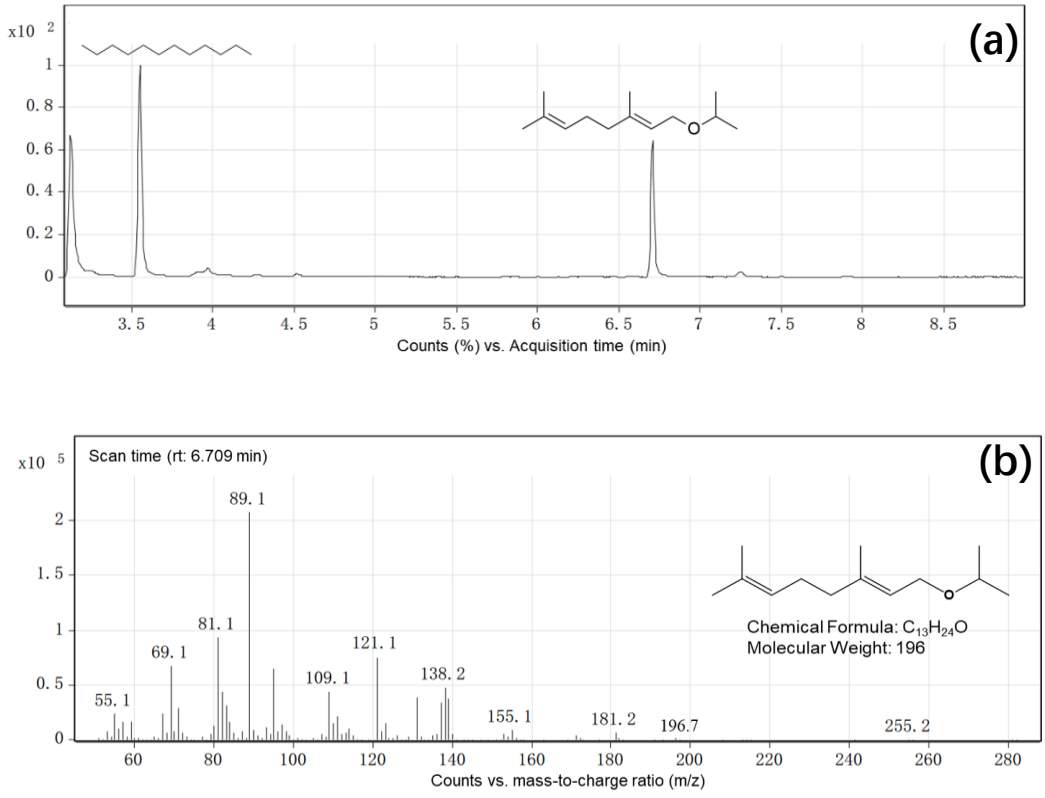


Figure S15. (a) GC conversion of the unsaturated ether from the reaction of 1 mmol of citral and n-butanol at 120 ℃ under 0.1 MPa H_2 pressure; (b) GC-MS spectra and its fragmentation pattern of unsaturated ether.

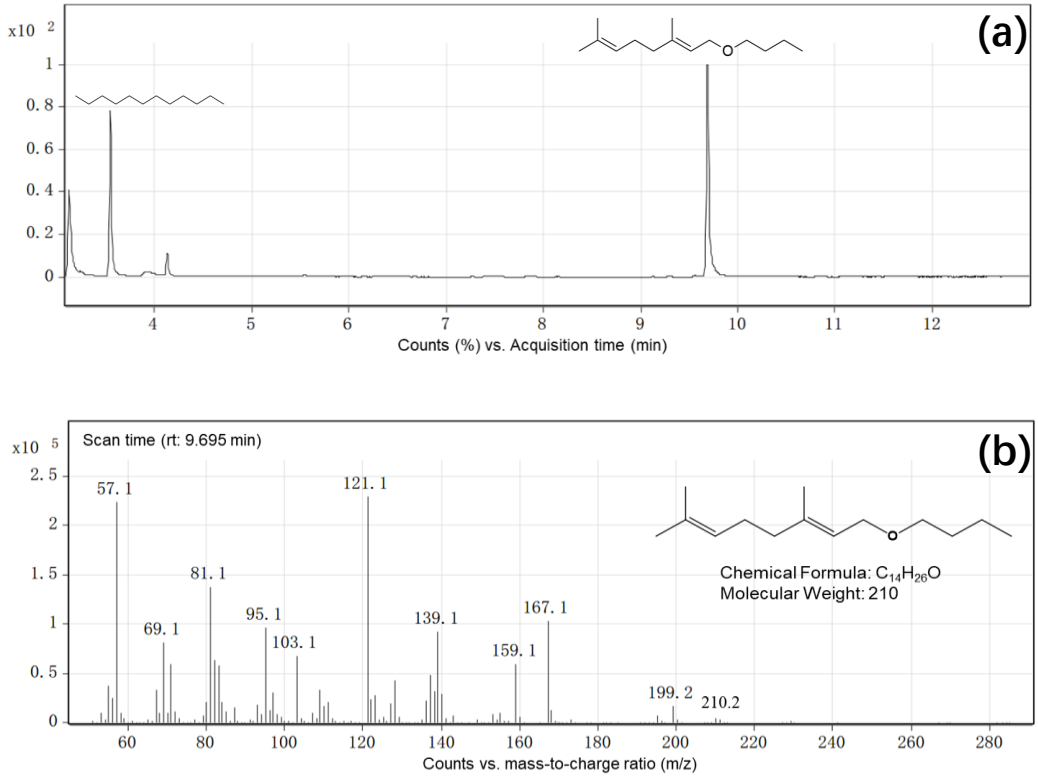


Figure S16. (a) GC conversion of the unsaturated ether from the reaction of 1 mmol of citral and sec-butanol at 120 ℃ under 0.1 MPa H_2 pressure; (b) GC-MS spectra and its fragmentation pattern of unsaturated ether.

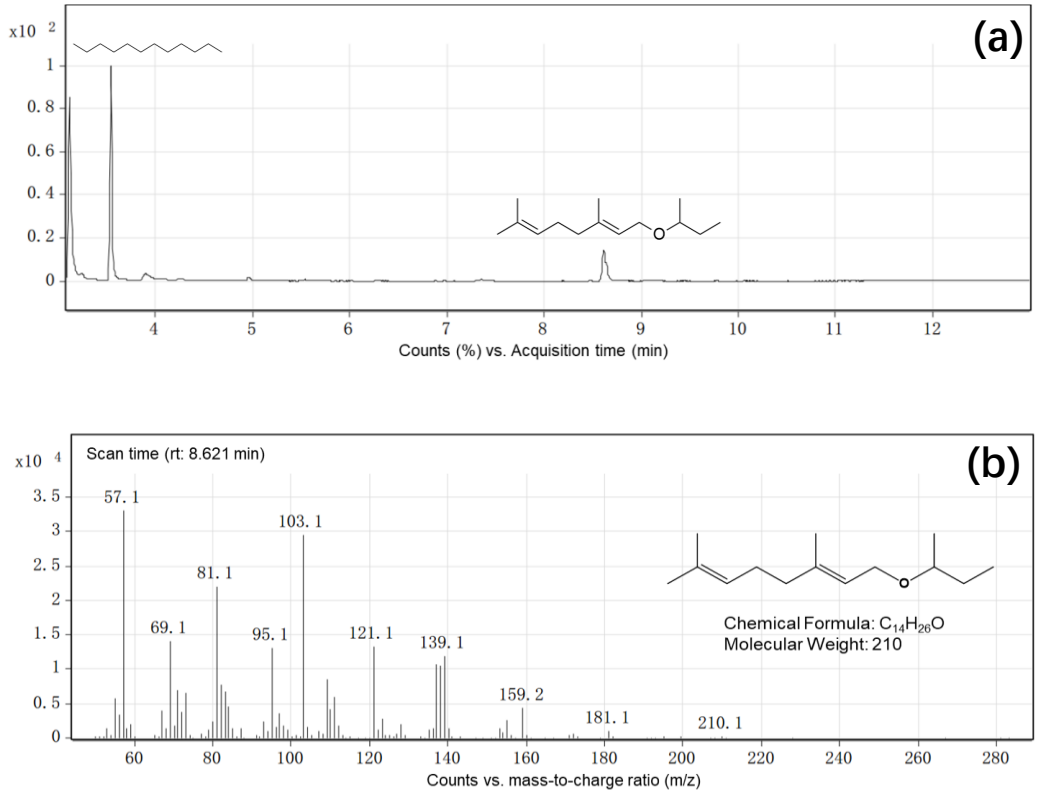


Figure S17. (a) GC conversion of the unsaturated ether from the reaction of 1 mmol of citral and n-pentanol at 120 ℃ under 0.1 MPa H_2 pressure; (b) GC-MS spectra and its fragmentation pattern of unsaturated ether.

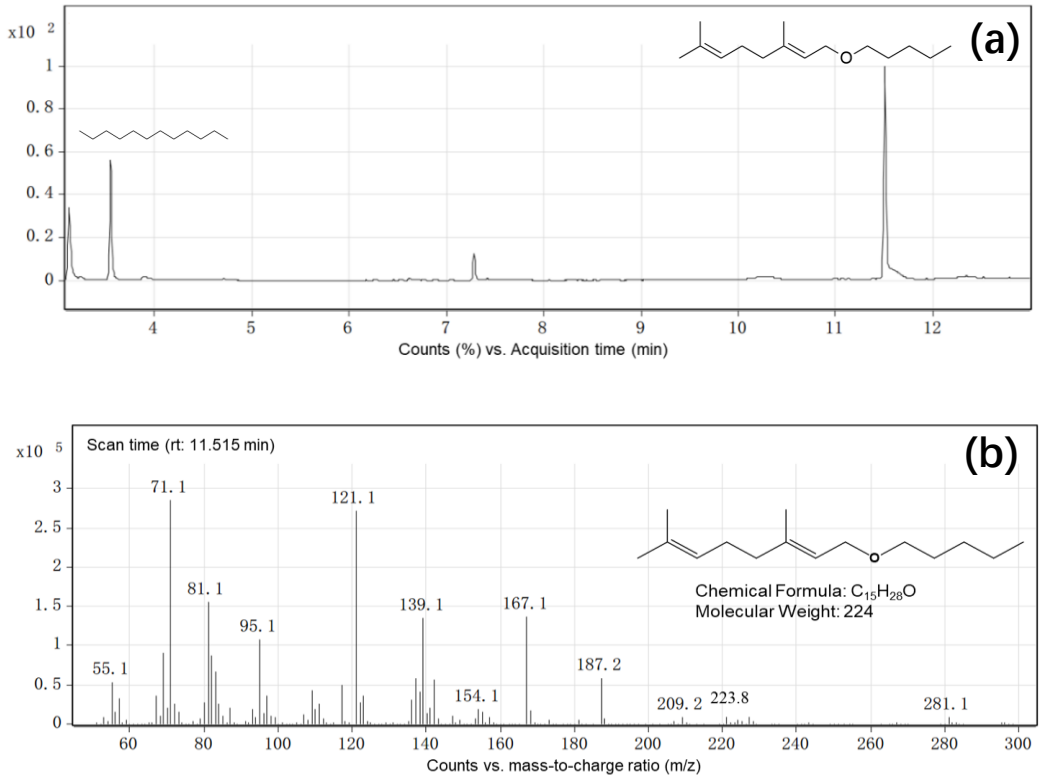


Figure S18. (a) GC conversion of the unsaturated ether from the reaction of 1 mmol of citral and 2-pentanol at 120 ℃ under 0.1 MPa H_2 pressure; (b) GC-MS spectra and its fragmentation pattern of unsaturated ether.