Support information

Charge Tags for Most Comprehensive ESI-MS Monitoring of Morita−Baylis−Hillman (MBH)/aza-MBH Reactions: Solid Mechanistic View and the Dualistic Role of the Charge Tagged Acrylate

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1. Materials and Methods: All reactions were carried out on normal atmosphere, in round bottom flask fitted with magnetic stirring, unless otherwise noted. Commercially available reagents and solvents were used without further purification.

Organic solutions were concentrated under reduced pressure. Reactions were monitored by thin-layer chromatography (TLC). Chromatograms were visualized by fluorescence quenching with UV light at 254 nm or by staining using phosphomolybdic acid or vanillin solutions. Flash column chromatography was performed using silica gel (particle size 35-70μm). ^{1}H and ^{13}C NMR spectra were recorded on a 250 MHz spectrometer. Chemical shifts (δ) are given in parts per million, referenced to the residual peak of $CDCl_3$, MeOD and $(CD_3)_2SO$, δ = 7.26; 3.35; 4.78 and 2.54 respectively (^{1}H NMR) and δ = 77.0; 49.0 respectively (^{13}C NMR) as internal references.

2. NMR Spectra

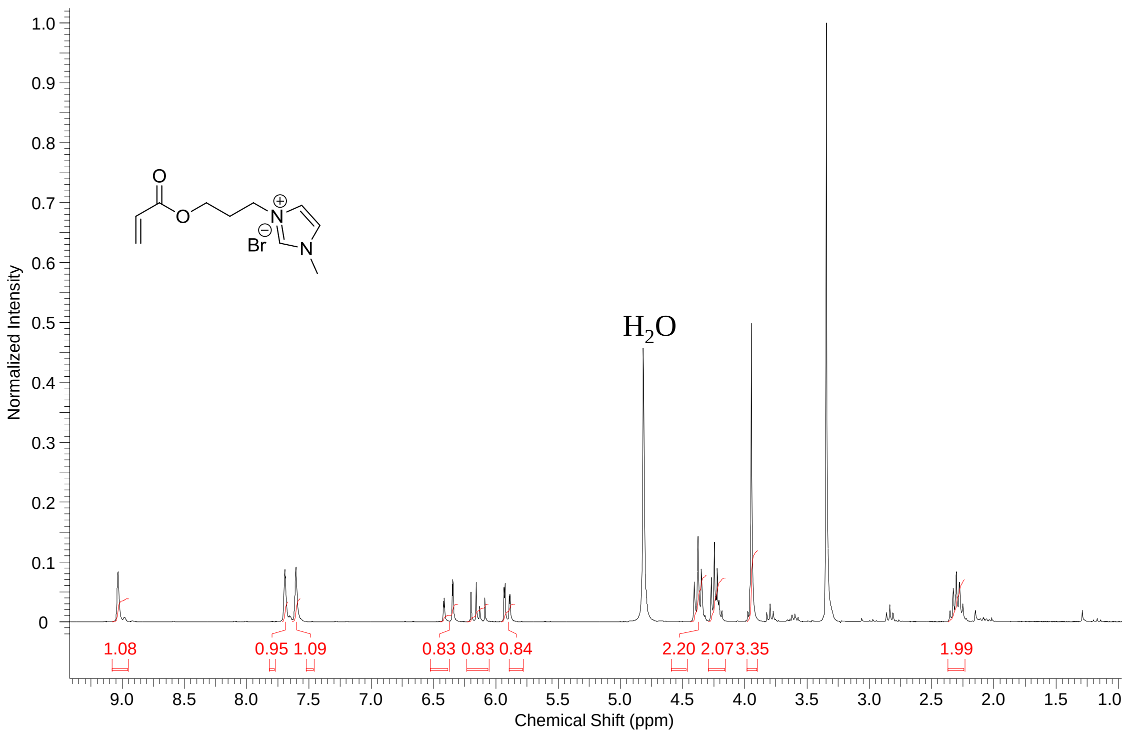


Figure S1. ^{1}H NMR (250 MHz, CD_3OD) spectrum of charge tagged acrylate **5a**

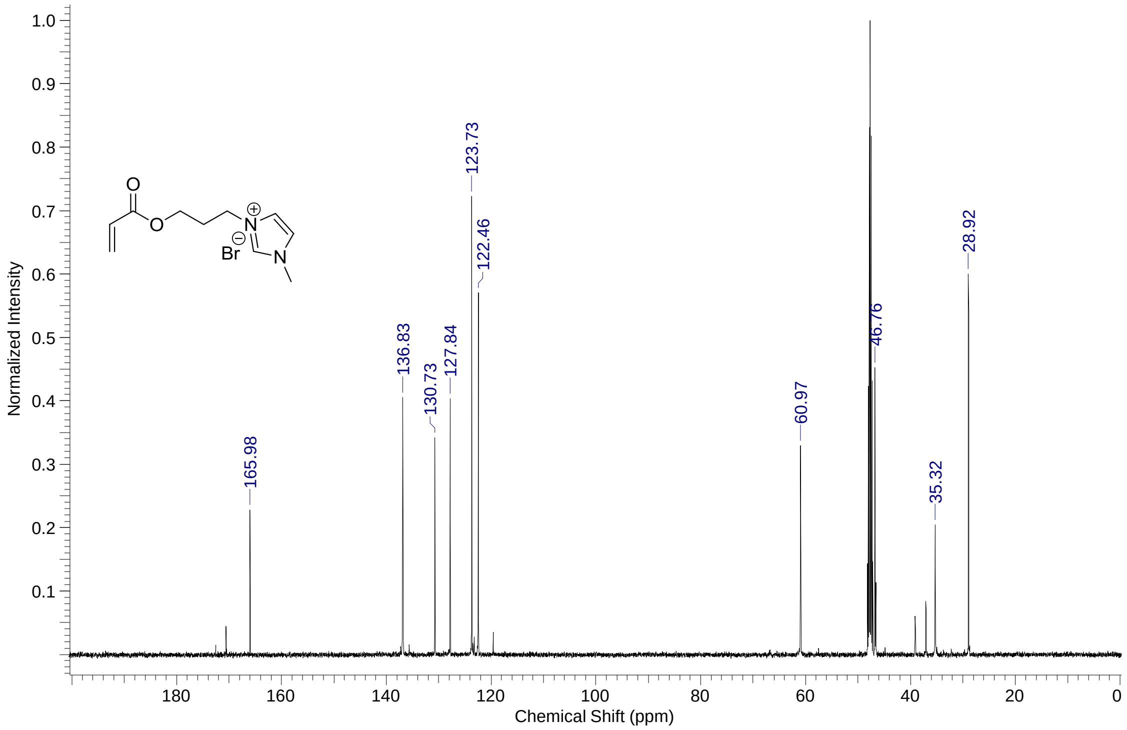


Figure S2. ^{13}C NMR (62.5 MHz, CD_3OD) spectrum of charge tagged acrylate **5a**

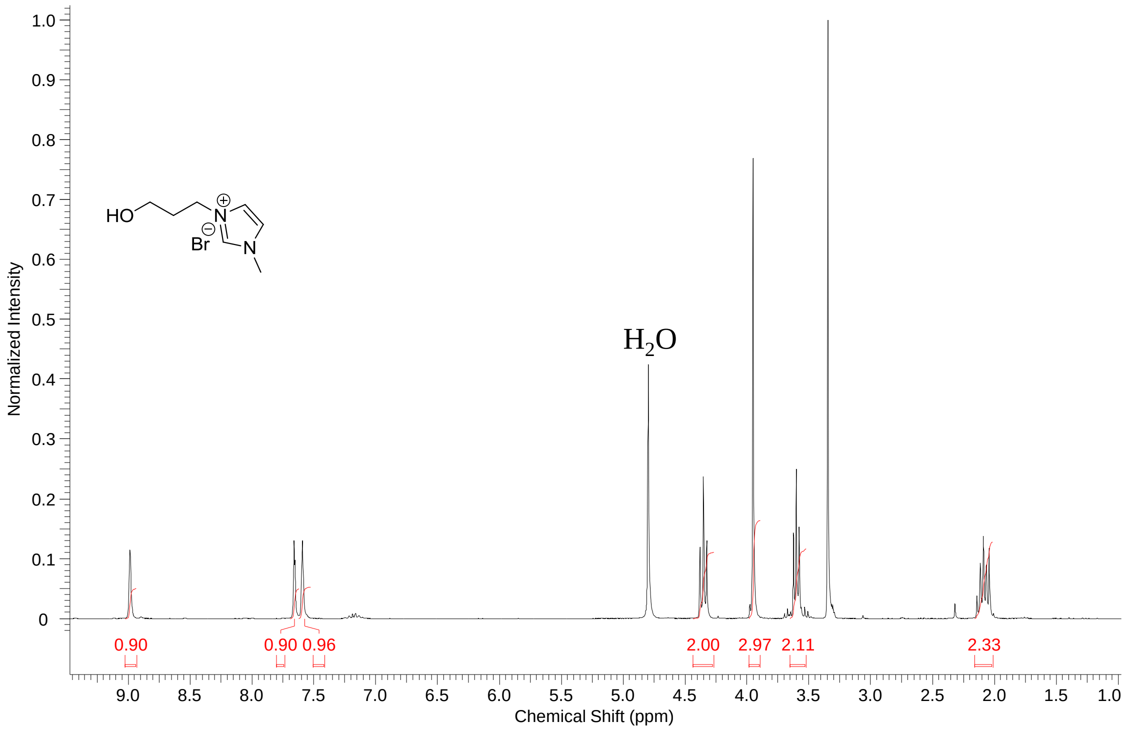


Figure S3. [1]H NMR (250 MHz, CD_3OD) spectrum of 1-(3-Hydroxypropyl)-3-methylimidazolium bromide

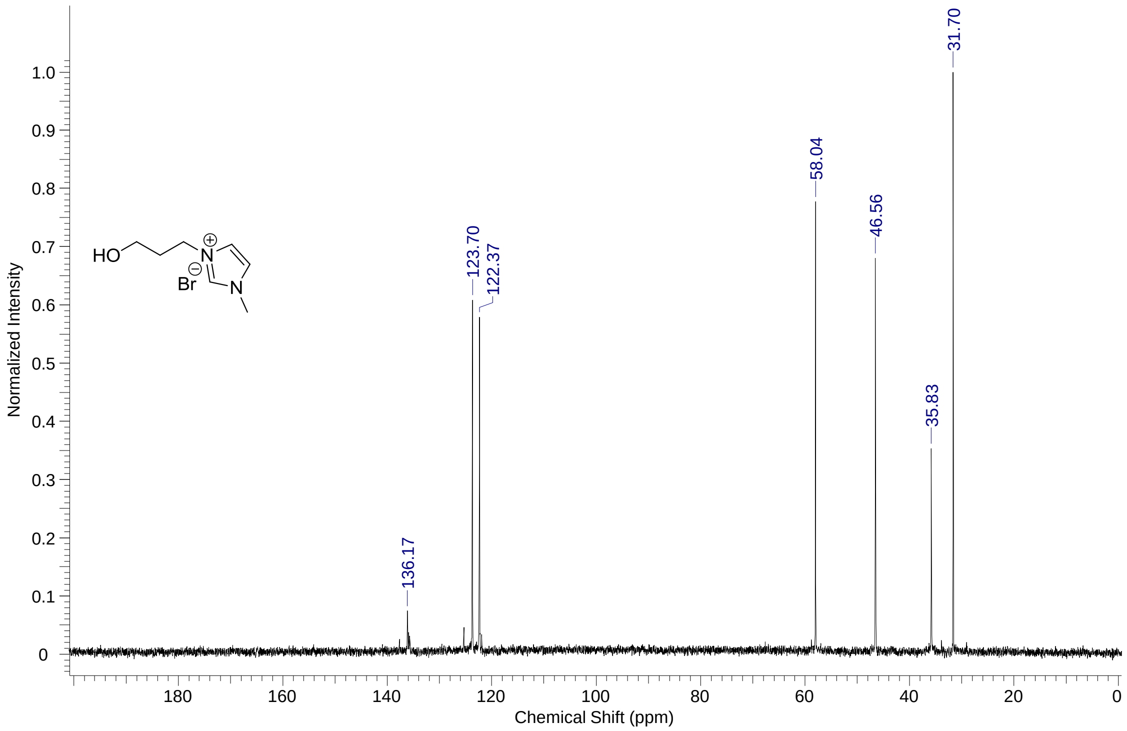


Figure S4. [13]C NMR (62.5 MHz, D_2O) spectrum of 1-(3-Hydroxypropyl)-3 methylimidazolium bromide

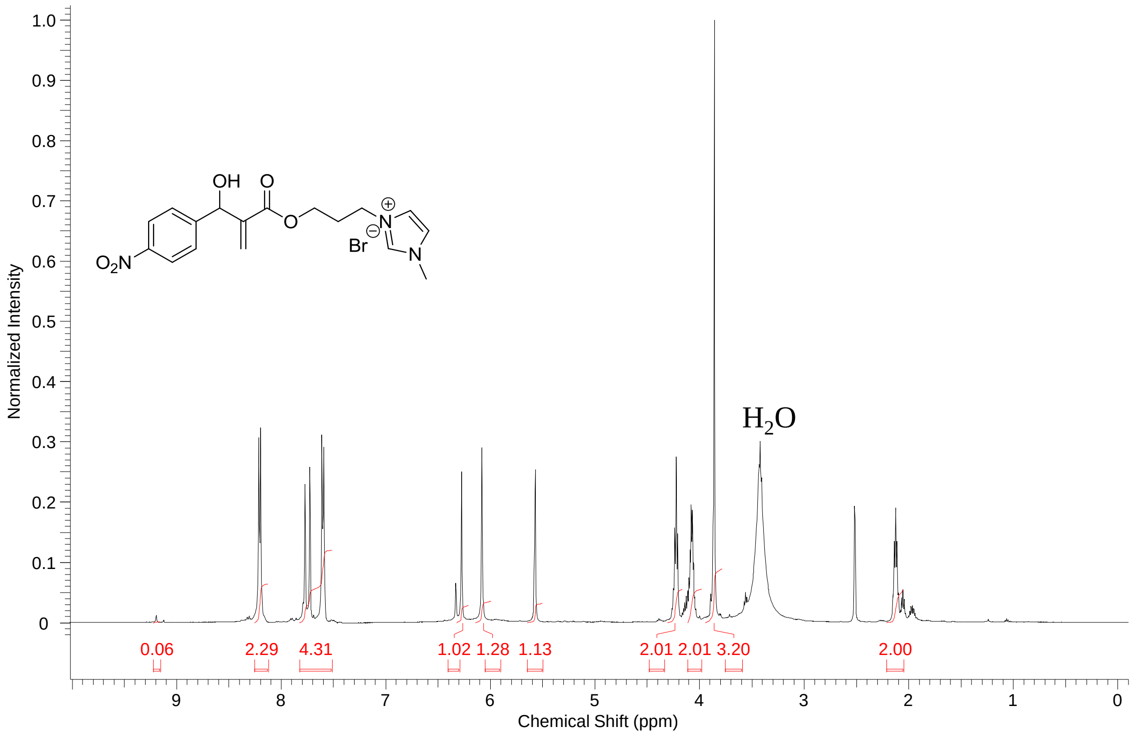


Figure S5. [1]H NMR (250MHz, CD_3OD) spectrum of charge tagged MBH adduct **10a (**Low intensity of methylimidazolium hydrogen due its acidity forming a carbine).

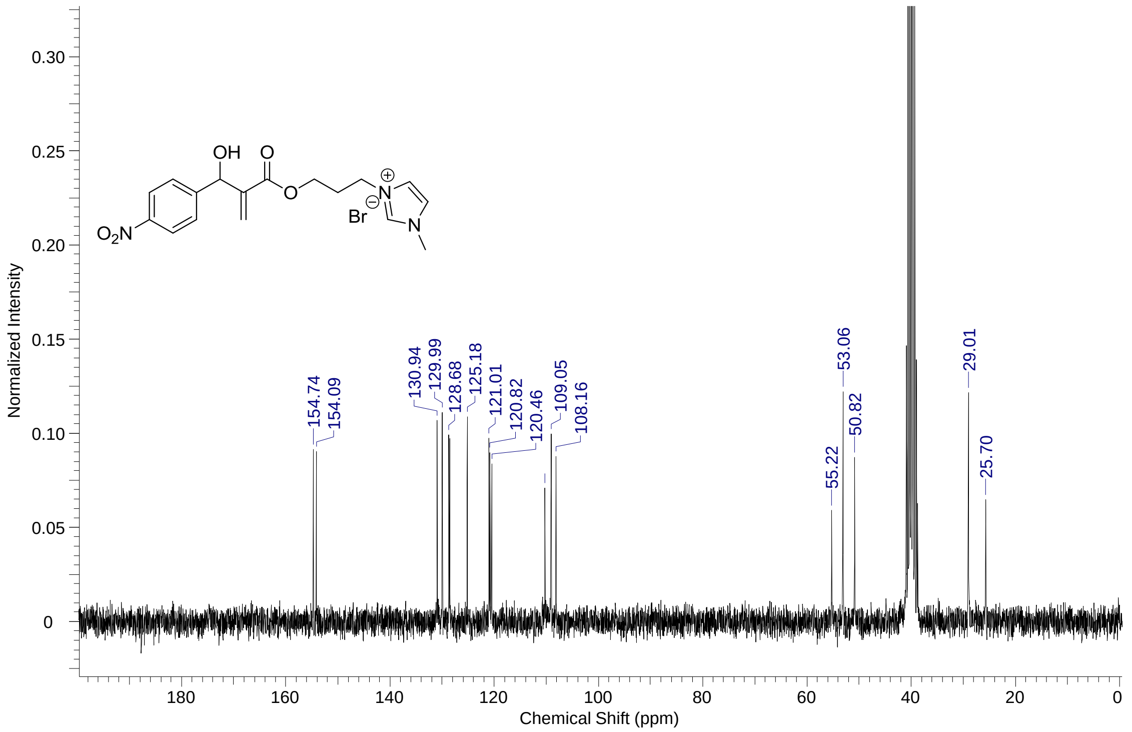


Figure S6. [13]C NMR (62.5MHz, CD_3OD) spectrum of charge tagged MBH adduct **10a**.

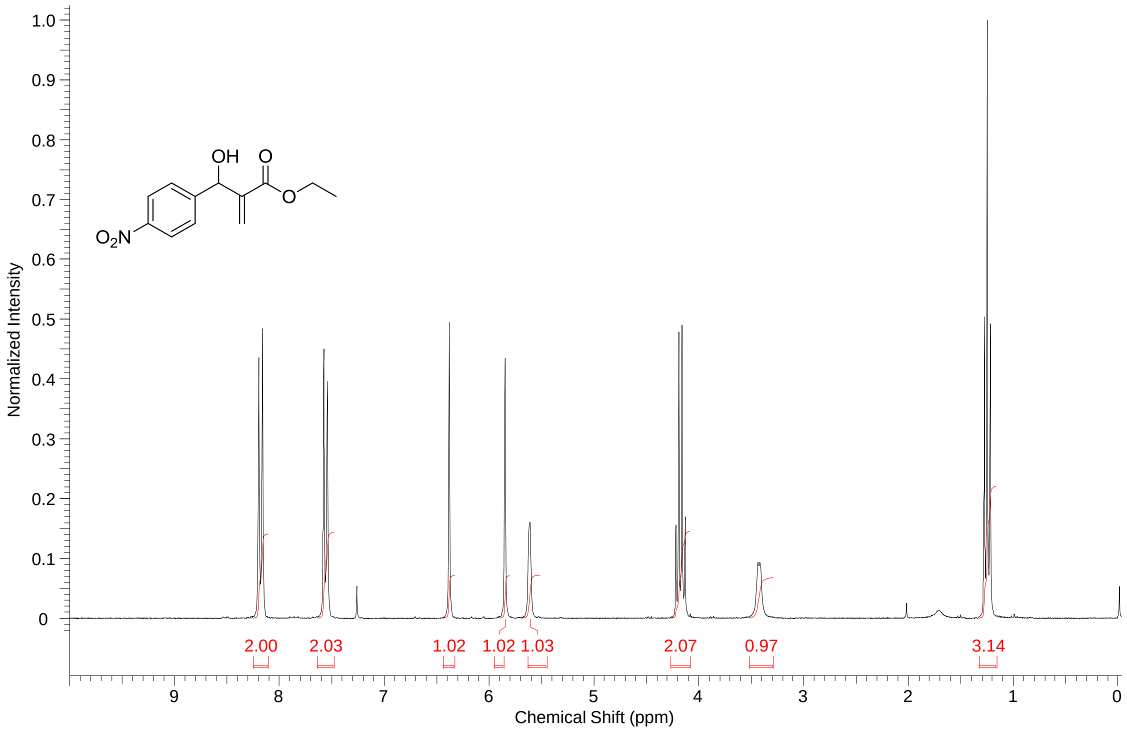


Figure S7. ^{1}H NMR (250 MHz, $CDCl_3$) of MBH adduct **10b**.

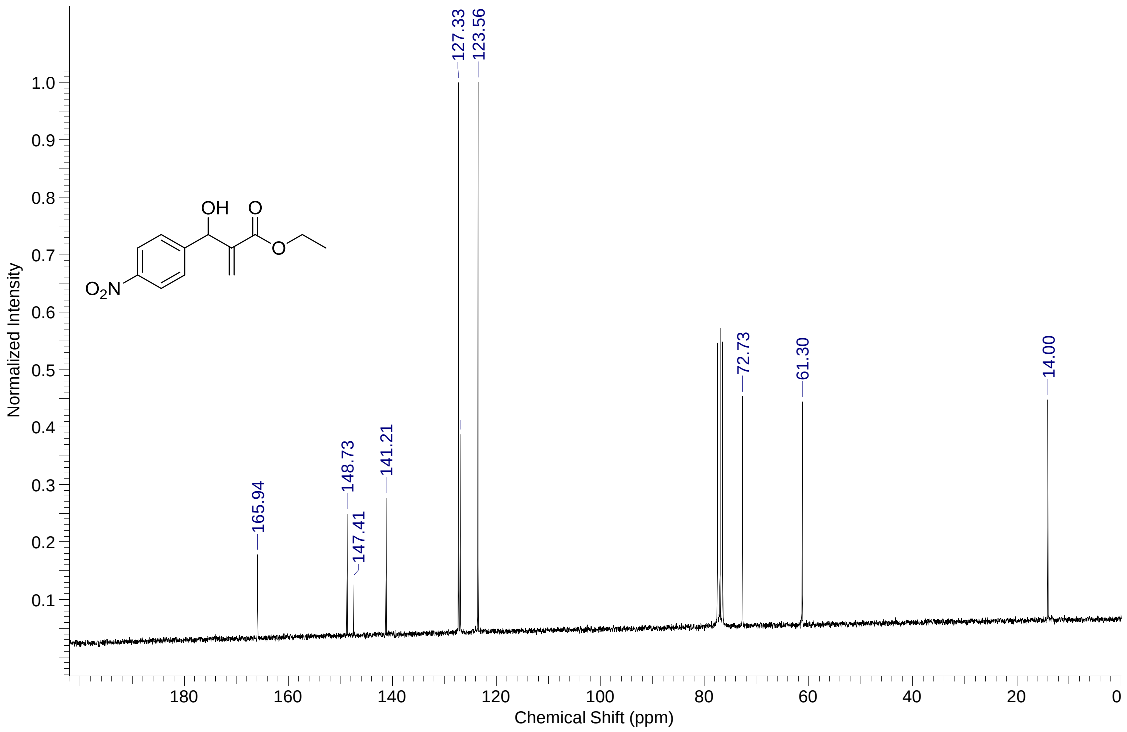


Figure S8. ^{13}C NMR (62.5 MHz, $CDCl_3$) spectrum of MBH adduct **10b**.

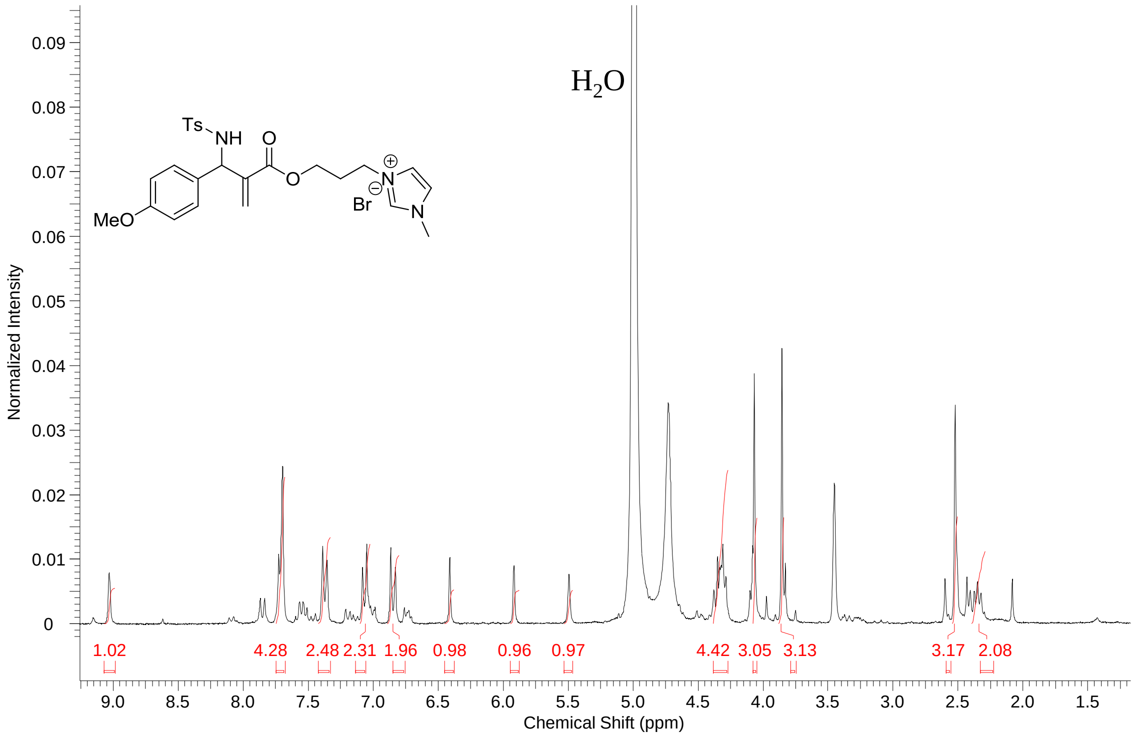


Figure S9. ^{1}H NMR (250 MHz, CD_3OD) spectrum of charge tagged *aza*-MBH adduct **10c**.

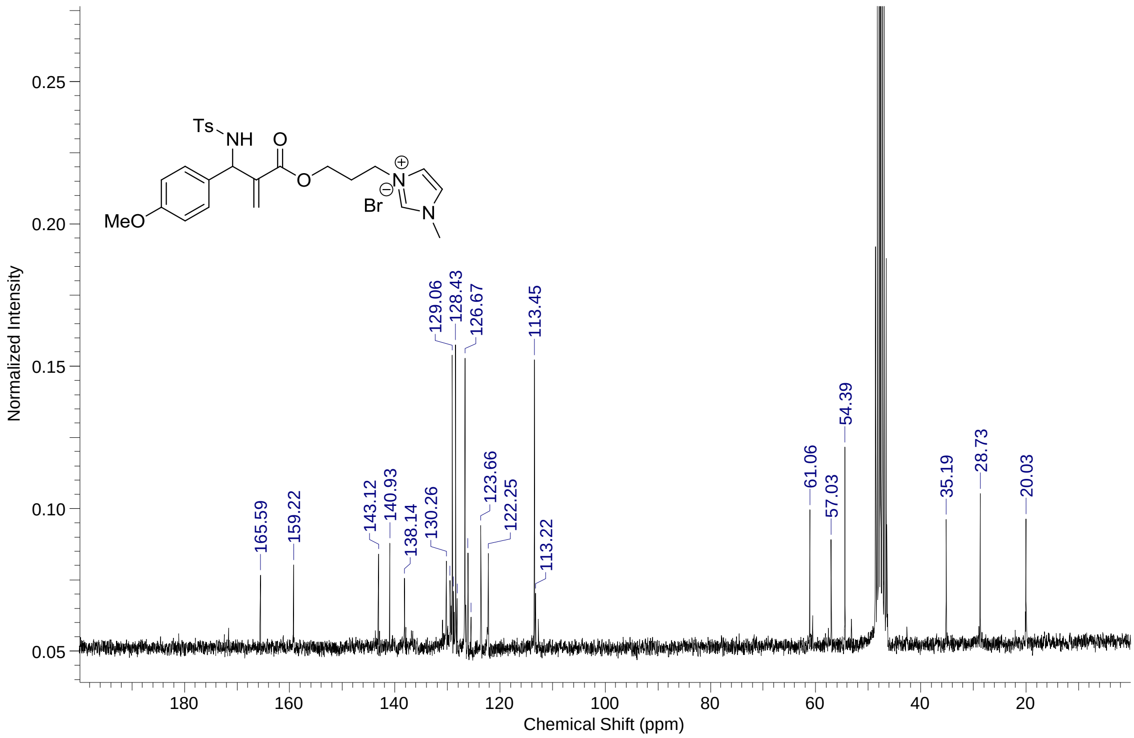


Figure S10. ^{13}C NMR (62.5 MHz, CD_3OD) spectrum of charge tagged *aza*-MBH adduct **10c**.

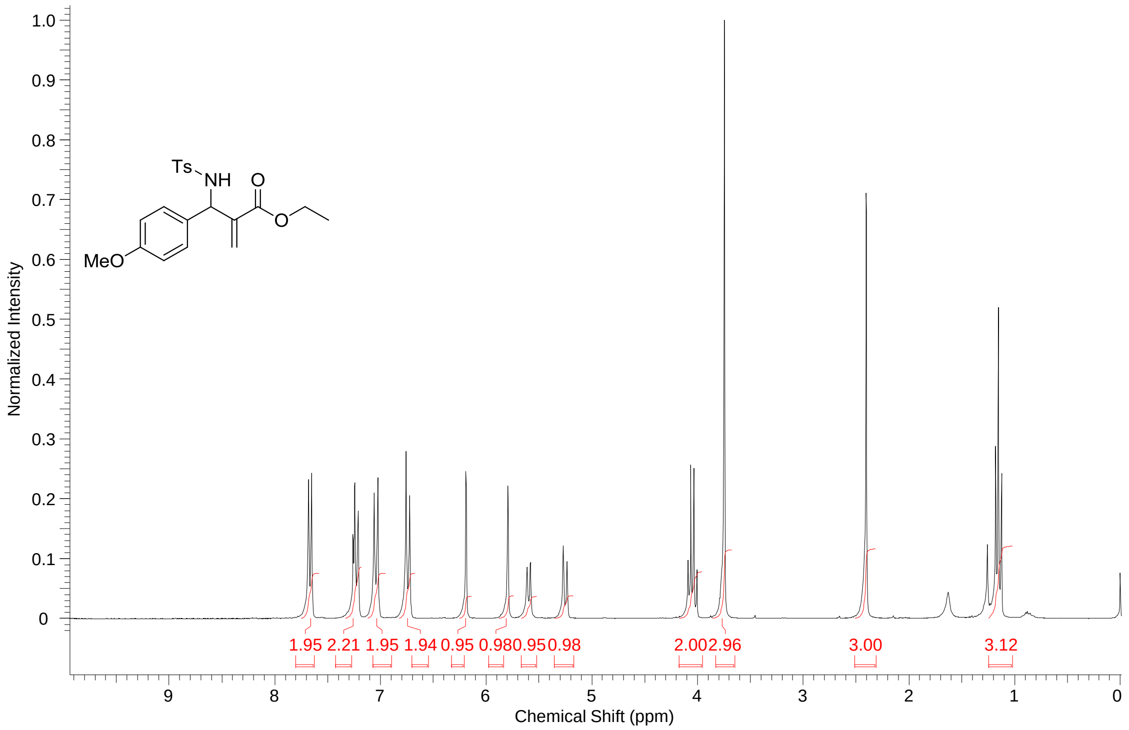


Figure S11. ^{1}H NMR (250 MHz, $CDCl_3$) spectrum of *aza*-MBH adduct **10d**.

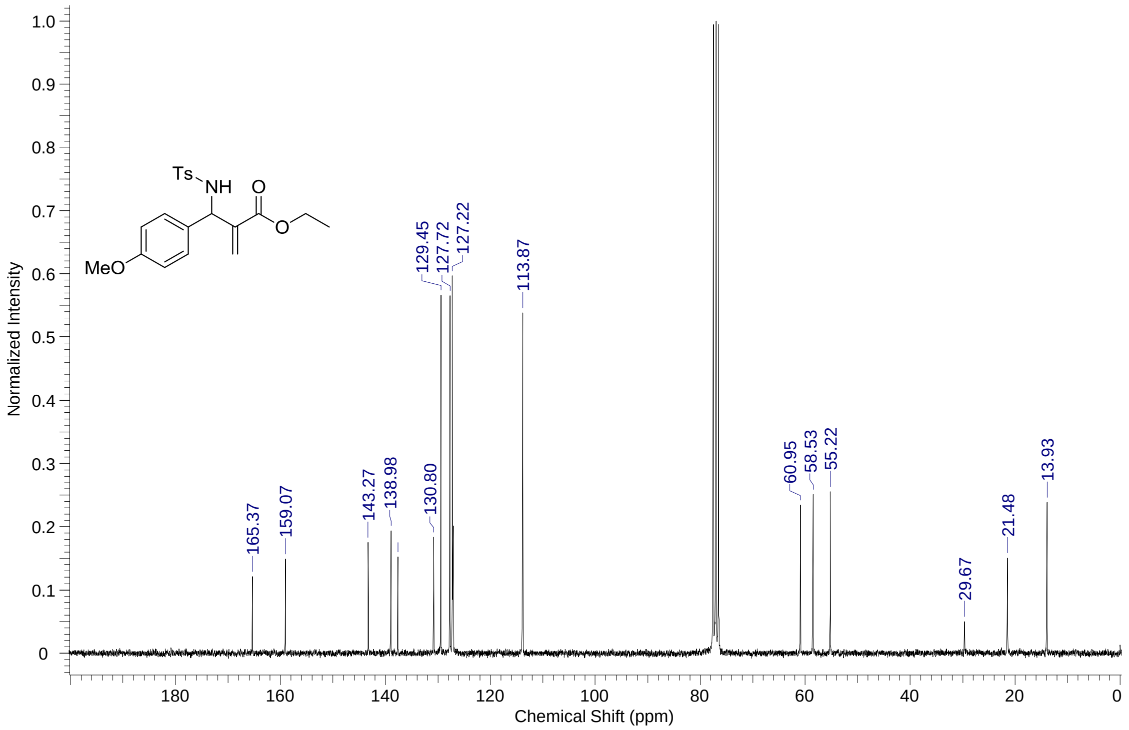


Figure S12. ^{13}C NMR (62.5 MHz, $CDCl_3$) spectrum of *aza*-MBH adduct **10d**.

3. ESI(+)-MS monitoring using charge tagged benzaldehyde: **Figure S13** shows the ESI(+)-MS for the classical MBH reaction using charge tagged benzaldehyde (**7**), ethyl acrylate (**5b**), DABCO (**4a**) as catalyst and acetonitrile as solvent. Note that just the enolate product (**6b**, first intermediate of *m/z* 213) and the final adduct (**10e**, of *m/z* 264) were detected. The aldol product (second intermediate, doubly charged ion of *m/z* 188.6) and the hemiacetal intermediate described by McQuade (triply charged ion of *m/z* 180.5) were not detected during the whole reaction monitoring. Others species were however detected, such as those of *m/z* 353, 404 and 455. They were attributed as a series of aggregates as we described: Two protonated catalyst with an iodine counterion of *m/z* 353 $[I^- + (DABCO{+}H)_2]^+$, protonated catalyst and charge tagged benzaldehyde with a iodine counterion of *m/z* 404 $[(DABCO{+}H) + I^- + (Benzaldehyde)]^+$ and two charge tagged benzaldehyde with o iodine counterion of *m/z* 455 $(Benzaldehyde)_2 + I^-)^+$.

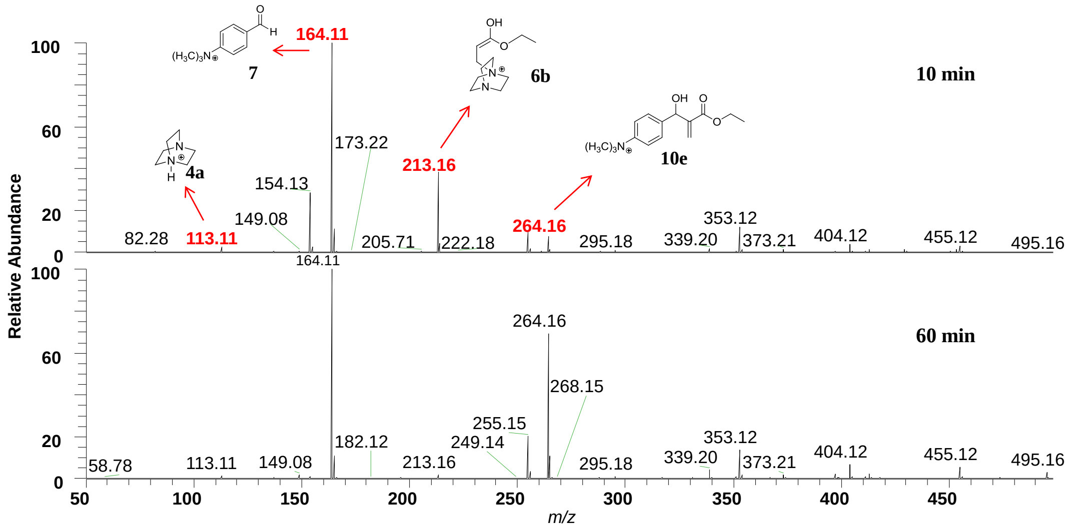
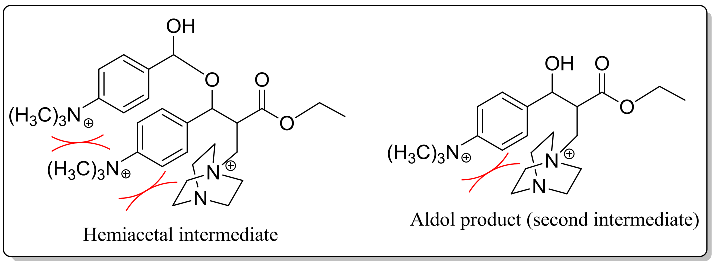


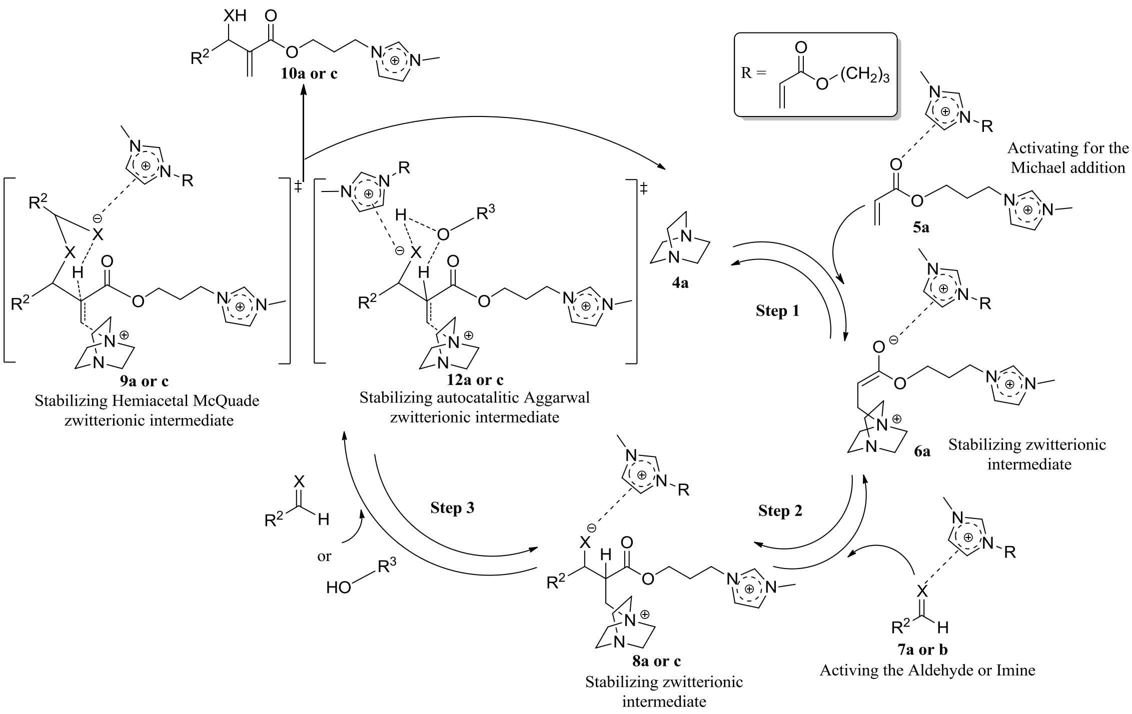
Figure S13. ESI(+)-MS of the classical MBH reaction solution at 10 min (top) and 60 min (bottom) using charge tagged benzaldehyde.

Scheme S1 shows the disfavors/unstable aldol product (second intermediate) and hemiacetal not detected by ESI(+)-MS in the MBH reaction using charge tagged benzaldehyde as electrophile. Note the proximity of the positive charge in these structures.



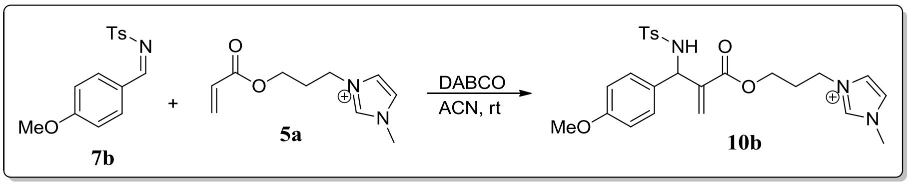
Scheme S1. Disfavors/unstable aldol and hemiacetal intermediates.

4. Participation of the charge tagged acrylate on the mechanism of the MBH/aza-MBH reactions: The co-catalyst action of the methylimidazolium ion for the acrylate **5a** could be rationalized as contributing in the mechanism steps as **Scheme 5** rationalizes below.



Scheme S2. Global participation of the charge tagged acrylate **5a** on the mechanism of the MBH/*aza*-MBH reactions.

5. ESI(+)-MS/MS and accurate mass measurements for the main species detected in the monitoring of the neutral and charge tagged MBH/aza-MBH reactions.



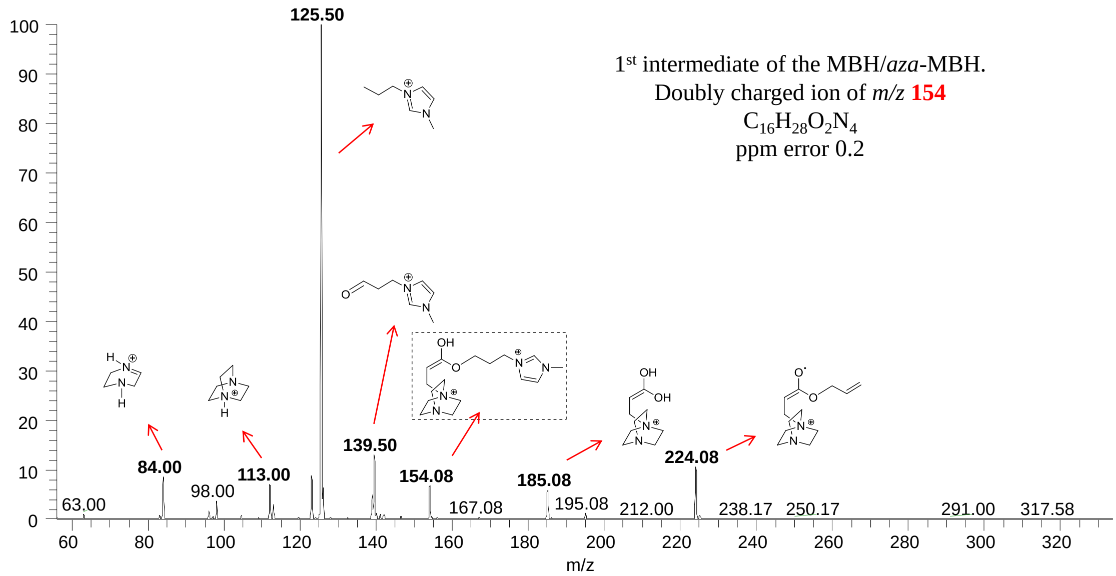


Figure S14. ESI(+)-MS/MS of enolate product from MBH/*aza*-MBH reactions (charge tagged reactions)

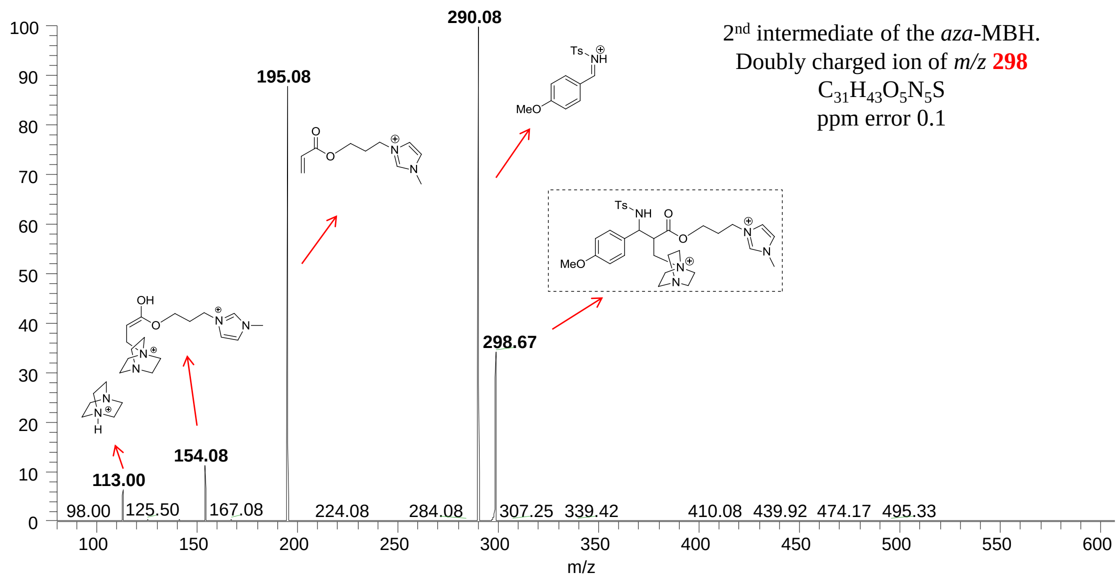


Figure S15. ESI(+)-MS/MS of aldol product from *aza*-MBH reaction (charge tagged reaction)

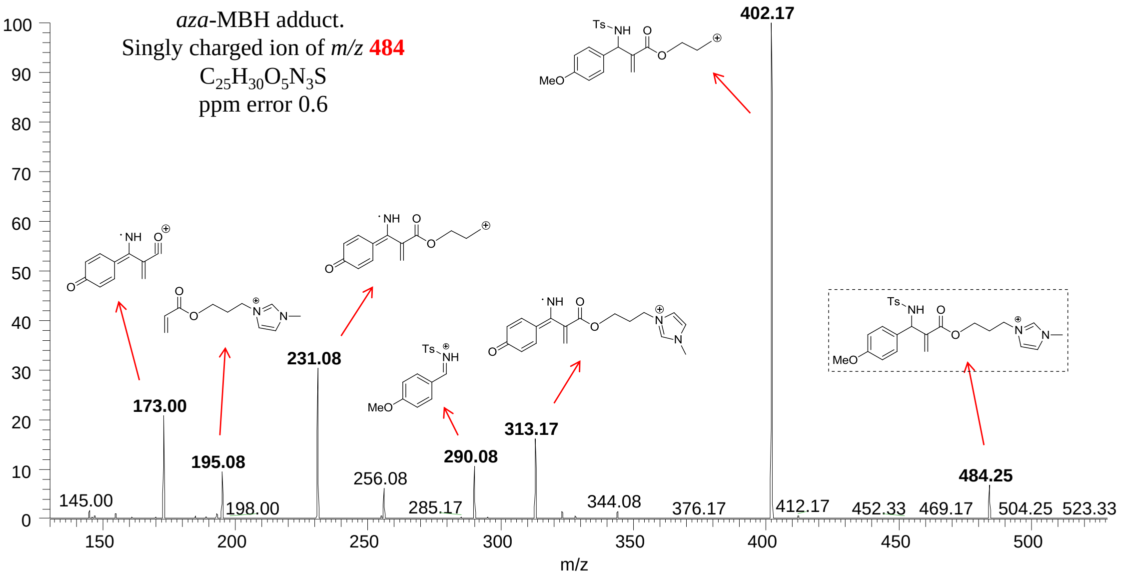


Figure S16. ESI(+)-MS/MS of *aza*-MBH adduct (charge tagged reaction)

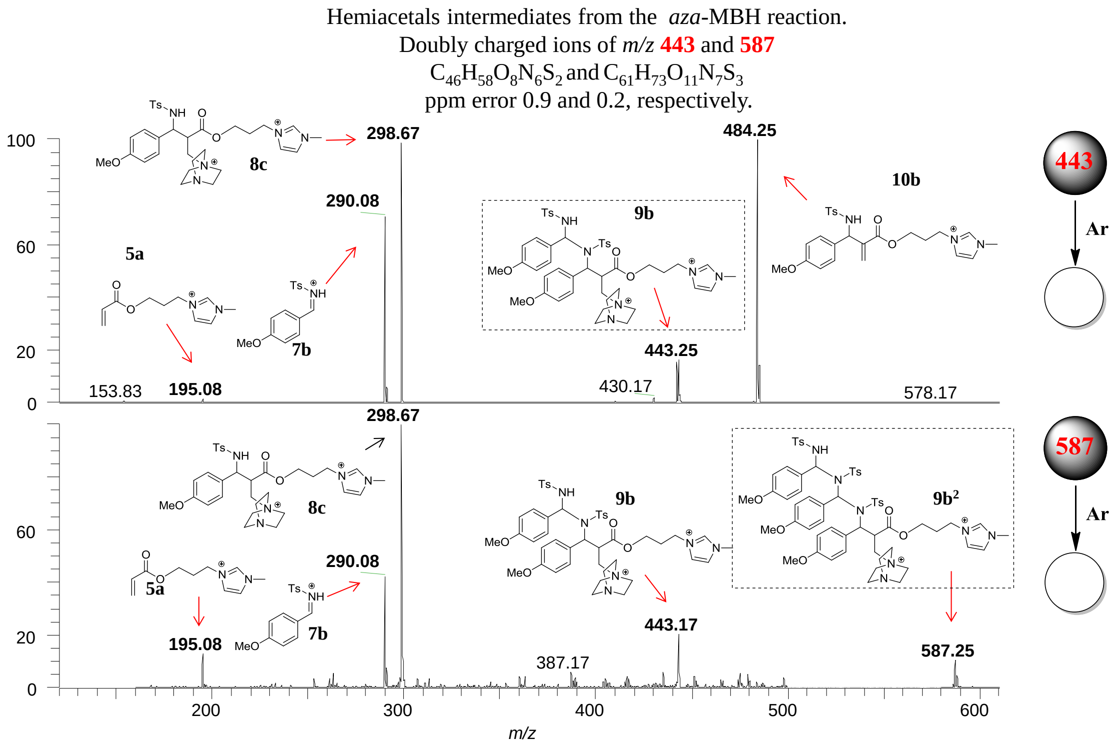
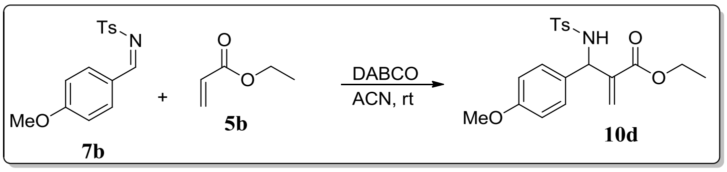


Figure S17. ESI(+)-MS/MS of hemiacetals from the *aza*-MBH reaction (charge tagged reaction).



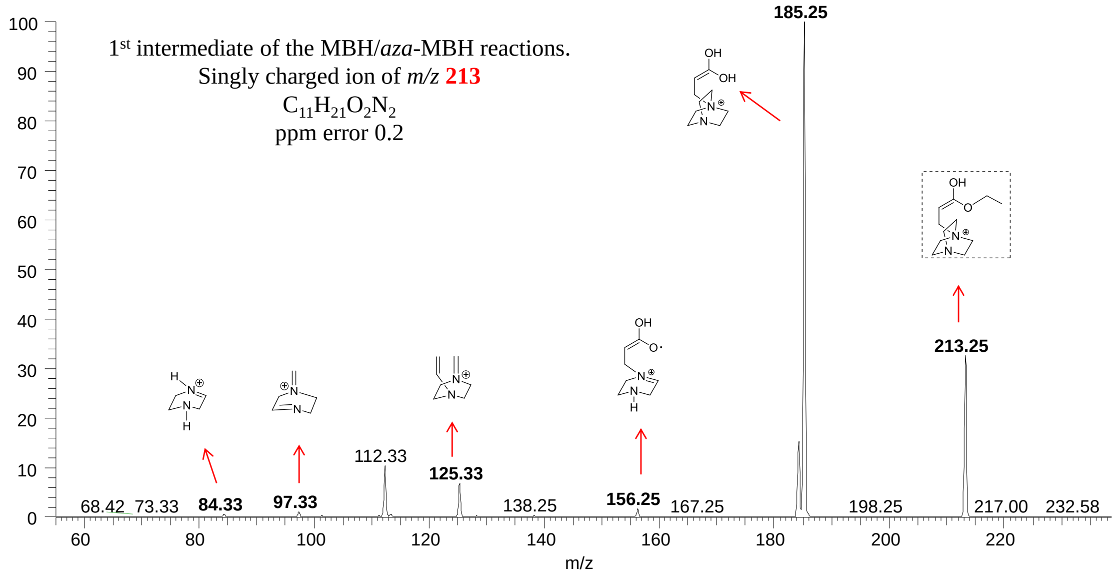


Figure S18. ESI(+)-MS/MS of enolate product from MBH/*aza*-MBH reactions (neutral reactions)

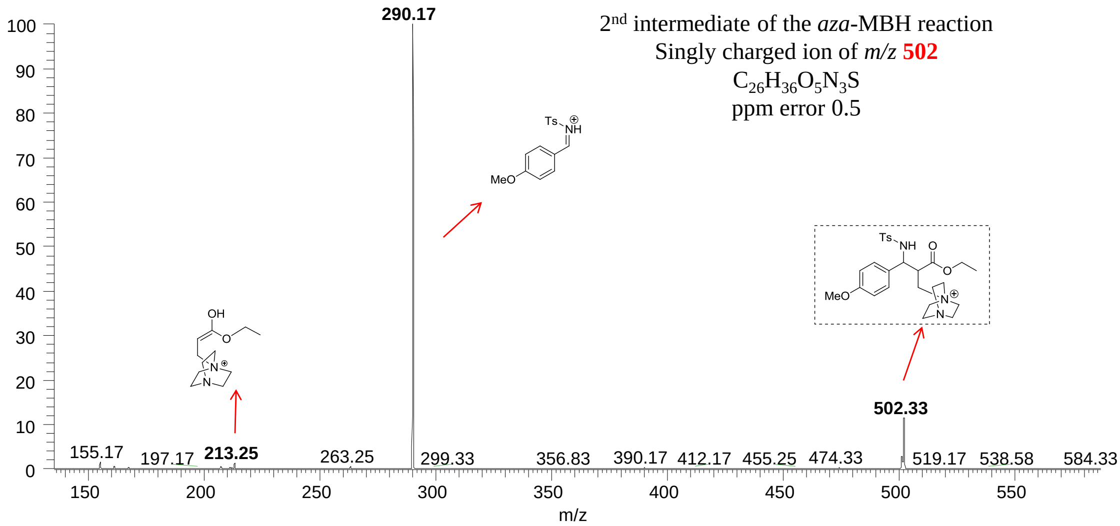
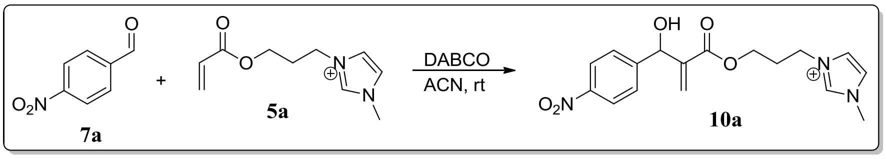


Figure S19. ESI(+)-MS/MS of aldol product from *aza*-MBH reaction (neutral reaction).



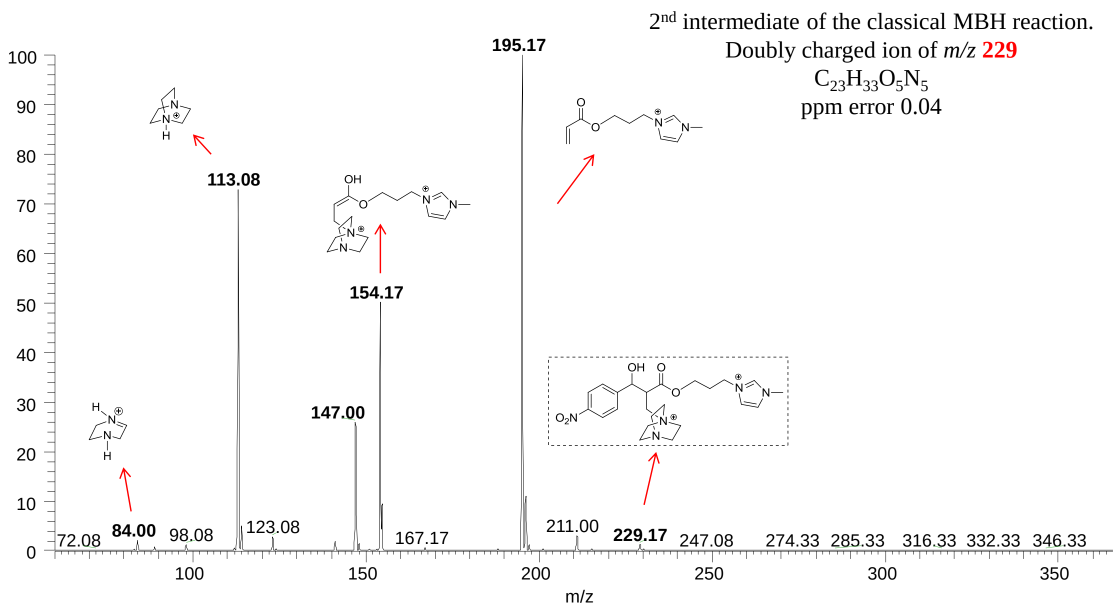


Figure S20. ESI(+)-MS/MS of aldol product from MBH reaction (charge tagged reaction)

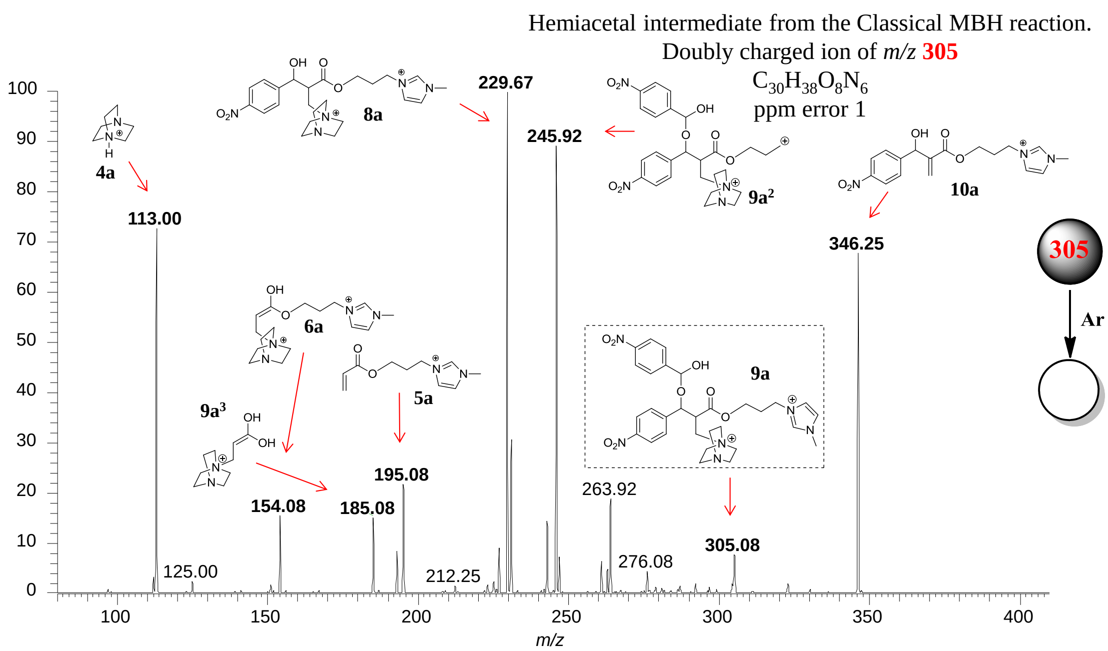


Figure S21. ESI(+)-MS/MS of hemiacetal from MBH reaction (charge tagged reaction)

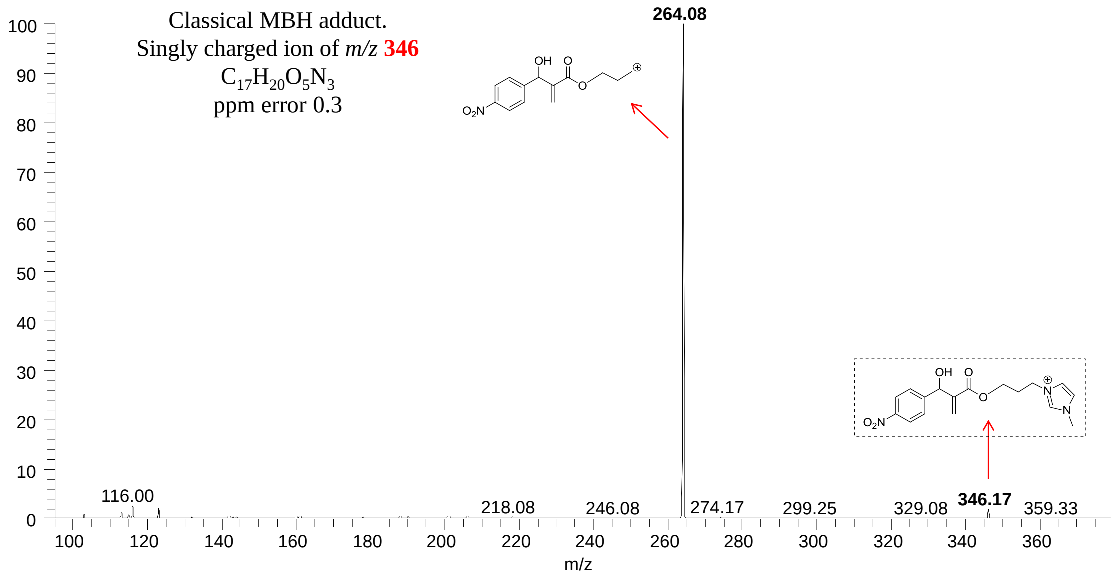
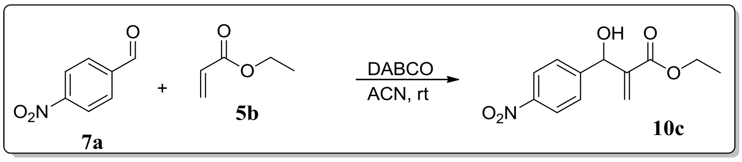


Figure S22. ESI(+)-MS/MS of MBH adduct (charge tagged reaction)



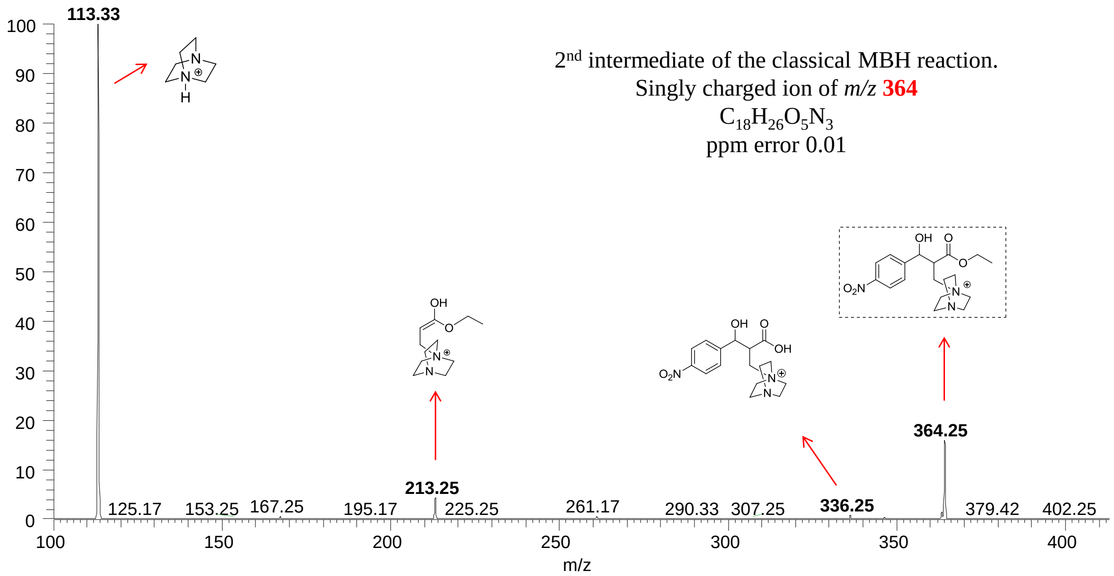
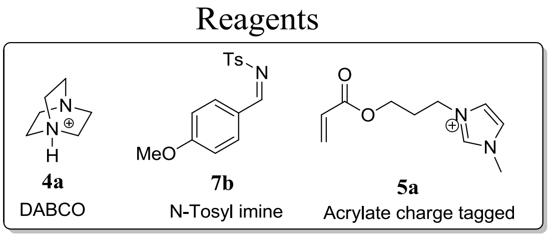


Figure S23. ESI(+)-MS/MS of aldol product from MBH reaction (neutral reaction)



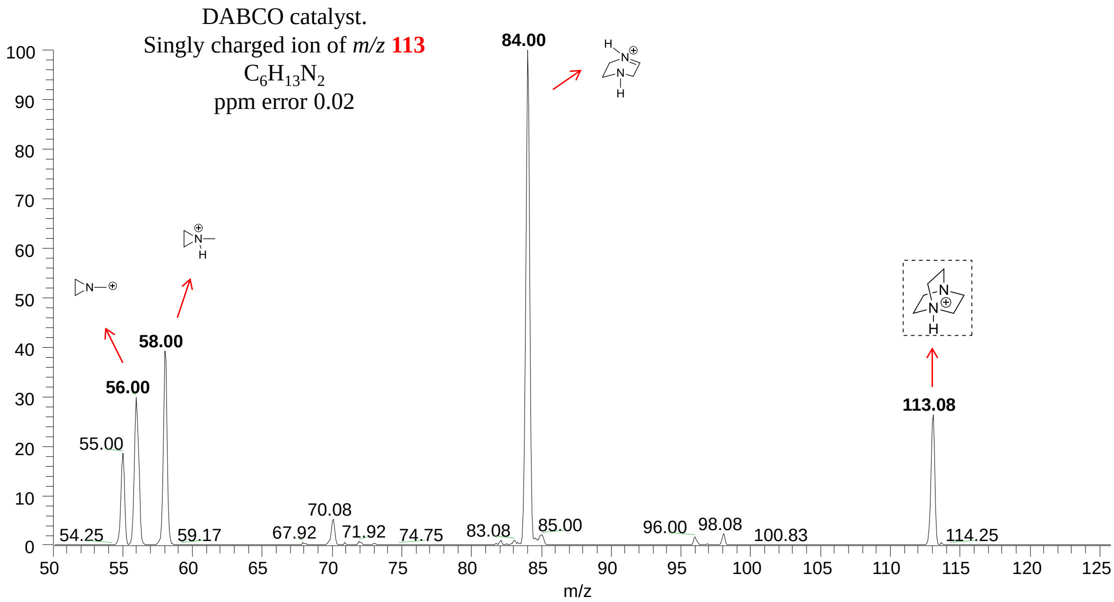


Figure S24. ESI(+)-MS/MS of protonated catayst DABCO.

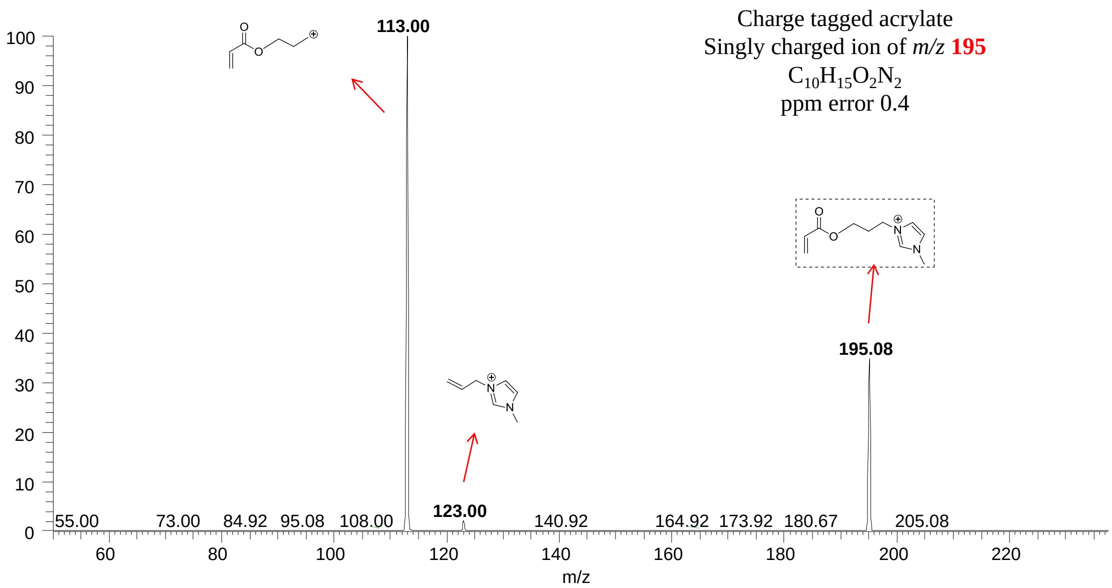


Figure S25. ESI(+)-MS/MS of charge tagged acrylate **5a.**

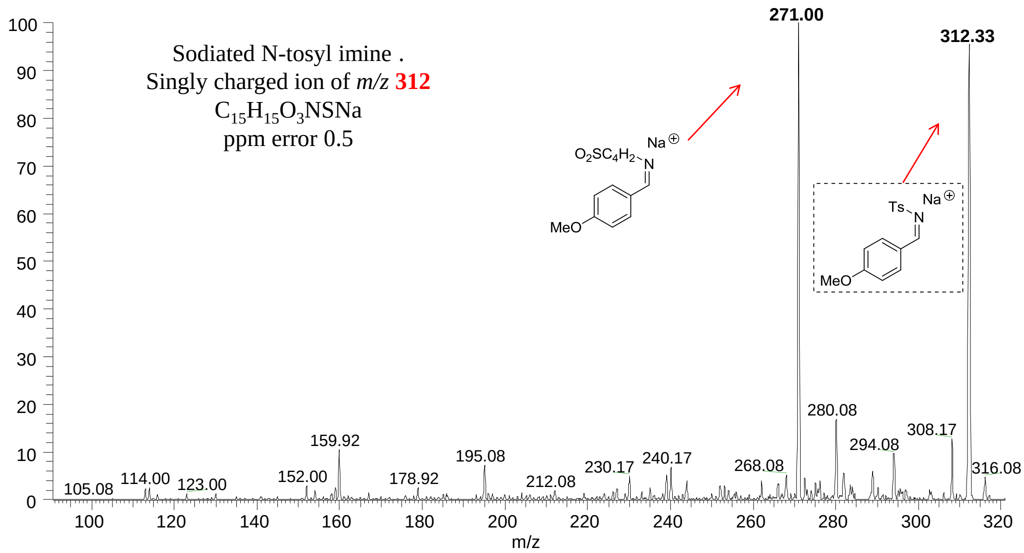
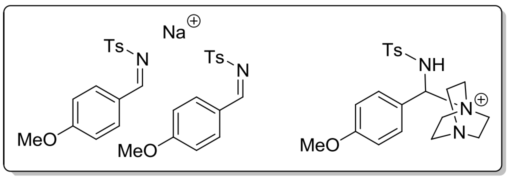


Figure S26. ESI(+)-MS/MS of sodiated N-tosyl imine.



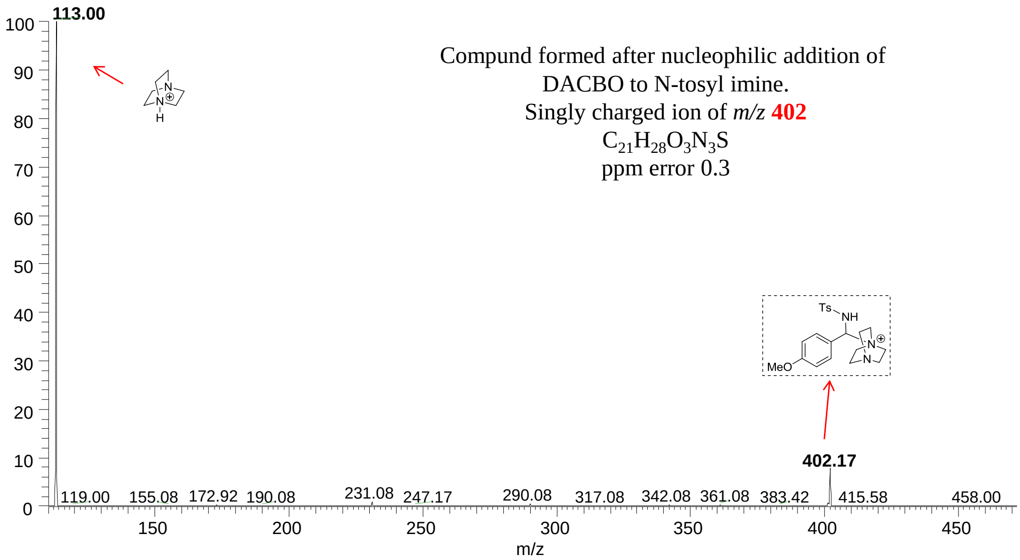


Figure S27. ESI(+)-MS/MS of compound formed by attack of DABCO to the N-tosyil imine.

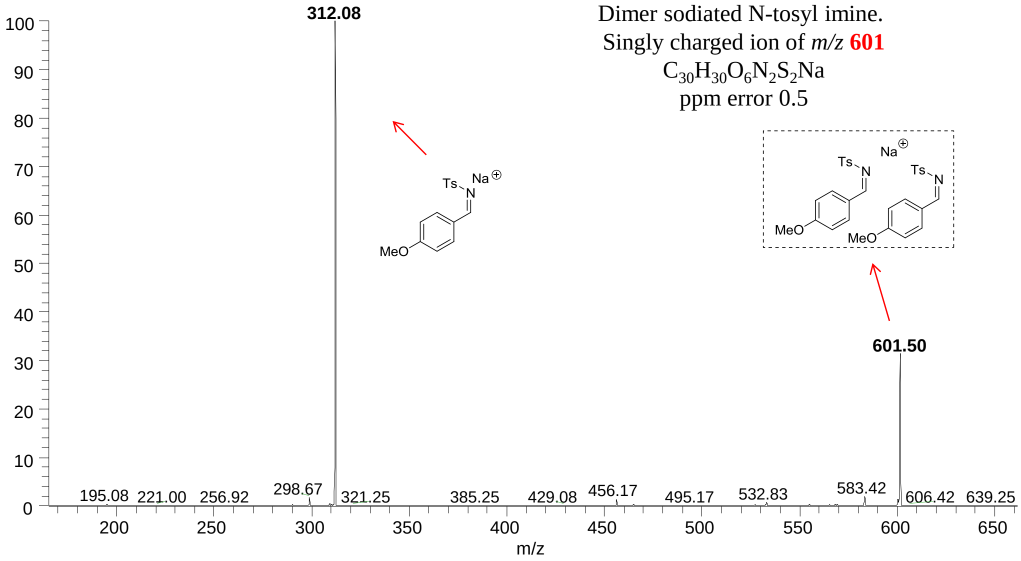


Figure S28. ESI(+)-MS/MS of dimer sodiated N-tosyl imine.