Supporting Information

Microwave Catalytic Degradation of Antibiotic Molecules by 2D Sheets of Spinel Nickel Ferrite

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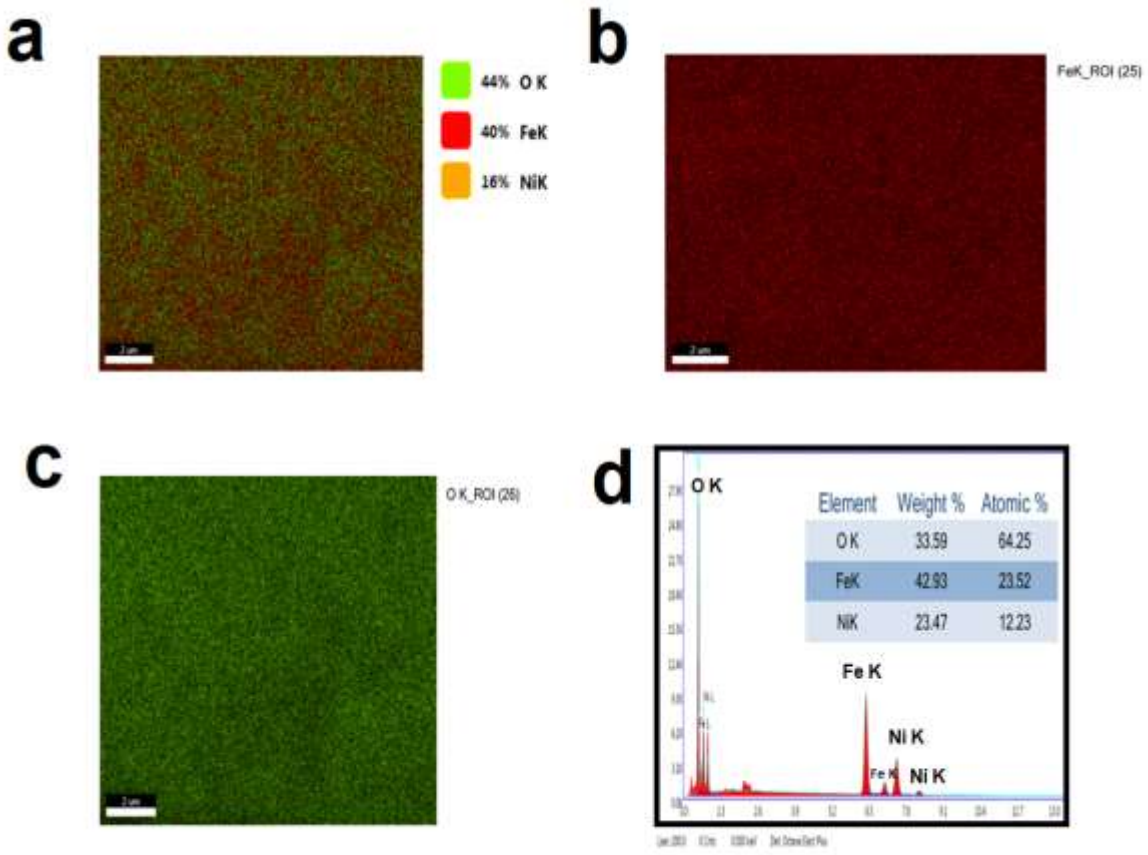

Figure S1. The elemental mapping and SEM-EDS of the SNFO catalyst.

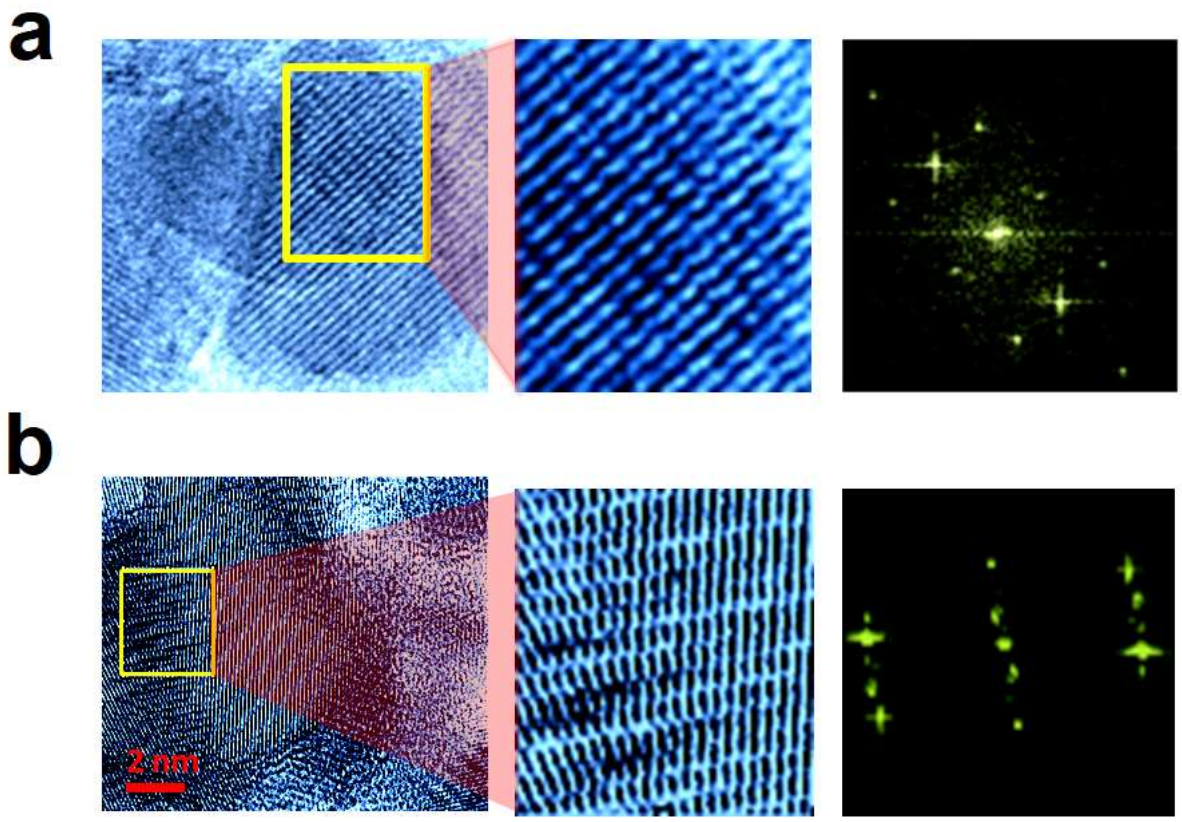

Figure S2. HRTEM images and FFT of SNFO catalyst.

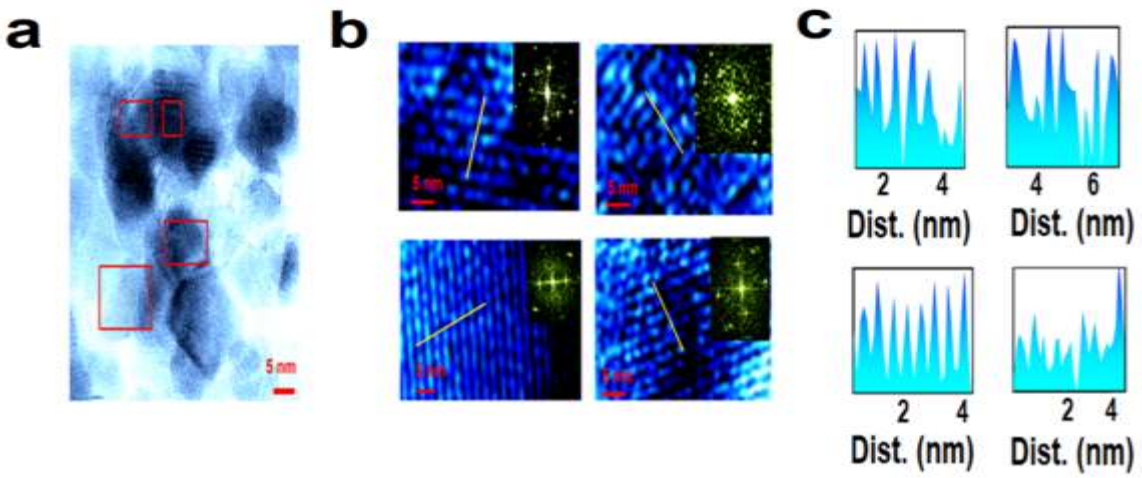

Figure S3. HRTEM images, FFT and the line profiles of the SNFO sheets.

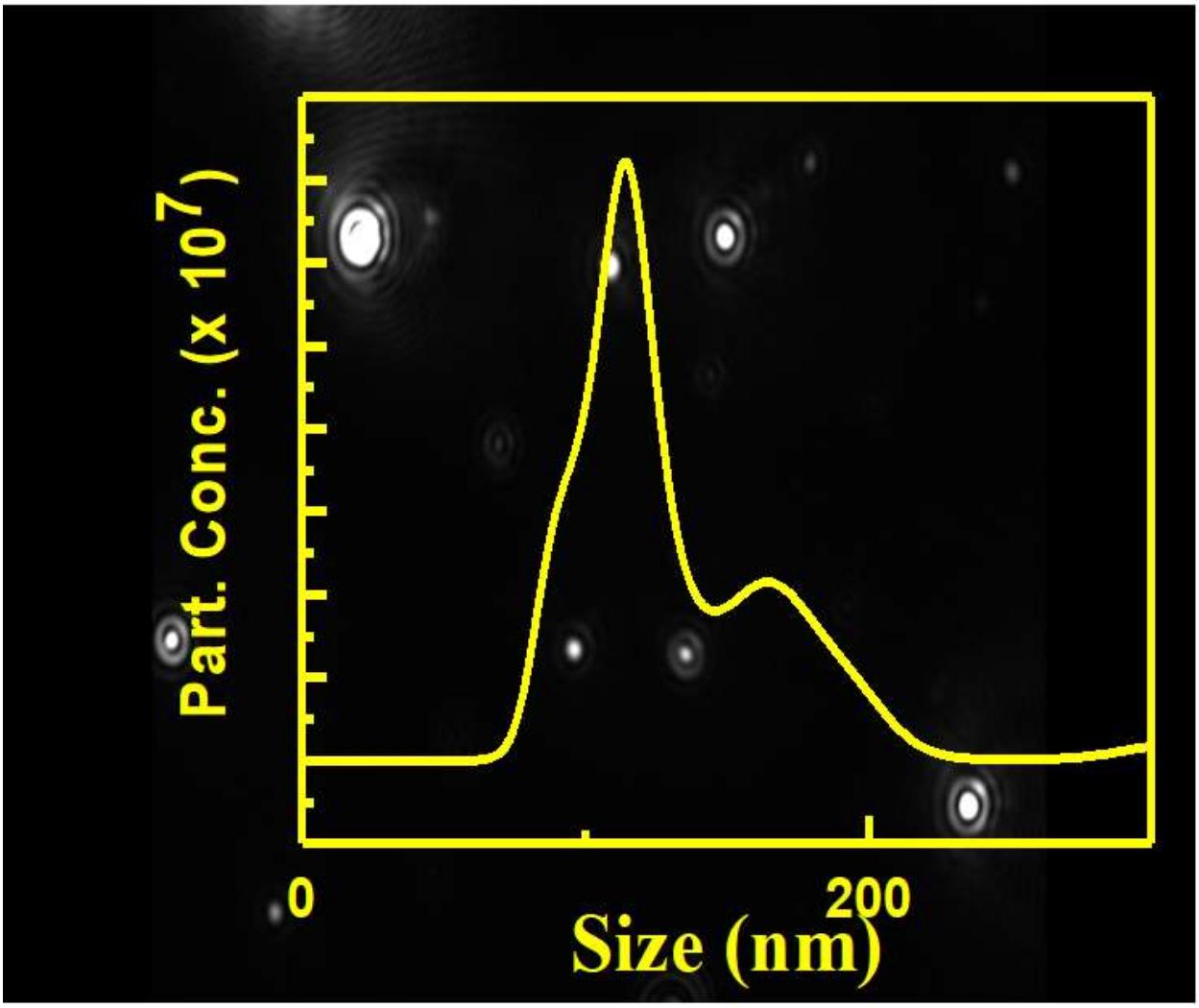

Figure S4. The hydrodynamic particle size distribution of the magnetic SNFO sheets.

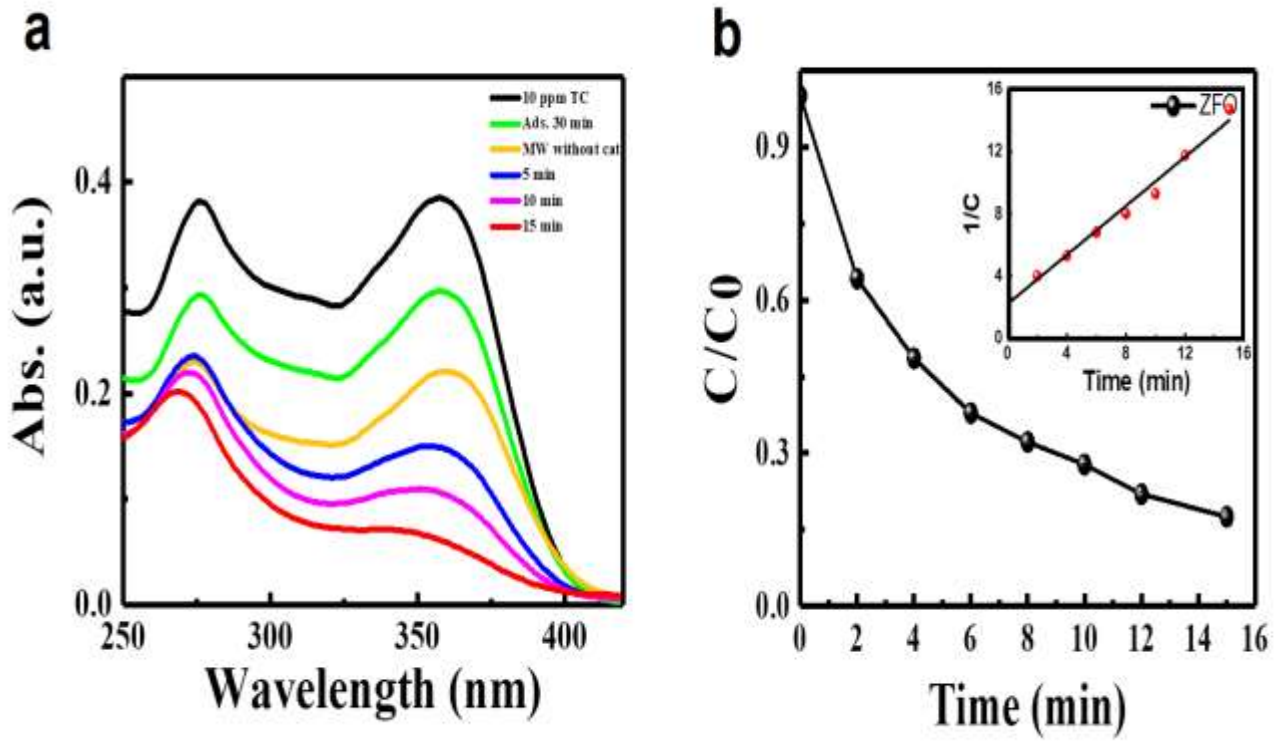

Figure S5 (a) UV-Vis spectra recorded after the degradation with time; (b) the kinetics plot for the TCH antibiotic degradation with SZFO under the MW irradiation.

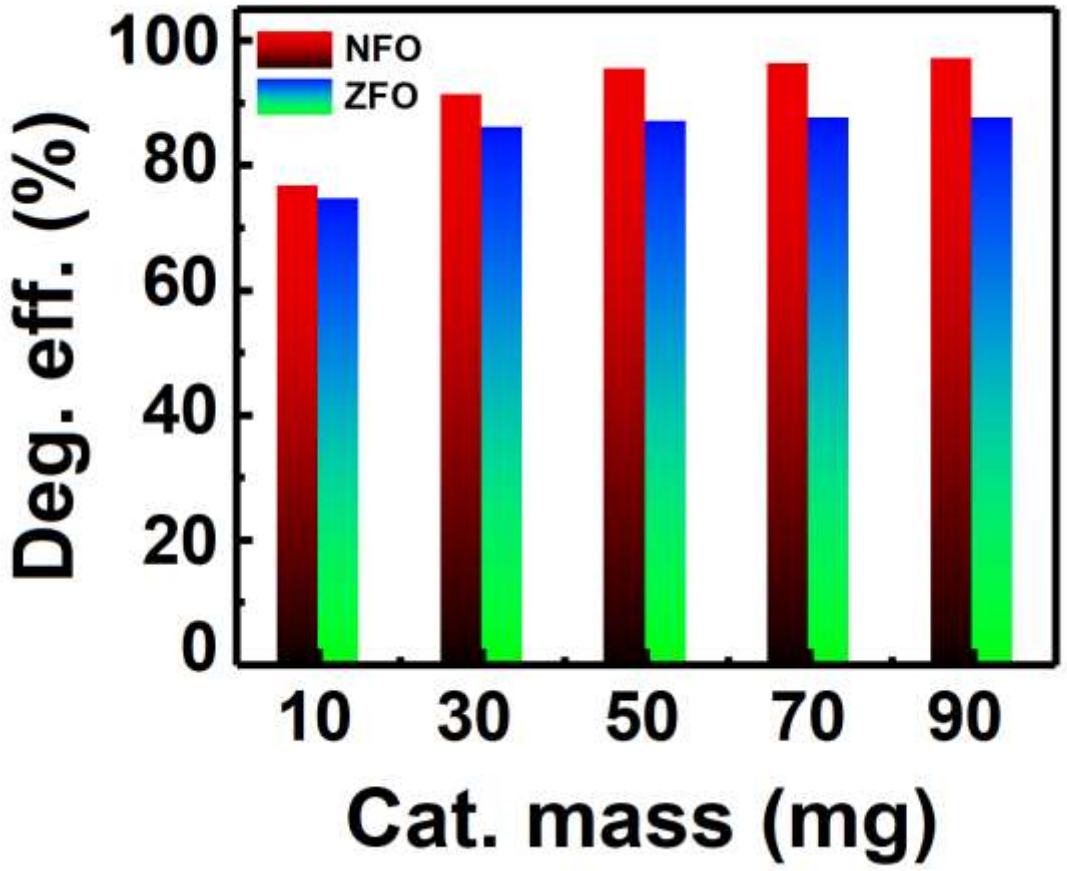

Figure S6. The effect of the catalyst mass on the TCH antibiotic degradation using SNFO and SZFO catalysts.

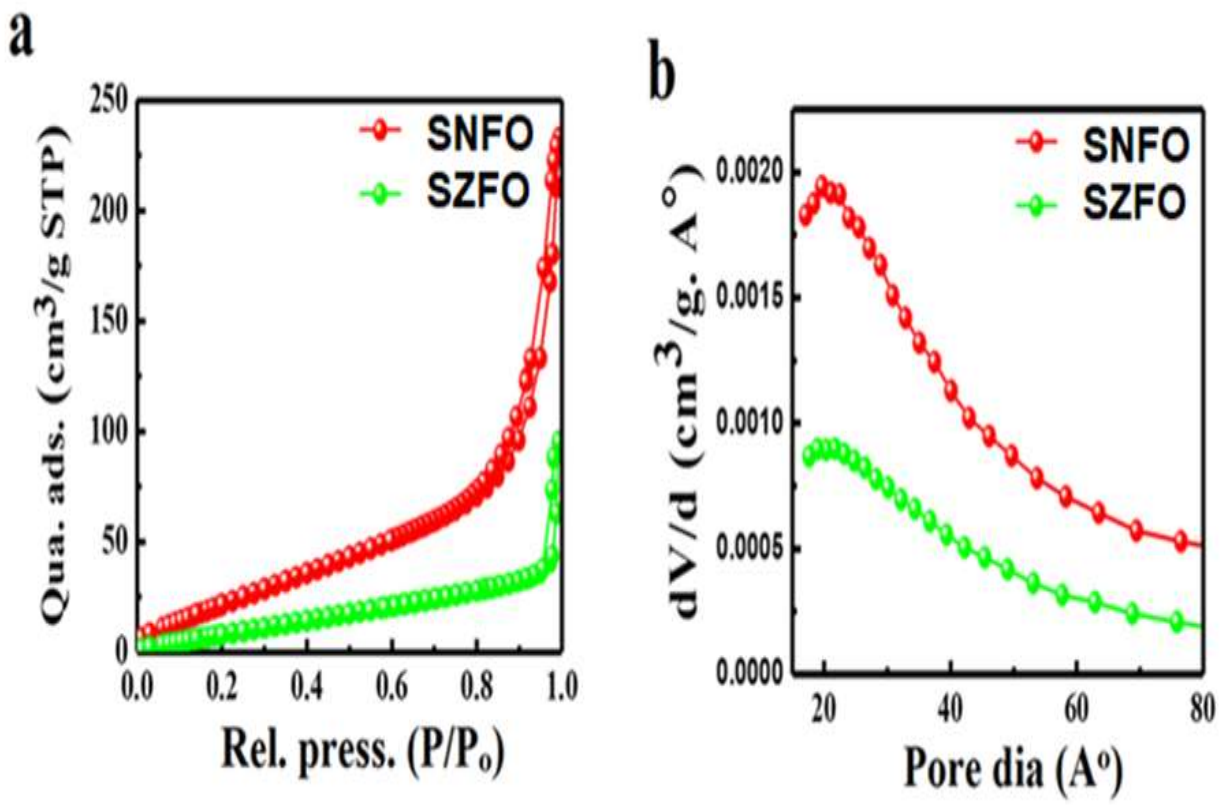

Figure S7 (a) N_2 adsorption-desorption isotherm; (b) pore volume vs pore diameter plots for SNFO and SZFO catalysts.

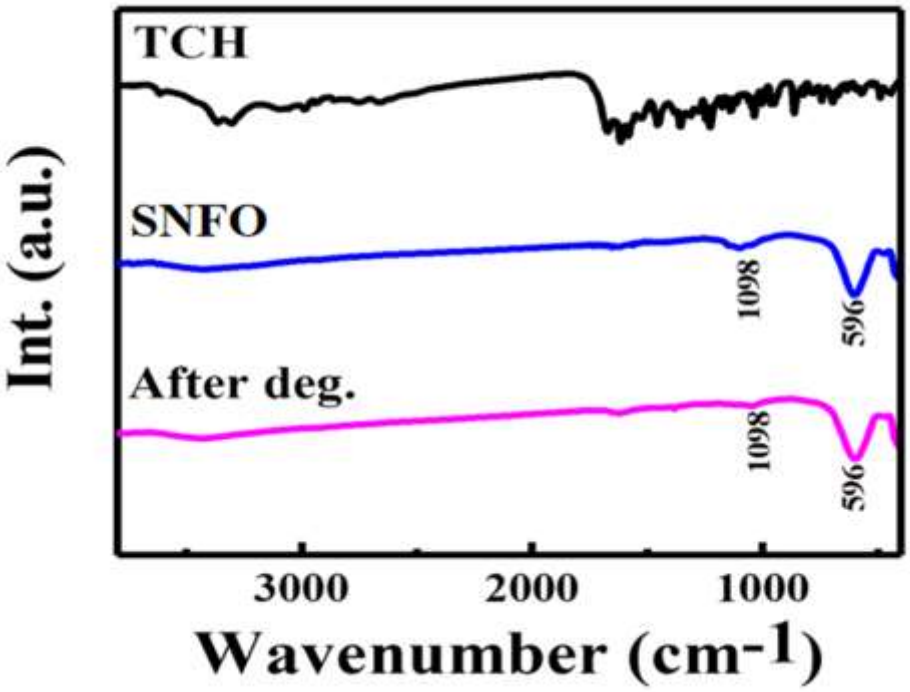

Figure S8. FTIR spectra of the TCH antibiotic molecule anchored on the SNFO catalyst before and after the degradation.

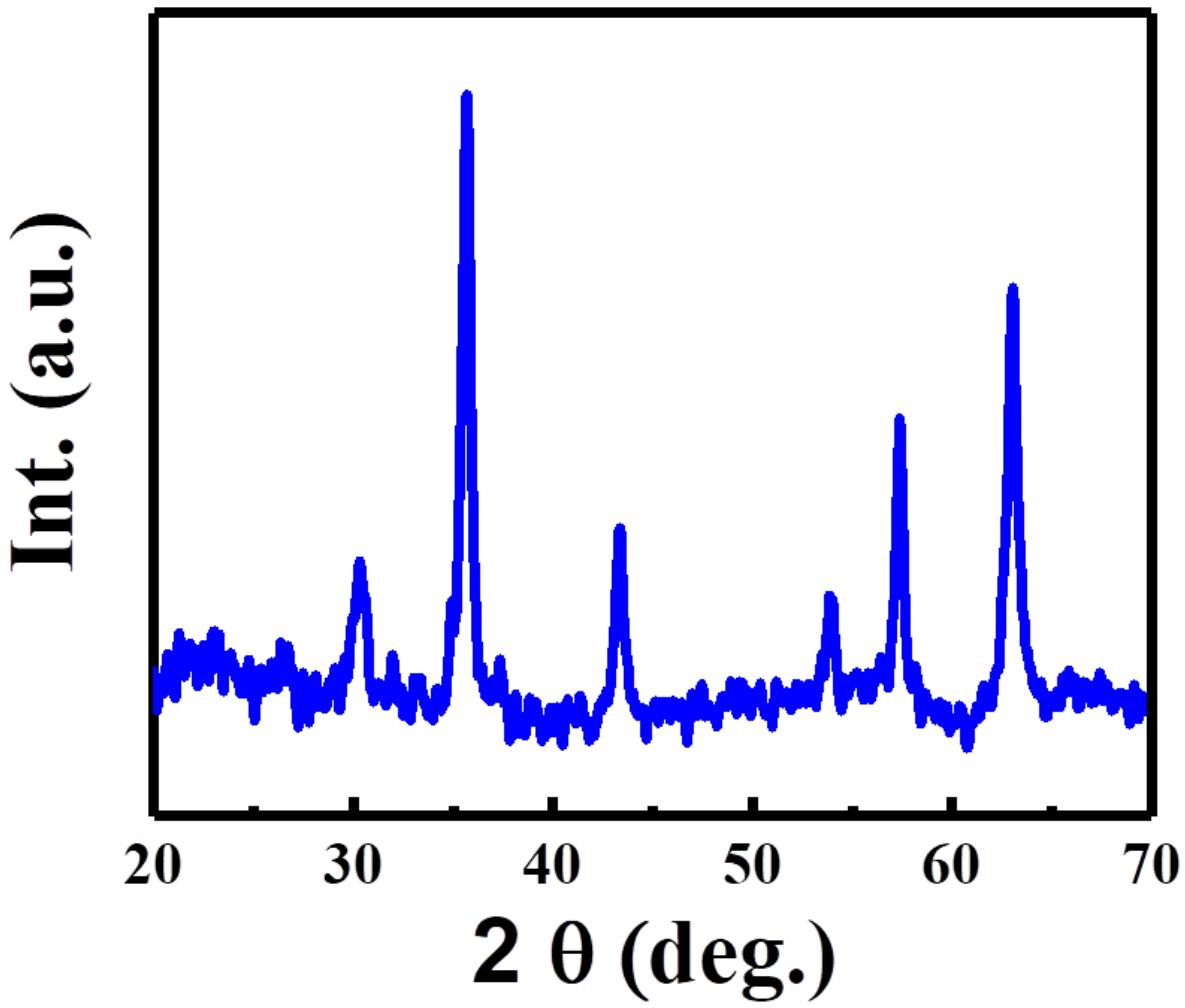

Figure S9. XRD pattern of SNFO after the MW treatment.

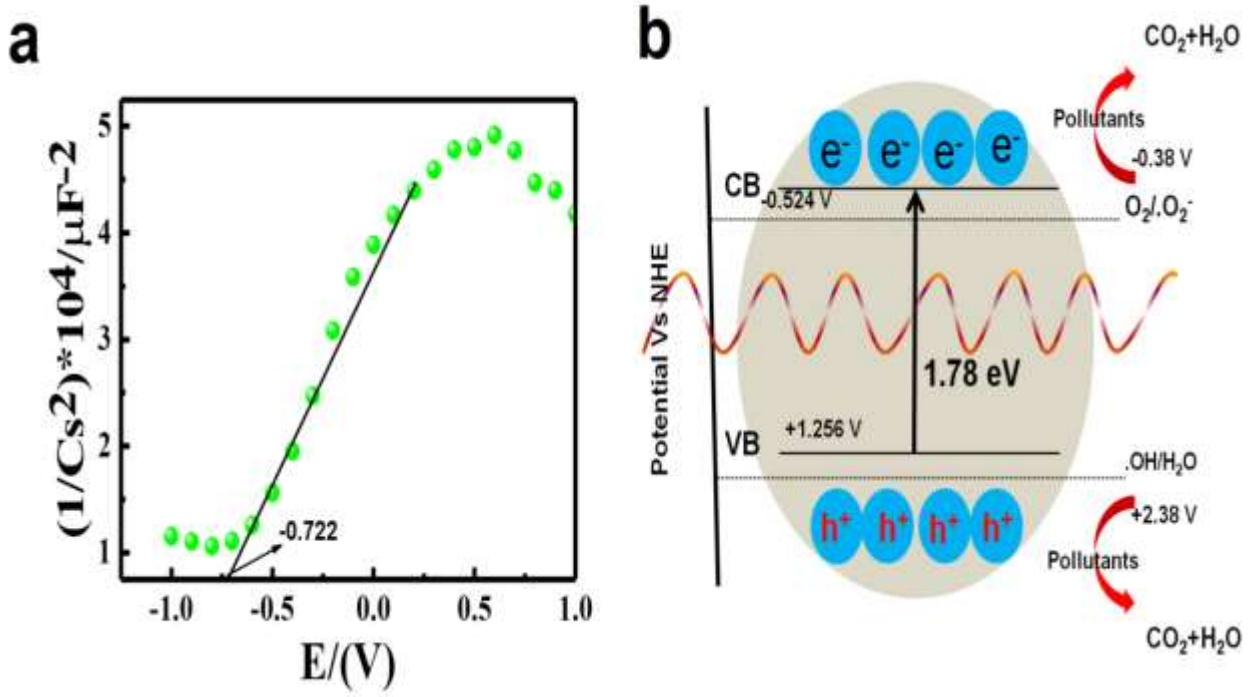

Figure S10 (a) The Mott−Schottky plots for SNFO; (b) the mechanism of generations of the electrons and holes under the MW irradiation for SNFO.

Table S1. The comparisons of the degradation efficiency and TOC removal of other methods reported in the literature with those of the present method for the degradataion of the TCH antibiotic.

Catalyst	Method	pH	Power (W)	Initial Concentration	Time (min)	Degradation efficiency (%)	TOC (%)	References
Ti_4O_7	Ozonation	7	NG*	5 mg/L	80	77.1	9.1	[64]
$BiFeO_3$	Photo-Fenton	3	120	10 mg/L	120	40	21	[65]
Fe^{+2}/H_2O_2	Ultrasound	6	100	100 mg/L	60	85.1	18.7	[66]
TiO_2	Photocatalysis	6	120	40 mg/L	120	75	15	[67]
$NiFe_2O_4$	Photocatalysis	NG*	150	10 mg/L	90	47.43	NG*	[68]
Boron-doped diamond(BDD)/carbon-felt electrode, Fe^{3+}, Fe^{2+}	Electro-Fenton	7	18	100 mg/L	120	87.5	15	[69]
SNFO	MW assisted method	6	700	10 mg/L	15	90	40	Present work

* NG=Not Given

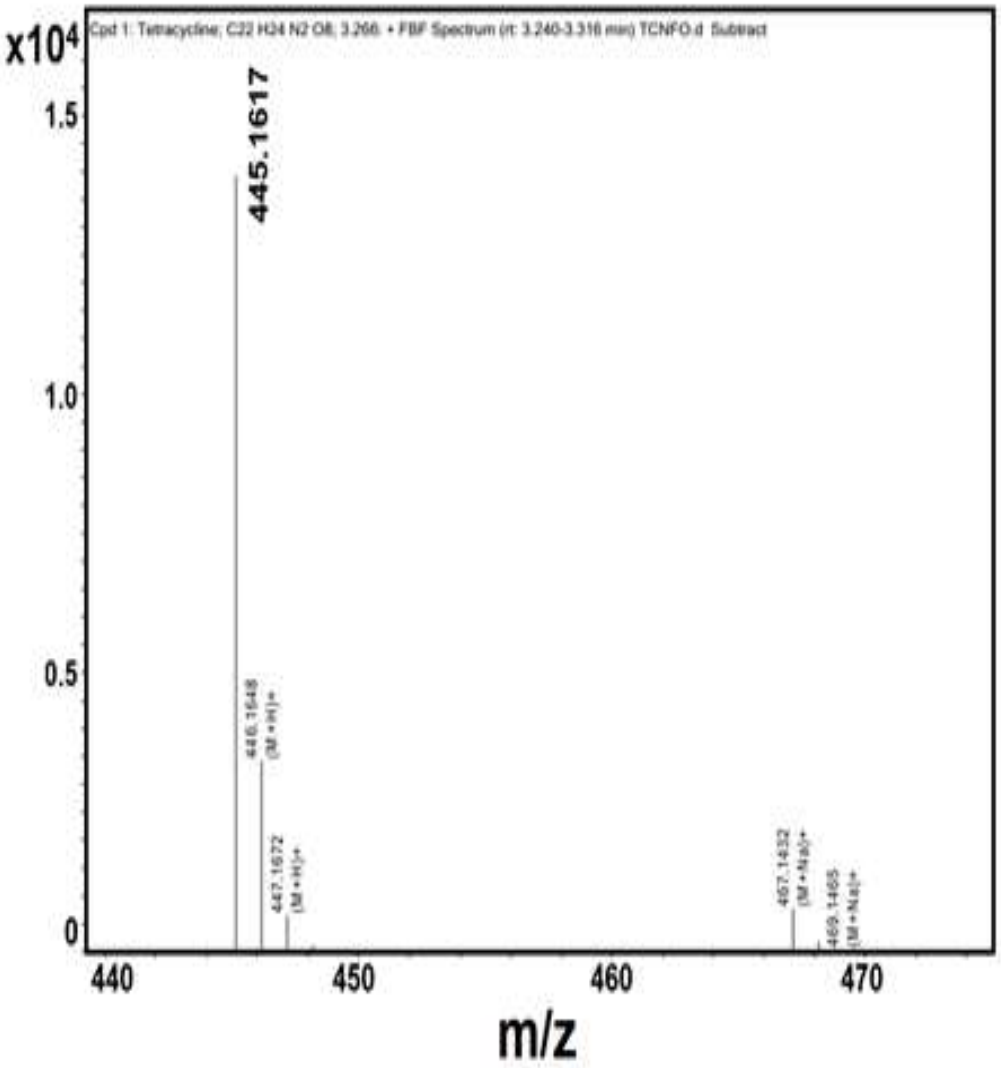
Cpd 1: Tetracycline; C22 H24 N2 O8; 3.266: + FBF Spectrum (rt: 3.240-3.316 min) TCNFO.d Subtract
x10^4
1.5
1.0
0.5
0
445.1617
446.1648
(M+H)+
447.1672
(M+H)+
467.1432
(M+Na)+
469.1465
(M+Na)+
440
450
460
470
m/z

Figure S11 (a)

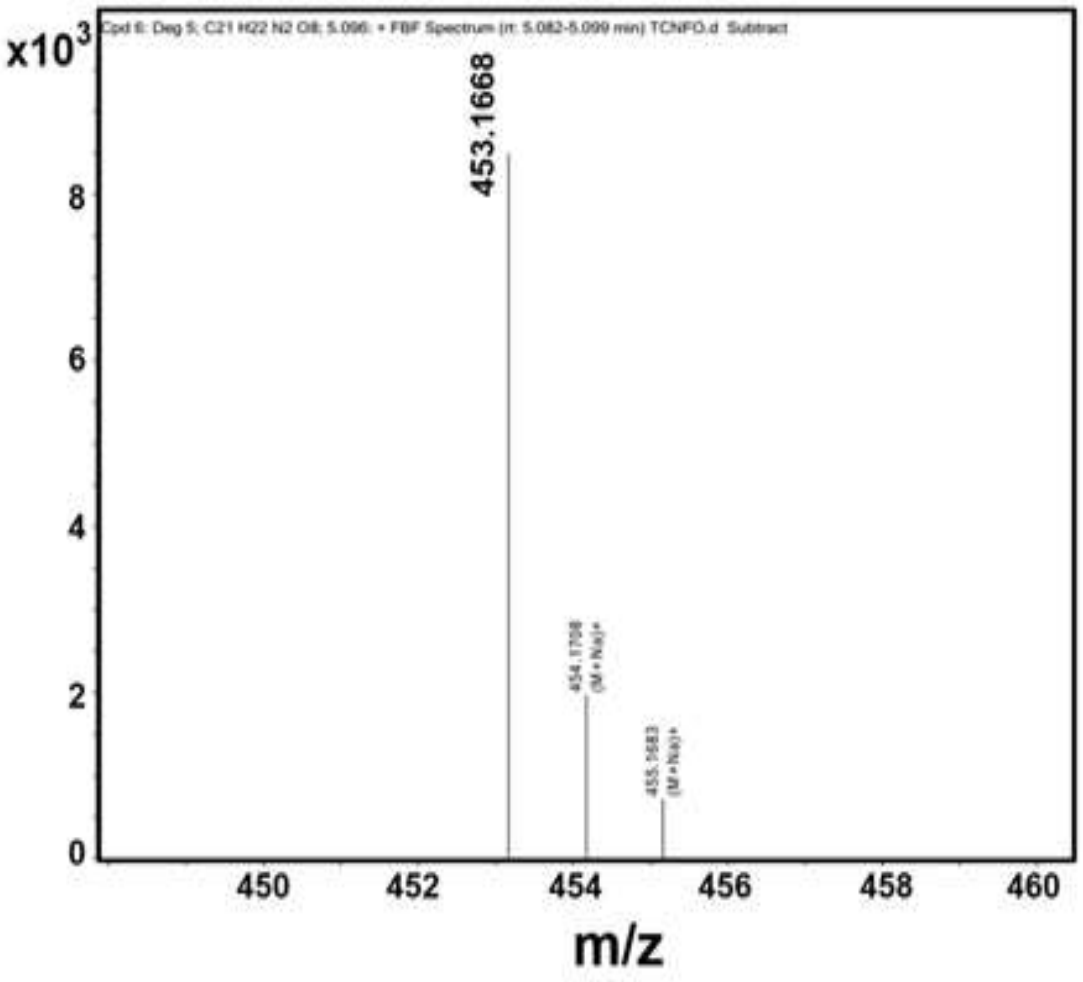
Cpd 6: Deg 5; C21 H22 N2 O8; 5.096: + FBF Spectrum (rt: 5.082-5.099 min) TCNFO.d Subtract
x10^3
453.1668
8
6
4
2
0
450
452
454
456
458
460
m/z

Figure S11(b)

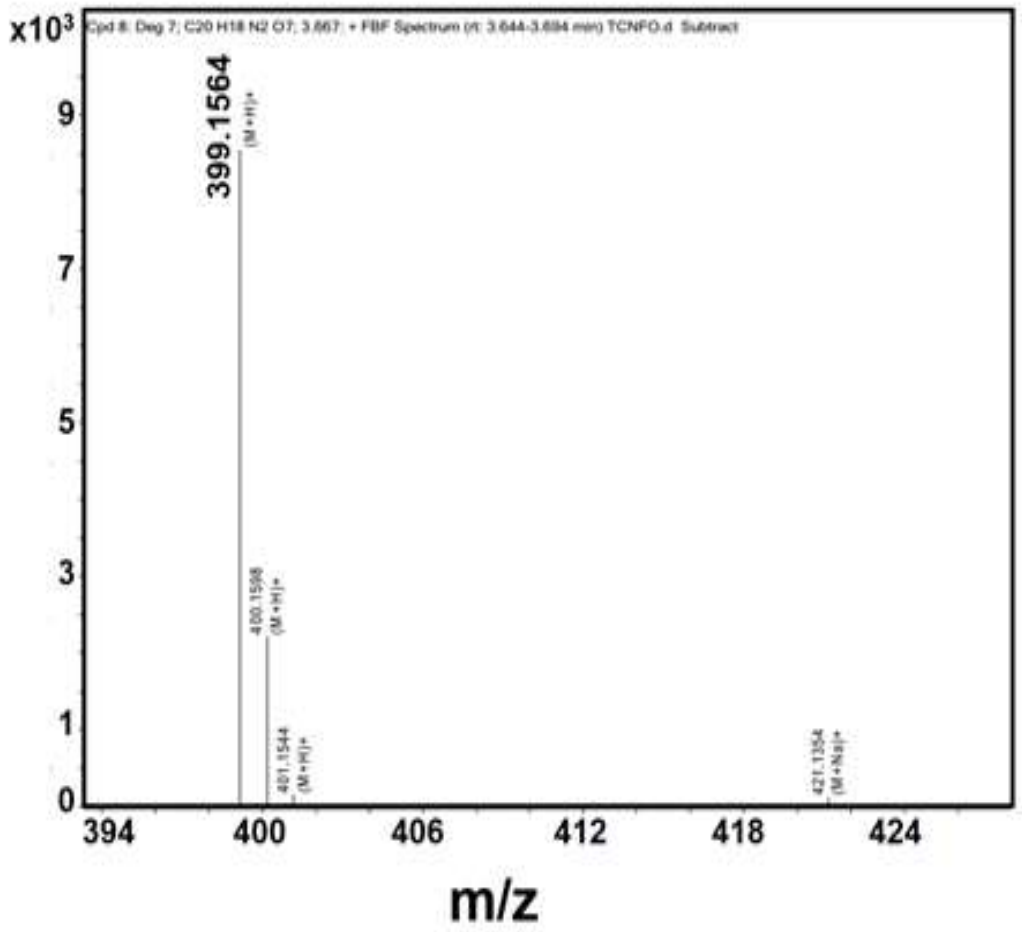
x10^3
Cpd 8: Deg 7; C20 H18 N2 O7; 3.667: + FBF Spectrum (rt: 3.644-3.694 min) TCNFO.d Subtract
399.1564
(M+H)+
400.1598
(M+H)+
401.1544
(M+H)+
421.1354
(M+Na)+
9
7
5
3
1
0
394
400
406
412
418
424
m/z

Figure S11 (c)

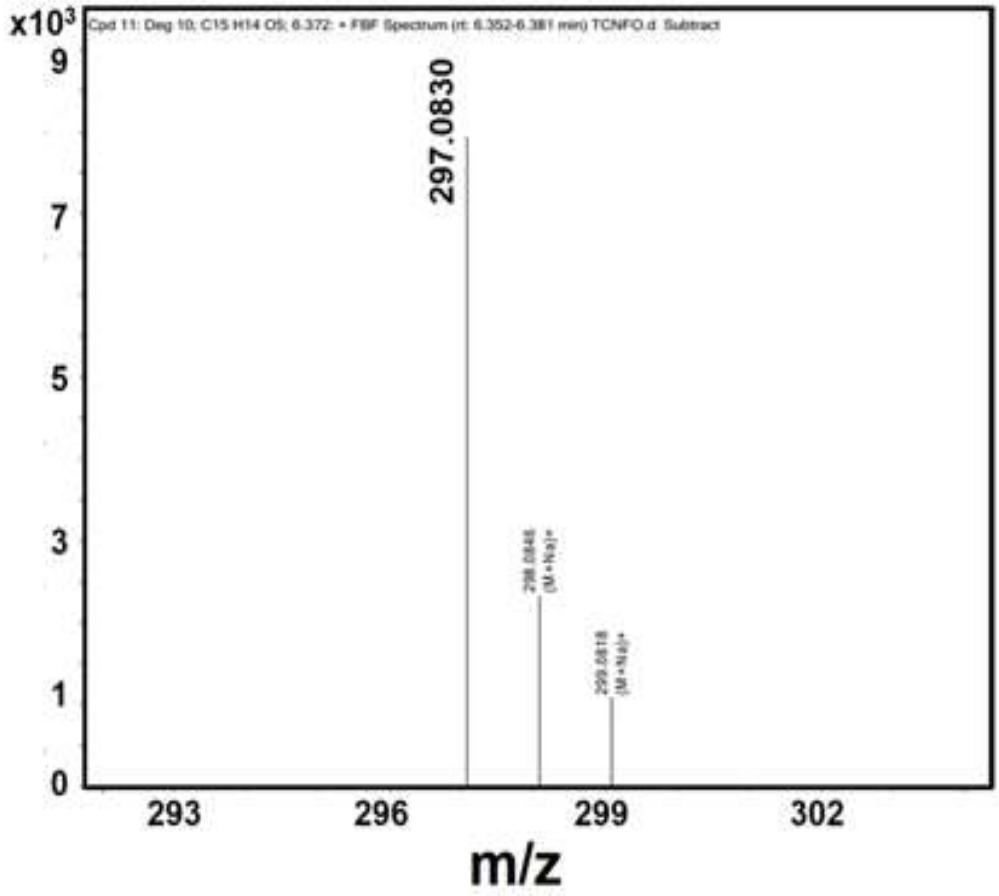
x10^3
Cpd 11: Deg 10; C15 H14 O5; 6.372: + FBF Spectrum (rt: 6.352-6.381 min) TCNFO.d Subtract
9
7
5
3
1
0
297.0830
293
296
299
302
m/z

Figure S11 (d)

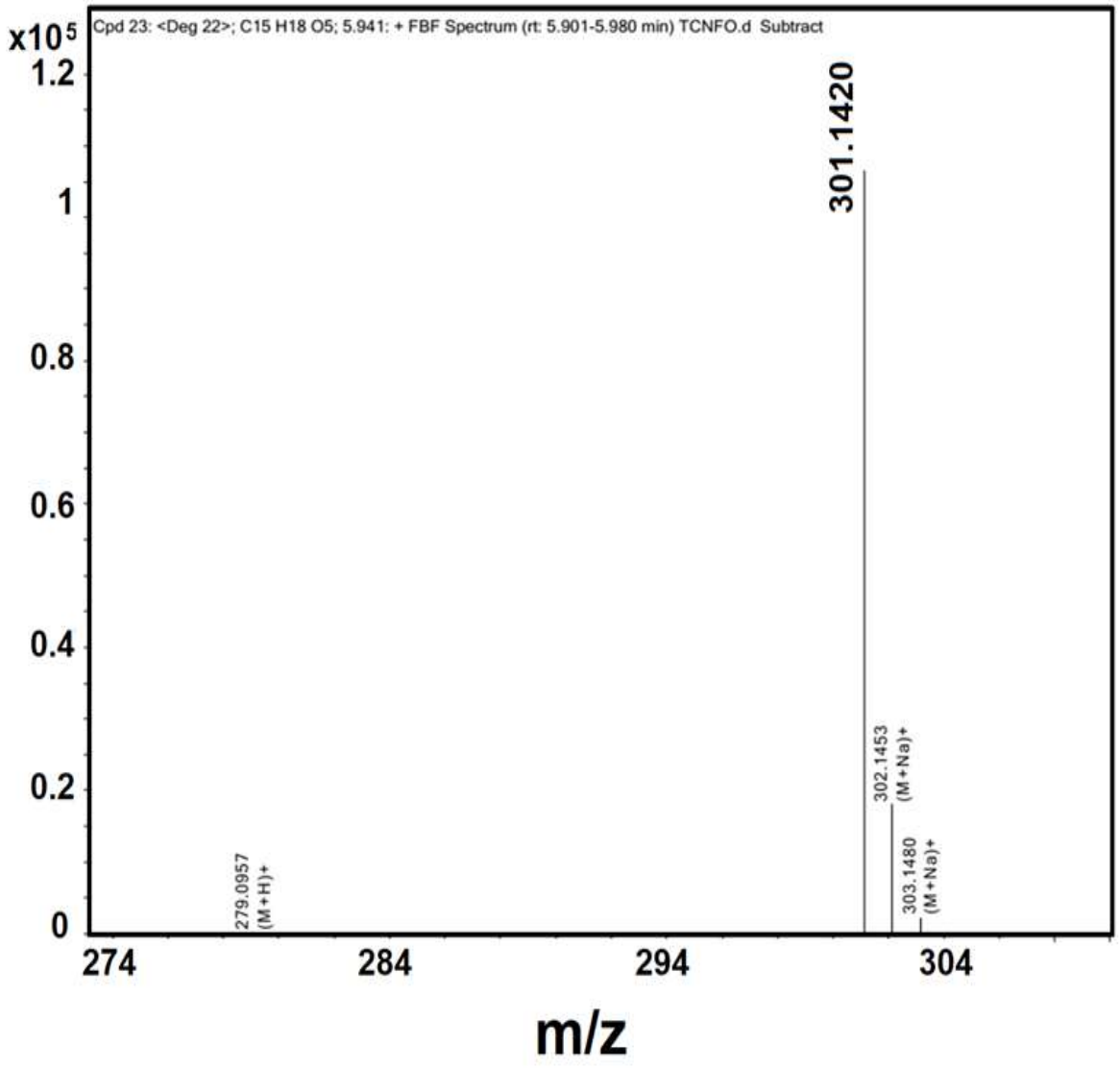
Cpd 23: <Deg 22>; C15 H18 O5; 5.941: + FBF Spectrum (rt: 5.901-5.980 min) TCNFO.d Subtract
x10^5
1.2
1
0.8
0.6
0.4
0.2
0
301.1420
302.1453
(M+Na)+
303.1480
(M+Na)+
279.0957
(M+H)+
274
284
294
304
m/z

Figure S11(e)

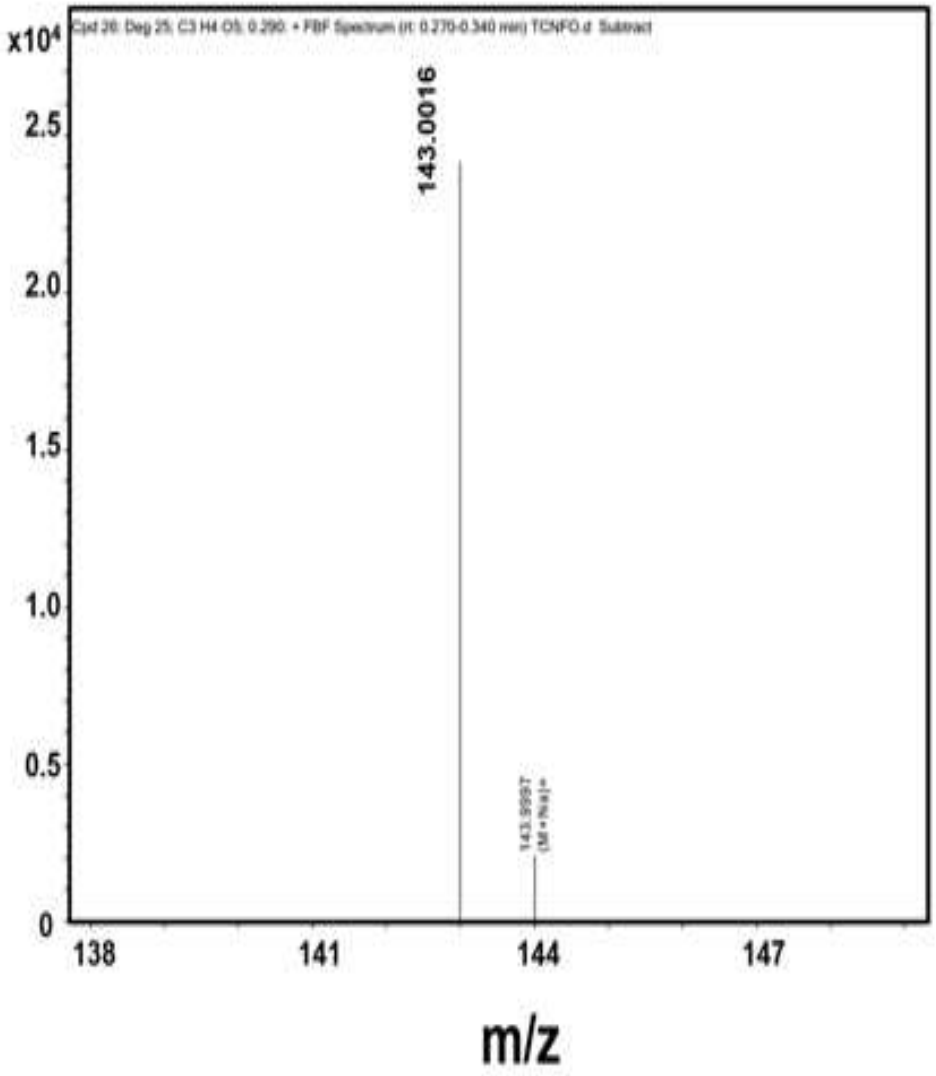
Cpd 26: Deg 25: C3 H4 O5: 0.290 : + FBF Spectrum (rt: 0.270-0.340 min) TCNFO.d Subtract
x10^4
2.5
2.0
1.5
1.0
0.5
0
143.0016
143.9997
(M+Na)+
138
141
144
147
m/z

Figure S11(f)

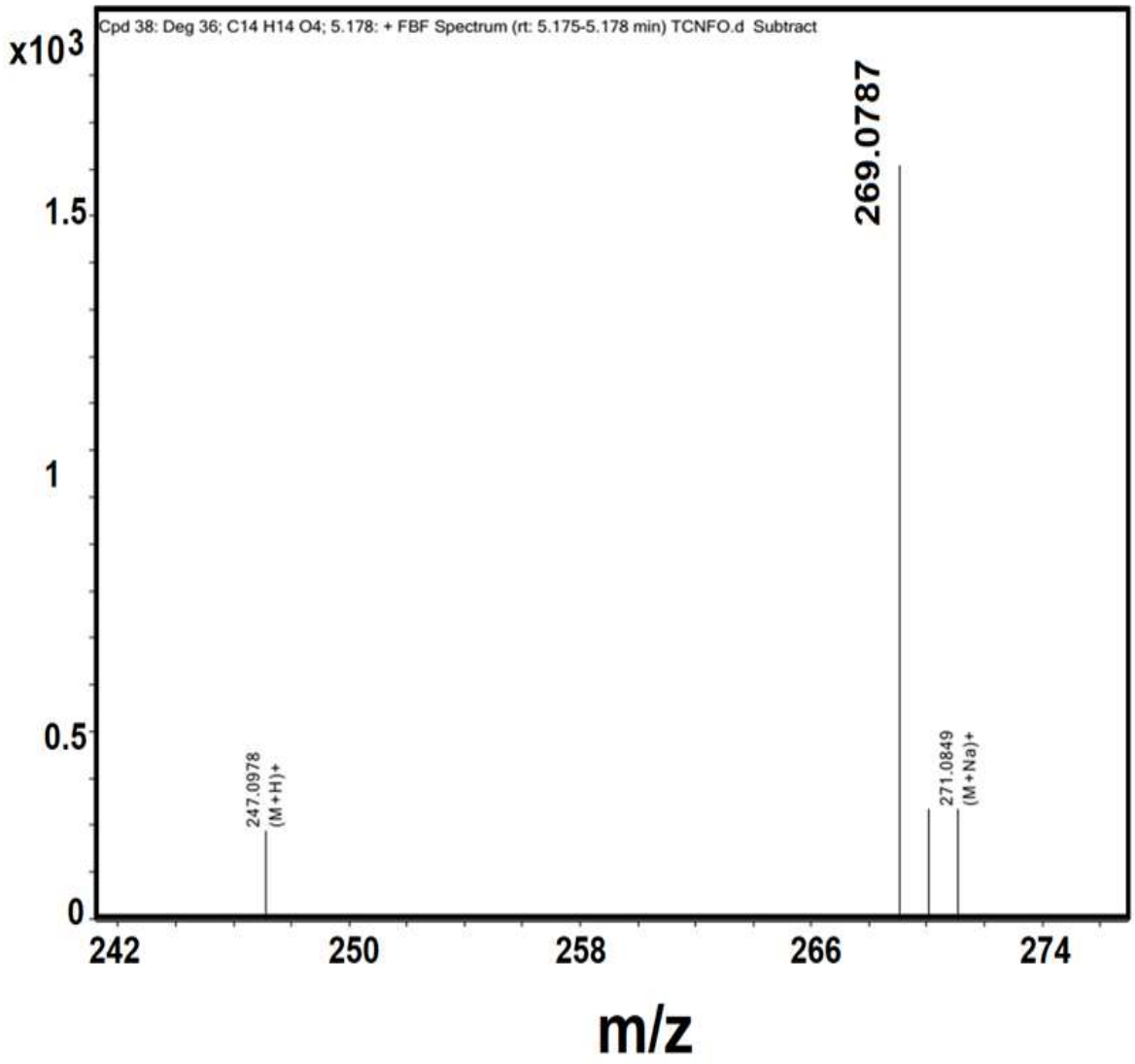
Cpd 38: Deg 36; C14 H14 O4; 5.178: + FBF Spectrum (rt: 5.175-5.178 min) TCNFO.d Subtract
x10^3
1.5
1
0.5
0
269.0787
247.0978
(M+H)+
271.0849
(M+Na)+
242
250
258
266
274
m/z

Figure S11(g)

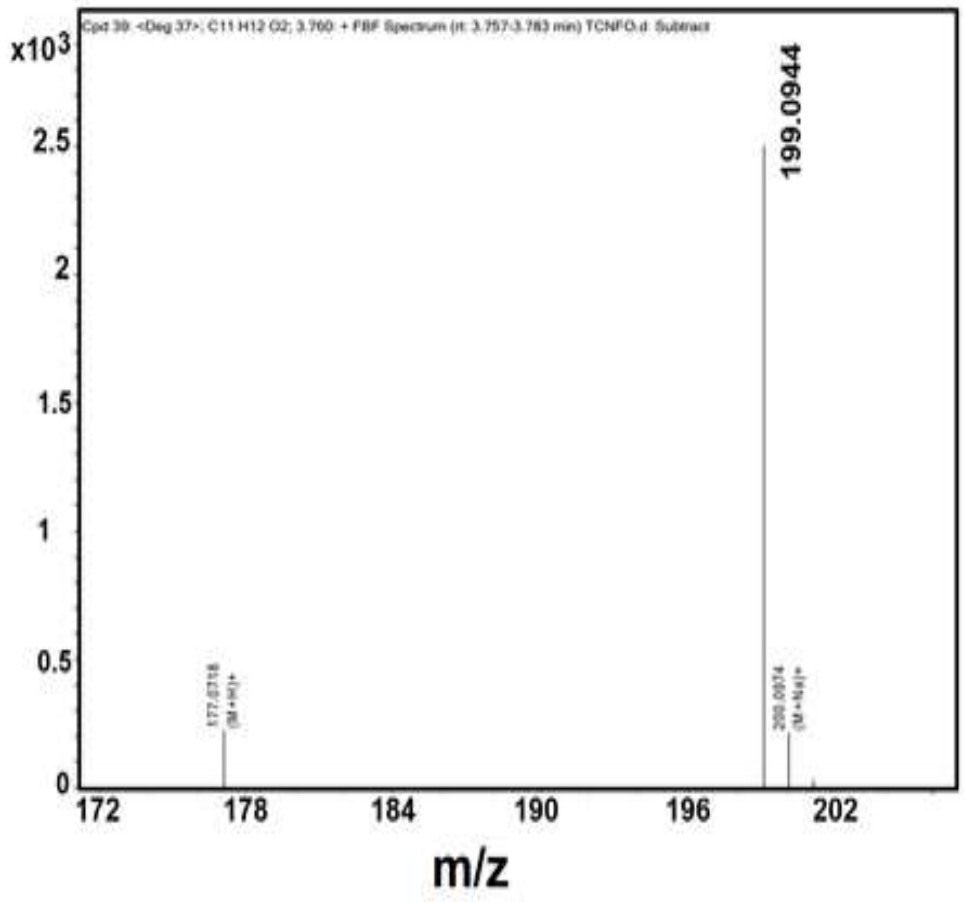

Figure S11(h)

Figure S11. The mass spectra for the intermediates are shown for (a-h) at various time intervals during the degradation of the TCH antibiotic using the SNFO catalyst.

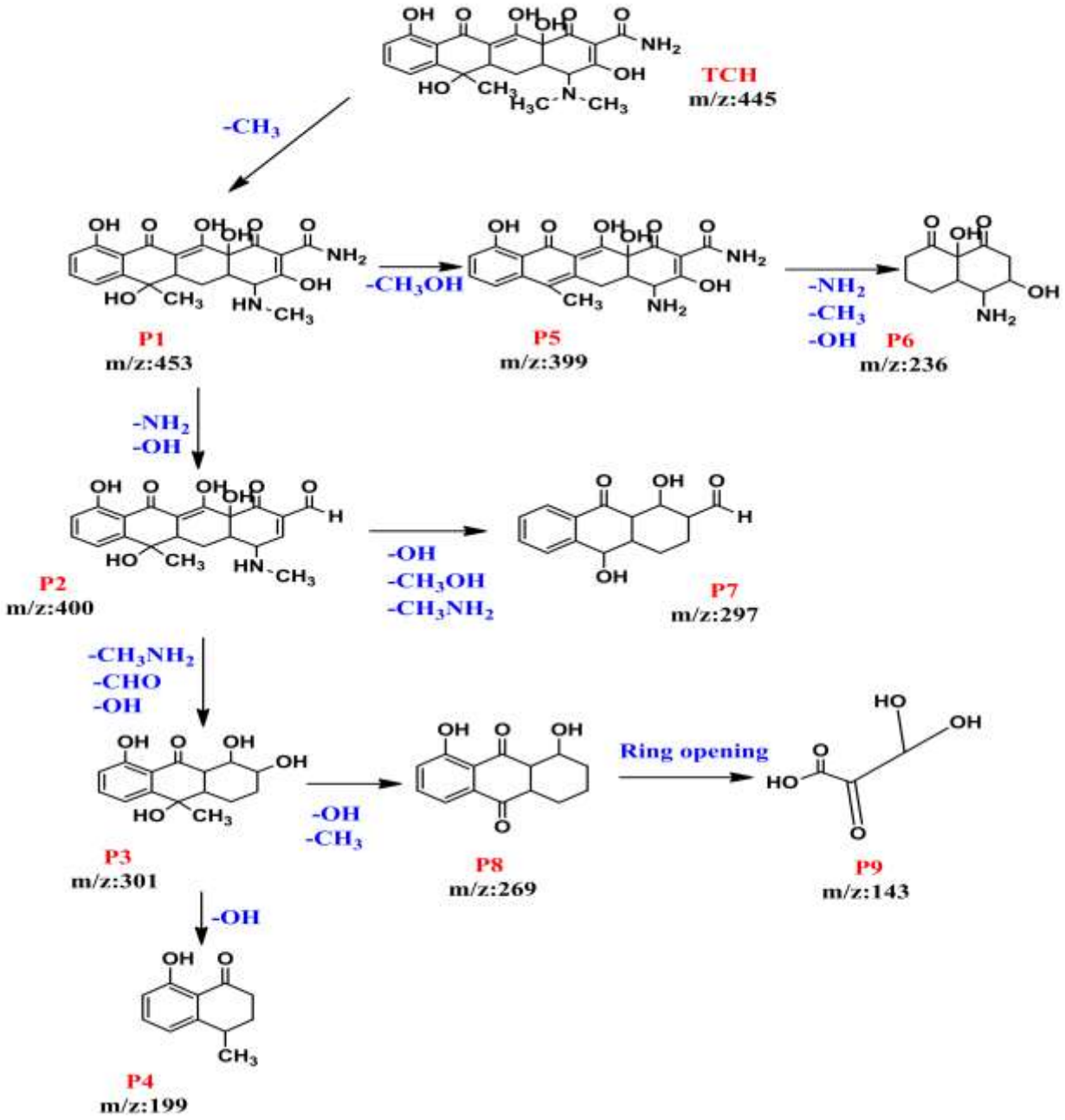

Figure S12. The proposed reaction pathways for the catalytic degradation of the TCH antibiotic molecule using the SNFO catalyst.

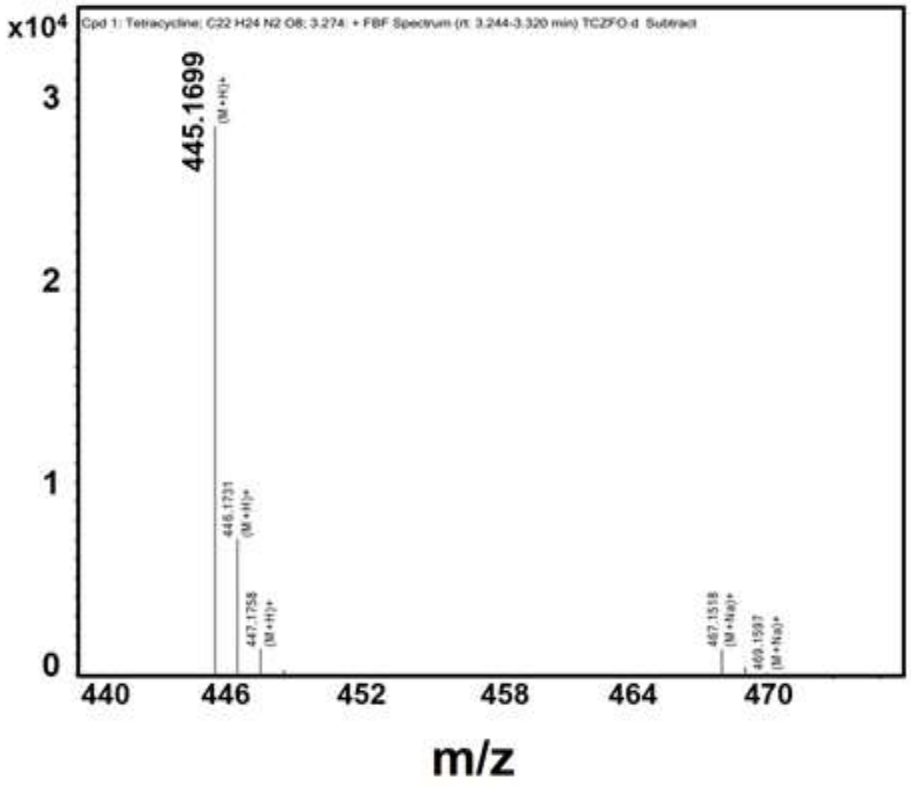
x10^4
Cpd 1: Tetracycline; C22 H24 N2 O8; 3.274: + FBF Spectrum (rt: 3.244-3.320 min) TCZFO.d Subtract
445.1699
(M+H)+
446.1731
(M+H)+
447.1758
(M+H)+
467.1518
(M+Na)+
469.1597
(M+Na)+
3
2
1
0
440
446
452
458
464
470
m/z

Figure S13(a)

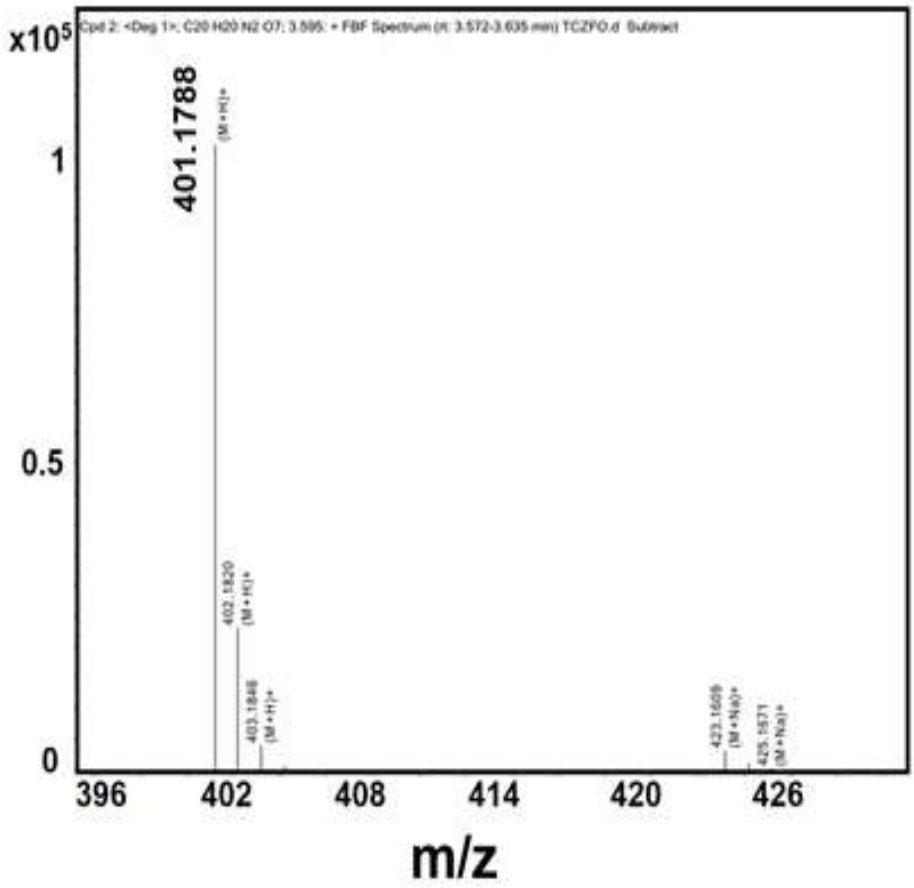
x10^5
Cpd 2: <Deg 1>: C20 H20 N2 O7: 3.595: + FBF Spectrum (rt: 3.572-3.635 min) TCZFO.d Subtract
401.1788
(M+H)+
1
0.5
0
402.1820
(M+H)+
403.1848
(M+H)+
423.1609
(M+Na)+
425.1577
(M+Na)+
396
402
408
414
420
426
m/z

Figure S13(b)

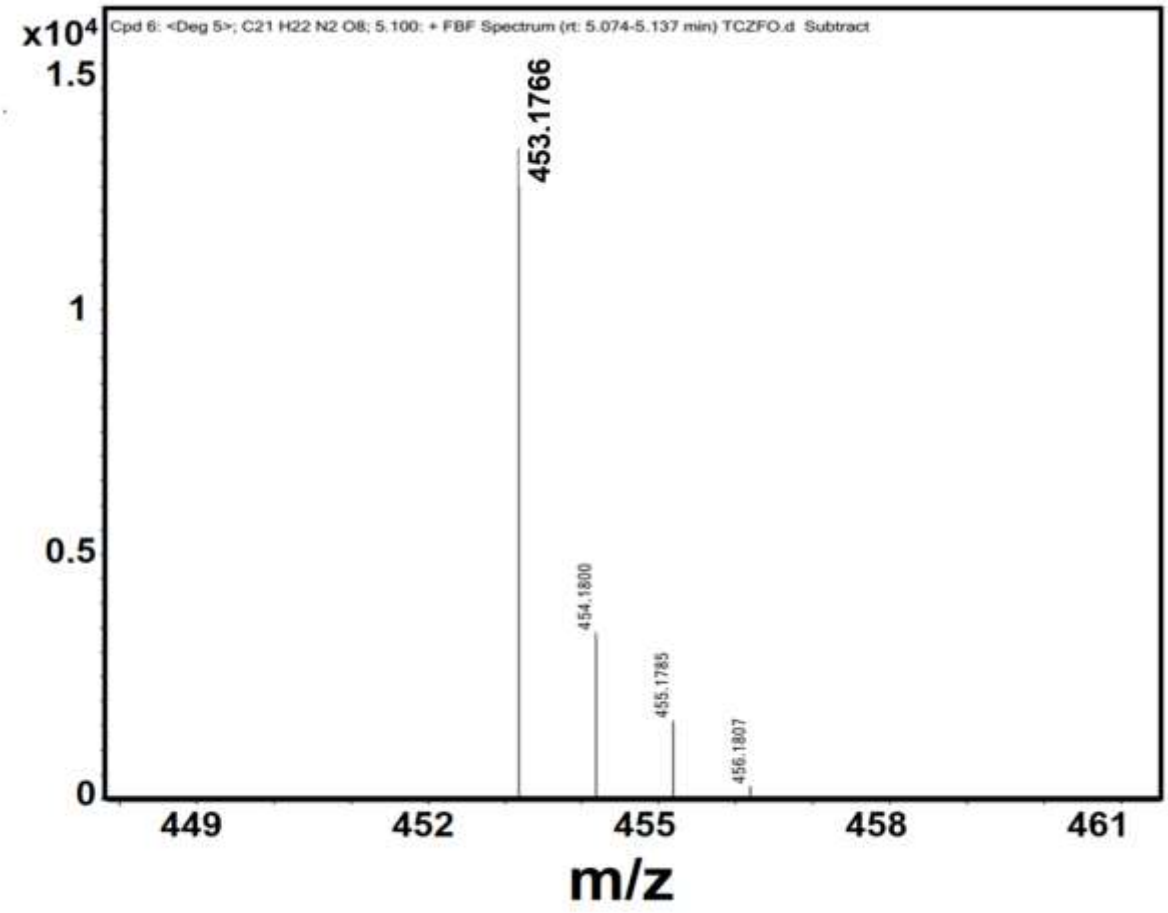
Cpd 6: <Deg 5>; C21 H22 N2 O8; 5.100: + FBF Spectrum (rt: 5.074-5.137 min) TCZFO.d Subtract
x10^4
1.5
1
0.5
0
453.1766
454.1800
455.1785
456.1807
449
452
455
458
461
m/z

Figure S13(c)

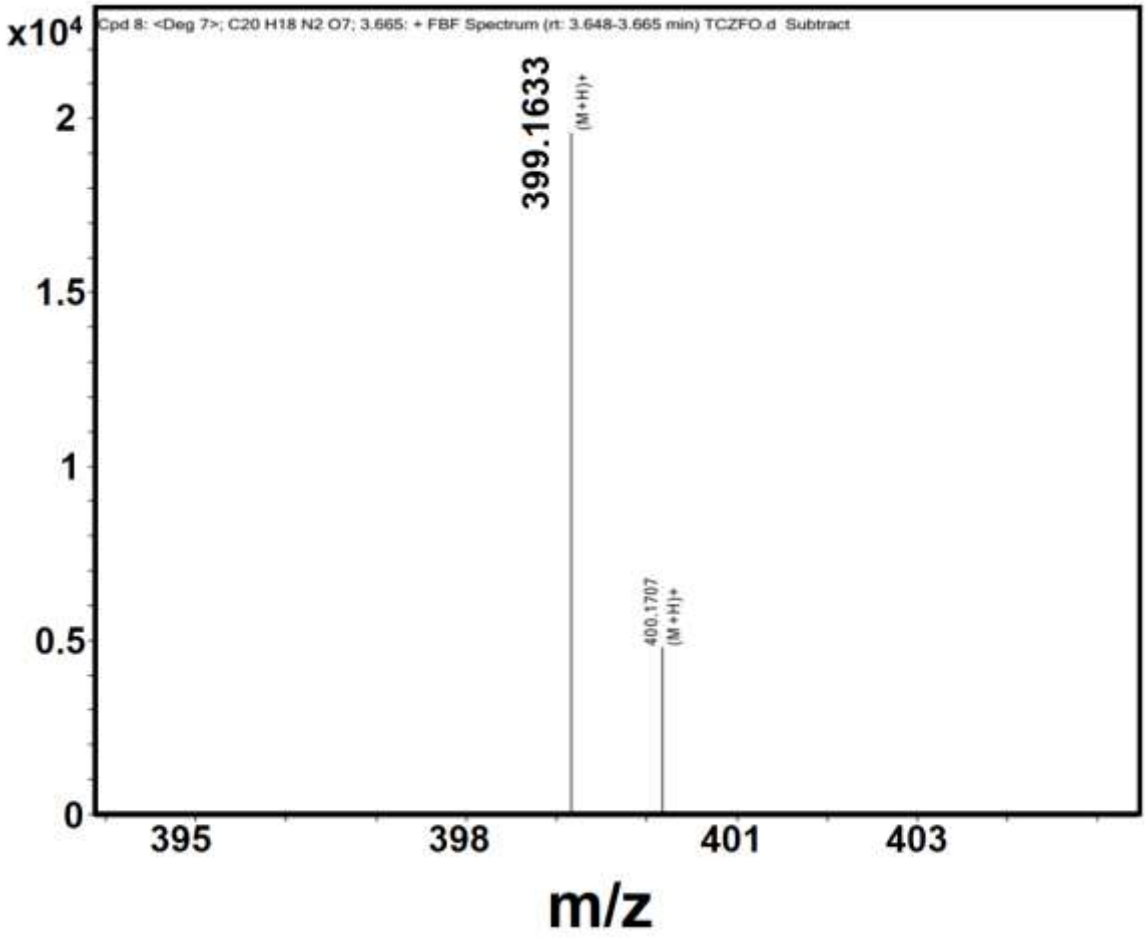
Cpd 8: <Deg 7>; C20 H18 N2 O7; 3.665: + FBF Spectrum (rt: 3.648-3.665 min) TCZFO.d Subtract
x10^4
2
1.5
1
0.5
0
399.1633
(M+H)+
400.1707
(M+H)+
395
398
401
403
m/z

Figure S13(d)

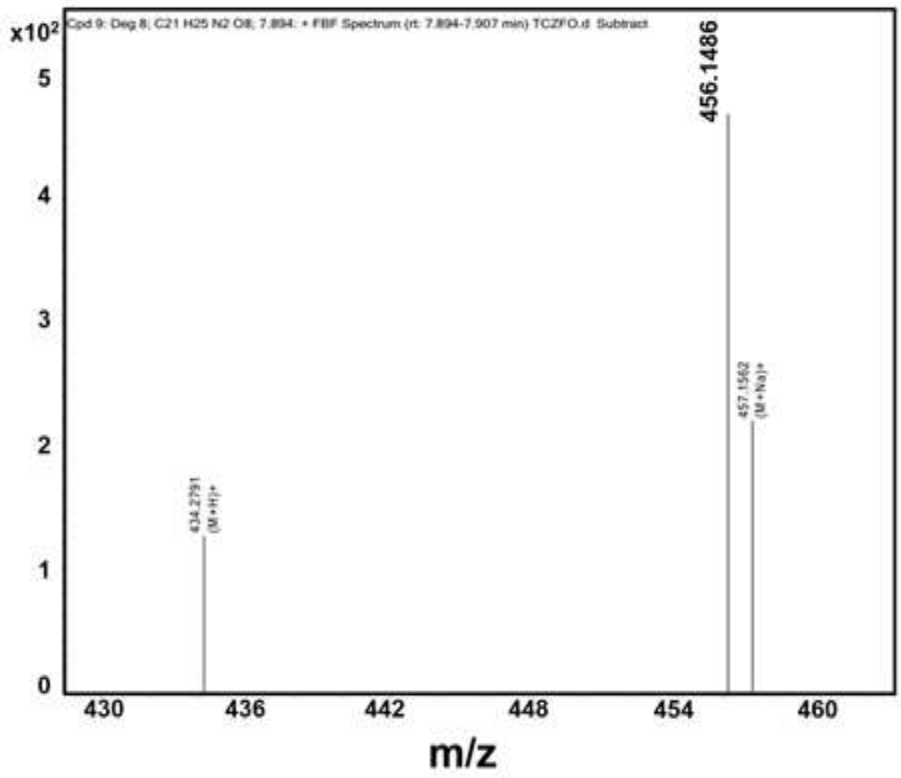
Cpd 9: Deg 8; C21 H25 N2 O8; 7.894: + FBF Spectrum (rt: 7.894-7.907 min) TCZFO.d Subtract
x10²
5
4
3
2
1
0
456.1486
457.1562
(M+Na)+
434.2791
(M+H)+
430
436
442
448
454
460
m/z

Figure S13(e)

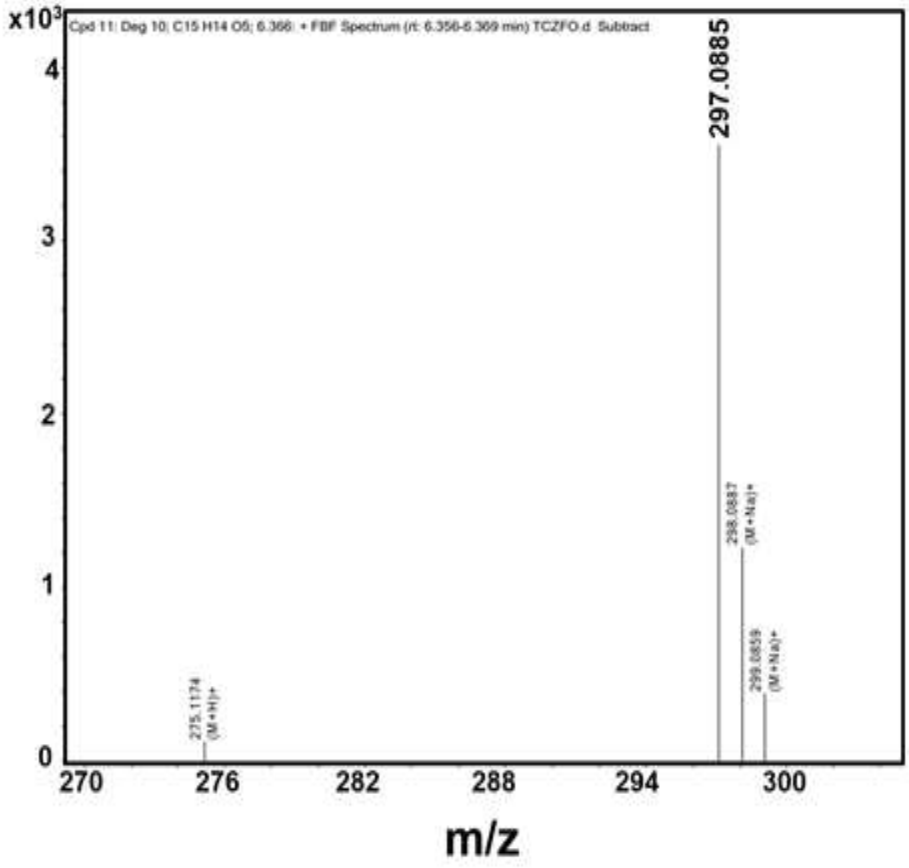
x10^3
Cpd 11: Deg 10; C15 H14 O5; 6.366: + FBF Spectrum (rt: 6.356-6.369 min) TCZFO.d Subtract
297.0885
298.0887
(M+Na)+
299.0859
(M+Na)+
275.1174
(M+H)+
4
3
2
1
0
270
276
282
288
294
300
m/z

Figure S13(f)

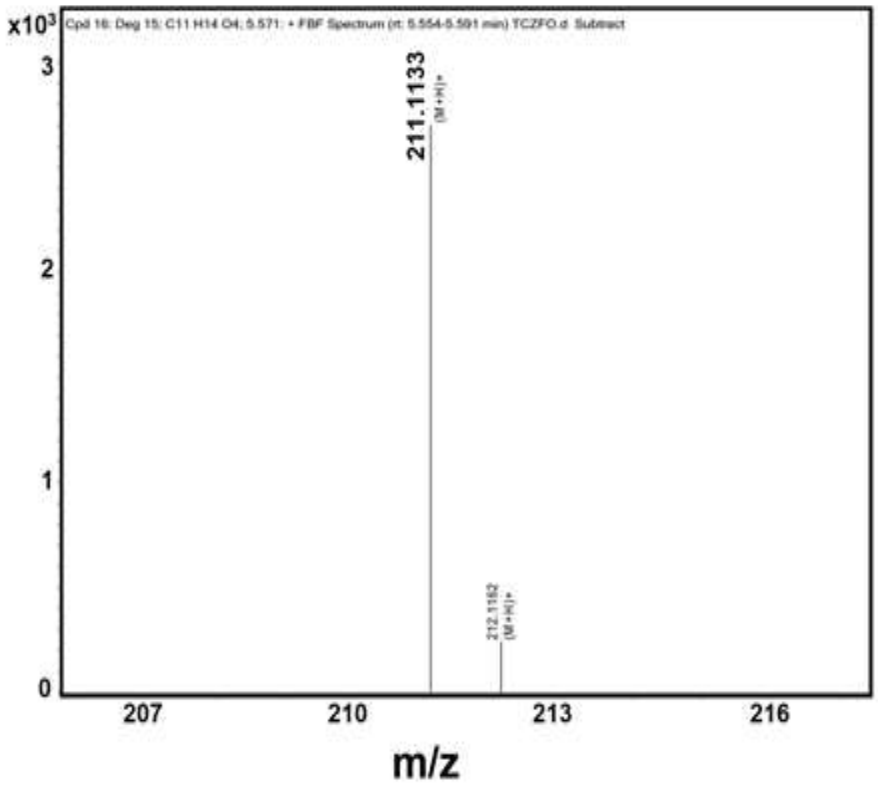
x10^3
Cpd 16: Deg 15; C11 H14 O4; 5.571: + FBF Spectrum (rt: 5.554-5.591 min) TCZFO.d Subtract
3
2
1
0
211.1133
(M+H)+
212.1162
(M+H)+
207
210
213
216
m/z

Figure S13(g)

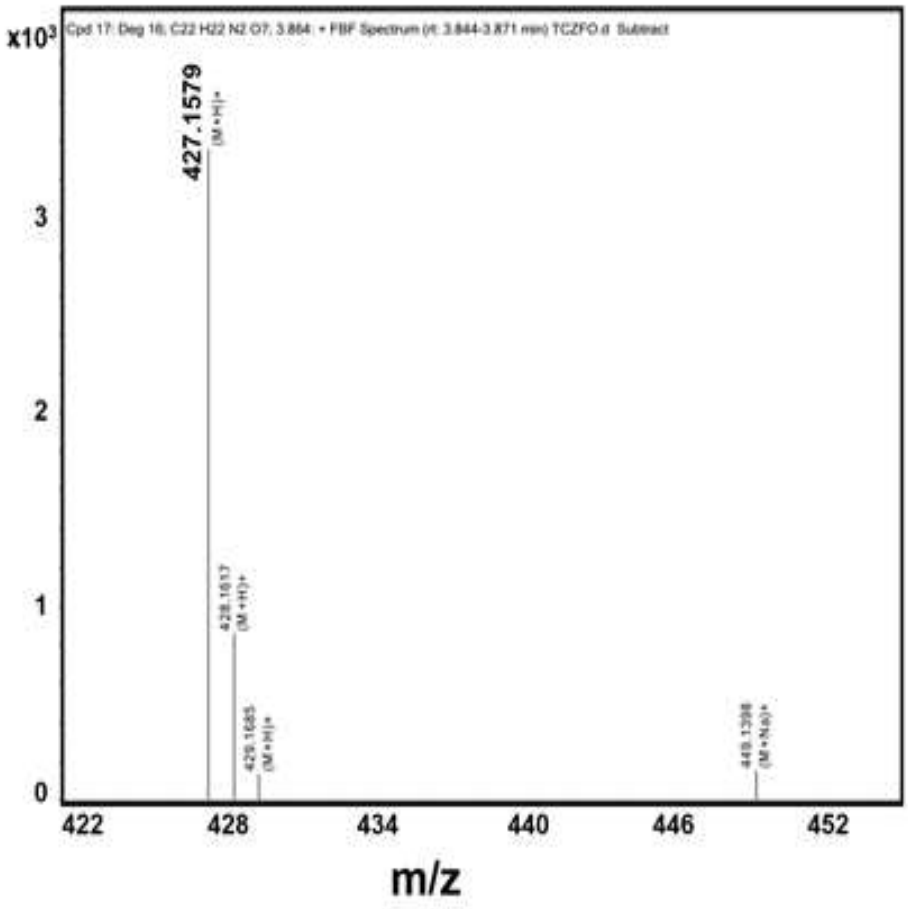
x10^3
Cpd 17: Deg 16, C22 H22 N2 O7, 3.864 : + FBF Spectrum (rt: 3.844-3.871 min) TCZFO.d Subtract
427.1579
(M+H)+
428.1617
(M+H)+
429.1685
(M+H)+
449.1398
(M+Na)+
3
2
1
0
422
428
434
440
446
452
m/z

Figure S13 (h)

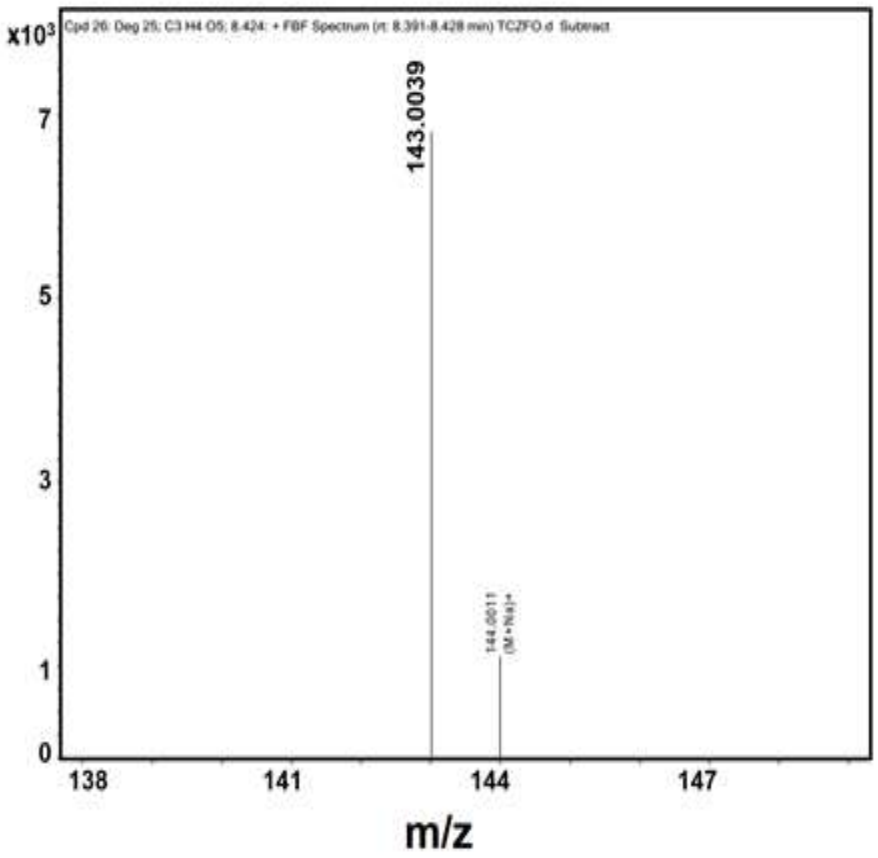
Cpd 26: Deg 25; C3 H4 O5; 8.424: + FBF Spectrum (rt: 8.391-8.428 min) TCZFO.d Subtract
x10³
7
5
3
1
0
143.0039
144.0011
(M+Na)+
138
141
144
147
m/z

Figure S13(i)

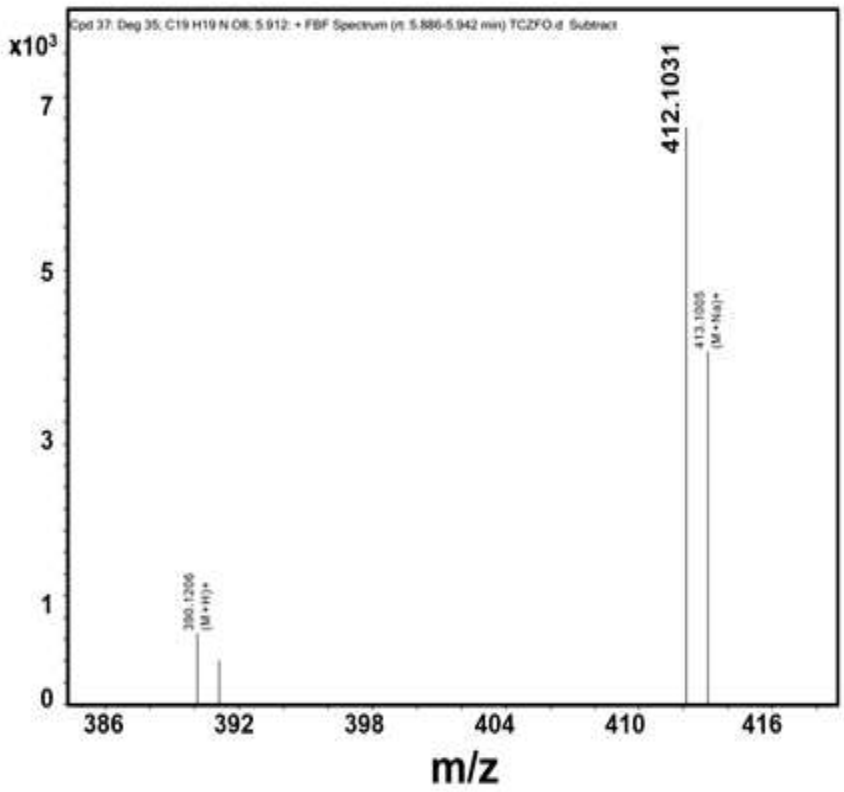
Cpd 37: Deg 35, C19 H19 N O8, 5.912: + FBF Spectrum (rt: 5.886-5.942 min) TCZFO.d Subtract
x10^3
7
5
3
1
0
412.1031
413.1065
(M+Na)+
390.1206
(M+H)+
386
392
398
404
410
416
m/z

Figure S13(j)

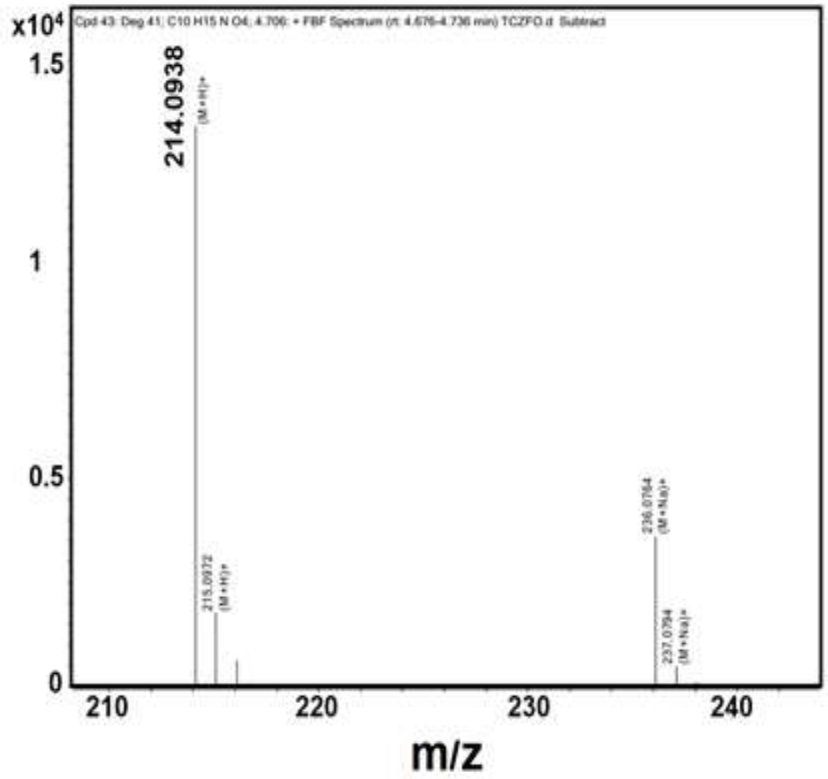
x10^4
1.5
1
0.5
0
214.0938
(M+H)+
215.0972
(M+H)+
236.0764
(M+Na)+
237.0794
(M+Na)+
210
220
230
240
m/z

Figure S13 (k)

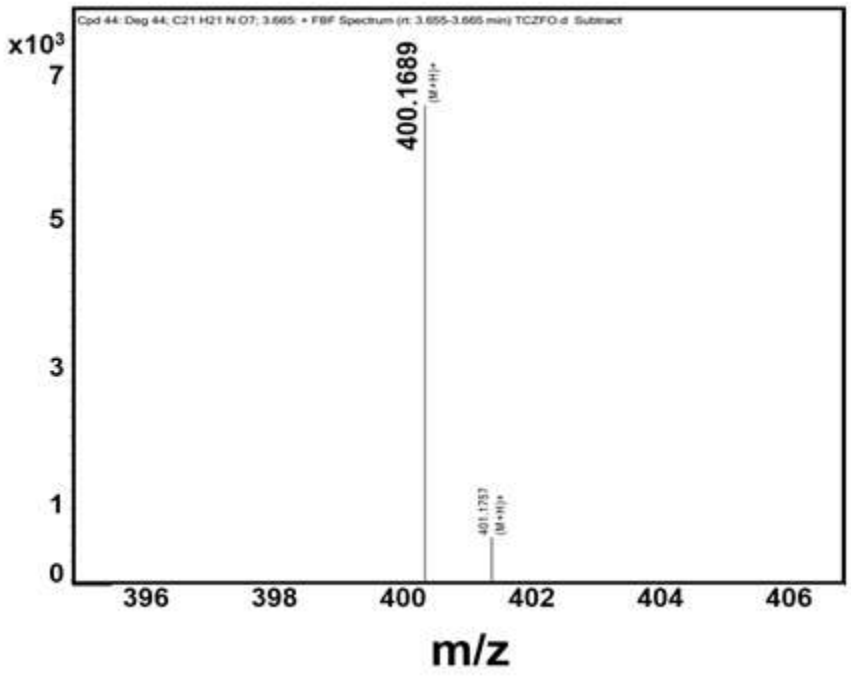

Fig. S13 (l)

Figure S13. The mass spectra for the intermediates are shown for (a-l) at various time intervals during the degradation of the TCH antibiotic using the SZFO catalyst.

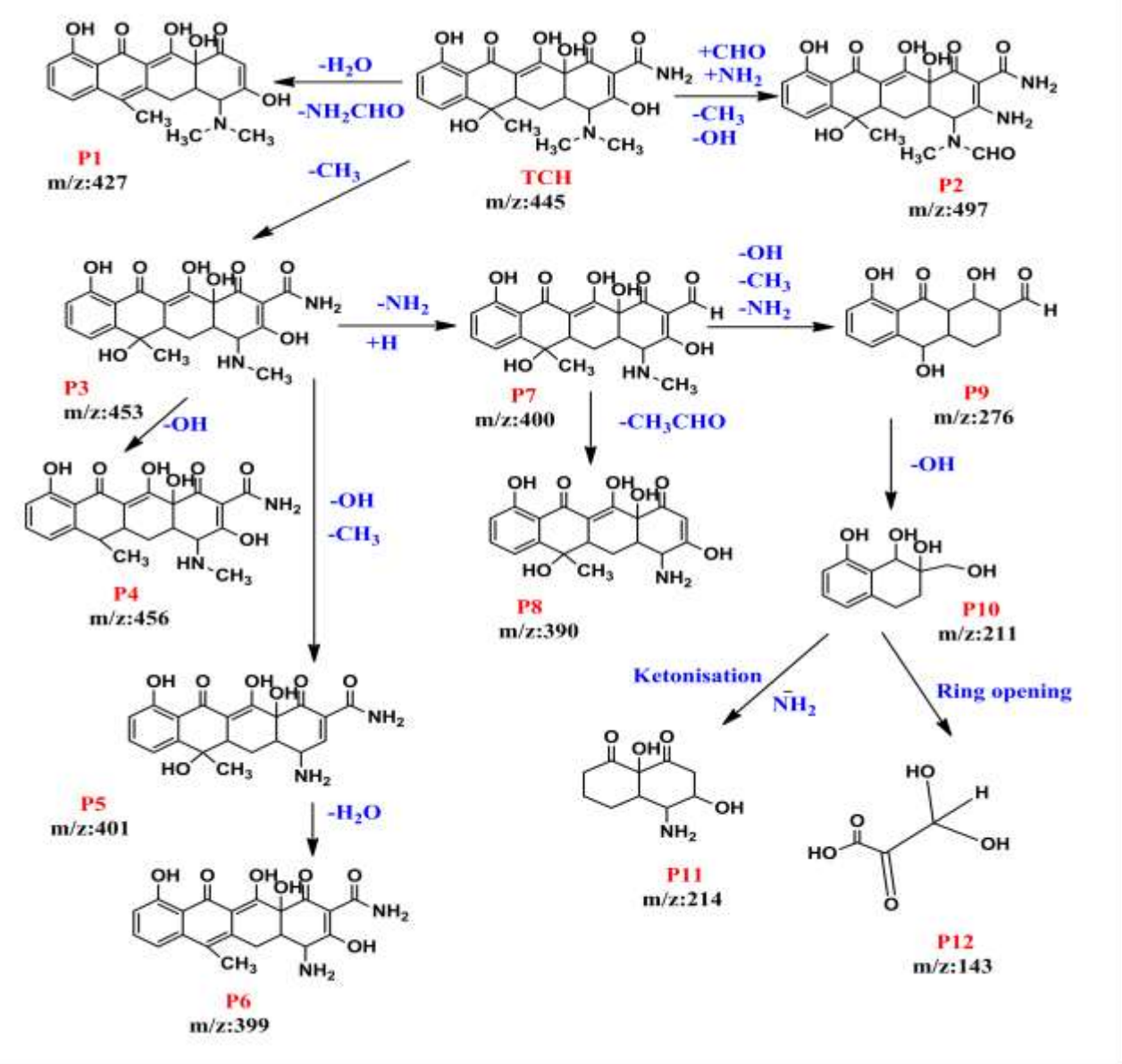

Figure S14. The proposed reaction pathways for the catalytic degradation of the TCH antibiotic molecule using the SZFO catalyst.