Electronic Supplementary Material (ESI) for Journal of Materials Chemistry B.

Support Information

Synthesis of L-aspartic acid-based bimetallic hybrid nanoflowers to immobilization snailase for production of rare ginsenoside Compound K

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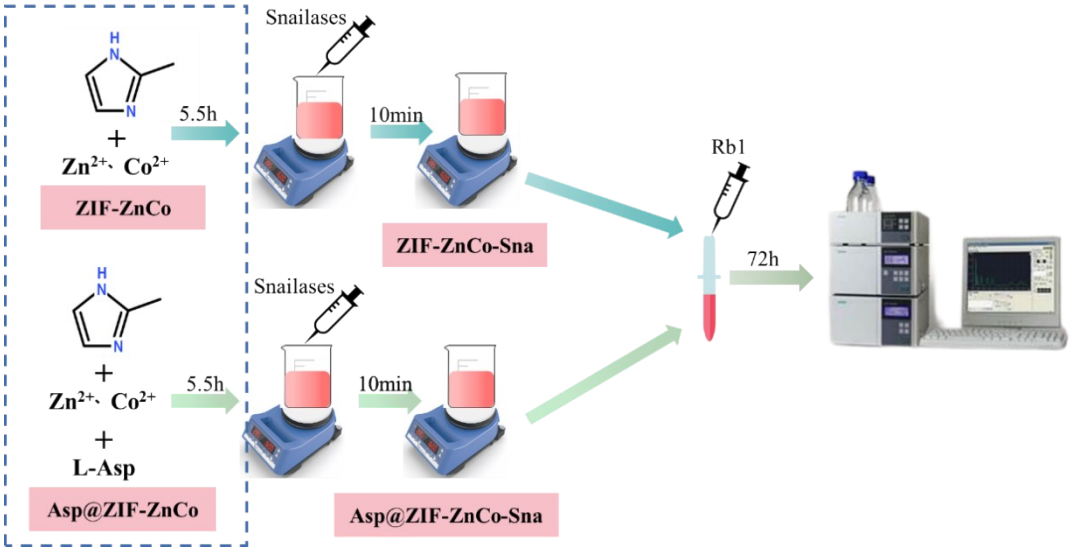

Figure. S1 Schematic diagram of the ZIF-ZnCo, ZIF-ZnCo-Sna, Asp@ZIF-ZnCo and Asp@ZIF-ZnCo-Sna material preparation process

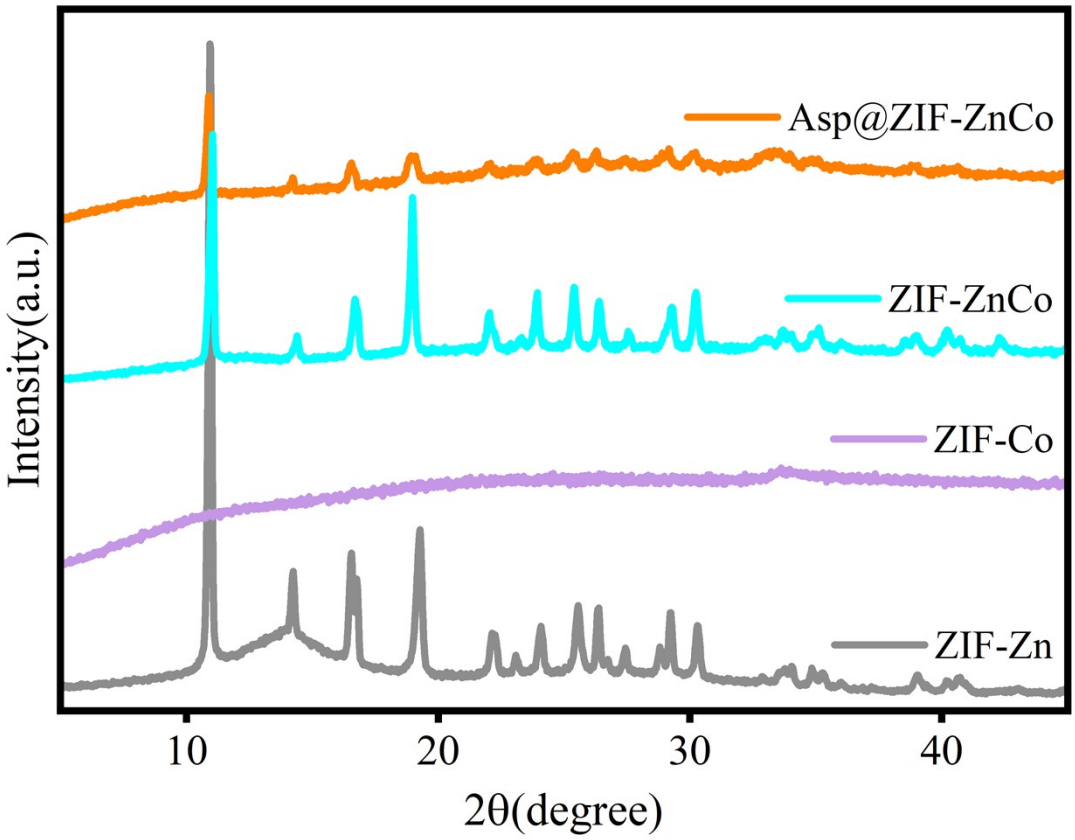

Figure. S2 XRD of ZIF-Zn, ZIF-Co, ZIF-ZnCo, Asp@ZIF-ZnCo

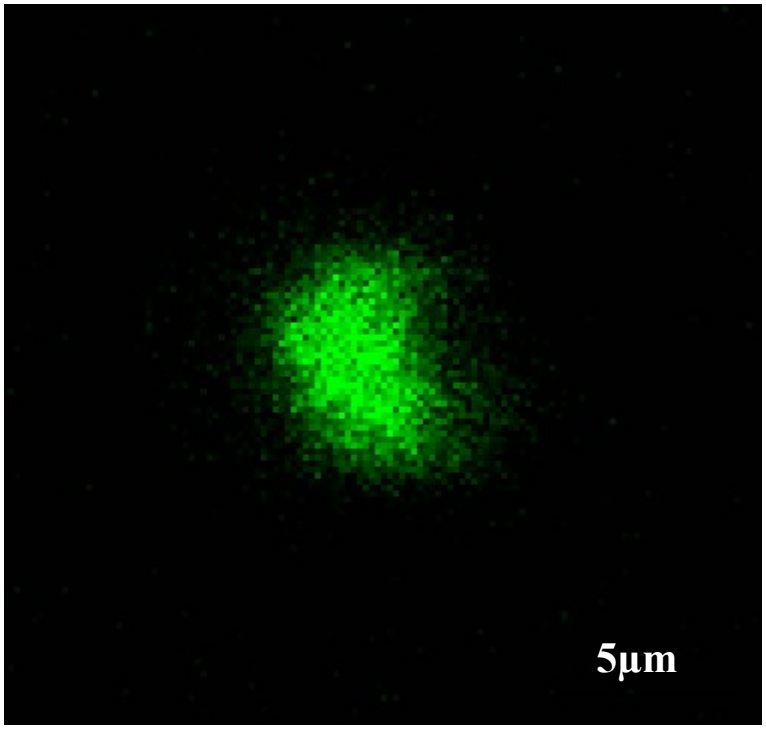

Figure. S3 FITC images of ZIF-ZnCo-Sna

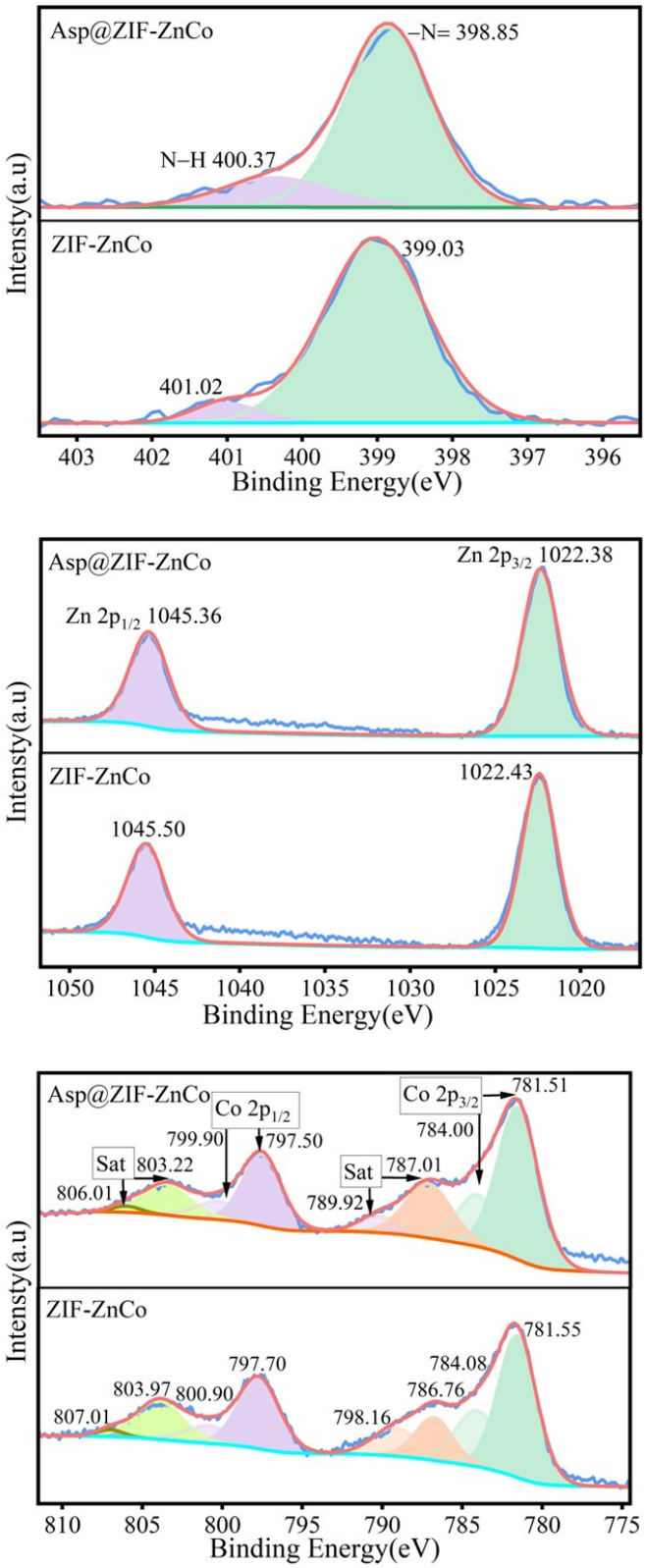

Figure. S4 ZIF-ZnCo and Asp@ZIF-ZnCo were scanned with XPS extended spectra for the N 1s, Zn 2p and Co 2p regions.

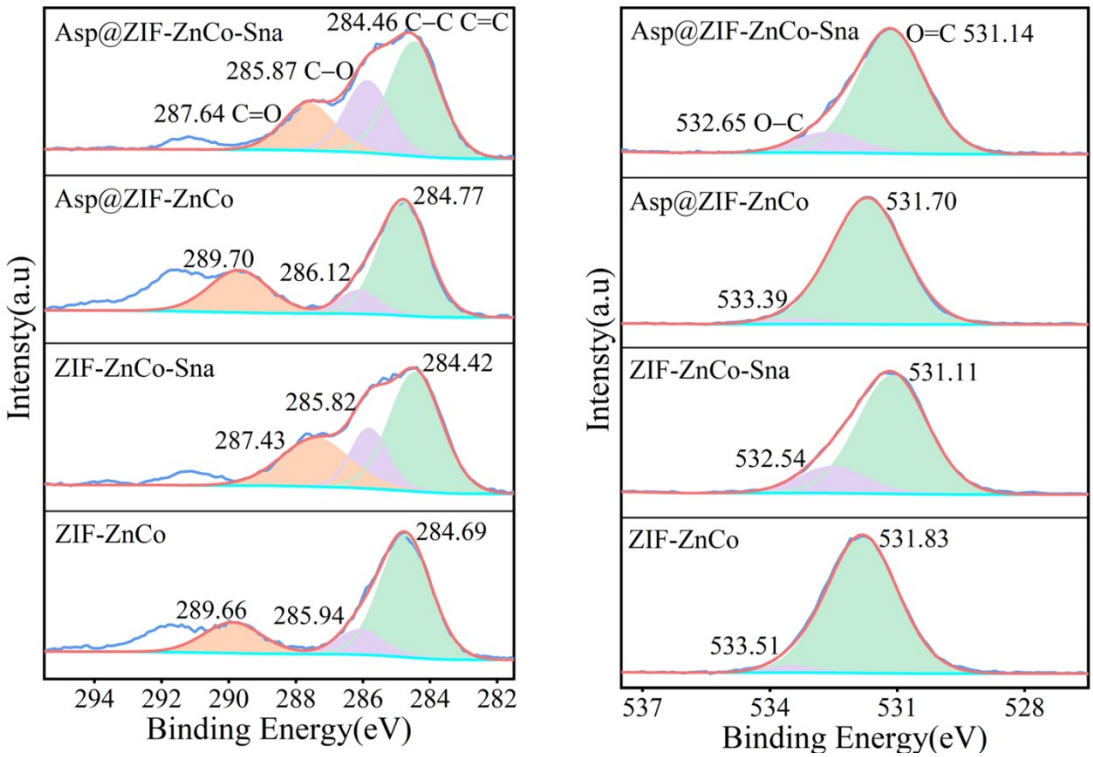

Figure. S5 Extended XPS spectral scans of the C 1s and O 1s regions for ZIF-ZnCo, ZIF-ZnCo-Sna, Asp@ZIF-ZnCo, Asp@ZIF-ZnCo-Sna.

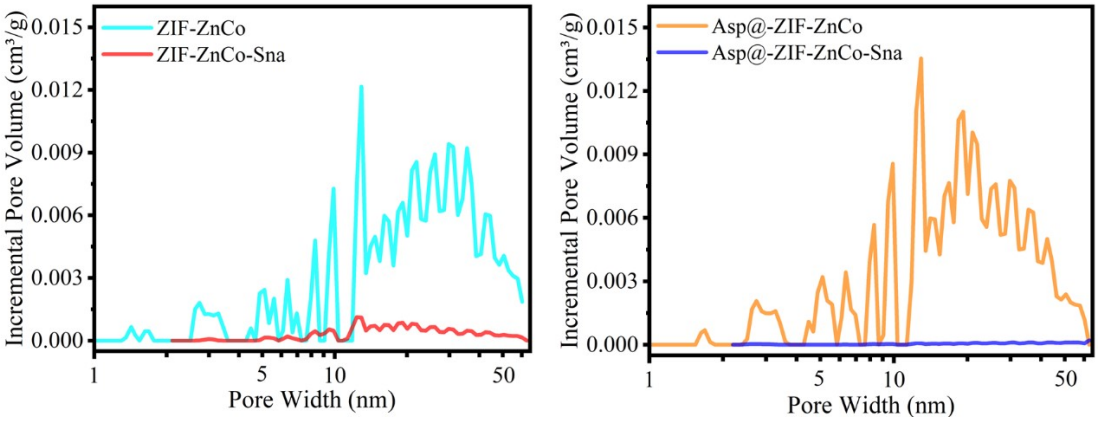

Figure. S6 DFT simulation of ZIF-ZnCo, ZIF-ZnCo-Sna (a), Asp@ZIF-ZnCo, Asp@ZIF-ZnCo-Sna

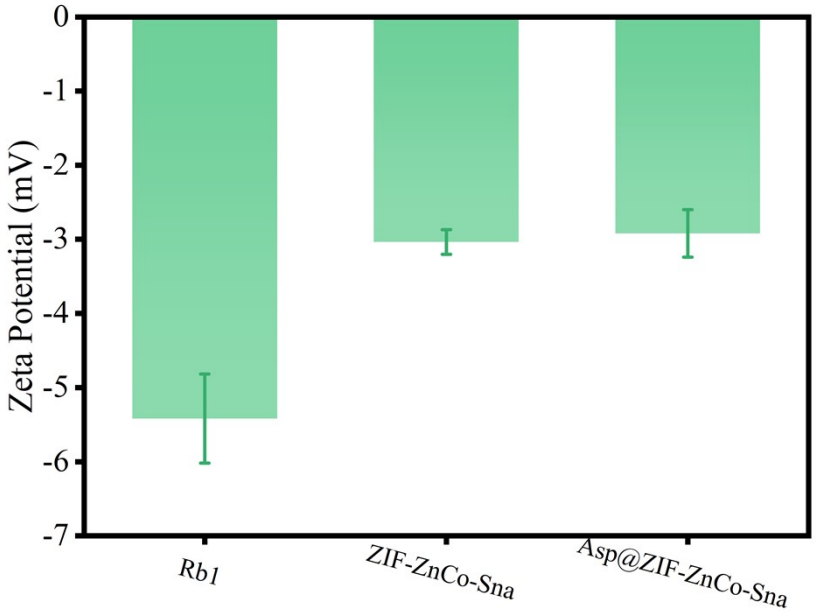

Figure. S7 Snailase, ZIF-ZnCo-Sna, Asp@ZIF-ZnCo-Sna zeta potential

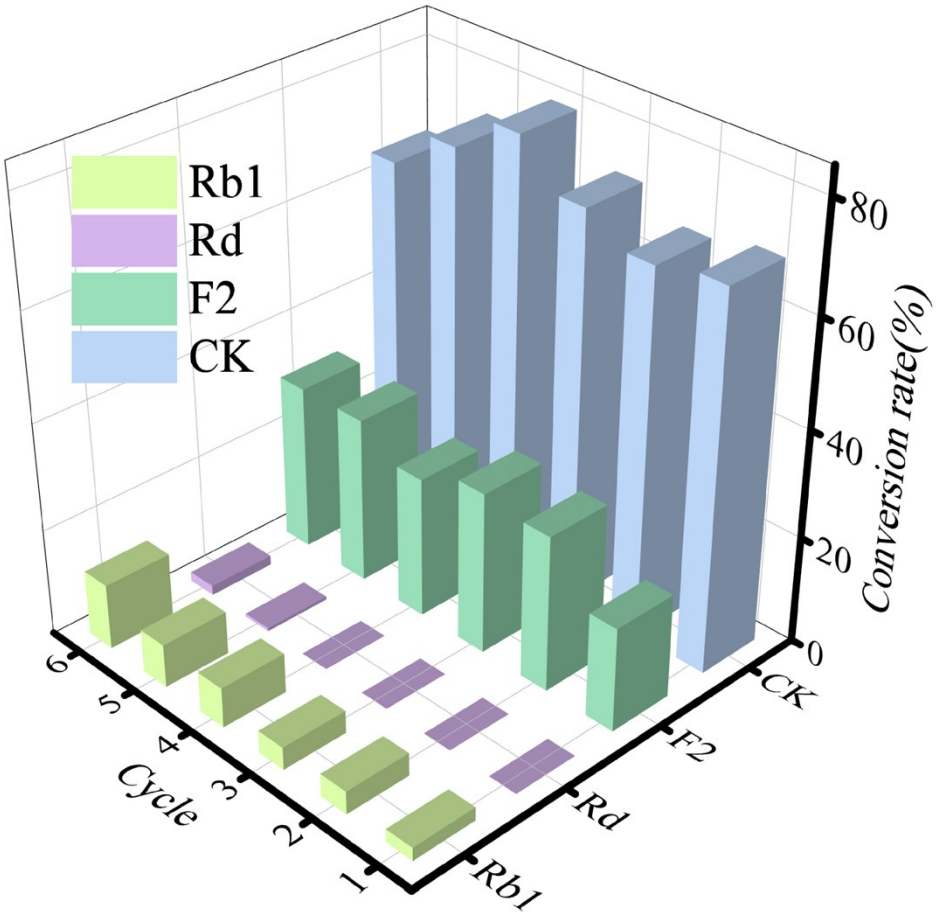

Figure. S8 Catalytic efficiency of Asp@ZIF-ZnCo-Sna on Rb1

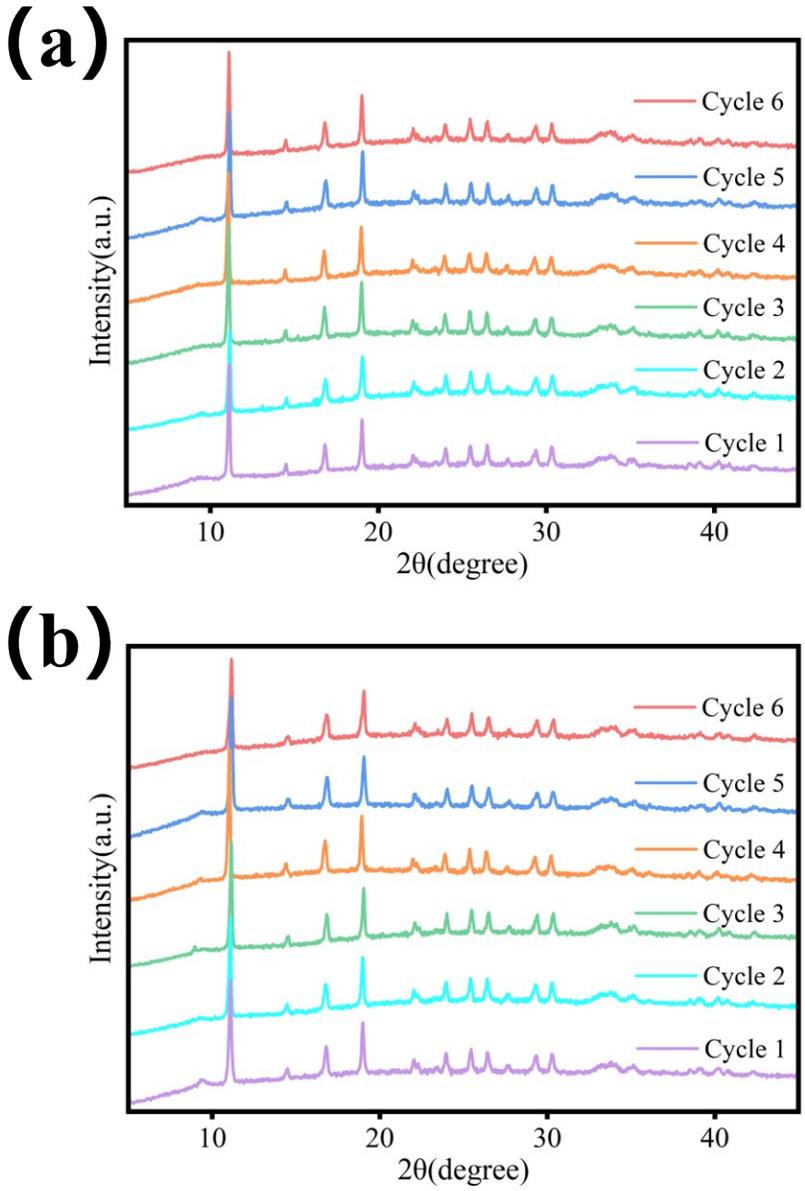

Figure. S9 XRD of cycles of ZIF-ZnCo-Sna (a) and Asp@ZIF-ZnCo-Sna (b).

Table S1. Temperature stability parameters for free and immobilised enzymes

℃	Asp@ZIF-ZnCo-Sna		ZIF-ZnCo-Sna		Sna	
	Mean	Standard	Mean	Standard	Mean	Standard
30	99.59489	0.35132	98.39943	1.35071	99.50839	0.60428
40	98.45228	0.96731	86.08292	2.55268	95.73881	0.44299
50	73.83267	2.70924	61.59583	1.35936	83.85455	0.49087
60	70.76023	1.35338	59.0751	2.045	30.27465	0.37629
70	65.39056	2.04099	52.59322	1.73636	8.60674	0.37629
80	49.51407	1.13453	42.87041	2.4357	4.29042	0.53911

Table S2. pH stability parameters for free and immobilised enzymes

pH	Asp@ZIF-ZnCo-Sna		ZIF-ZnCo-Sna		Sna	
	Mean	Standard	Mean	Standard	Mean	Standard
3	80.27736	1.18159	83.43272	1.75084	55.11507	0.37378
4	94.45647	1.18159	91.66368	1.07088	82.19145	0.42189
5	98.86774	1.1168	98.43707	1.43213	99.72037	0.24358
6	66.33458	1.25048	65.42751	0.53544	78.33363	1.52785
7	61.9233	0.89469	59.68299	0.82684	37.00597	2.53368
8	45.93242	0.49194	43.4783	1.07088	32.85916	1.49124
9	43.41169	0.85206	38.41969	0.82684	15.00567	0.26611
10	35.29809	1.18944	32.84665	0.77165	3.77956	1.41015

Table S3. Storage stability parameters for free and immobilised enzymes

d	Asp@ZIF-ZnCo-Sna		ZIF-ZnCo-Sna		Sna	
	Mean	Standard	Mean	Standard	Mean	Standard
0	99.5227	0.30415	100.0469	0.39473	99.01538	0.9988
5	101.0644	1.02286	98.47277	0.35366	96.2243	2.31236
10	98.89455	0.60798	98.87604	0.88431	88.74098	0.4425
15	95.6316	0.92928	97.21963	1.10343	78.4974	0.46064
20	92.1181	0.78223	94.96882	0.84318	73.81998	0.15782
25	91.23481	1.05231	94.47832	1.37499	62.563	0.61821
30	92.64263	1.05869	88.05311	0.99282	57.82971	0.77178

Table S4. Cycle stability enzyme activity parameters for immobilised enzymes

Cycle	Asp@ZIF-ZnCo-Sna		ZIF-ZnCo-Sna	
	Mean	Standard	Mean	Standard
0	98.97517	0.98439	94.93445	1.61526
1	93.89843	1.50462	90.0414	1.22157
2	92.79064	1.68951	82.85569	1.86055
3	79.36836	1.56082	71.86599	2.04349
4	62.3981	1.95396	51.72525	2.04841
5	62.67735	3.46902	39.92965	1.78307
6	51.61065	2.59215	37.7977	1.78824

Table S5. Snailase catalytic ginsenoside conversion parameters

Time(h)	Rb1	Rd	F2	CK
12	10.55	12.31	1.79	50.82694
24	10.11	1.03	9.54	49.4792
36	3.99	0.92	3.95	55.96048
48	0.08	0.9	0.14	58.88427
60	0.07	0.07	0.8	59.33867
72	0.09	0.05	0.6	58.33867
84	0.06	0.06	0.8	58.84012
96	0.07	0.05	0.7	58.84012

Table S6. ZIF-ZnCo-Sna catalytic ginsenoside conversion parameters

Time(h)	Rb1	Rd	F2	CK
12	2.35	8.95	14.97	30.95
24	2.71	7.43	17.36	32.1
36	2.74	5.2	19.95	35.45
48	2.43	0.9	23.41	47.53
60	2.29	0.09	27.34	53.07
72	2.36	1.05	14.46	59.88
84	2.62	2.06	14.21	62.85
96	2.53	1.01	14.27	61.3

Table S7. Asp@ZIF-ZnCo-Sna catalytic ginsenoside conversion parameters

Time(h)	Rb1	Rd	F2	CK
12	5.82	10.21	9.32	35.27
24	3.92	9.99	18.63	36.1
36	3.68	6.3	22.56	39.33
48	2.43	0.16	29.41	47.53
60	2.21	0.05	30.34	53.07
72	2.51	0.08	19.07	69.2
84	2.32	0.08	19.21	62.85
96	2.25	0.07	20.27	61.3

Table S8. Asp@ZIF-ZnCo-Sna cyclic catalytic ginsenoside conversion parameters

Time(h)	Rb1	Rd	F2	CK
1	2.51	0.08	19.46	69.88
2	4.32	0.08	29.21	67.85
3	4.25	0.07	30.27	72.33
4	7.50	0.08	26.33	79.87
5	8.10	0.58	31.12	72.85
6	12.26	1.77	31.01	65.32