Support Information for

Synthesis of acryl groups-modified adsorption resins and their adsorption properties for matrine and oxymatrine in aqueous solutions

Tao Sun[a,b]; Hui Li[a,b]; Xiaoli Ma[a,b]; Jianbao Ding[c] Jianlong Ma[d,e], Bolin Gong[a,b], Jin Yang[a,b,e*]

[a] School of Chemistry and Chemical Engineering, North Minzu University, Yinchuan 750021, China

[b] Key Laboratory for Chemical Engineering and Technology (North Minzu University), State Ethnic Affairs Commission, Yinchuan 750021, China

[c] Ningxia Wuxing Science and Technology Co. Ltd, Yinchuan 750021, China

[d] College of Chemistry and Chemical Engineering, Ningxia University, Yinchuan 750021, China

[e] Ningxia Engineering Research Center for Natural Medicine (Ningxia University), Yinchuan 750021, China

* Corresponding author: E-mail address: yang_jin@nun.edu.cn

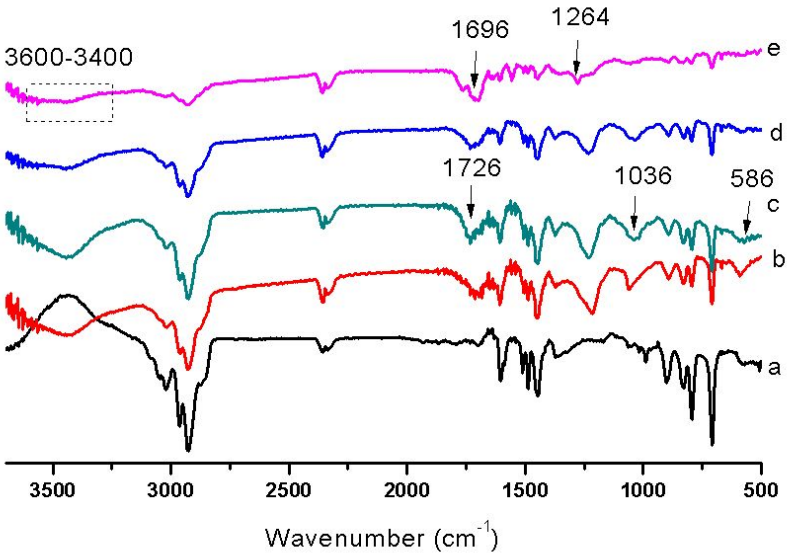

Figure S1 FTIR spectra of D101 (a), PS-Br (b), PS-EA (c), PS-MP (d) and PS-BA (e)

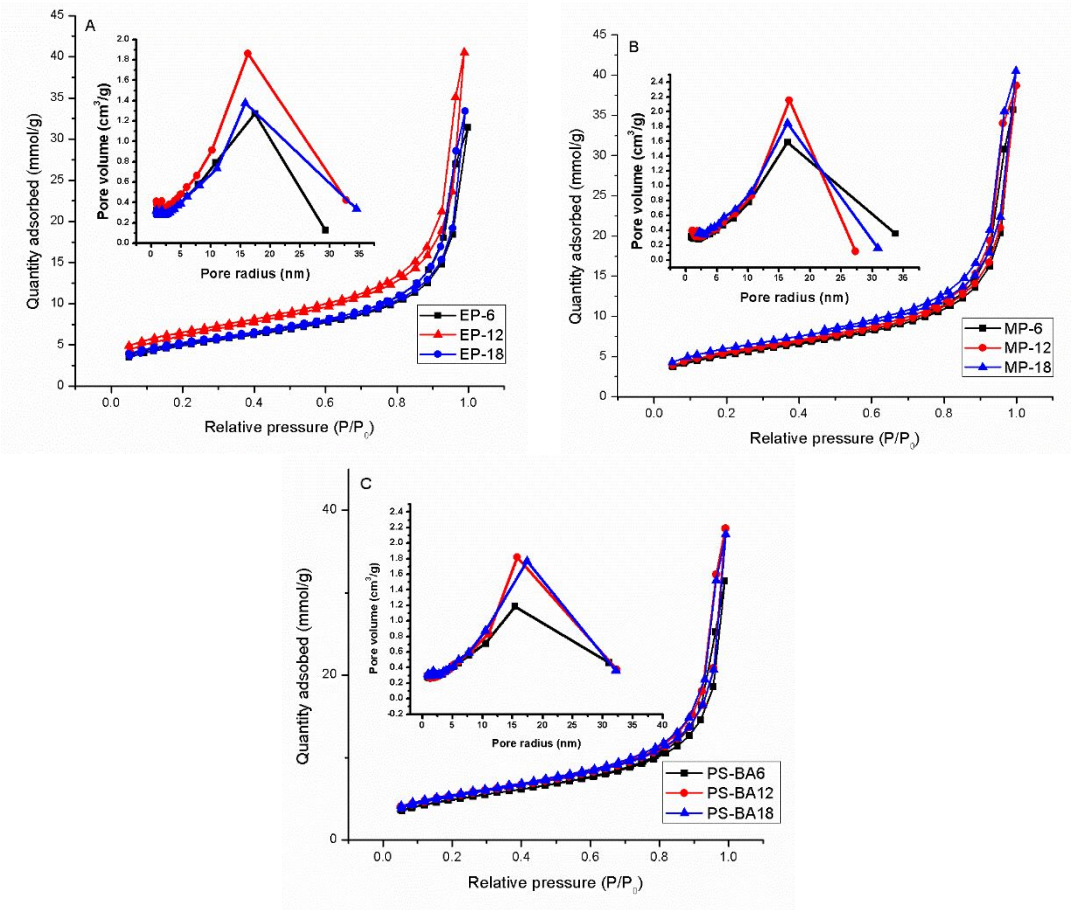

Figure S2 N_2 adsorption/desorption isotherms and pore diameter distribution for D101 resin and modified resins (A) PS-EA series resins, (B) PS-MP series resins, (C) PS-BA series resins

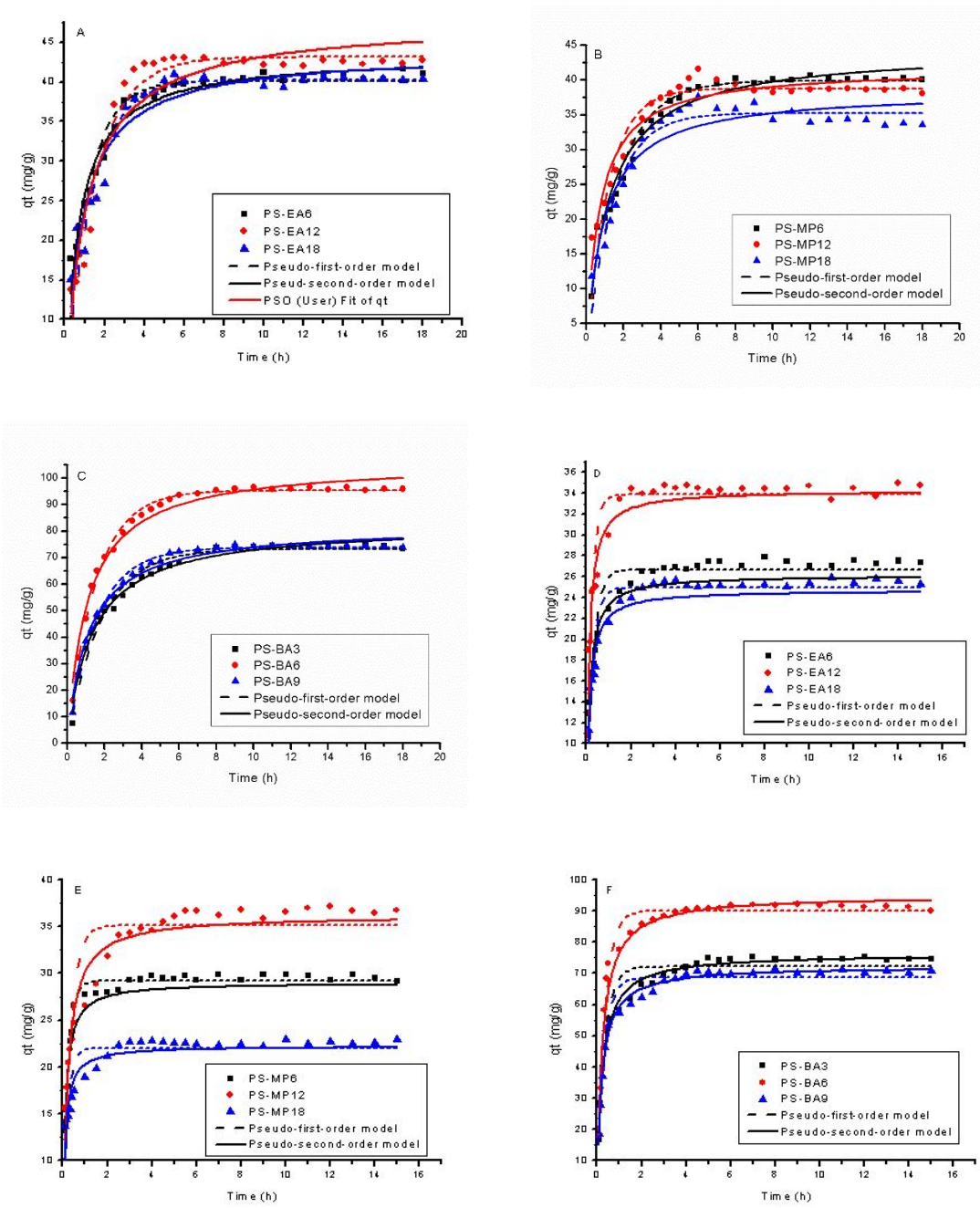

Figure S3 Kinetic curves of MT on PS-EA (A), PS-MP (B) and PS-BA (C) resins and OM on PS-EA (D), PS-MP (E) and PS-BA (F) at 293.15 K

Table S1 The linear regression equations of matrine (MT) and oxymatrine (OM) (n=5)

Name	Linear regression equations	R^2	Concentrations range (mg·mL^{-1})
MT	A=11496963C+365504	0.9999	1.0~5.0
OM	A=10095376C+394220	0.9999	1.0~5.0

Table S2 Parameters in pseudo-first-order rate equation and pseudo-second-order rate equation for MT onto modified resins

Type of resins	T (K)	$q_{e,exp}$ (mg/g)	Pseudo-first-order model			Pseudo-second-order model		
			k_1	$q_{e,cal}$ (mg/g)	R^2	k_2	$q_{e,cal}$ (mg/g)	R^2
PS-EA6	293.15	41.59	0.90	38.05	0.8485	0.03	43.33	0.9572
	303.15	40.18	0.90	38.16	0.9729	0.03	41.24	0.9932
	313.15	36.27	1.71	34.84	0.8612	0.09	36.34	0.8790
PS-EA12	293.15	43.04	0.79	43.33	0.9019	0.03	43.97	0.9540
	303.15	46.97	1.06	44.60	0.8513	0.04	47.87	0.9584
	313.15	39.05	1.37	37.22	0.8922	0.07	39.05	0.9532
PS-EA18	293.15	40.98	0.75	40.28	0.9092	0.03	43.74	0.9682
	303.15	41.59	1.26	40.03	0.8955	0.06	42.26	0.9769
	313.15	39.12	1.90	32.71	0.8275	0.09	40.33	0.9235
PS-MP6	293.15	40.29	0.60	39.90	0.9309	0.02	44.31	0.9698
	303.15	38.45	1.05	36.88	0.9158	0.04	39.33	0.9767
	313.15	35.93	1.60	36.00	0.8535	0.08	37.80	0.9203
PS-MP12	293.15	41.58	0.86	38.78	0.8916	0.03	41.67	0.9088
	303.15	42.82	0.93	40.79	0.9086	0.04	43.82	0.9392
	313.15	32.53	1.83	36.02	0.8659	0.11	37.35	0.9732
PS-MP18	293.15	37.65	0.70	35.73	0.9404	0.02	38.41	0.9766
	303.15	37.85	0.93	37.21	0.9424	0.03	40.04	0.9622
	313.15	25.91	2.01	29.38	0.8174	0.17	30.05	0.8911
PS-BA6	293.15	75.04	0.55	73.31	0.9742	0.01	82.61	0.9826
	303.15	61.44	3.11	60.33	0.8898	0.08	63.08	0.9322
	313.15	59.15	2.44	57.14	0.8343	0.08	59.85	0.8403
PS-BA12	293.15	96.68	0.65	95.40	0. 9794	0.01	106.09	0. 9926
	303.15	87.70	4.12	85.21	0.8995	0.09	88.69	0.9877
	313.15	86.07	2.90	76.25	0.8226	0.08	79.18	0.9210
PS-BA18	293.15	74.89	0.63	73.83	0. 9810	0.01	82.23	0. 9908
	303.15	67.89	3.41	66.30	0.8942	0.09	69.22	0.9569
	313.15	68.31	2.23	66.10	0.8980	0.05	69.95	0.9175

Table S3 Parameters in pseudo-first-order rate equation and pseudo-second-order rate equation for OM onto modified resins

Type of resins	T (K)	$q_{e,exp}$ (mg/g)	Pseudo-first-order model			Pseudo-second-order model		
			k_1	$q_{e,cal}$ (mg/g)	R^2	k_2	$q_{e,cal}$ (mg/g)	R^2
PS-EA6	293.15	26.01	4.17	25.43	0.8920	0.31	26.12	0.9145
	303.15	22.54	6.36	22.41	0.8280	0.65	22.91	0.9189
	313.15	21.95	8.26	19.57	0.8766	0.83	22.16	0.8849
PS-EA12	293.15	33.74	2.95	33.30	0.8459	0.28	34.26	0.8958
	303.15	29.32	3.29	28.68	0.8605	0.50	29.85	0.9202
	313.15	25.26	4.84	25.62	0.8332	0.55	27.55	0.9054
PS-EA18	293.15	23.87	4.44	23.99	0.8065	0.34	24.70	0.8825
	303.15	26.09	4.84	22.62	0.8332	0.32	26.61	0.9106
	313.15	19.64	5.56	20.00	0.8809	0.41	23.78	0.9369
PS-MP6	293.15	28.33	4.92	28.21	0.8976	0.32	29.01	0.8918
	303.15	25.25	5.52	24.29	0.8498	0.39	25.21	0.9669
	313.15	15.26	6.70	21.71	0.8412	0.47	25.01	0.9667
PS-MP12	293.15	35.90	3.22	34.49	0.8840	0.14	36.17	0.9169
	303.15	27.05	5.96	26.18	0.8550	0.43	27.01	0.9312
	313.15	14.78	6.89	20.55	0.8316	0.50	25.18	0.9652
PS-MP18	293.15	22.31	5.41	21.61	0.8983	0.47	22.25	0.9392
	303.15	21.99	5.79	21.70	0.8313	0.53	22.82	0.9254
	313.15	14.09	6.99	19.30	0.8267	0.66	19.46	0.9764
PS-BA6	293.15	74.51	2.91	72.16	0.9423	0.05	76.17	0.9838
	303.15	74.44	2.83	72.95	0.9292	0.06	76.81	0.9304
	313.15	71.31	3.24	70.67	0.9072	0.06	72.27	0.9724
PS-BA12	293.15	92.12	2.86	90.13	0.9757	0.04	94.89	0.9863
	303.15	92.91	4.12	91.66	0.9004	0.08	94.81	0.9836
	313.15	81.77	7.10	86.82	0.8821	0.08	91.01	0.9812
PS-BA18	293.15	71.64	3.13	68.67	0.9486	0.06	72.17	0.9813
	303.15	71.83	3.08	70.41	0.9132	0.07	73.76	0.9559
	313.15	63.46	6.99	65.12	0.8180	0.09	69.62	0.9237

Table S4 Parameters of Langmuir and Freundlich model and the enthalpy change (ΔH) for the adsorption processes of MT on modified resins

Type of resins	T (K)	Langmuir model			Freundlich model			ΔH (kJ/mol)
		K_L	$q_{e,cal}$ (mg/g)	R^2	K_F	$1/n$	R^2	
PS-EA6	293.15	1.50	196.08	0.9629	144.08	0.76	0.9650	-1.54
	303.15	4.50	111.11	0.9310	119.40	0.53	0.9438	
	313.15	1.19	178.57	0.9820	152.92	0.64	0.9640	
PS-EA12	293.15	1.44	256.41	0.9883	140.71	0.63	0.9765	-2.32
	303.15	1.03	277.78	0.9796	163.09	0.79	0.9736	
	313.15	0.80	303.03	0.9904	166.20	0.86	0.9869	
PS-EA18	293.15	1.79	169.49	0.9501	117.03	0.61	0.9519	-3.01
	303.15	1.05	256.41	0.9530	148.96	0.74	0.9102	
	313.15	1.00	204.08	0.9899	140.70	0.83	0.9804	
PS-MP6	293.15	1.52	200.00	0.9844	144.55	0.71	0.9675	-1.97
	303.15	0.83	294.11	0.9960	153.59	0.85	0.9925	
	313.15	0.72	303.03	0.9930	147.87	0.84	0.9871	
PS-MP12	293.15	1.34	232.56	0.9844	157.69	0.74	0.9681	-0.56
	303.15	0.94	322.58	0.9814	174.18	0.77	0.9563	
	313.15	0.75	333.33	0.9896	154.87	0.79	0.9827	
PS-MP18	293.15	2.40	138.89	0.9685	123.41	0.64	0.9653	-1.24
	303.15	0.70	303.03	0.9362	127.32	0.76	0.9341	
	313.15	0.67	312.50	0.9747	133.86	0.80	0.9477	
PS-BA6	293.15	0.62	178.57	0.9951	201.93	0.47	0.9749	-4.96
	303.15	3.07	232.56	0.9825	233.92	0.62	0.9722	
	313.15	5.36	169.49	0.9751	192.06	0.52	0.9809	
PS-BA12	293.15	1.04	192.31	0.9132	221.36	0.34	0.9102	-9.94
	303.15	11.80	169.49	0.9380	204.55	0.36	0.9341	
	313.15	1.92	434.78	0.9142	329.21	0.65	0.9312	
PS-BA18	293.15	1.12	149.25	0.9982	177.84	0.36	0.9895	-4.01
	303.15	15.80	126.58	0.9805	155.80	0.31	0.9545	
	313.15	3.00	238.09	0.9649	232.04	0.62	0.9757	

Table S5 Parameters of Langmuir and Freundlich model and the enthalpy change (ΔH) for the adsorption processes of OM on modified resins

Type of resins	T (K)	Langmuir model			Freundlich model			ΔH (kJ/mol)
		K_L	$q_{e,cal}$ (mg/g)	R^2	K_F	$1/n$	R^2	
PS-EA6	293.15	0.71	185.18	0.9776	93.53	0.77	0.9745	-1.03
	303.15	1.29	204.08	0.9669	97.72	0.91	0.9630	
	313.15	0.55	156.25	0.9637	72.87	0.89	0.9564	
PS-EA12	293.15	1.21	243.90	0.8986	85.11	0.75	0.8970	-0.95
	303.15	1.07	121.77	0.9075	95.02	0.71	0.9104	
	313.15	0.31	178.57	0.9720	82.95	0.81	0.9605	
PS-EA18	293.15	3.07	68.02	0.9705	59.36	0.76	0.9525	-2.00
	303.15	2.94	68.03	0.9670	61.42	0.56	0.9738	
	313.15	0.61	166.67	0.9833	68.61	0.80	0.9613	
PS-MP6	293.15	3.67	64.94	0.9380	64.22	0.54	0.9717	-1.28
	303.15	1.98	81.30	0.9139	65.25	0.65	0.9189	
	313.15	1.02	109.89	0.9491	65.79	0.78	0.9156	
PS-MP12	293.15	1.53	111.11	0.9828	76.97	0.68	0.9732	-1.63
	303.15	2.43	87.82	0.9203	81.83	0.67	0.9282	
	313.15	1.07	128.81	0.9791	80.80	0.80	0.9657	
PS-MP18	293.15	2.31	64.52	0.9033	58.18	0.67	0.9045	-0.59
	303.15	1.37	90.09	0.9805	69.05	0.81	0.9149	
	313.15	1.10	97.08	0.9033	61.34	0.79	0.9739	
PS-BA6	293.15	13.67	121.95	0.9655	27.95	0.67	0.9982	-2.55
	303.15	16.33	102.04	0.9980	114.73	0.25	0.9747	
	313.15	9.78	113.64	0.9748	127.05	0.34	0.9439	
PS-BA12	293.15	25.33	131.58	0.9431	55.77	0.84	0.9046	-5.28
	303.15	25.67	129.87	0.9608	156.04	0.26	0.9363	
	313.15	14.60	136.99	0.9562	158.67	0.28	0.9088	
PS-BA18	293.15	15.00	111.11	0.9196	33.13	0.76	0.9747	-2.56
	303.15	16.67	100.00	0.9526	114.08	0.25	0.9535	
	313.15	6.67	125.00	0.9348	150.13	0.47	0.9567	