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Supporting information

Effect of ion form of ion-exchange resin on ε-poly-L-lysine purification from microbial fermentation broth

Xusheng Chen*, Qin Li, Honggang He, Jianhua Zhang, Zhonggui Mao

The Key Laboratory of Industrial Biotechnology, Ministry of Education, School of Biotechnology, Jiangnan University, Wuxi 214122, China

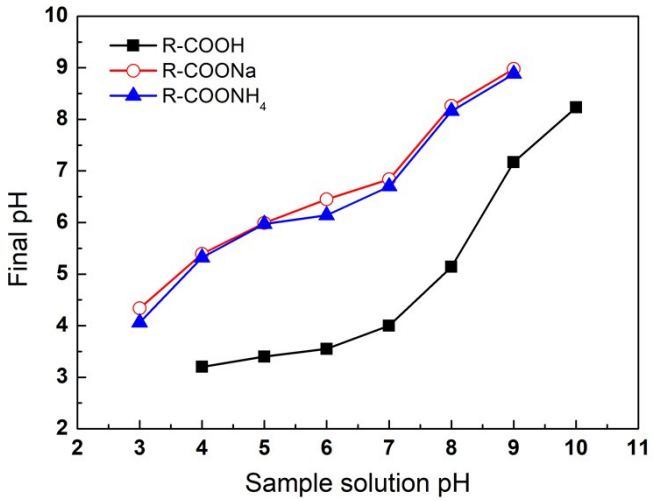

Fig. S1 Final pH of the sample solutions with different initial pH adsorpted by Amberlite IRC-50 resin with H^+, Na^+ and NH_4^+ ion forms

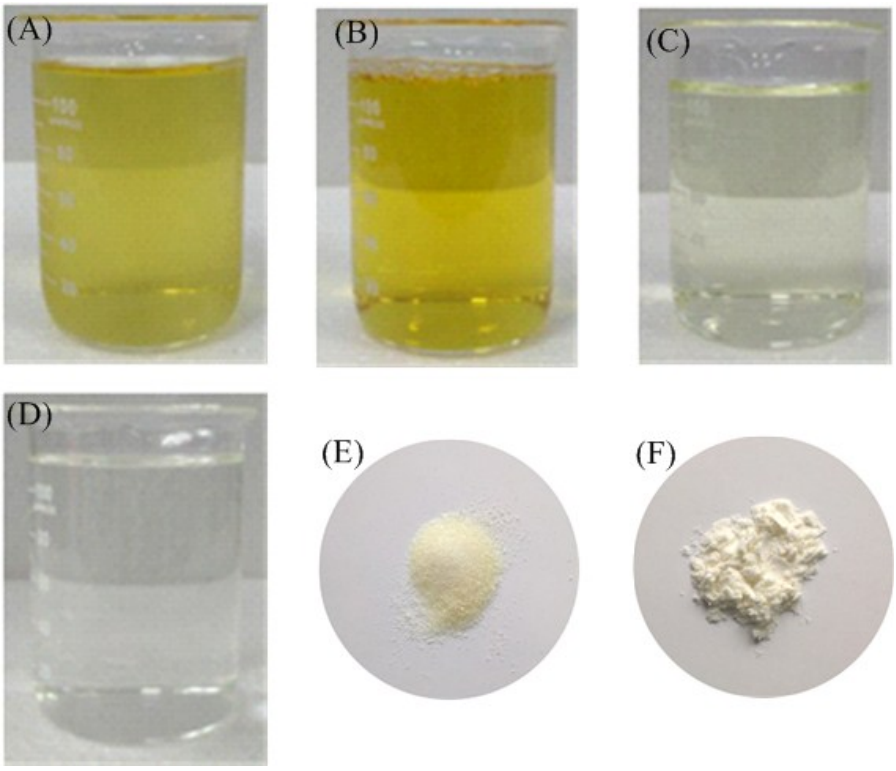

Fig. S2 Sample photograph of each operation in the process of ε-PL extraction. (a) Supernatant of fermentation broth. (b) Elution of IRC-50 with NH_4^+. (c) Filtrate of decoloration by active carbon. (d) Retentate of 1.0 kDa ultrafiltration. (e) Extracted ε-PL sample by vacuum drying. (f) Standard ε-PL sample by spray drying.

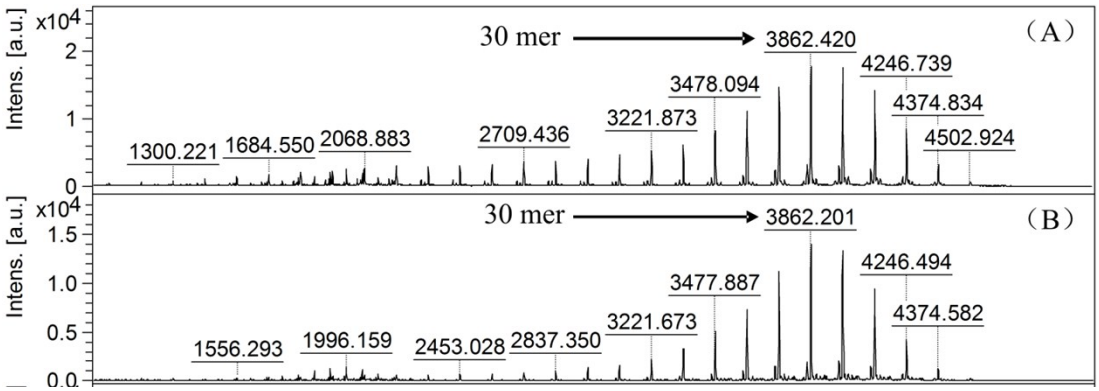

Fig. S3 Positive-ion MALDI-TOF mass spectrum of extracted ε-PL sample (a) and commercial ε-PL sample (b). The chain length could be calculated using the equation: (Mn-19.02)/128.17.

Table S1 Physical and chemical properties of resins

Resin	Matrix	Functional group	Particle size (mm)	Total exchange capacity (mmol/g)	Moisture content (%)
HD-8	Styrene-divinylbenzene	$-SO_3H$	0.3-1.2	4.0	55-65
HZD-3B	Styrene-divinylbenzene	$-SO_3H$	0.3-1.2	8.0	52-65
D113	Acrylic-divinylbenzene	-COOH	0.4-0.7	10.8	45-52
HZD-2	Acrylic-divinylbenzene	-COOH	0.3-1.2	9.5	47-58
DK110	Acrylic-divinylbenzene	-COOH	0.3-1.2	8.0	52-65
D115	Acrylic-divinylbenzene	-COOH	0.3-1.2	9.0	45-55
HD-2	Acrylic-divinylbenzene	-COOH	0.3-1.2	9.5	65-75
D152	Acrylic-divinylbenzene	-COOH	0.3-1.2	8.0	50-65
D155C	Acrylic-divinylbenzene	-COOH	0.3-1.2	7.5	55-65
D151	Acrylic-divinylbenzene	-COOH	0.3-1.2	9.5	60-72
Amberlite® IRC-50	Methacrylic-divinylbenzene	-COOH	0.3-0.7	10.0	43-53

Table S2 Effect of NaOH concentration on ε-PL desorption parameters on IRC-50 resin with Na^+

NaOH concentration (mol/L)	Elution time (min)	Desorption ratio (%)	NaOH amount (mmol)
0.05	480	27.45	25.2
0.10	480	87.18	50.4
0.15	422	95.08	63.3
0.20	342	96.16	71.8
0.25	300	95.91	73.2
0.30	275	96.58	85.8

Table S3 Effect of $NH_3 \cdot H_2O$ concentration on ε-PL desorption parameters on IRC-50 resin with NH_4^+

$NH_3 \cdot H_2O$ concentration (mol/L)	Elution time (min)	ε-PL desorption ratio (%)	$NH_3 \cdot H_2O$ amount (mmol)
0.05	480	20.11	26.9
0.10	480	66.74	50.4
0.15	420	92.61	63.2
0.20	265	95.02	63.8
0.25	240	95.84	70.6
0.30	227	96.69	80.1

Table S4 Effect of elution rate on the ε-PL desorption parameters on IRC-50 resin with Na^+

Elution rate (BV/h)	ε-PL desorption ratio (%)	Elution time (min)	NaOH amount (mmol)
1.0	95.66	570	73.8
1.5	97.18	376	73.0
2.0	95.08	305	77.1
2.5	96.16	270	87.4
3.0	96.58	241	93.6

Table S5 Effect of elution rate on the ε-PL desorption parameters on IRC-50 resin with NH_4^+

Elution rate (BV/h)	ε-PL desorption ratio (%)	Elution time (min)	$NH_3 \cdot H_2O$ amount (mmol)
1.0	95.64	605	61.8
1.5	96.81	436	63.8
2.0	96.05	322	67.2
2.5	95.63	298	70.8
3.0	95.53	276	74.4

Table S6 Dynamic adsorption and desorption parameters of ε-PL on IRC-50 resin with H^+, Na^+ and NH_4^+

Exchange ion form	Adsorption capacity (mg/g)	Purity (%)	Protein removal ratio (%)	Pigment removal ratio (%)	ε-PL recovery ratio (%)
H^+	171.03	52.62	12.13	37.82	96.4
Na^+	303.25	75.86	67.36	62.58	96.7
NH_4^+	307.96	76.52	75.92	64.13	96.2

Table S7 Physical and chemical parameters of the extracted and commercial ε-PL hydrochloride samples[a]

Items	GB2760-2014	Extracted ε-PL hydrochloride sample	Commercial ε-PL hydrochloride sample
Purity (%, w/w)	≥ 95.00	97.20	99.00
Loss weight (%, w/w)	≤8.00	4.81	6.55
pH (10 g/L in water)	2.50-5.50	4.61	5.15
Lead content (mg/kg)	≤2.00	ND	ND
Burning residue (%, w/w)	≤2.00	0.33	0.67
Total arsenic content (mg/kg)	≤3.00	ND[b]	ND

[a] Physical and chemical parameters are detected as GB2760-2014 proved by National Health and Family Planning Commission of the People's Republic of China.

[b] Not detectable.

Table S8 The ε-PL separation and purification parameters in ten times operation

Batch No.	Adsorption capacity (mg/g)	Recovery ratio (%)	Purity (%)	Protein removal ratio (%)	Pigment removal ratio (%)
1	307.13	65.27	95.86	94.98	99.11
2	304.54	64.81	96.30	95.31	99.36
3	303.55	63.21	99.11	99.54	99.84
4	304.11	64.22	96.25	95.38	99.23
5	301.08	66.13	97.55	96.81	99.27
6	298.13	72.17	98.15	96.57	99.88
7	295.84	68.85	97.52	97.02	99.62
8	289.98	64.53	96.38	95.88	99.17
9	287.58	65.89	96.82	93.85	99.02
10	283.79	65.02	97.05	96.82	99.93