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APPENDIX A

EXTRACTION EQUILIBRIUM CALCULATION DATA

Table A-1. Extraction coefficient calculation data on pH variable.

pH	L-lysine Concentration in External Phase (mol/l)	Equilibrium pH	[ARm]eq	$[H^+]$eq	$[A^+]$eq (mol/l)	$[HR]_i$ (mol/l)	[HR]eq (mol/l)	Kex
2.0	0.0081	1.41	0.0019	0.0389	0.0069	0.3100	0.3098	0.2112
3.0	0.0083	1.62	0.0017	0.0240	0.0065	0.3100	0.3098	0.1868
4.0	0.0085	1.98	0.0016	0.0105	0.0052	0.3100	0.3098	0.1992
5.0	0.0086	2.65	0.0014	0.0022	0.0022	0.3100	0.3098	0.3649
6.0	0.0087	3.04	0.0014	0.0009	0.0010	0.3100	0.3098	0.6393

Table A-2. Extraction coefficient calculation data on carrier variable.

Carrier Concentration %(v/v)	L-lysine Concentration in External Phase (mol/l)	Equilibrium pH	[ARm]eq	$[H^+]$eq	$[A^+]$eq (mol/l)	$[(HR)_2]_i$ (mol/l)	[HR]eq (mol/l)	Kex
3	0.0084	1.40	0.0016	0.0398	0.0072	0.0930	0.0928	0.1977
5	0.0083	1.41	0.0017	0.0389	0.0071	0.1550	0.1548	0.2073
7	0.0082	1.41	0.0018	0.0389	0.0070	0.2170	0.2168	0.2075
10	0.0081	1.41	0.0019	0.0389	0.0069	0.3100	0.3098	0.2098
15	0.0081	1.41	0.0019	0.0389	0.0069	0.4650	0.4648	0.2011

APPENDIX B

EXTRACTION EXPERIMENTAL DATA

Part I External phase pH variable

Experimental conditions :

External phase : 10 mMolar L-lysine at various pH (adjust by H_2SO_4)

Membrane phase : 5% Span80, 10%D2EHPA and 85%Dodecane

Internal phase : 1N HCl Solution

Membrane preparation : at homoginizing speed = 8000 rpm 10 minute

Agitation speed : 360 rpm

Table B-1 Experimental data for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various pH.

Time (min)	Concentration (mM)				
	pH 2.0	pH 3.0	pH 4.0	pH 5.0	pH 6.0
0	10	10	10	10	10
1	9.55	8.74	8.15	7.78	8.02
2	9.55	8.32	7.82	6.34	7.34
3	9.55	8.04	7.60	6.02	6.86
4	9.50	7.84	7.34	5.68	6.58
5	9.50	7.61	7.26	5.47	6.38
7	9.50	7.42	7.00	5.20	5.90
10	9.50	7.21	6.80	4.64	5.54
15	9.50	7.11	6.60	4.20	4.93
20	9.50	7.01	6.40	4.02	4.80
25	9.50	6.72	6.23	4.02	4.80
30	9.50	6.72	6.18	4.02	4.80
40	9.50	6.70	6.18	4.00	4.80
50	9.50	6.70	6.18	4.00	4.80
60	9.50	6.70	6.18	4.00	4.80

Table B-2 Calculation [C]i/[C]o for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various pH.

Time (min)	[C]i/[C]o				
	pH 2.0	pH 3.0	pH 4.0	pH 5.0	pH 6.0
0	1.000	1.000	1.000	1.000	1.000
1	0.955	0.874	0.815	0.778	0.802
2	0.955	0.832	0.782	0.634	0.734
3	0.955	0.804	0.760	0.602	0.686
4	0.950	0.784	0.734	0.568	0.658
5	0.950	0.761	0.726	0.547	0.638
7	0.950	0.742	0.700	0.520	0.590
10	0.950	0.721	0.680	0.464	0.554
15	0.950	0.711	0.660	0.420	0.493
20	0.950	0.701	0.640	0.402	0.480
25	0.950	0.672	0.623	0.402	0.480
30	0.950	0.672	0.618	0.402	0.480
40	0.950	0.670	0.618	0.400	0.480
50	0.950	0.670	0.618	0.400	0.480
60	0.950	0.670	0.618	0.400	0.480

Table B-3 Calculation of internal phase cocentration for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various pH.

Time (min)	Internal phase concentration (mMolar)				
	pH 2.0	pH 3.0	pH 4.0	pH 5.0	pH 6.0
0	0.00	0.00	0.00	0.00	0.00
1	1.80	5.04	7.40	8.68	7.92
2	1.80	6.72	8.72	14.64	10.64
3	1.80	7.84	9.60	15.92	12.56
4	2.00	8.64	10.64	17.28	13.68
5	2.00	9.56	10.96	18.12	14.48
7	2.00	10.32	12.00	19.20	16.40
10	2.00	11.16	12.80	21.44	17.84
15	2.00	11.56	13.60	23.20	20.28
20	2.00	11.96	14.40	23.92	20.80
25	2.00	13.12	15.08	23.92	20.80
30	2.00	13.12	15.28	23.92	20.80
40	2.00	13.20	15.26	24.00	20.80
50	2.00	13.20	15.28	24.00	20.80
60	2.00	13.20	15.28	24.00	20.80

Table B-4 Calculation of initial rate for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various pH (at 4 minutes).

pH	Initial Rate (mMolar/min)
2.0	0.0100
3.0	0.0478
4.0	00548
5.0	0.0906
6.0	0.0724

Table B-5 Experimental data of pH change for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various pH.

Time (min)	pH				
	pH 2.0	pH 3.0	pH 4.0	pH 5.0	pH 6.0
0	2.00	3.00	4.00	5.00	6.00
1	2.00	2.90	3.52	4.05	5.15
2	2.00	2.82	3.15	3.55	4.02
3	2.00	2.74	2.83	3.13	3.32
4	2.00	2.66	2.70	2.82	2.85
5	2.00	2.58	2.60	2.75	2.80
7	2.00	2.51	2.52	2.64	2.68
10	2.00	2.44	2.45	2.50	2.52
15	2.00	2.38	2.40	2.46	2.48
20	2.00	2.32	2.33	2.44	2.44
25	2.00	2.28	2.30	2.43	2.43
30	2.00	2.24	2.25	2.42	2.40
40	2.00	2.22	2.23	2.40	2.40
50	2.00	2.20	2.20	2.40	2.40
60	2.00	2.20	2.20	2.40	2.40

Table B-6 Experimental data of internal phase volume for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various pH.

Time (min)	Internal phase volume (ml)				
	pH 2.0	pH 3.0	pH 4.0	pH 5.0	pH 6.0
0	50.00	50.00	50.00	50.00	50.00
1	50.00	50.00	50.00	50.00	50.00
2	50.00	50.00	50.00	50.00	50.00
3	50.00	50.00	50.00	50.00	50.00
4	50.00	50.00	50.00	50.00	50.00
5	55.00	55.00	53.00	52.00	50.00
7	60.00	59.00	55.00	53.00	52.00
10	64.00	62.00	57.00	55.00	53.00
15	68.00	65.00	59.00	56.00	54.00
20	71.00	68.00	61.00	58.00	55.00
25	74.00	71.00	64.00	60.00	56.00
30	76.00	73.00	67.00	52.00	57.00
40	80.00	75.00	69.00	63.00	58.00
50	83.00	78.00	71.00	65.00	59.00
60	85.00	80.00	73.00	65.00	60.00

Table B-7 Calculation of %swelling for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various pH.

Time (min)	%swelling				
	pH 2.0	pH 3.0	pH 4.0	pH 5.0	pH 6.0
0	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00
5	10.00	10.00	6.00	4.00	0.00
7	20.00	18.00	10.00	6.00	4.00
10	28.00	24.00	14.00	10.00	6.00
15	36.00	30.00	18.00	12.00	8.00
20	42.00	36.00	22.00	16.00	10.00
25	48.00	42.00	28.00	20.00	12.00
30	52.00	46.00	34.00	24.00	14.00
40	60.00	50.00	38.00	26.00	16.00
50	66.00	56.00	42.00	30.00	18.00
60	70.00	60.00	46.00	30.00	20.00

Part II External phase concentration variable

Experimental conditions :

External phase : Variuos concentration of L-lysine at pH 5.0(adjust by H_2SO_4)

Membrane phase : 5% Span80, 10%D2EHPA and 85%Dodecane

Internal phase : 1N HCl Solution

Membrane preparation : at homoginizing speed = 8000 rpm 10 minute

Agitation speed : 360 rpm

Table B-8 Experimental data for extraction of L-lysine from aqueous by emulsion liquid membrane at various L-lysine concentration.

Time (min)	Concentration (mM)				
	1 mMolar	5 mMolar	10 mMolar	50 mMolar	100 mMolar
0	1.00	5.00	10.00	50.00	100.00
1	0.63	3.58	7.78	42.50	85.40
2	0.48	3.07	6.34	34.20	72.20
3	0.45	2.87	6.02	31.20	67.40
4	0.42	2.65	5.68	29.50	63.80
5	0.40	2.43	5.47	28.40	61.40
7	0.39	2.32	5.20	26.10	58.40
10	0.38	2.24	4.64	24.40	53.40
15	0.38	2.10	4.20	22.30	49.10
20	0.38	1.98	4.02	20.80	46.50
25	0.38	1.98	4.02	20.50	44.20
30	0.38	1.98	4.02	20.10	42.30
40	0.38	1.98	4.00	20.00	40.50
50	0.38	1.98	4.00	20.00	40.50
60	0.38	1.98	4.00	20.00	40.50

Table B-9 Calculation [C]i/[C]o for extraction of L-lysine from aqueous by emulsion liquid membrane at various L-lysine concentration.

Time (min)	[C]i/[C]o				
	1 mMolar	5 mMolar	10 mMolar	50 mMolar	100 mMolar
0	1.000	1.000	1.000	1.000	1.000
1	0.630	0.716	0.778	0.850	0.854
2	0.550	0.614	0.634	0.684	0.722
3	0.480	0.574	0.602	0.624	0.674
4	0.450	0.530	0.568	0.590	0.638
5	0.420	0.486	0.547	0.568	0.64
7	0.400	0.464	0.520	0.522	0.584
10	0.390	0.448	0.464	0.488	0.534
15	0.380	0.420	0.420	0.446	0.491
20	0.380	0.396	0.402	0.416	0.465
25	0.380	0.396	0.402	0.410	0.442
30	0.380	0.396	0.402	0.402	0.423
40	0.380	0.396	0.400	0.400	0.405
50	0.380	0.396	0.400	0.400	0.405
60	0.380	0.396	0.400	0.400	0.405

Table B-10 Calculation of internal phase cocentration for extraction of L-lysine from aqueous by emulsion liquid membrane at various L-lysine concentrations.

Time (min)	Internal phase concentration (mMolar)				
	1 mMolar	5 mMolar	10 mMolar	50 mMolar	100 mMolar
0	0.00	0.00	0.00	0.00	0.00
1	1.48	5.68	8.88	30.00	56.40
2	1.80	7.72	14.64	63.20	111.20
3	2.08	8.52	15.92	75.20	130.40
4	2.20	9.40	17.28	82.00	144.80
5	2.32	10.28	18.12	86.40	154.40
7	2.40	10.72	19.20	95.60	166.40
10	2.44	11.04	21.44	102.40	186.40
15	2.48	11.60	23.20	110.80	203.60
20	2.48	12.08	23.92	116.80	241.00
25	2.48	12.08	23.92	118.00	223.20
30	2.48	12.08	23.92	119.60	230.80
40	2.48	12.08	24.00	120.00	238.80
50	2.48	12.08	24.00	120.00	238.80
60	2.48	12.08	24.00	120.00	238.80

Table B-11 Calculation of initial rate for extraction of L-lysine from aqueous by emulsion liquid membrane at various L-lysine concentations (at 4 minutes).

L-lysine concentration (mMolar)	Initial Rate (mM/mM/min)	Actual Initial Rate (mM/min)
1	0.138	0.138
5	0.118	0.588
10	0.080	0.1080
50	0.061	5.125
100	0.055	9.050

Table B-12 Experimental data of pH change for extraction of L-lysine from aqueous by emulsion liquid membrane at various L-lysine concentrations.

Time (min)	pH				
	1 mMolar	5 mMolar	10 mMolar	50 mMolar	100 mMolar
0	5.00	5.00	5.00	5.00	5.00
1	4.52	4.63	4.05	4.71	4.78
2	4.05	4.20	3.55	4.38	4.43
3	3.60	3.71	3.13	3.87	3.95
4	3.22	3.53	2.82	3.72	3.84
5	2.80	3.20	2.75	3.43	3.56
7	2.51	3.05	2.64	3.35	3.47
10	2.20	2.70	2.50	3.17	3.26
15	2.01	2.52	2.46	2.86	2.99
20	2.00	2.40	2.44	2.64	2.74
25	2.00	2.40	2.43	2.52	2.63
30	2.00	2.40	2.42	2.45	2.49
40	2.00	2.40	2.40	2.40	2.40
50	2.00	2.40	2.40	2.40	2.40
60	2.00	2.40	2.40	2.40	2.40

Table B-13 Experimental data of internal phase volume for extraction of L-lysine from aqueous by emulsion liquid membrane at various L-lysine concentrations.

Time (min)	Internal phase volume (ml)				
	1 mMolar	5 mMolar	10 mMolar	50 mMolar	100 mMolar
0	50.00	50.00	50.00	50.00	50.00
1	50.00	50.00	50.00	50.00	50.00
2	50.00	50.00	50.00	50.00	50.00
3	50.00	50.00	50.00	50.00	50.00
4	50.00	50.00	50.00	50.00	50.00
5	50.00	52.00	52.00	52.00	52.00
7	50.00	53.00	53.00	54.00	54.00
10	52.00	54.00	55.00	55.00	56.00
15	55.00	56.00	56.00	58.00	58.00
20	56.00	58.00	58.00	59.00	59.00
25	58.00	59.00	60.00	60.00	61.00
30	59.00	61.00	52.00	63.00	63.00
40	61.00	62.00	63.00	65.00	65.00
50	63.00	64.00	65.00	66.00	66.00
60	63.00	65.00	65.00	66.00	66.00

Table B-14 Calculation of %swelling for extraction of L-lysine from aqueous by emulsion liquid membrane at various L-lysine concentrations.

Time (min)	%swelling				
	1 mMolar	5 mMolar	10 mMolar	50 mMolar	100 mMolar
0	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00
5	0.00	4.00	4.00	4.00	4.00
7	0.00	6.00	6.00	8.00	8.00
10	4.00	8.00	10.00	10.00	12.00
15	10.00	12.00	12.00	16.00	16.00
20	12.00	16.00	16.00	18.00	18.00
25	16.00	18.00	20.00	20.00	22.00
30	18.00	22.00	24.00	26.00	26.00
40	22.00	24.00	26.00	30.00	30.00
50	26.00	28.00	30.00	32.00	32.00
60	26.00	30.00	30.00	32.00	32.00

Part III Surfactant concentration variable

Experimental conditions :

External phase : 10 mMolar L-lysine at pH 5.0(adjust by H_2SO_4)

Membrane phase : Span80 at various concentration, 10%D2EHPA and Dodecane(%of dodecane due to % of Span80)

Internal phase : 1N HCl Solution

Membrane preparation : at homoginizing speed = 8000 rpm 10 minute

Agitation speed : 360 rpm

Table B-15 Experimental data for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various surfactant concentrations.

Time (min)	Concentration (mM)				
	1% Span80	3% Span80	5% Span80	7% Span80	10% Span80
0	10	10	10	10	10
1	8.78	8.01	7.78	7.86	8.50
2	8.45	7.35	6.34	6.75	8.21
3	8.22	6.78	6.02	6.24	7.90
4	7.92	6.21	5.68	6.01	7.72
5	7.76	5.97	5.47	5.73	7.52
7	7.53	5.54	5.20	5.31	7.34
10	7.44	5.02	4.64	4.75	7.02
15	7.40	4.84	4.20	4.31	6.84
20	7.35	4.80	4.02	4.11	6.54
25	7.31	4.78	4.02	4.11	6.50
30	7.32	4.76	4.02	4.08	6.50
40	7.35	4.76	4.00	4.08	6.50
50	7.34	4.76	4.00	4.08	6.50
60	7.36	4.76	4.00	4.08	6.50

Table B-16 Calculation [C]i/[C]o for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various surfactant concentrations .

Time (min)	[C]i/[C]o				
	1% Span80	3% Span80	5% Span80	7% Span80	10 % Span80
0	1.000	1.000	1.000	1.000	1.000
1	0.878	0.801	0.778	0.786	0.850
2	0.845	0.735	0.634	0.675	0.821
3	0.822	0.678	0.602	0.624	0.790
4	0.792	0.621	0.568	0.601	0.772
5	0.776	0.597	0.547	0.573	0.752
7	0.753	0.554	0.520	0.531	0.734
10	0.744	0.502	0.464	0.475	0.702
15	0.740	0.484	0.420	0.431	0.684
20	0.735	0.480	0.402	0.411	0.654
25	0.731	0.478	0.402	0.411	0.650
30	0.732	0.476	0.402	0.408	0.650
40	0.735	0.476	0.400	0.408	0.650
50	0.734	0.476	0.400	0.408	0.650
60	0.736	0.476	0.400	0.408	0.650

Table B-17 Calculation of internal phase cocentration for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various surfactant concentrations.

Time (min)	Internal phase concentration (mMolar)				
	1% Span80	3% Span80	5% Span80	7% Span80	10% span80
0	0.00	0.00	0.00	0.00	0.00
1	4.88	7.96	8.88	8.56	6.00
2	6.20	10.60	14.64	13.00	7.16
3	7.12	12.88	15.92	15.04	8.40
4	8.32	15.16	17.28	15.96	9.12
5	8.96	16.12	18.12	17.08	9.92
7	9.88	17.84	19.20	18.76	10.64
10	10.24	19.92	21.44	21.00	11.92
15	10.40	20.64	23.20	22.76	12.64
20	10.60	20.80	23.92	23.56	13.84
25	10.76	20.88	23.92	23.56	14.00
30	10.72	20.96	23.92	23.68	14.00
40	10.60	20.96	24.00	23.68	14.00
50	10.64	20.96	24.00	23.68	14.00
60	10.56	20.96	24.00	23.68	14.00

Table B-18 Calculation of initial rate for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various surfactant concentrations (at 4 minutes).

Surfactant concentration (%v/v)	Initial Rate (mMolar/min)
1	0.0593
3	0.1073
5	0.1327
7	0.1253
10	0.0700

Table B-19 Experimental data of pH change for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various surfactant concentrations.

Time (min)	pH				
	1% Span80	3% Span80	5% Span80	7% Span80	10% Span80
0	5.00	5.00	5.00	5.00	5.00
1	4.70	4.45	4.05	4.33	4.65
2	4.50	4.32	3.55	4.25	4.34
3	4.20	4.03	3.13	3.88	4.02
4	3.86	3.80	2.82	3.65	3.77
5	3.51	3.43	2.75	3.34	3.45
7	3.20	3.15	2.64	3.10	3.24
10	2.94	2.88	2.50	2.77	2.84
15	2.70	2.65	2.46	2.50	2.53
20	2.50	2.44	2.44	2.40	2.44
25	2.40	2.22	2.43	2.40	2.30
30	2.40	2.20	2.42	2.40	2.30
40	2.40	2.20	2.40	2.40	2.30
50	2.30	2.20	2.40	2.40	2.30
60	2.20	2.20	2.40	2.30	2.30

Table B-20 Experimental data of internal phase volume for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various surfactant concentrations.

Time (min)	Internal pnase volume (ml)				
	1% Span80	3% Span80	5% Span80	7% Span80	10% Span80
0	50.00	50.00	50.00	50.00	50.00
1	50.00	50.00	50.00	50.00	50.00
2	50.00	50.00	50.00	50.00	50.00
3	50.00	50.00	50.00	50.00	50.00
4	50.00	50.00	50.00	50.00	50.00
5	55.00	55.00	52.00	52.00	50.00
7	58.00	57.00	53.00	54.00	50.00
10	60.00	60.00	55.00	55.00	52.00
15	62.00	62.00	56.00	57.00	53.00
20	65.00	65.00	58.00	58.00	55.00
25	66.00	66.00	60.00	61.00	56.00
30	67.00	67.00	52.00	62.00	58.00
40	69.00	68.00	63.00	63.00	58.00
50	69.00	68.00	65.00	63.00	60.00
60	69.00	68.00	65.00	63.00	60.00

Table B-21 Calculation of %swelling for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various surfactant concentrations.

Time (min)	%swelling				
	1% Span80	3% Span80	5% span80	7% Span80	10% Span80
0	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00
5	10.00	10.00	4.00	4.00	0.00
7	16.00	14.00	6.00	8.00	0.00
10	20.00	20.00	10.00	10.00	4.00
15	24.00	24.00	12.00	14.00	6.00
20	30.00	30.00	16.00	16.00	10.00
25	32.00	32.00	20.00	22.00	12.00
30	34.00	34.00	24.00	24.00	16.00
40	38.00	36.00	26.00	26.00	16.00
50	38.00	36.00	30.00	26.00	20.00
60	38.00	36.00	30.00	26.00	20.00

Part IV Carrier concentration variable

Experimental conditions :

External phase : 10 mMolar L-lysine at pH 5.0 (adjust by H_2SO_4)

Membrane phase : 5% Span80, D2EHPA At various concentration and Dodecane (depends on D2EHPA concentration)

Internal phase : 1N HCl Solution

Membrane preparation : at homoginizing speed = 8000 rpm 10 minute

Agitation speed : 360 rpm

Table B-22 Experimental data for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various carrier concentrations.

Time (min)	Concentration (mM)				
	3% D2EHPA	5% D2EHPA	7% D2EHPA	10% D2EHPA	15% D2EHPA
0	10	10	10	10	10
1	9.34	8.84	8.53	7.78	6.80
2	9.15	8.05	7.04	6.34	6.12
3	9.02	7.53	6.52	6.02	5.80
4	8.74	7.06	6.30	5.68	5.61
5	8.64	6.62	6.01	5.47	5.37
7	8.51	6.37	5.82	5.20	5.01
10	8.43	6.14	5.70	4.64	4.42
15	8.31	6.03	5.61	4.20	3.97
20	8.02	5.97	5.53	4.02	3.80
25	7.94	5.84	5.51	4.02	3.80
30	7.75	5.84	5.51	4.02	3.80
40	7.72	5.84	5.51	4.00	3.64
50	7.72	5.84	5.50	4.00	3.64
60	7.72	5.84	5.50	4.00	3.64

Table B-23 Calculation [C]i/[C]o for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various carrier concentrations.

Time (min)	[C]i/[C]o				
	3% D2EHPA	5% D2EHPA	7% D2EHPA	10% D2EHPA	15% D2EHPA
0	1.000	1.000	1.000	1.000	1.000
1	0.934	0.884	0.853	0.778	0.680
2	0.915	0.805	0.704	0.634	0.612
3	0.902	0.753	0.652	0.602	0.580
4	0.874	0.706	0.630	0.568	0.561
5	0.864	0.660	0.601	0.547	0.537
7	0.851	0.637	0.582	0.520	0.501
10	0.843	0.614	0.570	0.464	0.442
15	0.831	0.603	0.561	0.420	0.397
20	0.802	0.597	0.553	0.402	0.380
25	0.794	0.584	0.551	0.402	0.380
30	0.775	0.584	0.551	0.402	0.380
40	0.772	0.584	0.551	0.400	0.364
50	0.772	0.584	0.550	0.400	0.364
60	0.772	0.584	0.550	0.400	0.364

Table B-24 Calculation of internal phase cocentration for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various carrier concentrations.

Time (min)	Internal phase concentration (mMolar)				
	3% D2EHPA	5% D2EHPA	7% D2EHPA	10% D2EHPA	15% D2EHPA
0	0.00	0.00	0.00	0.00	0.00
1	2.64	4.64	5.88	8.88	12.80
2	3.40	7.80	11.84	14.64	15.52
3	3.92	9.88	13.92	15.92	16.80
4	5.04	11.76	14.80	17.28	17.56
5	5.44	13.52	15.96	18.12	18.52
7	5.96	14.52	16.72	19.20	19.96
10	6.28	15.44	17.20	21.44	22.32
15	6.76	15.88	17.56	23.20	24.12
20	7.92	16.12	17.88	23.92	24.80
25	8.24	16.64	17.96	23.92	24.80
30	9.00	16.64	17.96	23.92	24.80
40	9.12	16.64	17.96	24.00	25.44
50	9.12	16.64	18.00	24.00	25.44
60	9.12	16.64	18.00	24.00	25.44

Table B-25 Calculation of initial rate for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various carrier concentrations (at 4 minutes).

Carrier concentration (%v/v)	Initial Rate (mMolar/min)
3	0.0327
5	0.0823
7	0.1160
10	0.1327
15	0.1400

Table B-26 Experimental data of pH change for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various carrier concentrations.

Time (min)	pH				
	3% D2EHPA	5% D2EHPA	7% D2EHPA	10% D2EHPA	15% D2EHPA
0	5.00	5.00	5.00	5.00	5.0
1	4.20	4.20	4.22	4.05	4.30
2	4.12	4.15	4.16	3.55	4.25
3	3.68	3.70	3.71	3.13	3.80
4	3.60	3.62	3.65	2.82	3.73
5	3.20	3.20	3.25	2.75	3.35
7	2.88	2.90	2.98	2.64	3.10
10	2.40	2.40	2.45	2.50	2.60
15	2.40	2.35	2.44	2.46	2.40
20	2.40	2.30	2.44	2.44	2.30
25	2.40	2.25	2.43	2.43	2.30
30	2.40	2.22	2.42	2.42	2.30
40	2.40	2.20	2.40	2.40	2.30
50	2.30	2.20	2.40	2.40	2.30
60	2.30	2.20	2.40	2.40	2.30

Table B-27 Experimental data of internal phase volume for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various carrier concentrations.

Time (min)	Internal phase volume (ml)				
	3% D2EHPA	5% D2EHPA	7% D2EHPA	10% D2EHPA	15% D2EHPA
0	50.00	50.00	50.00	50.00	50.00
1	50.00	50.00	50.00	50.00	50.00
2	50.00	50.00	50.00	50.00	50.00
3	50.00	50.00	50.00	50.00	50.00
4	50.00	50.00	50.00	50.00	52.00
5	50.00	50.00	51.00	52.00	53.00
7	51.00	52.00	53.00	53.00	55.00
10	53.00	55.00	55.00	55.00	57.00
15	55.00	55.00	56.00	56.00	58.00
20	55.00	56.00	57.00	58.00	60.00
25	57.00	58.00	58.00	60.00	62.00
30	59.00	60.00	60.00	52.00	63.00
40	60.00	62.00	62.00	63.00	65.00
50	62.00	64.00	65.00	65.00	68.00
60	63.00	65.00	65.00	65.00	70.00

Table B-28 Calculation of %swelling for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various carrier concentrations.

Time (min)	%swelling				
	3% D2EHPA	5% D2EHPA	7% D2EHPA	10% D2EHPA	15% D2EHPA
0	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	4.00
5	0.00	0.00	2.00	4.00	6.00
7	2.00	4.00	6.00	6.00	10.00
10	6.00	10.00	10.00	10.00	14.00
15	10.00	10.00	12.00	12.00	16.00
20	10.00	12.00	14.00	16.00	20.00
25	14.00	16.00	16.00	20.00	24.00
30	18.00	20.00	20.00	24.00	26.00
40	20.00	24.00	24.00	26.00	30.00
50	24.00	28.00	30.00	30.00	36.00
60	26.00	30.00	30.00	30.00	40.00

Part V Agitation speed variable

Experimental conditions :

External phase : 10 mMolar L-lysine at pH 5.0(adjust by H_2SO_4)

Membrane phase : 5% Span80, 10%D2EHPA and 85%Dodecane

Internal phase : 1N HCl Solution

Membrane preparation : at homoginizing speed = 8000 rpm 10 minute

Agitation speed : vary 240 to 480 rpm

Table B-29 Experimental data for extraction of L-lysine from aqueous by emulsion liquid membrane at various agitation speed.

Time (min)	Concentration (mM)				
	240 rpm	300 rpm	360 rpm	420 rpm	480 rpm
0	10.00	10.00	10.00	10.00	10.00
1	9.35	8.45	7.78	7.03	6.65
2	8.78	7.86	6.34	6.12	5.83
3	8.36	7.38	6.02	5.84	5.45
4	8.01	6.86	5.68	5.42	5.21
5	7.68	6.45	5.47	5.28	4.84
7	6.89	5.85	5.20	4.86	4.62
10	6.12	5.34	4.64	4.43	4.25
15	5.02	4.75	4.20	4.02	3.88
20	4.64	4.40	4.02	3.84	3.65
25	4.52	4.22	4.02	3.80	3.62
30	4.32	4.21	4.02	3.76	3.60
40	4.32	4.21	4.00	3.76	3.60
50	4.32	4.21	4.00	3.76	3.60
60	4.32	4.21	4.00	3.76	3.60

Table B-30 Calculation [C]i/[C]o for extraction of L-lysine from aqueous by emulsion liquid membrane at various agitaiton speed.

Time (min)	[C]i/[C]o				
	240 rpm	300 rpm	360 rpm	420 rpm	480 rpm
0	1.000	1.000	1.000	1.000	1.000
1	0.935	0.845	0.778	0.703	0.665
2	0.878	0.786	0.634	0.612	0.583
3	0.836	0.738	0.602	0.584	0.545
4	0.801	0.686	0.568	0.542	0.521
5	0.768	0.645	0.547	0.528	0.484
7	0.689	0.585	0.520	0.486	0.462
10	0.612	0.534	0.464	0.443	0.425
15	0.502	0.475	0.420	0.402	0.388
20	0.464	0.440	0.402	0.384	0.365
25	0.452	0.422	0.402	0.380	0.362
30	0.432	0.421	0.402	0.376	0.360
40	0.432	0.421	0.400	0.376	0.360
50	0.432	0.421	0.400	0.376	0.360
60	0.432	0.421	0.400	0.376	0.360

Table B-31 Calculation of internal phase cocentration for extraction of L-lysine from aqueous by emulsion liquid membrane at variousagitation speed.

Time (min)	Internal phase concentration (mMolar)				
	240 rpm	300 rpm	360 rpm	420 rpm	480 rpm
0	0.00	0.00	0.00	0.00	0.00
1	2.60	6.20	8.88	11.88	13.40
2	4.88	8.56	14.64	15.52	16.68
3	6.56	10.48	15.92	16.64	18.20
4	7.96	12.56	17.28	16.32	19.16
5	9.28	14.20	18.12	18.88	20.64
7	12.44	16.60	19.20	20.56	21.52
10	15.52	18.64	21.44	22.28	23.00
15	19.92	21.00	23.20	23.92	24.48
20	21.44	22.40	23.92	24.64	25.40
25	21.92	23.12	23.92	24.80	25.52
30	22.72	23.16	23.92	24.96	25.60
40	22.72	23.16	24.00	24.96	25.60
50	22.72	23.16	24.00	24.96	25.60
60	22.72	23.16	24.00	24.96	25.60

Table B-32 Calculation of initial rate for extraction of L-lysine from aqueous by emulsion liquid membrane at various agitation speed (at 4 minutes).

Agitation speed (rpm)	Initial Rate (mMolar/min)
240	0.0498
300	0.0785
360	0.1080
420	0.1145
480	0.1198

Table B-33 Experimental data of pH change for extraction of L-lysine from aqueous by emulsion liquid membrane at various agitation speed.

Time (min)	pH				
	240 rpm	300 rpm	360 rpm	420 rpm	480 rpm
0	5.00	5.00	5.00	5.00	5.00
1	4.20	4.30	4.22	4.20	4.10
2	4.12	4.20	4.16	4.12	4.05
3	3.68	3.80	3.71	3.65	3.60
4	3.60	3.75	3.65	3.60	3.40
5	3.20	3.34	3.25	3.20	3.10
7	2.88	3.03	2.98	2.85	2.81
10	2.65	2.88	2.45	2.65	2.30
15	2.54	2.65	2.44	2.50	2.30
20	2.40	2.48	2.44	2.35	2.30
25	2.35	2.35	2.43	2.35	2.30
30	2.30	2.22	2.42	2.35	2.30
40	2.26	2.20	2.40	2.35	2.30
50	2.22	2.20	2.40	2.35	2.30
60	2.14	2.20	2.40	2.35	2.30

Table B-34 Experimental data of internal phase volume for extraction of L-lysine from aqueous by emulsion liquid membrane at various agitation speed.

Time (min)	Internal phase volume (ml)				
	240 rpm	300 rpm	360 rpm	420 rpm	480 rpm
0	50.00	50.00	50.00	50.00	50.00
1	50.00	50.00	50.00	50.00	50.00
2	50.00	50.00	50.00	50.00	50.00
3	50.00	50.00	50.00	50.00	50.00
4	50.00	50.00	50.00	50.00	50.00
5	52.00	52.00	52.00	51.00	50.00
7	55.00	54.00	53.00	52.00	52.00
10	56.00	55.00	55.00	54.00	53.00
15	58.00	57.00	56.00	55.00	54.00
20	61.00	60.00	58.00	57.00	56.00
25	65.00	63.00	60.00	59.00	58.00
30	67.00	65.00	52.00	61.00	60.00
40	68.00	68.00	63.00	62.00	63.00
50	70.00	68.00	65.00	65.00	64.00
60	70.00	68.00	65.00	65.00	64.00

Table B-35 Calculation of %swelling for extraction of L-lysine from aqueous by emulsion liquid membrane at various agitation speeed.

Time (min)	%swelling				
	240 rpm	300 rpm	360 rpm	420 rpm	480 rpm
0	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00
5	4.00	4.00	4.00	2.00	0.00
7	10.00	8.00	6.00	4.00	4.00
10	12.00	10.00	10.00	8.00	6.00
15	16.00	14.00	12.00	10.00	8.00
20	22.00	20.00	16.00	14.00	12.00
25	30.00	26.00	20.00	18.00	16.00
30	34.00	30.00	24.00	22.00	20.00
40	36.00	36.00	26.00	24.00	26.00
50	40.00	36.00	30.00	30.00	28.00
60	40.00	36.00	30.00	30.00	28.00

Part VI Internal phase (HCl) concentration variable

Experimental conditions :

External phase : 10 mMolar L-lysine at pH 5.0(adjust by H_2SO_4)

Membrane phase : 5%Span80 , 10%D2EHPA and 85% Dodecane

Internal phase : 0.5 N, 1.0 N and 2.0 N HCl Solution

Membrane preparation : at homoginizing speed = 8000 rpm 10 minute

Agitation speed : 360 rpm

Table B-36 Experimental data for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various internal phase concentrations.

Time (min)	Concentration (mM)		
	0.5 N HCl	1.0 N HCl	2.0 N HCl
0	10	10	10
1	9.02	7.78	6.85
2	8.58	6.34	5.74
3	7.85	6.02	5.32
4	7.34	5.68	5.02
5	7.04	5.47	4.84
7	6.35	5.20	4.62
10	5.84	4.64	4.41
15	5.41	4.20	4.21
20	5.22	4.02	4.03
25	5.13	4.02	3.98
30	4.96	4.02	3.98
40	4.93	4.00	3.97
50	4.84	4.00	3.97
60	4.84	4.00	3.97

Table B-37 Calculation [C]i/[C]o for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various internal phase concentrations .

Time (min)	[C]i/[C]o		
	0.5 N HCl	1.0 N HCl	2.0 N HCl
0	1.000	1.000	1.000
1	0.902	0.778	0.685
2	0.858	0.634	0.574
3	0.785	0.602	0.532
4	0.734	0.568	0.502
5	0.704	0.547	0.484
7	0.635	0.520	0.462
10	0.584	0.464	0.441
15	0.541	0.420	0.421
20	0.522	0.402	0.403
25	0.513	0.402	0.398
30	0.496	0.402	0.398
40	0.493	0.400	0.397
50	0.484	0.400	0.397
60	0.484	0.400	0.397

Table B-38 Calculation of internal phase cocentration for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various internal phase concentrations.

Time (min)	Internal phase concentration (mMolar)		
	0.5 N HCl	1.0 N HCl	2.0 N HCl
0	0.00	0.00	0.00
1	3.92	6.88	12.60
2	5.68	14.64	17.04
3	8.60	15.92	18.72
4	10.64	17.28	19.92
5	11.84	18.12	20.64
7	14.60	19.20	21.52
10	16.64	21.44	22.36
15	18.36	23.20	23.16
20	19.12	23.92	23.88
25	19.48	23.92	24.08
30	20.16	23.92	24.08
40	20.28	24.00	24.12
50	20.64	24.00	24.12
60	20.64	24.00	24.12

Table B-39 Calculation of initial rate for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various surfactant concentrations (at 4 minutes).

Internal phase concentration (N)	Initial Rate (mMolar/min)
0.5	0.665
1.0	0.1080
2.0	0.1245

Table B-40 Experimental data of pH change for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various internal phase concentrations.

Time (min)	pH		
	0.5 N HCl	1.0 N HCl	2.0 N HCl
0	5.00	5.00	5.00
1	4.30	4.05	4.20
2	4.25	3.55	4.10
3	3.85	3.13	3.60
4	3.70	2.82	3.50
5	3.34	2.75	3.10
7	3.15	2.64	2.80
10	2.96	2.50	2.40
15	2.65	2.46	2.30
20	2.56	2.44	2.20
25	2.50	2.43	2.20
30	2.50	2.42	2.20
40	2.50	2.40	2.20
50	2.50	2.40	2.20
60	2.50	2.40	2.20

Table B-41 Experimental data of internal phase volume for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various internal phase concentrations.

Time (min)	Internal phase volume (ml)		
	0.5 N HCl	1.0 N HCl	2.0 N HCl
0	50.00	50.00	50.00
1	50.00	50.00	50.00
2	50.00	50.00	50.00
3	50.00	50.00	50.00
4	50.00	50.00	52.00
5	50.00	52.00	55.00
7	52.00	53.00	58.00
10	53.00	55.00	60.00
15	54.00	56.00	64.00
20	55.00	58.00	68.00
25	56.00	60.00	75.00
30	57.00	52.00	80.00
40	58.00	63.00	86.00
50	59.00	65.00	88.00
60	60.00	65.00	90.00

Table B-42 Calculation of %swelling for extraction of 10 mMolar L-lysine from aqueous by emulsion liquid membrane at various internal phase concentrations.

Time (min)	%swelling		
	0.5 N HCl	1.0 N HCl	2.0 N HCl
0	0.00	0.00	0.00
1	0.00	0.00	0.00
2	0.00	0.00	0.00
3	0.00	0.00	0.00
4	0.00	0.00	4.00
5	0.00	4.00	10.00
7	4.00	6.00	16.00
10	6.00	10.00	20.00
15	8.00	12.00	28.00
20	10.00	16.00	36.00
25	12.00	20.00	50.00
30	14.00	24.00	60.00
40	16.00	26.00	72.00
50	18.00	30.00	76.00
60	20.00	30.00	80.00

APPENDIX C

METHOD OF DETERMINATION OF L-LYSINE

Colorimetric Determination of Amino Acids with the Use of Ninhydrin

The reaction between - amino acids and ninhydrin is one of the most commonly used methods for detection and estimation of amino acids. A number of improvements have been introduced to increase the stability of the color formed and prevent the offensive odor during the reaction. The effect of metals on the ninhydrin reaction has been studied by several workers. Various cations impair the ninhydrin reaction but this inhibition is overcome in the presence of citrate buffer.

Reagent :- Ninhydrin Solution (1% W/V)

- Glycerol (55% V/V)
- 0.5 M Citrate (Na^+) Buffer pH 5.5
- $MnCl_2 \cdot 4H_2O$ (100 Mg/ml)

Method : -

1. In test tube:

1% Ninhydrin Solution	1	ml
55% (V/V) Glycerol	2.4	ml
0.5 M Citrate Buffer (pH 5.5)	0.2	ml
$MnCl_2 \cdot 4H_2O$ Solution (100 Mg/ml)	0.2	ml
Amino Acid Solution (Sample)	0.2	ml

2. Mix well and Heat in boiling water bath 12 miinutes
3. Cool in tab water
4. Reading absorbance at 570 nm within an hour.

VITA

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