APPENDICES

APPENDIX A

A-1 Calculation of stoma number

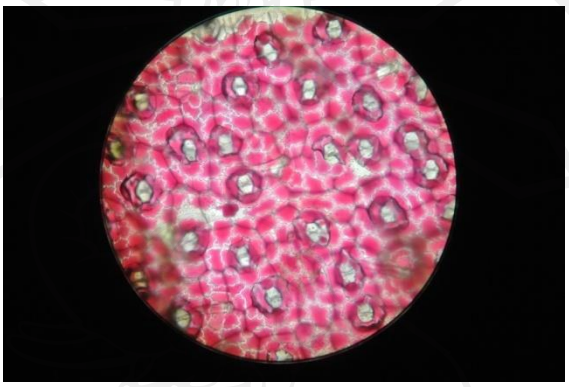

Figure A-1 stoma of dumb cane (400x)

A diameter of circle amount 44 slit of stage micrometer

Stage micrometer 1 slit	= 0.01 mm
∴ diameter of circle	= 44 x 0.01 mm
	= 0.44 mm
Area of circle	= ¶r^2
∴ Area of microscope 400x	= 3.41 x $(0.44/2)^2$
	= 0.15 mm^2
Stoma count 400x	= 28 cell / 0.15 mm^2
	= 186 stoma cell/mm^2
Area of dumb cane	= 4659 mm^2/leaf
∴ stoma of dumb cane	= (186 stoma cell/mm^2) x (4659 mm^2/leaf)
	= 866574 stoma/leaf

APPENDIX B

Nitrogen dioxide absorbed by selected plant

Table B-1 NO_2 absorption by dumb cane stating 20 ppm every 30 minutes for 8 hours

Time (hours)	control				soil				dumb cane				soil and dumb cane			
	1	**2**	**3**	**average**	**1**	**2**	**3**	**average**	**1**	**2**	**3**	**average**	**1**	**2**	**3**	**average**
0.0	20.2	19.5	20.8	20.2	19.7	19.4	19.8	19.6	20.6	19.6	20.8	20.3	20.6	20.4	20.0	20.3
0.5	16.0	15.5	17.0	16.2	12.5	12.3	12.4	12.4	16.4	14.6	15.9	15.6	13.9	11.3	13.1	12.8
1.0	13.9	13.3	14.5	13.9	9.5	7.5	8.4	8.5	13.3	12.5	12.5	12.8	9.7	9.7	9.9	9.8
1.5	12.1	11.9	12.3	12.1	7.5	6.3	7.3	7.0	11.1	11.1	10.7	11.0	5.1	6.7	7.1	6.3
2.0	11.3	10.7	10.7	10.9	5.5	5.1	5.4	5.3	9.3	9.7	8.5	9.2	4.0	4.8	5.1	4.6
2.5	10.5	9.5	10.1	10.0	4.6	4.0	4.2	4.3	8.1	8.3	7.1	7.8	2.6	3.6	3.8	3.3
3.0	9.5	8.9	9.5	9.3	3.8	3.4	3.9	3.7	6.9	7.1	6.1	6.7	2.2	2.8	3.2	2.7
3.5	8.5	8.5	8.7	8.6	3.0	2.8	2.8	2.9	6.3	6.5	5.3	6.0	1.8	2.2	2.4	2.1
4.0	7.9	8.1	8.1	8.0	2.6	2.4	2.4	2.5	5.5	5.9	4.6	5.3	1.0	1.8	1.8	1.5
4.5	7.5	7.5	7.7	7.6	2.2	2.0	2.2	2.1	4.9	5.3	4.0	4.7	1.0	1.4	1.6	1.3
5.0	7.5	7.3	7.3	7.4	1.8	1.8	1.8	1.8	4.5	5.1	3.4	4.3	0.8	1.2	1.4	1.1
5.5	6.9	6.9	6.7	6.8	1.6	1.2	1.4	1.4	4.5	4.8	3.0	4.1	0.6	1.0	1.0	0.9
6.0	6.5	6.5	6.3	6.4	1.2	1.2	1.2	1.2	4.3	4.8	2.8	4.0	0.4	0.8	0.8	0.7
6.5	6.5	5.7	5.9	6.0	1.2	1.0	1	1.1	4.2	4.6	2.4	3.7	0.4	0.6	0.8	0.6
7.0	6.3	5.7	5.9	6.0	0.8	0.8	0.8	0.8	3.8	4.3	2.4	3.5	0.4	0.6	0.6	0.5
7.5	6.0	5.7	5.5	5.7	0.8	0.8	0.8	0.8	3.8	4.0	2.2	3.3	0.4	0.6	0.6	0.5
8.0	5.7	5.7	5.3	5.6	0.6	0.6	0.6	0.6	3.8	3.6	2.2	3.2	0.4	0.4	0.4	0.4
							Total leaf area (mm^2)		**38069**	**34563**	**42851**	**38494**	**42851**	**34563**	**38069**	38494

Table B-2 NO_2 absorption by dumb cane stating 40 ppm every 30 minutes for 8 hours

Time (hours)	control				soil				dumb cane				soil and dumb cane			
	1	2	3	average	1	2	3	average	1	2	3	average	1	2	3	average
0.0	42.2	41.5	40.5	41.4	41.7	39.1	41.1	40.6	38.8	40.5	40.1	39.8	38.1	39.0	40.5	39.2
0.5	24.4	31.1	32.4	29.3	29.7	30.2	31.6	30.5	27.9	31.4	30.3	29.9	22.8	26.6	21.6	23.7
1.0	26.1	26.1	27.0	26.4	20.8	21.0	23.4	21.7	20.8	23.8	23.8	22.8	15.6	18.8	13.3	15.9
1.5	22.4	20.4	21.4	21.4	16.0	17.2	16.5	16.6	17.4	21.0	20.4	19.6	11.3	13.3	10.3	11.6
2.0	19.8	18.2	19.5	19.2	12.9	13.3	12.5	12.9	15.1	17.8	17.4	16.8	8.3	9.9	7.9	8.7
2.5	18.2	16.0	18.6	17.6	10.7	11.1	9.7	10.5	13.3	16.2	14.9	14.8	6.3	7.3	6.1	6.6
3.0	17.4	15.2	17.4	16.7	9.1	9.5	7.7	8.8	11.9	14.6	13.5	13.3	4.7	5.3	4.6	4.9
3.5	16.8	14.6	16.4	15.9	8.1	7.3	6.5	7.3	10.9	13.3	11.7	12.0	3.6	4.2	3.8	3.9
4.0	16.2	14.1	15.3	15.2	7.3	6.3	5.4	6.3	10.5	12.5	10.9	11.3	3.0	3.4	3.0	3.1
4.5	15.4	13.3	14.6	14.4	6.3	5.1	4.6	5.3	9.7	11.5	9.5	10.2	2.6	2.4	2.6	2.5
5.0	14.6	12.7	12.8	13.4	5.7	4.4	3.8	4.6	8.7	10.9	9.3	9.6	2.2	2.0	1.8	2.0
5.5	13.8	12.1	12.1	12.7	5.1	4.0	3.4	4.2	8.3	10.5	8.3	9.0	2.0	2.0	1.6	1.9
6.0	13.0	11.7	11.8	12.2	4.4	3.6	3.0	3.7	8.3	9.9	7.5	8.6	1.6	1.6	1.4	1.5
6.5	12.3	11.3	11.5	11.7	4.0	2.8	3.8	3.5	7.7	9.3	6.5	7.8	1.4	1.2	1.2	1.3
7.0	11.7	11.1	11.2	11.3	3.8	2.4	3.4	3.2	7.1	8.9	5.7	7.2	1.0	1.0	0.8	0.9
7.5	11.7	10.5	10.7	11.0	3.2	2.4	3.4	3.0	7.1	8.5	5.5	7.0	1.0	0.8	0.8	0.9
8.0	11.5	10.1	10.3	10.6	3.0	2.2	2.0	2.4	6.3	8.3	5.3	6.6	0.6	0.6	0.6	0.6
							Total leaf area (mm^2)		**35889**	**35356**	**36904**	**36049**	**35889**	**35356**	**36904**	**36049**

Table B-3 NO_2 absorption by little prayer plant stating 40 ppm every 30 minutes for 8 hours

Time	control				soil				little prayer plant				soil and little prayer plant			
(hours)	1	2	3	average	1	2	3	average	1	2	3	average	1	2	3	average
0.0	42.2	41.5	40.5	41.4	41.7	39.1	41.1	40.6	40.8	39.8	40.8	40.5	38.4	39.9	40.0	39.4
0.5	34.4	31.1	32.4	32.6	29.7	30.2	31.6	30.5	29.6	32.4	32.0	31.3	23.9	24.2	25.1	24.4
1.0	26.1	26.1	27.0	26.4	20.8	21.0	23.4	21.7	24.0	24.9	25.2	24.7	17.1	17.4	17.3	17.3
1.5	22.4	20.4	21.4	21.4	16.0	17.2	16.5	16.6	19.1	19.5	21.6	20.1	12.3	12.2	12.7	12.4
2.0	19.8	18.2	19.5	19.2	12.9	13.3	12.5	12.9	15.9	16.1	18.9	17.0	9.9	9.8	9.9	9.9
2.5	18.2	16.0	18.6	17.6	10.7	11.1	9.7	10.5	13.1	13.7	16.3	14.4	7.1	7.4	7.8	7.4
3.0	17.4	15.2	17.4	16.7	9.1	9.5	7.7	8.8	11.1	12.5	14.1	12.6	6.0	6.2	6.4	6.2
3.5	16.8	14.6	16.4	15.9	8.1	7.3	6.5	7.3	9.7	11.5	12.1	11.1	4.4	5.1	5.2	4.9
4.0	16.2	14.1	15.3	15.2	7.3	6.3	5.4	6.3	8.5	10.5	10.3	9.8	4.0	4.4	4.2	4.2
4.5	15.4	13.3	14.6	14.4	6.3	5.1	4.6	5.3	7.9	9.9	9.1	9.0	3.4	3.4	3.6	3.5
5.0	14.6	12.7	12.8	13.4	5.7	4.4	3.8	4.6	7.3	9.3	8.5	8.4	3.2	3.2	3.2	3.2
5.5	13.8	12.1	12.1	12.7	5.1	4.0	3.4	4.2	6.7	8.7	7.9	7.8	3.0	3.0	2.8	2.9
6.0	13.0	11.7	11.8	12.2	4.4	3.6	3.0	3.7	6.3	8.3	7.7	7.4	2.8	2.5	2.6	2.6
6.5	12.3	11.3	11.5	11.7	4.0	2.8	3.8	3.5	5.9	7.9	7.1	7.0	2.4	2.4	2.2	2.3
7.0	11.7	11.1	11.2	11.3	3.8	2.4	3.4	3.2	5.7	7.5	6.7	6.6	2.4	2.2	1.2	1.9
7.5	11.7	10.5	10.7	11.0	3.2	2.4	3.4	3.0	5.5	7.3	6.3	6.4	2.0	1.8	1.8	1.9
8.0	11.5	10.1	10.3	10.6	3.0	2.2	2.0	2.4	4.9	6.5	5.9	5.8	1.6	1.7	1.8	1.7
							Total leaf area (mm^2)		**77863**	**77305**	**80723**	**78630**	**78894**	**75921**	**81090**	**78634**

Table B-4 Uptake of 20 ppm NO_2 by dumb cane every 30 minutes for 8 hours

Time	Control				Soil				dumb cane				Soil and dumb cane				Δ1	Δ2	Δ3
(min)	1	2	3	average	1	2	3	average	1	2	3	average	1	2	3	average	soil	plant	soil and plant
0.0	20.2	19.5	20.8	20.2	19.7	19.4	19.8	19.6	20.4	19.6	20.0	20.0	20.6	20.4	20.0	20.3	0.5	0.2	-0.2
0.5	16.0	15.5	17.0	16.2	12.5	12.3	12.4	12.4	16.4	14.6	15.9	15.6	13.9	11.3	13.1	12.8	3.8	0.5	3.4
1.0	13.9	13.3	14.5	13.9	9.5	7.5	8.4	8.5	13.3	12.5	12.5	12.8	9.7	9.7	9.9	9.8	5.4	1.1	4.1
1.5	12.1	11.9	12.3	12.1	7.5	6.3	7.3	7.0	11.1	11.1	10.7	11.0	5.1	6.7	7.1	6.3	5.1	1.1	5.8
2.0	11.3	10.7	10.7	10.9	5.5	5.1	5.4	5.3	9.3	9.7	8.5	9.2	4.0	4.8	5.1	4.6	5.6	1.7	6.3
2.5	10.5	9.5	10.1	10.0	4.6	4.0	4.2	4.3	8.1	8.3	7.1	7.8	2.6	3.6	3.8	3.3	5.8	2.2	6.7
3.0	9.5	8.9	9.5	9.3	3.8	3.4	3.9	3.7	6.9	7.1	6.1	6.7	2.2	2.8	3.2	2.7	5.6	2.6	6.6
3.5	8.5	8.5	8.7	8.6	3.0	2.8	2.8	2.9	6.3	6.5	5.3	6.0	1.8	2.2	2.4	2.1	5.7	2.5	6.4
4.0	7.9	8.1	8.1	8.0	2.6	2.4	2.4	2.5	5.5	5.9	4.6	5.3	1.0	1.8	1.8	1.5	5.6	2.7	6.5
4.5	7.5	7.5	7.7	7.6	2.2	2.0	2.2	2.1	4.9	5.3	4.0	4.7	1.0	1.4	1.6	1.3	5.4	2.8	6.2
5.0	7.5	7.3	7.3	7.4	1.8	1.8	1.8	1.8	4.5	5.1	3.4	4.3	0.8	1.2	1.4	1.1	5.6	3.0	6.2
5.5	6.9	6.9	6.7	6.8	1.6	1.2	1.4	1.4	4.5	4.8	3.0	4.1	0.6	1.0	1.0	0.9	5.4	2.7	6.0
6.0	6.5	6.5	6.3	6.4	1.2	1.2	1.2	1.2	4.3	4.8	2.8	4.0	0.4	0.8	0.8	0.7	5.2	2.5	5.8
6.5	6.5	5.7	5.9	6.0	1.2	1.0	1	1.1	4.2	4.6	2.4	3.7	0.4	0.6	0.8	0.6	5.0	2.3	5.4
7.0	6.3	5.7	5.9	6.0	0.8	0.8	0.8	0.8	3.8	4.3	2.4	3.5	0.4	0.6	0.6	0.5	5.2	2.5	5.4
7.5	6.0	5.7	5.5	5.7	0.8	0.8	0.8	0.8	3.8	4.0	2.2	3.3	0.4	0.6	0.6	0.5	4.9	2.4	5.2
8.0	5.7	5.7	5.3	5.6	0.6	0.6	0.6	0.6	3.8	3.6	2.2	3.2	0.4	0.4	0.4	0.4	5.0	2.4	5.2
								Total leaf area (mm^2)	38069	34563	42851	38494	42851	34563	38069	38494			
								Ratio between NO_2 absorption and leaf area (ppb/m^2)	0.436	0.463	0.415	0.438	0.579	0.515	0.522	0.522		

Δ1 : the difference of control and soil

Δ2 : the difference of control and dumb cane

Δ3 : the difference of control and soil + dumb cane

Table B-5 Uptake of 40 ppm NO_2 by dumb cane every 30 minutes for 8 hours

Time (hours)	Control				Soil				dumb cane				Soil and dumb cane				Δ1	Δ2	Δ3
	1	2	3	average	1	2	3	average	1	2	3	average	1	2	3	average	soil	plant	soil and plant
0.0	42.2	41.5	40.5	41.4	41.7	39.1	41.1	40.6	38.8	40.5	40.1	39.8	38.1	39.0	40.5	39.2	0.8	1.6	2.2
0.5	34.4	31.1	32.4	32.6	29.7	30.2	31.6	30.5	27.9	31.4	30.3	29.9	22.8	26.6	21.6	23.7	2.1	2.8	9.0
1.0	26.1	26.1	27.0	26.4	20.8	21.0	23.4	21.7	20.8	23.8	23.8	22.8	15.6	18.8	13.3	15.9	4.7	3.6	10.5
1.5	22.4	20.4	21.4	21.4	16.0	17.2	16.5	16.6	17.4	21.0	20.4	19.6	11.3	13.3	10.3	11.6	4.8	1.8	9.8
2.0	19.8	18.2	19.5	19.2	12.9	13.3	12.5	12.9	15.1	17.8	17.4	16.8	8.3	9.9	7.9	8.7	6.3	2.4	10.5
2.5	18.2	16.0	18.6	17.6	10.7	11.1	9.7	10.5	13.3	16.2	14.9	14.8	6.3	7.3	6.1	6.6	7.1	2.8	11.0
3.0	17.4	15.2	17.4	16.7	9.1	9.5	7.7	8.8	11.9	14.6	13.5	13.3	4.7	5.3	4.6	4.9	7.9	3.3	11.8
3.5	16.8	14.6	16.4	15.9	8.1	7.3	6.5	7.3	10.9	13.3	11.7	12.0	3.6	4.2	3.8	3.9	8.6	4.0	12.1
4.0	16.2	14.1	15.3	15.2	7.3	6.3	5.4	6.3	10.5	12.5	10.9	11.3	3.0	3.4	3.0	3.1	8.9	3.9	12.1
4.5	15.4	13.3	14.6	14.4	6.3	5.1	4.6	5.3	9.7	11.5	9.5	10.2	2.6	2.4	2.6	2.5	9.1	4.2	11.9
5.0	14.6	12.7	12.8	13.4	5.7	4.4	3.8	4.6	8.7	10.9	9.3	9.6	2.2	2.0	1.8	2.0	8.7	3.7	11.4
5.5	13.8	12.1	12.1	12.7	5.1	4.0	3.4	4.2	8.3	10.5	8.3	9.0	2.0	2.0	1.6	1.9	8.5	3.6	10.8
6.0	13.0	11.7	11.8	12.2	4.4	3.6	3.0	3.7	8.3	9.9	7.5	8.6	1.6	1.6	1.4	1.5	8.5	3.6	10.6
6.5	12.3	11.3	11.5	11.7	4.0	2.8	3.8	3.5	7.7	9.3	6.5	7.8	1.4	1.2	1.2	1.3	8.2	3.9	10.4
7.0	11.7	11.1	11.2	11.3	3.8	2.4	3.4	3.2	7.1	8.9	5.7	7.2	1.0	1.0	0.8	0.9	8.1	4.1	10.4
7.5	11.7	10.5	10.7	11.0	3.2	2.4	3.4	3.0	7.1	8.5	5.5	7.0	1.0	0.8	0.8	0.9	8.0	3.9	10.1
8.0	11.5	10.1	10.3	10.6	3.0	2.2	2.0	2.4	6.3	8.3	5.3	6.6	0.6	0.6	0.6	0.6	8.2	4.0	10.0
								Total leaf area (mm^2)	35889	35356	36904	36050	35889	35356	36904	36050			
								Ratio between NO_2 absorption and leaf area (ppb/m^2)	0.906	0.911	0.943	0.920	1.045	1.086	1.081	1.071			

Δ1 : the difference of control and soil

Δ2 : the difference of control and dumb cane

Δ3 : the difference of control and soil + dumb cane

Table B-6 Uptake of 40 ppm NO_2 by little prayer plant every 30 minutes for 8 hours

Time (hours)	Control				Soil				little prayer plant				Soil and little prayer plant				Δ1	Δ2	Δ3
	1	2	3	average	1	2	3	average	1	2	3	average	1	2	3	average	soil	plant	soil and plant
0.0	42.2	41.5	40.5	41.4	41.7	39.1	41.1	40.6	40.8	39.8	40.8	40.5	38.4	39.9	40.0	39.4	0.8	0.9	2.0
0.5	34.4	31.1	32.4	32.6	29.7	30.2	31.6	30.5	29.6	32.4	32.0	31.3	23.9	24.2	25.1	24.4	2.1	1.3	8.2
1.0	26.1	26.1	27.0	26.4	20.8	21.0	23.4	21.7	24.0	24.9	25.2	24.7	17.1	17.4	17.3	17.3	4.7	1.7	9.1
1.5	22.4	20.4	21.4	21.4	16.0	17.2	16.5	16.6	19.1	19.5	21.6	20.1	12.3	12.2	12.7	12.4	4.8	1.3	9.0
2.0	19.8	18.2	19.5	19.2	12.9	13.3	12.5	12.9	15.9	16.1	18.9	17.0	9.9	9.8	9.9	9.9	6.3	2.2	9.3
2.5	18.2	16.0	18.6	17.6	10.7	11.1	9.7	10.5	13.1	13.7	16.3	14.4	7.1	7.4	7.8	7.4	7.1	3.2	10.2
3.0	17.4	15.2	17.4	16.7	9.1	9.5	7.7	8.8	11.1	12.5	14.1	12.6	6.0	6.2	6.4	6.2	7.9	4.1	10.5
3.5	16.8	14.6	16.4	15.9	8.1	7.3	6.5	7.3	9.7	11.5	12.1	11.1	4.4	5.1	5.2	4.9	8.6	4.8	11.0
4.0	16.2	14.1	15.3	15.2	7.3	6.3	5.4	6.3	8.5	10.5	10.3	9.8	4.0	4.4	4.2	4.2	8.9	5.4	11.0
4.5	15.4	13.3	14.6	14.4	6.3	5.1	4.6	5.3	7.9	9.9	9.1	9.0	3.4	3.4	3.6	3.5	9.1	5.5	11.0
5.0	14.6	12.7	12.8	13.4	5.7	4.4	3.8	4.6	7.3	9.3	8.5	8.4	3.2	3.2	3.2	3.2	8.7	5.0	10.2
5.5	13.8	12.1	12.1	12.7	5.1	4.0	3.4	4.2	6.7	8.7	7.9	7.8	3.0	3.0	2.8	2.9	8.5	4.9	9.7
6.0	13.0	11.7	11.8	12.2	4.4	3.6	3.0	3.7	6.3	8.3	7.7	7.4	2.8	2.5	2.6	2.6	8.5	4.7	9.5
6.5	12.3	11.3	11.5	11.7	4.0	2.8	3.8	3.5	5.9	7.9	7.1	7.0	2.4	2.4	2.2	2.3	8.2	4.7	9.4
7.0	11.7	11.1	11.2	11.3	3.8	2.4	3.4	3.2	5.7	7.5	6.7	6.6	2.4	2.2	1.2	1.9	8.1	4.7	9.4
7.5	11.7	10.5	10.7	11.0	3.2	2.4	3.4	3.0	5.5	7.3	6.3	6.4	2.0	1.8	1.8	1.9	8.0	4.6	9.1
8.0	11.5	10.1	10.3	10.6	3.0	2.2	2.0	2.4	4.9	6.5	5.9	5.8	1.6	1.7	1.8	1.7	8.2	4.9	8.9
								Total leaf area (mm^2)	77863	77305	80723	78630	78894	75921	81090	78635			
								Ratio between NO_2 absorption and leaf area (ppb/m^2)	0.461	0.431	0.432	0.441	0.466	0.503	0.471	0.480			

Δ1 : the difference of control and soil

Δ2 : the difference of control and little prayer plant

Δ3 : the difference of control and soil + little prayer plant

APPENDIX C

Ion analysis

C-1 chemical composition change in plant leaves after NO_2 exposure

1. Calculation of sampler concentration from the linear regression

Calculate NO_3^- concentration (µg/mL) from linear regression of calibration curve, which constructed by plotting between Peak area (µS/cm)xmin and NO_3^- concentration (µg/mL)

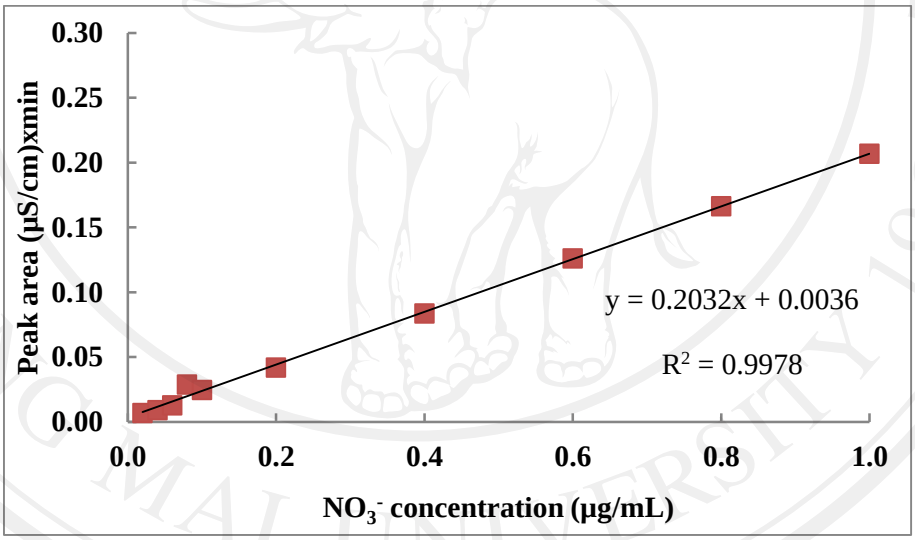

Figure C-1 Calibration curves for determination of nitrate ion

Example calculation for NO_3^- concentration = 0.4964 (µg/mL)

Y = 0.2032x + 0.0036

= 0.2032(0.4964) + 0.0036

= 0.1045 µg/mL

CURRICULUM VITAE

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