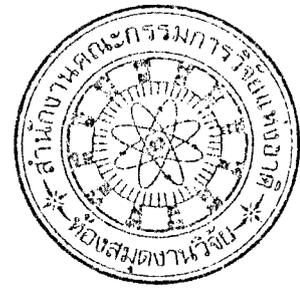


## ภาคผนวก

อาหารเลี้ยงเชื้อ (NIES, 2000 อ้างโดย ชูวดี และคณะ, 2544)

อาหารสูตรอย่างง่าย algal medium (AM) ในปริมาณ 1 L มีสูตรอาหาร ดังนี้

1. $K_2HPO_4$	0.25	g/L
2. $MgSO_4 \cdot 7H_2O$	0.513	g/L
3. $NaNO_3$	1.0	g/L
4. $NHCl_4$	0.05	g/L
5. $CaCl_2$	0.058	g/L
6. $FeCl_3$	0.003	g/L



ผลการทดสอบทางสถิติ

1. การเพาะเลี้ยง *Scenedesmus* sp. AARL G022 แบบ mixotrophic โดยใช้ glucose เป็นแหล่งคาร์บอน

1.1 Dry weight (g.L<sup>-1</sup>)

ANOVA

Dry weight (g/L)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	9.679	3	3.226	1270.621	.000
Within Groups	.018	7	.003		
Total	9.697	10			

Dry weight (g/L)

glucose	N	Subset for alpha = .05				
		1	2	3	4	1
Tukey HSD(a,b)	1.00	3	.1669			
	2.00	3		.3478		
	3.00	3			1.0723	
	4.00	2				2.7814
Sig.			1.000	1.000	1.000	1.000
Duncan(a,b)	1.00	3	.1669			
	2.00	3		.3478		
	3.00	3			1.0723	
	4.00	2				2.7814
Sig.			1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.667.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

## 1.2 Total lipid (mg.L<sup>-1</sup>)

### ANOVA

#### Total lipid (mg L<sup>-1</sup>)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	26272.969	3	8757.656	2.670	.128
Within Groups	22958.706	7	3279.815		
Total	49231.675	10			

#### Total lipid (mg L<sup>-1</sup>)

	totallipid	Subset for alpha = .05		
		N	2	1
Tukey HSD(a,b)	1.00	3	22.5499	
	2.00	3	38.6049	
	3.00	3	74.0918	
	4.00	2	161.2938	
	Sig.		.098	
Duncan(a,b)	1.00	3	22.5499	
	2.00	3	38.6049	
	3.00	3	74.0918	74.0918
	4.00	2		161.2938
	Sig.		.350	.122

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.667.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

	totallipid	Subset for alpha = .05		
		N	2	1
Tukey HSD(a,b)	1.00	3	22.5499	
	2.00	3	38.6049	
	3.00	3	74.0918	
	4.00	2	161.2938	
	Sig.		.098	
Duncan(a,b)	1.00	3	22.5499	
	2.00	3	38.6049	
	3.00	3	74.0918	74.0918
	4.00	2		161.2938
	Sig.		.350	.122

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.667.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

### 1.3 Lipid (%)

#### ANOVA

Lipid (%)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	76.110	3	25.370	2.926	.109
Within Groups	60.699	7	8.671		
Total	136.809	10			

Lipid (%)

persen

lipid	Subset for alpha = .05		
	N	1	2
Tukey			
HSD(a,b)			
	3.00	3	6.7737
	4.00	2	8.4285
	2.00	3	11.0701
	1.00	3	13.4917
	Sig.		.121
Duncan(a,b)			
	3.00	3	6.7737
	4.00	2	8.4285
	2.00	3	11.0701
	1.00	3	13.4917
	Sig.		.149

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.667.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

1.4 จำนวนเซลล์ (colony.ml<sup>-1</sup>)

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	174165437 779809.10 0	3	58055145926 603.000	3.494	.070
Within Groups	132939986 268717.40 0	8	16617498283 589.680		
Total	307105424 048526.60 0	11			

rate

growth	N	Subset for alpha = .05	
		1	2
Tukey HSD(a)	1.00	3	2546296.2 967
	2.00	3	4123456.7 900
	3.00	3	10413580. 2467
	4.00	3	11280864. 1967
	Sig.		.113
Duncan(a)	1.00	3	2546296.2 967
	2.00	3	4123456.7 900
	3.00	3	10413580. 2467
	4.00	3	11280864. 1967
	Sig.		.053

Means for groups in homogeneous subsets are displayed.  
a Uses Harmonic Mean Sample Size = 3.000.

1.5 ค่า OD<sub>665</sub>

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.566	3	1.189	9.554	.005
Within Groups	.995	8	.124		
Total	4.561	11			

	OD	N	Subset for alpha = .05			
			1	2	3	1
Tukey	1.00	3		.2150		
HSD(a)	2.00	3		.4717		
	3.00	3		.9907	.9907	
	4.00	3			1.6400	
	Sig.			.103	.188	
Duncan(a)	1.00	3		.2150		
	2.00	3		.4717	.4717	
	3.00	3			.9907	.9907
	4.00	3				1.6400
	Sig.			.399	.109	.054

Means for groups in homogeneous subsets are displayed.  
a. Uses Harmonic Mean Sample Size = 3.000.

หมายเหตุ

หมายเลข 1.00 = control

2.00 = 0.01 M

3.00 = 0.02 M

4.00 = 0.05 M

2. การเพาะเลี้ยง *Scenedesmus* sp. AARL G022 แบบ mixotrophic โดยใช้ glycerol เป็นแหล่งคาร์บอน

2.1 Dry weight ( $\text{g.L}^{-1}$ )

ANOVA

weight

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.065	3	.022	2.359	.158
Within Groups	.065	7	.009		
Total	.130	10			

weight

		N	Subset for alpha = .05
glycerol		1	1
Tukey HSD(a,b)	5.00	3	.1230
	6.00	3	.1947
	7.00	3	.2890
	8.00	2	.3230
	Sig.		.164
Duncan(a,b)	5.00	3	.1230
	6.00	3	.1947
	7.00	3	.2890
	8.00	2	.3230
	Sig.		.058

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.667.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

## 2.2 Total lipid (mg L<sup>-1</sup>)

### ANOVA

mg

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1582.870	3	527.623	2.473	.146
Within Groups	1493.722	7	213.389		
Total	3076.592	10			

mg

		N	Subset for alpha = .05
totallipid		1	1
Tukey HSD(a,b)	5.00	3	17.5810
	6.00	3	31.2363
	7.00	3	45.8603
	8.00	2	46.8545
	Sig.		.184
Duncan(a,b)	5.00	3	17.5810
	6.00	3	31.2363
	7.00	3	45.8603
	8.00	2	46.8545
	Sig.		.065

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.667.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

### 1.3 Lipid (%)

#### ANOVA

persen

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.473	3	2.158	.680	.591
Within Groups	22.202	7	3.172		
Total	28.675	10			

persen

		N	Subset for alpha = .05
lipid		1	1
Tukey HSD(a,b)	5.00	3	14.4898
	8.00	2	14.5170
	7.00	3	15.9637
	6.00	3	16.1110
	Sig.		.727
Duncan(a,b)	5.00	3	14.4898
	8.00	2	14.5170
	7.00	3	15.9637
	6.00	3	16.1110
	Sig.		.352

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.667.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

## 2.4 จำนวนเซลล์ (colony.mL<sup>-1</sup>)

### ANOVA

rate

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	126218981 1895.499	3	42072993729 8.500	1.124	.402
Within Groups	262002742 2503.431	7	37428963178 6.204		
Total	388221723 4398.929	10			

rate

	N	Subset for alpha = .05
		1
growth	1	1
1.00	3	2663580.2 467
2.00	3	3012345.6 800
Tukey HSD(a,b)	3	3012345.6 800
4.00	2	3685185.1 900
Sig.		.298
1.00	3	2663580.2 467
2.00	3	3012345.6 800
Duncan(a,b)	3	3012345.6 800
4.00	2	3685185.1 900
Sig.		.111

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.667.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

2.5

### ANOVA

ssh

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.049	3	.016	2.196	.176
Within Groups	.052	7	.007		
Total	.101	10			

ssh

		N	Subset for alpha = .05
OD		1	1
Tukey HSD(a,b)	1.00	3	.1477
	2.00	3	.2667
	4.00	2	.2755
	3.00	3	.3213
	Sig.		.180
Duncan(a,b)	1.00	3	.1477
	2.00	3	.2667
	4.00	2	.2755
	3.00	3	.3213
	Sig.		.064

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.667.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

## 2.5 ค่า OD <sub>665</sub>

ssh

		N	Subset for alpha = .05
OD		1	1
Tukey HSD(a,b)	1.00	3	.1477
	2.00	3	.2667
	4.00	2	.2755
	3.00	3	.3213
	Sig.		.180
Duncan(a,b)	1.00	3	.1477
	2.00	3	.2667
	4.00	2	.2755
	3.00	3	.3213
	Sig.		.064

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.667.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

หมายเหตุ

หมายเลข 1.00 = control

2.00 = 0.01 M

3.00 = 0.02 M

4.00 = 0.05 M

3. การเพาะเลี้ยง *Scenedesmus* sp. AARL G022 แบบ mixotrophic โดยใช้ sodium acetate เป็นแหล่งคาร์บอน

3.1 Dry weight (g.L<sup>-1</sup>)

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8.584	3	2.861	.941	.487
Within Groups	15.201	5	3.040		
Total	23.785	8			

weight

	N	Subset for alpha = .05	
sodium	1	1	
12.00	2	12.0785	
11.00	2	12.6765	
Tukey HSD(a,b)	2	13.8925	
9.00	3	14.4897	
Sig.		.528	
12.00	2	12.0785	
11.00	2	12.6765	
Duncan(a,b)	2	13.8925	
9.00	3	14.4897	
Sig.		.221	

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.182.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

3.2 Total lipid (mg L<sup>-1</sup>)

ANOVA

mg

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	529.741	3	176.580	5.457	.049
Within Groups	161.787	5	32.357		
Total	691.527	8			

mg

		N	Subset for alpha = .05	
		1	2	1
Tukey HSD(a,b)	9.00	3	17.5810	
	11.00	2	31.6935	
	10.00	2	33.3870	
	12.00	2	35.7255	
	Sig.			.072
Duncan(a,b)	9.00	3	17.5810	
	11.00	2		31.6935
	10.00	2		33.3870
	12.00	2		35.7255
	Sig.		1.000	.502

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.182.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

### 3.3 Lipid (%)

#### ANOVA

persen

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8.584	3	2.861	.941	.487
Within Groups	15.201	5	3.040		
Total	23.785	8			

persen

		N	Subset for alpha = .05
		1	1
Tukey HSD(a,b)	lipid 12.00	2	12.0785
	11.00	2	12.6765
	10.00	2	13.8925
	9.00	3	14.4897
	Sig.		.528
Duncan(a,b)	lipid 12.00	2	12.0785
	11.00	2	12.6765
	10.00	2	13.8925
	9.00	3	14.4897
	Sig.		.221

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.182.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

3.4 จำนวนเซลล์ (colony/ml)

ANOVA

rate

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	689005099 071.026	3	22966836635 7.009	.700	.591
Within Groups	163971765 4263.832	5	32794353085 2.766		
Total	232872275 3334.858	8			

rate

	N	Subset for alpha = .05
		1
growth	1	1
2.00	2	1972222.2 250
4.00	2	2467592.5 950
Tukey HSD(a,b) 1.00	3	2663580.2 467
3.00	2	2671296.2 950
Sig.		.613
2.00	2	1972222.2 250
4.00	2	2467592.5 950
Duncan(a,b) 1.00	3	2663580.2 467
3.00	2	2671296.2 950
Sig.		.271

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.182.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

ANOVA

ssh

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.041	3	.014	5.222	.053
Within Groups	.013	5	.003		
Total	.054	8			

ssh

OD	N	Subset for alpha = .05		
	1	2	1	
Tukey HSD(a,b)	1.00	3	.0347	
	2.00	2	.1325	
	4.00	2	.1805	
	3.00	2	.1955	
	Sig.		.074	
Duncan(a,b)	1.00	3	.0347	
	2.00	2	.1325	.1325
	4.00	2		.1805
	3.00	2		.1955
	Sig.		.101	.264

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.182.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

หมายเหตุ

หมายเลข 1.00 = control

2.00 = 0.01 M

3.00 = 0.02 M

4.00 = 0.05 M

4. การเพาะเลี้ยง *Scenedesmus* sp. AARL G022 แบบ mixotrophic โดยใช้ sodium acetate เป็นแหล่งคาร์บอน

4.1 Dry weight (g.L<sup>-1</sup>)

ANOVA

biomass

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	29.692	5	5.938	29.938	.000
Within Groups	1.984	10	.198		
Total	31.676	15			

biomass

	darklight	N	Subset for alpha = .05		
		1	2	3	1
Tukey HSD(a,b)	1.00	3	.1426		
	5.00	3		1.5620	
	6.00	2		1.9389	
	3.00	2		2.1198	
	4.00	3			3.5589
	2.00	3			4.0372
	Sig.			1.000	.716
Duncan(a,b)	1.00	3	.1426		
	5.00	3		1.5620	
	6.00	2		1.9389	
	3.00	2		2.1198	
	4.00	3			3.5589
	2.00	3			4.0372
	Sig.			1.000	.205

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.571.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

4.2 Total lipid (mg.L<sup>-1</sup>)

ANOVA

mg

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	257494.15 3	5	51498.831	24.629	.000
Within Groups	20909.947	10	2090.995		
Total	278404.09 9	15			

mg

		N		Subset for alpha = .05		
		1	2	3	4	1
Tukey HSD(a,b)	1.00	3	22.5713			
	5.00	3	129.1563	129.1563		
	6.00	2	158.0412	158.0412	158.0412	
	3.00	2		185.0000	185.0000	
	2.00	3			297.2924	297.2924
	4.00	3				396.3475
	Sig.			.059	.735	.052
Duncan(a,b)	1.00	3	22.5713			
	5.00	3		129.1563		
	6.00	2		158.0412		
	3.00	2		185.0000		
	2.00	3			297.2924	
	4.00	3				396.3475
	Sig.			1.000	.216	1.000

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.571.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

### 4.3 Lipid (%)

ANOVA

persen

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	142.694	5	28.539	5.160	.013
Within Groups	55.305	10	5.530		
Total	197.999	15			

persen

		N		Subset for alpha = .05	
		1	2	...	1
Tukey HSD(a,b)	2.00	3	7.4706		
	5.00	3	8.4259		
	3.00	2	8.4495		
	6.00	2	9.2168	9.2168	
	4.00	3	11.1377	11.1377	
	1.00	3			15.9819
	Sig.			.523	.069
Duncan(a,b)	2.00	3	7.4706		
	5.00	3	8.4259		
	3.00	2	8.4495		
	6.00	2	9.2168		
	4.00	3	11.1377		
	1.00	3			15.9819
	Sig.			.135	1.000

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.571.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

#### 4.4 จำนวนเซลล์ (colony/ml)

#### ANOVA

cell

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	354744246 6786296.0 00	5	70948849335 7259.000	6.941	.005
Within Groups	102223216 7393820.0 00	10	10222321673 9382.000		
Total	456967463 4180110.0 00	15			

cell

growth	N	Subset for alpha = .05			
	1	2	3	1	
1.00	3	3212962.9 633			
6.00	2	15083333. 3300			
5.00	3	18271604. 9400			
Tukey HSD(a,b)	4.00	25024691. 3567	25024691. 3567		
	3.00	27148148. 1450	27148148. 1450		
	2.00		49679012. 3433		
	Sig.	.163	.145		
1.00	3	3212962.9 633			
6.00	2	15083333. 3300	15083333. 3300		
5.00	3	18271604. 9400	18271604. 9400		
Duncan(a,b)	4.00		25024691. 3567		
	3.00		27148148. 1450		
	2.00			49679012. 3433	
	Sig.	.138	.235	1.000	

Means for groups in homogeneous subsets are displayed.

a Uses Harmonic Mean Sample Size = 2.571.

b The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

- หมายเหตุ
- 1.00 = phototrophic
  - 2.00 = light all time
  - 3.00 = L8:16D
  - 4.00 = L16:8D
  - 5.00 = L12:12D
  - 6.00 = heterotrophic



