APPENDICES

Appendix A

ANALYSIS METHODS

Physico-chemical analyses method (APHA and WPCF, 1985; Traichaiyaporn, 2000)

1. DO and BOD analysis

Chemicals preparation

1. concentrated sulfuric acid
2. manganous sulfate solution
   - Disolve 480 g. of $MnSO_4 .4H_2O$ (or 400 g. of $MnSO_4 .2H_2O$ or 364 g. of $MnSO_4 .H_2O$) in distilled water, filterd and add distilled water to 1,000 mL. It should be noted that this solution should not produce any color when added to acidified potassium iodide having starch solution as indicator.
3. alkali-iodide azide reagent
   - For water sample which has estimated DO-value lower than saturated point, dissolve 500 g. of NaOH (or 700 g. of KOH) and 135 g of Nal (or 150 g. of KI) in 250 mL.of distilled water. Add 10 g of $NaNO_3$ dissolved in 40 mL. of distilled water, then make up to 1,000 mL. (This solution should not present any color with starch solution when being diluted and acidified.)
   - For water sample which has estimated FO-value higher than saturated point, dissolve 10 g of $NaNO_3$ in 500 mL of distilled water. Add 480 g of NaOH and 75 g Nal. Shake well until completely

dissolved. (This solution appear with cloudy whitish of Na_2CO_3, adding acid to the solution produces toxic hydrazoic acid gas.)

4. starch solution
   - Weight 2 g of starch powder and 0.2 g of salicylic acid, then dissolve them in hot distilled water and make up to 100 mL.
5. standard solution : sodium thiosulfate 0.021 M
   - Dissolve 6.205 g of $Na_2S_2O_3 .5H_2O$ in distilled water. Add 1.5 mL of NaOH 6 N (or solid NaOH 0.4 g) and diluted with distilled water to 1,000 ml. Titrate this solution for comparison with potassium bi-iodate to make standardization.
6. standard solution : potassium bi-iodate (0.021 M)
   - Dissolve 812.4 g of $KH(IO_3)_2$ in distilled water and make up to 1,000 mL.

Determination

1. Distilled water is aerated overnight or at least 2 hours before the analysis.
2. After arriving at laboratory, water sample is suddenly diluted to 2 % by adding 2 m L of filtered sample into 300 mL BOD bottle and filled with aerated distilled water. Two set of samples are prepared; one set for DO_1 (measured on day 0) analysis carried out on the sampling day, another set for DO_2 analysis (measured on day 5) which is put in the incubator at 20 $\pm$ 0.1 ^0C for five days before the analysis.
3. One ml. of $MnSO_4$ is added followed by 1 mL of alkali-iodide-azide reagent.
4. The bottle is closed and shook well until 2/3 of precipitate to occur.

5. The bottle is then repeated shaking and left for 2/3 of precipitate to occur.
6. One mL of conc. H_2SO_4 is added and then the bottle is shook well to completely dissolve the precipitate.
7. Solution obtained from 4. is titrated with $Na_2S_2O_3$ 0.021 M until pale-yellow color appears.
8. Few drops of starch solution is then added followed by shaking the bottle till blue color appears.
9. The titration is continued until the end point indicated by the disappearing of the blue color.
10. DO as ppm (mg L^{-1}) is then calculated using the formula :

DO (mg L^{-1}) = mL of $Na_2S_2O_3$ 0.021 M x 2

And BOD_5 as ppm (mg L^{-1}) is then calculated from :

$BOD_5 = DO_1 - DO_2$

2. COD analysis

1. Potassium dichromate 0.0167 M (digestion solution)

   - Dissolve 4.913 g of solid $K_2Cr_2O_7$ (dried at 103 ^{0}C for 2 hours) in distilled water and make up to 500 mL. Then 167 mL of concentrated sulfuric acid was slowly added followed by 33.3 g of $HgSO_4$. The solution is then stirred up and left to cool down before being diluted by making up with distilled water 1,000 mL.

2. sulfuric acid reagent

- Add 22 g. of Ag_3SO_4 into conc. H_2SO_4 which is normally in 9 lb or 2.65 L-bottle. Allow to be completely dissolved which could take L – 2 days. (ratio is 5.5 g of Ag_3SO_4 to 1 kg of conc. H_2SO_4)

3. ferion indicator
4. ferrous ammonium sulfate solution (FAS) 0.10 M
   - Dissolve 39.2 g of Fe $(NH_4)2(SO_4)_2.6H_2O$ in a small amount of distilled water followed with adding 20 mL of conc. H_2SO_4 and let it cool down before making up with distilled water to 1,000 mL.

determination

1. Digestion tubes are rinsed with 20 % H_2SO_4
2. Five mL of water sample (not filtered and diluted to 40 %) is added to each digestion tube.
3. Three mL of $K_2Cr_2O_7$ 0.0167 M, digestion solution, is added.
4. Seven mL of conc. H_2SO_4 is then slowly added followed by closing the tube-cap tightly and shaking the tube well.
5. All digestion tubes and put in the incubator set at 150 ^{0}C for 2 hours.
6. The tubes are taken out and let to cool down to room temperature.
7. Add 2 drops of feroin indicator and titrate with FAS until the end point where the solution's color changes from green-blue to brownish-red.
8. At least two tubes of blank (distilled water) are prepared and passed through all the same procedure with water samples in order to get factor "b" in the calculation formula.
9. COD as ppm (mg L^{-1}) is then calculated using formula:

   COD (mg L^{-1}) = [(a–b) x N x 8 x 1,000] / [m L of water sample]

Where a = mL of FAS used in titration with blank

b = mL of FAS used in titration with water sample

N = Normality of FAS

3. Total phosphorus (Persulfate Digestion Method)

Procedure

1. Use 50 mL of thoroughly mixed sample. Add 1 drop phenolphthalein indicator solution. If a red color develop, add H_2SO_4 solution dropwise to just discharge the color.
2. Then add 1 mL H_2SO_4 solution and either 0.4 g solid ammonium persulfate.
3. Boil gently on a preheated hot plate for 30 to 40 min, or until a final volume of 10 mL is reach.
4. Cool, dilute to 30 mL with distilled water, add 1 drop phenolphthalein indicator solution.
5. Neutralize to a faint pink color with NaOH.
6. Make up to 100 mL with distilled water.
7. Add, with through mixing after each addition, 4.0 mL molybdate reagent and 0.5 mL stannous chloride regent for color development.
8. After 10 min, but before 12 min, using the same specific interval for all determinations, measure color photo-metrically at 690 nm and compare with a calibration curve, using a distilled water blank.

(APHA and WPCF., 1998; Traichaiyaporn, 2000)

4. PO_4-P analysis

Chemical preparation

1. phenolphthalein indicator
   - Dissolve 5 g of phenolphthalein disodium salt in 1 L of distilled water.
2. strong acid solution
   - Slowly pore 300 mL of conc. H_2SO_4 into 600 mL of distilled water and let to cool down before adding 4.0 mL of conc. HNO_3 and make up with distilled water to 1,000 mL.
3. ammonium molybdate reagent (I)
   - Dissolve 25 g of $(HN_4)_6MO_7 .O_{24}\ 4H_2O$ in 175 mL of distilled water Slowly pore 280 m L of conc. H_2SO_4 into 400 mL of distilled water in another beaker, Then mix the two solution by adding molybdate solution to the solution of conc. Sulfuric acid and make up with distilled water to 1,000 mL.
4. stannous chloride reagent (I)
   - Dissolve 2.5 g of $SnCl_2 . 2H_2O$ in 100 mL of glycerol. Heat the solution on water bath and rub with a glass rod until completely dissolved.
5. standard solution
   - Dissolve 219.5 g of anhydrous KH_2PO_4 in distilled water and make up to 1,000 mL.

determination

1. Obtain 100 mL of filtered water sample.
2. color development : Add 4.0 mL of molybdate reagent (I) It should be noticed here that color and concentration vary with temperature of the solution, 1 ^{0}C increase 1 % color intensity increase, so temperature of blank, standard and reagent should in between 20-30 ^{0} C.

3. color measurement : measure the percentage transmittance at the wavelength of 690 nm with spectrophotometer (Spectronic DR 2000) provided with 1 cm light path.
4. A series of standard stock solution of anhydrous KH_2PO_4 are prepared and measured prepared and measured percentage transmittance at the same wavelength (690 nm) in order to get data for making standard curve.
5. PO_4-P as ppm (mg L^{-1})then calculated using formula :

$$PO_4\text{-}P\ (mg\ L^{-1}) = \frac{mg\ PO_4\text{-}P^*\ x\ 100}{mL\ of\ sample}$$

*obtained by compared with standard curve

(APHA and WPCF., 1998; Traichaiyaporn, 2000)

5. NH_3-N analysis

Chemical preparation

1. zinc sulfate solution
   - Dissolve 100 g of $ZnSO_4.7H_2O$ in free-ammonia distilled water and make up to 1,000 mL.
2. sodium hydroxide 6 N
   - Dissolve 240 g of NaOH in 500 ml of distilled water and make up to 1,000 mL.
3. stabilizer reagent (EDTA reagent)
   - Dissolve 50 g of $Na_2EDTA.2H_2O$ in 60 mL of water dissolved in with 10 g of NaOH. The solution is then diluted by making up to 200 mL using distilled water.
4. Nessler reagent

- Dissolve 100 g Hg_2I and 70 g of KI in trace amount of distilled water while, in another beaker, 160 g of NaOH is dissolved in 500 mL of distilled water. The solution is let to cool down and slowly added with the solution of Hg_2I and KI followed by making up to 1,000 mL. (keep this solution in dark bottle)

5. ammonium chloride stock solution
   - Dissolve 3.819 g of NH_4Cl in 1 L of distilled water (1 mL = 1.22 mg NH_3-N = 1.00 mg N)
6. dechlorinating agents : sodium thiosulfate solution (0.0142 N $Na_2S_2O_3$)
   - Dissolve 3.5 g of $Na_2S_2O_3$ in 1,000 mL of distilled water.

determination

1. On hundred ml of filtered water sample (diluted to 2%) is put in 250 mL Erlenmeyer flask.
2. One ml of $AnSO_4$ solution is added and the flask is well-shook.
3. NaOH 6 N is added with the amount of 0.4- 0.5 mL to obtain pH 10.5 in the solution. (measured by pH meter)
4. Shake the flask and leave it for few minutes until the presence of white precipitate occurs.
5. The solution is then filtered to separate the supernatant. Do not rinse the precipitate with distilled water.
6. One drop of EDTA reagent is added to the obtained supernatant
7. Two ml of Nessler reagent is then added and the flask is well-shook.

8. Percentage transmittance at the wavelength of 430 nm is then measured using spectrophotometer (Spectronic DR 2000) provided with 1 cm light path.
9. A series of standard stock solutions of ammonium chloride (NH_4Cl) are prepared and measured percentage transmittance at the same wavelength (430 nm) in order to get data for making standard curve. It should be noticed that all standard NH_4Cl solution with known concentration must be prepared and treated under and with the same condition with water sample being analyzed.
10. NH_3-N as ppm (mg/l) is then calculated using formula :

$$NH_3\text{-}N\ (mg\ L^{-1}) = \frac{mg\ \ NH_3\text{-}N^* \times 100}{m\ L\ of\ sample}$$

*obtained by compared with standard curve

(APHA and WPCF., 1998; Traichaiyaporn, 2000)

6. NO_3-N analysis

Chemical preparation

1. standard 0.02 N H_2SO_4

- Prepare 0.02 N H_2SO_4 by diluting conc. H_2SO_4 with distilled water and make up to 1,000 mL. The volume of conc. H_2SO_4 can be calculated from the formula :

$$mL\ of\ stock\ H_2SO_4 = \frac{20}{Normality\ of\ stock\ H_2SO_4}$$

2. aluminium hydroxide

- Dissolve 125 g of pure $Al_2(SO_4)_3$ in 500 mL of distilled water and add NH_4OH until being completely precipitated. Filter to separate supernatant by rinsing several times with distilled water. Stir the solution well and then precipitate to eliminate chlorides, nitrate and ammonia.

3. phenoldisulfonic acid solution

- Dissolve 4.397 g of $AgSO_4$ (CP) in distilled water 1 L (1 mL = 1 mg Cl)

4. phenoldisulfanic acid solution

- Dissolve 25 g of pure phenol in 150 mL of conc. H_2SO_4 and add 75 mL of fuming H_2SO_4 . Then the solution is heated for 2 hours in the water bath.

5. 12 N NaOH

- Dissolve 480 g of NaOH in distilled water and make up to 1,000 mL.

6. standard nitrate solution

- Dissolve 0.7216 g of KNO_3 (AR) in 1,000 mL of distilled water
- Pipette 50 ml nitrate standard solution and evaporate to dry on water bath. Then moisten the residue thoroughly with 2 mL of phenoldisulfonic acid and rub it well with a glass rod to ensure the well contact of the residue and acid before making up with distilled water to 500 m L (1 m L = 0.01 mg N = 0.04426 mg NO_3)

determination

1. Place 50 mL of water sample (diluted to 50 %) in a 50-ml beaker and evaporate to dryness(on water bath or hot plate)

2. Moisten the residue with 2 mL phenoldisulfonic acid and rub it well with a glass rod to ensure contact of the acid with the residue.
3. Dilute to about 20 ml with nitrate-free distilled water.
4. Add 12 N NaOH, until the maximum yellow color is developed (not more than 6 ml of NaOH should be used)
5. Filter the solution, rinse the beaker and filter paper with nitrate-free distilled water, make up to 100 mL using distilled water.
6. percentage transmittance at the wavelength of 425 nm is then measured using spectrophotometer (Spectronic DR 2000) provided with 1 cm light path.
7. A series of standard stock solutions of potassium nitrate (KNO_3) are prepared and measured percentage transmittance at the same wavelength (425 nm) in order to get data for making standard curve. It should be noticed that all standard (KNO_3) solution with known concentration must be prepared and treated under and with the same condition with water sample being analyzed.
8. NO_3-N as ppm (mg L^{-1}) is then calculated using formula :

$$NO_3\text{-N (mg L}^{-1}) = \frac{\text{mg } NO_3\text{-N* x 10}}{\text{mL of sample}}$$

- obtained by compared with standard curve

(APHA and WPCF., 1998; Traichaiyaporn, 2000)

Table 5 Standard curve NH_3-N = 1.22 mg mL^{-1}.;430 nm

ml.st.NH_4Cl (100 ml.)	X (xb) NH_3-N(mg/l)	Y Absorbance	Y^2	XY
0.01	0.122	0.200	0.0400	0.0244
0.02	0.244	0.360	0.1296	0.0878
0.03	0.366	0.530	0.2809	0.194
0.04	0.488	0.600	0.3600	0.928
0.05	0.610	0.833	0.6939	0.5081
0.06	0.732	0.871	0.7586	0.6376
0.07	0.854	0.928	0.8612	0.7925
0.08	0.976	1.020	1.0404	0.9955
0.09	1.098	1.057	1.1172	1.1606
0.1	1.220	1.073	1.1513	1.3091
0.15	1.830	1.257	1.5800	2.3003
0.2	2.440	1.404	1.9712	3.4258
0.25	3.050	1.519	2.3074	4.633
0.3	3.660	1.678	2.8157	6.1415
0.5	6.100	2		12.2
n = 15	£x = 23.79	£y = 15.33	£y^2 = 19.1074	£xy = 34.703

$m=\frac{15(34.703)-(23.79)(15.33)}{15(19.1074)-(15.33)^2} = 3.0201$

$b=\frac{(19.1074)(23.79)-15.33)(34.703)}{15(19.1074)-(15.33)^2} = 1.5001$

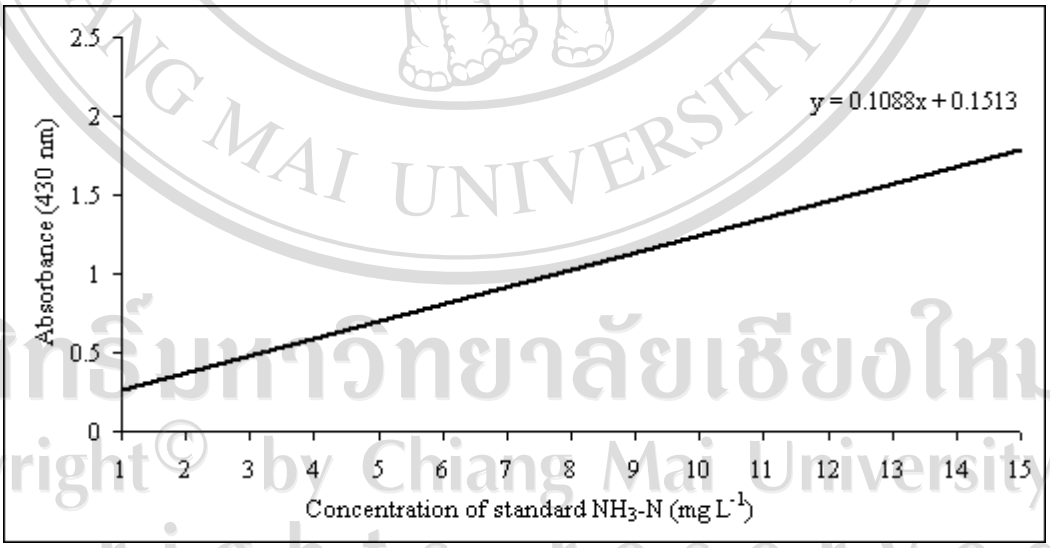


Table 6 Standard curve NO_3-N = 0.04426 mg mL^{-1}.;425 nm

mL.st.KNO_3 (100 mL.)	X (xb) NO_3-N (mg L-1)	Y Absorbance	Y^2	XY
0.01	0.0044	0.002	0.00004	0.000009
0.05	0.0221	0.009	0.00008	0.002
0.10	0.0443	0.012	0.00014	0.0005
0.20	0.0885	0.022	0.0005	0.0019
0.40	0.1770	0.047	0.0022	0.0003
0.60	0.2666	0.084	0.0071	0.0224
0.80	0.3541	0.086	0.0074	0.0305
1.00	0.4426	0.121	0.0146	0.0536
1.50	0.6639	0.161	0.0262	0.1076
2.00	0.8852	0.221	0.0484	0.1956
4.00	1.7704	0.456	0.2079	0.8073
6.00	2.6556	0.686	0.4706	1.8217
8.00	3.5408	0.934	0.8724	3.3071
10.00	4.4260	1.085	1.1772	4.8022
15.00	6.6390	1.702	2.8968	11.2996
20.00	8.8520	2.078	4.3181	18.3945
n = 16	£x = 30.8325	£y = 7.707	£y^2 = 10.0496	£xy =40.8530

$$m = \frac{16(40.8530)-(30.8325)(7.707)}{16(10.0496)-(7.707)^2} = 4.1030$$

$$B=\frac{(10.0496)(30.8325)-(7.707)(40.8530)}{16(10.0496)-(7.707)^2} = -0.0493$$

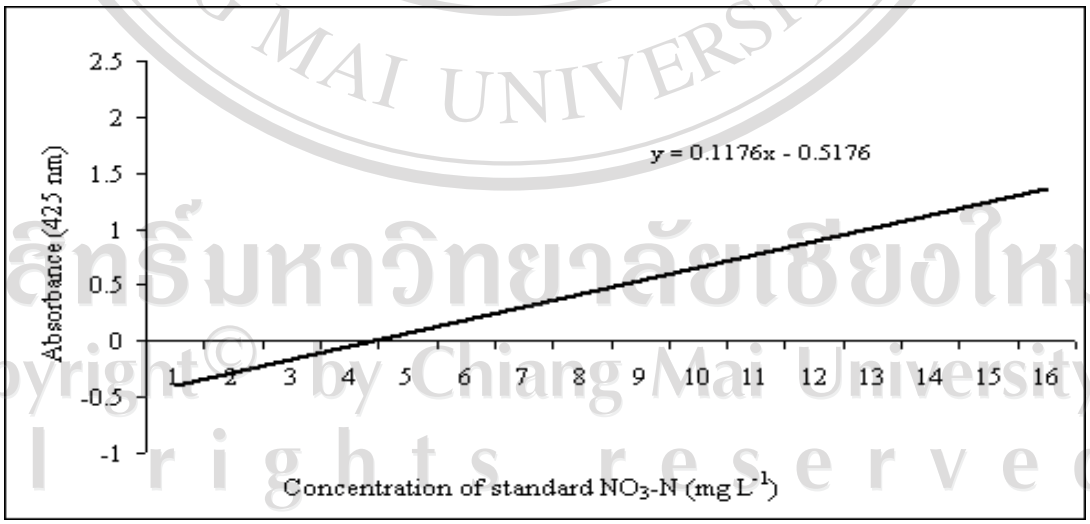
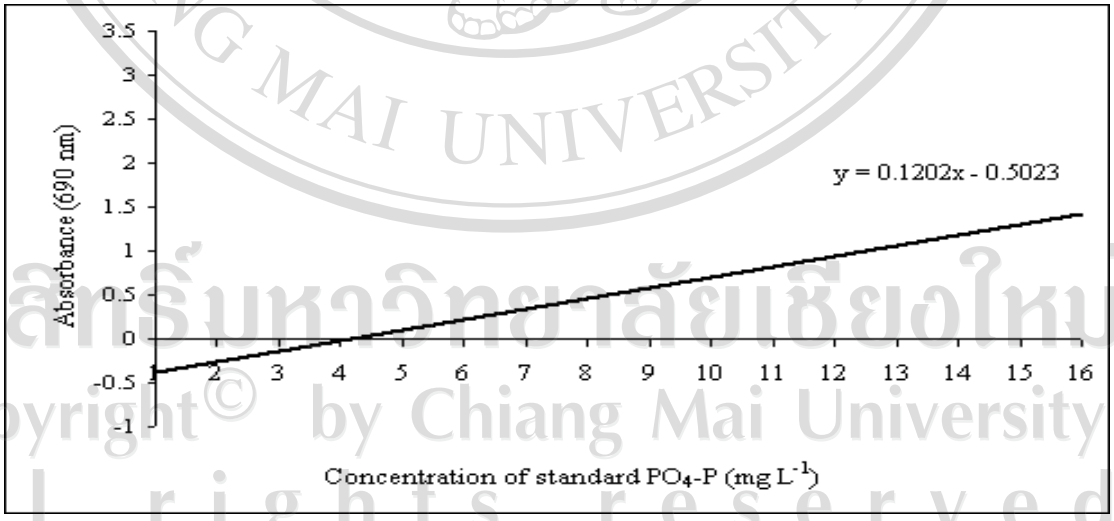


Table 7 Standard curve PO_4-P = 0.05 mg mL^{-1}.; 690 nm

ml.st.KH_2PO_4 (100 ml.)	X (xb) PO_4-P (mg/l)	Y Absorbance	Y^2	XY
0.01	0.0025	0.046	0.0021	0.0001
0.01	0.005	0.048	0.0023	0.0002
0.02	0.010	0.051	0.0026	0.0005
0.04	0.020	0.065	0.0042	0.0013
0.06	0.030	0.076	0.0062	0.0024
0.08	0.040	0.104	0.0108	0.0042
0.10	0.050	0.113	0.0128	0.0057
0.20	0.100	0.218	0.0475	0.0218
0.30	0.150	0.298	0.0888	0.0447
0.40	0.200	0.361	0.1303	0.0722
0.50	0.250	0.485	0.2352	0.1213
0.60	0.300	0.535	0.2862	0.1605
0.80	0.400	0.683	0.4665	0.2732
1	0.500	0.848	0.7191	0.424
2	1.000	1.468	2.1550	1.468
3	1.500	2.914	8.4914	4.371
n = 16	£x = 4.5575	£y = 8.316	£y^2 = 12.661	£xy = 6.9711

$$M = \frac{16(6.9711)-(4.5575)(8.316)}{16(12.661)-(8.316)^2} = 0.5519$$

$$b = \frac{(12.661)(4.5575)-(8.316)(6.9711)}{16(12.661)-(8.316)^2} = -.002$$



7. NO_2-N analysis

1. Filtered water sample with filter paper.
2. Used 50 mL of water sample and 50 mL deionized water was blank in flask 80- 100 mL.
3. Added buffer solution 5 mL/ sample and mixture.
4. Added sulphanilamide solution 1 mL / sample, mixture and keep at least 5 minute.
5. Added NNED solution 1 mL / sample, mixture and keep at least 10 minute, low should not 2 exceed hour.
6. Measured absorbance by spectrophotometer wave lengths use 543 nm, absorbance record and minus with absorbance of blank and compare to calibration graph.

(Jackson, 1993)

8. Analytical Procedure for the Organic Nitrogen by the Kjeldahl Digestion/Distillation Method

This rest has some dangerous aspects to be aware of:

- The digestion of highly acidic solutions under relatively high temperatures;
- Production of some extremely offensive fumes in the form of sulfur dioxide and sulfur trioxide;
- Distillation of a highly alkaline solution with a large amount of dissolved solids that will tend to "bump" during the distillation process.
- Always wear eye and clothes protection during this measurement.

1. It is assumed that the ammonia nitrogen has already been measured by direct Nesslerization and is known on the sample to be tested for organic nitrogen.

2. Then both the ammonia nitrogen and organic nitrogen will be digested and the ammonia nitrogen will be subtracted from the final results of the organic nitrogen test to yield just the organic fraction of the sample's nitrogen content.
3. Add 300 mL or water sample to a clean 800 mL Kjeldahl flask.
4. Add 200 mL of distilled water to the 800 mL Kjeldahl flask.
5. Add 100 mL of the digestion mixture very carefully down then neck of the flak as the sample will heat up on the dissolution of this reagent. *Caution*: this is a strong acid solution containing mercuric ions.
6. Add two to three boiling beads to the 800 mL Kjeldahl flask. Do not forget this addition, as the beads are very important in the control of "bumping."
7. Place the 800 mL flask on the digestion heating mantel of the Kjeldahl apparatus (ensure that the fume suction system is functional) and digest until sulfur trioxide (SO_3) fumes are given off and the solution turns colorless or a pale yellow color. These sulfur trioxide fumes will be heavy white fumes produced in side of the Kjeldahl flask when the digestion is complete.
8. After the digestion, allow the sample to cool for one hour, then carefully add 300 ml of distilled ammonia-free water to dissolve the solidified ammonium sulfate in the bottom of the flask.
9. Turn on the water to the condensers of the Kjeldahl distillation apparatus. This must be done prior to distillation to cool the condensate which will contain the distilled ammonia gas in the form of ammonium hydroxide.
10. Prepare a condensate receiving flask by decanting 75 mL of the boric acid indicator solution (this has a purple color to it) into a clean 500 mL wide-mouth Erlenmeyer receiving flask. Ensure that the ends of the condensers extend

below the liquid level of the boric acid indicator solution. A total of the distillation period.

11. Prepare the 800 mL Kjeldahl flask for distillation by adding 100 mL of the sodium hydroxide distillation solution to it.

    Note : Carefully add the sodium hydroxide-thiosulfate solution down the tilted neck of the 800 mL Kjeldahl flask, allowing the heavier alkaline solution to underlay the aqueous sulfuric acid solution, Add 1 to 3 mL of phenolphthalein indicator and a pink enterface should occur between the two layers. *Do not mix* until the flask is placed on the distillation rack and connected to the splash bulb of the condensers. This prevents loss under alkaline conditions. As soon as the contents are mixed, apply the heat to the 800 mL Kjeldahl flask-this is to ensure that the indicator solution is not sucked back into the reaction flask.

12. Distill the sample until about 200 mL of distillate has been collected.

Note : During the distillation, a large amount of solids will be generated as the solvent distills off and a sample may start to bump. If this happens, *immediately* remove the distillate collection flask and turn the heat off to the sample being distilled.

13. To the distillation collection flask, add several drops of mixed indicator and titrate with 0.02 N sulfuric acid until the sample content changed from a green to a lavender-purple color (if indicator is not already in the boric acid collection flask)

CALCULATIONS

For the Direct Nesslerization Method

The final concentration of ammonia nitrogen is found by comparison with the standard curve or graph.

If no dilution :

$$mg\ L^{-1}\ as\ NH_3\text{–}N\ =\ mg\ L^{-1}\ as\ read\ form\ the\ standard\ curve$$

If dilution was done :

$$mg\ L^{-1}\ as\ NH_3\text{–}N\ =\ (curve\ value)\ (dilution\ factor)$$

EXAMPLE : If 25 m L of sample had been diluted to 100 mL, and then 50 ml of this solution was used for analysis, the dilution factor to multiply times the curve value (which is in terms of concentration) would be 4.0. Suppose the diluted sample produced an absorbance equivalent to 0.145 mg L^{-1}, then the actual concentration would be :

$$mg\ L^{-1}\ as\ NH_3\text{–}N\ = (0.145)\ (4)\ =\ 0.580\ mg\ L^{-1}\ as\ NH_3\text{–}N$$

For the Kjeldahl Digestion/Distillation Method

This is a titrimetric calculation because of the large values generally obtained, since most spent waters as well as natural stream water, generally contain in excess of 10 mg L^{-1} as organic nitrogen expressed as ammonia nitrogen.

$$mg\ L^{-1}\ as\ org\text{-}N\ = \frac{\left[\begin{array}{c}mL\ of\ Sx.\\ Titration\end{array} - \begin{array}{c}mL\ of\ blank\\ Titration\end{array}\right]\left[0.02N\ H_2SO_4\right]\left[\begin{array}{c}14\ mg/meq\\ as\ N\end{array}\right]\left[1000\ ml\ L^{-1}\right]}{mL\ of\ original\ distilled\ sample}$$

or, a short form of the above formula would be the following :

$$\text{mg L}^{-1} \text{ as org-N} = \frac{(\text{mL of Sx.} - \text{mL of Blk})\ (280)}{\text{mL of Sx.}}$$

where: Sx. = sample
Blk = blank
280 = (0.02) (14) (1000)

EXAMPLE : Suppose 50 mL of a stream sample was analyzed for total ammonia and TKN values and the following data was obtained :

Volume of sample = 50 mL

Ammonia - nitrogen derived from calibration graph = 3.56 mg L^{-1} as NH_3 –N

TKN data mL of blank titration = 0.30 mL

mL of sample titration = 10.45 mL

Normality of titrant = 0.02 mL

Volume of sample distilled = 50 mL

TKN = (10.45-0.30) (0.02) (14) (1000)/50 = 56.84 mg L^{-1} as org-N

However, the actual organic nitrogen must have the ammonia subtracted out, since the TKN value normally includes both the ammonia and organic nitrogen components.

Corrected organic nitrogen = 56.84-3.56 = 53.28 mg L^{-1} NH_3-N

(Jackson, 1993)

9. β-carotene analysis (*S. platenisis*, flesh and egg tuptim tilapia**)**

1. The β-carotene concentration (mg g^{-1}, dry weight) sample were determined by HPLC (Mightysil RP-18 GP, 5 μm, 150 x 4.6 mm ID column, Kanto Reagent Co., Ltd, Japan).

2. For saponification solution 5.5 mL (freshly prepared each week, contained 11% w/v potassium hydroxide in a mixture of 55% v/v absolute ethanol and 45% v/v distilled water), 0.75 g (dry weight) of homogenized samples were

extracted with hexane and evaporated to dryness. The samples were re-dissolved in methanol : chloroform (80:20).

3. The mobile phase wavelength and flow rate of methanol : chloroform (80:20) were 456 nm and 1 mL / min respectively.

4. The β-carotene standard (Sigma) was carried through the same procedure as described for the *S. platensis* samples.

10. C-phycocyanin analysis (*S. platenisis*, flesh and egg Tuptim tilapia)

1. The C-phycocyanin concentration in (mg g^{-1}, dry weight) samples were determined by HPLC (Agilent Technologies, USA) using a reversed phase (ZORBAX Eclipse XDB-C-18, 5 µm, 150 x 4.6 mm column).

2. Approximately 1g (dry weight) of samples were suspended in 10 ml of PBS buffer, pH 7.2 (NaCl, 8.0 g L^{-1}; KCl, 0.2 g L^{-1}; Na_2HPO_4, 2.9 g L^{-1} and KH_2PO_4, 0.2 g L^{-1}) and maintained in the dark at 4 ^{0}C for 16 h.

3. The crude extract was then centrifuged at 10,000 rpm for 15 min at 4 ^{0}C to separate cell debris. The volume was adjusted to 10 mL with PBS.

4. Then other components in the supernatant were precipitated by addition of solid ammonium sulfate (25% w/v final composition).

5. The resulting C-phycocyanin-containing solutions were evaporated to dryness and combined. The solid was re-dissolved in 10 m L of a methanol : water mixture (50:50).

6. The mobile phase was methanol : water (50:50), the flow rate was 0.50 m L/min, and the detector wavelength was 214 nm.

7. C-phycocyanin standards (Sigma) were carried through the same procedure as described for the *S. platensis* samples.

11. γ- linolic acid analyses (*S. platensis*, flesh and eggs)

1. Total lipids of diet samples were extracted by homogenization in chloroform/methanol (2:1, v/v) containing 0.01% butylated hydroxytoluene (BHT) as antioxidant, basically according to Folch *et al.* (1957).
2. Fatty acid methyl esters (FAME) were prepared from total lipids by acid-catalyzed trans-esterification using 2 mL of 1% H_2SO_4 in methanol plus 1mL toluene as described by Christie (1982) and FAME extracted and purified as described previously (Tocher and Harvie,1988).
3. FAME were separated and quantified by gas–liquid chromatography (Fisons GC8600, Carlo Erba, Milan, Italy) using a 30 m×0.32 mm capillary column (CP wax 52CB; Chromapak Ltd., London, U.K)

12. Crude protein analyses ($CuSO_4$ /TiO_2 Mixed Catalyst Kjeldahl Method) of *S. platensis*, flesh and eggs

Procedure

1. Weigh 0.250 - 1.000 g sample into digestion flask. Add 16.7 g K_2SO_4, 0.01 g anhydrous $CuSO_4$ and 20 mL H_2SO_4 (Add additional 1.0 mL H_2SO_4 for each 0.1 g fat or 0.2 g other organic matter if sample weight is > 1 g).
2. Include at least 1 sample of high purity lysine HCI in each day's run as check of correctness of digestion parameters. If recovery is not complete, make appropriate adjustments.

3. To digest sample, first adjust heat to bring 250 mL H_2O at 25 ^{o} C to rolling boil in 5 min.

4. Add a few boiling chips to prevent superheating. Then heat samples at this 5-min boil rate until dense white fumes clear bulb of flask (10 min), swirl gently, and continue heating additional 40 min, (*Note* : Reagent proportions, heat input, and digestion time are critical factors-do not change.).

5. Cool, cautiously add about 250 mL H_2O, and cool to room temperature (*Note* : Add H_2O as soon as possible to reduce amount of caking, If excessive bumping occurs during distillation, increase dilution H_2O from 250 mL to ca 300 mL).

6. Prepare titration beaker by adding appropriate volume of acid standard solution to amount of H_2O such that condenser tip will be sufficiently immersed to trap all NH_3 evolved. Add 3-4 drops of indicator solution.

7. Add additional 0.5-1.0 g Alundum granules to digestion flask. Optionally, 2-3 drops of tributyl citrate may also be added to reduce foaming. Slowly down side of flask, add sufficient NaOH solution such that mixture will be strongly alkaline. Immediately connect flask to distillation apparatus, mix completely, and distill at 7.5 min boil rate until $\geq$ 150 mL distillate is collected in titration beaker.

8. Titrate excess standard acid in distillate with NaOH standard solution. Correct for blank determination on reagents. Calculate % nitrogen:

$$\% N = \{ [(N_{acid}) (mL_{acid}) - (mL_{bank}) (N_{NaOH}) - (mL_{NaOH}) (N_{NaOH})] \times 1400.67 \} / mg\ sample$$

% protein = % N x 6.25 (6.25= Conversion factors or Kjeldahl factors 100/ 16 = 6.25 gm.)

(AOAC, 1990)

13. Crude Fat or Ether Extract analyses ($CuSO_4$ / Tio_2 Mixed Catalyst Kjeldahl Method) of *S. platensis*, meat and eggs

Procedure

1. Mojonnier fat-extraction tube took temperature controlled hot air oven to 105 ^{o} C for 2 hour and weight record.
2. Weight 2-3 g sample on filter paper into each thimble and putted into soxhlet extract.
3. Add 70 ml hexane putted into each Mojonnier fat-extraction tube, it jointed to soxhlet extract with condenser.
4. Water opened pass soxhlet extract and open condenser at temperature controlled 20- 30 ^{o} C for 8 hour.
5. Re-extract liquid remaining in tube, each time with only 5-10 mL.
6. Evaporate slowly to cool at room temperature.
7. Mojonnier fat-extraction tube in temperature controlled furnace preheated to 105 ^{o} C for 4 hour and weight record.
8. Cooled to room temperature in desiccator and weighted immediately.
9. Calculate

$$\% \text{ crude fat} = \frac{(B - A) \times 100}{C}$$

A = Mojonnier fat-extraction tube weight

B = Mojonnier fat-extraction tube weight after fat extracted and desiccator

C = sample weight

(AOAC, 1990)

14. Ash analyses (Muffle furnace at 600 ^{o} C) of *S. platensis*, flesh and eggs

Procedure

1. Weigh 2 g sample into porcelain crucible.
2. Place in temperature controlled furnace preheated to 600 ^{o} C.
3. Hole at this temperature for 2 hour.
4. Transfer crucible directly to desiccator to cool.
5. Weigh immediately, reporting % ash to first decimal place.

Calculate = $\frac{(A-B)}{C} \times 100$

A = Weight porcelain crucible and sample before furnace preheated to 600 ^{o} C.

B = Weight aluminium dishes after into drying oven

C = Sample weight

(AOAC, 1990)

15. **Crude fiber analyses (Method by Uric Acid and Potassium hydroxide)** of *S. platensis*, flesh and eggs

Procedure

1. Weight 1 g (Fo) sample on filter screen cups into each condenser.
2. Add hot sulfuric acid into condenser tubes.
3. Add 3-5 drops antifoam into condenser tubes boiling temperature 35- 40 ^{o}C for 30 min.

4. Filtered out solution**,** cleaned three time with hot distilling water.
5. Add hot potassium hydroxide into condenser tubes and add 3-5 drops antifoam boiling temperature 35- 40 ^{o}C for 30 min.
6. Filtered out solution**,** cleaned three time with cool distilling water, cleaned first time with cool distilling water and cleaned three time with acetone.
7. Hot air oven at 105 ^{o}C for 1 hour and weighted record (F1).
8. Controlled furnace preheated to 500 ^{o}C for 3 hour and weight record (F3).
9. Calculate: % Crude fiber = $\frac{F1-F2}{F3} \times 100$

(AOAC, 1990)

16. Moisture analyses (Drying at 105 ^{o} C) of *S. platensis*, flesh and eggs

Procedure

1. Aluminium dishes took desiccator and weight record.
2. Weight 2-3 g. sample putted into each aluminium dishes and weight record.
3. Sample took into drying oven at 105 ^{o} C for 2 hour.
4. Place covers on dishes and transfer to desiccator to cool.
5. Weight, and calculate loss in weight as H_2O

Calculate = $\frac{(A-B)}{C} \times 100$

A = Weight aluminium dishes and sample before into drying oven

B = Weight aluminium dishes after into drying oven

C = Sample weight

(AOAC, 1990)

17. Immune function analysis

Lysozyme activity assay:

1. The bacteriolytic activity of lysozyme activity were tested in the sampled Tuptim tilapia fish both laval and juvenile stages based on the method by Sarder *et al*., (2001).
2. The serum was extracted from blood of Tuptim tilapia feeding with and without raw *S. pltensis* from dried *Micrococcus* (0.2 mg mL^{-1}).
3. The vaccine will be prepared in saline water at 1 M (pH 6). Fish serum (40 μ-liter) was then added to the 3 mL vaccine.
4. After being left at room temperature for 0.5 and 5 minutes, measured with spectrophotometer at 540 nm was made.
5. A decrease of turbidity 0.001 unit / minute means one unit of lysozyme activity and therefore an increase in fish immunity.
6. Twelve fish of each stage were sampled for the estimation at every two weeks till 3 months for larval stage and 6 months for the juvenile.

18. Total red blood cell (Erythrocyte) and white blood cell (Leucocyte) counts

1. Blood from each female tilapia was collected by using a 1-mL syringe with 25 g needle from the caudal blood vessels (Figure 49).
2. After withdrawal, the red blood cell and white blood cell were immediately diluted with white blood cell reagent (1: 50).

3. Red blood cell and white blood cell were counted using a calculated as number of blood cell (red blood cell and white blood cell μ L^{-1}) by microscope.

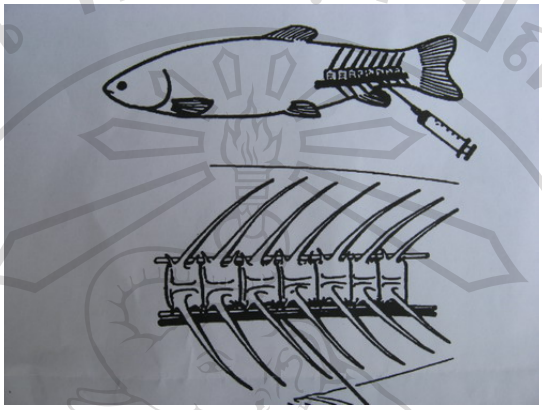


Figure 49 Blood from each tilapia was collected by using a 1-mL syringe with 25 g needle from the caudal blood vessels.

19. Production variable cost

The production variable cost was culture of *S. platensis* and juvenile Tuptim with the calculation of variable cost : feed or nutrients cost + stock *S. platensis* or fish cost + labor cost + electricity and water cost (De Silva *et al*., 1986).

20. Growth performance:

Recording fish weights, number of fishes at the beginning and at the completion of the experiments, where the calculations were included:

Average weight (g $fish^{-1}$) = Average final weight – Average initial weight

Growth rate (g $fish^{-1}$ day^{-1}) = $\frac{\text{Average final weight – Average initial weight}}{\text{Day}}$

Weight gain percentage (%) = $\frac{\text{Average final weight – Average initial weight}}{\text{Average initial weight}} \times 100$

Specific growth rate (% day $^{-1}$)

= $\frac{[\text{logE average final weight – logE average initial weight}]}{\text{Day}} \times 100$

Survival rate (%) = $\frac{\text{Number of fish survived}}{\text{Number of initial fish}} \times 100$

Feed conversion ratio (units) = $\frac{\text{fish feed weight}}{\text{Increment weight of fish}}$

Protein efficiency ratio (units) = $\frac{\text{Increment of fish weight}}{\text{Average to protein fish feed}}$

Gonadosomatic Index (GSI; %) = $\frac{\text{Gonad weight}}{\text{Body weight}} \times 100$

(Male and female of Tuptim tilapia came to body weight. The both split the gonads to weight and calculated (GSI) to above.)

Appendix B

STATISTICAL ANALYSIS

1. Laboratory culture of *S. platensis*

Table 8 Statistical summary (mean ± SD) of water quality in modified Zm, Kw and Sw media and biomass of *S. platensis* cultured for 15 days

Treatment	0 day					5 days					10 days					15 days				
	pH	TN (mg L^{-1})	TP (mg L^{-1})	N : P Ratio	algae dry weight (g L^{-1})	pH	TN (mg L^{-1})	TP (mg L^{-1})	N : P Ratio	algae dry weight (g L^{-1})	pH	TN (mg L^{-1})	TP (mg L^{-1})	N : P ratio	algae dry weight (g L^{-1})	pH	TN (mg L^{-1})	TP (mg L^{-1})	N : P ratio	algae dry weight (g L^{-1})
Zm	8.73	29.80±1.02^{a}	4.35±0.39^{a}	6.9:1^{a}	0.30^{ns}	9.50	19.60±0.98^{a}	1.95±0.01^{a}	10:1^{a}	0.55^{a}	**9.32**	**10.72±1.13^{a}**	**1.77±0.02^{a}**	**6.1:1^{a}**	**0.84^{a}**	9.38	1.83±0.67^{a}	1.65±0.20^{a}	1.2:1^{a}	0.51^{a}
100%Kw	8.95	26.36±0.47^{b}	4.25±0.13^{a}	6.2:1^{b}	0.30^{ns}	9.13	16.64±0.98^{b}	1.91±0.02^{b}	8.5:1^{b}	0.43^{bc}	**9.48**	**6.45±0.14^{b}**	**1.78±0.02^{a}**	**3.6:1^{bc}**	**0.82^{b}**	8.51	0.71±0.02^{b}	1.62±0.14^{a}	0.4:1^{b}	0.49^{a}
90%Kw	8.96	23.59±0.64^{c}	3.83±0.12^{b}	6.2:1^{b}	0.30^{ns}	8.97	14.98±0.89^{c}	1.76±0.02^{c}	8.5:1^{b}	0.50^{ab}	**9.10**	**6.04±0.08^{bc}**	**1.60±0.01^{b}**	**3.8:1^{bc}**	**0.73^{c}**	8.91	0.64±0.02^{c}	1.45±0.13^{b}	0.4:1^{b}	0.41^{b}
80%Kw	8.99	20.97±0.57^{d}	3.40±0.10^{c}	6.2:1^{b}	0.30^{ns}	9.00	13.31±0.78^{d}	1.56±0.01^{d}	8.5:1^{b}	0.47^{bc}	9.28	5.63±0.09^{c}	1.43±0.01^{c}	3.:1^{b}	0.66^{d}	8.98	0.57±0.03^{d}	1.30±0.11^{c}	0.4:1^{b}	0.34^{c}
70%Kw	8.72	18.34±0.50^{e}	2.98±1.00^{d}	6.2:1^{b}	0.30^{ns}	8.80	11.65±0.68^{e}	1.37±0.01^{e}	8.5:1^{b}	0.42^{c}	9.14	3.26±0.06^{d}	1.26±0.01^{d}	2.6:1^{d}	0.19^{d}	8.42	0.50±0.03^{e}	1.13±0.10^{d}	0.5:1^{b}	0.17^{d}
60%Kw	8.67	15.72±0.43^{f}	2.55±0.08^{e}	6.2:1^{b}	0.30^{ns}	8.70	9.99±0.59^{f}	1.17±0.01^{f}	8.5:1^{b}	0.45^{bc}	9.06	2.96±0.14^{de}	1.07±0.01^{e}	2.8:1^{d}	0.21^{d}	8.42	0.43±0.04^{f}	0.97±0.08^{e}	0.5:1^{b}	0.15^{d}
50%Kw	8.57	13.10±0.36^{g}	2.13±0.07^{f}	6.2:1^{b}	0.30^{ns}	8.67	8.32±0.49^{g}	0.98±0.01^{g}	8.5:1^{b}	0.41^{c}	9.00	2.58±0.09^{ef}	0.91±0.01^{f}	2.8:1^{d}	0.12^{e}	8.34	0.36±0.05^{g}	0.81±0.07^{f}	0.4:1^{b}	0.07^{e}
40%Kw	8.49	10.48±0.28^{h}	1.70±0.05^{g}	6.2:1^{b}	0.30^{ns}	8.57	6.68±0.39^{h}	0.78±0.01^{h}	8.5:1^{b}	0.38^{c}	8.82	2.12±1.02^{fg}	0.76±0.08^{g}	2.8:1^{d}	0.08^{f}	8.39	0.29±0.06^{h}	0.65±0.06^{g}	0.4:1^{b}	0.05^{e}
30%Kw	8.35	7.61±0.32^{i}	1.28±0.04^{h}	6 :1^{b}	0.30^{ns}	8.43	4.99±0.29^{i}	0.59±0.01^{i}	8.5:1^{b}	0.26^{d}	8.71	1.52±1.00^{gh}	0.56±0.04^{h}	2.7:1^{d}	0.06^{gh}	8.28	0.21±0.02^{i}	0.49±0.04^{h}	0.5:1^{b}	0.03^{e}
20%Kw	8.29	5.29±0.14^{j}	0.85±0.03^{i}	6.2:1^{b}	0.30^{ns}	8.33	3.33±2.10^{j}	0.39±0.003^{j}	8.5:1^{b}	0.15^{e}	8.72	1.18±0.23^{hi}	0.37±0.03^{i}	3.2:1^{cd}	0.04^{gh}	8.35	0.14±0.02^{j}	0.32±0.03^{i}	0.4:1^{b}	0.02^{e}
10%Kw	8.10	2.62±0.70^{k}	0.43±0.02^{j}	6.2:1^{b}	0.30^{ns}	8.20	1.66±0.10^{k}	0.20±0.002^{k}	8.5:1^{b}	0.16^{e}	8.50	0.45±0.04^{i}	0.18±0.04^{j}	2.5:1^{d}	0.03^{h}	8.13	0.07±0.01^{k}	0.16±0.01^{j}	0.4:1^{b}	0.01^{e}
100%Sw	7.00	75.01±2.47^{a}	9.09±0.16^{a}	8.3:1^{a}	0.30^{ns}	8.42	63.19±1.36^{a}	8.04±0.22^{a}	7.8:1^{ns}	0.15^{e}	8.42	43.33±1.51^{a}	7.26±0.31^{a}	5.97:1^{b}	0.10^{h}	8.47	31.37±0.51^{a}	4.53±0.28^{a}	6.93:1^{ns}	0.02^{h}
90%Sw	6.84	67.51±2.22^{b}	8.18±0.15^{b}	8.3:1^{a}	0.30^{ns}	8.45	56.87±1.23^{b}	7.24±0.20^{b}	7.8:1^{ns}	0.16^{e}	8.46	38.43±1.03^{b}	6.89±0.57^{a}	5.60:1^{b}	0.12^{h}	8.50	28.19±0.49^{b}	4.08±0.25^{a}	6.92:1^{ns}	0.03^{eh}
80%Sw	7.08	60.00±1.98^{c}	7.27±0.13^{c}	8.3:1^{a}	0.30^{ns}	8.55	50.62±1.15^{c}	6.43±0.18^{c}	7.8:1^{ns}	0.15^{e}	8.49	35.86±0.04^{c}	5.85±0.42^{b}	6.61:1^{b}	0.23^{g}	8.42	25.07±0.42^{c}	3.63±0.22^{b}	6.93:1^{ns}	0.06^{fe}
70%Sw	7.15	52.51±1.73^{d}	6.36±0.12^{d}	8.3:1^{a}	0.30^{ns}	8.68	44.23±0.96^{d}	5.63±0.15^{d}	7.8:1^{ns}	0.16^{e}	8.54	30.30±1.0^{d}	5.13±0.06^{c}	5.91:1^{b}	0.30^{f}	8.54	21.93±0.37^{d}	3.17±0.19^{c}	6.93:1^{ns}	0.09^{f}
60%Sw	7.24	45.01±1.49^{e}	5.45±1.00^{e}	8.3:1^{a}	0.30^{ns}	8.75	37.91±0.82^{e}	4.83±0.13^{e}	7.8:1^{ns}	0.16^{e}	8.55	24.57±1.48^{e}	4.42±0.07d	5.56:1^{b}	0.33^{f}	8.55	18.80±1.13^{e}	2.72±0.17d	6.94:1^{ns}	0.13^{g}
50%Sw	7.33	37.51±1.23^{f}	4.54±0.08^{f}	8.3:1^{a}	0.30^{ns}	8.83	31.59±0.68^{f}	4.02±0.11^{f}	7.8:1^{ns}	0.16^{e}	8.61	22.50±1.14^{f}	3.92±0.63^{e}	5.83:1^{b}	0.39^{e}	8.61	15.67±0.26^{f}	2.27±0.14^{e}	6.93:1^{ns}	0.16^{e}
40%Sw	7.44	30.00±0.99^{g}	3.64±0.07^{g}	8.3:1^{a}	0.30^{ns}	8.85	25.28±0.55^{g}	3.22±0.09^{g}	7.8:1^{ns}	0.25^{d}	8.66	18.27±0.06^{g}	2.89±0.04^{f}	6.32:1^{b}	0.51^{c}	8.54	12.53±0.21^{g}	1.81±0.11^{f}	6.93:1^{ns}	0.22^{d}
30%Sw	7.72	22.50±0.74^{h}	2.73±0.05^{h}	8.3:1^{a}	0.30^{ns}	8.97	18.96±0.41^{h}	2.41±0.07^{h}	7.8:1^{ns}	0.31^{c}	8.67	13.70±0.44^{h}	2.23±0.06^{g}	6.15:1^{b}	0.61^{c}	8.55	9.40±0.16^{h}	1.36±0.08^{g}	6.93:1^{ns}	0.22^{d}
20%Sw	7.75	14.99±0.49^{i}	1.82±0.04^{i}	8.3:1^{a}	0.30^{ns}	9.25	12.64±0.27^{i}	1.61±0.04^{i}	7.8:1^{ns}	0.41^{b}	8.67	9.08±0.41^{i}	1.52±0.08^{h}	5.98:1^{b}	0.21^{c}	9.09	6.27±0.10^{i}	0.91±0.06^{h}	6.93:1^{ns}	0.26^{c}
10%Sw	7.78	7.50±0.25^{j}	0.91±0.02^{j}	8.2:1^{b}	0.30^{ns}	9.32	6.30±0.14^{j}	0.80±0.02^{j}	7.8:1^{ns}	0.47^{b}	**8.89**	**4.33±0.19^{j}**	**0.76±0.04^{i}**	**5.70:1^{a}**	**0.80^{b}**	8.89	3.13±0.05^{j}	0.45±0.03^{i}	6.93:1^{ns}	0.32^{b}
5%Sw	7.80	3.75±0.17^{k}	0.45±0.01^{k}	8.3:1^{b}	0.30^{ns}	9.06	3.16±0.07^{k}	0.40±0.01^{k}	7.8:1^{ns}	0.35^{b}	**9.22**	**2.17±0.16^{k}**	**0.36±0.03^{i}**	**6.0:1^{a}**	**0.90^{a}**	9.09	1.57±0.03^{k}	0.23±0.01j	6.93:1^{ns}	0.38^{b}

Note: the mean ±SD in the same column with different superscripts are significantly different ($p < 0.05$)

2. Outdoor mass culture of *S. platensis* in the experimental tanks

Table 9 Statistical summary (mean ± SD) in the modified Zm, Kw and Sw media of *S. platensis* cultured for 15 days

The culture of *S. platensis*	Treatment	pH	TN (mg L^{-1})	TP (mg L^{-1})	N: P Ratio	Algal dry weight (g L^{-1})
0 day	Zm	8.73	30.80 ± 1.02^{a}	4.35 ± 0.39^{a}	$7.1 : 1^{c}$	0.32^{ns}
	100%Kw	9.54	26.40 ± 0.29^{b}	4.25 ± 0.13^{a}	$6.21 : 1^{d}$	0.32^{ns}
	90%Kw	9.30	23.78 ± 0.22^{c}	3.83 ± 0.12^{b}	$6.21 : 1^{d}$	0.32^{ns}
	10%Sw	7.87	7.50 ± 0.11^{d}	0.92 ± 0.03^{c}	$8.21 : 1^{b}$	0.32^{ns}
	5%Sw	7.90	3.86 ± 0.07^{e}	0.46 ± 0.06^{d}	$8.39 : 1^{a}$	0.32^{ns}
5 days	Zm	9.60	26.77 ± 1.53^{a}	2.50 ± 0.07^{a}	$8.3 : 1^{b}$	0.55^{a}
	100%Kw	9.97	16.56 ± 0.90^{b}	2.05 ± 0.04^{b}	$8.1 : 1^{c}$	0.43^{e}
	90%Kw	9.70	14.90 ± 0.81^{b}	1.76 ± 0.08^{c}	$8.5 : 1^{a}$	0.50^{c}
	10%Sw	9.57	6.81 ± 0.12^{c}	0.85 ± 0.01^{d}	$8.0 : 1^{c}$	0.47^{d}
	5%Sw	9.87	3.12 ± 0.06^{d}	0.38 ± 0.05^{e}	$8.2 : 1^{b}$	0.53^{b}
10 days	Zm	9.70	10.64 ± 0.36^{a}	1.62 ± 0.09^{a}	$6.6 : 1^{a}$	0.84^{ab}
	100%Kw	9.71	6.55 ± 0.15^{b}	1.75 ± 0.05^{a}	$3.7 : 1^{c}$	0.82^{b}
	90%Kw	9.77	5.90 ± 0.21^{c}	1.58 ± 0.09^{a}	$3.7 : 1^{c}$	0.74^{c}
	10%Sw	9.12	4.54 ± 0.18^{c}	0.71 ± 0.02^{b}	$6.4 : 1^{b}$	0.85^{ab}
	5%Sw	8.92	2.27 ± 0.10^{d}	0.36 ± 0.06^{c}	$6.3 : 1^{b}$	0.90^{a}
15 days	Zm	9.70	1.84 ± 0.09^{b}	2.17 ± 0.06^{b}	$0.08 : 1^{c}$	0.57^{a}
	100%Kw	9.71	$0.71 \pm 0.03^{c\,d}$	2.11 ± 0.14^{b}	$0.34 : 1^{b}$	0.51^{a}
	90%Kw	9.77	0.64 ± 0.03^{c}	1.90 ± 0.13^{c}	$0.34 : 1^{b}$	0.05^{c}
	10%Sw	9.12	3.09 ± 0.16^{a}	2.58 ± 0.08^{a}	$1.2 : 1^{a}$	0.34^{b}
	5%Sw	8.92	1.53 ± 0.06^{c}	1.29 ± 0.08^{d}	$1.19 : 1^{a}$	0.42^{b}

Note: the mean ± SD in the same column with different superscripts are significantly different ($p < 0.05$)

Table 10 Statistical summary (mean ± SD) for the analysis of pigment contents and γ- linoleic acid of *S. platensis* cultured in modified Zm, 100% Kw, 90%Kw, 10%Sw and 5% Sw media for 15 days

Parameter	Zm	100%Kw	90%Kw	10%Sw	5%Sw
β-carotene (mg g^{-1})	0.29 ± 0.02^{b}	0.29 ± 0.02^{b}	0.26 ± 0.02^{c}	0.42 ± 0.01^{a}	0.22 ± 0.02^{d}
C-phycocyanin (mg g^{-1})	6.94 ± 1.69^{d}	18.44 ± 1.09^{b}	16.31 ± 1.10^{b}	23.32 ± 1.45^{a}	11.73 ± 0.64^{c}
γ-linoleic acid (mg g^{-1})	0.302 ± 0.02^{a}	0.206 ± 0.017^{b}	0.163 ± 0.018^{c}	0.176 ± 0.012^{c}	0.089 ± 0.014^{d}

Note: the mean $\pm$SD in the same row with different superscripts are significantly different ($p < 0.05$)

Table 11 Statistical summary (mean ± SD) for the analysis of biomass production (dry weight), production variable cost and nutritional values of *S. platensis* cultured in modified Zm, 100%Kw, 90%Kw, 10%Sw and 5%Sw media for 15 day

Parameter	**Modified Zm**	**100%Kw**	**90%Kw**	**10%Sw**	**5%Sw**
Biomass production (dry weight; g L^{-1})	0.84 ± 0.02^{ab}	0.82 ± 0.03b	0.73 ± 0.04^{c}	0.85 ± 0.05^{ab}	0.90 ± 0.05^{a}
Production variable costs (baht/kg)	310.6 ± 7.6^{a}	276.7 ± 9.6^{c}	303.6 ± 14.7^{ab}	285.5 ± 16.8^{c}	236.6 ± 13^{d}
Protein (%)	54.44 ± 0.63^{a}	35.86 ± 1^{c}	32.27 ± 0.91^{d}	41.49 ± 0.50^{b}	20.55 ± 0.30^{e}
NFE (%)	37.38 ± 1.1^{b}	22.42 ± 0.48^{d}	30.13 ± 0.20^{c}	21.37 ± 0.61^{d}	51.38 ± 2.78^{a}
Fat (%)	1.93 ± 0.16^{c}	3.13 ± 0.02^{a}	2.82 ± 0.02^{b}	1.60 ± 0.09^{d}	0.77 ± 0.08^{e}
Fiber (%)	2.31 ± 0.27^{e}	10.65 ± 0.79^{a}	9.58 ± 0.71^{b}	8.04 ± 0.02^{c}	4.7 ± 0.7^{d}
Moisture (%)	10.95 ± 0.61^{a}	7.72 ± 0.24^{b}	6.95 ± 0.21^{c}	8.01 ± 0.27^{b}	8.17 ± 0.24^{b}
Ash (%)	3.94 ± 0.15^{c}	27.94 ± 1.56^{a}	25.2 ± 1.4^{ab}	27.5 ± 1^{a}	22.6 ± 2.3^{b}

Note: the mean $\pm$SD in the same column with different superscripts are significantly different ($p < 0.05$)

Table 12 The statistical summary (mean ± SD) of water quality and percentage removal in wastewater culture of *S. platensis* after15 days. Boldface numbers indicate the largest changes

Chemistry Parameter	Zm			100%Kw			90%Kw			standard	References
	Zm before culture	Final culture after 15 days	% Removal	Filtrate before culture	Final culture after 15 days	% Removal	Filtrate before culture	Final culture after 15 days	% Removal	Limits	
Air tem .(^{o}C)	30	29	-	30	29	-	30	29	-	-	
Water tem. (^{o}C)	28.1	27.9	-	28.2	27.93	-	28.1	27.97	-	< 40 ^{o}C	(Pollution, 1994)
pH	8.73	9.7	-	9.3	9.71		9.54	9.77	-	5.5 - 9	(Pollution, 1994)
DO (mg L^{-1})	3.73 ± 0.15^{a}	7.20± 0.10^{a}	-	0.2 ± 0.05^{b}	6.12 ± 0.12^{b}	-	0.3 ± 0.05^{b}	7 ± 0.26^{a}	-	> 5 (mg L^{-1})	Clair *et al.*,2003)
BOD (mg L^{-1})	9.99 ± 0.5^{a}	6.11± 0.10^{c}	38.8 ± 2.1^{b}	18.71± 0.61^{a}	5.15±0.11^{a}	**72.74± 0.1^{a}**	16.84 ± 0.55^{b}	4.87 ± 0.10^{b}	**71.08± 0.1^{a}**	< 20 (mg L^{-1})	(Pollution, 1994)
COD (mg L^{-1})	13.21±1.00^{c}	7.20± 0.25^{ab}	45.1 ± 3.8^{b}	28.07± 0.64^{a}	7.69 ± 0.35^{a}	**72.6 ± 1.2^{a}**	25.26 ± 0.58^{b}	6.93 ± 0.32^{b}	**73 ± 1^{a}**	< 120 (mg L^{-1})	(Pollution, 1994)
TP (mg L^{-1})	4.35 ± 0.39^{a}	2.17± 0.06^{a}	50 ± 6 ^{ns}	4.25 ± 0.13^{ab}	2.11± 0.14^{a}	50.4 ± 1.8^{ns}	3.83 ± 0.12^{b}	1.9 ± 0.13^{b}	50.4 ± 1.9^{ns}	< 0.4 (mg L^{-1})	(Pollution, 1994)
NH_3-N (mg L^{-1})	0.03 ± 0.01^{c}	0.0± 0.006^{b}	67 ±18^{b}	7.03 ± 0.06^{a}	0.14 ± 0.006^{a}	**98.0 ± 0.1^{a}**	5.75 ± 0.14^{b}	0.13± 0.005^{a}	**97.8 ± 0.1^{a}**	< 1.1 (mg L^{-1})	(Pollution, 1994)
Org. N (mg L^{-1})	0.04 ± 0.00^{c}	0.02±0.004^{c}	0	15.53± 0.50^{a}	0.54 ± 0.014^{a}	**96.52±0.02^{a}**	14.55 ± 0.36^{b}	0.48± 0.015^{b}	**96.7± 0.02^{a}**	< 10 (mg L^{-1})	Jackson,1993
TKN (mg L^{-1})	0.07± 0.01^{c}	0.05± 0.01^{b}	70 ± 16^{b}	22.56± 0.56^{a}	0.68±0.02^{a}	**97.0 ± 0.2^{a}**	20.3 ± 0.50^{b}	0.61 ± 0.02^{a}	**97 ± 0.2^{a}**	< 100 (mg L^{-1})	(Pollution, 1994)
NO_3-N (mg L^{-1})	30.73±1.00^{a}	1.78± 0.07^{a}	94.2 ± 0.2^{b}	3.8 ± 0.9^{b}	0.03±0.01^{b}	**99.2 ± 0.3^{a}**	3.47 ± 0.69^{b}	0.027± 0.01^{b}	**99.2 ± 0.2^{a}**	< 0.5 (mg L^{-1})	(Pollution, 1994)
NO_2-N (mg L^{-1})	0.003±0.001^{b}	0.001±0.001^{b}	67 ± 33^{ns}	0.009±0.001^{a}	0.003±0.001^{b}	65 ± 15^{ns}	0.008± 0.001^{a}	0.002±0.001^{b}	73 ± 15^{ns}	-	-
TON (mg L^{-1})	30.73± 1.00^{a}	1.78± 0.07^{a}	94.18±0.07^{b}	3.809±0.901^{b}	0.033±0.011^{b}	**99.15±0.09^{a}**	3.478± 0.691^{b}	0.029±0.011^{b}	**99.19±0.16^{a}**	< 0.5 (mg L^{-1})	(Pollution, 1994)
TN (mg L^{-1})	30.8 ± 1.01^{a}	1.83± 0.08^{a}	94.03±0.10^{b}	26.37±1.46^{b}	0.713±0.031^{ab}	**97.30±0.04^{a}**	23.778±1.191^{c}	0.639±0.031^{b}	**97.31±0.01^{a}**	< 4 (mg L^{-1})	(Pollution, 1994)

Note: the mean ± SD in the same row with different superscripts are significantly different ($p < 0.05$)

Table 13 The statistical summary (mean ± SD) of water quality and percentage removal in wastewater culture of *S. platensis* after15- days. Boldface numbers indicate the largest changes

Chemistry Parameter	10% Sw			5% Sw			standard	References
	Filtrate before culture	**Final culture after 15 days**	**% Removal**	**Filtrate before culture**	**Final culture after 15 days**	**% Removal**	**Limits**	
Air temperature (^{o} C)	30	29	-	30	29	-	-	-
Water temperature (^{o} C)	28.20	27.93	-	28.10	28.42	-	< 40 ^{o}C	(Pollution, 1994)
pH	8.33	9.12	-	8.51	8.92	-	5.5 - 9	(Pollution, 1994)
DO (mg L^{-1})	0.15 ± 0.04^{b}	6.09 ± 0.10^{d}	-	0.21± 0.05^{b}	6.60 ± 0.17^{b}	-	> 5 (mg L^{-1})	Clair *et al.*,2003)
BOD (mg L^{-1})	169.85± 5.26^{a}	9.33 ± 0.51^{a}	**94.5 ± 8.5^{a}**	126.47 ± 0.61	4.70 ± 0.26^{c}	**96.28 ± 8.5^{a}**	< 20 (mg L^{-1})	(Pollution, 1994)
COD (mg L^{-1})	254.43± 5.26^{a}	14.94 ± 0.09^{a}	**94 ± 26^{a}**	186.50 ± 0.56 ^{b}	7.44 ± 0.04^{b}	**96 ± 29^{a}**	<120 (mg L^{-1})	(Pollution, 1994)
TP (mg L^{-1})	9.92 ± 0.32^{a}	2.58 ± 0.08^{a}	74 ± 28^{ns}	4.96 ± 0.16^{b}	1.29 ± 0.08^{d}	74 ± 28^{ns}	< 0.4 (mg L^{-1})	(Pollution, 1994)
NH_3-N (mg L^{-1})	12.08 ± 0.01^{a}	0.28 ± 0.02^{a}	**97.66 ± 1.8^{a}**	9.37 ± 0.56^{b}	0.14 ± 0.01^{b}	**98.5 ± 0.89^{a}**	< 1.1 (mg L^{-1})	(Pollution, 1994)
Organic N (mg L^{-1})	33.38 ± 0.31^{a}	2.68 ± 0.11a	91.97 ± 1.0^{b}	14.97 ± 0.61^{b}	1.34 ± 0.06^{b}	91.05 ±0.02^{b}	< 10 (mg L^{-1})	Jackson,1993
TKN (mg L^{-1})	45.46 ± 0.32^{a}	2.96 ± 0.13^{a}	94 ± 4^{b}	24.34 ± 1.17^{b}	1.48 ± 0.07^{b}	94.0 ± 4^{b}	<100 (mg L^{-1})	(Pollution, 1994)
NO_3-N (mg L^{-1})	31.43 ± 0.64^{a}	0.07 ± 0.006^{b}	**99.77 ± 0.2^{a}**	11.47 ± 0.49^{b}	0.03 ± 0.006^{b}	**99.2 ± 0.3^{a}**	< 0.5 (mg L^{-1})	(Pollution, 1994)
NO_2-N (mg L^{-1})	0.07 ± 0.015^{a}	0.01 ± 0.006^{b}	85.71 ± 13^{ns}	0.053 ± 0.006^{b}	0.01 ± 0.01^{b}	79 ± 28^{ns}	-	-
TON (mg L^{-1})	31.50 ± 0.65^{a}	0.08 ± 0.036^{b}	**99.75±0.07^{a}**	11.52 ± 0.50^{b}	0.04 ± 0.016^{c}	**99.65 ±0.09^{a}**	< 0.5 (mg L^{-1})	(Pollution, 1994)
TN (mg L^{-1})	77.68 ± 0.59^{a}	3.04 ± 0.16^{a}	**96 ± 2^{a}**	35.86 ± 0.67^{b}	1.52 ± 0.031^{ab}	**96.00 ± 2^{a}**	< 4 (mg L^{-1})	(Pollution, 1994)

Note: the mean ± SD in the same row with different superscripts are significantly different ($p < 0.05$)

3. Nursing larval Tuptim tilapia in the earthen pond using raw *S. platensis*

Table 14 Average weight (g fish^{-1}) of larval Tuptim tilapia fed with experimental diet for 90 days

Treatment (%)	raw *Spirulina* (day)	Average weight (g fish^{-1}) of larval Tuptim tilapia at various nursing period						
		0	**15**	**30**	**45**	**60**	**75**	**90**
5%CD	0	0.02 ± 0.00^{ns}	1.16 ± 0.22^{a}	3.21± 0.34^{a}	6.46 ±1.48^{a}	6.90 ± 1.36^{a}	7.57 ± 1.17^{ns}	8.67 ±1.53^{ns}
1%RS	1	0.02 ± 0.00^{ns}	0.46 ± 0.03^{c}	0.80± 0.18^{c}	1.53 ± 0.25^{b}	3.79 ± 0.62^{b}	7.57 ± 1.49^{ns}	7.87±0.58^{ns}
3%RS	3	0.02 ± 0.00^{ns}	0.72 ± 0.09^{bc}	1.09± 0.13^{c}	1.55± 0.18^{b}	6.06 ± 1.18^{a}	6.24 ± 1.01^{ns}	8.00±1.00^{ns}
5%RS	5	0.02 ± 0.00^{ns}	0.89 ± 0.17^{ab}	1.68± 0.06^{b}	2.10± 0.24^{b}	6.20 ± 1.29^{a}	7.57 ± 0.51^{ns}	9.25±1.39^{ns}

Note: the mean ± SD in the same column with different superscripts are significantly different ($p < 0.05$)

Table 15 Growth performance of larval Tuptim tilapia after nursing for 90 days

Parameter	Treatment	30 days	60 days	90 days
weight gain (%) percentage	5%CD	**3.19 ± 0.01^{a}**	**6.86 ± 0.05^{a}**	8.66 ± 0.10^{ns}
	10%RS	0.77± 0.12^{d}	3.78 ± 0.01^{d}	7.84 ± 0.11^{ns}
	30%RS	1.08 ± 0.01^{c}	6.05 ± 0.01^{c}	8.02 ± 0.09^{ns}
	50%RS	1.68 ± 0.97^{b}	6.20 ± 0.03^{b}	**9.23 ± 0.12^{ns}**
Specific growth rate (%/day)	5%CD	**16.80 ± 0.26^{a}**	**9.71 ± 0.06^{a}**	**7.99 ± 0.11^{ns}**
	10%RS	12.49 ± 0.16^{d}	8.65 ± 0.09^{c}	7.63 ± 0.13^{ns}
	30%RS	13.60 ± 0.24^{c}	9.52 ± 0.006^{b}	7.72 ± 0.06^{ns}
	50%RS	15.12 ± 0.43^{b}	9.52 ± 0.08^{b}	**8.00 ± 0.06^{ns}**
Survival rate (%)	5%CD	**65.67± 1.40^{a}**	**55.33 ± 2.08^{a}**	**51.00 ± 1.00^{a}**
	10%RS	48.67± 1.15^{c}	47.67± 0.58^{c}	44.00 ± 1.00^{c}
	30%RS	63.00 ± 1.73^{b}	51.00 ± 1.00^{b}	48.00 ± 1.00^{b}
	50%RS	**66.34 ± 1.52^{a}**	**56.00 ± 1.00^{a}**	**52.00 ± 1.00^{a}**
Feed conversion ratio (Units)	5%CD	2.92 ± 0.09^{a}	1.92 ± 0.37^{ns}	**2.05 ± 0.13^{a}**
	10%RS	2.00 ± 0.03^{c}	2.35 ± 0.18^{ns}	1.51 ± 0.03^{b}
	30%RS	2.15 ± 0.48^{b}	2.12 ± 0.03^{ns}	**0.99 ± 0.10^{d}**
	50%RS	**2.54 ± 0.56^{a}**	2.04 ± 0.21^{ns}	1.20 ± 0.03^{c}
Protein efficiency ratio (Units)	5%CD	**0.08 ± 0.01^{a}**	**0.17± 0.01^{a}**	**0.22 ± 0.04^{a}**
	10%RS	0.03 ± 0.01^{c}	0.09 ± 0.01^{c}	0.11 ± 0.02^{b}
	30%RS	0.04 ± 0.01^{b}	0.15 ± 0.01^{b}	**0.21 ± 0.03^{a}**
	50%RS	**0.07 ± 0.01^{a}**	**0.16 ± 0.01^{a}**	**0.22 ± 0.02^{a}**

Note: the mean ± SD in the same column with different superscripts are significantly different ($p < 0.05$)

Table 16 The estimation of fish immunity as unit of lysozyme activity (units mL^{-1}), red blood cell ($x10^6$ cell μL^{-1}) and white blood cell count ($x10^3$cell μL^{-1}) after feeding with experimental diet for 90 days

Treatment	Lysozyme activity (units m L^{-1})		Red blood Cell ($x10^6$ cell μ L^{-1})		White Blood Cell (x 10^3 cell μ L^{-1})	
	60days	90days	60days	90days	60days	90days
5%CD	1.70 ±0.10[a]	21.68 ± 1.0 [a]	2.54± 0.03[c]	2.57±0.03[c]	76.00±2.00[c]	85.67± 3.51[bc]
10%RS	1.30±0.10 [b]	13.18±1.36[b]	2.53±0.04[c]	2.54±0.01[c]	72.33±8.14[c]	82.00 ± 8.72[c]
30%RS	0.90±0.10 [c]	8.71 ± 0.53[c]	2.67±0.04[b]	2.72±0.06[b]	85.33±0.58[b]	95.33± 0.58[b]
50%RS	1.17±0.06 [b]	8.11 ± 1.01[c]	2.81±0.06[a]	2.88±0.10[a]	94.33±3.06[a]	109.00±8.54[a]

Note: the mean ± SD in the same column with different superscripts are significantly different ($p< 0.05$)

Table 17 Statistical summary (mean ± SD) of water quality parameters in larval Tuptim tilapia nursing ponds using raw *S. platensis* as feeding formulas and nursing for 90 day

Parameter	Treatment	30 days	60 days	90 days
Air temperature (^{o} C)	5%CD	30.00 ± 0.00 ^{ns}	32.00 ± 0.00 ^{ns}	31.00 ± 0.00 ^{ns}
	10%RS	30.00 ± 0.00 ^{ns}	32.00 ± 0.00 ^{ns}	31.00 ± 0.00 ^{ns}
	30%RS	30.00 ± 0.00 ^{ns}	32.00 ± 0.00 ^{ns}	31.00 ± 0.00 ^{ns}
	50%RS	30.00 ± 0.00 ^{ns}	32.00 ± 0.00 ^{ns}	31.00 ± 0.00 ^{ns}
Water temperature (^{o} C)	5%CD	27.03 ± 0.06 ^{ns}	31.03 ± 0.06 ^{ns}	30.60 ± 0.06 ^{ns}
	10%RS	27.50 ± 0.10 ^{ns}	31.00 ± 0.00 ^{ns}	30.50 ± 0.10 ^{ns}
	30%RS	27.57 ± 0.06 ^{ns}	31.33 ± 0.58 ^{ns}	30.85 ± 0.06 ^{ns}
	50%RS	27.50 ± 0.10 ^{ns}	31.20 ± 0.10 ^{ns}	30.85 ± 0.10 ^{ns}
pH	5%CD	9.07± 0.12 ^{ns}	7.67± 0.06^{b}	7.17 ± 0.06^{b}
	10%RS	8.97± 0.06 ^{ns}	**8.03 ± 0.12^{a}**	7.23 ± 0.15^{b}
	30%RS	8.93± 0.06 ^{ns}	**8.00 ± 0.00^{a}**	**8.23 ± 0.06^{a}**
	50%RS	8.67± 0.58 ^{ns}	**7.93 ± 0.06^{a}**	**8.23 ± 0.15^{a}**
Alkalinity (mg L^{-1})	5%CD	**100.33± 6.43^{a}**	78.33 ± 0.58^{b}	73.23 ± 1.09^{b}
	10%RS	78.33± 0.58^{b}	**94.67 ± 3.06^{a}**	**112.75 ± 3.70^{a}**
	30%RS	70.87± 3.35^{b}	**94.67± 2.31^{a}**	**107.60 ± 5.92^{a}**
	50%RS	76.33± 8.62^{b}	**92.33 ± 0.56^{a}**	**109.70 ± 4.50^{a}**
TDS (mg L^{-1})	5%CD	116.67± 11.55 ^{ns}	116.67± 11.55^{b}	116.67 ± 11.55^{b}
	10%RS	116.67± 5.77 ^{ns}	114.67± 5.77^{b}	116.67 ± 5.77^{b}
	30%RS	113.33± 5.77 ^{ns}	**123.33 ± 5.77^{a}**	113.33 ± 5.77^{b}
	50%RS	113.33± 5.77 ^{ns}	**134.33 ± 5.77^{a}**	**140.00 ± 10.00^{a}**
Conductivity (μs cm^{-1})	5%CD	220.00± 10.00 ^{ns}	230.00 ± 10.00^{b}	223.33 ± 11.55^{b}
	10%RS	230.00± 43.59 ^{ns}	240.00 ± 43.59^{b}	213.33 ± 5.77^{b}
	30%RS	250.00± 10.00 ^{ns}	**260.00 ± 10.00^{a}**	**260 ± 10.00^{a}**
	50%RS	223.33± 5.77 ^{ns}	**265.33 ± 5.77^{a}**	**262.33 ± 5.77^{a}**
DO (mg L^{-1})	5%CD	7.97± 0.72 ^{ns}	5.700 ± 0.26 ^{ns}	**6.43 ± 0.15^{a}**
	10%RS	7.87± 0.15 ^{ns}	5.83 ± 0.15 ^{ns}	6.13 ± 0.06^{b}
	30%RS	8.13 ± 0.35 ^{ns}	5.70 ± 0.10 ^{ns}	5.97± 0.15^{b}
	50%RS	7.80 ± 0.20 ^{ns}	6.03 ± 0.21 ^{ns}	5.87± 0.21^{b}
PO_4-P (mg L^{-1})	5%CD	0.003± 0.001 ^{ns}	0.004 ± 0.001^{b}	0.003 ± 0.002^{b}
	10%RS	0.003± 0.001 ^{ns}	0.004 ± 0.00^{b}	**0.005 ± 0.001^{a}**
	30%RS	0.003± 0.001^{ns}	0.004 ± 0.001^{b}	**0.005 ± 0.001^{a}**
	50%RS	0.004± 0.001^{ns}	**0.005 ± 0.00^{a}**	**0.005 ± 0.006^{a}**
NH_3-N (mg L^{-1})	5%CD	0.01± 0.001^{d}	0.011 ± 0.001^{d}	0.011 ± 0.002^{c}
	10%RS	0.012± 0.001^{c}	0.012 ± 0.00^{c}	0.013 ± 0.001^{b}
	30%RS	0.013± 0.001^{b}	0.014 ± 0.00^{b}	0.015 ± 0.001^{b}
	50%RS	**0.014± 0.001^{a}**	**0.016 ± 0.001^{a}**	**0.017 ± 0.002^{a}**

Note: the mean ± SD in the same column with different superscripts are significantly different ($p< 0.05$)

4. Culturing male and female juvenile Tuptim tilapia in the earthen pond

Table 18 Statistical summary (mean ± SD) of average weight (g $fish^{-1}$) of male juvenile Tuptim tilapia fed with experimental diet for 150 days

Treatment	0 days	30 days	60 days	90 days	120 days	150 days
0%RS	27.67 ± 2.08^{a}	43.11±3.36^{a}	44.67±1.53^{b}	58.33 ±7.64^{a}	100±0.00^{ns}	115±8.66^{ns}
45%RS	25.00 ± 3.00^{a}	30.55±3.85^{b}	34.33 ±4.51^{c}	38.00 ±3.00^{b}	92.67±4.62^{ns}	98±2.89^{ns}
50%RS	21.00 ±1.00^{b}	44.56±2.69^{a}	47.78±0.69^{ab}	66.67±11.55^{a}	96.00±5.29^{ns}	110±6.03^{ns}
55%RS	27.25 ± 1.39^{a}	45.00±1.67^{a}	52.33 ±2.52^{a}	62.67±6.43^{a}	85.00±5.00^{ns}	108±14.4^{ns}

Note: the mean ± SD in the same column with different superscripts are significantly different ($p< 0.05$)

Table 19 Statistical summary (mean ± SD) of growth performance of the cultured male juvenile Tuptim tilapia after feeding with experimental diet for 150 days.

Parameter	Treatment	30 days	60 days	90 days	120 days	150 days
Weight gain percentage (%)	CD(0%RS)	61.07±16.38^{b}	5.83±5.79^{ns}	30.5±22.8^{ns}	80.17±35.09^{a}	14.70±8.93 ^{ns}
	45%RS	22.36±8.06^{c}	12.44±7.11^{ns}	11.19±5.79^{ns}	46.60±13.66^{b}	6.22 ± 4.59 ^{ns}
	50%RS	114.9±23.4^{a}	7.23±6.99^{ns}	34.01±33.5^{ns}	46.11±19.46^{b}	15.35±4.83 ^{ns}
	55%RS	65.30±6.80^{b}	16.31±1.34^{ns}	20.28±17.79^{ns}	36.64±17.11^{b}	28.34±24.39 ^{ns}
Specific growth rate (%/day)	CD(0%RS)	2.68 ± 0.07^{b}	1.82 ± 0.02^{c}	1.56 ± 0.05^{b}	1.63 ± 0.03^{a}	1.42 ± 0.01^{b}
	45%RS	2.27± 0.01^{c}	1.63 ± 0.01^{d}	1.31 ± 0.01^{c}	1.64 ± 0.02^{a}	1.41 ± 0.01^{b}
	50%RS	2.87± 0.01^{a}	1.97± 0.01^{a}	1.77 ± 0.01^{a}	1.66 ± 0.01^{a}	1.46 ± 0.01^{a}
	55%RS	2.64± 0.006^{b}	1.93 ± 0.01^{b}	1.59 ± 0.006^{b}	1.49 ± 0.01^{b}	1.36 ± 0.01^{c}
Survival Rate (%)	CD(0%RS)	94.67±0.58^{ns}	91.33±1.53^{ns}	84.33±1.15^{ns}	80.67 ± 1.15^{ns}	86.00 ± 1.00^{ns}
	45%RS	94.33±1.53^{ns}	90.33±0.58^{ns}	84.67± 0.58^{ns}	81.00 ± 1.73^{ns}	84.00 ± 1.00^{ns}
	50%RS	95.00±1.00^{ns}	90.67±1.15^{ns}	84.67±1.53^{ns}	80.00 ± 0.00^{ns}	83.33 ± 1.53^{ns}
	55%RS	95.67±1.15^{ns}	92.67±2.52^{ns}	84.00±1.00^{ns}	81.00 ± 1.73^{ns}	83.33 ± 4.16^{ns}
Feed conversion Ratio (units)	CD(0%RS)	0.58 ± 0.08^{b}	0.55 ± 0.05^{c}	2.58 ± 0.09^{a}	0.29 ± 0.02^{c}	0.26 ± 0.03^{c}
	45%RS	0.67± 0.01^{b}	0.67± 0.04^{b}	0.41 ± 0.04^{d}	0.25 ± 0.02^{c}	0.26 ± 0.02^{c}
	50%RS	0.65 ± 0.68^{b}	0.67 ± 0.04^{b}	0.70 ± 0.01^{c}	0.06 ± 0.05^{b}	0.48 ± 0.02^{b}
	55%RS	0.95 ± 0.07^{a}	0.98 ± 0.02^{a}	1.02 ± 0.06^{b}	0.98 ± 0.03^{a}	0.70 ± 0.10^{a}
Protein efficiency Ratio (units)	CD(0%RS)	0.54 ± 0.02^{b}	0.02 ± 0.01^{d}	0.42 ± 0.01^{b}	1.61 ± 0.08^{b}	0.27 ± 0.01^{c}
	45%RS	0.16 ± 0.006^{c}	0.13 ± 0.01^{b}	0.13 ± 0.01^{d}	1.85 ± 0.02^{a}	0.15 ± 0.01^{d}
	50%RS	0.83 ± 0.03^{a}	0.0 ± 0.006^{c}	0.64 ± 0.01^{a}	0.94 ± 0.04^{c}	0.48 ± 0.006^{b}
	55%RS	0.56 ± 0.006^{b}	0.24 ± 0.01^{a}	0.34 ± 0.01^{c}	0.72 ± 0.01^{d}	0.77 ± 0.01^{a}

Note: the mean ± SD in the same column with different superscripts are significantly different ($p<0.05$)

Table 20 Average weight (g fish^{-1}) of female juvenile Tuptim tilapia fed with experimental diet for 150 days.

Treatment	0 day	30 days	60 days	90 days	120 days	150 days
0%RS	**27.67 ± 2.08^{a}**	32.11±2.59^{b}	43.33±2.08^{b}	**57.33 ± 2.52^{a}**	62.67±3.06^{ns}	**86.00±2.65^{a}**
45%RS	18.33 ± 1.53^{b}	26.22±1.07^{c}	28.33 ± 1.53^{d}	36.67 ± 7.64^{b}	60.00±5.00^{ns}	61.22±4.95^{c}
50%RS	21.00 ± 1.00^{b}	26.00±1.00^{c}	34.00± 4.00^{c}	44.33 ± 1.15^{b}	59.00±3.61^{ns}	75.00±5.00^{b}
55%RS	**27.25 ± 1.59^{a}**	**35.89±2.21^{a}**	**48.67 ± 1.95^{a}**	**66.67 ± 7.64^{a}**	69.33±7.77^{ns}	69.52±1.34^{b}

Note: **t**he mean ± SD in the same column with different superscripts are significantly different ($p < 0.05$)

Table 21 Growth performance of the cultured female juvenile Tuptim tilapia after feeding with experimental diet for 150 days

Parameter	Treatment	0 day	30 days	60 days	90 days	120 days	150 days
Weight Gain percentage (%)	CD(0%RS)	19.50±0.50^{a}	4.65±0.31^{c}	11.07±1.00^{b}	14.5± 0.50^{b}	16.31±0.89^{b}	12.11±1.17^{a}
	45%RS	11.15±0.78^{c}	8.00±0.62^{a}	2.87 ± 0.70^{d}	8.67± 0.33^{d}	11.67±0.67^{c}	6.31 ± 0.89^{b}
	50%RS	12.47±0.50^{b}	5.83±0.22^{b}	7.83 ± 0.29^{c}	11.07±1.00^{b}	14.76±0.21^{b}	6.31 ± 0.89^{b}
	55%RS	18.87±0.80^{a}	8.75±0.22^{a}	13.13±0.42^{a}	19.00±1.00^{a}	19.32±1.20^{a}	11.31±0.89^{a}
Specific Growth Rate (%/day)	CD(0%RS)	3.93 ± 0.06^{a}	2.67±0.42^{a}	1.86 ± 0.12^{a}	1.63 ± 0.06^{a}	1.35±0.02^{ns}	1.29 ± 0.01^{a}
	45%RS	2.85 ± 0.04^{d}	2.01±0.006^{b}	1.43 ± 0.02^{c}	1.27 ± 0.03^{c}	1.39±0.05^{ns}	1.16 ± 0.03^{b}
	50%RS	3.32 ± 0.10^{c}	1.97±0.02^{b}	1.65 ± 0.06^{b}	1.47 ± 0.06^{b}	1.33±0.006^{ns}	1.26 ± 0.02^{a}
	55%RS	3.65 ± 0.06^{b}	2.28±0.01^{ab}	1.88 ± 0.06^{a}	1.68 ± 0.06^{a}	1.35 ± 0.02^{ns}	1.25 ± 0.04^{a}
Survival rate (%)	CD(0%RS)	100± 0.00^{ns}	95.67±0.58^{a}	91.33±1.53^{ns}	86.33±1.15^{a}	80.67±1.15^{ns}	86.00±1.00^{a}
	45%RS	101± 0.00^{ns}	93.33±1.53^{c}	90.33±0.58^{ns}	84.67±0.58^{b}	81.00±1.73^{ns}	84.00±1.00^{b}
	50%RS	102± 0.00^{ns}	94.00±1.00^{b}	90.67±1.15^{ns}	84.67±1.53^{b}	80.00±0.00^{ns}	84.00±1.53^{b}
	55%RS	103± 0.00^{ns}	95.6 ± 1.15^{a}	92.67±2.51^{ns}	86.00±1.00^{a}	81.00±1.73^{ns}	86.00±1.00^{a}
Feed conversion Ratio (units)	CD(0%RS)	1.96± 0.09^{d}	0.46 ±0.01^{d}	0.36 ± 0.02^{d}	0.39 ± 0.05^{c}	0.37 ± 0.01^{c}	0.28 ±0.02^{d}
	45%RS	2.63 ± 0.06^{c}	0.56 ± 0.04^{c}	0.56 ± 0.03^{c}	0.36 ±0.02^{d}	0.37 ± 0.01^{c}	0.36 ± 0.01^{c}
	50%RS	3.26 ± 0.02^{b}	0.68 ± 0.02^{b}	0.67 ± 0.02^{b}	0.75 ± 0.05^{b}	0.72 ± 0.01^{b}	0.57 ± 0.01^{b}
	55%RS	5.03 ± 0.06^{a}	0.85 ± 0.05^{a}	0.96 ± 0.05^{a}	1.01 ± 0.02^{a}	1.04 ± 0.03^{a}	0.97 ± 0.01^{a}
Protein efficiency ratio (units)	CD(0%RS)	0.65 ± 0.02^{a}	0.16 ± 0.01^{c}	0.37 ± 0.04^{b}	0.49 ± 0.02^{b}	0.21± 0.03^{c}	0.74 ± 0.04^{a}
	45%RS	0.37 ± 0.03^{c}	0.27 ± 0.02^{a}	0.10 ± 0.03^{d}	0.29 ± 0.01^{d}	0.76 ± 0.03^{a}	0.48 ± 0.10^{b}
	50%RS	0.41± 0.02^{b}	0.20 ± 0.03^{b}	0.26 ± 0.01^{c}	0.37± 0.03^{c}	0.49± 0.006^{b}	0.65 ± 0.09^{a}
	55%RS	0.62 ± 0.02^{a}	0.29±0.006^{a}	0.43 ± 0.00^{a}	0.63 ± 0.04^{a}	0.44 ± 0.04^{b}	0.72 ± 0.04^{a}

Note: the mean ± SD in the same column with different superscripts are significantly different ($p < 0.05$)

Table 22 The estimation of juvenile Tuptim tilapia immunity as unit of lysozyme activity, red blood cell (x 10^6 cell μL^{-1}) and white blood cell (x10^3 cell μL^{-1}) count after feeding with experimental diet for 150 days

Parameter	Treatment	0 day	30 days	60 days	90 days	120 days	150 days
Lysozyme	0%RS	21.68 ± 1.0^{a}	23.47± 1.0^{a}	9.70 ± 0.78^{ns}	30.58 ± 1.31^{a}	33.17 ± 0.29^{a}	30.31± 1.06^{a}
Activity assay	45%RS	13.18 ± 1.36^{b}	17.27± 1.22^{b}	9.17 ± 0.61^{ns}	27.24 ± 1.33^{b}	30.41± 0.69^{b}	27.75 ± 0.77^{a}
(LAA)	50%RS	**8.71 ± 0.53^{c}**	**10.47 ± 1.14^{c}**	9.05 ± 1.15^{ns}	19.40 ± 0.92^{c}	28.70 ± 1.31^{b}	25.96 ± 0.68^{c}
(Units ml^{-1})	55%RS	**8.11 ± 1.01^{c}**	**10.47± 1.36^{c}**	8.70 ± 1.90^{ns}	**15.62± 0.98^{d}**	**19.28 ± 1.55^{c}**	**16.98± 0.69^{d}**
Red blood Cell	0%RS	2.57± 0.03^{c}	2.55± 0.006^{c}	2.47± 0.006^{b}	2.66± 0.03^{d}	2.52 ± 0.01^{d}	2.05 ± 0.14^{c}
(Erythrocyte)	45%RS	2.54± 0.01^{c}	2.56± 0.02^{c}	2.50± 0.02^{b}	2.75± 0.01^{c}	2.65 ± 0.03^{c}	2.34 ± 0.03^{b}
(RBC)	50%RS	2.72± 0.06^{b}	2.80± 0.06^{b}	2.64± 0.09^{a}	2.85 ± 0.04^{b}	2.74 ± 0.03^{b}	2.37 ± 0.03^{b}
(x10^6 cell uL^{-1})	55%RS	**2.88± 0.10^{a}**	**2.94± 0.05^{a}**	**2.70± 0.05^{a}**	**3.56 ± 0.09^{a}**	**2.84 ± 0.02^{a}**	**2.56 ± 0.04^{a}**
White Blood Cell	0%RS	85.67±3.51^{bc}	73.00 ± 1.00^{c}	62.00 ± 6.00^{c}	95.00 ± 5.00^{c}	83.67 ± 3.21^{d}	79.67 ± 1.53^{d}
(Leukocyte)	45%RS	82.00 ± 8.72^{c}	98.00 ± 9.17^{b}	89.67 ± 2.52^{b}	150.00±7.55^{b}	131.67±1.53^{c}	113.3 ± 0.58^{c}
(WBC)	50%RS	95.330.58^{b}	103.67±8.50^{b}	97.33 ± 2.52^{a}	154.33±2.89^{b}	150.00±1.00^{b}	116.67±0.58^{b}
(x10^3 cell μL^{-1})	55%RS	**109.00±8.54^{a}**	**120.67±7.77^{a}**	**102.00±2.65^{a}**	**165.33±2.31^{a}**	**154.33±1.53^{a}**	**126.67±0.58^{a}**

Note: the mean ± SD in the same column with different superscripts are significantly different ($p< 0.05$)

Table 23 Statistical summary (mean ± SD) for analyses of β-carotene, C-phycocyanin and γ- linoleic acid of feed, flesh and eggs of juvenile Tuptim tilapia using raw *S. platensis* culture for 150 days

Treatment	β-carotene (mg g^{-1})			C-phycocyanin (mg g^{-1})			γ- linoleic acid (mg g^{-1})		
	Juveniles feed	Juvenile flesh	juvenile eggs	Juvenile feed	Juvenile flesh	juvenile eggs	juvenile feed	juvenile flesh	juvenile eggs
CD (0%RS)	0.09±0.006^{d}	0.08±0.01^{b}	0.04±0.001^{ns}	4.1±1.00^{d}	2.86±0.97^{c}	1.90±0.06^{d}	0.06±1.18^{c}	0.12±0.053^{ns}	0.09±0.04^{d}
45%RS	0.13 ± 0.00^{c}	0.08±0.01^{b}	0.05±0.001^{ns}	11.62±2.08^{c}	5.54±0.26^{bc}	2.19±0.02^{c}	0.09±1.25^{b}	0.13±0.011^{ns}	0.11±0.01^{b}
50%RS	0.15±0.001^{b}	0.09±0.01^{a}	0.06±0.001^{ns}	12.9± 2.65^{b}	6.16± 0.15^{b}	2.43±0.01^{b}	0.10±1.14^{ab}	0.14±0.013^{ns}	0.12±0.03^{a}
55%RS	0.17±0.002^{a}	0.10±0.02^{a}	0.06±0.001^{ns}	14.02±2.51^{a}	6.77± 0.31^{a}	2.68±0.03^{a}	0.11± 0.96^{a}	0.14±0.011^{ns}	0.13±0.08^{a}

Note: the mean ±SD in the same column with different superscripts are significantly difference ($p<0.05$)

Table 24. Statistical summary (mean ± SD) production variable cost and nutrition value of feed of juvenile Tuptim tilapia using raw *S. platensis* feed culture in the earthen pond for 150 days

Treatment	Variable cost (baht kg fish^{-1})	Protein (%)	carbohy. (NFE) (%)	Fat (%)	Fiber (%)	Moisture (%)	Ash (%)
0%RS	43.62 ±3.04^{ns}	30.14±0.16^{ns}	37.73±0.04^{c}	**6.10±0.10^{a}**	**3.60 ± 0.10^{a}**	7.64 ± 0.35^{c}	**15.11±0.01^{a}**
45%RS	46.44 ±0.95^{ns}	30.64±0.21^{ns}	48.16±0.04^{b}	2.18±0.01^{d}	1.52 ± 0.02^{c}	**10.54±0.03^{a}**	6.86 ± 0.01^{c}
50%RS	43.91 ±2.42^{ns}	30.52±0.29^{ns}	**49.75±0.05^{a}**	2.37±0.06^{c}	1.53 ± 0.03^{c}	9.85 ±0.03^{b}	6.65 ± 0.03^{d}
55%RS	44.09 ±2.68^{ns}	30.53±0.32^{ns}	48.56±0.05^{b}	2.53±0.04^{b}	1.63 ± 0.02^{b}	10.13±0.03^{b}	7.15 ± 0.04^{b}

Note: the mean ± SD in the same column with different superscripts are significantly different ($p< 0.05$)

Table 25 Statistical summary (mean ± SD) nutrition value of flesh and eggs of juvenile Tuptim tilapia using raw *S. platensis* feed culture in the earthen pond for 150 days

Parameter	Treatment	Protein (%)	carbohy. (NFE) (%)	Fat (%)	Fiber (%)	Moisture (%)	Ash (%)
Nutrition value in flesh	CD(0%RS)	23.51± 0.55^{b}	1.96 ±0.79^{ns}	3.82± 0.06^{bc}	0.026±0.02^{ns}	70.79±1.35^{ns}	1.56±0.42^{ns}
	45%RS	23.21 ±1.02^{b}	1.77 ±0.70^{ns}	5.84 ± 0.86^{a}	0.026±0.02^{ns}	69.97±0.59^{ns}	1.19±0.19^{ns}
	50%RS	23.23 ±1.08^{b}	1.26 ±0.54^{ns}	4.48 ±1.13^{b}	0.03±0.10^{ns}	69.58±1.63^{ns}	1.49±0.22^{ns}
	55%RS	25.97 ±0.89^{a}	1.54 ±0.42^{ns}	2.80 ± 0.26^{c}	0.027±0.02^{ns}	68.57±0.54^{ns}	1.09±0.60^{ns}
Nutrition value in eggs	CD(0%RS)	31.23 ±0.89^{c}	3.21 ±1.12^{bc}	7.32 ± 1.31^{a}	0.02 ± 0.01^{ns}	55.15±1.52^{ns}	3.06±0.63^{ns}
	45%RS	33.37 ±1.02^{b}	2.40 ± 0.68^{c}	6.29 ±0.70^{a}	0.017±0.012^{ns}	55.12±1.31^{ns}	2.80±0.43^{ns}
	50%RS	36.33 ±1.53^{a}	4.31 ±0.57^{ab}	5.44 ±0.74^{a}	0.013±0.006^{ns}	52.33±2.10^{ns}	2.57±0.58^{ns}
	55%RS	37.18 ±0.78^{a}	5.32 ± 0.27^{a}	3.56 ±1.00^{b}	0.016±0.008^{ns}	52.34±1.82^{ns}	2.23±0.85^{ns}

Note:the mean ± SD in the same column with different superscripts are significantly different ($p< 0.05$)

Table 26 Statistical summary (mean ± SD) of GSI (%) in juvenile male and female Tuptim tilapia cultured for 150 days

Treatment	0 day	30 days	60 days	90 days	120 days	150 days	Note
CD(0%RS)	0.07± 0.00^{b}	**0.67± 0.05^{a}**	0.09± 0.03^{b}	0.47±0.08^{b}	0.56±0.03^{ab}	0.66±0.10^{b}	**Male**
45%RS	**0.75± 0.55^{a}**	**1.14± 0.06^{a}**	**0.40± 0.15^{a}**	0.09± 0.05^{c}	0.67±0.27^{ab}	**0.85±0.12^{a}**	**Juvenile**
50%RS	0.61± 0.30^{ab}	**0.77± 0.49^{a}**	**0.27± 0.00^{a}**	**0.68±0.06^{a}**	0.49± 0.06^{b}	**0.85±0.01^{a}**	**Tubtim**
55%RS	0.11± 0.07^{b}	0.19± 0.02^{b}	**0.32± 0.08^{a}**	**0.70±0.13^{a}**	**0.78± 0.07^{a}**	**0.94±0.03^{a}**	
CD(0%RS)	0.44 ± 0.07^{b}	0.54 ± 0.27^{c}	0.44± 0.18^{b}	**4.22±0.59^{a}**	1.34 ± 0.14^{b}	1.22±0.02^{d}	**female**
45%RS	0.41 ± 0.40^{b}	0.47± 0.15^{c}	**2.74± 1.46^{a}**	0.95±0.07^{b}	2.62±1.11^{ab}	2.33± 0.22^{c}	**Juvenile**
50%RS	**1.25 ± 0.20^{a}**	**3.37± 0.51^{a}**	1.7± 0.35^{ab}	**3.65±0.51^{a}**	2.56±0.63^{ab}	2.78± .09^{b}	**Tubtim**
55%RS	0.57± 0.27^{b}	1.63 ± 0.73^{b}	1.08±0.13^{ab}	**4.61±0.63^{a}**	**2.83 ± 0.61^{a}**	**3.15± .29^{a}**	

Note: the mean ± SD in the same column with different superscripts are significantly different ($p < 0.05$)

Table 27 Statistical summary (mean ± SD) of water quality parameters in juvenile Tuptim tilapia culturing earthen pond using raw *S. platensis* feed for 150 days

Treatment	water temperture (°C)	pH (Units)	alkalinity (mg L^{-1})	TDS (mg L^{-1})	conduc. (μs cm^{-1})	DO (mg L^{-1})	NH_3-N (mg L^{-1})	PO_4-P (mg L^{-1})	Note the culture
CD (0%RS)	24.83±0.76^{ab}	7.03±0.15^{ns}	104±0.76^{ab}	100±10^{ns}	196±15^{b}	8.80±0.53^{b}	0.12±0.02^{b}	0.30±0.04^{a}	for
45%RS	25.50±0.50^{a}	7.10±0.26^{ns}	110±0.50^{a}	110±10^{ns}	216±20^{a}	8.60±0.53^{b}	0.04±0.02^{d}	0.23±0.02^{b}	0
50%RS	25.17±0.29^{ab}	7.03±0.06^{ns}	105±0.29^{ab}	100±0.00^{ns}	190±10^{b}	8.07±0.31^{a}	0.09±0.02^{c}	0.24±0.05^{b}	day
55%RS	24.33±0.58^{b}	6.93±0.06^{ns}	73±0.58^{b}	100±10^{ns}	200±10^{a}	8.07±0.12^{b}	0.25±0.05^{a}	0.29±0.03^{a}	
CD (0%RS)	23.83±0.29^{b}	7.13±0.11^{ns}	102±5^{ns}	96±5^{ab}	193±11^{ab}	8.17±0.05^{a}	0.11±0.01^{b}	0.30±0.04^{a}	for
45%RS	24.83±0.76^{a}	7.10±0.27^{ns}	101±4^{ns}	103±5^{a}	203±5^{a}	7.83±0.06^{b}	0.12±0.02^{b}	0.29±0.02^{b}	30
50%RS	24.50±0.50^{ab}	6.99±0.11^{ns}	100±3^{ns}	93±5^{b}	183±5^{b}	7.90±0.09^{ab}	0.19±0.02^{a}	0.24±0.05^{c}	days
55%RS	24.00±0.00^{ab}	7.00±0.10^{ns}	101±3^{ns}	103±5^{a}	210±10^{a}	8.10±0.26^{ab}	0.18±0.05^{a}	0.29±0.03^{b}	
CD (0%RS)	20.83±0.76^{ns}	7.30±0.20^{ns}	112±3^{ns}	106±5^{ns}	210±10^{a}	5.67±0.29^{ns}	0.14±0.02^{a}	0.25±0.08^{a}	for
45%RS	20.50±0.50^{ns}	6.97±0.06^{ns}	111±2^{ns}	93±5^{ns}	183±5^{b}	5.93±0.47^{ns}	0.04±0.01^{d}	0.15±0.04^{b}	60
50%RS	21.00±0.87^{ns}	7.20±0.26^{ns}	110±2^{ns}	103±11^{ns}	193±11^{ab}	5.80±0.90^{ns}	0.07±0.01^{b}	0.15±0.03^{b}	days
55%RS	21.17±0.29^{ns}	7.00±0.10^{ns}	100±2^{ns}	103±11^{ns}	206±0.5^{a}	5.78±0.60^{ns}	0.09±0.4^{c}	0.13±0.03^{b}	
CD (0%RS)	25.50±0.50^{ab}	7.03±0.15^{ns}	98±1^{ab}	96±5^{b}	190±10^{c}	9.73±0.31^{a}	0.27±0.01^{a}	0.28±0.006^{a}	For
45%RS	24.67±0.29^{b}	7.07±0.06^{ns}	95±3^{b}	133±5^{a}	270±10^{a}	7.93±0.12^{b}	0.23±0.00^{b}	0.18±0.006^{b}	90
50%RS	25.50±0.50^{ab}	7.10±0.26^{ns}	97±2^{ab}	130±10^{a}	246±5^{b}	8.30±0.26^{b}	0.09±0.02^{c}	0.10±0.02^{c}	days
55%RS	26.17±0.76^{a}	7.07±0.21^{ns}	101±2^{a}	103±5^{b}	206±11^{c}	9.80±0.35^{a}	0.10±0.02^{c}	0.07±0.01^{d}	
CD (0%RS)	28.67±1.53^{ns}	6.93±0.32^{ns}	102±1^{a}	120±10^{b}	240±20^{b}	11.07±0.23^{a}	0.15±0.01^{a}	0.17±0.02^{a}	For
45%RS	26.83±0.29^{ns}	7.30±0.17^{ns}	98±2^{b}	170±17^{a}	360±10^{a}	10.40±0.35^{b}	0.09±0.02^{b}	0.10±0.01^{c}	120
50%RS	28.00±0.87^{ns}	7.27±0.25^{ns}	100±1^{ab}	173±15^{a}	360±26^{a}	11.00±0.35^{ab}	0.11±0.02^{b}	0.10±0.02^{c}	days
55%RS	28.17±0.76^{ns}	6.97±0.25^{ns}	100±0.50^{ab}	123±5^{b}	353± 15a	11.40±0.35^{a}	0.15±0.02^{a}	0.14±0.02^{b}	
CD (0%RS)	28.00±1.0^{a}	7.09±0.26^{ns}	107±1^{a}	123±5^{b}	240±20^{c}	10.90±0.26^{ab}	0.14±0.01^{a}	0.17±0.01^{a}	For
45%RS	26.17±0.29^{b}	7.18±0.07^{ns}	96±1^{b}	133±5^{a}	313±6^{b}	10.40±0.35^{b}	0.09±0.01^{c}	0.10±0.01^{c}	150
50%RS	27.33±0.29^{a}	7.27±0.25^{ns}	106±2^{a}	133±10^{a}	347±6^{a}	11.20±0.01^{a}	0.11±0.01^{b}	0.10±0.00^{c}	days
55%RS	28.17±0.29^{a}	7.00±0.20^{ns}	106±1^{a}	120±0.00^{b}	340±10^{a}	11.40±0.35^{a}	0.15±0.15^{a}	0.14±0.01^{b}	

Note: the mean ± SD in the same column with different superscripts are significantly different ($p < 0.05$)

APPENDIX C

DATA OF *S. platensis* AND FISH CULTURED

Table 28 The data of *S. platensis* culture in modified Zm (control) and kitchen wastewater in laboratory for 0 day

Traetment	rep.	OD	dry weight ($g\ L^{-1}$)	pH (Units)	Water temp. (^oC)	air.temp. (^oC)	DO ($mg\ L^{-1}$)	TP ($mg\ L^{-1}$)	NH_3 –N ($mg\ L^{-1}$)	Orga.N ($mg\ L^{-1}$)	TKN ($mgL1^{-1}$)	NO_3 -N (mgL^{-1})	NO_2 -N (mgL^{-1})	Tot. Oxi.N ($mg\ L^{-1}$)	TN (mgL^{-1})	N : P ratio
Zm	r1	0.30	0.30	8.73	21	23	3.73	4.35	0.01	0.06	0.07	30.74	0.003	30.743	30.813	7.08: 1
	r2	0.29	0.29	8.79	22	23	3.58	3.96	0.02	0.06	0.08	28.73	0.002	28.732	28.812	7.28: 1
	r3	0.31	0.31	8.67	21	23	3.88	4.74	0.01	0.05	0.06	29.72	0.004	29.724	29.784	6.28: 1
100%Kw	r1	0.30	0.30	8.62	21	23	0.20	4.25	7.03	15.53	22.56	3.80	0.009	3.809	26.369	6.20: 1
	r2	0.29	0.29	8.56	22	23	0.20	4.12	7.09	16.03	23.12	3.70	0.008	3.708	26.828	6.51:1
	r3	0.31	0.31	8.76	21.5	23	0.15	4.38	6.97	15.03	22.00	3.87	0.009	3.879	25.879	5.91:1
90%Kw	r1	0.30	0.30	8.98	21.9	23	0.24	3.83	6.33	13.97	20.30	3.42	0.008	3.428	23.728	6.20: 1
	R2	0.29	0.29	9.20	22.0	23	2.25	3.71	6.27	14.54	20.81	3.33	0.007	3.337	24.147	6.51: 1
	R3	0.31	0.31	8.72	22.0	23	0.28	3.94	6.38	13.42	19.80	3.08	0.008	3.088	22.888	5.81: 1
80%Kw	R1	0.30	0.30	8.92	21.6	23	0.25	3.40	5.62	12.43	18.05	3.04	0.007	3.047	21.097	6.21: 1
	R2	0.29	0.29	8.71	22.0	23	0.26	3.30	5.58	12.92	18.50	2.96	0.006	2.966	21.466	6.50: 1
	R3	0.31	0.31	9.35	21.7	23	0.29	3.50	5.67	11.93	17.60	2.74	0.007	2.747	20.347	5.81: 1
70%Kw	R1	0.30	0.30	8.65	20.5	23	0.26	2.98	4.92	10.87	15.79	2.66	0.006	2.666	18.456	6.19: 1
	R2	0.29	0.29	8.85	21.5	23	0.29	2.88	4.88	11.30	16.18	2.59	0.005	2.595	18.775	6.52: 1
	R3	0.31	0.31	8.65	21.7	23	0.27	3.07	4.96	10.44	15.40	2.39	0.006	2.396	17.796	5.80: 1
60%Kw	R1	0.30	0.30	8.64	19.8	23	0.28	2.55	4.22	9.32	13.54	2.28	0.005	2.285	15.825	6.21: 1
	R2	0.29	0.29	8.76	21.4	23	0.29	2.47	4.18	9.69	13.87	2.22	0.004	2.224	16.094	6.52: 1
	R3	0.31	0.31	8.61	21.6	23	1.10	2.63	4.25	8.95	13.20	2.05	0.005	2.055	15.255	5.80: 1
50%Kw	R1	0.30	0.30	8.53	19.7	23	0.29	2.13	2.81	8.47	11.28	1.90	0.004	1.904	13.184	6.19: 1
	R2	0.29	0.29	8.65	21.4	23	1.10	2.06	3.49	8.07	11.56	1.85	0.003	1.853	13.413	6.51: 1
	R3	0.31	0.31	8.54	21.5	23	1.30	2.19	3.55	7.45	11.00	1.71	0.004	1.714	12.714	5.81: 1
40%Kw	R1	0.30	0.30	8.47	19.6	23	1.20	1.70	2.81	6.21	9.02	1.52	0.004	1.524	10.544	6.20: 1
	R2	0.29	0.29	8.53	21.2	23	1.30	1.65	2.79	6.46	9.25	1.48	0.002	1.482	10.732	6.50: 1
	R3	0.31	0.31	8.48	21.3	23	1.50	1.75	2.84	5.96	8.80	1.37	0.003	1.373	10.173	5.81: 1
30%Kw	R1	0.30	0.30	8.41	19.4	23	1.30	1.28	2.11	4.66	6.77	1.14	0.003	1.143	7.913	6.18: 1
	R2	0.29	0.29	8.32	21.1	23	1.40	1.24	2.09	4.85	6.94	0.34	0.001	0.341	7.281	5.87: 1
	R3	0.31	0.31	8.32	21.1	23	1.60	1.31	2.13	4.47	6.60	1.03	0.002	1.032	7.632	5.83: 1
20%Kw	R1	0.30	0.30	8.25	19.2	23	1.40	0.85	1.41	3.10	4.51	0.76	0.002	0.762	5.272	6.20: 1
	R2	0.29	0.29	8.12	21.0	23	1.60	0.82	1.39	3.23	4.62	0.74	0.001	0.741	5.361	6.54: 1
	R3	0.31	0.31	8.20	21	23	1.70	0.88	1.42	2.98	4.40	0.68	0.002	0.682	5.082	5.78: 1
10%Kw	R1	0.30	0.30	7.75	19.1	23	1.50	0.43	0.70	1.56	2.26	0.38	0.001	0.381	2.641	6.14: 1
	R2	0.29	0.29	7.86	20.0	23	1.70	0.41	0.70	1.61	2.31	0.37	0.001	0.371	2.681	6.54: 1
	R3	0.31	0.31	7.65	20	23	1.80	0.44	0.71	1.49	2.20	0.34	0.002	0.342	2.542	5.78: 1

Table 29 The data of *S. platensis* culture in oil-extracted soybean fermented water in laboratory for 0 day.

Traetment	Rep.	OD	dry wight ($g\ L^{-1}$)	pH (Units)	Water .temp. (^{o}C)	air.temp. (^{o}C)	DO ($mgL1^{-1}$)	TP ($mgL1^{-1}$)	NH_3 –N ($mg\ L^{-1}$)	Orga.N ($mgL1^{-1}$)	TKN ($mg\ L^{-1}$)	NO_3 -N ($mg\ L^{-1}$)	NO_2 -N ($mg\ L^{-1}$)	Tot. Oxi.N ($mg\ L^{-1}$)	TN ($mg\ L^{-1}$)	N : P Ratio
100%Sw	r1	0.30	0.29	7.12	20	23	0.01	9.24	27.80	11.71	39.51	36.35	0.010	36.36	75.87	8.21: 1
	r2	0.29	0.28	6.87	21	23	0.02	8.92	28.35	10.86	39.21	37.70	0.015	37.72	76.93	8.62: 1
	r3	0.31	0.30	7.00	21	23	0.01	9.10	27.80	10.05	37.85	34.35	0.016	34.37	72.22	7.94: 1
90%Sw	r1	0.30	0.28	6.89	20	23	0.02	8.32	25.02	10.54	35.56	32.72	0.009	32.73	68.29	8.21: 1
	r2	0.29	0.27	6.76	22	23	0.03	8.03	25.52	9.77	35.29	33.93	0.014	33.94	69.23	8.62: 1
	r3	0.31	0.30	6.87	19	23	0.04	8.19	25.02	9.05	34.07	30.92	0.014	30.93	65.00	7.94: 1
80%Sw	r1	0.30	0.28	7.00	20	23	0.05	7.39	22.24	9.37	31.61	29.08	0.008	29.09	60.70	8.21: 1
	r2	0.29	0.29	7.10	18	23	0.07	7.14	22.68	8.69	31.37	30.16	0.012	30.17	61.54	8.62: 1
	r3	0.31	0.30	7.15	19	23	0.08	7.28	22.24	8.04	30.28	27.48	0.013	27.49	57.77	7.94: 1
70%Sw	r1	0.30	0.29	7.10	20	23	0.08	6.47	19.46	8.20	27.66	25.45	0.007	25.46	53.12	8.21: 1
	r2	0.29	0.29	7.16	21	23	1.00	6.24	22.68	4.77	27.45	26.39	0.0105	26.40	53.85	8.63: 1
	r3	0.31	0.30	7.18	18	23	1.10	6.37	19.46	7.04	26.50	24.05	0.0112	24.06	50.56	7.94: 1
60%Sw	r1	0.30	0.31	7.20	19	23	1.20	5.54	16.68	7.03	23.71	21.81	0.006	21.82	45.53	8.22: 1
	r2	0.29	0.28	7.25	21	23	1.10	5.35	17.01	6.52	23.53	22.62	0.009	22.63	46.16	8.63: 1
	r3	0.31	0.30	7.28	22	23	1.30	5.46	16.68	6.03	22.71	20.61	0.0096	20.62	43.33	7.94: 1
50%Sw	r1	0.30	0.30	7.32	19	23	1.20	4.62	13.90	5.86	19.76	18.18	0.005	18.19	37.95	8.21: 1
	r2	0.29	0.29	7.35	20	23	1.10	4.46	14.18	5.43	19.61	18.85	0.0075	18.86	38.47	8.63: 1
	r3	0.31	0.30	7.31	21	23	1.40	4.55	13.90	5.03	18.93	17.18	0.008	17.19	36.12	7.94: 1
40%Sw	r1	0.30	0.30	7.48	20	23	1.50	3.70	11.12	4.68	15.80	14.54	0.004	14.54	30.34	8.20: 1
	r2	0.29	0.29	7.40	21	23	1.55	3.57	11.34	4.34	15.68	15.08	0.006	15.09	30.77	8.62: 1
	r3	0.31	0.30	7.43	19	23	1.60	3.64	11.12	4.02	15.14	13.74	0.0064	13.75	28.89	7.94: 1
30%Sw	r1	0.30	0.30	7.70	23	23	1.70	2.77	8.34	3.51	11.85	10.91	0.003	10.91	22.76	8.22: 1
	r2	0.29	0.29	7.65	22	23	1.63	2.68	8.51	3.25	11.76	11.31	0.0045	11.31	23.07	8.61: 1
	r3	0.31	0.30	7.80	21	23	1.75	2.73	8.34	3.02	11.36	10.31	0.0048	10.31	21.67	7.94: 1
20%Sw	r1	0.30	0.28	8.46	21	23	1.70	1.85	5.56	2.34	7.90	7.27	0.002	7.27	15.17	8.20: 1
	r2	0.29	0.29	8.54	21	23	1.72	1.78	5.67	2.17	7.84	7.54	0.003	7.54	15.38	8.64: 1
	r3	0.31	0.29	8.23	22	23	1.75	1.82	5.56	2.01	7.57	6.87	0.0032	6.87	14.44	7.94: 1
10%Sw	r1	0.30	0.30	8.72	21	23	1.80	0.92	2.78	1.17	3.95	2.34	0.001	2.34	6.29	6.84: 1
	r2	0.29	0.29	8.81	22	23	1.78	0.89	2.84	1.08	3.92	2.77	0.0015	2.77	6.69	7.52: 1
	r3	0.31	0.31	8.71	21	23	1.75	0.91	2.78	1.01	3.79	2.44	0.0016	2.44	6.23	6.85: 1
5%Sw	r1	0.30	0.30	8.86	21	23	1.80	0.46	1.39	0.19	1.58	1.82	0.0005	1.82	3.40	7.39: 1
	r2	0.29	0.29	8.99	22	23	1.85	0.45	1.42	0.24	1.66	1.89	0.001	1.89	3.55	7.89: 1
	r3	0.31	0.30	8.76	21	23	1.80	0.46	1.39	0.10	1.49	1.72	0.0080	1.73	3.22	7.00: 1

Table 30 The data of *S. platensis* culture in modified Zm and kitchen wastewater in laboratory for 5days

Traetment	Rep.	OD	dry weight (g L^{-1})	pH (Units)	Water temp. (^{o}C)	air.temp. (^{o}C)	DO (mg L^{-1})	TP (mg L^{-1})	NH_3 -N (mg L^{-1})	Orga.N (mg L^{-1})	TKN (mg L^{-1})	NO_3 -N (mg L^{-1})	NO_2 -N (mg lL^{-1})	Tot. Oxi.N (mg L^{-1})	TN (mg L^{-1})	N : P Ratio
Zm	r1	0.60	0.60	9.5	25.8	26	7.67	1.920	1.23	7.610	8.840	10.870	0.060	10.930	19.770	10.3: 1
	r2	0.55	0.55	9.5	26.1	26	7.56	1.904	1.21	7.720	8.930	11.480	0.070	11.550	20.480	10.7: 1
	r3	0.50	0.50	9.5	26.1	26	7.78	1.912	1.25	6.980	8.230	10.260	0.050	10.310	18.540	9.70: 1
100%Kw	r1	0.50	0.40	8.7	26.1	26	7.27	1.931	1.45	11.890	13.340	2.900	0.320	3.220	16.560	8.58: 1
	r2	0.50	0.50	9.3	25.6	26	7.13	1.954	1.40	12.720	14.120	3.200	0.340	3.540	17.660	9.04: 1
	r3	0.45	0.40	9.4	25.7	26	7.41	1.967	1.50	11.060	12.560	2.850	0.300	3.150	15.710	7.99: 1
90%Kw	r1	0.60	0.60	9.0	25.6	26	7.34	1.738	1.31	10.696	12.006	2.610	0.288	2.898	14.904	8.58: 1
	r2	0.50	0.50	9.2	25.6	26	7.82	1.759	1.26	11.448	12.708	2.880	0.306	3.186	15.894	9.04: 1
	r3	0.50	0.40	8.7	26.0	26	6.86	1.770	1.35	9.954	11.304	2.565	0.270	2.835	14.139	7.99: 1
80%Kw	r1	0.45	0.45	8.9	25.7	26	7.35	1.545	1.16	9.512	10.672	2.320	0.256	2.576	13.248	8.57: 1
	r2	0.50	0.50	8.7	25.3	26	7.83	1.563	1.12	10.176	11.296	2.560	0.272	2.832	14.128	9.04: 1
	r3	0.45	0.45	9.4	25.3	26	6.87	1.574	1.20	8.848	10.048	2.280	0.240	2.520	12.568	7.98: 1
70%Kw	r1	0.41	0.41	8.8	25.7	26	7.38	1.352	1.015	8.323	9.338	2.030	0.224	2.254	11.592	8.57: 1
	r2	0.42	0.42	8.5	25.5	26	7.84	1.368	0.98	8.904	9.884	2.240	0.238	2.478	12.362	9.04: 1
	r3	0.42	0.42	9.1	25.3	26	6.89	1.377	1.05	7.742	8.792	1.995	0.210	2.205	10.997	7.99: 1
60%Kw	r1	0.49	0.49	8.7	25.5	26	7.39	1.159	0.87	7.134	8.004	1.740	0.192	1.932	9.936	8.57: 1
	r2	0.42	0.42	8.4	25.3	26	7.85	1.172	0.84	7.632	8.472	1.920	0.204	2.124	10.596	9.04: 1
	r3	0.43	0.43	9.0	25.3	26	7.00	1.180	0.90	6.636	7.536	1.710	0.180	1.890	9.426	7.99: 1
50%Kw	r1	0.41	0.41	8.6	25.4	26	7.40	0.966	0.725	5.945	6.670	1.450	0.160	1.610	8.280	8.57: 1
	r2	0.42	0.42	8.5	25.3	26	7.87	0.977	0.70	6.360	7.060	1.600	0.170	1.770	8.830	9.04: 1
	r3	0.40	0.40	8.9	25.2	26	7.23	0.984	1.20	5.080	6.280	1.425	0.150	1.575	7.855	7.98: 1
40%Kw	r1	0.41	0.41	8.5	25.7	26	7.42	0.772	0.58	4.756	5.336	1.160	0.192	1.352	6.688	8.66: 1
	r2	0.38	0.38	8.4	25.3	26	7.90	0.782	0.56	5.088	5.648	1.280	0.136	1.416	7.064	9.03: 1
	r3	0.36	0.36	8.8	25.3	26	7.45	0.787	0.60	4.424	5.024	1.140	0.120	1.260	6.284	7.98: 1
30%Kw	r1	0.22	0.22	8.4	25.2	26	7.43	0.580	0.435	3.567	4.002	0.870	0.096	0.966	4.968	8.57: 1
	r2	0.28	0.28	8.3	25.1	26	7.91	0.586	0.42	3.816	4.236	0.960	0.102	1.062	5.298	9.04: 1
	r3	0.29	0.29	8.6	25.3	26	7.55	0.591	0.45	3.318	3.768	0.855	0.090	0.945	4.713	7.97: 1
20%Kw	r1	0.13	0.13	8.3	24.7	26	7.45	0.386	0.435	2.233	2.668	0.580	0.064	0.644	3.312	8.58: 1
	r2	0.18	0.18	8.2	24.3	26	7.93	0.391	0.28	2.544	2.824	0.640	0.068	0.708	3.532	9.03: 1
	r3	0.14	0.14	8.5	25.0	26	7.80	0.393	0.30	2.212	2.512	0.570	0.060	0.630	3.142	7.99: 1
10%Kw	r1	0.14	0.14	8.1	24.2	26	7.48	0.193	0.145	1.189	1.334	0.290	0.032	0.322	1.656	8.58: 1
	r2	0.19	0.19	8.2	25.3	26	7.95	0.195	0.14	1.272	1.412	0.320	0.034	0.354	1.766	9.06: 1
	r3	0.14	0.14	8.3	24.5	26	7.83	0.197	0.15	1.106	1.256	0.285	0.030	0.315	1.571	7.97: 1

Table 31 The data of *S. platensis* culture in oil-extracted soybean fermented water in laboratory for 5 days

Traetment	Rep.	OD	dry weight (g L^{-1})	pH (Units)	Water .temp. (°C)	air.temp. (°C)	DO (mg L^{-1})	TP (mg L^{-1})	NH_3 -N (mg L^{-1})	Orga.N (mg L^{-1})	TKN (mg L^{-1})	NO_3 -N (mg L^{-1})	NO_2 -N (mg L^{-1})	Tot. Oxi.N (mg L^{-1})	TN (mg L^{-1})	N : P ratio
100%Sw	r1	0.13	0.13	8.57	24.4	26	0.05	8.100	22.400	11.390	33.790	30.530	0.014	30.544	64.334	7.94: 1
	r2	0.18	0.18	8.34	25.8	26	0.06	8.230	25.870	8.550	34.420	29.120	0.012	29.132	63.552	7.72: 1
	r3	0.14	0.14	8.34	25.7	26	0.05	7.800	26.890	6.270	33.160	28.500	0.014	28.514	61.674	7.91: 1
90%Sw	r1	0.14	0.14	8.54	24.4	26	0.06	7.290	20.160	10.251	30.411	27.477	0.013	27.490	57.901	7.94: 1
	r2	0.19	0.19	8.40	25.8	26	0.07	7.407	23.283	7.695	30.978	26.208	0.013	26.221	57.199	7.72: 1
	r3	0.14	0.14	8.40	25.7	26	0.07	7.020	24.201	5.643	29.844	25.650	0.011	25.661	55.505	7.91: 1
80%Sw	r1	0.13	0.13	8.64	24.4	26	0.07	6.480	17.920	9.112	27.032	24.424	0.112	24.536	51.568	7.96: 1
	r2	0.18	0.18	8.50	25.8	26	0.07	6.584	20.696	6.840	27.536	23.296	0.112	23.408	50.944	7.74: 1
	r3	0.14	0.14	8.50	25.7	26	0.80	6.240	21.512	5.016	26.528	22.800	0.010	22.810	49.338	7.91: 1
70%Sw	r1	0.14	0.14	8.75	24.4	26	0.08	5.670	15.680	7.973	23.653	21.371	0.010	21.381	45.034	7.94: 1
	r2	0.19	0.19	8.60	25.8	26	0.08	5.761	18.109	5.985	24.094	20.384	0.010	20.394	44.488	7.72: 1
	r3	0.14	0.14	8.70	25.7	26	0.09	5.460	18.823	4.389	23.212	19.950	0.009	19.959	43.171	7.91: 1
60%Sw	r1	0.14	0.14	8.80	24.4	26	0.08	4.860	13.440	6.834	20.274	18.318	0.008	18.326	38.600	7.94: 1
	r2	0.19	0.19	8.65	25.8	26	0.09	4.938	15.522	5.130	20.652	17.472	0.008	17.480	38.132	7.72: 1
	r3	0.14	0.14	8.80	25.7	26	1.00	4.680	16.134	3.762	19.896	17.100	0.008	17.108	37.004	7.91: 1
50%Sw	r1	0.13	0.13	8.90	24.4	26	0.09	4.050	13.440	3.455	16.895	15.265	0.007	15.272	32.167	7.94: 1
	r2	0.18	0.18	8.70	25.8	26	1.00	4.115	12.935	4.275	17.210	14.560	0.007	14.567	31.777	7.72: 1
	r3	0.17	0.17	8.90	25.7	26	1.02	3.900	13.445	3.135	16.580	14.250	0.006	14.256	30.836	7.91: 1
40%Sw	r1	0.25	0.25	8.80	24.4	26	0.10	3.240	8.960	4.556	13.516	12.212	0.006	12.218	25.734	7.94: 1
	r2	0.24	0.24	8.75	25.8	26	1.01	3.292	10.348	3.420	13.768	11.648	0.006	11.654	25.422	7.72: 1
	r3	0.26	0.26	9.00	25.7	26	1.03	3.120	10.756	2.508	13.264	11.400	0.005	11.405	24.669	7.91: 1
30%Sw	r1	0.3	0.3	9.00	24.4	26	1.00	2.430	6.720	3.417	10.137	9.159	0.004	9.163	19.300	7.94: 1
	r2	0.32	0.32	8.80	25.8	26	1.02	2.469	7.761	2.565	10.326	8.738	0.004	8.742	19.068	7.72: 1
	r3	0.31	0.31	9.12	25.7	26	1.03	2.340	8.067	1.881	9.948	8.550	0.004	8.554	18.502	7.91: 1
20%Sw	r1	0.41	0.41	9.16	26.4	26	1.01	1.620	4.480	2.278	6.758	6.106	0.003	6.109	12.867	7.94: 1
	r2	0.42	0.42	9.12	26.1	26	1.03	1.646	5.174	1.710	6.884	5.824	0.003	5.827	12.711	7.72: 1
	r3	0.42	0.42	9.48	26.1	26	1.04	1.560	5.378	1.254	6.632	5.700	0.002	5.702	12.334	7.91: 1
10%Sw	r1	0.50	0.50	9.57	25.8	26	1.02	0.810	2.240	1.139	3.379	3.053	0.002	3.055	6.434	7.94: 1
	r2	0.50	0.50	8.81	26.5	26	1.04	0.823	2.587	0.855	3.442	2.912	0.002	2.914	6.356	7.72: 1
	r3	0.40	0.40	9.57	25.6	26	1.05	0.780	2.689	0.627	3.316	2.850	0.001	2.851	6.167	7.91: 1
5%Sw	r1	0.50	0.50	9.08	25.8	26	1.03	0.405	1.120	0.570	1.690	1.527	0.001	1.528	3.218	7.95: 1
	r2	0.60	0.60	8.99	26.1	26	1.05	0.412	1.294	0.427	1.721	1.456	0.001	1.457	3.178	7.71: 1
	r3	0.50	0.50	9.12	25.6	26	1.06	0.390	1.345	0.313	1.658	1.425	0.002	1.427	3.085	7.91: 1

Table 32 The data of *S. platensis* culture in modified Zm and kitchen wastewater in laboratory for 10 days

Traetment	Rep..	OD	dry weight (g L^{-1})	pH (Units)	Water .temp. (^{o}C)	air.temp. (^{o}C)	DO (mg L^{-1})	TP (mg L^{-1})	NH_3 -N (mg L^{-1})	Orga.N (mg L^{-1})	TKN (mg L^{-1})	NO_3-N (mg L^{-1})	NO_2 -N (mg L^{-1})	Tot. Oxi.N (mgL $^{-1}$)	TN (mg L^{-1})	N: P ratio	β-carotene (mg g^{-1})	Phycocyanin (mg g^{-1})
Zm	r1	**0.84**	**0.84**	9.30	23.40	27.00	3.46	1.794	0.760	0.480	1.240	8.110	0.384	8.494	9.734	**5.43: 1**	0.29	6.94
	r2	**0.85**	**0.86**	9.33	23.00	27.00	3.38	1.757	0.680	0.740	1.420	10.200	0.328	10.528	11.948	**6.80: 1**	0.26	8.63
	r3	**0.75**	**0.82**	9.33	23.00	27.00	3.38	1.757	0.700	0.360	1.060	9.100	0.328	9.428	10.488	**5.97: 1**	0.27	5.25
100%Kw	r1	**0.70**	**0.82**	9.63	22.90	27.00	4.57	1.773	0.750	1.900	2.650	3.600	0.100	3.700	6.350	**3.58: 1**	0.29	18.44
	r2	**0.85**	**0.85**	9.50	22.95	27.00	4.63	1.773	0.700	1.880	2.580	3.800	0.230	4.030	6.610	**3.73: 1**	0.25	19.53
	r3	**0.80**	**0.79**	9.30	23.50	27.00	4.52	1.807	0.800	1.550	2.350	3.900	0.150	4.050	6.400	**3.54: 1**	0.23	17.35
90%Kw	r1	**0.70**	**0.73**	9.05	22.90	27.00	4.58	1.593	0.630	1.755	2.385	3.500	0.090	3.590	5.975	**3.75: 1**	0.26	16.60
	r2	**0.75**	**0.77**	9.12	23.00	27.00	4.60	1.600	0.675	1.647	2.322	3.600	0.207	3.807	6.129	**3.83: 1**	0.21	14.60
	r3	**0.76**	**0.69**	9.12	23.10	27.00	4.60	1.620	0.720	1.395	2.115	3.760	0.135	3.895	6.010	**3.71: 1**	0.24	13.40
80%Kw	r1	**0.60**	**0.63**	9.21	23.30	27.00	4.60	1.416	0.560	1.560	2.120	3.500	0.080	3.580	5.700	**4.03: 1**	0.23	14.75
	r2	**0.55**	**0.70**	9.32	22.70	27.00	4.59	1.430	0.600	1.464	2.064	3.412	0.184	3.596	5.660	**3.96: 1**	0.19	12.80
	r3	**0.60**	**0.65**	9.32	22.37	27.00	4.70	1.440	0.640	1.240	1.880	3.527	0.120	3.647	5.527	**3.84: 1**	0.20	11.12
70%Kw	r1	0.21	0.21	9.02	23.45	27.00	4.70	1.239	0.490	1.165	1.655	1.600	0.070	1.670	3.325	2.68: 1	0.20	12.91
	r2	0.21	0.21	9.10	22.80	27.00	4.60	1.260	0.525	0.881	1.406	1.638	0.161	1.799	3.205	2.54: 1	0.16	10.53
	r3	0.16	0.16	9.29	22.18	27.00	4.80	1.267	0.560	0.985	1.545	1.602	0.105	1.707	3.252	2.57: 1	0.18	9.37
60%Kw	r1	0.20	0.20	9.01	23.50	27.00	4.80	1.062	0.420	0.970	1.390	1.516	0.060	1.576	2.966	2.79: 1	0.17	11.06
	r2	0.21	0.21	8.98	22.83	27.00	4.70	1.080	0.450	1.098	1.548	1.404	0.138	1.542	3.090	2.86: 1	0.14	8.45
	r3	0.21	0.21	9.20	22.80	27.00	4.90	1.080	0.480	0.930	1.410	1.316	0.090	1.406	2.816	2.61: 1	0.13	9.20
50%Kw	r1	0.10	0.10	9.10	23.80	27.00	4.90	0.885	0.360	0.830	1.190	1.230	0.115	1.345	2.535	2.86: 1	0.15	9.22
	r2	0.12	0.12	8.80	22.84	27.00	4.74	0.950	0.375	0.915	1.290	1.170	0.050	1.220	2.510	2.64: 1	0.13	8.12
	r3	0.14	0.14	9.10	22.64	27.00	5.10	0.900	0.400	0.775	1.175	1.430	0.075	1.505	2.680	2.98: 1	0.11	7.87
40%Kw	r1	0.09	0.09	8.90	23.90	27.00	5.00	0.708	0.280	0.780	1.060	1.044	0.092	1.136	2.196	3.10: 1	0.12	7.38
	r2	0.08	0.08	8.67	22.85	27.00	4.79	0.850	0.300	0.732	1.032	0.936	0.040	0.976	2.008	2.36: 1	0.09	5.90
	r3	0.06	0.06	8.89	22.35	27.00	5.20	0.720	0.320	0.620	0.940	1.144	0.060	1.204	2.144	2.98: 1	0.10	6.40
30%Kw	r1	0.05	0.05	8.93	24.00	27.00	5.10	0.531	0.210	0.585	0.795	0.758	0.030	0.788	1.583	2.98: 1	0.09	5.53
	r2	0.06	0.06	8.56	22.87	27.00	5.00	0.600	0.225	0.549	0.774	0.702	0.090	0.792	1.566	2.61: 1	0.07	4.35
	r3	0.06	0.06	8.65	22.17	27.00	5.30	0.540	0.240	0.465	0.705	0.658	0.045	0.703	1.408	2.61: 1	0.06	2.18
20%Kw	r1	0.04	0.04	8.94	24.10	27.00	5.20	0.354	0.140	0.390	0.530	0.472	0.030	0.502	1.032	2.92: 1	0.06	3.69
	r2	0.04	0.04	8.45	23.10	27.00	5.11	0.400	0.150	0.366	0.516	0.468	0.460	0.928	1.444	3.61: 1	0.04	2.60
	r3	0.03	0.03	8.76	23.00	27.00	5.30	0.360	0.160	0.310	0.470	0.572	0.030	0.602	1.072	2.98: 1	0.02	1.98
10%Kw	r1	0.05	0.05	8.92	24.20	27.00	5.30	0.177	0.070	0.199	0.269	0.286	0.030	0.316	0.585	3.31: 1	0.03	1.84
	r2	0.03	0.03	8.32	23.00	27.00	5.25	0.250	0.075	0.183	0.258	0.234	0.023	0.257	0.515	2.06: 1	0.01	1.40
	r3	0.02	0.02	8.25	23.14	27.00	5.40	0.180	0.080	0.155	0.235	0.286	0.015	0.301	0.536	2.98: 1	0.02	1.01

Table 33 The data of *S. platensis* culture in oil-extracted soybean fermented water in laboratory for 10 days

Traetment	Rep.	OD	dry weight (g L^{-1})	pH (Units)	wat.temp. (^{o}C)	air.temp. (^{o}C)	DO (mg L^{-1})	TP (mg L^{-1})	NH_3 -N (mg L^{-1})	Orga.N (mg L^{-1})	TKN (mgL^{-1})	NO_3 -N (mgL^{-1})	NO_2 -N (mg L^{-1})	Tot. Oxi.N (mg L^{-1})	TN (mg L^{-1})	N: P ratio	β-carotene (mg g^{-1})	C-phycocyanin (mg g^{-1})
100%Sw	r1	0.10	0.09	8.57	23.40	27.00	0.07	7.270	9.200	12.90	22.100	19.680	0.010	19.690	41.790	5.75: 1	0.20	8.23
	r2	0.09	0.10	8.34	22.80	27.00	0.06	7.290	8.450	14.75	23.200	21.600	0.012	21.612	44.812	6.15: 1	0.14	7.00
	r3	0.08	0.08	8.34	22.80	27.00	0.08	7.230	10.230	12.37	22.600	20.780	0.011	20.791	43.391	6.00: 1	0.28	6.58
90%Sw	r1	0.10	0.10	8.59	23.40	27.00	0.08	6.540	8.280	11.61	19.890	17.412	0.009	17.421	37.311	5.71: 1	0.17	7.20
	r2	0.12	0.10	8.36	22.80	27.00	0.08	7.550	7.605	13.28	20.880	18.440	0.010	18.450	39.330	5.21: 1	0.15	8.00
	r3	0.14	0.10	8.44	22.80	27.00	0.08	6.580	9.207	11.13	20.340	18.300	0.010	18.310	38.650	5.87: 1	0.18	6.78
80%Sw	r1	0.20	0.11	8.60	23.40	27.00	0.09	5.820	7.360	10.32	17.680	18.144	0.008	18.152	35.832	6.16: 1	0.16	8.30
	r2	0.21	0.12	8.38	22.80	27.00	1.00	5.900	6.760	11.80	18.560	17.280	0.010	17.290	35.850	6.08: 1	0.10	9.00
	r3	0.21	0.13	8.50	23.80	27.00	1.00	5.840	8.184	9.90	18.080	17.820	0.009	17.829	35.909	6.15: 1	0.16	11.00
70%Sw	r1	0.20	0.23	8.62	23.70	27.00	1.00	5.090	6.440	9.03	15.470	15.876	0.007	15.883	31.353	6.16: 1	0.14	6.90
	r2	0.19	0.22	8.39	23.40	27.00	1.10	5.100	5.915	10.33	16.240	13.120	0.009	13.129	29.369	5.76: 1	0.10	8.50
	r3	0.21	0.25	8.60	22.80	27.00	1.16	5.200	7.161	8.66	15.820	14.360	0.008	14.368	30.188	5.81: 1	0.12	4.00
60%Sw	r1	0.26	0.29	8.65	22.80	27.00	1.10	4.360	5.520	6.74	12.260	13.608	0.006	13.614	25.874	5.93: 1	0.15	5.20
	r2	0.28	0.30	8.42	23.70	27.00	1.14	4.400	5.070	7.85	12.920	11.960	0.008	11.968	24.888	5.66: 1	0.14	6.80
	r3	0.30	0.32	8.58	23.40	27.00	1.18	4.500	6.138	6.42	12.560	10.390	0.007	10.397	22.957	5.10: 1	0.12	9.45
50%Sw	r1	0.38	0.35	8.68	23.40	27.00	1.15	4.640	4.600	6.45	11.050	11.340	0.005	11.345	22.395	4.83: 1	0.10	13.65
	r2	0.36	0.32	8.44	22.80	27.00	1.18	3.500	4.225	6.38	10.600	10.800	0.007	10.807	21.407	6.12: 1	0.18	12.00
	r3	0.35	0.31	8.70	23.40	27.00	1.19	3.620	5.115	6.19	11.300	12.390	0.006	12.396	23.696	6.55: 1	0.17	11.00
40%Sw	r1	0.42	0.38	8.69	23.40	27.00	1.16	2.910	3.680	5.16	8.840	9.072	0.004	9.076	17.916	6.16: 1	0.18	14.89
	r2	0.43	0.39	8.50	22.80	27.00	1.19	2.920	3.380	5.90	9.280	8.640	0.005	8.645	17.925	6.14: 1	0.14	13.00
	r3	0.46	0.40	8.80	23.40	27.00	1.16	2.850	4.092	4.95	9.040	9.912	0.003	9.915	18.955	6.65: 1	0.10	11.00
30%Sw	r1	0.50	0.50	8.70	23.50	27.00	1.17	2.180	2.760	3.87	6.630	6.804	0.004	6.808	13.438	6.16: 1	0.16	13.84
	r2	0.47	0.51	8.58	22.80	27.00	1.18	2.300	2.535	4.43	6.960	6.480	0.003	6.483	13.443	5.84: 1	0.30	12.50
	r3	0.48	0.51	8.70	23.40	27.00	1.18	2.200	3.069	3.71	6.780	7.434	0.004	7.438	14.218	6.46: 1	0.19	11.00
20%Sw	r1	0.62	0.60	8.57	23.60	27.00	1.18	1.450	1.840	2.58	4.420	4.236	0.002	4.238	8.658	5.97: 1	0.18	12.60
	r2	0.60	0.61	8.70	22.80	27.00	1.18	1.500	1.690	3.27	4.960	4.132	0.002	4.134	9.094	6.06: 1	0.12	13.50
	r3	0.65	0.61	8.75	23.40	27.00	1.18	1.600	2.046	2.47	4.520	4.956	0.003	4.959	9.479	5.92: 1	0.21	14.30
10%Sw	r1	**0.83**	**0.81**	8.75	23.40	27.00	2.10	0.730	0.920	1.29	2.210	3.268	0.001	3.269	5.479	**7.51: 1**	0.42	23.10
	r2	**0.80**	**0.80**	8.75	22.80	27.00	1.19	0.750	0.845	1.48	2.320	3.160	0.002	3.162	5.482	**7.31: 1**	0.30	22.40
	r3	**0.82**	**0.80**	9.17	22.80	27.00	1.19	0.800	1.023	1.24	2.260	2.878	0.003	2.881	5.141	**6.43: 1**	0.40	18.30
5%Sw	r1	**0.87**	**0.90**	9.35	23.40	27.00	2.10	0.400	0.460	0.65	1.105	2.134	0.001	2.135	3.240	**8.10: 1**	0.21	11.18
	r2	**0.90**	**0.95**	9.19	23.30	27.00	2.15	0.380	0.423	0.74	1.160	1.780	0.001	1.781	2.941	**7.74: 1**	0.20	10.00
	r3	**0.87**	**0.85**	9.13	23.00	27.00	2.18	0.350	0.512	0.62	1.130	1.839	0.002	1.841	2.971	**8.49: 1**	0.18	9.34

Table 34 The data of *S. platensis* culture in modified Zm and kitchen wastewater in laboratory for 15 days

Traetment	Rep..	OD	dry weight ($g\ L^{-1}$)	pH (Units)	Water .temp. (ºC)	air.temp. (ºC)	DO ($mg\ L^{-1}$)	TP ($mg\ L^{-1}$)	NH_3 -N (mg^{-1})	Orga.N ($mg\ L^{-1}$)	TKN (mgL^{-1})	NO_3 -N ($mg\ L^{-1}$)	NO_2 -N ($mg\ L^{-1}$)	Tot. Oxi.N ($mg\ L^{-1}$)	TN ($mg\ l^{-1}$)	N: P ratio
Zm	r1	**0.64**	**0.52**	9.46	25.80	25.00	6.56	1.650	0.010	0.048	0.058	1.780	0.001	1.781	1.839	**1.11: 1**
	r2	**0.58**	**0.43**	9.34	26.00	25.00	7.86	1.450	0.020	0.028	0.048	1.710	0.002	1.712	1.760	**1.21: 1**
	r3	**0.65**	**0.58**	9.34	26.00	25.00	7.12	1.850	0.011	0.035	0.046	1.850	0.001	1.851	1.897	**1.03: 1**
100%Kw	r1	**0.65**	**0.53**	8.54	26.00	25.00	6.12	1.620	0.140	0.540	0.680	0.042	0.003	0.045	0.725	**0.45: 1**
	r2	**0.61**	**0.45**	8.56	26.00	25.00	6.24	1.760	0.145	0.515	0.660	0.031	0.004	0.035	0.695	**0.39: 1**
	r3	**0.63**	**0.48**	8.44	25.80	25.00	6.10	1.480	0.154	0.546	0.700	0.021	0.002	0.023	0.723	**0.49: 1**
90%Kw	r1	**0.53**	**0.35**	8.8	25.70	25.00	5.67	1.450	0.126	0.486	0.612	0.038	0.003	0.041	0.653	**0.45: 1**
	r2	**0.61**	**0.51**	8.96	25.80	25.00	5.45	1.320	0.131	0.463	0.594	0.028	0.004	0.032	0.626	**0.47: 1**
	r3	**0.55**	**0.38**	8.96	25.80	25.00	5.85	1.580	0.139	0.491	0.630	0.019	0.002	0.021	0.651	**0.41: 1**
80%Kw	r1	**0.50**	**0.37**	9.02	25.90	25.00	5.68	1.300	0.112	0.432	0.544	0.034	0.002	0.036	0.580	**0.45: 1**
	r2	**0.45**	**0.35**	8.96	26.10	25.00	5.35	1.190	0.116	0.412	0.528	0.025	0.003	0.028	0.556	**0.47: 1**
	r3	**0.45**	**0.31**	8.96	26.10	25.00	5.91	1.410	0.123	0.437	0.560	0.017	0.002	0.019	0.579	**0.41: 1**
70%Kw	r1	0.20	0.18	8.48	25.80	25.00	5.72	1.130	0.098	0.378	0.476	0.029	0.002	0.031	0.507	0.45: 1
	r2	0.19	0.17	8.38	26.12	25.00	5.45	1.000	0.102	0.360	0.462	0.022	0.003	0.025	0.487	0.49: 1
	r3	0.18	0.16	8.39	25.91	25.00	6.10	1.230	0.108	0.382	0.490	0.015	0.001	0.016	0.506	0.41: 1
60%Kw	r1	0.17	0.15	8.45	25.83	25.00	5.76	0.970	0.084	0.324	0.408	0.025	0.002	0.027	0.435	0.45: 1
	r2	0.18	0.16	8.36	26.14	25.00	5.52	1.050	0.087	0.309	0.396	0.019	0.002	0.021	0.417	0.40: 1
	r3	0.15	0.13	8.46	26.14	25.00	6.12	0.890	0.092	0.328	0.420	0.013	0.001	0.014	0.434	0.49: 1
50%Kw	r1	0.09	0.07	8.43	25.85	25.00	5.81	0.810	0.070	0.270	0.340	0.021	0.002	0.023	0.363	0.45: 1
	r2	0.08	0.06	8.35	26.18	25.00	5.65	0.740	0.073	0.257	0.330	0.016	0.002	0.018	0.348	0.47: 1
	r3	0.10	0.08	8.23	26.18	25.00	6.21	0.880	0.077	0.273	0.350	0.011	0.001	0.012	0.362	0.41: 1
40%Kw	r1	0.06	0.05	8.41	25.89	25.00	5.85	0.650	0.056	0.216	0.272	0.017	0.001	0.018	0.290	0.45: 1
	r2	0.05	0.06	8.45	26.25	25.00	5.75	0.710	0.058	0.206	0.264	0.012	0.002	0.014	0.278	0.39: 1
	r3	0.05	0.03	8.31	26.24	25.00	6.31	0.580	0.062	0.218	0.280	0.008	0.001	0.009	0.289	0.50: 1
30%Kw	r1	0.05	0.04	8.38	25.90	25.00	5.91	0.490	0.042	0.162	0.204	0.013	0.001	0.014	0.218	0.44: 1
	r2	0.05	0.03	8.21	26.28	25.00	5.85	0.530	0.044	0.154	0.198	0.009	0.001	0.010	0.208	0.39: 1
	r3	0.04	0.02	8.26	26.31	25.00	6.24	0.450	0.046	0.164	0.210	0.006	0.001	0.007	0.217	0.48: 1
20%Kw	r1	0.03	0.04	8.35	26.10	25.00	6.12	0.320	0.028	0.108	0.136	0.008	0.001	0.009	0.145	0.45: 1
	r2	0.03	0.02	8.38	26.30	25.00	5.92	0.290	0.029	0.103	0.132	0.006	0.001	0.007	0.139	0.48: 1
	r3	0.02	0.01	8.32	26.32	25.00	6.35	0.350	0.031	0.109	0.140	0.004	0.0001	0.004	0.144	0.41: 1
10%Kw	r1	0.03	0.02	8.12	26.11	25.00	6.25	0.160	0.014	0.054	0.068	0.004	0.0003	0.004	0.072	0.45: 1
	r2	0.02	0.01	8.11	26.32	25.00	6.12	0.150	0.015	0.051	0.066	0.003	0.0004	0.003	0.069	0.46: 1
	r3	0.01	0.01	8.15	26.54	25.00	6.56	0.170	0.015	0.055	0.070	0.002	0.0002	0.002	0.072	0.42: 1

Table 35 The data of *S. platensis* culture in oil-extracted soybean fermented water in laboratory for 15 days

Traetment	Rep.	OD	dry weight (g L^{-1})	pH (Units)	Water .temp. (ºC)	air.temp. (ºC)	DO (mg L^{-1})	TP (mg L^{-1})	NH_3 –N (mg L^{-1})	Orga.N (mg L^{-1})	TKN (mg L^{1})	NO_3-N (mg L^{-1})	NO_2 -N (mg L^{-1})	Tot. Oxi.N (mg L^{-1})	TN (mg L^{-1})	N : P ratio
100%Sw	r1	0.03	0.02	8.36	24.40	27.00	0.09	4.460	7.340	7.060	14.400	16.480	0.0060	16.486	30.886	6.93: 1
	r2	0.04	0.02	8.44	24.80	27.00	1.00	4.300	8.240	9.960	18.200	13.100	0.0040	13.104	31.304	7.28: 1
	r3	0.02	0.02	8.60	23.80	27.00	0.09	4.840	7.020	9.680	16.700	15.200	0.0080	15.208	31.908	6.59: 1
90%Sw	r1	0.05	0.02	8.38	24.40	27.00	1.00	4.014	6.606	6.314	12.920	14.832	0.0054	14.837	27.757	6.92: 1
	r2	0.04	0.03	8.50	24.80	27.00	1.00	3.870	7.416	8.964	16.380	11.700	0.0036	11.704	28.084	7.26: 1
	r3	0.04	0.04	8.62	25.80	27.00	1.00	4.356	6.318	8.712	15.030	13.680	0.0072	13.687	28.717	6.59: 1
80%Sw	r1	0.06	0.05	8.39	25.40	27.00	0.09	3.568	5.872	5.648	11.520	13.184	0.0048	13.189	24.709	6.93: 1
	r2	0.07	0.07	8.38	24.80	27.00	1.00	3.440	6.592	7.968	14.560	10.400	0.0032	10.403	24.963	7.26: 1
	r3	0.06	0.06	8.50	24.80	27.00	1.00	3.872	5.616	7.744	13.360	12.160	0.0064	12.166	25.526	6.59: 1
70%Sw	r1	0.07	0.08	8.62	24.70	27.00	1.00	3.122	5.138	4.942	10.080	11.536	0.0042	11.540	21.620	6.93: 1
	r2	0.08	0.10	8.39	23.40	27.00	1.10	3.010	5.768	6.972	12.740	9.100	0.0028	9.103	21.843	7.26: 1
	r3	0.06	0.09	8.60	24.80	27.00	1.16	3.388	4.914	6.776	11.690	10.640	0.0056	10.646	22.336	6.59: 1
60%Sw	r1	0.11	0.12	8.65	23.80	27.00	1.10	2.676	4.404	4.236	8.640	9.882	0.0036	9.886	18.526	6.92: 1
	r2	0.12	0.13	8.42	25.70	27.00	1.14	2.580	4.944	5.976	10.920	9.120	0.0024	9.122	20.042	7.77: 1
	r3	0.13	0.14	8.58	24.40	27.00	1.18	2.904	4.212	5.808	10.020	7.800	0.0048	7.805	17.825	6.14: 1
50%Sw	r1	0.13	0.16	8.68	23.40	27.00	1.15	2.230	3.670	3.530	7.200	8.240	0.0030	8.243	15.443	6.93: 1
	r2	0.15	0.15	8.44	24.80	27.00	1.18	2.150	4.120	4.980	9.100	6.500	0.0020	6.502	15.602	7.26: 1
	r3	0.14	0.18	8.70	23.40	27.00	2.10	2.420	3.510	4.840	8.350	7.600	0.0040	7.604	15.954	6.59: 1
40%Sw	r1	0.12	0.21	8.62	23.40	27.00	1.19	1.784	2.936	2.824	5.760	6.592	0.0024	6.594	12.354	6.93: 1
	r2	0.11	0.23	8.39	24.40	27.00	1.19	1.720	3.296	3.984	7.280	5.200	0.0016	5.202	12.482	7.26: 1
	r3	0.09	0.22	8.60	23.40	27.00	1.16	1.936	2.808	3.872	6.680	6.080	0.0032	6.083	12.763	6.59: 1
30%Sw	r1	0.14	0.21	8.65	23.80	27.00	1.17	1.338	2.202	2.118	4.320	4.944	0.0018	4.946	9.266	6.93: 1
	r2	0.14	0.22	8.42	23.80	27.00	1.18	1.290	2.472	2.988	5.460	3.910	0.0012	3.911	9.371	7.26: 1
	r3	0.15	0.23	8.58	24.40	27.00	1.18	1.452	2.106	2.904	5.010	4.560	0.0024	4.562	9.572	6.59: 1
20%Sw	r1	0.19	0.25	8.75	23.40	27.00	2.10	0.892	1.468	1.412	2.880	3.296	0.0012	3.297	6.177	6.96: 1
	r2	0.21	0.26	9.17	24.80	27.00	1.19	0.860	1.648	1.992	3.640	2.600	0.0008	2.601	6.241	7.26: 1
	r3	0.25	0.28	9.35	23.40	27.00	1.18	0.968	1.404	1.936	3.340	3.040	0.0016	3.042	6.382	6.59: 1
10%Sw	r1	**0.35**	**0.31**	8.75	23.40	27.00	2.10	0.446	0.734	0.706	1.440	1.648	0.0006	1.649	3.089	**6.96: 1**
	r2	**0.38**	**0.36**	8.75	23.80	27.00	1.19	0.430	0.824	0.996	1.820	1.300	0.0004	1.300	3.120	**7.26: 1**
	r3	**0.40**	**0.28**	9.17	24.80	27.00	2.10	0.484	0.702	0.968	1.670	1.520	0.0008	1.521	3.191	**6.59: 1**
5%Sw	r1	**0.45**	**0.42**	8.75	23.40	27.00	1.19	0.223	0.367	0.353	0.720	0.824	0.0003	0.824	1.544	**6.96: 1**
	r2	**0.51**	**0.38**	9.17	23.30	27.00	2.15	0.215	0.412	0.498	0.910	0.650	0.0002	0.650	1.560	**7.26: 1**
	r3	**0.54**	**0.34**	9.35	23.00	27.00	2.18	0.242	0.351	0.484	0.835	0.760	0.0004	0.760	1.595	**6.59: 1**

Outdoor mass culture of *S. platensis* in experimental tank

Table 36 The data of *S. platensis* culture in modified Zm, Kw and Sw in experimental cement tank (outdoor) for 0 day.

Parameter	Rep.	Zm	100%Kw	90%Kw	10%Sw	5%Sw
water temperature (^{o}C)	r1	28.1	28.1	28.2	28.1	28.1
	r2	28.0	28.2	28.4	28.2	28.2
	r3	28.2	28.0	28.0	28.3	28.0
pH(Units)	r1	8.77	9.43	9.10	8.37	8.53
	r2	8.66	9.58	9.01	8.23	8.55
	r3	8.75	9.60	9.80	8.38	8.45
DO(mg L^{-1})	r1	3.73	0.25	0.30	0.19	0.26
	r2	3.88	0.15	0.21	0.12	0.17
	r3	3.58	0.20	0.39	0.15	0.21
BOD(mg L^{-1})	r1	9.99	18.97	16.66	174.85	136.47
	r2	9.49	16.17	18.67	180.11	137.08
	r3	10.5	18.97	15.66	159.59	135.86
COD (mg L^{-1})	r1	13.21	28.07	25.26	263.97	186.4
	r2	12.17	28.71	25.84	253.65	187.1
	r3	14.25	27.43	24.69	245.67	186
NO_3 - N (mg L^{-1})	r1	30.73	3.80	3.32	31.43	11.47
	r2	31.74	4.70	4.23	32.07	11.96
	r3	29.72	2.90	2.87	30.79	10.98
NO_2 - N (mg L^{-1})	r1	0.003	0.009	0.008	0.06	0.05
	r2	0.004	0.008	0.007	0.09	0.06
	r3	0.003	0.01	0.008	0.07	0.05
TON(mg L^{-1})	r1	30.733	3.809	3.328	31.490	11.520
	r2	29.744	4.708	4.237	32.160	12.020
	r3	29.723	2.910	2.878	30.860	12.023
TKN (mg L^{-1})	r1	0.06	22.56	20.30	46.51	24.45
	r2	0.08	22.00	19.80	45.88	23.12
	r3	0.07	23.11	20.80	46.14	25.45
NH_3 - N (mg L^{-1})	r1	0.04	7.10	5.75	12.24	9.15
	r2	0.03	6.98	5.15	11.00	8.95
	r3	0.02	7.00	6.23	13.00	10.00
Organic N (mg L^{-1})	r1	0.02	15.46	14.55	34.27	15.30
	r2	0.05	15.02	14.65	34.88	14.17
	r3	0.05	16.11	14.57	33.14	15.45
TN (mg L^{-1})	r1	30.79	26.37	23.63	78.00	35.97
	r2	29.82	26.71	24.04	78.04	35.14
	r3	29.79	26.02	23.68	77.00	37.47
TP (mg L^{-1})	r1	4.35	4.25	3.83	9.92	4.96
	r2	4.74	4.38	3.94	10.24	5.12
	r3	3.96	4.12	3.71	9.6	4.8

Table 37 The data of *S. platensis* culture in modified Zm, Kw and Sw in experimental cement tank (outdoor) for 5 days.

Parameter	Rep.	Zm	100%Kw	90%Kw	10%Sw	5%Sw
Water temperature	r1	28.23	28.97	28.7	28.87	28.8
(^{o}C)	r2	28.63	29.05	28.6	28.7	28.6
	r3	28.23	28.88	28.9	28.5	28.7
pH(Units)	r1	9.60	9.97	9.70	9.57	9.87
	r2	9.70	10.12	9.53	9.66	9.66
	r3	9.50	9.82	9.87	9.48	10.08
DO(mg L^{-1})	r1	7.57	7.38	6.79	1.53	4.77
	r2	7.78	7.32	7.56	1.67	4.1
	r3	7.65	7.12	7.67	1.87	4.23
BOD(mg L^{-1})	r1	8.5	13.43	12.09	90	44.66
	r2	9.74	12.98	10.58	86.9	42.67
	r3	11.26	11.88	11.59	90	41.65
COD (mg L^{-1})	r1	11.53	20.67	18.6	85.36	67.68
	r2	12.92	19.55	17.6	137.08	68.54
	r3	10.14	20.6	18.54	133.64	66.82
NO_3 – N	r1	16.87	2.90	2.61	9.92	4.96
(mg L^{-1})	r2	16.26	3.00	2.70	10.08	5.04
	r3	17.48	2.80	2.52	9.76	4.88
NO_2 – N	r1	0.06	0.32	0.29	0.08	0.07
(mg L^{-1})	r2	0.07	0.34	0.29	0.1	0.06
	r3	0.05	0.31	0.28	0.13	0.08
TON (mg L^{-1})	r1	16.93	3.22	2.90	10.00	5.03
	r2	16.33	3.34	2.99	10.18	5.10
	r3	17.53	3.11	2.80	9.89	4.96
TKN (mg L^{-1})	r1	9.84	13.34	12	33.79	16.89
	r2	8.93	14.12	12.71	33.16	16.58
	r3	10.75	12.56	11.3	34.42	17.21
NH_3 – N	r1	1.23	1.45	1.31	2.97	1.49
(mg L^{-1})	r2	1.25	1.5	1.35	3.03	1.52
	r3	1.21	1.4	1.26	2.91	1.46
Organic N	r1	8.61	11.89	10.69	30.82	15.4
(mg L^{-1})	r2	7.68	12.62	11.36	30.13	15.06
	r3	9.54	11.16	10.04	31.51	15.75
TN (mg L^{-1})	r1	26.77	16.56	14.90	43.79	21.92
	r2	25.26	17.46	15.70	43.34	21.68
	r3	28.28	15.67	14.10	44.31	22.17
TP (mg L^{-1})	r1	3.36	3.94	3.55	5.94	2.97
	r2	2.45	4.00	3.60	6.00	3.00
	r3	3.10	4.20	3.78	6.50	3.25

Table 38 The data of *S. platensis* culture in modified Zm, Kw and Sw in experimental tank (outdoor) for 10 days.

Parameter	Rep.	Zm	100%Kw	90%Kw	10%Sw	5%Sw
water	r1	27.80	27.00	27.03	27.03	28.80
Temperature	r2	27.50	26.80	26.90	27.00	28.00
(^oC)	r3	27.30	27.20	27.09	26.80	28.50
pH(Units)	r1	9.7	9.71	9.77	9.12	8.92
	r2	9.61	9.26	10.25	8.81	9.61
	r3	9.79	10.16	9.29	9.43	8.23
DO(mg L^{-1})	r1	3.47	4.57	5.07	3.47	4.90
	r2	3.38	4.51	4.98	4.10	4.00
	r3	3.53	4.63	4.09	4.00	4.80
BOD(mg L^{-1})	r1	6.87	12.67	10.40	14.73	7.16
	r2	7.56	10.10	9.89	12.03	8.57
	r3	5.18	13.24	10.92	13.43	9.45
COD (mg L^{-1})	r1	8.79	15.37	13.83	22.07	11.04
	r2	7.84	18.01	16.21	21.37	10.68
	r3	9.74	12.73	11.46	22.77	11.38
NO_3 – N	r1	1.42	2.60	2.34	3.13	1.57
(mg L^{-1})	r2	1.20	2.34	2.11	3.00	1.50
	r3	1.50	2.86	2.57	4.13	2.00
NO_2 – N	r1	0.03	0.02	0.02	0.14	0.07
N (mg L^{-1})	r2	0.02	0.01	0.01	0.20	0.10
	r3	0.04	0.03	0.02	0.08	0.04
TON (mg L^{-1})	r1	1.45	2.62	2.36	3.27	1.64
	r2	1.22	2.35	2.12	3.20	1.60
	r3	1.54	2.89	2.59	4.21	2.04
TKN (mg L^{-1})	r1	1.24	2.85	2.56	12.80	6.40
	r2	1.42	2.60	2.30	12.58	6.29
	r3	1.06	2.50	2.20	13.02	6.51
NH_3 – N	r1	0.68	0.95	0.86	1.26	0.63
N (mg L^{-1})	r2	0.59	0.80	0.72	1.17	0.63
	r3	0.77	0.70	0.63	1.35	0.68
Organic N	r1	0.56	1.90	1.70	11.54	5.77
(mg L^{-1})	r2	0.83	1.80	1.58	11.41	5.66
	r3	0.29	1.80	1.57	11.67	5.83
TN (mg L^{-1})	r1	2.69	5.47	4.92	16.07	8.04
	r2	2.64	4.95	4.42	15.78	7.89
	r3	2.60	5.39	4.79	17.23	8.55
TP (mg L^{-1})	r1	2.62	2.54	2.29	2.99	1.49
	r2	2.53	1.64	1.48	3.00	1.50
	r3	2.70	2.63	2.37	3.20	1.60

Table 39 The data of *S. platensis* culture in modified Zm, Kw and Sw in experimental tank (outdoor) for 15 days.

Parameter	Rep.	Zm	100%Kw	90%Kw	10%Sw	5%Sw
water	r1	27.93	27.93	27.97	27.93	28.37
temperature	r2	27.81	27.81	27.82	28.05	27.99
.(^{o}C)	r3	28.05	28.05	28.12	27.81	28.37
pH (Units)	r1	11	12	11.6	10.57	10.83
	r2	11.37	11.9	10.81	10.36	10.98
	r3	11.03	11	12.39	10.78	10.68
DO (mg L^{-1})	r1	7.20	6.12	7.00	6.07	6.50
	r2	7.30	6.24	6.74	6.00	6.80
	r3	7.10	6.00	5.26	6.20	6.50
BOD (mg L^{-1})	r1	4.12	5.58	5.62	10.40	3.90
	r2	4.00	4.70	5.73	11.90	2.96
	r3	3.96	4.80	8.82	9.89	3.44
COD (mg L^{-1})	r1	7.50	7.31	6.58	14.83	7.41
	r2	7.00	8.00	7.21	14.98	7.42
	r3	7.20	7.78	7.00	15.00	7.50
NO_3 - N	r1	1.840	0.020	0.018	0.070	0.040
(mg L^{-1})	r2	1.800	0.040	0.038	0.080	0.030
	r3	1.700	0.030	0.027	0.070	0.030
NO_2 - N	r1	0.001	0.003	0.002	0.04	0.002
(mg L^{-1})	r2	0.001	0.004	0.003	0.1	0.005
	r3	0.002	0.002	0.001	0.05	0.025
TON (mg L^{-1})	r1	1.841	0.023	0.020	0.110	0.042
	r2	1.801	0.044	0.041	0.180	0.035
	r3	1.702	0.032	0.028	0.120	0.055
TKN (mg L^{-1})	r1	0.10	0.68	0.61	2.96	1.48
	r2	0.11	0.70	0.63	3.09	1.55
	r3	0.13	0.66	0.59	2.83	1.42
NH_3 - N	r1	0.010	0.140	0.126	0.280	0.140
(mg L^{-1})	r2	0.011	0.134	0.121	0.300	0.150
	r3	0.004	0.146	0.131	0.260	0.130
Organic N	r1	0.090	0.540	0.484	2.680	1.340
(mg L^{-1})	r2	0.099	0.566	0.509	2.790	1.400
	r3	0.126	0.514	0.459	2.570	1.290
TN (mg L^{-1})	r1	1.941	0.703	0.630	3.070	1.522
	r2	1.911	0.744	0.671	3.270	1.585
	r3	1.832	0.692	0.618	2.950	1.475
TP (mg L^{-1})	r1	2.17	2.11	1.90	2.58	1.29
	r2	2.12	2.25	2.03	2.66	1.33
	r3	2.23	1.97	1.77	2.50	1.25

Table 40 The data pigment and γ- linoleic acid of *S. platensis* cultured in modified Zm, Kw and Sw at experimental tank (outdoor) for 15 days.

Treatment	Replication	β-carotene (mg g^{-1})	C-phycocyanin (mg g^{-1})	γ-linoleic acid (mg g^{-1})
Zm	r1	0.31	8.58	0.33
	r2	0.28	7.03	0.30
	r3	0.27	5.20	0.28
100%Kw	r1	0.31	19.40	0.23
	r2	0.29	18.66	0.20
	r3	0.28	17.25	0.19
90%Kw	r1	0.28	17.46	0.16
	r2	0.26	16.78	0.18
	r3	0.25	15.30	015
10%Sw	r1	0.42	22.05	0.18
	r2	0.41	24.90	0.19
	r3	0.42	23.00	0.16
5%Sw	r1	0.21	11.23	0.088
	r2	0.22	12.45	0.12
	r3	0.24	11.50	0.07

Table 41 The data biomass production, variable cost and nutritional values of *S. platensis* cultured in modified Zm, Kw and Sw at experimental tank (outdoor) for 15 days.

Treatment	Rep.	raw wetght (g/l)	dry weight (g/l)	Protien (%)	fat (%)	fiber (%)	moisture (%)	ash (%)	variable cost (baht/kg; DW.)
Zm	r1	8.60	0.86	54.83	1.96	2.09	11.56	4.08	302.10
	r2	8.30	0.83	54.78	1.75	2.62	10.93	3.78	313.00
	r3	8.20	0.82	53.72	2.07	2.23	10.35	3.96	316.83
100%Kw	r1	8.00	0.80	36.88	3.15	11.36	7.56	26.57	282.25
	r2	8.00	0.80	35.84	3.11	10.79	7.99	27.61	282.30
	r3	8.50	0.85	34.86	3.14	9.80	7.61	29.65	265.65
90%Kw	r1	7.20	0.72	33.19	2.84	10.22	6.80	23.91	307.36
	r2	7.00	0.70	32.26	2.8	9.71	7.19	24.85	316.14
	r3	7.70	0.77	31.37	2.83	8.82	6.85	26.69	287.40
10%Sw	r1	9.00	0.90	40.91	1.52	8.05	7.96	28.74	269.00
	r2	8.00	0.80	41.76	1.69	8.02	8.30	26.96	302.60
	r3	8.50	0.85	41.80	1.59	8.06	7.77	26.76	284.80
5%Sw	r1	9.50	0.95	20.46	0.76	4.15	7.90	24.37	223.70
	r2	9.00	0.90	20.88	0.85	5.46	8.38	23.48	236.10
	r3	8.50	0.85	20.3	0.70	4.48	8.22	20.00	250.00

Table 42 The data costs of *S. platensis* cultured in modified Zm, Kw and Sw at experimental tank (outdoor) for 15 days.

Treatment	nutrients (baht/100 L)	stock *Spirulina* (baht / 30L)	Labor cost (baht/day)	electricity+ water cost (baht /day)	total (baht/100)	raw *Spiru.* (g /100L)	dry *Spiru.* (g L-1)	variable cost (baht/kg (dry spi.)
Zm (R1)	7.90	2.28	3.3	12 + 0.5	25.98	**860**	**0.86**	**302.10**
R2	7.90	2.28	3.3	12 + 0.5	25.98	**830**	**0.83**	**313.00**
R3	7.90	2.28	3.3	12 + 0.5	25.98	**820**	**0.82**	**316.80**
100%Kw(R1)	5.00	2.28	3.3	12 + 0	22.58	**800**	**0.80**	**282.30**
R2	5.00	2.28	3.3	12 + 0	22.58	**800**	**0.80**	**282.30**
R3	5.00	2.28	3.3	12 + 0	22.58	**850**	**0.85**	**265.70**
90%Kw (R1)	4.50	2.28	3.3	12 + 0.05	22.13	**650**	**0.72**	**307.40**
R2	4.50	2.28	3.3	12 + 0.05	22.13	**620**	**0.70**	**316.10**
R3	4.50	2.28	3.3	12 + 0.05	22.13	**640**	**0.77**	**287.40**
10%Sw (R1)	6.00	2.28	3.3	12 + 0.63	24.21	**900**	**0.90**	**269.00**
R2	6.00	2.28	3.3	12 + 0.63	24.21	**800**	**0.80**	**302.60**
R3	6.00	2.28	3.3	12 + 0.63	24.21	**850**	**0.85**	**284.80**
5%Sw(R1)	3.00	2.28	3.3	12 + 0.67	21.25	**950**	**0.95**	**223.70**
R2	3.00	2.28	3.3	12 + 0.67	21.25	**900**	**0.90**	**236.1**
R3	3.00	2.28	3.3	12 + 0.67	21.25	**850**	**0.85**	**250.00**

Cultures of *S. platensis* in cement raceway ponds and earthen raceway ponds

Table 43 The data costs of *S. platensis* cultured in 10%Sw in cement raceway ponds and earthen raceway ponds for 10 days

Treatment	Nutrients (baht/ 4000 L)	stock *Spirulina* (baht/ 4000L)	Labor cost (baht/30days)	electricity+ water cost (baht/30 days)	total (baht /4000 L)	raw *Spiru.* (kg / 4000 L)	dry *Spiru.* ($g L^{-1}$)	variable costs (baht / kg (dry spi.)
cement pond (R1)	**240.00**	**100**	**270**	**160**	**770.00**	**25**	**0.63**	224.00
R2	**240.00**	**100**	**270**	**160**	**770.00**	**27**	**0.68**	207.41
R3	**240.00**	**100**	**270**	**160**	**770.00**	**24**	**0.60**	233.33
earthen pond (R1)	**240.00**	**100**	**270**	**160**	**770.00**	**22**	**0.55**	254.55
R2	**240.00**	**100**	**270**	**160**	**770.00**	**23**	**0.58**	243.48
R3	**240.00**	**100**	**270**	**160**	**770.00**	**25**	**0.63**	224.00

Table 44 Water quality of *S. platensis* cultured in 10%Sw water cement raceway ponds and earthen raceway ponds for 0 day

Traetment	Rep.	OD	air Tem. (ºC)	water temp. (ºC)	pH	DO (mg L^{-1})	BOD (mg L^{-1})	COD (mg L^{-1})	NO_3 -N (mg L^{-1})	NO_2 -N (mg L^{-1})	NH_3 -N (mg L^{-1})	TP (mg L^{-1})
10%Sw	T1R1	0.41	33.00	29.93	8.33	0.15	274.83	254.40	31.38	0.070	11.25	9.46
earthen raceway	T1R2	0.50	33.00	29.81	9.18	0.16	280.48	263.40	31.87	0.050	12.92	11.61
Pond	T1R3	0.32	33.00	30.05	7.48	0.14	269.18	245.40	30.89	0.090	9.58	7.31
10%Sw	T2R1	0.51	32.00	30.23	8.57	0.14	271.35	249.10	29.10	0.060	9.80	8.11
cement raceway pond	T2R2	0.50	32.00	30.98	8.63	0.13	264.46	259.10	30.63	0.070	11.04	9.21
	T2R3	0.52	32.00	29.5	8.63	0.15	278.24	239.10	27.57	0.050	8.56	7.01

Table 45 Water quality of *S. platensis* cultured in 10%Sw water cement raceway ponds and earthen raceway ponds for 5 days

Traetment	Rep.	OD	air Tem. (ºC)	water temp. (ºC)	pH	DO (mg L-1)	BOD (mg L-1)	COD (mg L-1)	NO_3 -N (mg L-1)	NO_2 -N (mg L-1)	NH_3 -N (mg L-1)	TP (mg L-1)
10%Sw	T1R1	0.47	29.00	26.8	9.87	1.73	133.47	135.59	9.17	0.040	2.54	6.12
earthen raceway	T1R2	0.53	29.00	26.81	10.08	1.89	138.05	138.65	10.42	0.050	3.15	6.24
Pond	T1R3	0.41	29.00	26.79	9.66	1.63	128.89	132.53	7.92	0.030	1.93	6.00
10%Sw	T2R1	0.54	28.00	27.20	9.43	1.53	129.13	133.76	8.01	0.030	2.63	6.94
cement raceway	T2R2	0.57	28.00	27.72	9.49	1.64	132.63	137.53	8.17	0.020	3.05	7.01
Pond	T2R3	0.51	28.00	26.7	9.37	1.42	132.63	129.99	7.85	0.020	2.21	6.87

Table 46 Water quality of *S. platensis* cultured in 10%Sw water cement raceway ponds and earthen raceway ponds for 10 days

Traetment	Rep..	OD	air temp.. (ºC)	water temp.. (ºC)	pH	DO (mg L^{-1})	BOD (mg L^{-1})	COD (mg L^{-1})	NO_3 –N (mg L^{-1})	NO_2 -N (mg L^{-1})	NH_3 -N (mg L^{-1})	TP (mg L^{-1})	raw *S. platensis* (g L^{-1})	dry *S. platensis* (g L^{-1})
10%Sw earthen raecway pond	T1R1	0.74	31	29.10	10.33	3.73	19.34	29.18	5.17	0.090	1.27	2.900	8.80	0.80
	T1R2	0.77	31	29.63	10.54	3.79	20.67	31.37	5.42	0.100	1.28	2.920	8.90	0.89
	T1R3	0.71	31	28.57	10.12	3.67	17.34	26.99	4.92	0.080	1.26	2.880	7.10	0.71
10%Sw cement raceway pond	T2R1	0.73	31	28.63	9.90	3.93	15.32	23.44	6.67	0.030	1.25	2.990	8.50	0.85
	T2R2	0.77	31	28.75	10.07	4.31	16.87	24.40	7.73	0.040	1.29	3.030	7.80	0.78
	T2R3	0.69	31	28.5	9.73	3.55	14.65	22.48	5.61	0.020	1.21	2.950	9.20	0.92

Nursing larval Tuptim tilapia in earthen pond using raw *S. platensis*

Table 47 The data growth performance of larval Tuptim tilapia fed with experimental diet for 90 days

Treatment	repication	0 day	15 days	30 days	45 days	60 days	75 days	90 days
5%CD / fish weight	R1	0.02	1.16	3.21	6.40	6.90	7.57	8.67
	R2	0.02	1.38	3.55	7.94	8.26	8.74	10.20
	R3	0.02	0.94	2.87	4.98	5.54	6.40	7.14
1%RS / fish weight	R1	0.02	0.46	0.80	1.53	3.79	7.57	7.87
	R2	0.02	0.49	0.98	1.78	4.41	9.06	8.45
	R3	0.02	0.43	0.62	1.28	3.17	6.08	7.29
3%RS / fish weight	R1	0.02	0.72	1.09	1.55	6.06	6.34	8.00
	R2	0.02	0.81	1.22	1.73	7.24	7.35	9.00
	R3	0.02	0.81	0.96	1.37	4.88	5.33	7.00
5%RS / fish weight	R1	0.02	0.89	1.68	2.10	6.2	7.57	9.25
	R2	0.02	0.91	1.74	2.34	7.49	8.08	10.64
	R3	0.02	0.72	1.62	1.86	4.91	7.06	7.86

Table 48 The data growth performance of growth larval Tuptim tilapia for 30 days

Parameter	Replication	5%CD	1%RS	3%RS	5%RS
Weight gain percentage (%)	R1	3.19	0.65	1.07	0.71
	R2	3.20	0.89	1.09	2.65
	R3	3.18	0.77	1.08	1.68
Specific growth rate (% / day)	R1	16.8	12.49	13.6	15.12
	R2	16.54	13.64	13.84	15.55
	R3	17.06	12.33	13.36	14.69
Survival rate (%)	R1	65.67	48.67	63	66.34
	R2	67.07	49.82	64.73	67.87
	R3	64.27	47.52	61.27	64.82
Feed conversion ratio (units)	R1	2.92	2.00	2.15	2.54
	R2	3.01	2.03	2.63	3.10
	R3	2.83	1.97	1.67	1.98
Protein efficiency ratio (units)	R1	0.08	0.03	0.04	0.07
	R2	0.06	0.04	0.05	0.08
	R3	0.10	0.02	0.03	0.06

Table 49 The data growth performance of growth larval Tuptim tilapia for 60 days

Parameter	**Replication**	**5%CD**	**1%RS**	**3%RS**	**5%RS**
Weight gain percentage (%)	R1	6.86	3.78	6.05	6.2
	R2	6.91	3.79	6.06	6.23
	R3	6.81	3.77	6.04	6.17
Specific growth rate (% / day)	R1	9.71	8.65	9.52	9.52
	R2	9.77	8.74	9.53	9.60
	R3	9.65	8.56	9.51	9.44
Survival rate (%)	R1	55.33	47.67	51.00	56.00
	R2	57.41	48.25	52.00	55.00
	R3	53.25	47.09	53.00	57.00
Feed conversion ratio (units)	R1	1.92	2.35	2.12	2.04
	R2	2.29	2.53	2.15	2.25
	R3	1.55	2.17	2.09	1.83
Protein efficiency ratio (units)	R1	0.170	0.090	0.150	0.160
	R2	0.176	0.096	0.156	0.166
	R3	0.164	0.084	0.144	0.154

Table 50 The data growth performance of growth larval Tuptim tilapia for 90 days

Parameter	**Replication**	**5%CD**	**1%RS**	**3%RS**	**5%RS**
Weight gain percentage (%)	R1	8.66	7.84	8.02	9.23
	R2	8.76	7.85	8.11	9.25
	R3	8.56	7.83	7.93	9.21
Specific growth rate (% / day)	R1	7.99	7.63	7.72	8
	R2	8.10	7.76	7.78	8.06
	R3	7.88	7.50	7.66	7.94
Survival rate (%)	R1	51.00	44	48	52.00
	R2	52.00	43	49	51.00
	R3	50.00	45	47	53.00
Feed conversion ratio (units)	R1	2.05	1.51	0.99	1.2
	R2	2.18	1.54	1.09	1.23
	R3	1.92	1.48	0.89	1.17
Protein efficiency ratio (units)	R1	0.22	0.110	0.21	0.22
	R2	0.26	0.130	0.24	0.24
	R3	0.18	0.093	0.18	0.20

Table 51 The data of lysoyme activity (units mL^{-1}) larval Tuptim tilapia for 90 days

Treatment	repication	60day	90day
5%CD / fish weight	R1	1.17	21.68
	R2	1.23	22.68
	R3	1.11	20.68
1%RS / fish weight	R1	1.7	13.18
	R2	1.8	14.54
	R3	1.6	11.82
3%RS / fish weight	R1	0.9	8.71
	R2	1	9.4
	R3	0.8	8.18
5%RS / fish weight	R1	1.3	8.11
	R2	1.4	9.12
	R3	1.2	7.11

Table 52 The data of red blood cell ($x10^6$ cell uL^{-1}) larval Tuptim tilapia for 90 days

Treatment	repication	60day	90day
5%CD / fish weight	R1	2.54	2.57
	R2	2.57	2.60
	R3	2.51	2.54
1%RS / fish weight	R1	2.53	2.54
	R2	2.57	2.55
	R3	2.49	2.53
3%RS / fish weight	R1	2.67	2.72
	R2	2.71	2.78
	R3	2.63	2.66
5%RS / fish weight	R1	2.81	2.88
	R2	2.87	2.98
	R3	2.75	2.78

Table 53 The data of white blood cell ($x10^3$ cell μL^{-1}) of larval Tuptim tilapia for 90 days

Treatment	repication	60day	90day
5%CD / fish weight	R1	76	85.67
	R2	78	89.18
	R3	74	82.16
1%RS / fish weight	R1	72.33	82
	R2	80.47	90.72
	R3	64.19	73.28
3%RS / fish weight	R1	85.33	95.33
	R2	85.91	98.91
	R3	84.75	91.72
5%RS / fish weight	R1	94.33	109
	R2	97.39	117.54
	R3	91.27	100.46

Table 54 The data water quality of larval Tuptim tilapia with experimental diet in earthen pond for 30 days

Treatment	Water temp. (^oC)	air.Tem. (^oC)	pH	Alkality (mg L^{-1})	TDS (mg L^{-1})	Conduc. (μs cm^{-1})	DO (mg L^{-1})	NH_3 –N (mg L^{-1})	PO_4-P (mg L^{-1})
5%CD	27.00	30.00	9.20	112.00	110.00	220.00	7.50	0.010	0.006
	27.00	30.00	9.00	102.00	110.00	230.00	7.60	0.011	0.008
	27.10	30.00	9.00	114.00	130.00	240.00	8.80	0.010	0.007
1%RS	27.60	30.00	9.00	79.00	150.00	320.00	7.70	0.011	0.008
	27.50	30.00	9.00	78.00	150.00	310.00	8.00	0.012	0.007
	27.40	30.00	8.90	78.00	140.00	390.00	7.90	0.012	0.007
3%RS	27.50	30.00	8.90	73.00	120.00	270.00	8.10	0.013	0.005
	27.60	30.00	8.90	72.60	110.00	260.00	7.80	0.014	0.007
	27.60	30.00	9.00	67.00	110.00	250.00	8.50	0.014	0.006
5%RS	27.50	30.00	8.00	84.00	110.00	220.00	7.80	0.016	0.007
	27.40	30.00	9.00	78.00	120.00	230.00	7.60	0.017	0.007
	27.60	30.00	9.00	67.00	110.00	220.00	8.00	0.015	0.007

Table 55 The data water quality of larval Tuptim tilapia with experimental diet in the earthen for 60 days

Treatment	Water temp. (°C)	air.Tem. (°C)	pH	Alkality (mg L^{-1})	TDS (mg L^{-1})	Conduc. (μs cm^{-1})	DO (mg L^{-1})	NH_3 -N (mg L^{-1})	PO_4-P (mg L^{-1})
5%CD	31.10	32.00	7.70	79.00	110.00	220.00	6.00	0.011	0.001
	31.00	32.00	7.80	78.00	110.00	230.00	5.60	0.011	0.002
	31.00	32.00	7.80	78.00	130.00	240.00	5.50	0.010	0.002
1%RS	31.00	32.00	7.90	102.00	150.00	320.00	5.80	0.012	0.001
	31.00	32.00	8.10	98.00	150.00	310.00	5.70	0.012	0.001
	31.00	32.00	8.10	96.00	140.00	390.00	6.00	0.012	0.001
3%RS	31.00	32.00	8.00	96.00	120.00	270.00	5.80	0.014	0.001
	31.00	32.00	8.00	96.00	110.00	260.00	5.60	0.014	0.001
	32.00	32.00	8.00	92.00	110.00	250.00	5.70	0.014	0.002
5%RS	31.90	32.00	7.90	84.00	110.00	220.00	5.80	0.016	0.008
	31.80	32.00	8.00	85.00	120.00	230.00	6.20	0.017	0.008
	32.00	32.00	7.90	84.00	110.00	220.00	6.10	0.016	0.008

Table 56 The data water quality of larval Tuptim tilapiawith experimental diet for 90 days

Treatment	Rep.	Water temp. (°C)	air.Tem. (°C)	pH	Alkalinity (mg L^{-1})	TDS (mg L^{-1})	Conduc. (μs cm^{-1})	DO (mg L^{-1})	NH_3 -N (mg L^{-1})	PO_4-P (mg L^{-1})
5%CD	T1R1	30.50	31.00	7.10	72.60	110.00	230.00	6.40	0.010	0.003
	T1R2	30.90	31.00	7.20	72.60	110.00	210.00	6.30	0.013	0.002
	T1R3	30.50	31.00	7.20	74.50	130.00	230.00	6.60	0.010	0.005
1%RS	T2R1	30.50	31.00	7.10	109.00	110.00	210.00	6.20	0.013	0.005
	T2R2	30.50	31.00	7.20	116.40	120.00	220.00	6.10	0.014	0.004
	T2R3	30.50	31.00	7.40	112.86	120.00	210.00	6.10	0.012	0.005
3%RS	T3R1	30.90	31.00	8.20	111.60	110.00	260.00	5.80	0.015	0.005
	T3R2	30.90	31.00	8.30	110.40	120.00	270.00	6.10	0.014	0.004
	T3R3	30.80	31.00	8.20	100.80	110.00	250.00	6.00	0.015	0.006
5%RS	T4R1	30.90	31.00	8.10	69.60	140.00	240.00	6.10	0.017	0.003
	T4R2	30.90	31.00	8.20	64.80	130.00	250.00	5.80	0.017	0.002
	T4R3	30.80	31.00	8.40	65.70	150.00	240.00	5.70	0.017	0.002

Culturing male and female juvenile Tuptim tilapia in the earthen pond

Table 57 The data of average weight (g $fish^{-1}$) male juvenile Tuptim tilapia used raw *S. platensis* culture feed for 150 days.

Treatment	Rep.	0 day (g $fish^{-1}$)	30 days (g $fish^{-1}$)	60 days (g $fish^{-1}$)	90 days (g $fish^{-1}$)	120 days (g $fish^{-1}$)	150 days (g $fish^{-1}$)
0% raw *S. platensis* + CD (T_1)	R_1	30.00	46.67	43.00	50.00	100.00	110.00
	R_2	27.00	40.00	45.00	65.00	100.00	125.00
	R_3	26.00	42.67	46.00	60.00	100.00	110.00
45% raw *S. platensis* + 55% rice polish (T_2)	R_1	22.00	28.33	30.00	35.00	90.00	95.00
	R_2	28.00	35.00	39.00	41.00	90.00	100.00
	R_3	25.00	28.33	34.00	38.00	98.00	100.00
50% raw *S. platensis* + 50% rice polish (T_3)	R_1	22.00	45.00	47.00	60.00	90.00	105.00
	R_2	21.00	41.67	48.00	60.00	98.00	117.00
	R_3	20.00	47.00	48.33	80.00	100.00	110.00
55% raw *S. platensis* + 45% rice polish (T_4)	R_1	28.75	46.67	55.00	58.00	90.00	100.00
	R_2	26.00	45.00	52.00	60.00	80.00	125.00
	R_3	27.00	43.33	50.00	70.00	85.00	100.00

Table 58 The data of weight gain percentage (%) of male juvenile Tuptim tilapia using raw *S. platensis* feed for 150 days

Treatment	repication	30 days (%)	60 days (%)	90 days (%)	120 days (%)	150 days (%)
0% raw *S. platensis* + CD (T_1)	R_1	55.57	2.85	4.17	120.00	19.09
	R_2	48.15	12.50	44.44	53.84	25.00
	R_3	79.50	2.14	42.86	66.67	10.00
45% raw *S. platensis* + 55% rice polish (T_2)	R_1	28.77	5.89	16.67	46.14	15.56
	R_2	25.00	11.43	5.13	33.51	11.11
	R_3	13.32	20.01	11.76	60.16	12.00
50% raw *S. platensis* + 50% rice polish (T_3)	R_1	104.55	4.44	27.66	50.00	16.67
	R_2	98.42	15.19	4.17	63.33	19.38
	R_3	141.65	2.07	70.21	25.00	10.00
55% raw *S. platensis* + 45% rice polish (T_4)	R_1	62.33	17.85	5.45	55.17	18.34
	R_2	73.08	15.56	15.38	33.33	22.73
	R_3	60.48	15.51	40.00	21.43	13.95

Table 59 The data of specific growth rate (% / day) of male juvenile Tuptim tilapia using raw *S. platensis* feed for 150 days

Treatment	Rep.	30 days (g fish^{-1})	60 days (g fish^{-1})	90 days (g fish^{-1})	120 days (g fish^{-1})	150 days (g fish^{-1})
0% raw	R_1	2.72	1.83	1.59	1.65	1.42
S. platensis	R_2	2.73	1.82	1.58	1.60	1.41
+ CD (T_1)	R_3	2.60	1.80	1.50	1.64	1.43
45%						
raw *S. platensis*	R_1	2.27	1.64	1.31	1.65	1.40
+ 55% rice polish	R_2	2.28	1.63	1.32	1.64	1.42
(T_2)	R_3	2.26	1.62	1.30	1.62	1.40
50%						
raw *S. platensis*	R_1	2.88	1.97	1.77	1.66	1.46
+ 50% rice polish	R_2	2.87	1.96	1.76	1.67	1.45
(T_3)	R_3	2.86	1.98	1.78	1.65	1.47
55%						
raw *S. platensis*	R_1	2.64	1.93	1.59	1.48	1.36
+ 45% rice polish	R_2	2.63	1.94	1.59	1.49	1.35
(T_4)	R_3	2.64	1.92	1.60	1.50	1.37

Table 60 The data of survival rate (%) of male juvenile Tuptim tilapia using raw *S. platensis* feed for 150 days

Treatment	Rep.	30 days (g fish^{-1})	60 days (g fish^{-1})	90 days (g fish^{-1})	120 days (g fish^{-1})	150 days (g fish^{-1})
0% raw	R_1	95	90	85	80	85
S. platensis	R_2	94	91	83	82	86
+ CD (T_1)	R_3	95	93	85	80	87
45%						
raw *S. platensis*	R_1	95	90	85	80	84
+ 55% rice polish	R_2	93	91	84	83	85
(T_2)	R_3	92	90	85	80	83
50%						
raw *S. platensis*	R_1	95	92	84	80	82
+ 50% rice polish	R_2	96	90	85	80	85
(T_3)	R_3	94	90	82	80	83
55%						
raw *S. platensis*	R_1	95	95	87	83	82
+ 45% rice polish	R_2	97	93	85	80	80
(T_4)	R_3	95	90	86	80	88

Table 61 The data of feed conversion ratio male juvenile Tuptim tilapia using raw *S. platensis* feed for 150 days

Treatment	repication	30 days (g fish^{-1})	60 days (g fish^{-1})	90 days (g fish^{-1})	120 days (g fish^{-1})	150 days (g fish^{-1})
0% RS + CD (T_1)	R_1	0.50	0.50	1.06	0.27	0.23
	R_2	0.60	0.55	0.98	0.29	0.28
	R_3	0.65	0.60	1.00	0.30	0.26
45% RS + 55% RP (T_2)	R_1	0.67	0.63	0.38	0.23	0.25
	R_2	0.70	0.70	0.40	0.26	0.26
	R_3	0.60	0.67	0.45	0.27	0.28
50% RS + 50% RP (T3)	R_1	0.60	0.63	0.69	0.56	0.48
	R_2	0.65	0.70	0.70	0.60	0.46
	R_3	0.70	0.68	0.71	0.65	0.50
55% RS + 45% RP (T4)	R_1	1.00	0.96	1.09	1.00	0.80
	R_2	0.87	0.97	0.98	0.95	0.70
	R_3	0.98	1.00	1.00	1.00	0.60

Table 62 The data of protein efficiency ratio of male juvenile Tuptim tilapia using raw *S. platensis* feed for 150 days

Treatment	Rep.	30 days (g fish^{-1})	60 days (g fish^{-1})	90 days (g fish^{-1})	120 days (g fish^{-1})	150 days (g fish^{-1})
0% RS + CD (T_1)	R_1	0.53	0.01	0.43	1.54	0.26
	R_2	0.54	0.02	0.42	1.60	0.27
	R_3	0.56	0.03	0.41	1.70	0.28
45% RS + 55% RP (T_2)	R_1	0.16	0.12	0.12	1.87	0.14
	R_2	0.17	0.13	0.13	1.84	0.15
	R_3	0.16	0.14	0.14	1.85	0.16
50% RS + 50% RP (T3)	R_1	0.80	0.07	0.64	0.90	0.49
	R_2	0.85	0.08	0.65	0.97	0.48
	R_3	0.85	0.07	0.63	0.96	0.48
55% RS + 45% RP (T4)	R_1	0.56	0.23	0.33	0.73	0.77
	R_2	0.57	0.24	0.34	0.72	0.76
	R_3	0.56	0.25	0.35	0.71	0.78

Table 63 The data of average weight (g $fish^{-1}$) female juvenile Tuptim tilapia using raw *S. platensis* feed for 150 days.

treatment	Rep.	0 day	30 days	60 days	90 days	120 days	150 days
0% RS + CD	R_1	30.00	31.33	45.00	55.00	62.00	83.00
(T_1)	R_2	27.00	30.00	41.00	57.00	66.00	85.00
	R_3	26.00	35.00	44.00	60.00	60.00	87.00
45% RS + 55% RP	R_1	18.00	25.00	27.00	35.00	55.00	57.00
(T_2)	R_2	20.00	27.00	28.00	30.00	65.00	60.00
	R_3	17.00	26.67	30.00	45.00	60.00	66.67
50% RS + 50% RP	R_1	22.00	25.00	30.00	45.00	62.00	70.00
(T3)	R_2	21.00	26.00	38.00	43.00	55.00	75.00
	R_3	20.00	27.00	34.00	45.00	60.00	80.00
55% RS + 45% RP	R_1	28.75	38.33	48.00	60.00	63.00	70.55
(T4)	R_2	26.00	35.33	50.00	65.00	67.00	70.00
	R_3	27.00	34.00	48.00	75.00	78.00	68.00

Table 64 The data of weight gain percentage (%) female juvenile Tuptim tilapia using raw *S. platensis* feed for 150 days

treatment	repication	30 days	60 days	90 days	120 days	150 days
0% RS + CD	R_1	4.44	11.22	14.00	15.34	23.33
(T_1)	R_2	4.50	10.00	14.56	16.50	21.00
	R_3	5.00	12.00	15.00	17.10	22.00
45% RS + 55% RP	R_1	7.89	2.11	8.34	13.33	11.22
(T_2)	R_2	8.67	3.00	9.00	12.00	15.00
	R_3	7.45	3.50	8.67	12.67	17.10
50% RS + 50% RP	R_1	5.00	8.00	10.33	14.67	22.00
(T3)	R_2	6.00	7.50	11.00	15.00	20.00
	R_3	6.50	8.00	12.00	14.60	16.80
55% RS + 45% RP	R_1	8.64	12.78	18.00	19.60	20.52
(T4)	R_2	9.00	13.00	19.00	20.66	22.65
	R_3	8.60	13.60	20.00	20.70	21.70

Table 65 The data of specific growth rate (% / day) of female juvenile Tuptim tilapia using raw *S. platensis* feed for 150 days

treatment	repication	30 days	60 days	90 days	120 days	150 days
0% RS + CD (T_1)	R_1	2.20	1.78	1.60	1.36	1.28
	R_2	2.80	2.00	1.58	1.33	1.29
	R_3	3.00	1.80	1.70	1.37	1.30
45% RS + 55% RP (T_2)	R_1	2.02	1.45	1.23	1.45	1.15
	R_2	2.01	1.43	1.28	1.36	1.14
	R_3	2.01	1.41	1.29	1.36	1.20
50% RS + 50% RP (T3)	R_1	1.96	1.61	1.43	1.33	1.24
	R_2	2.00	1.72	1.54	1.34	1.27
	R_3	1.96	1.61	1.43	1.33	1.28
55% RS + 45% RP (T4)	R_1	2.27	1.85	1.65	1.34	1.21
	R_2	2.29	1.95	1.75	1.34	1.27
	R_3	2.27	1.85	1.65	1.38	1.28

Table 66 The data of survival rate (%) of female juvenile Tuptim tilapia using raw *S. platensis* feed for 150 days

treatment	repication	30 days	60 days	90 days	120 days	150 days
0% RS + CD (T_1)	R_1	95	90	85	80	85
	R_2	94	91	83	82	86
	R_3	95	93	85	80	87
45% RS + 55% RP (T_2)	R_1	95	90	85	80	84
	R_2	93	91	84	83	85
	R_3	92	90	85	80	83
50% RS + 50% RP (T3)	R_1	95	92	84	80	82
	R_2	96	90	85	82	85
	R_3	94	90	82	80	83
55% RS + 45% RP (T4)	R_1	95	95	87	83	82
	R_2	97	93	85	80	80
	R_3	95	90	86	80	88

Table 67 The data of feed conversion ratio (units) female juvenile Tuptim tilapia using raw *S. platensis* feed for 150 days

treatment	repication	30 days	60 days	90 days	120 days	150 days
0% RS + CD (T_1)	R_1	0.45	0.34	0.35	0.37	0.26
	R_2	0.46	0.36	0.45	0.38	0.28
	R_3	0.47	0.38	0.38	0.36	0.29
45% RS + 55% RP (T_2)	R_1	0.55	0.53	0.35	0.38	0.35
	R_2	0.53	0.56	0.38	0.37	0.36
	R_3	0.60	0.58	0.35	0.36	0.37
50% RS + 50% RP (T3)	R_1	0.68	0.67	0.70	0.72	0.56
	R_2	0.70	0.65	0.80	0.71	0.57
	R_3	0.67	0.68	0.75	0.73	0.58
55% RS + 45% RP (T4)	R_1	0.90	0.98	1.00	1.00	0.98
	R_2	0.80	0.90	1.03	1.06	0.96
	R_3	0.85	1.00	1.00	1.05	0.98

Table 68 The data of protein efficiency ratio (units) of female juvenile Tuptim tilapia using raw *S. platensis* feed for 150 days

Treatment	Replication	30 days	60 days	90 days	120 days	150 days
0% RS + CD (T_1)	R_1	0.15	0.37	0.47	0.18	0.78
	R_2	0.15	0.33	0.49	0.22	0.70
	R_3	0.17	0.40	0.50	0.24	0.73
45% RS + 55% RP (T_2)	R_1	0.26	0.07	0.28	0.78	0.37
	R_2	0.29	0.10	0.30	0.73	0.50
	R_3	0.25	0.12	0.29	0.76	0.57
50% RS + 50% RP (T3)	R_1	0.17	0.27	0.34	0.49	0.73
	R_2	0.20	0.25	0.37	0.50	0.67
	R_3	0.22	0.27	0.40	0.49	0.56
55% RS + 45% RP (T4)	R_1	0.29	0.43	0.60	0.42	0.68
	R_2	0.30	0.43	0.63	0.42	0.75
	R_3	0.29	0.43	0.67	0.49	0.72

Table 69 The data lysozyme activity (units mL^{-1}) juvenile Tuptim tilapia using raw *S. platensis* feed for 150 days

Treatment	repication	0 day	30 days	60 day	90 day	120 days	150 days
0% raw	R_1	20.74	22.40	9.30	29.60	33.07	31.37
S. platensis	R_2	21.56	23.60	10.60	30.07	33.43	30.30
+ CD (T_1)	R_3	22.74	24.40	9.20	32.07	32.85	29.25
45%							
Raw *S. platensis*	R_1	11.62	16.20	8.50	27.07	33.07	27.13
+ 55% rice polish	R_2	13.86	18.60	9.70	28.64	33.43	28.61
(T_2)	R_3	14.07	17.00	9.30	26.00	32.85	27.51
50%							
Raw *S. platensis*	R_1	8.11	11.40	10.20	18.40	27.80	25.18
+ 50% rice polish	R_2	8.92	9.20	7.90	20.21	28.10	26.31
(T_3)	R_3	9.10	10.80	9.05	19.60	30.20	26.40
55%							
Raw *S. platensis*	R_1	7.10	9.40	10.60	14.57	17.54	16.24
+ 45% rice polish	R_2	8.11	12.00	8.70	15.80	19.79	17.10
(T_4)	R_3	9.12	10.00	6.80	16.50	20.50	17.60

Table 70 The data red blood cell; RBC ($x10^6$ cell μL^{-1}) juvenile Tuptim tilapia using raw *S. platensis* feed in earthen pond for 150 day

Treatment	repication	0 day	30 days	60 day	90 day	120 days	150 days
0% raw	R_1	2.60	2.55	2.47	2.68	2.52	1.97
S. platensis	R_2	2.54	2.56	2.46	2.67	2.51	1.98
+ CD (T_1)	R_3	2.57	2.55	2.47	2.63	2.53	2.21
45%							
Raw *S. platensis*	R_1	2.55	2.58	2.48	2.74	2.67	2.32
+ 55% rice polish	R_2	2.54	2.56	2.51	2.76	2.62	2.32
(T_2)	R_3	2.53	2.54	2.50	2.76	2.65	2.37
50%							
Raw *S. platensis*	R_1	2.75	2.78	2.56	2.85	2.76	2.37
+ 50% rice polish	R_2	2.65	2.75	2.64	2.89	2.70	2.35
(T_3)	R_3	2.76	2.87	2.73	2.82	2.75	2.40
55%							
Raw *S. platensis*	R_1	2.78	2.97	2.75	3.65	2.85	2.56
+ 45% rice polish	R_2	2.88	2.88	2.70	3.48	2.86	2.53
(T_4)	R_3	2.98	2.96	2.65	3.56	2.82	2.60

Table 71 The data white blood cell (Leukocyte): WBC (x 10^3 cell μL^{-1}) of juvenile Tuptim tilapia using raw *S. platensis* feed in earthen pond for 150 days

Treatment	repication	0 day	30 days	60 day	90 day	120 days	150 days
0% raw	R_1	82.00	74.00	68.00	95.00	80.00	78.00
S. platensis	R_2	89.00	73.00	56.00	100.00	86.00	81.00
+ CD (T_1)	R_3	86.00	72.00	62.00	90.00	85.00	80.00
45%							
raw *S. platensis*	R_1	72.00	90.00	87.00	142.00	130.00	114.00
+ 55% rice polish	R_2	86.00	108.00	92.00	157.00	132.00	113.00
(T_2)	R_3	88.00	96.00	90.00	151.00	133.00	113.00
50%							
raw *S. platensis*	R_1	95.00	95.00	95.00	156.00	149.00	117.00
+ 50% rice polish	R_2	96.00	112.00	100.00	151.00	150.00	116.00
(T_3)	R_3	95.00	104.00	97.00	156.00	151.00	117.00
55%							
raw *S. platensis*	R_1	117.00	127.00	105.00	164.00	154.00	126.00
+ 45% rice polish	R_2	100.00	112.00	101.00	164.00	153.00	127.00
(T_4)	R_3	110.00	123.00	100.00	168.00	156.00	127.00

Table 72 The data nutrition value of feed juvenile Tuptim tilapia culture using raw S. *platensis* feed earthen pond for 150 days

Treatment	variable cost (baht/ kg fish)	protien (%)	carbohy. (%)	fat (%)	Fiber (%)	mosture (%)	ash (%)	β-carotene (mg g^{-1})	C-phycocyanin (mg g^{-1})	γ-linoleic acid (mg g^{-1})
(0%RS) T1R1	43.48	30	37.65	6	3.6	7.23	15.11	0.090	4.11	0.055
T1R2	40.65	30.1	37.71	6.1	3.5	7.8	15.1	0.084	5.11	0.078
T1R3	46.73	30.32	37.82	6.2	3.7	7.88	15.12	0.096	3.11	0.066
(45%RS) T2R1	46.43	30.65	48.19	2.18	1.53	10.54	6.87	0.130	11.62	0.102
T2R2	47.40	30.84	48.11	2.17	1.52	10.51	6.86	0.110	13.70	0.083
T2R3	45.50	30.43	48.17	2.19	1.5	10.56	6.85	0.130	9.54	0.078
(50%RS) T3R1	43.56	30.23	49.86	2.35	1.5	9.82	6.68	0.150	12.91	0.113
T3R2	46.49	30.8	49.75	2.32	1.55	9.85	6.65	0.130	15.56	0.091
T3R3	41.68	30.54	49.64	2.43	1.53	9.87	6.63	0.150	10.26	0.106
(55%RS) T4R1	46.70	31.8	47.59	2.52	1.63	10.15	7.17	0.170	14.02	0.124
T4R2	41.34	31.18	47.5	2.57	1.62	10.1	7.17	0.160	16.53	0.116
T4R3	44.25	31.6	47.58	2.5	1.65	10.13	7.1	0.150	11.51	0.105

Table 73 The data nutrition value of flesh juvenile Tuptim tilapia culture using raw *S. platensis* feed in earthen pond for 150 days

Treatment	protien (%)	Carbohy. (%)	Fat (%)	fiber (%)	mosture (%)	Ash (%)	β-carotene (mg g^{-1})	C-phycocyanin (mg g^{-1})	γ- linoleic acid (mg g^{-1})
(0%RS) T1R1	23.26	2.74	3.77	0.04	72.34	1.85	0.08	2.86	0.14
T1R2	24.14	1.98	3.89	0.03	69.89	1.07	0.09	3.83	0.11
T1R3	23.13	1.17	3.81	0.01	70.13	1.75	0.09	1.89	0.11
(45%RS)T2R1	23.10	1.38	6.79	0.01	69.33	1.39	0.08	5.54	0.12
T2R2	24.28	2.57	5.61	0.04	70.48	1.02	0.09	5.80	0.11
T2R3	22.25	1.35	5.11	0.03	70.10	1.16	0.07	5.28	0.14
(50%RS) T3R1	22.22	1.89	4.63	0.03	69.93	1.30	0.12	6.16	0.13
T3R2	23.10	0.96	3.19	0.02	71.00	1.73	0.11	6.31	0.14
T3R3	24.36	0.94	5.42	0.04	67.80	1.44	0.13	6.01	0.15
(55%RS)T4R1	25.22	1.87	3.10	0.03	68.75	1.03	0.05	6.77	0.15
T4R2	26.14	1.07	2.63	0.01	69.00	1.15	0.08	7.08	0.14
T4R3	26.56	1.68	2.67	0.04	67.97	1.08	0.06	6.46	0.13

Table 74 The data nutrition value of eggs juvenile Tuptim tilapia culture using raw *S. platensis* feed in earthen pond for 150 days

Treatment	Protein (%)	Carbohy. (%)	fat (%)	fiber (%)	Moisture (%)	Ash (%)	β-carotene (mg g^{-1})	C-phycocyanin (mg g^{-1})	γ- linoleic acid (mg g^{-1})
(0%RS) T1R1	32.12	2.64	8.69	0.02	54.10	2.43	0.005	1.90	0.105
T1R2	30.34	2.50	7.19	0.01	56.89	3.07	0.006	2.50	0.084
T1R3	31.24	4.50	6.09	0.03	54.45	3.69	0.004	1.84	0.079
(45%RS)T2R1	32.23	1.64	6.51	0.01	56.49	3.12	0.005	2.19	0.101
T2R2	33.69	2.59	6.86	0.01	53.89	2.96	0.005	2.21	0.128
T2R3	34.20	2.96	5.51	0.03	54.99	2.31	0.006	2.17	0.096
(50%RS T3R1	35.00	3.66	4.59	0.01	54.50	2.24	0.006	2.43	0.112
T3R2	36.00	4.70	5.85	0.02	52.20	1.23	0.005	2.42	0.113
T3R3	38.00	4.57	5.89	0.01	50.30	1.23	0.006	2.44	0.108
(55%RS)T4R1	38.00	5.60	4.28	0.01	50.59	1.52	0.005	2.68	0.114
T4R2	37.10	5.31	3.98	0.01	52.21	1.39	0.005	2.71	0.115
T4R3	36.45	5.06	2.42	0.02	54.21	1.54	0.006	2.65	0.118

Table 75 The data costs of juvenile Tuptim tilapia culture using raw *S. platensis* feed in earthen pond for 150 days

Treatment	repication	feed cost (baht/100 fish)	fish cost (baht/ 100 fish)	Labor cost (baht/150days)	Electricity (baht/150 days)	total (baht /100 fish)	fish wt. (kg /20 m^3)	variable costs (baht / kg fish)
0% RS + CD	R_1	225.00	100	125	50	500.00	11.50	43.48
(T_1)	R_2	225.00	100	125	50	500.00	12.30	40.65
	R_3	225.00	100	125	50	500.00	10.70	46.73
45% RS + 55% RP	R_1	180.00	100	125	50	455.00	9.80	46.43
(T_2)	R_2	180.00	100	125	50	455.00	9.60	47.40
	R_3	180.00	100	125	50	455.00	10.00	45.50
50% RS + 50% RP	R_1	208.50	100	125	50	483.50	11.10	43.56
(T3)	R_2	208.50	100	125	50	483.50	10.40	46.49
	R_3	208.50	100	125	50	483.50	11.60	41.68
55% RS + 45% RP	R_1	229.40	100	125	50	504.40	10.80	46.70
(T4)	R_2	229.40	100	125	50	504.40	12.20	41.34
	R_3	229.40	100	125	50	504.40	11.40	44.25

Table 76 The data of gonadosomatic index (GSI %) of juvenile Tuptim tilapia culture using raw *S. platensis* feed in earthen pond for 0 day

Treatment	Body weight ♂(g)	Testis weight ♂(g)	% GSI ♂	Body weight ♀(g)	Overy weight ♀(g)	% GSI♀
(0%RS) T1R1	26	0.0189	0.07	17.5	0.0637	0.364
T1R2	27	0.0194	0.07	19	0.0845	0.44
T1R3	30	0.021	0.07	18.5	0.0937	0.506
(45%RS) T2R1	23	0.2769	1.2	15.5	0.0696	0.449
T2R2	28	0.0359	0.13	17.5	0.076	0.434
T2R3	32	0.29	0.91	15.5	0.8319	5.367
(50%RS) T3R1	19	0.1085	0.571	14.5	0.5071	3.49
T3R2	34	0.1126	0.331	22.5	0.2559	1.137
T3R3	25	0.2332	0.932	18.25	0.2058	1.127
(55%RS) T4R1	36	0.0675	0.187	17.5	0.225	1.29
T4R2	32.5	0.0292	0.089	16.5	0.1072	0.649
T4R3	34	0.015	0.044	16	0.042	0.263

Table 77 The data of GSI (%) of juvenile Tuptim tilapia culture using raw *S. platensis* feed in earthen pond for 30 days

Treatment	Body weight ♂(g)	Testis weight ♂(g)	% GSI ♂	Body weight ♀(g)	Overy weight ♀(g)	% GSI♀
(0%RS) T1R1	92.5	0.649	0.7	37.5	1.0637	0.84
T1R2	27	0.0194	0.7	19	0.0845	0.44
T1R3	43.5	0.6621	0.62	32.5	1.0537	0.33
(45%RS) T2R1	23	0.2769	1.2	22.5	0.3696	0.64
T2R2	27.5	0.0359	1.13	27.5	0.1076	0.39
T2R3	26.5	0.29	1.09	12.5	0.8319	0.367
(50%RS) T3R1	19	0.1085	0.571	14.5	0.5071	3.49
T3R2	45	0.1826	0.406	30.5	0.8559	2.81
T3R3	25	0.3321	1.32	25	1.2058	3.82
(55%RS) T4R1	60	0.1069	0.1782	17.5	0.225	1.29
T4R2	32.5	0.0692	0.2128	20.5	0.5072	2.47
T4R3	34	0.0585	0.1719	32.5	0.042	1.129

Table 78 The data of GSI (%) of juvenile Tuptim tilapia culture using raw *S. platensis* feed in earthen pond for 60 days

Treatment	Body weight ♂(g)	Testis weight ♂(g)	% GSI ♂	Body weight ♀(g)	Overy weight ♀(g)	% GSI♀
(0%RS) T1R1	32	0.033	0.10	25	1.592	0.36
T1R2	25	0.012	0.05	21	0.136	0.65
T1R3	42	0.467	0.11	44	0.142	0.32
(45%RS) T2R1	30	0.035	0.32	22	0.215	1.65
T2R2	39	0.225	0.58	20	0.434	2.17
T2R3	34	0.104	0.31	24	1.054	4.39
(50%RS) T3R1	26	0.070	0.27	20	0.054	0.27
T3R2	38	0.062	0.26	28	0.821	2.93
T3R3	27	0.073	0.27	34	0.683	2.01
(55%RS) T4R1	35	0.064	0.28	48	0.259	1.14
T4R2	52	0.145	0.28	30	0.352	1.17
T4R3	30	0.722	0.41	28	0.26	0.93

Table 79 The data of GSI (%) of juvenile Tuptim tilapia culture using raw *S. platensis* feed in earthen pond for 90 days

Treatment	Body weight ♂(g)	Testis weight ♂(g)	% GSI ♂	Body weight ♀(g)	Overy weight ♀(g)	% GSI♀
(0%RS) T1R1	40	0.224	0.56	55	2.117	3.85
T1R2	80	0.237	0.40	40	1.561	3.90
T1R3	60	0.275	0.45	40	1.978	4.90
(45%RS) T2R1	25	0.026	0.10	35	0.844	1.01
T2R2	35	0.019	0.05	30	0.145	0.88
T2R3	35	0.085	0.14	45	0.433	0.96
(50%RS) T3R1	60	0.374	0.62	45	1.745	3.88
T3R2	60	0.439	0.73	25	1.00	4.00
T3R3	80	0.179	0.68	45	1.382	3.07
(55%RS) T4R1	55	0.456	0.83	60	2.906	4.84
T4R2	35	0.045	0.70	40	1.561	3.90
T4R3	70	0.401	0.57	75	3.822	5.10

Table 80 The data of GSI (%) of juvenile Tuptim tilapia culture using raw *S. platensis* feed in earthen pond for 120 day

Treatment	Body weight ♂(g)	Testis weight ♂(g)	% GSI ♂	Body weight ♀(g)	Overy weight ♀(g)	% GSI♀
(0%RS) T1R1	110	0.371	0.54	40	0.504	1.26
T1R2	100	0.744	0.54	80	1.198	1.50
T1R3	100	0.594	0.59	60	0.158	1.26
(45%RS) T2R1	60	1.784	0.97	55	1.031	1.87
T2R2	90	0.316	0.55	90	3.506	3.9
T2R3	73	0.683	0.48	50	1.05	2.1
(50%RS) T3R1	73	0.351	0.48	30	0.701	2.34
T3R2	40	0.054	0.44	33	1.80	3.27
T3R3	100	0.56	0.56	103	1.095	2.06
(55%RS) T4R1	55	0.456	0.83	60	1.292	2.15
T4R2	35	0.045	0.70	70	0.923	3.32
T4R3	70	0.401	0.81	50	1.508	3.02

Table 81 The data of GSI (%) of juvenile Tuptim tilapia culture using raw *S. platensis* feed in earthen pond for 150 day

Treatment		Body weight ♂(g)	Testis weight ♂(g)	% GSI ♂	Body weight ♀(g)	Overy weight ♀(g)	% GSI♀
(0%RS)	T1R1	75	0.461	0.61	83	1.08	1.24
	T1R2	125	0.571	0.78	88	1.08	1.22
	T1R3	95	0.571	0.60	87	1.08	1.20
(45%RS)	T2R1	60	1.784	0.99	57	2.5	2.39
	T2R2	90	1.784	0.78	83.33	0.81	2.09
	T2R3	75	0.35	0.77	43	1.08	2.51
(50%RS)	T3R1	75	0.35	0.86	70	1.08	2.78
	T3R2	117	0.091	0.84	64	1.08	2.69
	T3R3	100	0.091	0.85	92	0.81	2.88
(55%RS)	T4R1	70	0.519	0.94	50	0.5	3.23
	T4R2	125	0.391	0.91	78	0.65	2.83
	T4R3	90	0.326	0.96	68	1.63	3.40

Table 82 The data of water quality of juvenile Tuptim tilapia culture using raw *S. platensis* feed in earthen pond for 0 day

Treatment		water temp. (°C)	TDS (mg L^{-1})	conduc. (μs cm^{-1})	pH (Units)	alkalinity (mg L^{-1})	DO (mg L^{-1})	NH_3-N (mg L^{-1})	PO_4-P (mg L^{-1})
(0%RS)	T1R1	25.50	110.00	210.00	6.90	104	9.20	0.13	0.32
	T1R2	25.00	100.00	200.00	7.00	105	8.20	0.10	0.25
	T1R3	24.00	90.00	180.00	7.20	104	9.00	0.12	0.32
(45%RS)	T2R1	25.00	110.00	210.00	6.90	111	10.00	0.24	0.37
	T2R2	25.50	100.00	200.00	7.00	110	11.00	0.22	0.39
	T2R3	26.00	120.00	240.00	7.40	110	10.80	0.26	0.40
(50%RS)	T3R1	25.00	80.00	180.00	7.00	106	8.00	0.09	0.28
	T3R2	25.00	80.00	190.00	7.10	105	8.40	0.08	0.19
	T3R3	25.50	80.00	200.00	7.00	105	7.80	0.11	0.24
(55%RS)	T4R1	24.00	100.00	210.00	6.90	74	8.00	0.16	0.16
	T4R2	24.00	110.00	200.00	7.00	73	8.20	0.11	0.22
	T4R3	25.00	90.00	190.00	6.90	75	8.00	0.20	0.19

Table 83 The data of water quality of juvenile Tuptim tilapia using raw *S. platensis* feed in earthen pond for 30 days

Treatment	water temp. (^oC)	TDS (mg L^{-1})	conduc. ($\mu s\ cm^{-1}$)	pH (units)	alkalinity (mg L^{-1})	DO (mg L^{-1})	NH_3-N (mg L^{-1})	PO_4-P (mg L^{-1})
(0%RS) T1R1	23.50	100.00	200.00	7.19	102	8.20	0.12	0.22
T1R2	24.00	100.00	200.00	7.00	103	8.20	0.10	0.25
T1R3	24.00	90.00	180.00	7.20	102	8.12	0.12	0.23
(45%RS) T2R1	24.00	110.00	200.00	6.89	102	7.90	0.22	0.37
T2R2	25.50	100.00	200.00	7.00	101	7.80	0.22	0.39
T2R3	25.00	110.00	210.00	7.40	101	7.80	0.22	0.38
(50%RS) T3R1	25.00	90.00	180.00	6.89	100	8.00	0.07	0.18
T3R2	24.00	90.00	190.00	7.10	101	7.84	0.08	0.19
T3R3	24.50	100.00	180.00	6.98	100	7.86	0.09	0.18
(55%RS) T4R1	24.00	100.00	210.00	7.10	101	8.30	0.16	0.16
T4R2	24.00	110.00	220.00	7.00	102	8.20	0.16	0.17
T4R3	24.00	100.00	200.00	6.90	101	7.80	0.17	0.18

Table 84 The data of water quality of juvenile Tuptim tilapia culture using raw *S. platensis* feed at earthen pond for 60 days

Treatment	water temp. (^oC)	TDS (mg L^{-1})	conduc. ($\mu s\ cm^{-1}$)	pH (units)	alkalinity (mg L^{-1})	DO (mg L^{-1})	NH_3-N (mg L^{-1})	PO_4-P (mg L^{-1})
(0%RS) T1R1	21.50	110.0	220.00	7.30	112	5.50	0.16	0.32
T1R2	21.00	100.0	200.00	7.10	113	5.50	0.12	0.17
T1R3	20.00	110.0	210.00	7.50	112	6.00	0.14	0.25
(45%RS) T2R1	20.00	90.0	180.00	7.00	111	5.40	0.05	0.18
T2R2	21.00	90.0	180.00	6.90	112	6.30	0.04	0.15
T2R3	20.50	100.0	190.00	7.00	111	6.10	0.04	0.11
(50%RS) T3R1	21.50	110.0	200.00	7.00	110	5.80	0.11	0.12
T3R2	20.00	110.0	200.00	7.10	110	6.70	0.10	0.18
T3R3	21.50	90.0	180.00	7.50	109	4.90	0.12	0.15
(55%RS) T4R1	21.00	90.0	190.00	6.90	100	5.00	0.06	0.10
T4R2	21.00	110.0	220.00	7.00	101	6.70	0.08	0.15
T4R3	21.50	110.0	210.00	7.10	100	5.40	0.07	0.13

Table 85 The data of water quality of juvenile Tuptim tilapia culture using raw *S. platensis* feed at earthen pond for 90 days

Treatment	water temp. (°C)	TDS (mg L^{-1})	conduc. (μs cm^{-1})	pH (Units)	alkalinity (mg L^{-1})	DO (mg L^{-1})	NH_3-N (mg L^{-1})	PO_4-P (mg L^{-1})
(0%RS)								
T1R1	25.00	90.00	180.00	6.90	98	9.40	0.28	0.29
T1R2	25.50	100.00	200.00	7.00	97	10.00	0.26	0.28
T1R3	26.00	100.00	190.00	7.20	98	9.80	0.27	0.28
(45%RS)								
T2R1	24.50	140.00	270.00	7.10	95	8.00	0.23	0.18
T2R2	25.00	130.00	280.00	7.00	96	8.00	0.23	0.18
T2R3	24.50	130.00	260.00	7.10	95	7.80	0.23	0.17
(50%RS)								
T3R1	25.00	120.00	250.00	7.00	98	8.20	0.10	0.08
T3R2	25.50	90.00	250.00	6.90	97	8.60	0.09	0.12
T3R3	26.00	110.00	240.00	7.40	97	8.10	0.07	0.10
(55%RS)								
T4R1	27.00	100.00	200.00	7.00	102	10.00	0.09	0.06
T4R2	25.50	110.00	220.00	7.30	101	10.00	0.12	0.08
T4R3	26.00	100.00	200.00	6.90	101	9.40	0.10	0.07

Table 86 The data water quality of juvenile Tuptim tilapia culture using raw *S. platensis* feed at earthen pond for 120 days

Treatment	water tem. (°C)	TDS (mg L^{-1})	conduc. (μs cm^{-1})	pH (Units)	alkalinity (mg L^{-1})	DO (mg L^{-1})	NH_3-N (mg L^{-1})	PO_4-P (mg L^{-1})
(0%RS)								
T1R1	29.00	120.00	240.00	6.70	102	10.80	0.16	0.17
T1R2	30.00	130.00	260.00	6.80	103	11.20	0.15	0.19
T1R3	27.00	110.00	220.00	7.30	102	11.20	0.14	0.16
(45%RS)								
T2R1	26.50	180.00	360.00	7.40	98	10.60	0.11	0.11
T2R2	27.00	150.00	350.00	7.40	99	10.60	0.10	0.10
T2R3	27.00	180.00	370.00	7.10	98	10.00	0.08	0.09
(50%RS)								
T3R1	27.00	170.00	340.00	7.50	100	10.60	0.12	0.11
T3R2	28.50	160.00	350.00	7.00	100	11.20	0.11	0.10
T3R3	28.50	190.00	390.00	7.30	101	11.20	0.11	0.10
(55%RS)								
T4R1	28.00	120.00	240.00	7.00	100	11.60	0.15	0.14
T4R2	27.50	130.00	270.00	7.20	101	11.00	0.16	0.16
T4R3	29.00	120.00	250.00	6.70	100	11.60	0.15	0.13

Table 87 The data of water quality of juvenile Tuptim tilapia culture using raw *S. platensis* feed at earthen pond for 150 days

Treatment	water tem. (ºC)	TDS (mg L^{-1})	conduc. (μs cm^{-1})	pH (Units)	Alkalinity (mg L^{-1})	DO (mg L^{-1})	NH_3-N (mg L^{-1})	PO_4-P (mg L^{-1})
(0%RS)								
T1R1	29.00	120.00	240.00	7.17	107	10.80	0.14	0.17
T1R2	28.00	130.00	260.00	6.80	106	10.70	0.15	0.18
T1R3	27.00	120.00	220.00	7.30	107	11.20	0.14	0.16
(45%RS)								
T2R1	26.50	140.00	320.00	7.24	96	10.60	0.10	0.11
T2R2	26.00	150.00	310.00	7.20	97	10.60	0.10	0.10
T2R3	26.00	140.00	310.00	7.10	96	10.00	0.08	0.09
(50%RS)								
T3R1	27.00	150.00	340.00	7.50	106	11.20	0.12	0.10
T3R2	27.50	120.00	350.00	7.00	107	11.20	0.11	0.10
T3R3	27.50	130.00	350.00	7.30	106	11.20	0.11	0.10
(55%RS)								
T4R1	28.00	120.00	240.00	7.00	106	11.60	0.15	0.14
T4R2	28.50	120.00	230.00	7.20	105	11.00	0.15	0.15
T4R3	28.00	120.00	250.00	6.80	106	11.60	0.15	0.13

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Faculty of Agriculture Production, Maejo University, Chiang Mai.

Attended Conference

Promya J, Traichaiyaporn S and Deming RL. 2006. Phytoremediation of domestic and industrial wastewater by *S. platensis* (Nordstedt) Geiteler, 40th Western Regional Meeting American Chemical Society. 22-25 January 2006 Double Tree Hotel Anaheim/ Orange, CA, USA.

Promya , J.,Hongvityakorn , P.,Traichaiyaporn , S.,2004. Meat Quality Improvement of red tilapia (*Oreochromis niloticus* x *Oreochromis mossambicus*) using *Spirulina platensis* and *Cladophora* sp., 30th Congress on Science and Technology of Thailand, Impact Exhibition and Convention Center,Muang Thong Thani ,Thailand,p.54

Promya J and Traichaiyaporn S. 2003. Improvement of effluent from pig manure biogas digester by the *Spirulina platensis* (Nordstedt) Geiteler. Journal of the Science Faculty of Science, Chiang Mai University. 30(2).95-101.

Promya J., Mengumpan K., Somboonchai S. and Traichaiyaporn S. 2003. Improvement of the dormitory effluent by *Spirulina platensis* (Nordstedt) Geiteler. Abstract International Conference on WATER RESOURCES MANAGEMENT FOR SAFE DRINKING WATER. 25 – 29 March 2003, Novotel Hotel, Chaing Mai, Thailand.

Promya J. and S. Traichaiyapore. 2001. Some nutritional values of *Spirulina platensis* cultivated in waste water from pig manure biogas digester, 26th congresson and Technology of Thailand 18-20 October 2000 Queen Sirikit Wational Convention Center, Bangkok, Thailand.

Promya J. and Traichaiyaporn S. 2000. Improvement of pig manure biogas digested effluent by *Spirulina platensis*. 4th Asia Pacific Conference on Algal biotechnology, Hong Kong convention and Exhibition centre. China. P.220.

Recent Research Work

Research investigating the culture of *Spirulina platensis* in kitchen effluent use to nursing and culture fancy carps (*Cyprinus carpio*) to be stable feed, decrease cost production of tilapia (*Oreochromis niloticus*) for use *Spirulina* and phytoplankton density different, the study to increase mass production of giant freshwater prawn (*Macrobrachium rosenbergii*) in earthen pond by using artificial habitat as augment sanctuary for molting prawn and biodiversity of phytoplankton, zooplankton and water quality in the reservoir of Mae Ngat Somboonchol Dam