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EFFECTS OF SALINITY AND TEMPERATURE ON GROWTH AND ULTRASTRUCTURE OF Tetraselmis tetrathele (WEST) BUTCHER, 1959

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EFFECTS OF SALINITY AND TEMPERATURE ON GROWTH AND ULTRASTRUCTURE OF *Tetraselmis tetrathele* (WEST) BUTCHER, 1959

By

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

EFFECTS OF SALINITY AND TEMPERATURE ON GROWTH AND ULTRASTRUCTURE OF *Tetraselmis tetrathele* (WEST) BUTCHER, 1959

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The effects of salinity and temperature on the growth and ultrastructure of *Tetraselmis tetrathele* were evaluated in this study. Seven salinity levels (0, 10, 20, 30, 40, 50 and 60 ppt) were examined with a 12h:12h light:dark cycle under light intensity of 67.5 µmol/m^2 s. Effects of temperature on the growth and ultrastructure of *T. tetrathele* was carried out at 25°C and 30°C at the salinity of 30 ppt with other culture conditions similar (12h:12h L:D; 67.5 µmol/m^2 s) to those used in salinity experiment. After execution of the studies with salinity and temperature, the selected salinity (30 ppt) and temperature, 26±2°C were used to up-scale *T. tetrathele* using annular photobioreactors with different culture medium (f/2 and Conway medium) in an indoor environment.

The specific growth rate of *T. tetrathele* was lowest ($p<0.05$) at 0 ppt. However, the growth rates of *T. tetrathele* did not differ significantly ($p>0.05$) in 10, 20, 30, 40, 50 and 60 ppt. The study revealed that *T. tetrathele* thrived best in 40 ppt. Upon exposure for 30 minutes, transmission electron micrographs of *T. tetrathele* revealed that cells were surrounded with a few layers of thecae and chloroplast of the cells were filled with starch and lipid. After 4 days of cultivation, layers of thecae, amount of lipid and starch decreased in all the treatments.

The specific growth rate of *T. tetrathele* at 30˚C (0.24/day) was significantly lower to those grown in 25°C (0.63/day). Numerous starch plates and lipid globules observed in cultures exposed for 30 minutes at 25°C and 30°C. Starch plates and lipid globules were depleted after 4 days of both culture. Electron micrographs of *T. tetrathele* grown at 30°C revealed that chloroplast structure was loosely stacked in the microalgal cells indicating that cells were unable to withstand high temperatures (30˚C).

Culture medium did not affect ($p>0.05$) the growth and biomass production of *T. tetrathele* grown in indoor photobioreactors. Protein content was affected by growth phases ($p<0.05$) with a significantly higher percentage ($p<0.05$) during the exponential phases compared to the stationary phases in both culture medium. Carbohydrate and lipid contents increased during the stationary phase of both f/2 and Conway enriched cultures. Conway enriched *T. tetrathele* produced significantly higher ($p<0.05$) lipid content as

compared to f/2 enriched cultures. Polyunsaturated fatty acids (PUFA) were found to be the major proportion in the fatty acid profiles of *T. tetrathele.*

Fatty acids that were found to be major constituents of *T. tetrathele* were palmitic acid (C16:0), oleic acid (C18:1), linoleic acid (C18:2 n-6) and α-linolenic acid (C18:3 n-3). The results of the present study showed that low salinity (0 ppt) and high temperature (30°C) decreased the growth of *T. tetrathele*. Both f/2 and Conway medium can be used for the cultivation of *T. tetrathele* as growth and biomass were comparable in both medium ($p>0.05$). Besides that, protein was found to be a major composition (16.00 to 39.00%) in *T. tetrathele* as compared to carbohydrate (16.00 to 23%), lipid (21.00 to 35.00%), ash (15.00 to 23.00%) and moisture (0.10 to 0.30%).

Abstrak thesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai mematuhi keperluan untuk ijazah Master Sains

KESAN KEMASINAN DAN SUHU KE ATAS PERTUMBUHAN DAN ULTRASTRUKTUR *Tetraselmis tetrathele* (WEST) BUTCHER, 1959

Oleh

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Kesan kemasinan dan suhu terhadap pertumbuhan dan ultrastruktur *Tetraselmis tetrathele* diuji dalam kajian ini. Tujuh tahap kemasinan (0, 10, 20, 30, 40, 50 dan 60 ppt) digunakan dengan jangkamasa cahaya 12h:12h siang:malam di bawah kesan cahaya 67.5 µmol/m^2 s. Kesan suhu pula dikaji pada 25°C dan 30°C dengan tahap kemasinan 30 ppt. Parameter eksperimen (jangkamasa cahaya dan keamatan cahaya) adalah sama seperti yang digunakan dalam kajian tahap kemasinan. Selepas kajian tahap kemasinan dan suhu, kemasinan (30 ppt) dan suhu (26±2°C) dipilih untuk pengkulturan *T. tetrathele* dalam media berlainan (f/2 dan Conway media) dengan menggunakan fotobioreaktor dalam bilik.

Kadar pertumbuhan spesifik *T. tetrathele* adalah paling rendah ($p<0.05$) pada tahap kemasinan 0 ppt. Namun demikian, kadar pertumbuhan spesifik *T. tetrathele* pada 10, 20, 30, 40, 50 dan 60 ppt tidak menunjukkan perbezaan yang signifikan ($p>0.05$). Keputusan kajian menunjukkan tahap kemasinan 40 ppt adalah paling baik untuk pertumbuhan *T. tetrathele*. Selepas didedahkan selama 30 minit dalam tahap kemasinan masing-masing, mikrograf mikroskop elektron menunjukkan sel-sel diselaputi beberapa lapisan dinding sel dan kloroplast sel dipenuhi dengan kanji dan lipid. Selepas 4 hari, lapisan dinding sel, jumlah lipid dan kanji semakin berkurang dalam semua rawatan.

Kadar pertumbuhan spesifik *T. tetrathele* adalah 0.24/hari pada 30°C dan jauh lebih rendah ($p<0.05$) daripada sel yang dikultur pada 25°C (0.63/hari). Banyak kanji dan lipid yang didapati dalam sel yang dikultur selama 30 minit pada 25°C dan 30°C. Kanji dan lipid didapati berkurangan selepas 4 hari dalam kedua-dua rawatan suhu. Namun, mikrograf elektron *T. tetrathele* yang dikultur pada 30°C menunjukkan struktur kloroplast disusun dengan longgar. Ini menunjukkan sel tidak dapat bertahan dalam suhu yang tinggi (30˚C).

Pertumbuhan dan penghasilan biomas *T. tetrathele* yang dikultur menggunakan fotobioreaktor dalam bilik tidak dipengaruhi ($p>0.05$) oleh kultur media yang digunakan (Conway dan f/2). Kandungan protein dipengaruhi oleh fasa pertumbuhan ($p<0.05$) dengan peratusan yang lebih

tinggi pada fasa eksponen berbanding dengan fasa pegun untuk kedua-dua media yang digunakan. Kandungan karbohidrat dan lipid meningkat semasa fasa pegun dalam kedua-dua kultur media f/2 dan media Conway. *Tetraselmis tetrathele* yang dikultur dalam media Conway menghasilkan lipid yang lebih tinggi ($p<0.05$) berbanding dengan kultur menggunakan media f/2. Asid lemak tak tepu (PUFA) adalah paling banyak didapati dalam profil asid lemak *T. tetrathele*.

Kandungan asid lemak yang banyak dalam sel adalah asid palmitik (C16:0), asid oleic (C18:1), asid linoleik (C18:2 n-6) dan α-asid linolenik (C18:3 n-3). Keputusan kajian menunjukkan tahap kemasinan yang rendah (0 ppt) and suhu yang tinggi (30˚C) melambatkan pertumbuhan *T. tetrathele.* Kedua-dua media f/2 dan media Conway didapati sesuai untuk pengkulturan *T. tetrathele* dengan pertumbuhan dan penghasilan biomas yang standing ($p>0.05$). Selain itu, protein merupakan kandungan nutrien yang paling tinggi dalam *T. tetrathele* (16.00 hingga 39.00%) berbanding dengan kandungan karbohidrat (16.00 hingga 23.00%), lipid (21.00 hingga 35.00%), abu (15.00 hingga 23.00%) dan kelembapan (0.10 hingga 0.30%).

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Microalgae are known as the baseline feed for young stages of crustaceans (Fabregas *et al.*, 1996; D'Souza and Kelly, 2000; D'Souza *et al.*, 2002), mollusks (Gallardo *et al.*, 1992; Ponis *et al.*, 2006) and fishes (Juario and Storch, 1984; Reitan *et al.*, 1997). Their high nutritional contents are important for enrichment of live feed organisms such as rotifers, *Artemia* and copepods (Barclay and Zeller, 1996; Ferreira *et al.*, 2008, 2009; Seychelles *et al.*, 2009; Matias-Peralta *et al.*, 2012) where the nutritional profiles of the fed organisms reflected those of their feed (Barclay and Zeller, 1996; Ferreira *et al.*, 2008, 2009; Seychelles *et al.*, 2009). Hence, microalgae are crucial as one of the main food items in hatcheries for aquaculture.

In the recent years, microalgae had extended their potentials and applications into the realm of food supplement industries for aquaculture (Muller-Feuga, 2000) and human diets (Lubian *et al.*, 2000; Olaizola, 2003). Applications in cosmetics (Spolaore *et al.,* 2006), pharmaceuticals (Spolaore *et al.,* 2006), CO_2 sequestration to reduce global warming effects (Dibenedetto, 2011; Kumar *et al.*, 2011) are emerging and of late, microalgae are metabolically engineered as a single cell factories for fine chemical productions such as astaxanthin (He *et al.*, 2007), β-carotene (Hejazi *et al.,* 2004; Garcia-Gonzalez *et al.,* 2005; Tafreshi and

Shariati, 2006) and biofuel production (Hirano *et al.*, 1997; Beer *et al.*, 2009; Radakovits *et al.*, 2010).

Chlorella, Chaetoceros, Isochrysis, Nannochloropsis, Pavlova, Phaeodactylum, Skeletonema, Tetraselmis and *Thalassiosira* are common genera of microalgae frequently used in aquaculture industries (Muller-Feuga, 2000). These microalgae were used in feeding zooplankton (Habib *et al.*, 2003; Lora-Vilchis *et al.*, 2004; Farhadian *et al.*, 2008), bivalves (Chotipuntu, 2005; Reitan, 2011), shrimps (Ju *et al.*, 2009), sea urchin (Carboni *et al.*, 2012), juvenile worms of *Sabellastarte spectabilis* (Tamaru *et al*, 2011) and fish (Zaki and Saad, 2010). Chrysophytes such as *Isochrysis galbana* and *Pavlova lutheri* are used in feeding the molluskan larvae as they are high in DHA (docosahexaenoic acid) and EPA (eicosapentaenoic acid) (Lora-Vilchis *et al.*, 2004; Hu *et al.*, 2008). *Nannochloropsis* is usually used in growing rotifers, corals and filter feeders due to their high EPA levels (Ferreira *et al.*, 2009; Hemaiswarya *et al.*, 2011) while diatoms such as *Chaetoceros* and *Thalassiosira* are used in shrimp farms (Hemaiswarya *et al.*, 2011). Combinations of these microalgae as feed were found to be more superior in nutritional values than monospecies diet (Spolaore *et al.*, 2006; O'Connor *et al.*, 2011). Microalgae monocultures can be used as feed, but it is not as better-quality as mixed microalgae formulation (Asha and Muthiah, 2006) in terms of biochemical composition and dietary energy (Phatarpekar *et al.*, 2000). A large number of investigations (Fabregas *et al.*, 2001; Lora-Vilchis *et al.*, 2004; O'Connor *et al.*, 2011) were conducted and are still ongoing to elucidate the

nutritional values of microalgae for aquaculture species. Usage of some species from the genus *Tetraselmis* is summarized in Table 1.

Table 1. Application of microalgae from genus *Tetraselmis.*

Microalgae species	Use	References
T. suecica *T. gracilis* *T. tetrathele* *T. chuii*	Common aquaculture feed	Asha and Muthiah (2006), Ronquillo *et al.* (2006)
T. suecica *T. chuii* PLY 429 *T. striata* PLAT-P *Tetraselmis* sp. MC:2 *T. chuii* UW.445 *T. chuii* PLY 429S	Bivalve production	Wikfors *et al.* (1996), Jo *et al.* (2004)
T. suecica	Heavy metal removal and biomonitoring	Perez-Rama *et al.* (2002), Moreno-Garrido *et al.* (2005)

Even though much work has been carried out to replace microalgae with commercial feed due to high operational cost and unpredictable culture conditions (Coutteau and Sorgeloos, 1993), results of the commercial feed is still not as superior as feeding with live or dried microalgae (Robert and Trintignac, 1997). The study conducted by Øie *et al.* (1994) revealed that rotifer fed with microalgae had better survival rate when tested at low temperature (8.0˚C) and high salinity (34 ppt) while lower growth rates and higher mortality rates were observed in cultures that were grown on non-algal feeds. Apart from that, growth and survival of *Penaeus monodon* postlarvae (PL) were found to be significantly higher when diatoms were supplied as supplement feed (Khatoon *et al.*, 2009). The authors reported that survival of the postlarvae was 56.3% in treatments supplemented with diatoms while only 36.0% was achieved in treatments fed with

commercial feed only. Besides that, *Litopenaeus vannamei* fed with *Diaphanosoma celebensis* enriched with *Chaetoceros calcitrans* showed a higher specific growth rate and survival rate from those fed with *Artemia* only (Khatoon *et al.*, 2013).

In this regard, microalgae production with various culture systems and techniques are equally important since culture conditions are known to change or modify the nutritional values of microalgae (Rousch *et al.*, 2003; Rodolfi *et al.*, 2009). Changes in nutritional value will in turn influence the organisms fed using microalgae (Seychelles *et al.*, 2009; Ferreira *et al.*, 2011). Besides that, culture systems such as photobioreactor enable high production of microalgae biomass from usual tank production (Zhang and Richmond, 2003; Briassoulis *et al.*, 2010). With the availability of suitable culture systems, culture conditions such as nutrient availability, light intensity, pH, temperature and salinity can then be optimized for high quality and maximum biomass production (Olaizola, 2003; Zhang and Richmond, 2003; Rodolfi *et al.*, 2009). For example, by optimizing the growth parameters of a helical-tubular photobioreactor, *Nannochloropsis* sp. cultured was able to achieve productivity of biomass that range between 1.10-3.03 g/L/day (Briassoulis *et al.*, 2010).

1.2 Statement of Problem

There has been a marked increase in aquaculture activities in Asia with China as the largest producer, accounting for 62.3% of the world production in 2008. In Malaysia, there was an increase of 96,140 t aquaculture production from 2007 to 2008 (FAO, 2010). Artificial diet such as yeast is developed as alternative feed due to their suitable particle size, stability in water column, high protein content and low operational cost (Coutteau and Sorgeloos, 1993). Øie *et al.* (1994) demonstrated that yeast and microalgae both offers equal protein content to rotifers though survivability of rotifers were better in those enriched with microalgae. Then again, preserved microalgae in commercial diets may lose their nutritional value during processing and storage. An investigation on the growth and survival of juvenile hard clam, *Mercenaria mercenaria* using fresh *Isochrysis* and commercial feeds added with *Isochrysis* showed that those fed with fresh diet had higher growth and survival (Espinosa and Allam, 2006). In addition, the same study also revealed that growth and survival of the controls (unfed clams) were similar to those fed with commercial diets indicating the loss of nutritional value in the commercial diets added with live algae. Therefore, sufficient high quality feed is vital for the development of this industry while maintaining low production cost and production reliability (Duerr *et al.*, 1998; Lopez-Elias *et al.*, 2005).

In the wild, environmental conditions alter growth, nutritional values and morphological characteristics of microalgae (Cai and Duan, 2007; He *et al.*, 2007; Converti *et al.,* 2009; Guedes *et al.*, 2010). With the knowledge that culture parameters are important for high quality microalgae production, these parameters needs to be optimised for the selected microalgae species. Apart from that, many hatcheries in tropical countries are situated outdoors, hence, are subjected to fluctuations of temperature, light intensity and rainfall (Mandeep *et al.*, 2011).

For marine microalgae, salinity and temperature changes are two important factors that alter their growth, biochemical composition and morphology (Pfeihofer and Belton, 1975; Villareal and Fryxell, 1983; Lewis *et al.*, 1993; Rousch *et al.*, 2003; Balzano *et al.*, 2011; Gu *et al.*, 2012). Ultrastructural changes in microalgae provide information at a cellular level which is important for understanding cellular feedback mechanisms of microalgae under different environments (Kirst and Kramer, 1981; Tchernov *et al.*, 2004). Feedback mechanisms are crucial for the adaptation and survivability of microalgae (Richardson *et al.*, 1983; Kirst, 1989; Davison, 1991). At the same time, it can serve as a basis of supporting evidence on the biochemical composition of microalgae, either for starch or lipid accumulation and to be utilized in consideration for mass culture harvesting (Damiani *et al.*, 2010).

Tetraselmis tetrathele is selected as the study organism because of its hardy characteristic, ease of culture, fast growing, good in nutrition and is isolated indigenously. Through selection of suitable salinity level and temperature,

nutrient composition of different media can be further investigated. In addition to that, biomass production of *T. tetrathele* with the selected salinity and temperature by upscaling in photobioreactor provide information for mass production of this species which is important for development of live feed in the aquaculture industry. Therefore, the study was undertaken with the following objectives:

1. To determine the effects of different salinity levels on the growth and ultrastructure of *T. tetrathele*
2. To determine the effects of different temperature levels on the growth and ultrastructure of *T. tetrathele*
3. To determine the growth and biochemical composition of *T. tetrathele* cultured with different media in 120 L annular photobioreactors

REFERENCES

Abu-Rezq, T.S., Al-Musallam, L., Al-Shimmari, J. and Dias, P. 1999. Optimum production conditions for different high-quality marine algae. *Hydrobiologia* 403:97-107.

Adarme-Vega, T.C., Lim, D.K.Y., Timmins, M., Vernen, F., Li, Y. and Schenk, P.M. 2012. Microalgal biofactories: a promising approach towards sustainable omega-3 fatty acid production. *Microbial Cell Factories* 11:96.

Affenzeller, M.J., Darehshouri, A., Andosch, A., Lutz, C. and Lutz-Meindi, U. 2009. Salt stress-induced cell death in the unicellular green alga *Microasterias denticulata*. *Journal of Experimental Botany* 60:939-954.

Ahmad, I. and Hellebust, J.A. 1984. Osmoregulation in the extremely euryhaline marine microalga *Chlorella autotropica*. *Plant Physiology* 74:1010-1015.

Aidar, E., Gianesella-Galvano, S.M.F., Sigaud, T.C.S., Asano, C.S., Liang, T.H., Rezende, K.R.V., Oishi, M.K., Aranha, F.J., Milani, G.M. and Sandes, M.A.L. 1994. Effects of light quality on growth, biochemical composition and photosynthetic production in *Cyclotella capsia* Grunow and *Tetraselmis gracilis* (Kylin) Butcher. *Journal of Experimental Marine Biology and Ecology* 180:175-187.

Aizdaicher, N.A. and Markina, Z.V. 2010. The effect of decrease in salinity on the dynamics of abundance and the cell size of *Corethron hystrix* (Bacillariophyta) in laboratory culture. *Ocean Science Journal* 45:1-5.

Ak, I., Cirik, S. and Goksan, T. 2008. Effects of light intensity, salinity and temperature on growth in Camalti strain of *Dunaliella viridis* Teodoresco from Turkey. *Journal of Biological Sciences* 8:1356-1359.

Andersen, R.A., Morton, S.L. and Sexton, J.P. 1997. Provasoli-Guillard National Center for culture of marine phytoplankton 1997 list of strains. *Journal of Phycology* 33 (suppl.):1-75.

Anning, T., Harris, G. and Geider, R. 2001. Thermal acclimation in the marine diatom *Chaetoceros calcitrans* (Bacillariophyceae). *European Journal of Phycology* 36:233-241.

AOAC. 1995. *American Official Analytical Chemists*. 15th ed. Association of Analytical Chemists: Washington D.C.

Asha, P.S. and Muthiah, P. 2006. Effects of single and combined microalgae on larval growth, development and survival of the commercial sea cucumber *Holothuria spinifera* Theel. *Aquaculture Research* 37:113-118.

Ashokkumar, V. and Rengasamy, R. 2012. Mass culture of *Botryococcus braunii* Kutz. under open raceway pond for biofuel production. *Bioresource Technology* 104:394-399.

Austin, B., Baudet, E. and Stobie, M. 1992. Inhibition of bacterial fish pathogens by *Tetraselmis suecica*. *Journal of Fish Diseases* 15:55-61.

Balzano, A., Sarno, D. and Kooistra, W.H.C.F. 2011. Effects of salinity on the growth rate and morphology of ten *Skeletonema* strains. *Journal of Plankton Research* 33:937-945.

Barclay, W. and Zeller, S. 1996. Nutritional enhancement of n-3 and n-6 fatty acids in rotifers and *Artemia* nauplii by feeding spray-dried *Schizochytrium* sp. *Journal of the World Aquaculture Society* 27:314-322.

Barsanti, L. and Gualtieri, P. 2006. Algal culturing. In *Algae: Anatomy, Biochemistry and Biotechnology*. pp.209-249. Florida: CRC Press.

Becker, B., Becker, D., Kamerling, J.P. and Melkonian, M. 1991. 2-keto-sugar acids in green flagellates: a chemical marker for prasinophycean scales. *Journal of Phycology* 27:498-504.

Becker, B., Hard, K., Melkonian, M., Kamerling, J.P. and Vliegenthart, F.G. 1989. Identification of 3-deoxy-*manno*-2-octulosonic acid, 3-deoxy-5-*O*-methyl-*manno*-2-octulosonic acid and 3-deoxy-*lyxo*-2-heptulosaric acid in the cell wall (theca) of the green alga *Tetraselmis striata* Butcher (Prasinophyceae). *European Journal of Biochemistry* 182:153-160.

Becker, B., Lommerse, J.P.M., Melkonian, M., Kamerling, J.P. and Vliegenthart, J.F.G. 1995. The structure of an acidic trisaccharide component from a cell wall polysaccharide preparation of the green alga *Tetraselmis striata* Butcher. *Carbohydrate Research* 267:313-321.

Becker, B., Marin, B. and Melkonian, M. 1994. Structure, composition and biogenesis of prasinophyte cell coverings. *Protoplasma* 181:233-244.

Becker, D., Becker, B., Satir, P. and Melkonian, M. 1990. Isolation, purification and characterization of flagellar scales from the green flagellate *Tetraselmis striata* (Prasinophyceae). *Protoplasma* 156:103-112.

Becker, E.W. 2007. Micro-algae as a source of protein. *Biotechnological Advances* 25:207-210.

Beer, L.L., Boyd, E.S., Peters, J. W. and Posewitz, M.C. 2009. Engineering algae for biohydrogen and biofuel production. *Current Opinion in Biotechnology* 20:264-271.

Bengtson, D.A. 2003. Status of marine aquaculture in relation to live prey: past, present and future. In *Live Feeds in Marine Aquaculture,* eds. J.G. Stottrup, and L.A. McEvoy, pp. 1-16. Oxford: Blackwell Science Ltd.

Berthon, V., Bouchez, A. and Rimet, F. 2011. Using diatom life-forms and ecological guilds to assess organic pollution and trophic level in rivers: a case study of rivers in south-eastern France. *Hydrobiologia* 673:259-271.

Berube, K., Dodge, J. and Ford, T. 1999. Effects of chronic salt stress on the ultrastructure of *Dunaliella bioculata* (Chlorophyta, Volvocales): mechanisms of response and recovery. *European Journal of Phycology* 34:117-123.

Borowitzka, M.A. 1992. Algal biotechnology products and processes – matching science and economics. *Journal of Applied Phycology* 4:267-279.

Borowitzka, M.A. 1995. Microalgae as sources of pharmaceuticals and other biologically active compounds. *Journal of Applied Phycology* 7:3-15.

Borowitzka, M.A. 1999. Commercial production of microalgae: ponds, tanks, tubes and fermenters. *Journal of Biotechnology* 70:313-321.

Briassoulis, D., Panagakis, P., Chionidis, M., Tzenos, D., Lalos, A., Tsinos, C., Berberidis, K. and Jacobsen, A. 2010. An experimental helical-tubular photobioreactor for continuous production of *Nannochloropsis* sp. *Bioresource Technology* 101:6768-6777.

Cai, Z. and Duan, S. 2007. Growth characteristics and chemical composition of *Phaeodactylum tricornutum* under different nitrogen concentrations. *Ecology and Environment* 16:1633-1636.

Carballo-Cardenas, E.C., Tuan, P.M., Janssen, M. and Wijffels, R.H. 2003. Vitamin E (α-tocopherol) production by the marine microalgae *Dunaliella tertiolecta* and *Tetraselmis suecica* in batch cultivation. *Biomolecular Engineering* 20:139-147.

Carboni, S., Vignier, J., Chiantore, M., Tocher, D.R. and Migaud, H. 2012. Effects of dietary microalgae on growth, survival and fatty acid composition of sea urchin *Paracentrotus lividus* throughout larval development. *Aquaculture* 324-325:250-258.

Carvalho, A.P., Monteiro, C.M. and Malcata, F.X. 2009. Simultaneous effect of irradiance and temperature on biochemical composition of the microalga *Pavlova lutheri*. *Journal of Applied Phycology* 21:543-552.

Chae, S.R., Hwang, E.J. and Shin, H.S. 2006. Single cell protein production of *Euglena gracilis* and carbon dioxide fixation in an innovative photobioreactor. *Bioresource Technology* 97:322-329.

Chisti, Y. 2004. Microalgae: our marine forest. *Biotechnology Advances* 22:565-567.

Cho, S.H., Ji, S.C., Hur, S.B., Bae, J., Park, I.S. and Song, Y.C. 2007. Optimum temperature and salinity conditions for growth of green algae *Chlorella ellipsoidea* and *Nannochloris oculata*. *Fisheries Science* 73:1050-1056.

Chotipuntu, P. 2005. Marine diatom (*Chaetoceros calcitrans*) as a monospecies diet for conditioning oyster (*Crassostrea belcheri* Sowerby) broodstock. *Walailak Journal of Science and Technology* 2:201-207.

Cid, A., Abalde, J. and Herrero, C. 1992. High yield mixotrophic cultures of the marine microalga *Tetraselmis suecica* (Kylin) Butcher (Prasinophyceae). *Journal of Applied Phycology* 4:31-37.

Claquin, P., Probert, I., Lefebvre, S. and Veron, B. 2008. Effects of temperature on photosynthetic parameters and TEP production in eight species of marine microalgae. *Aquatic Microbial Ecology* 51:1-11.

Converti, A., Casazza, A.A., Ortiz, E.Y., Perego, P. and Del Borghi, M. 2009. Effect of temperature and nitrogen concentration on the growth and lipid content of *Nannochloropsis oculata* and *Chlorella vulgaris* for biodiesel production. *Chemical Engineering and Processing* 48:1146-1151.

Converti, A., Lodi, A., Borghi, A.D. and Solisio, C. 2006. Cultivation of *Spirulina platensis* in a combined airlift-tubular reactor system. *Biochemical Engineering Journal* 32:13-18.

Coutteau, P. 1996. Microalgae, In *Manual on the Porduction and Use of Live Food for Aquaculture, FAO Fisheries Technical Paper No.361,* eds. P. Lavens and P. Sorgeloos, pp. 47-48. Rome: Food and Agriculture Organization of the United Nations.

Coutteau, P. and Sorgeloos, P. 1993. Substitute diets for live algae in the intensive rearing of bivalve mollusks – a state of the art report. *World Aquaculture* 24:45-52.

Cowan, A.K., Rose, P.D. and Horne, L.G. 1992. *Dunaliella salina*: a model system for studying the response of plant cells to stress. *Journal of Experimental Botany* 43:1535-1547.

Csavina, J.L., Stuart, B.J., Riefler, R.G. and Vis, M.L. 2011. Growth optimization of algae for biodiesel production. *Journal of Applied Microbiology* 111:312-318.

Curatolo, A., Ryan, M.J. and Mercer, J.P. 1993. An evaluation of the performance of Manila clam spat (*Tapes philippinarium*) fed on different rations of spray-dried algae (*Tetraselmis suecica*). *Aquaculture* 112:179-186.

D'Souza, F.M.L. and Kelly, G.J. 2000. Effects of a diet of a nitrogen-limited alga (*Tetraselmis suecica*) on growth, survival and biochemical composition of tiger prawn (*Penaeus semisulcatus*) larvae. *Aquaculture* 181:311-329.

D'Souza, F.M.L., Knuckey, R.M., Hohmann, S. and Pendrey, R.C. 2002. Flocculated microalgae concentrates as diets for larvae of the tiger prawn *Penaeus monodon* Fabricius. *Aquaculture Nutrition* 8:113-120.

Da Costa, A.C.A. and De Franca, F.P. 1998. The behaviour of the microalgae *Tetraselmis chuii* in cadmium-contaminated solutions. *Aquaculture International* 6:57-66.

Damiani, M.C., Popovich, C.A., Constenla, D. and Leonardi, P.I. 2010. Lipid analysis in *Haematococcus pluvialis* to assess its potential use as a biodiesel feedstock. *Bioresource Technology* 101:3801-3807.

Darehshouri, A. and Lutz-Meindl, U. 2010. H_2O_2 localization in the green alga *Micrasterias* after salt and osmotic stress by TEM-coupled electron energy loss spectroscopy. *Protoplasma* 239:49-56.

Davison, I.R. 1991. Environmental effects on algal photosynthesis: temperature. *Journal of Phycology* 27:2-8.

De Castro Araujo, S. and Garcia, V.M.T. 2005. Growth and biochemical composition of the diatom *Chaetoceros* cf. *wighamii* under different temperature, salinity and carbon dioxide levels. I. Protein, carbohydrates and lipids. *Aquaculture* 246:405-412.

De La Noue, J., Laliberte, G. and Proulx, D. 1992. Algae and waste water. *Journal of Applied Phycology* 4:247-254.

De La Pena, S. and Barreiro, R. 2009. Biomonitoring acidic drainage impact in a complex setting using periphyton. *Environmental Monitoring Assessment* 150:351-363.

Dibenedetto, A. 2011. The potential of aquatic biomass for CO_2-enhanced fixation and energy production. *Greenhouse Gases Science and Technology* 1:58-71.

Domozych, D.S., Stewart, K.D. and Mattox, K.R. 1981. Development of the cell wall in *Tetraselmis*: role of the Golgi apparatus and extracellular wall assembly. *Journal of Cell Science* 52:351-371.

Duerr, E.O., Molnar, A. and Sato, V. 1998. Culutred microalgae as aquaculture feeds. *Journal of Marine Biotechnology* 7:65-70.

Egeland, E.S., Eikrem, W., Throndsen, J., Wilhelm, C., Zapataii, M. and Liaaen-Jensen, S. 1995. Carotenoids from further Prasinophytes. *Biochemical Systematics and Ecology* 23:747-755.

Ehrenfeld, J. and Cousin, J.L. 1984. Ionic regulation of the unicellular green alga *Dunaliella tertiolecta*: response to hypertonic shock. *Journal of Membrane Biology* 77:45-55.

Errera, R.M. and Campbell, L. 2011. Osmotic stress triggers toxin production by the dinoflagellate *Karenia brevis*. *Proceedings of the National Academy of Sciences of the United States of America* 108:10597-10601.

Espinosa, E.P. and Allam, B. 2006. Comparative growth and survival of juvenile hard clams, *Mercenaria mercenaria*, fed commercially available diets. *Zoo Biology* 25:513-525.

Fabregas, J. and Herrero, C. 1985. Marine microalgae as a potential source of single cell protein (SCP). *Applied Microbiology and Biotechnology* 23:110-113.

Fabregas, J., Otero, A., Dominguez, A. and Patino, M. 2001. Growth rate of the microalga *Tetraselmis suecica* changes the biochemical composition of *Artemia* species. *Marine Biotechnology* 3:256-263 .

Fabregas, J., Otero, A., Morales, B., Cordero, B. and Patino, M. 1996. *Tetraselmis suecica* cultured in different nutrient concentrations varies in nutritional value to *Artemia*. *Aquaculture* 143:197-204.

FAO. 2010. FAO Yearbook: Fishery and Aquaculture Statistics, 2008. Rome: Statistics and Information Service of the Fisheries and Aquaculture Department.

Farhadian, O., Yusoff, F.M. and Arshad, A. 2008. Population growth and production of *Apocyclops dengizicus* fed on different diets. *Journal of the World Aquaculture Society* 39:384-396.

Farhat, N., Rabhi, M., Falleh, H., Jouini, J., Abdelly, C. and Smaoui, A. 2011. Optimization of salt concentrations for a higher carotenoid production in *Dunaliella salina* (Chlorophyceae). *Journal of Phycology* 47:1072-1077.

Ferjani, A., Mustardy, L., Sulpice, R., Marin, K., Suzuki, I., Hagemann, M. and Murata, N. 2003. Glucosylglycerol, a compatible solute, sustains cell division under salt stress. *Plant Physiology* 131:1628-1637.

Ferreira, M., Coutinho, P., Seixas, P., Fabregas, J. and Otero, A. 2009. Enriching rotifers with "premium" microalgae. *Nannochloropsis gaditana*. *Marine Biotechnology* 11:585-595.

Ferreira, M., Maseda, A., Fabregas, J. and Otero, A. 2008. Enriching rotifers with "premium" microalgae. *Isochrysis* aff. *galbana* clone T-ISO. *Aquaculture* 279:126-130.

Ferreira, M., Seixas, P., Coutinho, P., Fabregas, J. and Otero, A. 2011. Effect of the nutritional status of semi-continuous microalgal cultures on the productivity and biochemical composition of *Brachionus plicatilis*. *Marine Biotechnology* 13:1074-1085.

Ferroni, L., Baldisserotto, C., Pantaleoni, L., Billi, P., Fasulo, M.P. and Pancaldi, S. 2007. High salinity alters chloroplast morpho-physiology in a freshwater *Kirchneriella* species (Selenastraceae) from Ethiopian Lake Awasa. *Journal of Botany* 94:1972-1983.

Folch, J., Lees, M. and Stanley, G.H.S. 1957. A simple method for the isolation and purification of total lipids from animal tissues. *Journal of Biological Chemistry* 226:497-509.

Fredriksson, S., Elwinger, K. and Pickova, J. 2006. Fatty acid and carotenoid composition of egg yolk as an effect of microalgae addition to feed formula for laying hens. *Food Chemistry* 99:530-537.

Fujii, K., Nakashima, H. and Hashidzume, Y. 2010. Isolating of folate-producing microalgae, from oligotrophic ponds in Yamaguchi, Japan. *Journal of Applied Microbiology* 108:1421-1429.

Gaiser, E., Wachnicka, A., Ruiz, P., Tobias, F. and Ross, M. 2005. Diatom indicators of ecosystem change in subtropical coastal wetlands, In *Estuarine Indicators*, ed. S.A. Bortone, pp. 127-144. Florida: CRC Press.

Gallardo, W.G., De Castro, M.T.R., Buensuceso, R.T., Espegadera, C.C. and Baylon, C.C. 1992. Gonad development of *Placuna placenta* Linnaeus fed *Isochrysis galbana* Parke, *Tetraselmis tetrathele* (G.S. West) Butch, or their combination. *Aquaculture* 102:357-361.

Garcia-Gonzalez, M., Moreno, J., Carlos Manzano, J., Javier Florencio, F. and Guerrero, M.G. 2005. Production of *Dunaliella salina* biomass rich in 9-*cis*-β-carotene and lutein in a closed tubular photobioreactor. *Journal of Biotechnology* 115:81-90.

Geider, R.J. 1987. Light and temperature dependence of the carbon to chlorophyll *a* ratio in microalgae and cyanobacteria: implications for physiology and growth of phytoplankton. *New Phytologist* 106:1-34.

Genius, S.J. and Schwalfenberg, G.K. 2006. Time for an oil check: the role of essential omega-3 fatty acids in maternal and pediatric health. *Journal of Perinatology* 26:359-365.

Glencross, B.D. 2009. Exploring the nutritional demand for essential fatty acids by aquaculture species. *Reviews in Aquaculture* 1:71-124.

Gooday, G.W. 1971. A biochemical and autoradiographic study of the role of the golgi bodies in thecal formation in *Platymonas tetrathele*. *Journal of Experimental Botany* 22:959-979.

Grobbelaar, J.U. 2010. Microalgal biomass production: challenges and realities. *Photosynthesis Research* 106:135-144.

Griffiths, M.J., Hille, R.P.V. and Harrison, S.T.L. 2012. Lipid productivity, settling potential and fatty acid profile of 11 microalgal species grown under nitrogen replete and limited conditions. *Journal of Applied Phycology* 24:989-1001.

Gu, N., Lin, Q., Li, G., Qin, G., Lin, J. and Huang, L. 2012. Effect of salinity change on biomass and biochemical composition of *Nannochloropsis oculata*. *Journal of the World Aquaculture Society* 43: 97-106.

Guedes, A.C., Meireles, L.A., Amaro, H.M. and Malcata, F.X. 2010. Changes in lipid class and fatty acid composition of cultures of *Pavlova lutheri*, in response to light intensity. *Journal of the American Oil Chemists' Society* 87:791-801.

Guillard, R.R.L. and Sieracki, M.S. 2005. Counting cells in cultures with light microscope, In *Algal Culturing Techniques*, ed. R.A. Anderson, pp. 239-252. USA: Elsevier Academic Press.

Guillard, R.R.L. 1973. Division rates, In *Handbook of Phycological Methods: Culture Methods and Growth Measurements*, ed. J. Stein, pp. 289-311. New York: Cambridge University Press.

Guillard, R.R.L. and Ryther, J.H. 1962. Studies on marine planktonic diatoms: I. *Cyclotella nana* Hustedt and *Detonula confervacea* (Cleve) Gran. *Canadian Journal of Microbiology* 8:229-239.

Guo, Y.F., Duan, S.S., Li, A.F. and Liu, Z.Q. 2005. Over-compensatory growth of *Tetraselmis tetrathele* following salt stress. *Marine Sciences* 29:37-42.

Guo, Z., Chen, Z., Zhang, W., Yu, X. and Jin, M. 2008. Improved hydrogen photoproduction regulated by carbonylcyanide m-chlorophenylhrazone from marine green alga *Platymonas subcordiformis* grown in CO_2-supplemented air bubble column bioreactor. *Biotechnology Letters* 30:877-883.

Habib, M.A.B., Yusoff, F.M., Phang, S.M. and Mohamed, S. 2003. Growth and nutritional values of *Moina micrura* fed on *Chlorella vulgaris* grown in digested palm oil mill effluents. *Asian Fisheries Science* 16:107-119.

Hancke, K., Hancke, T.B., Olsen, L.M., Johnsen, G. and Glud, R.N. 2008. Temperature effects on microalgal photosynthesis-light responses measured by O_2 production, pulse-amplitude-modulator fluorescence and ^{14}C assimilation. *Journal of Phycology* 44:501-508.

Hansen, P.J. 2002. Effect of high pH on the growth and survival of marine phytoplankton: implications for species succession. *Aquatic Microbial Ecology* 28:279-288.

He, P., Duncan, J. and Barber, J. 2007. Astaxanthin accumulation in the green alga *Haematococcus pluvialis*: effects of cultivation parameters. *Journal of Integrative Plant Biology* 49:447-451.

Hejazi, M.A., Holwerda, E. and Wijffels, R.H. 2004. Milking microalga *Dunaliella salina* for β-carotene production in two-phase bioreactors. *Biotechnology and Bioengineering* 85:475-481.

Hellebust, J.A. 1976. Effect of salinity on photosynthesis and mannitol synthesis in the green flagellate *Platymonas suecica*. *Canadian Journal of Botany* 54:1735-1741.

Hemaiswarya, S., Raja, R., Kumar, R.R., Ganesan, V. and Anbazhagan, C. 2011. Microalgae: a sustainable feed source for aquaculture. *World Journal of Microbiology and Biotechnology* 27:1737-1746.

Herbert, D., Phipps, P.J. and Strange, R.E. 1971. Chemical analysis of microbial cells. In *Methods in Microbiology,* Vol. 5B, eds. J. R. Norris and D.W. Ribbons, pp. 209-344. Academic Press London.

Hirano, A., Ueda, R., Hirayama, S. and Ogushi, Y. 1997. CO_2 fixation and ethanol production with microalgal photosynthesis and intracellular anaerobic fermentation. *Energy* 22:137-142.

Hirayama, S., Ueda, R., Ogushi, Y., Hirano, A., Samejima, Y., Hon-Nami, K. and Kunito, S. 1998. Ethanol production from carbon dioxide by fermentative microalgae, In *Advances in Chemical Conversions for Mitigating Carbon Dioxide Studies in Surface Science and Catalysis*, eds. T. Inui, M. Anpo, K. Izui, S. Yanagida and T. Yamaguchi, Vol.114, pp.657-660. Amsterdam: Elsevier.

Holt, G.J. 2000. Symposium on Recent Advances in Larval Fish Nutrition. *Aquaculture Nutrition* 6:141.

Hu, C., Li, M., Li, J., Zhu, Q. and Liu, Z. 2008. Variation of lipid and fatty acid compositions of the marine microalga *Pavlova viridis* (Prymnesiophyceae) under laboratory and outdoor culture conditions. *World Journal of Microbiology and Biotechnology* 24:1209-1214.

Huerlimann, R., De Nys, R. and Heimann, K. 2010. Growth, lipid content, productivity and fatty acid composition of tropical microalgae for scale-up production. *Biotechnology and Bioengineering* 107:245-257.

Jo, Q., Choy, E.J., Park, D.W. and Veron, B. 2004. Sterol dynamics of heterotrophic *Tetraselmis suecica* and its nutritional implication in the bivalve aquaculture. *Aquaculture Research* 35:371-377.

Jones, D.A., Yule, A.B. and Holland, D.L. 1997. Larval nutrition, In *Crustacean Nutrition*, eds. L.R. D'Abramo, D.E. Coklin and D.M. Akiyama, pp.353-389. Baton Rouge, LA:World Aquaculture Society.

Ju, Z.Y., Forster, L.P. and Dominy, W.G. 2009. Effects of supplementing two species of marine algae or their fractions to a formulated diet on growth, survival and composition of shrimp (*Litopenaeus vannamei*). *Aquaculture* 292:237-243.

Juario, J.V. and Storch, V. 1984. Biological evaluation of phytoplankton (*Chlorella* sp., *Tetraselmis* sp. and *Isochrysis galbana*) as food for milkfish (*Chanos chanos*) fry. *Aquaculture* 40:193-198.

Kamal-Eldin, A. and Appelqvist, L. 1996. The chemistry and antioxidant properties of tocopherols and tocotrienols. *Lipids* 31:671-701.

Kanesaki, Y., Suzuki, I., Allakhverdiev, S.I., Mikami, K. and Murata, N. 2002. Salt stress and hyperosmotic stress regulate the expression of different sets of genes in *Synechocystis* sp. PCC 6803. *Biochemical and Biophysical Research Communications* 290:339-348.

Kaplan, D., Cohen, Z. and Abeliovich, A. 1986. Optimal growth conditions for *Isochrysis galbana*. *Biomass* 9:37-48.

Karp, G. 2002. The chemical basis of life, In *Cell and Molecular Biology: Concepts and Experiment*, ed. G. Karp, pp. 43-70. New York: John Wiley & Sons, Inc.

Kebede, E. 1997. Response of *Spirulina platensis* (= *Arthrospira fusiformis*) from Lake Chitu, Ethiopia, to salinity stress from sodium salts. *Journal of Applied Phycology* 9:551-558.

Khatoon, H., Banerjee, S., Yusoff, F.M. and Shariff, M. 2009. Evaluation of indigenous marine periphytic *Amphora, Navicula* and *Cymbella* grown on substrate as feed supplement in *Penaeus monodon* postlarval hatchery system. *Aquaculture Nutrition* 15:186-193.

Khatoon, H., Banerjee, S., Yusoff, F.M. and Shariff, M. 2010. Effects of salinity on the growth and proximate composition of selected tropical marine periphytic diatoms and cyanobacteria. *Aquaculture Research* 41:1348-1355.

Khatoon, H., Banerjee, S., Yusoff, F.M. and Shariff, M. 2013. Use of microalgal-enriched *Diaphanosoma celebensis* Stingelin, 1900 for rearing *Litopenaeus vannamei* (Boone, 1931) postlarvae. *Aquaculture Nutrition* 19:163-171.

Kirst, G.O. 1975. Correlation between content of mannitol and osmotic stress in the brackish-water alga *Platymonas subcordiformis* Hazen. *Zeitschrift fur Pflanzenphysiologie* 76:316-325.

Kirst, G.O. 1977. Ion composition of unicellular marine and fresh-water algae, with special reference to *Platymonas subcordiformis* cultivated in media with different osmotic strengths. *Oecologia* 28:177-189.

Kirst, G.O. 1989. Salinity tolerance of marine microalgae. *Annual Reviews of Plant Physiology and Plant Molecular Biology* 40:21-53.

Kirst, G.O. and Kramer, D. 1981. Cytological evidence for cytoplasmic volume control in *Platymonas subcordiformis* after osmotic stress. *Plant, Cell and Environment* 4:455-462.

Krichnavaruk, S., Loatoweesup, W., Powtongsook, S. and Pavasant, P. 2005. Optimal growth conditions and the cultivation of *Chaetoceros calcitrans* in airlift photobioreactor. *Chemical Engineering Journal* 105:91-98.

Kumar, K., Dasupta, C.N., Nayak, B., Lindblad, P. and Das, D. 2011. Development of suitable photobioreactors for CO_2 sequestration addressing global warming using green algae and cyanobacteria. *Bioresource Technology* 102:4945-4953.

Laing, I. and Verdugo, C.G. 1991. Nutritional value of spray-dried *Tetraselmis suecica* for juvenile bivalves. *Aquaculture* 92:207-218.

Leadbeater, B.S.C. and Green, J.C. 1993. Cell coverings of microalgae. In *Ultrastructure of Microalgae*, ed. T. Berner, pp. 80-87. Florida: CRC Press, Inc.

Lee, E.T.Y. and Bazin, M.J. 1990. A laboratory scale air-lift helical photobioreactor to increase biomass output rate of photosynthetic algal cultures. *New Phytologist* 116:331-335.

Lee, Y. 1997. Commercial production of microalgae in the Asia-Pacific rim. *Journal of Applied Phycology* 9:403-411.

Lewin, R.A. 1958. The cell walls of *Platymonas*. *Journal of General Microbiology*. 19:87-90.

Lewis, N.I., Bates, S.S., McLachlan, J.L. and Smith, J.C. 1993. Temperature effects on growth, domoic acid production, and morphology of the diatom *Nitzschia pungens* f. *multiseries*, In *Toxic Phytoplankton Blooms in the Sea*. eds. T.J. Smayda and Y. Shimizu, pp. 601-606. New York: Elsevier Science Publishers.

Li, P., Mai, K., Trushenski, J. and Wu, G. 2009. New developments in fish amino acid nutrition: towards functional and environmentally oriented aquafeeds. *Amino Acids* 37:43-53.

Li, X., Pribyl, P., Bisova, K., Kawano, S., Cepak, V., Zachleder, V., Cizkova, M., Branyikova, I. and Vitova, M. 2012. The microalga *Parachlorella kessleri* – a novel highly efficient lipid producer. *Biotechnology and Bioengineering* 110:97-107.

Lim, D.K.Y., Sharma, K., Garg, S. and Schenk, P.M. 2010. The race for highly productive microalgae strains. *Biofuels* 1:835-837.

Liu, B.H. and Lee, Y.K. 2000. Secondary carotenoids formation by the green alga *Chlorococum* sp. *Journal of Applied Phycology* 12:301-307.

Lopez-Elias, J.A., Voltolina, D., Enriquez-Ocana, F. and Gallegos-Simental, G. 2005. Indoor and outdoor mass production of the diatom *Chaetoceros muelleri* in a mexican commercial hatchery. *Aquacultural Engineering* 33:181-191.

Lora-Vilchis, M.C., Cordero-Esquivel, B. and Voltolina, D. 2004. Growth of *Artemia franciscana* fed *Isochrysis* sp. and *Chaetoceros muelleri* during its early life stages. *Aquaculture Research* 35:1086-1091.

Lourenco, S.O., Marquez, U.M.L., Macini-Filho, J., Barbarino, E. and Aidar, E. 1997. Changes in biochemical profile of *Tetraselmis gracilis* I. Comparison of two culture media. *Aquaculture* 148:153-168.

Lubian, L.M., Montero, O., Moreno-Garrido, I., Emma Huertas, I., Sobrino, C., Valle, M.G. and Pares, G. 2000. *Nannochloropsis* (Eustigmatophyceae) as source of commercially valuable pigments. *Journal of Applied Phycology* 12:249-255.

Lundholm, N., Hansen, P.J. and Kotaki, Y. 2004. Effect of pH on growth and domoic acid production by potentially toxic diatoms of the genera *Pseudo-nitzschia* and *Nitzschia*. *Marine Ecology Progress Series* 273:1-15.

Makri, A., Bellou, S., Birkou, M., Papatrehas, K., Dolapsakis, N.P., Bokas, D., Papanikolaou, S. and Aggelis, G. 2011. Lipid synthesized by micro-algae grown in laboratory- and industrial-scale bioreactors. *Engineering in Life Sciences* 11:52-58.

Mandeep, J.S., Nalinggam, R. and Ismai, W. 2011. Cumulative distribution of rainfall data for tropical countries. *Scientific Research and Essays* 6:447-452.

Manton, I., Oates, K. and Gooday, G. 1973. Further observations on the chemical compositions of thecae of *Platymonas tetrathele* West (Prasinophyceae) by means of the X-ray microanalyser electron microscope (EMMA). *Journal of Experimental Botany* 24:223-229.

Marin, K., Stirnberg, M., Eisenhut, M., Kramer, R. and Hagemann, M. 2006. Osmotic stress in *Synechocystis* sp. PCC 6803: low tolerance towards nonionic osmotic stress results from lacking activation of glucosylglycerol accumulation. *Microbiology* 152:2023-2030.

Martinez-Jeronimo, F. and Espinosa-Chavez, F. 1994. A laboratory-scale system for mass culture of freshwater microalgae in polyethylene bags. *Journal of Applied Phycology* 6:423-425.

Mata, T.M., Martins, A.A. and Caetano, N.S. 2010. Microalgae for biodiesel production and other applications: a review. *Renewable and Sustainable Energy Reviews* 14:217-232.

Matias-Peralta, H.M. 2004. *Biology and culture of a tropical harpacticoid copepod, Nitocra affinis californica Lang*, Master thesis, Universiti Putra Malaysia.

Matias-Peralta, H.M., Yusoff, F.M., Shariff, M. and Mohamed, S. 2012. Reproductive performance, growth and development time of a tropical harpacticoid copepod, *Nitocra affinis californica* Lang, 1965 fed with different microalgal diets. *Aquaculture* 344-349:168-173.

Matile, P. 1978. Biochemistry and function of vacuoles. *Annual Reviews of Plant Physiology* 29:193-213.

Matsumoto, M., Sugiyama, H., Maeda, Y., Sato, R., Tanaka, T. and Matsunaga, T. 2010. Marine diatom, *Navicula* sp. strain JPCC DA0580 and marine green alga, *Chlorella* sp. strain NKG400014 as potential sources for biodiesel production. *Applied Biochemistry and Biotechnology* 161:486-496.

Matsunaga, T., Takeyama, H., Nakao, T. and Yamazawa, A. 1999. Screening of marine microalgae for bioremediation of cadmium-polluted seawater. *Journal of Biotechnology* 70:33-38.

McFadden, G.I., Preisig, H.R. and Melkonian, M. 1986. Golgi apparatus activity and membrane flow during scale biogenesis in the green flagellate *Scheffelia dubia* (Prasinophyceae). II. Cell wall secretion and assembly. *Protoplasma* 131:174-184.

Meseck, S.L. 2007. Controlling the growth of a cyanobacterial contaminant, *Synechoccus* sp., in a culture of *Tetraselmis chui* (PLY429) by varying pH: implications for outdoor aquaculture production. *Aquaculture* 273:566-572.

Meyer, E. and Walther, A. 1988. Methods for estimation of protein, lipid, carbohydrates and chitin levels in freshwater invertebrates. *Archivium fur Hydrobilogie* 113:161-177.

Moestrup, Ø. 2002. Phylum Prasinophyta. In *The Freshwater Algal Flora of the British Isles*, eds. D.M. John, B.A. Whitton and A.J. Brook, pp. 281-286. United Kingdom: Cambridge University Press.

Moheimani, N.R. 2013. Long-term outdoor growth and lipid productivity of *Tetraselmis suecica*, *Dunaliella tertiolecta* and *Chlorella* sp. (Chlorophyta) in bag photobioreactors. *Journal of Applied Phycology* 25:167-176.

Molina Grima, E., Garcia Camacho, F., Sanchez Perez, J.A. and Garcia Sanchez, J.L. 1994. Biochemical productivity and fatty acid profiles of *Isochrysis galbana* Parke and *Tetraselmis* sp. as a function of incident light intensity. *Process Biochemistry* 29:119-126.

Molina Grima, E., Sanchez Perez, J.A., Garcia Camacho, F., Fernandez Sevilla, J.M., Acien Fernandez, F.G. and Urda Cardona, J. 1995. Biomass and eicosapentaenoic acid productivities from an outdoor batch culture of *Phaeodactylum tricornutum* UTEX 640 in an airlift tubular photobioreactor. *Applied Microbiology and Biotechnology* 42:658-663.

Molina, E., Martinez, E., Sanchez, S., Garcia, F. and Contreras, A. 1991. The influence of temperature and the initial N:P ratio on the growth of microalgae *Tetraselmis* sp. *Process Biochemistry* 26:183-187.

Moreno-Garrido, I., Campana, O., Lubian, L.M. and Blasco, J. 2005. Calcium alginate immobilized marine microalgae: Experiments on growth and short-term heavy metal accumulation. *Marine Pollution Bulletin* 51: 823-829.

Muller-Feuga, A. 2000. The role of microalgae in aquaculture: situation and trends. *Journal of Applied Phycology* 12:527-534.

Nakayama, T., Kawachi, M. and Inouye, I. 2000. Taxonomy and the phylogenetic position of a new prasinophycean alga, *Crustomastix didyma* gen. & sp. nov. (Chlorophyta). *Phycologia* 39:337-348.

Nasseri, A.T., Rasoul-Amini, S., Morowvat, M.H. and Ghasemi, Y. 2011. Single cell protein: production and process. *American Journal of Food Technology* 6:103-116.

Natrah, F.M.I., Yusoff, F.M., Shariff, M., Abas, F. and Mariana, N.S. 2007. Screening of Malaysian indigenous microalgae for antioxidant properties and nutritional value. *Journal Applied Phycology* 19:711-718.

Norris, R. E., Hori, T. and Chihara, M. 1980. Revision of the genus *Tetraselmis* (Class Prasinophyceae). *Botanical Magazine (Tokyo)* 93:317-339.

O'Connor, S., Moltschaniwskyj, N., Bolch, C.J.S. and O'Connor, W. 2011. Dietary influence on growth and development of flat oyster, *Ostrea angasi* (Sowerby, 1871), larvae. *Aquaculture Research* 43:1328-1334.

O'Kelley, J.C. 1968. Mineral nutrition of algae. *Annual Reviews of Plant Physiology* 19:89-112.

Øie, G., Reitan, K.I. and Olsen, Y. 1994. Comparison of rotifer culture quality with yeast plus oil and algal-based cultivation diets. *Aquaculture International* 2:225-238.

Ogbonna, J.C., Tomiyama, S. and Tanaka, H. 1999. Production of α-tocopherol by sequential heterotrophic-photoautotrophic cultivation of *Euglena gracilis*. *Journal of Biotechnology* 70:213-221.

Okauchi, M. and Fukusho, K. 1984. Environmental conditions and medium required for mass culture of a minute alga, *Tetraselmis tetrathele* (Prasinophyceae). *Bulletin of National Research Institution of Aquaculture* 5:1-11.

Okauchi, M. and Kawamura, K. 1997. Optimum medium for large-scale culture of *Tetraselmis tetrathele*. *Hydrobiologia* 358:217-222.

Olaizola, M. 2003. Commercial development of microalgal biotechnology: from the test tube to the marketplace. *Biomolecular Engineering* 20:459-466.

Otero, A. and Fabregas, J. 1997. Changes in the nutrient composition of *Tetraselmis suecica* cultured semi-continuously with different nutrient concentrations and renewal rates. *Aquaculture* 159:111-123.

Paerl, H.W., Dyble, J., Pinckney, J.L., Valdes, L.M., Millie, D.F., Moisander, P.H., Morris, J.T., Bendis, B. and Piehler, M.F. 2005. Using microalgal indicators to assess human- and climate-induced ecological change in estuaries In *Estuarine Indicators*, ed. S.A. Bortone, pp. 145-174. Florida: CRC Press.

Park, S., Choi, Y., Kim, E.J., Park, W., Kim, C.W. and Yang, J. 2012. Serial optimization of biomass production using microalga *Nannochloris oculata* and corresponding lipid biosynthesis. *Bioprocess and Biosystems Engineering* 35:3-9.

Patterson, G.W., Tsitsa-Tzardis, E., Wikfors, G.H., Gladu, P.K., Chitwood, D.J. and Harrison, D. 1993. Sterols of *Tetraselmis* (Prasinophyceae). *Comparative Biochemistry and Physiology* 105B:253-256.

Perez-Rama, M., Alonso, J.A., Lopez, C.H. and Vaamonde, E.T. 2002. Cadmium removal by living cells of the marine microalga *Tetraselmis suecica*. *Bioresource Technology* 84:265-270.

Pfeifhofer, A.O. and Belton, J.C. 1975. Ultrastructural changes in chloroplasts resulting from fluctuations in NaCl concentration: freeze-fracture of thylakoid membranes in *Dunaliella salina*. *Journal of Cell Science* 18:287-299.

Phatarpekar, P.V., Sreepada, R.A., Pednekar, C. and Achuthankutty, C.T. 2000. A comparative study on growth performance and biochemical composition of mixed culture of *Isochrysis galbana* and *Chaetoceros calcitrans* with monocultures. *Aquaculture* 181:141-155.

Ponis, E., Parisi, G., Chini Zittelli, G., Lavista, F., Robert, R. and Tredici, M.R. 2008. *Pavlova lutheri*: production, preservation and use as food for *Crassostrea gigas* larvae. *Aquaculture* 282:97-103.

Ponis, E., Parisi, G., Le Coz, J.R., Robert, R., Zittelli, G.C. and Tredici, M.R. 2006. Effect of the culture system and culture technique on biochemical characteristics of *Pavlova lutheri* and its nutritional value for *Crassostrea gigas* larvae. *Aquaculture Nutrition* 12:322-329.

Preisig, H.R. and Andersen, R.A. 2005. Historical review of algal culturing techniques, In *Algal Culturing Techniques,* ed. R.A. Andersen. pp.1-12. China: Elsevier Academic Press.

Pulz, O. and Gross, W. 2004. Valuable products from biotechnology of microalgae. *Applied Microbiology and Biotechnolgy* 65:35-648.

Qin, J.G. 2010. Lipid-containing secondary metabolites from algae, In *Handbook of Hydrocarbon and Lipid Microbiology*, ed. K.N. Timmis. pp.3021-3030. Springer Berlin Heidelberg. doi: 10.1007/978-3-540-77587-4_225.

Rad, F.A., Aksoz, N. and Hejazi, M.A. 2011. Effect of salinity on growth and β-carotene production in *Dunaliella* sp. isolates from Urmia Lake in northwest of Iran. *African Journal of Biotechnology* 10:2282-2289.

Radakovits, R., Jinkerson, R.E., Darzins, A. and Posewitz, M.C. 2010. Genetic engineering of algae for enhanced biofuel production. *Eukaryotic Cell* 9:486-501.

Radchenko, I.G. and Il'yash, L.V. 2006. Growth and photosynthetic activity of diatom *Thalassiosira weissflogii* at decreasing salinity. *Biology Bulletin* 33:242-247.

Rajadurai, M., Poornima, E.H., Narasimhan, S.V., Rao, V.N.R. and Venugopalan, V.P. 2005. Phytoplankton growth under temperature stress: laboratory studies using two diatoms from a tropical coastal power station site. *Journal of Thermal Biology* 30:299-305.

Rausch, T. 1981. The estimation of micro-algal protein content and its meaning to the evaluation of algal biomass I. Comparison of methods for extracting protein. *Hydrobiologia* 78:237-251.

Regunathan, C. and Wesley, S.G. 2004. Control of *Vibrio* spp. in shrimp hatcheries using the green algae *Tetraselmis suecica*. *Asian Fisheries Science* 17:147-158.

Reitan, K.I. 2011. Digestion of lipids and carbohydrates from microalgae (*Chaetoceros muelleri* Lemmerman and *Isochrysis* aff. *galbana* clone T-ISO) in juvenile scallops (*Pectan maximus L.*). *Aquaculture Research* 42:1530-1538.

Reitan, K.I., Rainuzzo, J.R. and Olsen, Y. 1994. Effect of nutrient limitation on fatty acid and lipid content of marine microalgae. *Journal of Phycology* 30:972-979.

Reitan, K.I., Rainuzzo, J.R., Øie, G. and Olsen, Y. 1997. A review of the nutritional effects of algae in marine fish larvae. *Aquaculture* 155:207-221.

Renaud, S.M., Thinh, L.V. and Parry, D.L. 1999. The gross chemical composition and fatty acid composition of 18 species of tropical Australian microalgae for possible use in mariculture. *Aquaculture* 170:147-159.

Renaud, S.M., Thinh, L.V., Lambrinidis, G. and Parry, D.L. 2002. Effect of temperature on growth, chemical composition and fatty acid composition of tropical Australian microalgae grown in batch cultures. *Aquaculture* 211:195-214.

Richardson, K., Beardall, J. and Raven, J.A. 1983. Adaptation of unicellular algae to irradiance: an analysis of strategies. *New Phytologist* 93:157-191.

Robert, R. and Trintignac, P. 1997. Substitutes for live microalgae in mariculture: a review. *Aquatic Living Resources* 10:315-327.

Robert, R., Parisi, G., Rodolfi, L., Poli, B.M. and Tredici, M.R. 2001. Use of fresh and preserved *Tetraselmis suecica* for feeding *Crassostrea gigas* larvae. *Aquaculture* 192:333-346.

Roder, K., Hantzsche, F. M., Gebuhr, C., Miene, C., Helbig, T., Krock, B., Hoppenrath, M., Luckas, B. and Gerdts, G. 2012. Effects of salinity, temperature and nutrients on growth, cellular characteristics and yessotoxin production of *Protoceratium reticulatum*. *Harmful Algae* 15:59-70.

Rodolfi, L., Zittelli, G.C., Bassi, N., Padovani, G., Biondi, N., Bonini, G. and Tredici, M.R. 2009. Microalgae for oil: strain selection, induction of lipid synthesis and outdoor mass cultivation in a low-cost photobioreactor. *Biotechnology and Bioengineering* 102:100-112.

Ronnestad, I., Thorsen, A. and Finn, R.N. 1999. Fish larval nutrition: a review of recent advances in the roles of amino acids. *Aquaculture* 177:201-216.

Ronquillo, J.D., Matias, J.R., Saisho, T. and Yamasaki, S. 1997. Culture of *Tetraselmis tetrathele* and its utilization in the hatchery production of different penaeid shrimps in Asia. *Hydrobiologia* 358:237-244.

Ronquillo, J.D., Saisho, T. and McKinley, R.S. 2006. Early developmental stages of the green tiger prawn, *Penaeus semisulcatus* de Haan (Crustacea, Decapoda, Penaeidae). *Hydrobiologia* 560:175-196.

Rouf, A.J.M.A., Phang, S.M. and Ambak, M.A. 2010. Depth distribution and ecological preferences of periphytic algae in Kenyir Lake, the largest tropical reservoir of Malaysia. *Chinese Journal of Oceanography and Limnology* 28:856-867.

Rousch, J.M., Bingham, S.E. and Sommerfeld, M.R. 2003. Changes in fatty acid profiles of thermo-intolerant and thermo-tolerant marine diatoms during temperature stress. *Journal of Experimental Marine Biology and Ecology* 295:145-156.

Sakamoto, K., Okimasu, E. and Amemura, A. 1998. Biochemical composition and food value for rotifers of the marine microalga *Tetraselmis tetrathele* grown in glucose medium. *Fisheries Science* 64:892-897.

Samejima, Y., Hirano, A., Hon-Nami, K., Masuda, K., Hasuike, M., Tsuyuki, Y. and Ogushi, Y. 1998. A marine microalga utilization for a paper: Semi-batch cultivation of *Tetraselmis* sp. Tt-1 by a tubular bioreactor and the partial substitution of whole kenaf pulp for a paper, In *Advances in Chemical for Mitigating Carbon Dioxide Studies in Surface Science and Catalysis,* eds. T. Inui, M. Anpo, K. Izui, S. Yanagida and T. Yamaguchi, Vol.114, pp. 649-652. Amsterdam: Elsevier.

Sayegh, F.A.Q. and Montagnes, D.J.S. 2011. Temperature shifts induce intraspecific variation in microalgal production and biochemical composition. *Bioresource Technology* 102:3007-3013.

Seychelles, L.H., Audet, C., Tremblay, R., Fournier, R. and Pernet, F. 2009. Essential fatty acid enrichment of cultured rotifers (*Brachionus plicatilis*, Muller) using frozen-concentrated microalgae. *Aquaculture Nutrition* 15:431-439.

Shahidi, F. and Wanasundara, U.N. 1997. Measurement of lipid oxidation and evaluation of antioxidant activity, In *Natural Antioxidants Chemistry, Health Effects and Applications*, ed. F. Shahidi, pp. 379-396. American Oil Chemists Society, Champaign, IL.

Sharkey, T.D. 2005. Effects of moderate heat stress on photosynthesis: importance of thylakoid reactions, rubisco deactivation, reactive oxygen species and thermotolerance provided by isoprene. *Plant, Cell and Environment* 28:269-277.

Siaut, M., Cuine, S., Cagnon, C., Fessler, B., Nguyen, M., Carrier, P., Beyly, A., Beisson, F., Triantaphylides, C., Li-Beisson, Y. and Peltier, G. 2011. Oil accumulation in the model green alga *Chlamydomonas reinhardtii*: characterization, variability between common laboratory strains and relationship with starch reserves. *BMC Biotechnology* 11:7. doi:10.1186/1472-6750-11-7.

Sigaud, T.C.S. and Aidar, E. 1993. Salinity and temperature effects on the growth and chlorophyll-a content of some planktonic algae. *Brazilian Journal of Oceanography* 41:95-103.

Sinclair, A.J., Attar-Bashi, N.M. and Li, D. 2002. What is the role of α-linolenic acid for mammals? *Lipids* 37:1113-1123.

Southgate, P.C., Beer, A.C., Duncan, P.F. and Tamburri, R. 1998. Assessment of the nutritional value of three species of tropical microalgae, dried *Tetraselmis* and a yeast-based diet for larvae of the blacklip pearl oyster, *Pinctata margaritifera* (L.). *Aquaculture* 162:247-257.

Spolaore, P., Joannis-Cassan, C., Duran, E. and Isambert, A. 2006. Commercial application of microalgae. *Journal of Bioscience and Bioengineering* 101:87-96.

Suda, S. 2004. Taxonomic characterization of *Pyramimonas aurea* sp. nov. (Prasinophyceae, Chlorophyta). *Phycologia* 43:682-692.

Sukenik, A., Bennet, J. and Falkowski, P.G. 1987. Light saturated photosynthesis limitation by electron transport or carbon fixation? *Biochimica et Biophysica Acta* 891:205-215.

Tafreshi, A.H. and Shariati, M. 2006. Pilot culture of three strains of *Dunaliella salina* for β-carotene production in open ponds in the central region of Iran. *World Journal of Microbiology and Biotechnology* 22:1003-1006.

Tamaru, C.S., Ako, H., Baker, A., Bybee, D.R., Brittain, K. and Nguyen, M. 2011. Growth and survival of juvenile feather duster worms, *Sabellastarte spectabilis,* fed live and preserved algae. *Journal of the World Aquaculture Society* 41:12-23.

Tchernov, D., Gorbunov, M.Y., De Vargas, C., Yadav, S.N., Milligan, A.J., Haggblom, M. and Falkowski, P.G. 2004. Membrane lipids of symbiotic algae are diagnostic of sensitivity to thermal bleaching in corals. *Proceedings of the National Academy of Sciences of the United States of America* 101(37):13531-13535.

Teoh, M.L., Chu, W.L. and Phang, S.M. 2010. Effect of temperature change on physiology and biochemistry of algae: a review. *Malaysian Journal of Science* 29:82-97.

Teoh, M.L., Phang, S.M. and Chu, W.L. 2013. Response of Antarctic, temperate and tropical microalgae to temperature stress. *Journal of Applied Phycology* 25:285-297.

Throndsen, J. 1993. The planktonic marine flagellates. In *Marine Phytoplankton: A Guide to Naked Flagellates and Coccolithophorids*, ed. C.R. Tomas, pp. 67-80. California: Academic Press, Inc.

Tjahjono, A.E., Hayama, Y., Kakizono, T., Terada, Y., Nishio, N. and Nagai, S. 1994. Hyper-accumulation of astaxanthin in a green alga *Haematococcus pluvialis* at elevated-temperatures. *Biotechnology Letters* 16:133-138.

Tompkins, J., Deville, M.M., Day, J.G. and Turner, M.F. 1995. Culture Collection of Algae and Protozoa. Catalogue of Strains. UK: Ambleside.

Trotta, P. 1983. An indoor solution for mass production of the marine rotifer *Brachionus plicatilis* Muller fed on the marine microalga *Tetraselmis suecica* Butcher. *Aquacultural Engineering* 2:93-100.

Tzovenis, I., Fountoulaki, E., Dolapsakis, N., Kotzamanis, I., Nengas, I., Bitis, I., Cladas, Y. and Economou-Amilli, A. 2009. Screening for marine nanoplanktonic microalgae from Greek coastal lagoons (Ionian Sea) for use in mariculture. *Journal of Applied Phycology* 21:457-469.

Varfolomeev, S.D. and Wasserman, L.A. 2011. Microalgae as source of biofuel, food, fodder and medicines. *Applied Biochemistry and Microbiology* 47:789-807.

Villareal, T.A. and Fryxell, G.A. 1983. Temperature effects on the valve structure of the bipolar diatoms *Thalassiosira antarctica* and *Porosira glacialis*. *Polar Biology* 2:163-169.

Voet, D. and Voet, J.G. 2004a. Amino acids, In *Biochemistry*, eds. D. Voet. and J.G. Voet, pp. 65-71. New Jersey: John Wiley & Sons, Inc.

Voet, D. and Voet, J.G. 2004b. Lipids and membranes, In *Biochemistry*, eds. D. Voet. and J.G. Voet, pp. 382-389. New Jersey: John Wiley & Sons, Inc.

Volkman, J.K., Barrestt, S.M., Dunstan, G.A. and Jeffrey, S.W. 1994. Sterol biomarkers for microalgae from the green algal class Prasinophyceae. *Organic Geochemistry* 12:1211-1218.

Vonshak, A. and Torzillo, G. 2004. Environmental stress physiology, In *Handbook of Microalgal Culture: Biotechnology and Applied Phycology*. ed. A. Richmond. pp. 57-82, UK: Blackwell Publishing Ltd.

Walker, G., Dorrell, R.G., Schlacht, A. and Dacks, J.B. 2011. Eukaryotic systematic: a 2011 user's guide for cell biologists and parasitologists. *Parasitology* 138:1-26.

Wang, S., Pan, Y., Liu, C., Chuang, L. and Chen, C.N. 2011. Characterization of a green microalga UTEX 2219-4: effects of photosynthesis and osmotic stress on oil body formation. *Botanical Studies* 52:305-312.

Weiss, V., Gromet-Elhanan, Z. and Halmann, M. 1985. Batch and continuous culture experiments on nutrient limitations and temperature effects in the marine alga *Tetraselmis suecica*. *Water Research* 19:185-190.

Wikfors, G.H. and Ohno, M. 2001. Impact of algal research in aquaculture. *Journal of Phycology* 37:968-974.

Wikfors, G.H., Patterson, G.W., Ghosh, P., Lewin, R.A., Smith, B.C. and Alix, J.H. 1996. Growth of post-set oysters, *Crassostrea virginica*, on high-lipids strains of algal flagellates *Tetraselmis* spp. *Aquaculture* 143:411-419.

Wu, L.C., Ho, J.A.A., Shieh, M.C. and Lu, I.W. 2005. Antioxidant and antiproliferative activities of *Spirulina* and *Chlorella* water extracts. *Journal of Agricultural and Food Chemistry* 53:4207-4212.

Xin, L., Hong-ying, H. and Yu-ping, Z. 2011. Growth and lipid accumulation properties of a freshwater microalga *Scenedesmus* sp. under different cultivation temperature. *Bioresource Technology* 102:3098-3102.

Yanase, R. and Imai, T. 1968. The effect of light intensity and temperature on the growth of several marine algae useful for rearing molluskan larvae. *Tohoku Journal of Agricultural Research* 19:75-82.

Yang, Z., Geng, L., Wang, W. and Zhang, J. 2012. Combined effects of temperature, light intensity, and nitrogen concentration on the growth and polysaccharide content of *Microcystis aeruginosa* in batch culture. *Biochemical Systematics and Ecology* 41:130-135.

Yim, J.H., Kim, S.J., Ahn, S.H. and Lee, H.K. 2003. Optimal conditions for the production of sulfated polysaccharide by marine microalga *Gyrodinium impudicum* strain KG03. *Biomolecular Engineering* 20:273-280.

Zaki, M.I. and Saad, H. 2010. Comparative study on growth and survival of larval and juvenile *Dicentrarchus labrax* rearing on rotifer and *Artemia* enriched with four different microalgae species. *African Journal of Biotechnology* 9:3676-3688.

Zhang, C.W. and Richmond, A. 2003. Sustainable, high-yielding outdoor mass cultures of *Chaetoceros muelleri* var. *subsalsum* and *Isochrysis galbana* in vertical plate reactors. *Marine Biotechnology* 5:302-310.

Zheng, Y., Chen, Z., Lu, H. and Zhang, W. 2011. Optimization of carbon dioxide fixation and starch accumulation by *Tetraselmis subcordiformis* in rectangular airlift photobioreactor. *African Journal of Biotechnology* 10:1888-1901.

Zhila, N.O., Kalacheva, G.S. and Volova, T.G. 2011. Effect of salinity on the biochemical composition of the alga *Botryococcus braunii* Kütz IPPAS H-252. *Journal of Applied Phycology* 23:47-52.

Zittelli, G., Rodolfi, L., Biondi, N. and Tredici, M.R. 2006. Productivity and photosynthetic efficiency of outdoor cultures of *Tetrasemis suecica* in annular columns. *Aquaculture* 261:932-943.

Zollner, N. and Kirsch, K. 1962. Uber die quantitative Bestimmung von Lipoiden (Mikromethode) mittels der vielen naturlichen Lipoiden (allen bekannten Plasmalipoiden) gemeinsamen Sulphophosphovanillin-reacktion. *Zeitschrift fur die gesamte experimentelle Medizin* 135:545-561. (in German)