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This project report is submitted in partial fulfillment of the requirements for the degree of Bachelor of Agriculture (Aquaculture)

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CERTIFICATION OF APPROVAL
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This is to certify that I have examined the final year project report and all corrections have been made as recommended by the panel of examiners. This report complies with the recommended format stipulated in the AKU 4999 project guidelines, Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia.

Signature and official stamp of supervisor:

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ABSTRAK

Satu eksperimen telah dijalankan untuk mengenalpasti kesan pergolakan air dalam liter per minit (LPM) terhadap mutu air terpilih dan pertumbuhan *Nannochloropsis* sp. yang dikultur pada 2×10^5 sel/ml dalam tangki plastik berukuran 8 L pada awal eksperimen. Kadar pergolakan ditentukan pada 0 (kawalan), 1, 3, 5 dan 7 LPM dalam 25 tangki secara rawak. Inokulum telah diambil dari stok yang sihat dan berada dalam fasa pertumbuhan dan dipindah ke dalam medium yang telah mengandungi *EPIZYM-AGP COMPLETE*. Pertumbuhan dalam semua tahap pergolakan telah diukur dengan menggunakan *Neubauer improved hemacytometer* dan mutu air telah diukur dengan menggunakan alat pengukur mutu air. Kedua-dua ukuran telah diambil semasa fasa cahaya. Keputusan telah menujukkan bahawa tahap pergolakan air 5 LPM member nilai SGR yang paling tinggi iaitu 0.21 dan mempunyai jumlah sel/ml yang agak memuaskan sebanyak 1.33×10^7. Mutu air dalam tangki yang mempunyai pergolakan menunjukkan paten turun naik yang sama dan kecil perbezaannya antara rawatan. Dalam rawatan kontrol (0 LPM), SGR hanya mencapai 0.12. Mutu air terutamanya oksigen terlarut adalah sangat tinggi (15.8 mg/L) dan paten turun naik adalah tidak konsisten bagi suhu dan pH sepanjang masa eksperimen dijalankan. Secara keseluruhannya, pergolakan air memainkan peranan penting dalam pengkulturan *Nannochloropsis* sp. dan tahap pergolakan yang sesuai bagi pengkulturan dalam tangki 8 L adalah 5 LPM untuk mengekalkan kualit mutu air and pertumbuhan yang optima.

ABSTRACT

An experiment was conducted to determine the effect of turbulence level (LPM) on selected water quality parameters and the growth performance of *Nannochloropsis* sp. inoculated at 2×10^5 cells/ml in 8 L tanks. Treatments of turbulence levels set at 0 (control), 1, 3, 5 and 7 LPM were randomly assigned to 25 plastic tanks. Inoculum was taken from a healthy exponentially growing culture and transferred to medium containing EPIZYM-AGP COMPLETE. The growth of all treatments was measured using Neubauer improved hemacytometer and the dissolved oxygen, temperature and pH were measured using water quality equipment daily during the light phase. Results showed that the turbulence level at 5 LPM gave the highest specific growth rate (SGR), which was 0.21, and also resulted in relatively high maximum cell count (1.33×10^7 cells/ml). Water quality parameters in all the turbulent treatments showed relatively small and synchronous fluctuation. In non-turbulent treatment (0 LPM), SGR was only 0.12. Water quality parameters particularly DO concentration was excessively high (15.8 mg/L) and temperature and pH were greater in fluctuation over the experimental period. In conclusion, turbulence is important for intensive photoautotrophic culture of *Nannochloropsis* sp. and the level at 5 LPM in 8 L tank was optimal to maintain reasonable water quality and growth performance.

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LIST OF ABBREVIATION/ SYMBOLS

HCl	Hydrochloric acid
NaOH	Sodium hydroxide
$Na_2S_2O_3$	Sodium thiosulphate
HUFA	Highly unsaturated fatty acids
EPA	Eicosapentaenoic acid
mg	Milligram
µg	Microgram
L	Liter
LPM	Liter per minute
Cells/ml	Cells per milliliter
cm	Centimeter
mm	Millimeter
µm	micrometer
µEinstein $m^{-2}s^{-1}$	Photon-flux density or light irradiance
ppt	Part per thousand
ppm	Part per million
%	Percentage
°C	Degree Celcius
CO_2	Carbon dioxide
DO	Dissolved oxygen
Ln	Natural logarithm
B_{12}	Cobalamin

K'	Specific growth rate
Div. day^{-1}	Divisions per day
Gen't	Generation time
ILL	Incipient limiting level
DPF	Days post-first feeding
CRD	Completely randomized design
AWL	Air-water lift system
PVC	Polyvinyl chloride
SPSS	Statistical Package for the Social Sciences
VAP	Vertical Aveolar Panel

CHAPTER 1

INTRODUCTION

Regardless of the type of culture system used to cultivate the microalgae, turbulence generated by mixing is required in any system in order to sustain the growth of high density microalgae culture. Turbulent flow is the most important factor to yield high quantity of microalgal mass when the nutritional requirements and environmental conditions are not growth limiting (Richmond and Becker, 1986).

Formation of nutritional and gaseous gradients can be prevented via turbulence generated from mixing. Grobbelaar (1991) reported that the boundary layer around the microalgae cells is decreased through the process of mixing. This is further proved by the lowering of oxygen saturation in the culture system. Turbulent flow is also necessary to prevent the sinking of the microalgal cells to the pond bottom and to allow alternate exposure of the entire microalgal population to light (Richmond and Becker, 1986).

Positive correlation between turbulence and photosynthetic activity has been demonstrated by many authors (Richmond *et al.*, 1980; Laws *et al.*, 1983; Belyaev, 1992; Grobbelaar, 1994). However, Karp-Boss *et al.* (2000) reported that vigorous turbulence can also cause unfavourable effects such as mechanical damage and behavioural alteration.

Microalgae such as *Nannochloropsis* sp. has thick cell wall and is quite resistant to turbulence (Thomas and Gibson, 1990). However, its growth affected by different water turbulence levels generated by air-water lift system is still unknown. Thus this study was established to determine the growth of *Nannochloropsis* sp. and the values of selected water quality parameters in relation to different water turbulence levels generated by air-water lift (AWL) system. This information has practical application in microalgal production.

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