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3rd iSNPiNSA



International Seminar on New Paradigm
and Innovation on Natural Sciences
and its Application



Developing Innovation
and Application of
Applied Sciences
for Sustainable
Development

PROCEEDINGS



Diponegoro University
2013

***The 3rd International
Seminar on
New Paradigm and Innovation
on Natural Sciences and its
Application 2013***



***"Developing Innovation and Application of
Applied Sciences for Sustainable Development"***

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PREFACE

Good Morning Ladies and Gentlement

On behalf of the Organizing Committee, i would like to warmly welcome you to the 3rd Internacional Seminar on New paradigm and Innovation on Natural Sciences and Its Application (ISNPINSA). This seminar has been successfully conducted since 2011 and therefore becoming an annual event since then. The theme of ISNPINSA this year is Developing Innovation and Its Application of Applied Sciences for Sustainable Development.

The aims of this seminar are to facilitate brain storming and state of the art information in field of sciences and mathematic; to increase innovation of technology that can be applied in industries; to contribute in formulating strategy to increase the role of science for the community; and to stimulate collaboration between industries, researchers and government to increase community welfare.

We divided the parallel session in this seminar into specific topic that can accommodate the field range from chemistry, physics, biology, mathematics and the science related to them. By inviting the speakers from academics and industries, we hope that this event can be a bridge between researchers, scientists and industries in order to foster developing innovation and its application to support sustainable development.

In closing, I wish to express my gratitude to all speakers, presenters and participants in this seminar. I hope that we can have a fruitful and productive discussion, brain storming and presentation that can increase and develop our understanding in sciences. I take this opportunity to thank the organizing committee for this seminar and the Faculty of Science and Mathematics for the necessary funding. The various sponsors are also thanked for their kind hospitality.

Thank you

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Evaluation of Growth Rate of Microalgae *Chlorella Sp* Cultivated in Palm Oil Mill Effluent (POME) Medium

Hadiyanto^a

^aCenter of Biomass and Renewable Energy (CBIORE), Chemical Engineering Diponegoro University,
Jl. Prof. Sudharto, SH-Tembalang Semarang, Telp: 024-7460058/Fax : 024-76480675
Email : hady.hadiyanto@gmail.com

ABSTRACT

Palm Oil Mill Effluent (POME) is waste water produced from CPO processing. Since 2006, Indonesia is the largest CPO producers which contribute 45% of the CPO needs in the world. This large amount of CPO can produce high amount of POME. It is estimated that 1 ton of Fresh Fruit Bunch (FFB) can result 0.5-0.6 ton POME while the CPO is merely 0.2 ton. Besides its high contents of COD and BOD, POME has high nutrients contents such as Nitrogen and Phosphor which may potential for microalgae growth. The objective of this research was to evaluate the use of POME as nutrient sources of microalgae (*Chlorella sp*) growth under variation of POME content in the medium (20-60%). The results showed that the algae was able to grow under 20% POME and the lipid productivity of 37.4 mg/L/day was achieved.

Keywords: *Chlorella sp*, POME, nutrient, lipid, microalgae

1. INTRODUCTION

Indonesia is the largest producer of crude oil palm in the world. In 2008, Indonesia produced 44% coconut palm oil, as shared demand from around the world [1], and from 2005 to 2008 the production rose up to 8.88%. Moreover, the production is predicted to increase from 2010 to 2014 with growth rate of 5.22% per annum. This high production of POME may lead to threat of environment, About 1 ton fresh fruit bunch (FFB) can be converted to 0.2 ton CPO while 0.5-0.66 ton is considered as palm oil mill effluent (POME) [2]. Currently, almost all POME in Indonesia are treated by using traditional anaerobic-aerobic pond to reduce COD and BOD contents, although the effluent is still above the threshold limit. Meanwhile other contents in wastewater such nitrogen and phosphorus are not utilized yet efficiently. Another threat is potential of eutrophication when POME is flew to the river or lake. Therefore, the utilization of its content of nitrogen and phosphor for microalgae growth are still an interest [4,5,6]. The use of POME as medium growth could reduce the operating cost [7].

Microalgae has been studied for its potential as feed/food sources, pharmaceuticals and oil sources. The productivity of microalgae showed higher than other terrestrial plant and the potential use of microalgae as renewable energy has been shown by work of Chisti [8]. *Chlorella sp* has been considered as the species with high content of lipid (20-30%) [8]. Microalgae is mostly cultivated in the fresh, or saline water medium, while utilizing POME for algae growth medium is not much studied. This paper is aimed to describe the potency of microalgae cultivated in palm oil mill effluent (POME) and to evaluate the lipid productivity from alga *Chlorella sp* under variation of C:N:P ratio of nutrients.

2. MATERIAL AND METHOD

2.1. Cultivation Condition

POME was collected from PTPN VII Lampung Indonesia. Prior its use as medium, POME was treated to reduce its COD and BOD contents by using facultative anaerobic method. The treated POME contains of 1800ppm COD, 800ppm BOD, 280 ppm total nitrogen, and 75 ppm phosphorus. POME was filtered to eliminate suspended solid and other impurities.

2.2. *Chlorella* sp culture

Chlorella sp was provided by BBPAP Jepara and cultivated in medium [12] which was composed by 875ppm NaHCO₃ as carbon source, 45 ppm urea as nitrogen source, 5 ppm TSP (triple super phosphate) as phosphate source, 1 ppm FeCl₃ and 25 µg/l B12 as micronutrient source. The control medium was used at the ratio of carbon: nitrogen: phosphorus = 56:9:1 [13].

2.3. Algae Cultivation

Chlorella sp was cultivated in different POME concentration (20,40,60% v/v) and different synthetic nutrient (SN) concentration (0,20,40,60,80,100% w/w). The term of synthetic nutrient (SN) was referred to medium which was composed by 45 ppm urea and 5 ppm TSP. NaHCO₃ was not added to POME medium. As source of carbon, COD in POME was solely used as carbon source [5]. This SN addition will give different C:N:P ratio in cultivation medium. *Chlorella* sp 10% v/v (0.7 OD₆₈₀) was used as inoculum. Medium was diluted using tap water in 1L glass flask. However, 1 ppm of FeCl₃ and 25 µg/l vitamin B12 were added for every run to enhance the micronutrient demand. Light intensity was maintained at 4000-6000 lux using fluorescent lamp, pH was adjusted using NaOH and HCl in the range of 6.8-7.2, temperature was maintained in 26-28°C, and salinity was to be set in 1 ppt by adding NaCl. Medium was aerated using aquarium air pump to mix the medium.

2.4. Measurement

The concentration of biomass was measured using spectrophotometer Optima sp-300, at 680nm wavelength during its cultivation. Growth rate (μ) of algae was calculated (Eq 1).

$$\mu = \frac{\ln OD_1 - \ln(OD_0)}{t_1 - t_0}$$

Where [OD]1 is optical density at last day of cultivation, [OD]0 is optical density at the first day of cultivation, t is end time of cultivation (day), and t0 is beginning time of cultivation (day) (5).

2.5. Harvesting of Biomass and lipid extraction

Medium was harvested by using flocculation method. NaOH 0.5 M was utilized to increase the pH until reach 10.5, then the microalgal suspension was intensively mixed (1000 rpm) for 10 min followed by gentler mixing (250 rpm) for an additional 20 min. Subsequently, the suspension was settled for 30 min [14]. Biomass was dried at 700 °C in tray dryer for 3 hours and the biomass product was weighed. Dry biomass of *Chlorella* sp was extracted using n-hexane (1:8 w/v). Mix of dry biomass and n-hexane was placed in ultrasound Branson 2510-DTH 40 KHz for 1 hour and heated at temperature 500C. The suspension was filtered to separate residual dry biomass from supernatant using whatman filter paper No.41. Solvent was removed from supernatant by distillation method until no more solvent collected[15].

3. RESULT AND DISCUSSION

3.1. Algae growth in POME medium

Algae *Chlorella* sp cultivated in different medium was described in Fig 1. A Higher optimum phase was shown by from control medium, while the growth in POME medium with concentration of 20%, 40% and 60% tend to decrease, and reaching stationary phase at 4-6 h. This trend was also showed by Hadiyanto & Nur [6], and Habib et al. [4]. They showed that at higher POME medium could inhibit the algae growth rate due to the dark color of POME will shading the light penetration. Furthermore, Wang et al. [18] found also that dark color of manure could influence growth rate of microalgae. The impurities responsible for its turbidity may include clay, silt, finely divided inorganic-organic matter, or soluble colored organic compounds [19]. One method to reduce darkness, the waste must be diluted such that the light penetration will be enhanced.

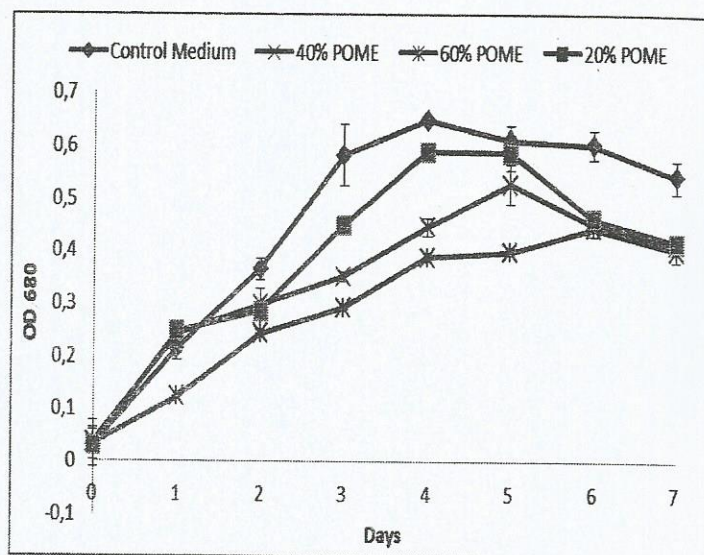


Figure 1. Growth phase of *Chlorella Sp* in different POME addition

The growth of microalgae is mainly affected by ratio of C:N:P in the medium. This ratio could influence growth rate of *Chlorella sp* [4,6,13]. An optimum C:N:P ratio for microalgae based on photosynthetic reaction is 106:16:1 molar ratio [20], or could be converted to 56:9:1 C:N:P ratio by weight atomic [13]. Table 1 shows the variation of POME and synthetic nutrient in the medium. The addition of synthetic nutrient up to 40% could increase the growth rate up to 0.749 /hr at the 20% concentration, while low growth rate was found at the 60% POME (0.22-2.23 /h).

Table 1 also shows that addition of synthetic nutrient will effect to C:N:P ratio. At the higher SN addition, it leads to increasing C/N ratio, which also decrease the growth rate of *Chlorella sp*. This phenomena is due to substrate inhibition. It is noted that most of unicellular algae and benthic plants such seaweed use light energy to fix carbon (C), nitrogen (N), and phosphorus (P) at relatively constant at stoichiometric ratios [13,21,22,23].

Several researcher investigated dependence of C:N:P ratio under different light intensities. Baird and Midleton [21] proposed that there are large number of factor that will exert an evolutionary pressure on carbon to nitrogen ratio of aquatic phototrophs. While Goldman [24] reported that C:N:P ratio demand for microalgae will be different due to light intensity addition.

Table 1. Summary of data growth rate, content of carbon nitrogen and phosphorus ratio in different medium POME.

POME (%v/v)	SN (%w/w)	μ (/days)	part C (mg-atom/l)	C	N	P	C/N
				weight ratio			
0	100	0.757	125	56	9	1	9,47
20	0	0.653	180	78,26	8,26	1	7,04
	20	0.698		62,04	8,82	1	6,36
	40	0.749		56,60	8,90	1	5,24
	60	0.675		46,96	8,97	1	4,64
	80	0.643		41,87	9,02	1	4,17
	100	0.566		37,78	9,06	1	9,47
40	0	0.449	340	75,56	9,33	1	8,10
	20	0.464		68,83	9,34	1	7,37
	40	0.498		63,20	9,35	1	6,76
	60	0.531		58,42	9,36	1	6,24

	80	0,459		54,31	9,36	1	5,80
	100	0,445		50,75	9,37	1	5,42
60	0	0,220	460	73,02	9,37	1	7,80
	20	0,238		68,25	9,37	1	7,28
	40	0,242		64,07	9,37	1	6,83
	60	0,244		60,37	9,38	1	6,44
	80	0,269		57,07	9,38	1	6,08
	100	0,239		54,12	9,38	1	5,77

*C is carbon content converted from COD of POME $\times \frac{12}{32}$ [4]. SN=synthetic nutrient

3.2. Biomass Production

Figure 2. describes biomass production from *Chlorella* sp under different medium composition. A higher dry biomass was obtained at 0%POME+100%SN, followed by 20% POME+40%SN, 40%POME+60%SN, and 60%POME+80%SN. However this result is still lower than control medium in biomass production and growth rate. This result also proves that C:N:P ratio, light intensity, micronutrient, pH, and other factors could limits biomass production [4,6,13,20,24,25].

Moreover, *Chlorella* sp grow slowly if cultivated in higher POME medium, and occur in longer adaptation phase. The algae cultured in high POME concentration require longer adaptation time to reach the stationary phase and consequently lower biomass. It seems that light shading also influences biomass production due to color of POME from tannic acid [18,25,26,27]. This phenomena was also reported by from Habib et al. [4] and Anton et al. [28] who cultivated green microalgae under different POME concentration. Ji et al. [29] cultivated *Chlorella vulgaris* under different diluted piggery wastewater and synthetic medium addition, it was stated that diluted wastewater generates higher biomass.

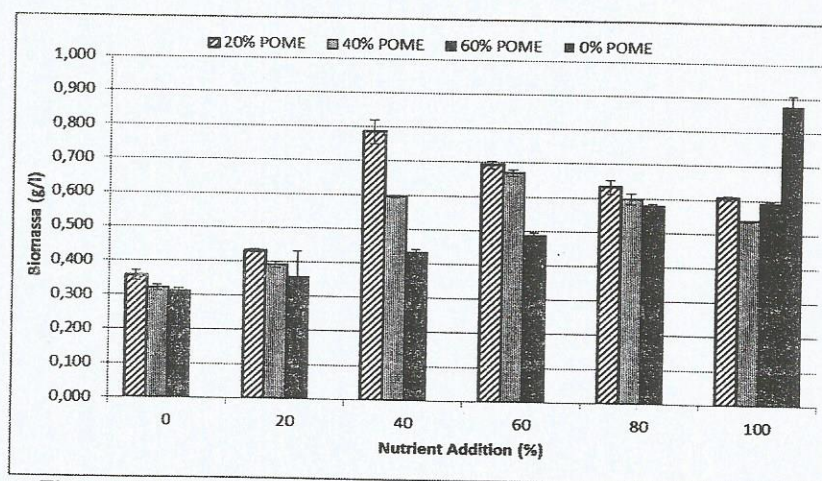


Figure 2. Biomass production of *Chlorella* sp in different medium

It also seems that higher POME concentration contains higher total nitrogen and it could also inhibit *Chlorella* sp in generating biomass. Previous studied showed that microalgae growth may inhibited by high concentrated ammonium ion and nitrite of which either could be assimilated even at low concentrations [30; 31; 32].

3.3. Lipid Content

A higher lipid content was recorded from 0%SN addition for 20,40,and 60% POME (Fig 3). This phenomena was also reported by Habib et al. [4], Wang et al. [18], Ji et al.,[29], Jiang et al. [33], and Mandal & Mallick [34] by using POME, piggery, manure and municipal wastewater, respectively.

Wang et al. [18] found that lower diluted manure wastewater contains higher C/N ratio, and accumulates higher lipid content. The higher lipid content was found in 40% SN in 20% POME medium.

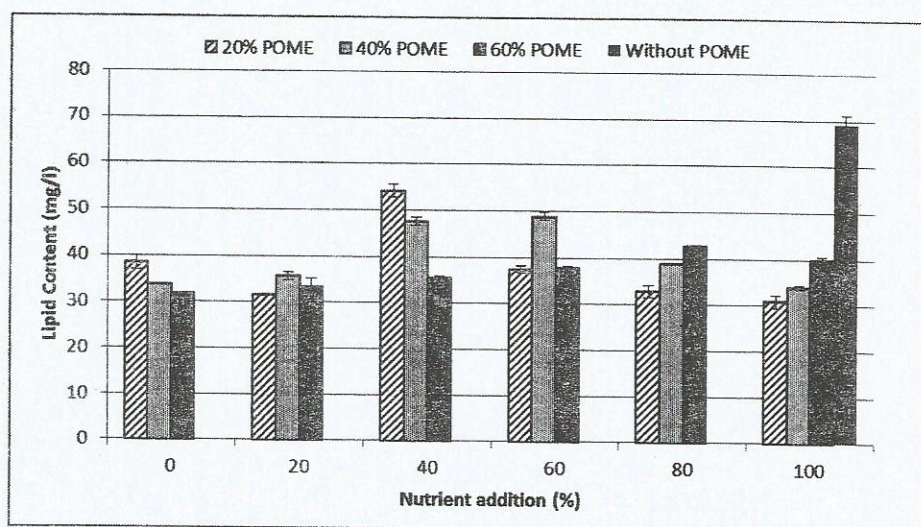


Figure 4. Lipid content of Chlorella in various medium

When SN was added to medium, lipid content slightly decreased in medium with 60, 40, and 20% POME, respectively. Several researcher studied relation of nitrogen depletion of microalgae medium and reported that higher C/N ratio, nitrogen starvation, could influence lipid accumulation but lowering growth rate and biomass [35,36,37,38]. This condition occurs when microalgae grow in stress condition in low nitrogen content.

3.4. Lipid Productivity

Several researcher reported that mixotrophic condition could give higher lipid accumulation rather than autotrophic or heterotrophic condition even in different C/N ratio [37,39,40]. It is reported that higher lipid productivity was found in MSG wastewater, followed by artificial wastewater, and municipal wastewater (Table 2). Our study has comparable result as compared to other waste water medium for microalgae. We found that the productivity could achieve up to 37.4 mg/L/d in 20% POME and addition of 40% synthetic nutrients, although the biomass content is much lower.

Table 2. Summary report of microalgae cultivation in various wastewater[18, 41,42,43]

Medium	time (day)	Growth rate (/day)	Biomass content (g/L)	Lipid content (%)	Lipid productivity (mg/L/d)	Source
Digested Dairy Manure	21	0.474	1.7	14	11.3	Wang et al.[18]
MSG Wastewater	5	1.803	1.6	14	44	Xue et al.[42]
Artificial Wastewater	14	0.663	1.7	33	40	Yujie et al.[42]
2 nd Municipal	9	0.458	0.67	31	22.9	Cho et al.[43]
20%POME+40% SN	7	0.749	0.73	6.9	37.4	This study
40%POME+60% SN	7	0.531	0.69	7.3	25.9	This study
60%POME+80%SN	7	0.269	0.59	7.6	11.8	This study

4. CONCLUSION

The study of potency of utilization of POME as medium growth of algae has been studied. It was found that CNP ratio, concentration of POME, and addition of synthetic nutrient influenced growth rate, biomass production, and lipid accumulation. Medium of Chlorella sp by using 20%POME and 40% of synthetic nutrient reveals at 37.4 mg/L/day. POME is a potential wastewater for Chlorella sp growth as replacement for synthetic nutrient. The maximum growth rate could be achieved in POME medium was 0.74/hr.

REFERENCES

- [1] Rupani PF, Singh RP, Ibrahim MH, and Esa Norizan..Review of Current Palm Oil Mill Effluent (POME) Treatment Methods:Vermicomposting as a Sustainable Practice. *World Applied Sciences Journal*.2010; 11: 70-81.
- [2] Indriyati.Potensi Limbah Industri Kelapa Sawit di Indonesia.M.Tek.Ling.2008;4(1):93-103.
- [3] Deptan. Rancangan Rencana Strategis Kementerian Pertanian Tahun 2010-2014. Departemen Pertanian.2009.[cited 2012, Aug 18] Available from <http://setjen.deptan.go.id/renstra-setjen-2010-2014.pdf>
- [4] Habib MAB., Yusoff FM, Phang SM, Kamarudin MS, and Mohamed S.Growth and Nutritional Values of *Moina micrura* Fed on *Chlorella vulgaris* Grown in Digested Palm Oil Mill Effluent. *Asi. Fisher. Scie.* 2003;16: 107-119.
- [5] Putri EV, Din MFM, Ahmed Z, Jamaluddin H, Chelliapan S. Investigation of Microalgae for High Lipid Content using Palm Oil Mill effluent (POME) as Carbon Source.International Conference on Environment and Industrial Innovation. Singapore: LACSIT Press; 2012.
- [6] Hadiyanto, Nur MMA. Potential of Palm Oil Mill Effluent (POME) as medium growth of *Chlorella* sp for bioenergy production.*Int.J.Env.Bioenerg.*2012;3(2):67-74.
- [7] USDA [internet]. Fertilizer use and price. [cited 2012 May 04] Available from: <http://www.ers.usda.gov/data-products/fertilizer-use-and-price.aspx#.Uei8idL0GSo>.
- [8] Habib MAB, Yusoff FM, Phang SM, Kamarudin MS, Mohamed S.. Chemical characteristics and essential nutrients of agroindustrial effluents in Malaysia. *Asian Fish. Sci.* 1998;11:279-286.
- [9] Ditjen PPHP.Pedoman pengelolaan limbah industri kelapa sawit.2006.Departemen Pertanian. [cited 2012, May 21] Available from <http://pphp.deptan.go.id/xplore/view.php?file=PENGOLAHAN-HASIL/B3olahlimbahkelapasawit.pdf>.
- [10] Chisti Y. Biodiesel from microalgae. *Biotechnol. Adv.* 2007;25:294–306.
- [11] MM Azimatun Nur, Hadiyanto. Utilization of agroindustry wastewater as growth medium for microalgae based bioenergy feedstock in Indonesia (an overview). *J.sustain.*2013;1:3-7.
- [12] Gusrina.Budidaya Ikan untuk Sekolah Menengah Kejuruan. 3th ed .Jakarta: Depdiknas;2008.
- [13] Edwards P, Sinchumpasak OA, Ouano, EAO. A study of a sewage fed highrate stabilization pond in Thailand. *Wastewater and Resources Recovery (IDRC-15e)*. International Development Research Centre, Ottawa, Canada.1980:p.42.
- [14] Vandamme D, Fourbert I, Fraeye I, Muyllaert K.Influence of organic matter generated by *Chlorella vulgaris* on five different modes of flocculation.*Bioresour.Technol.*2012;124:508-511.
- [15] Wiyarno Budi, Yunus Rosli Mohd, Mel Maizirwan.. Ultrasound Extraction Assisted (UEA) of oil from Microalgae (*Nannochloropsis* sp). *Int. J. Sci. Eng.*2010; 3 (1): 55-59.
- [16] Hu Bing, Min M, Zhou W, Du Z, Mohr M, Chen P, Zhu J, Cheng Y, Liu Y, Ruan, R.. Enhanced mixotrophic growth of microalga *Chlorella* sp. on pretreated swine manure for simultaneous biofuel feedstock production and nutrient removal.*Bioresour. Technol.*2012;126:71-79.
- [17] Puangbut M, Leesing R.. Integrated Cultivation Technique for Microbial Lipid Production by Photosynthetic Microalgae and Locally Oleaginous Yeast. *World Academy of Science. Engineering and Technology*.2012; 64:975-979.
- [18] Wang L, Li Y, Chen P, Min M, Chen Y, Zhu J, Ruan RR.. Anaerobic digested dairy manure as a nutrient supplement for cultivation of oil-rich green microalgae *Chlorella* sp. *Bioresour. Technol.* 2010;101: 2623–2628.
- [19] EPA.EPA guidance manual turbidity provisions:Importance of turbidity2009.[Cited 2013 March 04] http://www.epa.gov/ogwdw/mdbp/pdf/turbidity/chap_07.pdf.
- [20] Redfield AC, Ketchum BH, Richards FA, 1963. The influence of organisms on the composition of sea-water. In: Hill, N. (Ed.), *In the Sea*. 2nd ed. New York: Willey;1963 p.26– 77.
- [21] Baird ME, Middleton JH.On relating physical limits to the carbon:nitrogen ratio of unicellular algae and benthic plants.*J.Mar.Sys.* 2004;49:169-175.
- [22] Kirk, JTO. *Light and Photosynthesis in Aquatic Ecosystems*, 2nd ed. Cambridge. Cambridge Univ. Press:1994.
- [23] Goldman JC, Porcella DB, Middlebrooks JE, Toerin DF.The effect of carbon on algal growth-its relationship to eutrophication.Report.1971:p.462. [cited 2012, May 21] Available from http://digitalcommons.usu.edu/water_rep/462
- [24] Goldman JC.1986.On phytoplankton growth rates and particulate C:N:P ratios at low light.*Limnol.Oceanogr*,1986;31(6):1358-1363.
- [25] Phang SM, KC Ong. 1988. Algal biomass production in digested palm oil mill effluent. *Biological Wastes*.1988;25:177-191.
- [26] Choochote W, Paiboonsin K., Ruangpan S, Pharuang, A.. Effects of Urea and Light Intensity on the Growth of *Chlorella* sp. *Proceeding of the 8th International Symposium on Biocontrol and Biotechnology*;2010 October 4-6; King Mongkut & Khon kaen, Pattaya.Thailand.2012.
- [27] Nedosekin AG, GA Dallakyan, VN Maksimov, VD Myatlev.. Combined effect of nutrition and phosphorus on lipid content on alga population. *Hydrobiologia*.1991;27:77-80.
- [28] Anton A, Kusnan M, Hussin ARM. Effects of palm oil mills effluent on algae. *Proceedings of the Conference on Algal Biotechnology in the Asia-Pacific Region*, Universiti Malaya, Kuala Lumpur. Malaysia, 1994. p.320-323.

- [29] Ji MK., Kim HC, Sapireddy VR, Yun HS, Abou-Shahab RAI, Choi J, Lee W, Timmes, TC, Inamuddin, Jeon BH. Simultaneous nutrient removal and lipid production from pretreated piggery wastewater by *Chlorella vulgaris* YSW-04. *Appl. Microbiol. Biotechnol.* 2012.
- [30] Tam NFY, Wong YS. Effect of immobilized microalgal bead concentrations on wastewater nutrient removal. *Environ. Pollut.* 2010;107:145–151.
- [31] de Godos I, Blanco S, García-Encina PA, Becares E, Muñoz R. Long-term operation of high rate algal ponds for the bioremediation of piggery wastewaters at high loading rates. *Bioresour. Technol.* 2009;100(19): 4332–4339.
- [32] Park J, Jin H, Lim B, Park K, Lee K. Ammonia removal from anaerobic digestion effluent of livestock waste using green alga *Scenedesmus* sp. *Bioresour. Technol.* 2010;101(22): 8657–8849.
- [33] Jiang L, Luo S, Fan X, Yang Z, Guo R. Biomass and lipid production of marine microalgae using municipal wastewater and high concentration of CO₂. *Appl. Energ.* 2011:3336–3341.
- [34] Mandal S, Mallick N. Waste utilization and biodiesel production by the green microalga *Scenedesmus obliquus*. *Appl. Env. Microbiol.* 2011:374–377.
- [35] Widjaja Arief, Chien Chou-Chang, Ju Yi-Hsu. Study of increasing lipid production from fresh water microalgae *Chlorella vulgaris*. *J. Taiwan Institute of Chem Eng.* 2009; 40: 13–20.
- [36] Pruvost J, Vooren GJ, Gouic BL, Couzinet-Mossion A, Legrand J. Systematic investigation of biomass and lipid productivity by microalgae in photobioreactors for biodiesel application. *Bioresour. Technol.* 2011;102: 150–158.
- [37] Kong W, Song, H, Cao Y, Yang H, Hua S, and Xia C. The characteristics of biomass production, lipid accumulation and chlorophyll biosynthesis of *Chlorella vulgaris* under mixotrophic cultivation. *African J. Bio.* 2011;10: 11620–11630.
- [38] Gouveia L, Oliveira AC. Microalgae as a raw material for biofuels production. *J. Ind Microbiol Biotechnol.* 2009;36: 269–274.
- [39] Cheirsilp B, Torpee, S. Enhanced growth and lipid production of microalgae under mixotrophic culture condition: Effect of light intensity, glucose concentration and fed-batch cultivation. *Bioresour. Technol.* 2012;110: 510–516.
- [40] Liang Y, Sarkany N, Cui Y. Biomass and lipid productivities of *Chlorella vulgaris* under autotrophic, heterotrophic, and mixotrophic growth condition. *Biotechnol. Lett.* 2009;31: 1043–1049.
- [41] Xue F, Miao J, Zhnag X, Tan T. A new strategy for lipid production by mix cultivation of *Spirulina plantensis* and *Rhodotorula glutinis*. *Appl. Biochem. Biotechnol.* 2010;160: 498–503.
- [42] Yujie F, Li C, Zhang D. Lipid production of *Chlorella vulgaris* cultured in artificial wastewater medium. *Bioresour. Technol.* 2011;102: 101–105.
- [43] Cho S, Luong TT, Lee D, Oh YK., Lee T. Reuse of effluent water from a municipal wastewater treatment plant in microalgae cultivation for biofuel production. *Bioresour. Technol.* 2012;1:1–7.
- [44] Puhan S, Savanan N, Nagarajan G, and Vedaraman N. Effect of biodiesel unsaturated fatty acid on combustion characteristics of a DI compression ignition engine. *Biomass and Bioenerg.* 2010;34: 1079–1088.
- [45] Knothe Gerhard. Dependence of biodiesel fuel properties on the structure of fatty acid alkyl esters, *Fuel Processing Technology* 2005; 86: 1059–1070.



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