ARPN Journal of Engineering and Applied Sciences

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REMOVAL OF NUTRIENTS FROM MEAT FOOD PROCESSING INDUSTRY WASTEWATER BY USING MICROALGAE BOTRYOCOCCUS SP

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ABSTRACT

Wastewater that been discharge from meat processing industry has high content of nutrients such as nitrogen and orthophosphate. These nutrients was found abundant in meat products which is essentials for algae growth specifically. However, if these wastewater being discharge to environment without any treatments to assimilate those nutrients, it can lead to eutropication which also known as algae bloom; resulting the destruction of the ecosystem and health to human. Hence, this paper will illustrate the superiority of using microalgae botryococcus sp. in assimilate nutrients from meat processing wastewater i.e. Total Nitrogen and Orthophosphates. Furthermore, through this study, the primary characteristics of wastewater to be established prior and after treatments for assimilation analysis. From this, the efficiency of microalgae in phycoremediation process can be ascertain and recognized. Three different concentrations of *botrycoccus sp.* were used i.e. $1x10^3$ cells/ml, $1x10^4$ cells/ml and $1x10^6$ cells/ml. The microalgae then were cultivated into wastewater of 9.00 am and 12.00 pm. sampling in triplicate manner for phycoremediation took place. The results show that highest removal of Total Nitrogen and Orthophosphate is at concentration of $1x10^6$cells/ml i.e. 97% and 94% at 12.00 pm. sampling. Same goes for Biological Oxygen Demand, BOD and Chemical Oxygen Demand, COD removal, maximum removal are also at concentration of $1x10^6$ cells/ml i.e. 97% and 94% at 9.00 am. sampling.

Keywords: meat food processing wastewater, nutrients, microalgae.

INTRODUCTION

The use and applications of microalgae in wastewater treatment is one of the good solutions whereby its not only can purify the wastewater but also can cater environmental problem such as global warming resulting depletion of ozone layer and climate change. Not only that, microalgae also known to be very versatile since they can simply adapt in any environment conditions as stated by Rawat *et al.,* (2011); Latiffi *et al.,* (2015). In recent years, more attention has been given to the use of microalgae in wastewater treatment due to expansion in manufacturing capacity, low cost, and relatively low disposal problems compared to conventional method which require high costs and high energy usage (Suad., 2014). As there is a huge variation of the type of wastewaters, the type of nutrients exist in it and the type of microalgae that is capable to be used and lack of studies on wastewater from meat processing food industry, it became important to perform a research study that can give objective scientific support to the use of microalgae in the wastewater treatment for wastewater from meat processing food industry. As stated by Onet C., (2010), comparing with other industrial wastewater, food industry is on one of the industrial activity that uses tons of water. Furthermore, the generated wastewater contains unique characteristics in comparison with the common municipal wastewater whereby food usually complex to forecast especially in organic contents which can be varies due to its seasonal of nature food processing. For meat industry, study done by Tritt and Schuchardt., (1992) shows that meat processing wastewater contains high concentrations of suspended solids and other dissolved pollutants from blood which contribute to high COD reading of 375,000 mg/L.

When the untreated wastewater is discharged into the drainage, it often develops high nutrient and elements loading into aquatic environment of the drainage, which will lead to a favorable condition for the bloom of the undesired phytoplankton (Cai *et al.* 2013). This environmental problem has led to extensive researches into developing effective alternative technologies to remove these nutrients from wastewater. But each alternative method has its own advantages and disadvantages. In conventional method used in our country for wastewater treatment process, there will be need of mechanical aeration which is very expensive to provide oxygen for the aerobic bacteria so that it can consume the organic compounds in the wastewater. While, in algae based wastewater treatment, there is no need of aeration supply mechanically because the microalgae itself provides oxygen for aerobic bacteria. So, it is said to be more cost saving method compared to any other secondary treatment method of wastewater treatment (Suad, 2014).

Microalgae has become a significant medium especially in biological purification of wastewater treatment due to its own abilities to consume organic and inorganic toxic substance using their cells bodies. In line with this, microalgae is one of the most promising alternative treatment especially in pollutants removal from wastewater (Olguin *et al.,* (2003); Mohamed *et al.,* (2015). Furthermore, according to Singh and Gu., (2010), microalgae has a very good in doubling itself i.e. their abilities to growth very rapidly in a short period of time as well as double their biomass weight. Thus, this has put microalgae one of low cost alternative in wastewater treatment. On the other hand, treatment using microalgae mainly attractive due to its photosynthesis abilities in absorb nutrients, metals and carbon dioxide which resulting in minimize energy consumption for mechanical aeration and green gas mitigation (Su & Mennerich *et al*., 2012).

MATERIALS AND METHOD

a) Sample and material preparations

Sample was collected at one of small and medium food industries located in Johor. The chosen site was chose due to its high content of nutrients which is suitable for microalgae growth and assimilations proses. The sample were taken at two different time i.e. 9.00 a.m. and 12.00 p. m. through grab sampling method. These time was selected based on the research done by wastewater (Latiffi *et al.,* 2015) for the highest pollutant discharge for meat processing wastewater. The collected wastewater was preserve in plastic bottle of Polyethylene Terephthalate (PET) and were stored at 4 ^{0}C without any acid preservations.

b) Microalgae and wastewater preparations

Microalgae sampling, isolation and identification are done prior inoculation process. A small amount of collected microalgae were isolated and were identified using NIKON eclipse E600 microscope. After identification, the selected microalgae were cultivate in Basal Bold Medium, BBM (Nichols and Bold, 1965) and place under natural conditions for growth. Wastewater that was collected from the study site were filtered before phycoremediation process takes place to minimized all unwanted algae or bacteria that may exists in the wastewater . Conical flask was use and filled with filters wastewater water (375ml) (3/4 total volume of conical flask).

c) Inoculation of different microalgae concentrations

Three different concentration of microalgae was use in this study i.e. 1x10^3 cells/ml, 1x10^{4}cells/ml and 1x10^6 cells/ml. The microalgae then were inoculate inside the conical flask that contain the said wastewater in triplicate manner. The conical flask was placed under natural condition within 8days.8days were chosen based on assimilation efficiency of the pollutants. Samples were taken for every 2 days for removal analysis.

d) Testing and equipment

The equipment that use for this analysis are Ion Chromatography with Chemical Suppression of Effluent Conductivity, Method 4110B for Orthophosphate; TOC-V analyzer (TOC-VCSH, Japan, Shimadzu), method 5310B for Total Nitrogen while BOD use method 5210B and COD using reactor digestion method, Method 8000.

e) Primary investigation on wastewater characteristics

Table-1. Summary of wastewater characteristics compared with previous study and authorities.

Pollution	9.00 am sample	12.00 pm sample	Previous study(Onet Cristian, 2010)	Standard A	Standard B
COD(mg/L)	2160	1320	1683	50	100
BOD (mg/L)	760	415.67	863	20	50
TSS (mg/L)	500	400	640	50	100
pH	8.61	8.31	8.02	6-9	5.5-9
Nitrogen (mg/L)	1488/113	778/91	2743	nil	Nil
Phosphorus (mg/L0	236.54/39.55	95.68/14.98	328	nil	nil

RESULTS AND ANALYSIS

a) Total nitrogen removal

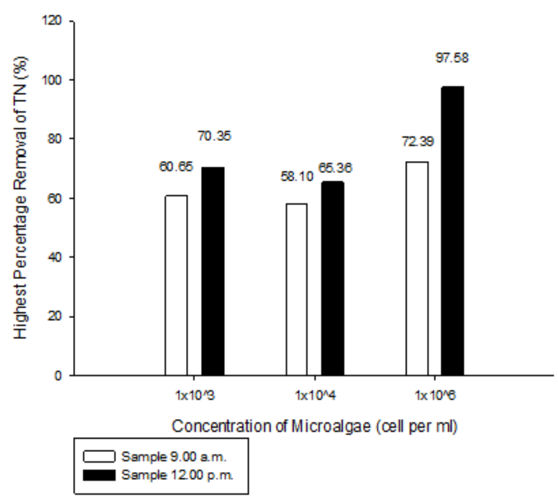

Figure-1. Highest percentage removal of TN versus concentration of microalgae.

VOL. 11, NO. 16, AUGUST 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

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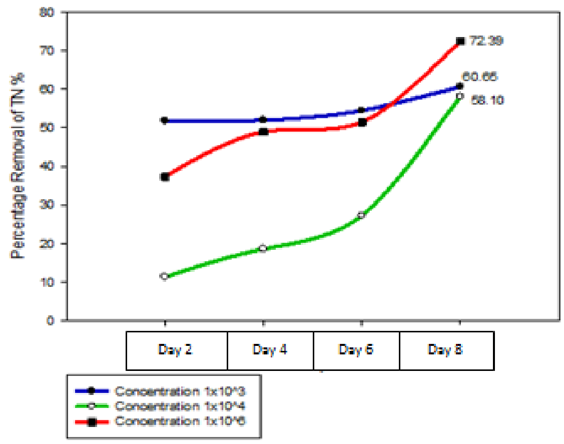

Figure-2. Highest percentage removal of TN vs Day (9.00 am sample).

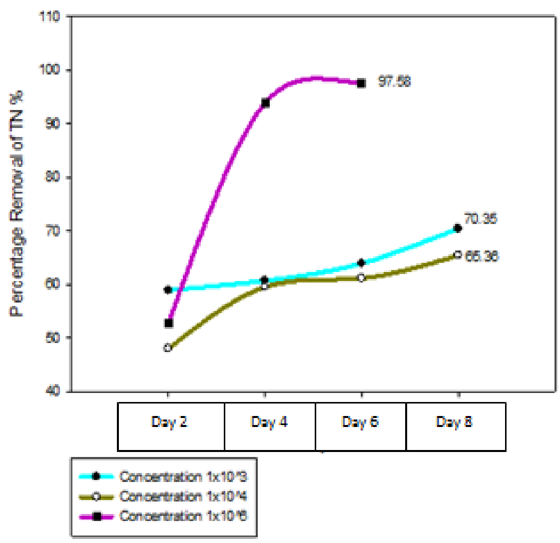

Figure-3. Highest percentage removal of TN vs Day (12.00 pm sample).

Based on Figure-1, 2 and 3, the highest percentage removal of TN for Sample at 9.00 a.m. with concentration $1x10^3$, $1x10^4$ and $1x10^6$ cell per ml are 60.65%, 58.1%, and 72.39% while highest percentage removal of TN for Sample at 12.00 p.m. with the same concentration of microalgae *Botryococcus sp.* which $1x10^3$, $1x10^4$ and $1x10^6$cell per ml are 70.35%, 65.36%, and 97.58%.. Study done by Lee and choul., (2001), says that microalgae has the ability to withstand high amount concentration of nitrogen as it is one of the important protein provider for cells growth. Furthemore, the reduction of nitrogen also due to oxygen decreased, chlorophyll contents and tissue productions (Juneja *et al.*, 2013).

b) Total PO_4^{3-} removal

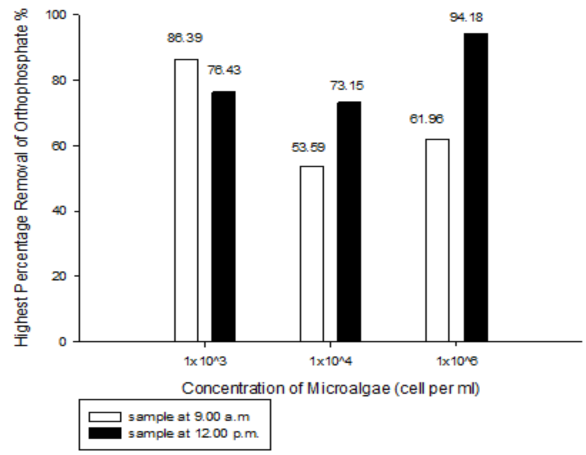

Figure-4. Highest percentage removal PO_4^{3-} vs concentration of microalgae.

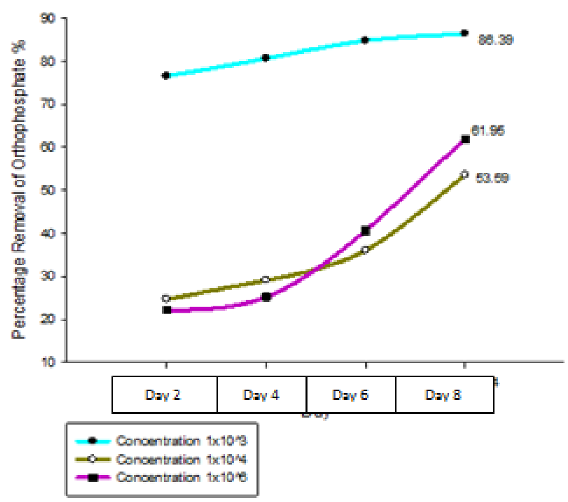

Figure-5. Highest percentage removal of PO_4^{3-} vs day (9.00 am sample).

Refer to Figure-4, 5 and 6, can be seen clearly that the highest percentage of PO_4^{3-} removal for each three different concentration which are $1x10^3$, $1x10^4$, and $1x10^6$ cell/ml are 86.39%, 53.59% and 61.95% respectively for Sample at 9.00 a.m. while for Sample at 12.00 p.m., the amount of PO_4^{3-} removal with the same concentrations are 76.43%, 73.15% and 94.18%. Microalgae utilize phosphorus in orthophosphate form. Moreover, microalgae can stored or reserve phosphorus in their cells and can be utilized if the phosphorus supply are depleted. The storing capabilities explain the depletion of orthophosphate in this study as they consume and store resulting decreasing phosphorus in wastewater (Markou *et al.,* 2014). Phosphorus normally comes from may part of food product resulting increasing of phosphorus concentration if discharge excessively to environment prior treatment (Onet C., 2010).

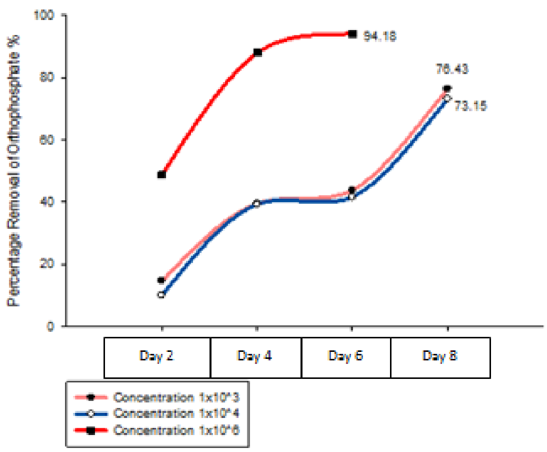

Figure-6. Highest percentage removal of PO_4^{3-} vs day (12.00pm sample).

c) Removal of BOD and COD

Table-2. Summary of percentage removal for BOD and COD.

Concentration Algae (cells/ml)	BOD (%)		COD (%)	
	9.00 am	12.00 pm	9.00 am	12.00 pm
$1x10^3$	39	18	73	53
$1x10^4$	56	29	56	53
$1x10^6$	97	71.5	94	31

From table above, each of the microalgae concentration gives a different value of removal percentage. These depends on the amount of microalgae concentration. As shown, for concentration $1x10^3$ cells/ml gives a total removal for BOD and COD of 39%, 18%, 73% and 53% respectively. Different with $1x10^4$ cells/ml which gives a total removal of 56%, 26%, 56% and 53% for both BOD and COD at 9.00 am and 12.00pm as shown in the table. On the other hand, the highest removal of BOD and COD falls at microalgae concentration of $1x10^6$cells/ml i.e. gives a maximum percentage removal by 97% and 94% at 9.00 am sampling. The assimilation of carbon from the wastewater is due to the consumption of carbon by microalgae for energy use (Markou *et al.*, 2014)

CONCLUSIONS

The highest removal of both nutrients, BOD and COD are at microalgae with concentration of $1x10^6$ cells/ml. At this concentration, the removal percentage are above 90% which is very excellent. It portay that by using microalgae *botrycoccus sp.* has the ability to assimilate pollutants effectively. Throughout this study, the characteristic of industrial wastewater from meat food processing industry is analyzed. It is also found that nutrients such as orthophosphate and nitrogen can be removed from meat processing wastewater by using microalgae *botryococcus sp.* The performance and efficiency of microalgae *botryococcus sp.* in removing nutrients orthophosphate and nitrogen from industrial wastewater from meat food processing industry and improving the wastewater's quality by considering COD and BOD is evaluated. As the objectives of this study were achieved and satisfied, therefore, it can be concluded that this study is successful.

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