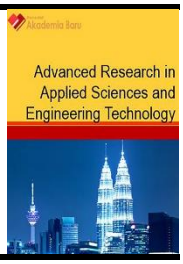
Penerbit Akademia Baru

Journal of Advanced Research in Applied Sciences and Engineering Technology

Journal homepage: www.akademiabaru.com/araset.html
ISSN: 2462-1943



Characteristics of Water Quality from Meat Processing Wastewater

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ARTICLE INFO

Article history:
Received 5 June 2019
Received in revised form 4 July 2019
Accepted 12 July 2019
Available online 17 December 2019

ABSTRACT

Assessment of wastewater quality characteristics from Meat Processing Wastewater (MPWW) effluents was conducted for 8 weeks at one of local small and medium factory. A total 8 samples was collected and analyzed for 10 selected parameters; pH, temperature, dissolved oxygen (DO), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD) and nutrients. Average reading of recorded ex-situ test of BOD from this finding is 1070mg/L, COD is 2350 mg/L, Total Suspended Solid (TSS) is 1400 mg/L, Total Nitrogen (TN) is 317.22 mg/L, Total Phosphorus (TP) 62.86 mg/L, Orthophosphate (PO43-) is 47.37 mg/L, Total Organic Carbon (TOC) is 493.82 mg/L and in-situ test of DO with average of 6.10 mg/L, pH of range 6.5 – 8.0 and temperature of 25.680C. According to Environmental Quality Act (EQA), water qualities generate from this effluent is exceedingly high and out of minimum allowable discharge of Standard B categories except for pH which was within the Standard A. Nevertheless, effluents produced are highly contaminated and exceed the allowable effluents discharge sets by the local authority by Department of Environmental, DOE.

Keywords:
Water quality; wastewater characteristics; Meat Processing Wastewater (MPWW)

1. Introduction

Water is a very important ingredient in any food processing industry. Typical activities involved in slaughterhouses and meat processing normaly require using a lot of water wherelse, water is also used for cleaning purposes especially in meat processing areas as calimed by Bustillo-Lecompte *et al*., [1]. Wastewaters that produced and released have significant effects on the environment and meat processing plants use clean water about 62 mm^3 / y [2] and claimed by Lu *et al*., [3], a typical meat processing facility located in USA produced approximately about 10,000 m3 wastewater per

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day. And for european regions, the european world bank of slaughter house industry specifically meat processing reported to consume clean water from 2.5m^3 up to 40m^3 per metric tons of meat products, hence resulting a total of 145 million m3 every year [4]. Only a small number of these quantities become a component of the final product; the remaining portion become a wastewater containing high demand biological and chemical oxygen, high fat content and the concentration of dry residue, sediment and suspended matter and rich in nutrients [2]. Wastewater from meat processing usually have a high organic content and consequently a high biochemical oxygen demand (BOD5) and chemical oxygen demand (COD) due to the presence of blood, fat, and mucosa. The high number of biodegradable organic matter are varying from 1100-2400 mg O_2 l-1 in terms of BOD5, soluble fraction varied from 40% to 60%. There are study on characteristics of wastewater effluent meat that have been studied before by Oostrom *et al*., [5], results showed that the characteristics of the wastewater in terms of pH (6.3- 6.6), chemical oxygen demand (COD) (2000- 6000 mg/l, biochemical oxygen demand (BOD5) (1300- 2300 mg/l), and the number suspended solids (TSS) (850-6300 mg/l). This indicates that wastewaters from meat processing typically contain high concentrations of nutrients such as nitrogen, which should be removed before release to water bodies. Nitrogen exists in different forms and it is essential for all life forms. In most food products, nitrogen exists in the form of protein and decomposition of protein in food waste are carried out by bacteria that converts organic nitrogen to ammonia. Under aerobic conditions, ammonia converted to nitrite, nitrate and then (NO_3) by a group of bacteria called nitrifies. Excessive nitrate leaching to ground water can cause health problems [5]. Furthermore, Meat processing wastewater typically reported containing organic nitrogen level (usually 70-250 gm-3), which have to be removed before the water are discharged into rivers or drains [4]. Meanwhile, according Oostrom *et al*.,[5], the meat processing industry also has the potential to generate large amounts of solid waste and waste water with biochemical oxygen demand (BOD5) 600 milligrams per litre (mg/l). BOD5 can be as high as 8,000 mg/l, or 10-20 kilograms per tonne (kg/t) according to animal slaughtered. Amount of wastewater generated and pollutant load depends on the type of processed meats. For example, the processing of the intestine have a major impact on the quantity and quality (as measured by levels of BOD5 and chemical oxygen demand, (COD) of wastewater generated. Therefore, the purpose of this study was to access the effluent water quality of the meat processing facility and investigates the characteristics of the wastewater compositions.

Disposal of waste untreated or not treated completely contains nutrients for algae, non-biodegradable organic matter, heavy metals and other toxic substances that would accelerate the deterioration of receiving water bodies. On a global scale, environmental pollution or food industries meat processing through effluent discharge has become a threat to plants and animals and can eventually threaten the quality of human life [6]. Every day, large quantities of industrial effluents discharged, virtually untreated into the river. Approximately 80% of industrial effluents flow directly into the rivers through shallow pits, waste, and drain. Effluent known to contain contaminants and disposal to water bodies without proper treatment will result in human exposure to contaminants [7].

2. Methodology

There are two major method was used in these study; sampling wastewater, preservation, analysis and on site observation together an interview with personnel in charge in finding actual activities conducted inside the facilities. All of the methods are accordingly with the standard of

Ipeaiyeda and Onianwa [7] respectively. Analysis of data was conducted thoroughly by in-situ test at the sampling location and ex-situ test in the wastewater laboratory of UTHM.

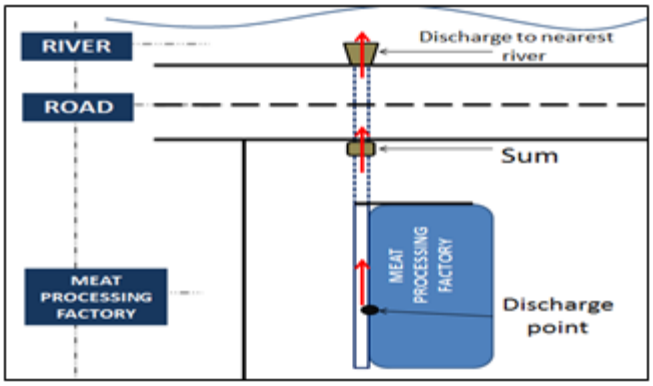

Fig. 1. Sampling location and discharge point of effluents from facility

2.1 Sampling, preservation and analysis

Meat processing facility is located in Parit Raja, Batu Pahat. The facility is a small and medium enterprise of facility which produces processing food from meat product for local markets. The operating hours starts at 9.00 a.m. to 5.00 p.m. from Sunday to Thursday. They are consume water for operation purpose approximately 160m3 of water every month. And prior discharge, there are no absolute on-site treatments to assimilate pollutants before entering the water bodies except for screening. Preservation of samples collected is done according to standard [8]. The collected samples were stored using HDPE bottle and were kept in chillier at 4°C temperature. In-situ test are done on site which are pH, temperature and dissolved oxygen using multi parameter quality monitoring equipment while ex-situ test are done in the laboratory using high end equipment's of Ion Chromatography (Dionex ASE 200), Ion Chromatography with Chemical Suppression of Eluent Conductivity Method) and TOC-VCSH, Japan.

2.2 On-Site Observation and Interview Personnel in-Charge

As for activities conducted by the facilities, an interiew with personel incharge and on-site observation was used. From the interview with in charge personnel, main product that was produced are all from meat based which indicates why nutrients contents are high. There are four major activities in this facility as stated in Table 1, such as preparation of raw product. This process consists of loading and unloading meats that arrived from slaughter house and cleaning the raw products. These normally were done in the morning sessions. At the same time, preparation of ingredients for the products also took place in the morning until afternoon, followed by packaging later in the evening and lastly cleaning process of the equipment and factory compound throughout the day. As stated by [9] the clean water is used in many stages of processing operation, such as slaughtering process, cleaning, packaging, cleaning of equipment and facilities and release back to water bodies. The production rate of MPWW are solely depends on the daily to daily basis usage which determined the loading characteristics. Average of water usage reported by the head of management of the

facility is roughly 160m3 per months, which gives an average usage of water flow rate of 5.260 m3/day.

Table 1
Summary of facility activities from morning to evening

Segment	Morning	Afternoon	Evening
Preparation Raw Product	▨		
Ingredients Preparation	▨	▨	
Packaging			▨
Cleaning	▨	▨	▨

3. Results and Discussion

Meat processing wastewater, (MPWW) characteristics produced by the meat processing factory vary extensively, depending on daily productions and demands. In small and medium factory, as in this study, both quality and quantity characteristics was obtained. The MPWW quality can be seen in Table 2 with comparison with standard set by the authority of Environmental Quality Act, (1974) under Industrial effluent discharge limit. Refer to results in Table 2 and Table 3, temperature recorded for MPWW is range between 25.13°C-26.77°C, which gives an average of 25.68°C. Temperature is an indicator used to indicate any metabolic activity by organism in the wastewater, which ultimately will reduce the natural content of oxygen in the water, also known as dissolved oxygen (DO) [7]. For pH, the values that have been recorded are range from 6.50 to 8.00 respectively. Comparing the obtained data with the standard set by Malaysia Departments of Environmental (DOE), all samples are within neutral state and in Standard A effluents wastewater quality based on EQA. pH in wastewater are controlled by the activities/process carries by organism exist in wastewater itself such as photosynthesis process and respirations cycle, resulting fluctuating readings, while in unpolluted water; ionic balanced of bicarbonate ions, carbonate and carbon dioxide are responsible in controlling the pH. Dissolved Oxygen, DO is a parameter used to check the availability oxygen that dissolved in the water. DO concentration in this study falls in the range of 5.46 – 6.64 mg/l. The higher the DO concentration indicates the lesser organism inside or lesser photosynthesis occur due to algae. Despite that, algae consume oxygen once degraded [10]. Total suspended solid (TSS) for this study is at high range of values which are highest at 1400 mg/l, higher than allowable standard discharge.

Biological Oxygen Demand, BOD and Chemical Oxygen Demand, COD are the two main parameters known to be the most basic means in determining the degree of water pollutions. BOD5 is an experimental test in finding the amount of oxygen during the oxidization of organic matter. The average ranges of BOD5 in this study are from 621.33 to 1760.33 mg/l. This high amount of concentration maybe was due to the high effluents being discharge during the sampling that associated with blood or any other pollutants from the cleaning of the meat into the stream untreated [11]. As comparing with the previous study by Cristian *et al*., [12], recorded of 863.40 mg/l

of BOD5, this study is slightly highest but still in the range. On the other hand, instead of BOD5, COD also can be used as an alternative test to BOD5 in determined the concentration of organic matter in wastewater sample [13]. COD generally defined as the total quantity of oxygen required for complete oxidation of organic compound to carbon dioxide and water and it is significantly to continually measure to determine the degree of pollution in an effluents [14]. The value represents the existence of biodegradable and non-biodegradable of organic compound [13]. As for this study, the COD range falls at higher values between 1313.33 to 3638.00 mg/l, higher than allowable standard of discharge by authorities. Comparing with the previous study of Cristian [12]. COD obtained was slightly lower as different MPWW facilities has different loads of meat, facilities and process occurs makes them difficult to standardize and predict [19-20]. Nutrients elements such as Nitrogen and Phosphorus can be the major causes of problems in the environmental if excessively exist/discharge in the water bodies such as eutrophication, leads to toxicity and biohazard to ecology. Furthermore, there has been reported that excessive penetrations of nitrogen into the groundwater can cause serious health issue to human who consumed [16-18]. Value obtained from this study shows that both nutrients elements exist in high range. For Total Nitrogen (TN) is range between 70.56-578.63 mg/l, Total Phosphorus (TP) range between 9.47–130.91 mg/l, orthophosphate range from 7.11 to 98.63 mg/l and Total Organic Carbon (TOC) range between 177.61 – 987.83 mg/l respectively. Comparing with the previous study, all of the above are slightly lower with the findings[12]. The huge different obtained in this study as compared with previous findings from Cristian et al. [12] is that possibility comes from the excessive blood from slaughtering activities that in this case study do not performed.

Table 2
Summary of an average value of water quality parameter investigated from MPWW. (n=3)

Physiochemical parameters	Average Concentrations mg/l	Previous Study [Chet, 2010]	*Standard A	*Standard B
Biological Oxygen Demand, BOD	1070 ±350.91	863.40	20	50
Chemical Oxygen Demand, COD	2350 ±835.42	1683.60	50	100
Total Nitrogen	317.22 ±171.14	2743.60	-	-
Total Phosphorus	62.86 ±36.52	328.40	5	10
Orthophosphate	47.37 ±27.53	-	-	-
Total Organic Carbon	493.82 ±267.88	-	-	-
Total Suspended Solids, TSS	1400 ±299.10	640.20	50	100
pH	6.50-8.00	8.00	6.0 – 9.0	5.5 – 9.0
Temperature [OC]	25.66 ±0.56	-	-	-
Dissolved Oxygen (DO)	6.10 ±0.0203	-	-	-

*EQA, 1974; *all units in mg/l except for pH and temperature.

As comparing with the experimental data obtained from this study, there are variations of pollutant concentrations as reported by previous researcher [10]. The meat food processing facility water quality can be differ from another facility as these variations are highly influences by the product produced, type of animals used and methods of preparing as well as disposal wastewater from the facilities [19].

Table 3
Overall readings for 8 weeks of sampling from Meat processing facility

Physiochemical parameters	WEEK			
	1	2	3	4
Biological Oxygen Demand, BOD	621.33	759.33	1003.67	1247.33
Chemical Oxygen Demand, COD	1521.67	1313.33	2137.33	3152.00
Total Nitrogen	186.73	174.83	346.47	311.00
Total Phosphorus	49.47	48.12	92.62	72.42
Orthophosphate	37.17	36.27	69.85	54.57
Total Organic Carbon	307.17	423.43	705.10	623.41
pH	6.67	6.43	7.10	7.47
Temperature (°C)	26.40	25.13	25.37	25.27
Dissolved Oxygen, DO	6.64	6.55	6.17	6.39

Physiochemical parameters	WEEK			
	5	6	7	8
Biological Oxygen Demand, BOD	1153.33	871.67	1144.00	1760.33
Chemical Oxygen Demand, COD	2927.33	1687.67	2423.33	3638.00
Total Nitrogen	505.63	70.65	363.71	578.73
Total Phosphorus	130.91	9.42	41.41	58.53
Orthophosphate	98.63	7.11	31.21	44.11
Total Organic Carbon	987.83	272.28	177.61	734.07
pH	7.07	6.83	6.63	7.13
Temperature (°C)	25.33	26.50	25.77	26.40
Dissolved Oxygen, DO	5.47	6.00	5.46	5.90

4. Conclusion

Characteristics of meat processing wastewater (MPWW) are known to be rather complex and varies depending on the industry activities that influence by volume of water usage as well as the strength of the productions demand. As an industry product produce several types of products, resulting different composition on wastewatwer characteristics as supported by Aris *et al*., [20]. From these preliminary data obtained from this study shows that MPWW wastewater are at high range of all pollutant tested which exceed the allowable effluent discharge standard as sets by the local authority of Department of Environmental (DOE). On the other hand, several types of suitable treatment can be suggested in treating MPWW such as utilization of microalgae as a based materials since MPWW are rich in Nitrogen and Phosphorus elements that essentials for microalgae growth. However, a further study needs to be carried out in terms of accessing the pollution impact and how to counter them through new and upgrading innovations for more sustainable, clean and safe wastewater treatment and water supply.

Acknowledgement
This study was supported under Fundamental Research Grant Scheme (FRGS) Vot 1453 for Faculty of Civil and Environmental Engineering, University Tun Hussein Onn, Johor. The authors are thankful and grateful for the grant and all the personnel who directly and indirectly involved in this research.

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