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Chicken Slaughterhouse Wastewater Disposal: The Challenges Ahead

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Abstract

Slaughterhouses generate large volumes of highly polluted wastewater composed mainly of large amounts of organic and inorganic pollutants as well as solids which pose a threat to the environment. Fresh undiluted wastewater was collected twice a day for a period of six weeks from a chicken slaughterhouse located in a suburb area to investigate the properties of slaughterhouse wastewater. The average results indicated very high pollutant levels of selected water quality parameters such as pH, COD, BOD, TSS, TDS, colour, turbidity, total coliform and NH_3-N which were 7.17, 4979 mg/L, 1360 mg/L, 515 mg/L, 545 mg/L, 14,163 PtCo, 697 NTU, 1.2×10^8 CFU/100mL and 110 mg/L, respectively. These results were compared with the values stated by Malaysia Environmental Quality Regulation (2000) for effluent discharge. It can be concluded that most of the parameters are not suitable for direct discharge to the water streams without prior treatment. It is however recommended for most abattoir wastewater to be discharged separately from the community sewerage systems or treated separately as hazardous wastewater as a way of reducing some of the dangers imminent in the reuse of such wastewater and also clogging of sewerage pipes.

Keywords: Abattoir, Discharge standards, Pollution, Wastewater, Water quality.

Introduction

In the future, livestock demands is expected to rise which will also lead to an increase in the volume of wastewater that will be generated from slaughterhouses. Wastewater produced from slaughterhouses is characterized by high organic content, as a result of the presence of blood, suspended solids, fats, faeces, grit, feathers, proteins, undigested foods and other particles (Maroneze et al., 2014).

In Asia, slaughterhouses are mostly for poultry and pigs, besides, the amount and composition of wastewater generated obviously depends on the number and type of animals processed (Ng, 2006). In Jakarta, Indonesia, 545 cattle are slaughtered per day; 200,000 per year with the entire wastewater flowing into a nearby surface water body without treatment, as reported in GTZ (2001). The solids in the wastewater which include feed leftovers and faeces are disposed on uncontrolled disposal sites resulting in an average pollution level of up to 7,200 mg chemical oxygen demand (COD) per liter of the total wastewater stream and also contains high amounts of chromium used for tanning. Soyong et al., (2010) postulated that raw piggery wastewater in Korea contains 11,533 mg/L (BOD), 21,894 mg/L (COD), 2255 mg/L (total nitrogen) and 415 mg/L (total phosphorus). It is however pertinent that such wastewater containing very high pollutant load must be treated before being discharged to water bodies or community sewerage systems. However such pre-treatment of wastewater before disposal is sometimes not done in most slaughterhouses around the world especially in developing and under-developed countries. It becomes one of the major environmental issues confronting slaughterhouses today which also results in blockage

and deterioration of the wastewater piping systems. Due to the fact that most slaughterhouses are located in city centers, outdated ways of making use of the effluents have become very difficult causing complex issues and problems. Consequently, the effluent flows into surface and groundwater through the process of infiltration and leads to further contamination of such water bodies.

Very few research work is available in literature on the characterization of chicken slaughterhouse wastewater, because, most studies focus on pre-treatment either biological, physical or chemical before discharge into surface water (Seswoya et al., 2012; Samsudin, 2010). However, knowing the characterization of such wastewater will help to plan long term wastewater treatment facilities as well as provide information on the levels of contamination of such wastewaters and the dangers of disposal of untreated wastewater to water bodies.

In view of that, this study is aimed at determining the varying characteristics of chicken slaughterhouse wastewater in terms of biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), total dissolved solids (TDS), turbidity, colour, pH, ammonia nitrogen (NH_3-N) and microbial count. The effect of discharging such wastewater without treatment will be highlighted in relation to environmental pollution, soil, water and other health hazards.

Materials and Method

Raw undiluted wastewater sample was collected twice weekly for six weeks 26th October 2015 – 7th December 2015 from a local chicken slaughterhouse located in a suburb area (GPS coordinate: 3.0333^{o}N, 101.7167^{o}E), in the city of Selangor, Malaysia (Fig. 1).

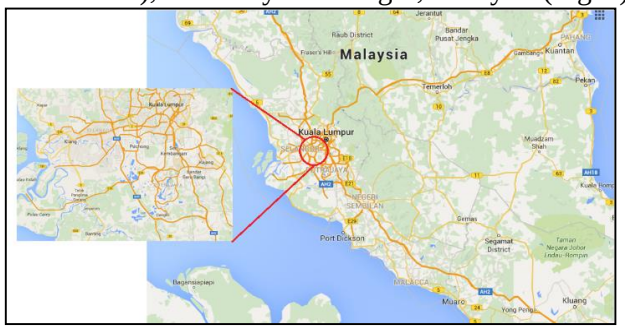

Fig. 1: Map of sampling location for chicken slaughterhouse wastewater

The samples were collected from the sewer at different times and alternate days covering all the days of the week to ensure that a good distribution of sampling was done. All samples collected were analyzed in duplicates and triplicates in line with Standard Methods for the Examination of Water and Wastewater (APHA, 2005).

Results

12 samples were tested for the selected parameters and the results obtained are summarized. The wastewater samples had varying pH values with a fluctuated pattern (Fig. 2). It can be summarized that the samples were moderately alkaline with pH values ranging from 6.74-7.62. These values fall within range for discharge and suitable for the growth of bacteria in biological treatment processes, low pH can hinder the growth of microorganisms.

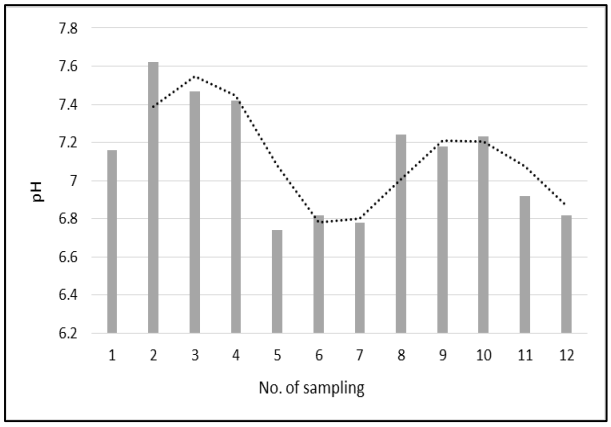

Fig. 2: pH values for chicken slaughter-house wastewater samples

The moving average trend line of the varying values of BOD and COD shows a fluctuated pattern for each sampling process (Fig. 3).

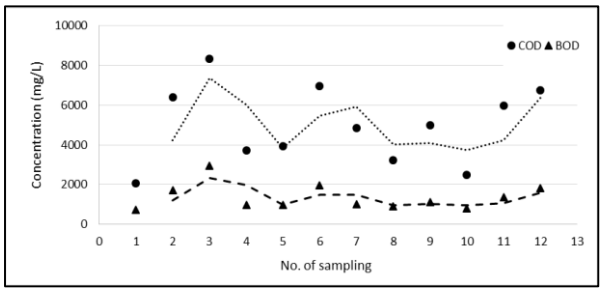

Fig. 3: COD and BOD values for the wastewater samples

The average concentrations of pH, temperature, colour, turbidity, TSS, TDS, COD, BOD, NH_3-N and microbial count also the acceptable discharge standard for wastewaters (Malaysia Environmental Quality Regulation, 2000) are tabulated in Table 1. The COD values ranges from 2080 mg/l to 8345 mg/l which exceeds the acceptable discharge standard of 100 mg/l. The BOD values ranges between 727 mg/l and 2960 mg/l also exceeding the acceptable discharge value of 50 mg/l.

Table 1. Chicken Slaughterhouse wastewater composition and Malaysia Environmental Quality Regulation (2000)

Parameter	Unit	Present Study	MEQR (2000)
pH	-	6.74 -7.62	5.5-9.0
Temp.	^oC	23.8-28.7	40
Color	PtCo	10200 -19440	300
Turbidity	NTU	319 -810	5
TSS	mg/L	254 -850	100
TDS	mg/L	495 -1563	1000
COD	mg/L	2080 - 8345	100
BOD	mg/L	727 - 2960	50
COD: BOD	-	3.7 :1	2.0:1
NH_3-N	mg/L	58 -122	1.5
Microbes	CFU/100 ml	1.2×10^8	5000

Keys: TSS – total suspended solids; TDS – total dissolved solids; COD – chemical oxygen demand; BOD – biochemical oxygen demand; NH_3-N – ammonia nitrogen; MEQR - Malaysia Environmental Quality Regulation, (2000)

Discussion

The average results presented in Table 1, shows a very high concentration for COD, BOD, microbial count, colour, NH_3-N, TSS, TDS and turbidity, which are more than the expected discharge standard for wastewaters. The ratio of COD and BOD value showed that the sample fall in high category, based on typical ratios in municipal wastewater (Henze et al., 2008). This ratio has a significant influence on the selection and functioning of wastewater treatment processes either biological or chemical treatment. For this case study, the ratio value indicates that a substantial part of the organic matter will be difficult to degrade biologically. These very high values shows greatly the amount of pollutants present in the wastewater with a very unpleasant red colour that signifies the presence of blood, fat and faeces in the sample.

Temperature ranges from 23.8 to 28.7^{o}C, is lower than the range of 40^{o}C which is the acceptable range for discharge. Temperature conditions during treatment ensures stability of the other properties and the chemical reactions that will occur through the activities of bacteria responsible for stabilization of organic content of wastewater. The values for suspended solids is very high when compared to the acceptable discharge value for effluent. Disposal of untreated wastewater containing high ranges of suspended solids into aquatic environment is responsible for development of sludge as well as anaerobic conditions. The average value for microbes was very high indicating the presence of organic matters which will influence biological treatment. The impact of these high levels of pollutants in chicken slaughterhouse wastewaters are all the numerous challenges associated with disposal of such wastewaters without treatment.

The challenges ahead

Slaughterhouses are usually located within residential houses which is a major threat and danger to those living around because slaughtering and rendering activities generate significant quantities of organic waste. Such organic wastes constitute potential hazards and threats to the environment, which include generation of large volumes of highly polluted wastewater, solid wastes including other by-products, release of toxic gases into the atmosphere and consumption of energy. Also, blood collection points, manure piles, carcasses and other waste-products generate very pungent odor which attract different forms of insects and rodents which can be very disturbing and can lead to outbreak of diseases or epidemics. Pruss-Ustun et al., (2008) further buttressed that this trend accounts for 10% of the global burden of diseases especially in poor countries of Africa and Asia with special recorded cases of diarrhea. According to Humphery (2009), tropical enteropathy could lead to adverse health consequences mostly in children which could affect their growth and development due to excessive exposure to faecal bacteria.

Most slaughterhouses are not adequately managed and so are exposed to some health hazards especially with regards to the workers. Workers who are involved in processes that require handling of birds are usually

exposed to dust and other microbiological causes which may result in eye, skin and respiratory tract infections as well as other allergies. Furthermore, Muhirwa et al., (2010), concluded that leaching action pollute groundwater and has become a source of concern because of the refractory nature of some pollutants. Furthermore, people living around such areas even sink shallow wells for domestic water supply. The challenges are complex and too numerous but studies are ongoing on the way forward especially for under-developed countries. Such studies include provision of cheap treatment alternatives for slaughterhouse wastewater treatment through the development of cheap adsorbents from waste materials.

Conclusion

This study has shown that wastewater from chicken slaughterhouses are unsuitable for discharge to the environment without prior treatment. Most of the values obtained from the tested parameters exceed the effluent discharge standards and therefore unsuitable for direct discharge into community sewerage systems or water streams without prior treatment. The problems are complex, most slaughter houses especially chicken slaughter houses are located within residential areas. Measures must to be put in place regarding the control of the environmental issues, especially odour generation, water contamination and other health implications associated with such activities. There is the need to have a re-think on the existing methods of disposal and find innovative, ecological and economical solutions to reduce the impact on the environment.

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