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Physicochemical properties of slaughterhouse wastewater in and around Guwahati city, Assam

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Abstract
The physicochemical qualities of wastewater from poultry, goat, pig and cattle slaughterhouses in and around Guwahati city were investigated to assess the influence of the slaughterhouse wastewater in the receiving drainage system and nearby rivers. Samples were analysed as per the standard methods. Out of the physicochemical parameters studied the Temperature (^{0}C) of slaughterhouse wastewater ranged from 28.51 ± 0.22 to 28.76 ± 0.20, pH 6.41±0.03 to 6.55±0.03, Total Dissolved Solids (g/L) 0.84± 0.04 to 4.70± 0.14, Total Solids (g/L) 4.03 ± 1.50 to 7.5±1.28 and Electrical conductivity (mS/cm) 0.89 ± 0.02 to 5.93 ± 013, which were below the WHO permissible limits. Unacceptably high levels of the assayed parameters were observed for Turbidity (107.33 ± 7.19 to 263.86 ± 9.11), Total Suspended Solids (mg/L) 4.43 ± 0.0 to 6.93 ± 0.13, Dissolved Oxygen (mg/L) 3.32 ± 0.10 to 4.73 ± 0.11, Biological Oxygen Demand (mg/L) 500.00 ± 20.00 to 792.50 ± 29.88 and Total Nitrogen (mg/L) 1197.78 ± 11.72, to 1381.97 ± 7.51. These findings were outside the compliance levels of the WHO tolerance limits for slaughterhouse wastewater.

Keywords: physicochemical, slaughterhouse, wastewater, turbidity

Introduction
Slaughterhouse produces large amount of waste during slaughtering of food animal *viz*. solid and liquid waste. Most of these wastewaters run through open drains to bigger adjoining drainages in neighborhood without any treatment. As a result these untreated slaughterhouse wastewater leads to significant alteration of some physiochemical properties of waters like Temperature, pH and Turbidity, Biological Oxygen Demand (BOD), Dissolved Oxygen (DO), Total Suspended Solid (TSS), pH, Nitrogen etc. Most of the wastewaters from slaughterhouses run through open drains to bigger adjoining drainages in neighborhood without any treatment. Currently there is less organized system for the disposal of solid wastes and effluents in the slaughterhouses in and around Guwahati city. The entire waste is collected and dumped in lakes or disposed of as landfill unhygienically which ultimately causes a threat to the human health as well as polluting the overall environment of the city.

Materials and Methods
The waste water samples were collected aseptically in sterile containers twice in a month from each location for a period of 3 months. Collection, storage and preservation of samples were done as per methods described by American Public Health Association (APHA, 1998) [1]. The samples were brought immediately to the laboratories for the analysis of physicochemical characteristics. Temperature and pH was measured at the time of collection of samples. The temperature was determined as per the method described by Swarup *et al*. (1992) [2]. Deluxe Water and Soil Analysis Kit was used to determine the pH, Turbidity, Total Dissolved Solids, Dissolved Oxygen and Electrical Conductivity of wastewater sample. Total Suspended Solids, Total Solids and Biological Oxygen Demand were done as per the methods described by APHA, (1998) [1]. Total Nitrogen content of the various samples was estimated by the Kjeldahl method as per AOAC, (1994) [3].

Results and Discussion
The recorded overall mean temperature (ºC) ranges were 28.51 ± 0.22, 28.76 ± 0.20, 28.58 ± 0.18 and 28.65 ± 0.19 in poultry, goat, pig and cattle slaughter houses respectively (Table I). Similar findings were found by Fadeyibi *et al*. (2011) [4] and Magaji and Chup (2011) [5].

All the temperatures recorded during the study period were within the World Health Organization (WHO) permissible limits (<40^{0}C).

The mean pH of waste water samples collected from different sources during the study were found to be 6.46 ± 0.02, 6.41 ± 0.03, 6.41 ± 0.04 and 6.55 ± 0.03 in poultry, goat, pig and cattle slaughterhouses respectively (Table 1). Similar findings were also found by Ubwa *et al*. (2013) [6]. The results were within the normal range prescribed by WHO (2006) [7].

The mean turbidity (NTU) of wastewater samples from different sources were 211.22 ±13.31, 107.33 ± 7.19, 190.02 ± 8.83 and 263.86 ± 9.11 in poultry, goat, pig and cattle slaughter houses respectively (Table 1). The cattle slaughter houses showed significantly highest turbidity than other which may be due to large amount of stomach content, blood and microbial contamination from the cattle slaughter house. All the findings were higher than the WHO guideline of 5 NTU for the discharged of waste water into river or stream. Akan *et al*. (2010) [8] found that turbidity values of abattoir waste water ranged from 410-660 NTU.

The mean TDS (g/L) values were 0.84 ± 0.04, 0.85 ± 0.04, 0.60 ± 0.01 and 4.70 ± 0.14 from poultry, goat, pig and cattle slaughter house respectively. (Table 1). Cattle slaughter house shows significantly the highest TDS. This can be attributed to addition of more amounts of effluent and solid wastes and also may be due to the higher degradation activity of the microflora. Similar findings were also reported by Ubwa *et al.* (2013) [6].

The mean Total Suspended Solids (TSS; g/L) content of waste water samples from different sources during the study were 4.43 ± 0.0, 4.89 ± 0.08, 4.43 ± 0.02 and 14.26 ± 1.40 in poultry, goat, pig and cattle slaughter houses respectively (Table 1). The mean TSS of cattle slaughter houses were significantly higher than the slaughter houses which might be due to various materials of solid waste from the slaughtered animals. Similar findings were also observed by Saidu and Musa (2012) [9] and Osibanjo and Adie (2007) [10]. In the present study the observed TSS values were higher than the WHO limits (0.02mg/L) for the discharged wastewater into river or stream.

Total Solids (g/L) content of wastewater samples from different sources were found to be 4.24 ± 1.49, 4.03 ± 1.50, 5.43±1.11 and 7.5±1.28 from poultry, goat, pig and cattle slaughter house respectively. Similar results were found by Wu and Mittal (2003) [11] and Akan *et al.* (2010) [8]. The significantly higher TS were observed in the waste water of cattle slaughter house which may be attributed to large amount of waste produced in cattle slaughter houses as the sizes of cattle is much more than that of other species.

Dissolved Oxygen (mg/L) content of wastewater samples from different sources were found to be 3.93 ± 0.09, 3.32 ± 0.10, 3.92 ± 0.07, and 4.73 ± 0.11 from poultry, goat, pig and cattle slaughter house, respectively. The cattle slaughterhouse showed the highest DO (4.73 ± 0.11) which may be attributed to mixing and re-aeration of the wastewater in the discharge point. Similar findings were also reported by Fadeyibi *et al.* (2011) [4].

In the present study the mean Biochemical Oxygen Demand (mg/L) content of slaughter house waste water samples from different sources (Table 1) exceeded the normal value (WHO, 2006) [7]. Similar findings were also recorded by Ubwa *et al.* (2013) [6]. The cattle slaughterhouse showed the highest BOD values (792.50 ± 29.88) which could be due to the higher organic load leading to higher microbial degradation.

In the present study, the significantly highest mean electrical conductivity (mS/cm) was observed in cattle slaughter house waste water samples (5.93 ± 0.13). This increased electrical conductivity may be due to soluble salt like NaCl and KCl which might derive from high volume of blood and digesta. Similar findings also were reported by Gregory *et al.* (2011) [12].

The mean total nitrogen (mg/L) of waste water samples from different sources were 1197.78 ± 11.72, 1204.67 ± 7.96, 1254.47 ± 7.72 and 1381.97 ± 7.51 from poultry, goat, pig and cattle respectively. Similar findings were also reported by Cristian (2010) [13]. Masse and Masse (2000) [14] viewed that total nitrogen concentration of the raw wastewater of slaughterhouse is 2 to 9 times higher than those of a strong domestic wastewater. The cattle slaughterhouses showed highest values than the rest of the slaughter houses which may be attributed due to higher total solids derived from meat scraps, intestinal contents, manure, hair, dirt etc. (Wu and Mittal, 2003) [11].

Table 1: Physicochemical properties of wastewaters of Poultry, Goat, Pig and Cattle Slaughterhouses.

Parameters	Species			
	Poultry (n=36)	**Goat (n=36)**	**Pig (n=36)**	**Cattle (n=36)**
Temperature (^{o}C)	28.51 ± 0.22	28.76 ± 0.20	28.58 ± 0.18	28.65 ± 0.19
pH	6.46^{ab}± 0.02	6.41^a± 0.03	6.41^a ± 0.04	6.55^b ±0.03
Turbidity (NTU)	211.22^a±13.31	110.66^b ± 18.32	190.02^a ±8.83	263.86^c ±9.11
TDS (g/L)	0.84^a ± 0.04	0.85^a ± 0.04	0.60^b ± 0.01	4.70^c ±0.14
TSS (g/L)	4.43^a ± 0.19	4.89^a ± 0.14	4.43^a± 0.69	14.26^b ± 1.40
TS (g/L)	4.24^a± 1.49	4.03^a ±1.50	5.43^b± 1.11	7.5^c ± 1.28
DO (mg/L)	3.93^a ± 0.09	3.32^b ± 0.10	3.92^a ± 0.07	4.73^c ± 0.11
BOD (mg/L)	535.83^a± 20.74	500.00^a ± 20.00	556.66 ^{a}±25.97	792.50^b± 29.88
EC (mS/L)	1.24^a± 0.04	1.20^a ± 0.12	0.89^b ± 0.02	5.93^c ± 0.27
TN (mg/L)	1197.78^a±11.72	1204.67^a ± 7.96	1254.47^b±7.72	1381.97^c±7.51

Means bearing different superscript in a row differ significantly (P< 0.05)

Conclusion

The analysis of physicochemical characteristics of the waste water samples from cattle, goat, pig and poultry slaughter houses revealed that except pH, dissolved oxygen and temperature, most of the parameters studied have exceeded maximum permissible limit and wastewater of cattle slaughter house showed significantly higher values than wastewater samples of other livestock species.

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