Physico-chemical characterization of slaughterhouse wastewater: case of Mamou prefecture (Guinea).

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Abstract
The objective of this work is the physico-chemical characterization of the wastewater of slaughterhouse of the urban commune of Mamou (Guinea) in order to propose an adequate treatment thus reducing the harmful consequences which undergoes the receiving environment (River Singuedala affluent of Bafing and this last affluent of the Senegal river) and to cure also the loss of this hydrous source in valorizable matters.
The physico-chemical characterization of the raw wastewater revealed that this liquid discharge is highly loaded with organic matter in terms of COD (Avg. = 228.54 mg/L), BOD5 (Avg. = 218.39 mg/L), TSS (Avg. = 418.50 mg/L) and mineral matter expressed in terms of electrical conductivity (Avg. = 1427.25 µs/cm) with a pH of 7.06.
The average concentrations of Nitrates and Phosphates were respectively 1.697 mg/L and 0.188 mg/L. The examination of the average COD/BOD5 ratio = 1.05 shows the biodegradable character of the wastewater of the municipal slaughterhouse of Mamou to which a treatment by adsorption on activated carbon could be possible.
Keywords: *wastewater, slaughterhouse, physicochemical, Mamou.*

I. Introduction

Water is an essential element for the life of living beings but, it can also be a source of diseases and cause the degradation of ecosystems when it is polluted. The satisfaction of the food needs of the man passes necessarily by the consumption of the meat. In order to meet this need, there are slaughterhouses in each of the large cities that use enough water. After being used, most of this waste water is returned to the environment. As this water is usually loaded with organic matter [1], it becomes a major source of pollution for the receiving environment.

The sudden and massive discharge of waste into the natural environment has led to the appearance of numerous risks for the balance of the natural environment and ecosystems, but also for man himself, who is the producer of this waste and instigator of this great imbalance [2].

Little information exists on the quality of slaughterhouse wastewater in sub-Saharan African countries [3-4] and there is no information on the characterization and treatment of slaughterhouse wastewater in Mamou. However, the effluents from this slaughterhouse are discharged directly into the Singuedala River (which is a tributary of the Bafing River and itself a tributary of the Senegal River) without prior treatment. This wastewater is a source of pollution for the waters of the Bafing and Senegal Rivers. They can be responsible for an irreversible ecological imbalance as well as for the eutrophication of the waters of the receiving environment.

The present article consists in making a physico-chemical and microbiological characterization by determining some major and global parameters of the wastewater pollution and describing the measures of protection of the receiving environment and by proposing a suitable means of treatment of these effluents.

II. Materials And Methods

2-1. Description of the study area

This study takes place in the prefecture of Mamou located 270 km from the capital Conakry between 10°22'39.93"N and 12°5'2.57"W at an average altitude of 700 m, with a climate characterized by the alternation of two seasons of equal duration, the dry season from November to April and the rainy season from May to

October. Rainfall varies between 1600 mm and 2000 mm, with an average annual temperature of 25°C. It covers an area of 8000 km2 with a population of 318,738 inhabitants (2014) [5].

2-2. Material and Methods

For the realization of this work, the following equipment was used: a pH meter HANA HI 1832, a conductivity meter HANA LF 330, a spectrophotometer DR 2800, Oximeter Model DO210, a turbidimeter Hach 2100p, an analytical balance with a precision of 0.0001 g ADAM - Model NBL124i, a filtration ramp with funnels and filter holders, a vacuum pump.

The physico-chemical and microbiological parameters were determined on the water samples taken during the month of July 2021 at a rate of two (2) samples per week.

III.   Results and Discussion

3-1 Results

The results of the analysis of raw wastewater from the slaughterhouse in Mamou (Guinea) gave the following values for physico-chemical characteristics.

Table 1

Parameter	Samples							
	E_1	E_2	E_3	E_4	E_5	E_6	E_7	E_8
Temperature °C	26,6	25,8	25,9	26,4	26,6	24,9	25,3	24,9
pH 25°C	7,03	7,08	7,06	7,08	7,11	7,09	7,02	7,02
Conductivity	1240	1225	1305	1285	1260	1255	1890	1958
TSS mg/L	361	365	372	382	392	389	498	589
Nitrites mg/L	0,026	0,028	0,032	0,029	0,037	0,042	0,325	0,326
Nitrates mg/L	1,623	1,628	1,675	1,589	1,601	1,745	1,825	1,889
Phosphates mg/L	0,079	0,081	0,079	0,086	0,086	0,089	0,91	0,093
Dissolved Oxygen mg/L	1,71	1,73	1,75	1,68	1,62	1,65	1,34	1,34
COD mg/L	228,32	227,89	227,65	226,87	228,12	229,18	230,14	230,16
BOD5 mg/L	185,43	189,25	192,26	179,98	200,68	219,32	289,56	290,6

3-2 Discussions

3-2-1 Temperature:

The results of the analysis of raw wastewater from the slaughterhouse in Mamou (Guinea) showed that the temperature of wastewater from the slaughterhouse in Mamou is between 24.9 ° C and 26.6 ° C as extreme minimum and maximum values and 25.8 ° C as average value (Table 1).These values are below 30 ° C considered as the limit value for direct discharge into the receiving environment [6]. Similarly, these values are lower than 35°C, considered as the maximum indicative value for water intended for irrigation [6].

3-2-2 The pH

The pH values between 7.02 and 7.11 as the minimum and maximum extreme values indicate that the wastewater from the slaughterhouse in Mamou is relatively neutral with an average of 7.6. However, the pH varies according to the samples. The variation in pH during sampling could be due to the passage of pollutants [7].

3-2-3 Electrical conductivity

Electrical conductivity is one of the simplest and most important parameters for wastewater quality control. It informs us about the degree of mineralization and the salinity level. It expresses the capacity of the water to conduct a measured electric current.

The results obtained indicate values between 1225 and 1958 with 1427.25 as the average value. They thus highlight a more or less important variation of the mineralization. The important variation in conductivity between samples E7 and E8 with the other samples could be due to the intense slaughter of oxen during this holiday period. These variations agree with the results obtained by Driss BELGHYTI et al, during the Physico-chemical characterization of slaughterhouse wastewater for the implementation of an adequate treatment: case

of Kenitra in Morocco but our results are inferior to those found by Abouelouafa et al during the physico-chemical and bacteriological characterization of raw wastewater from the city of Oujda.

The comparison of the electrical conductivity values of the analyzed wastewater with the quality standards of water intended for irrigation allows to deduce that these wastewaters are acceptable for crop irrigation. Similarly, these average values are lower than 2700μs/cm, considered as the limit value for direct discharge into the receiving environment [7].

3-2-4 Suspended solids (SS) mg/l

The determination of TSS of the wastewater from the slaughterhouse of Mamou shows that these waters are characterized by a high minimum concentration of 361 mg/l and 589 mg/l maximum with an average of 418.50 mg/l. this shows that these waters have a significant load of mineral and organic matter. The increase in TSS concentration observed from E1 to E8 would be related to the frequency of slaughter.

These results are close to those found by Driss BELGHYTI et al, during the Physico-chemical characterization of slaughterhouse wastewater for the implementation of an adequate treatment: case of Kenitra in Morocco.

According to the results, it is noted that the wastewater from the slaughterhouse has the same loads as Moroccan urban wastewater for which TSS concentrations are between 250 and 700 mg/L [8].

3-2-5 Nitrites, nitrates and phosphates.

Nitrates and other nitrogenous forms evolve rapidly in the natural environment according to the nitrogen cycle. The values of Nitrates obtained in the discharge waters of the slaughterhouse of Mamou showed variations during the period of study. Nitrate levels in the effluent from the slaughterhouse in the urban commune of Mamou varied between 1.589mg/L and 1.889mg/L with an average concentration of 1.697mg/L. The comparison of the average concentrations of Nitrates in the analyzed wastewater with the quality standard of water intended for irrigation shows that, these concentrations are lower than 50mg/L, which makes it possible to deduce that these effluents are acceptable for the irrigation of the cultures [9]. On the other hand, the values of Nitrites recorded in the treated samples do not show considerable variations except in samples E7 and E8, which could be due to the intensity of slaughtering noted during this period.

Nitrites are an important step in the metabolism of nitrogen compounds, they are also part of the nitrogen cycle between ammonium and nitrates. Nitrites are usually the result of incomplete degradation of ammonia or reduction of nitrate, they are only an intermediate stage and are easily oxidized to nitrate (chemically or bacterially). The Nitrite contents of the analyzed wastewater vary between 0.026mg/L and 0.326mg/L with an average value of about 0.106mg/L (Table 1).The low concentrations of Nitrite encountered in the wastewater of the studied effluent, could be explained by the fact that the Nitrite ion (NO_2^-) is an intermediate compound, unstable in the presence of oxygen, whose concentration is generally much lower than that of the two forms that are linked to it, the Nitrate and Ammonium ions.

The recorded phosphate contents do not show considerable variations during the sampling cycle. The recorded values vary between 0.079mg/L and 0.910 mg/L with an average value of 0.188 mg/L. Chennaoui et al [11] reported an average phosphate content of 1.8g/L. At the level of slaughterhouse wastewater in Canada, Massé and Masse, [12] found values between 25 and 42 mg/L while Driss BELGHYTI et al. found values that vary between 0.059mg/L and 0.147mg/L with an average value of 0.089mg/L.

3-2-6 Dissolved oxygen (DO), COD and BOD5

Dissolved oxygen conditions the reactions of degradation -aerobic- of organic matter and more generally the biological balance of water environments [13]. Its presence inhibits the denitrifying activities of the specialized flora. The contents of wastewater samples from the Mamou slaughterhouse vary between 1.34 mg/l (E7 and E8) and 1.75 mg/l (E3) with an average of 1.60 mg/l. The comparison of dissolved oxygen values in our analyzed wastewater samples with the surface water quality grid allows us to deduce that these wastewaters are of very poor quality [14]. These results prove that these waters are not capable of supporting an aquatic life because they are the seat of intense oxidation reactions.

The physico-chemical characterization of wastewater from the slaughterhouse in the urban commune of Mamou (Guinea), gives BOD5 values ranging from 179.98 mg/l (E4) to 290.6 mg/l (E8) for an average of 218.39 mg/l.

The high values of BOD5, could be explained by the abundance of organic matter and by the concentration of this effluent by the blood of the drained municipal slaughterhouse. For COD, the values are lower than those of Moroccan urban waters (500-1500 mg/L) [36]. These average values are lower than 500 mg/L, which is considered the limit value for direct discharge [28]. Furthermore, these wastewaters are classified as very poor according to surface water quality standards [15].

The COD values show a significant variation during the study period (between 226.87 mg/l E4 and 230.16 E8 with a monthly average of 228.54 mg/l). This observation is similar to that made by Khamar [16] and Zerhouni [17]. The pollutant load of the wastewater, as measured by its COD, is one of the most important criteria used in the design of a wastewater treatment to determine the degree of treatment required. The load to be treated is the COD of the wastewater that is fed to it [18]. In addition, these values are lower and do not agree with those reported by Sachon in France [19]; Tritt and Shuchard in Germany [20]; Gnagne et al. in Burkina Faso [21-22] and the work of Miranda et al, [23], Reginatto et al [24] in Brazil.

IV. Determination of the COD/BOD ratio5

The determination of the COD/BOD5 ratio is very important in order to determine the biodegradability or not of the pollutants.

Table 2

Parameter	Samples							
	E1	E2	E3	E4	E5	E6	E7	E8
COD	228,32	227,89	227,65	226,87	228,12	229,18	230,14	230,16
BOD5	185,43	189,25	192,26	179,98	200,68	219,32	289,56	290,6
COD/BOD5	1,23	1,20	1,18	1,26	1,14	1,04	0,79	0,79

The COD/BOD5 ratio is used to deduce whether the wastewater discharged directly into the receiving environment has the characteristics of domestic wastewater (COD/BOD5 ratio less than 3) [25]. The results of this ratio are an indication of the importance of pollutants with little or no biodegradability [26]. Wastewater from the municipal slaughterhouse in Mamou (Guinea) has a COD/BOD5 ratio ranging from 0.79mg/L (E7 and E8) to 1.26mg/L (E4), which is consistent with that of predominantly domestic urban wastewater with a COD/BOD5 ratio less than 3 [27]. Thus, it can be concluded that although the wastewater from the slaughterhouse in the urban commune of Mamou has a high organic load, it is easily biodegradable.

This COD/BOD5 ratio underlines the biodegradable character of the slaughterhouse wastewater, for which biological treatment or treatment with activated carbon would appear to be suitable. These results are in agreement with those reported by Gnagne and Brissaud [28] and Zerhouni [29].

V. Conclusion

The wastewater from the municipal slaughterhouse in the town of Mamou has values for major physico-chemical pollution parameters that relatively exceed the general limit values for direct and indirect discharges into the receiving environment (Singuedala River), which represents an environmental pollution risk for the latter, hence the need for treatment of this raw wastewater.

At the end of the physico-chemical characterization of the wastewater from the Mamou slaughterhouse, it was found that all the parameters studied (TSS, electrical conductivity, COD, BOD5) placed the wastewater analyzed in the medium to high concentration range [30]. Moreover, according to the classification of urban effluents carried out by the Moroccan National Office of Drinking Water, these wastewaters are 5 to 7 times more loaded with organic matter than Moroccan urban waters [31]. In addition to the organic matter, it contains adequate quantities of organic nitrogen to meet the needs of the purifying microorganisms of biological systems [32].

It can be concluded that the wastewater from this discharge is easily biodegradable since the BOD5/COD ratio is within the standards.

The analysis of the COD/BOD5 ratio shows the biodegradable character of the wastewater from the slaughterhouse to which a biological treatment or a treatment with activated carbon seems to be quite suitable. The treatment of this wastewater is necessary in order to produce an effluent that respects the direct and indirect discharge standards.

The Mamou slaughterhouse discharges wastewater that would be suitable for biological or activated carbon treatment in terms of BOD5, TSS, and nutrients (nitrates, nitrites).

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