International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

Vol. 35 No. 2 November 2022, pp. 11-22

Tillaberi Slaughterhouse Discharges And Their Impact On The Niger River: A Physicochemical And Microbiological Analysis

Hassimi Moussa [1*], Abdou Harouna [2], Bachir Yaou Balarabe [3], Adamou Moussa [4], Hafidi Mohamed [5]

[1] Département des Sciences de l'Environnement, Faculté des Sciences Agronomiques, Université Boubakar Bâ de Tillabéri, BP : 175 Tillabéri-Niger

[2] Département de Production et Nutrition Animale, Faculté des Sciences Agronomiques, Université Boubakar BÂ de Tillabéri, BP : 175 Tillabéri-Niger

[3] School of Engineering and Technology, National Forensic Sciences University, Sector-09, Gandhinagar –382007, India

[4] Laboratoire d'Analyse des eaux, Direction Régionale de l'Hydraulique et de l'Assainissement de Tillabéri,

[5] Laboratoire Ecologie et Environnement, Faculté des Sciences Semlalia Marrakech, Université Cadi Ayyad.

*Corresponding Author:

E-mail : atpscontact@gmail.com (Hassimi Moussa)

Tel : +227 97377838

Abstract – The main objective of this work was to study the solid and liquid waste discharges of the slaughterhouse of Tillaberi, and their impacts on the Niger River. Initially, the solid waste of the slaughterhouse was identified and quantified, then the liquid discharges of the slaughterhouse and of the river water were characterized physicochemically and microbiologically. The results obtained showed that the slaughterhouse in the urban commune of Tillaberi produced an average of 156.1 ± 41.1 kg of solid waste per day, divided into four groups: 133 kg of stercoral, 19.7 kg of seized organs, 1.9 kg of plastic, and 1.4 kg of skin pieces. The average values obtained after physicochemical and microbiological characterization of the liquid waste are as follows: pH (7.08 ± 0.15), Temperature (28.6 ± 0.49), Electrical conductivity (985 ±184.1 µS/cm), COD (12860 ± 3831.8mg/l), BOD (5338 ± 1572.05mg/l), Suspended Solid (835 ± 258.7mg/l) Chlore (81.5 ± 1.3 mg/l), Nitrate (0.66 ± 0.97mg/l). The BOD5/COD ratio is about 0.41. Then, the total microbiological characterization of the liquid discharges was about 6,6.10^4 CFU/ml of coliforms for the Slaughterhouse and 11,2 CFU/ml for the river water. The physicochemical and microbiological characterization of the river water showed that most of the physicochemical parameters comply with the WHO limits, except for the BOD5 and COD, which have fairly high average values of 62.5 ± 47.06mg/l and 200 ± 110.1mg/l respectively. It is evident from all these values that river water is polluted to the point of exceeding WHO standards. It is most likely that the pollution would come from the effluents released from the slaughterhouse.

Keywords – solid discharge, liquid discharge, Tillaberi slaughterhouse, pollution, river water

I. Introduction

The production of large animal food processing companies requires a significant amount of water. Most of the wastewater generated by this process is returned to the environment after it has been used. Usually, organic matter is present in this type of water, which contributes to the pollution of the environment where it is discharged. This pollution also affects the Niger River. 4200km long, the Niger River ranks third in length in Africa behind the Nile and Congo. Nine (09) countries are involved in its active basin: Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria, and Chad. Providing drinking water, irrigation, fish farming, energy production, and transport, the Niger River is a vital resource for the country. In this way, it makes up a substantial part of the country's wealth and represents a major asset for the country in terms of its development. Moreover, the area is also an exceptional natural and cultural reservoir, a cradle of prestigious civilizations, and a repository of cultural heritage. With a total area of 41,195 km^2, the Inner Niger Delta is the second-largest wetland in the world (ABN, 2018). Around 160 million people rely on it for their water and nutritional needs. It is unfortunate that there are a number of human activities that endanger the health of these waters (Rabani et *al.,* 2015). In the absence of treatment, wastewater from the food industry is considered very harmful to the receiving environment (Belghyti et *al.,* 2009). There is no doubt that slaughterhouses are a prime example of these industries in which water is used in order to wash by-products (offal) and to eliminate waste (feces, rumen debris, blood) that are generated during the process. Cattle carcasses discharge between 6 and 9 liters of wastewater for each kilo of wastewater discharged (Bisimwa, 2014). Consequently, surface and groundwater are likely to be contaminated by these effluents (Kerboub, 2012; Kerboub et Fehdi, 2014). Chemical contamination of groundwater results in vertical migration of the polluting liquid from soils impregnated with the polluting fluid at a concentration close to saturation. This was preceded by a horizontal migration (Michael, et *al.,* 2010). Numerous countries in the basin of the Niger River participate in efforts to protect the quality of this common resource since they have common interests (ABN, 2018). The majority of the processing industries in Niger can generally be found on the banks of the river, which is a dominant feature of the country. In light of this, the river's water quality affects the health of the local community. As a result, they may be at risk of serious health problems that may have major negative economic and social consequences (Amadou et *al.,* 2011). Surface water pollution is becoming a global concern. Increasing acidity levels are caused by greenhouse gases, toxic products, heavy metals, fertilizers, and pesticides carried by rivers (UN, 2021). The characterization of liquid waste from slaughterhouses has been the subject of several studies over the past few years (Jabari et *al.,* 2016; Ogbomida et *al.,* 2016; Bosede et Omokaro, 2021). So far, very little is known about the impact of slaughterhouse discharges on the Niger River and on the local environment in Niger. Consequently, this is the context in which this study was conducted. In this study, we examine the source of pollution in the Niger River: discharges from a slaughterhouse in Tillaberi.

II. Materials and Methods

2.1. Location of the study site

The Urban Commune of Tillaberi is located at an altitude of 215m between 14° 12'37" north and 1° 27'10" east. Located in the department of Tillaberi, this commune is part of the Tillaberi region (Figure 1). Tillaberi is one of the most influential cities. A significant proportion of the Tillaberi population is engaged in livestock farming, which is the second pillar of the economy. It is an agricultural commune where cattle, goats, sheep, camels, horses, and donkeys are raised (PDC, 2017).

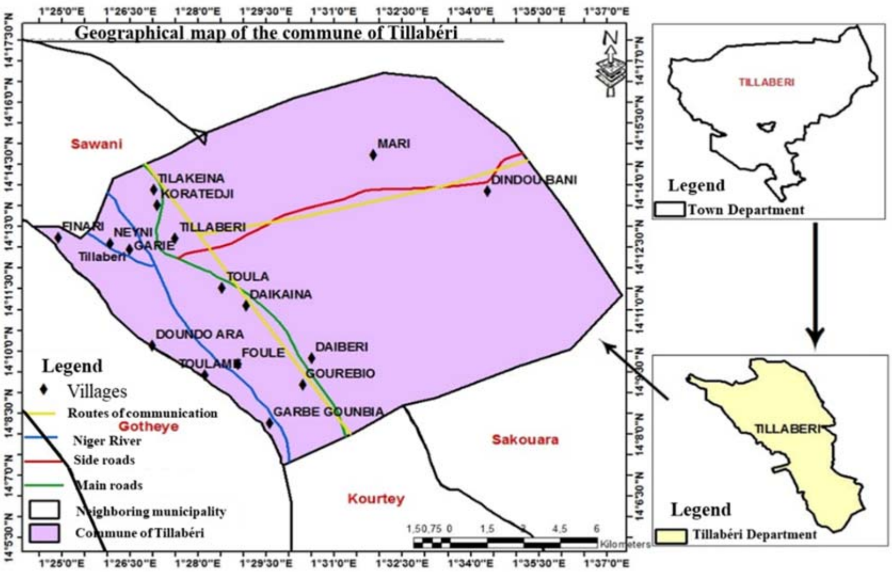

Figure 1: Location of Tillaberi communal slaughterhouse

Tillaberi slaughterhouse was built in 2009 with the assistance of the Decentralized Communities Investment Fund (FICOD), the town hall, and an association of butchers. A municipal livestock service maintains the management committee secretariat and inspects meat for health hazards. The town hall is managed by a committee, which includes a president, a breeding secretariat, a treasurer, and an auditor. Solid and liquid discharges are managed separately. An open-air basin is used to contain the liquid discharges from the slaughterhouse, i.e., blood from the slaughter as well as water from washing carcasses and viscera, which are drained through a pipe system (Figure 2a). In the enclosure, solid waste from the slaughterhouse (dung, droppings, organs, skin scraps, and other contaminants) is disposed of (Figure 2b).

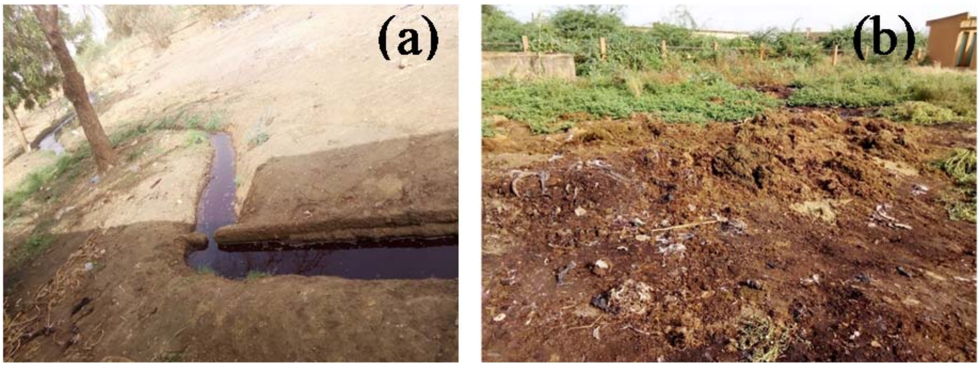

Figure 2: (a) Drainage channel for the municipal slaughterhouse in Tillaberi, (b) Solid waste accumulation point in Tillaberi slaughterhouse

2.2. Sampling

In the experimental study, solid waste was identified and quantified from the slaughterhouse. Liquid discharges from the slaughterhouse and stagnant water from the banks of the Niger River were analyzed physicochemically and microbiologically.

- A wastewater sample is collected at the evacuation channels located at 14°19"53' North and 1°46"11' East from the Tillaberi slaughterhouse. Another sample is taken along a stream draining liquid effluent from the slaughterhouse from the river at 14°19"48' North and 1°45"96' East. As a control, samples were taken approximately 100 meters downstream from the slaughterhouse in stagnant water areas along the river. Polyethylene terephthalate bottles (1 liter) were used to collect samples. The samples were kept at a temperature of 4°C before physicochemical and microbiological analyses were conducted.
- Solid waste is collected on-site, classified according to its nature (stercorary matter, seized organs, plastics, skin pieces), and then quantified daily. For a period of seven days (07), this procedure is repeated.

2.3. Liquid discharge physicochemical and microbiological characterization

Prior to analysis, the samples are filtered and diluted to 1/10th, given their concentration. Using Ademoriti's (1996) and Bosede and Omokaro's (2021) laboratory analysis methods, wastewater samples were analyzed. In this study, parameters such as temperature, pH, conductivity, dissolved oxygen (DO), total dissolved solids (TDS), biological oxygen demand (BOD), and chemical oxygen demand (COD) were monitored over a period of four weeks. Temperature, pH, dissolved oxygen, salinity, conductivity, and total dissolved solids (TDS) were measured in situ with a portable multifunction probe (WQC-30/DKK-TOA). Filtration was used to determine the suspended solids (MS). Chloride, chromium, ammonia, nitrate, nitrite, phosphate, and sulfate are detected by spectrophotometry for chemical elements. Using a BOD meter, liquid effluent samples were incubated at 20°C for BOD measurement, and COD was determined by oxidizing potassium dichromate in an acid medium (APHA, 1998). The microbiological analysis involved looking for fecal coliforms (E. coli) and total coliforms by mass and surface inoculation. According to ISO 9308 and ISO 11133, Chromogenic Coliform Agar (CC Agar) was used as a culture medium. All the parameters that have been studied can be seen in figure 3 below.

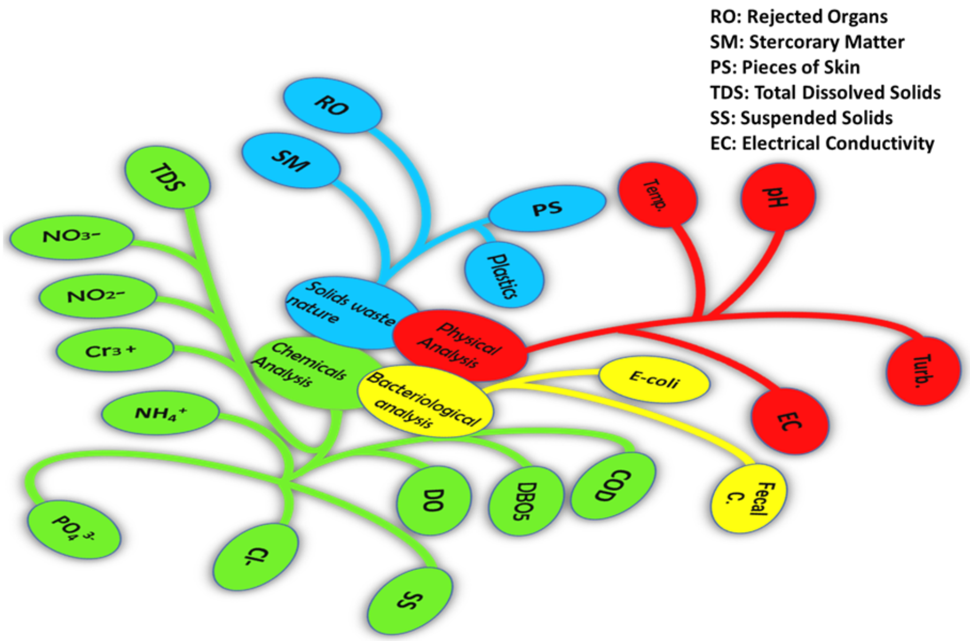

Figure 3: Parameters examined in the study

2.4. Analysis and processing of data

The data obtained during this study were analyzed using an analysis of variance (ANOVA) ($P > 0.05$) using SPSS 20.0 and Microsoft Excel version 2019. As for the graphs, they were drawn using Origin2021.

III. Results and Discussion

3.1. Quantification of solid waste

The study conducted in the Tillaberi slaughterhouse identified four (04) types of solid waste: (i) Stercorary matter, which is material found in the stomach, intestines, leaflets, etc. (ii) Organs seized after inspection, (iii) Skin scraps discarded during butchery, and (iv) plastics ingested by slaughtered animals. It is estimated that approximately 70% of the solid waste discharged from animal slaughterhouses is made up of this type of waste (Michael et *al.,* 2010). In contrast to slaughterhouses elsewhere, Tillaberi slaughterhouse does not reject the bones, horns, and claws of animals that are slaughtered (Tolera & Alemu, 2020). Upon eviscerating a carcass, butchers dispose of the entire piece. The heads and legs are integrated into the local value chain of the local market. As shown in Figure 4a, the slaughterhouse in Tillaberi discharges 1093 kg of waste a week, which is an average of 156.1 ± 41.1 kg. In the total quantity (1093 kg), 931 kg was stercorary matter (excrement), or 85.2%, 138 kg was organs (12.6%), 10 kg was skin (0.9%), and 13.8 kg was plastics (1.3%). Figure 4b shows how much waste is discharged each day over the seven (07) days of the week. As reported by Michael et al, this production corresponds to the waste generated by the slaughterhouse in Cotonou (Benin) (Michael *et al.* 2010). Approximately 557 kilograms of solid waste are generated daily by a slaughterhouse in Ouahigouya (Bosco (2009). Researchers found that the population density of a city has a significant impact on the amount of waste produced within slaughterhouses. Figure 4b shows there is approximately twice as much waste generated on the seventh day. Because the market day occurs on day 7, more heads are slaughtered and more waste is generated as meat demand increases. At present, there are a number of factors that can contribute to the pollution of sensitive environments due to the current state of waste management. Most African slaughterhouses lack systems capable of recovering by-products of slaughter for future use (Chennaoui et *al.,* 2012). Animal blood, stomach contents, urine, and feces, as well as possibly other organic constituents, are drained into storage basins or wastewater collectors (Abdou, 1999; Bosede et Omakaro, 2021). As an example, waste from the municipal slaughterhouse in El Jadida is discharged directly into the sea without any prior treatment (Chennaoui et *al.,* 2012).

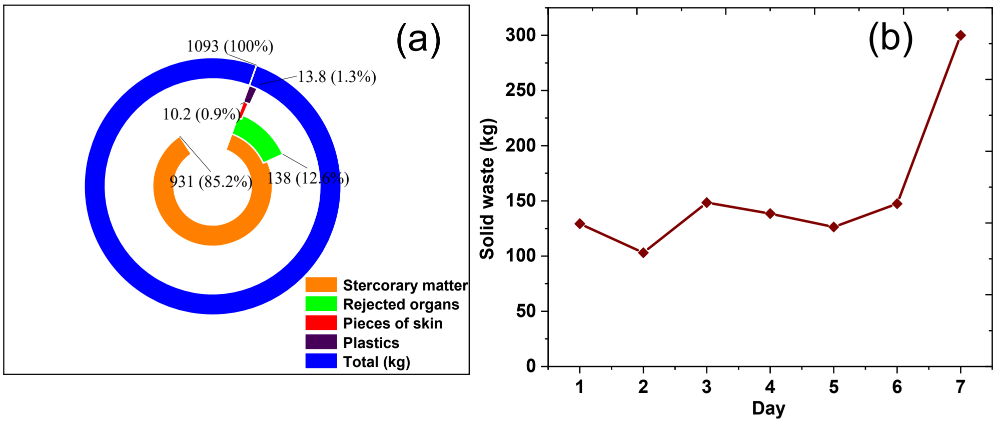

Figure 4: (a)-Solid waste distribution and quantitative estimation. (b)-7-day evolution of solid waste

3.2. Physical analyses of liquid discharges

In light of the monitoring of parameters that indicate aquatic pollution in the liquid discharges from the slaughterhouse and in the river waters, the following conclusions were drawn: During the first to fourth week of the study, slaughterhouse wastewater had an average temperature of 27.8°C to 29°C. There is a temperature fluctuation in the river waters of 29.3 - 31.7 °C (Figure 5a). During the same period, the pH evolution of river water and slaughterhouse wastewater was identical. Both cases show fluctuating values between 6.5 and 7.4 (Figure 5b). Conversely, slaughterhouse wastewater shows the highest value (1100 µS/cm) of electrical conductivity from the first week, followed by a decline from 1100 µS/cm to 700S/cm by the second week. Then it returns to its original value from the third week and remains constant until the fourth week (Figure 5c).

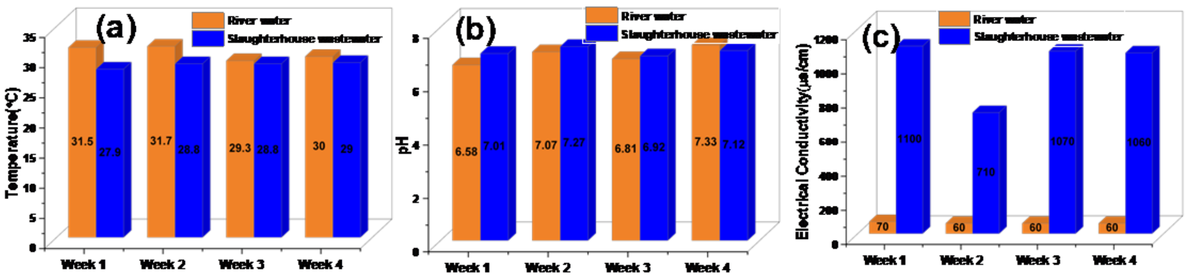

Figure 5: (a)-Temperature, (b)-pH, (c)-Electrical conductivity changes in river water and slaughterhouse wastewater over a one-month period

The slaughterhouse wastewater average temperature, as shown in figure 6a, is 28.6±0.49°C, and the river water is 29.7±1.3°C. According to the World Health Organization (WHO), wastewater should be discharged at a temperature of 30°C. Based on the results, it appears that the average temperature is below this level. Therefore, these results are not in agreement with those found by Belghyti *et al*., (2009), who obtained an average of 21.6°C across 85 samples, and those found by Michael *et al*., (2010), who found an average temperature of 30,6°C but slightly higher than that found by Rabani *et al.*, (2015). The water of the river, which is considered surface water, does not have a temperature limit. Except for a few species that can tolerate pH values below 5 or above 9, water with a pH between 6.5 and 8.5 supports a substantial number of aquatic species (Harrison, 1999). According to Sawyer (2003), these pH values are normal for unpolluted fresh water. As recommended by the WHO (WHO, 2004), these values are within the ranges of 6.5-9.5. According to a study conducted by Bosede and Omakaro in Nigeria, wastewater from Swale Slaughterhouse measured 7.19 pH in 2021. This falls within the WHO's recommended pH range for river water (Figure 6b). In a study by Rabani *et al*., 2015) it is noted that river water has a self-purification capacity that prevents pH variations. The average conductivity of wastewater is 985 ±181.1µS/cm. This value is 62.5 S/cm for river water. Electrical conductivity is a measure of the overall rate of mineralization in the water. Current conduction in an electrolyte is determined by the concentration of ionic species (Hayashi, 2004). It is one of the most crucial factors in controlling the quality of water. As shown in Figure 6c, the average value in the wastewater indicates mineralization. Compared to (Bosco, 2009), who found 1037µS/cm (Abdelaziz *et al*., 2013; Belghyti *et al.*, 2009), who found 1340µS/cm and 1360µS/cm, respectively, these results are lower. In Nigerian abattoir wastewater, (Bosede and Omakaro, 2021) found mean values of 4981µS/cm. In accordance with the WHO's recommendations, the average value of electrical conductivity of the river's waters is low (62.5 µS/cm). Turbidity is an indicator to measure the turbidity of a liquid, which has been recognized as a simple basic indicator of water quality (Harch). In addition, the turbidity values of the wastewater and river were 348.25 ± 36.8 NTU and 31.4 ± 4.3 NTU, respectively, which was well above the WHO recommended turbidity value of less than 5 NTU (Figure 6d). Turbidity due to suspended solids, on the other hand, can harm benthic organisms and fish by silting up spawning grounds. Furthermore, suspended solids in water can also serve as a vehicle for the transport of phosphorus and other pollutants such as pesticides, metals, and other toxins (Ng *et al.*, 1993; Kronvang *et al.*, 1997).

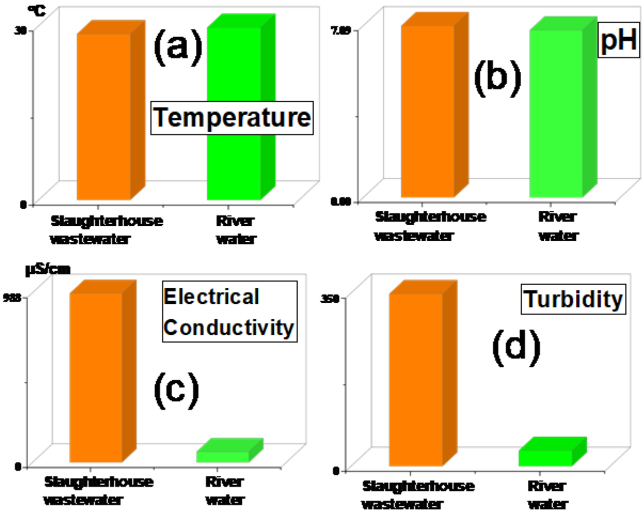

Figure 6: Comparison of physical parameters in wastewater and river water after 4 weeks: (a)-Temperature, (b)-Ph, (c)-(Electrical Conductivity), (d)-Turbidity

3.3. Chemical analyses of liquid discharges

The slaughterhouse wastewater contained 0.19±0.18 mg/l ammonium, while river water contained 0.02 mg/l ammonium, which are also safe values compared to the WHO maximum of 0.5 mg/l (Figure 8a). Additionally, the chlorine content of the slaughterhouse wastewater is 81.5±23.3 mg/l while it is 29.9±31.1 mg/l for the river water (Figure 8b). Compared to the World Health Organization's maximum of 250 mg, these values are safe. A total of 21.5 mg/l of phosphorus was found in wastewater (Figure 8c), with values ranging from 2.15 to 65.55 mg/l. Similarly, Bosede and Omokaro, (2021) found similar levels in slaughterhouse wastewater in Bayelsa, Nigeria. In terms of domestic and industrial effluents, this value is substantially higher than the WHO standard (0.4 mg/l). The values found in the waters of the river range between 0.47 and 4.65 mg/l, with an average of 2.17 mg/l. The effluents from the slaughterhouse have a high fecal matter content, which contributes to eutrophication in the river waters. In slaughter wastewater and river water, nitrite concentrations were 0.66 ± 0.09 and 0.141 ± 0.01 mg-N/l, respectively (Figure 8d). Similarly, wastewater has very high levels of nitrate. It is 10.89±2.71 and 2.01±0.32mg-N/l respectively for slaughterhouse and river water (Figure 8e). Nitrate levels are well above the WHO limit of 10 milligrams per liter. There is, however, a higher level of nitrate in the effluent of this slaughterhouse than in the river. The reason for the difference can be attributed to the high fecal content of the effluent. It is also possible that the nitrogen content of effluent is primarily derived from blood and stomach contents. As a result, receiving environments are not immune to pollution. Compared to Belghyti, *et al.*, (2009), who found an average value of 1.742 mg/l, these results are significantly higher. Alternatively, this high concentration of nitrate may come from the contents of animals' stomachs or from chemicals used to wash the viscera. The nitrate levels in slaughterhouse wastewater and river water differed significantly. In their study of industrial activities in the Niger River, Amadou *et al.* (2009) report 0.3 mg/l as an average value. A high concentration of nitrate and phosphate in surface waters has been reported to cause eutrophication. Similarly, high levels of nitrate can lead to blue eye syndrome in young children and pregnant women (AWWA, 1990). High concentrations of nitrite and nitrate in water can negatively affect water treatment processes and pose health risks. High levels of nitrate in water can indicate biological waste (Hach). Natural waters and wastewater contain a variety of phosphorus compounds, such as soluble orthophosphates, water-soluble phosphates, and organophosphate derivatives (Rodier, 2009).

Dissolved oxygen levels in the slaughterhouse wastewater and in the river have decreased slightly from the first to the third week, decreasing from 2.11mg/l to 1.75mg/l. The dissolved oxygen level nearly returns to its initial level from the fourth week, after increasing from the third week. A similar phenomenon was also observed in slaughterhouse wastewater, except that the dissolved oxygen level remained below 1mg/l for the first four weeks, making it extremely low (Figure 7a). A clear difference in the organic load of slaughterhouse wastewater and river water was observed over the study period when measuring BOD5 and COD. COD levels in the four samples vary from 10240 to 16720 mg/l of O_2 in the first two weeks to 15520 mg/l to 8960 mg/l in the third and fourth weeks. From week 1 to week 2 the BOD5 level was 5240 mg/l of O_2, then 6800 mg/l of O_2, then 3184 mg/l of O_2 in the last two withdrawals. Comparing surface water to slaughterhouse wastewater, BOD and COD values are relatively low. COD values range from 64 to 328 mgO_2/l (Figure 7b).

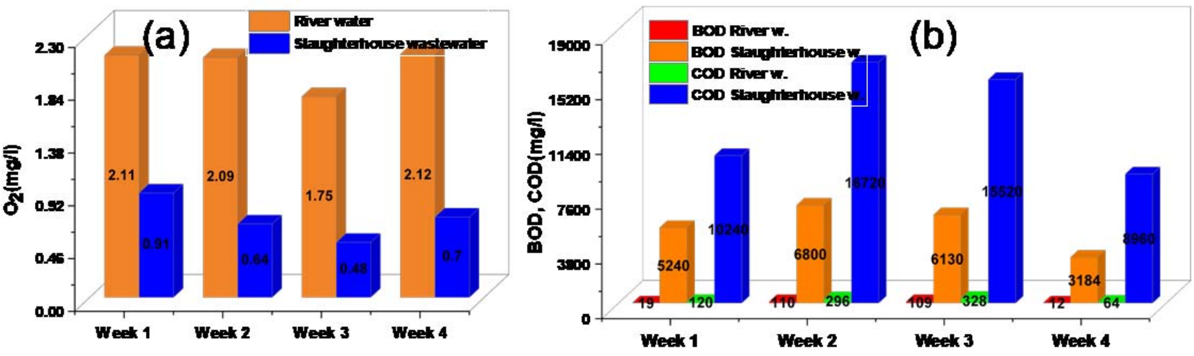

Figure 7: (a)-Dissolved oxygen, (b)-BOD and COD changes in river water and slaughterhouse wastewater over a one-month period

In both wastewater and river water, the chromium levels of 0.83±1.3 mg/l and 0.137±0.13 mg/l are much higher than the 0.05 mg/l imposed by the World Health Organization (Figure 8f). It has been shown that chromium can cause fatal effects in a variety of fish species, such as lymphocytosis, anemia, eosinophilia, and bronchial and renal lesions. The high concentration can damage fish gills in surface waters near places where chromium products are disposed of (Goyer RA, 2001). As compared to other test species, rainbow trout is 1.16 to 2.52 times more sensitive to Chromium at minute concentrations (Svecevicius, 2006). Dissolved solids in slaughterhouse wastewater and river water are 486 and 30 mg/l, respectively. The average value of suspended solids is approximately 985 mg/l. Moreover, the analyses showed average values of SS of 247.5 mg/l for the waters of the river (Figure 8g&h). The SS refers to the dry mass of solids captured on top of a filter paper after filtering a measurable volume of water using a 0.45 µm filter paper. The SS consists of both organic and inorganic materials (APHA, 1999). The concentration of suspended solids that are harmful to surface waters cannot be determined with precision because it is difficult to measure. For the protection of aquatic life only, the Department has established toxicity criteria of 25 mg/l for acute toxicity (long-term adverse effects) and 5 mg/l for chronic toxicity (Goyer RA, 2001).

The average value of dissolved oxygen in wastewater is 0.68 ± 0.17, while it is 2.01 ± 0.15 in river water (Figure 8i). Water samples from the slaughterhouse wastewater and the river water showed a slight decrease in the amount of dissolved oxygen between the first and third week. This dropped from 2.11mg/l to 1.75mg/l. We observe a rise in dissolved oxygen level after the third week, which returns to its original level after the fourth week. The dissolved oxygen level in slaughterhouse wastewater remained below 1 mg/l from the first to the fourth week, which is extremely low. Compared to river water, wastewater from a slaughterhouse has a high organic load of dissolved oxygen. Dissolved oxygen indicates the amount of pollution caused by organic matter, the biological degradation of organic matter, and the self-purification of the environment. In an aquatic environment, dissolved oxygen levels below 2.0 mg/l indicate stress. In natural waters, the permissible concentration must be greater than or equal to 7 mg/l (WHO, 2004). Rodier (2009) noted that dissolved oxygen is necessary for aerobic biodegradation reactions of organic matter in water. For river waters, the results range between 1.75 and 2.01 mg/l, with an average of 2.01 mg/l. This shows the influence of slaughterhouse discharges on these waters because these waters are generally stagnant. The average BOD5 and COD values from liquid waste from a slaughterhouse are 5338.5±157.20 mgO2/l and 12860±383.186 mgO2/l, respectively (Figure 8j). As a result of the abundance of organic matter in the liquid waste from the slaughterhouse, COD and BOD5 values are high. Biological oxygen demand (BOD) is the amount of dissolved oxygen aerobic microorganisms need to break down organic matter in a given water sample. Based on the assumption that water has no bactericidal or bacteriostatic effect, BOD5 indicates the amount of organic matter that can be degraded by microbial metabolism. (Bosede and Omokaro, 2021). As a result, the higher the COD and BOD values in slaughterhouse wastewater, the more organic matter there is. The values recorded in the slaughterhouse wastewater exceeded the WHO limit. As a result of slaughterhouse activities, huge amounts of biological waste are generated. Additionally, BOD to COD ratios are indicators of wastewater biodegradability. Generally, a high ratio of BOD to COD indicates relatively high biodegradability, whereas a low ratio indicates slower biodegradation (Vollertsen and Hvitved-Jacobsen, 2002). It has been estimated that the BOD5/COD value is approximately 0.41 in our study (Figure 8i inset). Several studies have estimated that this value ranges from 0.3 to 0.6 for waters containing enough organic matter to justify biological treatment (Pozo *et al*., 2003; Michael *et al.*, 2010; Abdelaziz *et al*., 2013). During the study period, BOD5 and COD were monitored in slaughterhouse wastewater and river water, showing a significant difference in organic load. In the first two weeks, the COD content varies between 10240 and 16720mg/l of O_2, then it varies from 15520mg/l of O_2 to 8960mg/l of O_2 from the third to the fourth week. From week 1 to week 2, the level of BOD5 increased from 5240 mg/l of O_2 to 6800 mg/l of O_2. In contrast, from 6130 mg/l of O_2 to 3184 mg/l of O_2 in the last two withdrawals. When compared to slaughterhouse wastewater, surface water presents extremely low BOD and COD values. There is a fluctuation between 64 and 328 mgO_2/l in COD values. A comparison of the evolution of BOD5 and COD in slaughterhouse wastewater and river water is shown in Figure 8j.

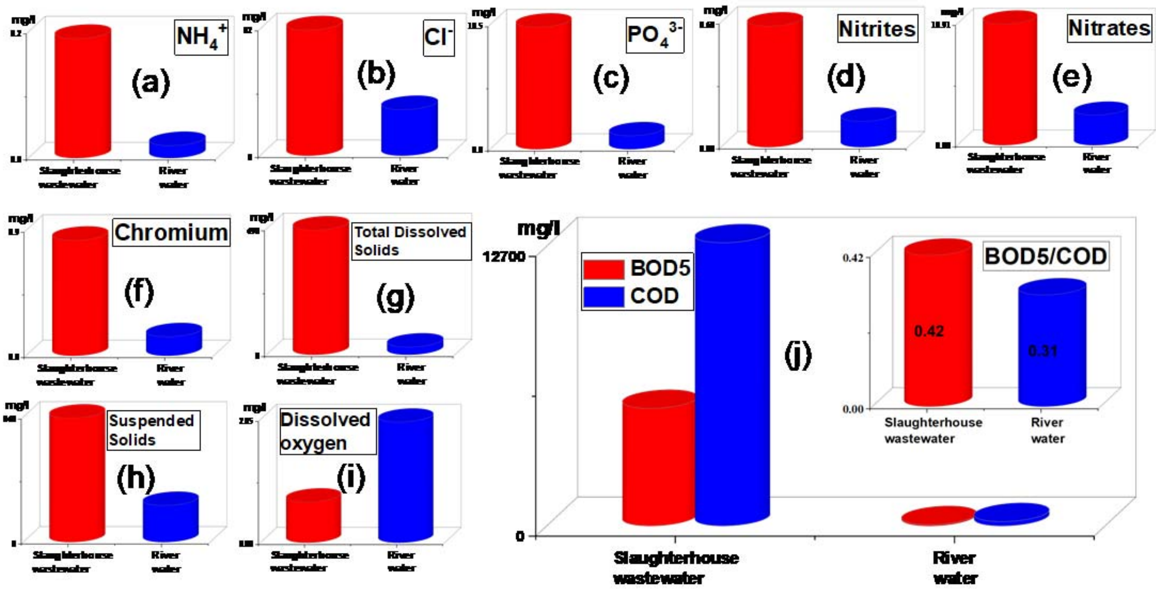

Figure 8: Comparison of physical parameters in wastewater and river water of 4 weeks cumulative: (a)-NH_4+, (b)-Cl-, (c)-PO_4^{3-}, (d)-Nitrites, (e)-Nitrates, (f)-Chrome, (g)-Total Dissolved Solids, (h)-Suspended Solids, (i)-Dissolved oxygen, (j)-BOD5&COD (inset) BOD5/COD rapport.

Based on the physicochemical parameters that were measured as part of this study, it is evident that the facilities operated by slaughterhouses have a negative impact on the water of the river and the immediate environment surrounding them. As a result, the slaughterhouses constitute a source of pollution of the Niger River in the town of Tillaberi. In addition, other researchers have recorded the same observation (Belghyti *et al.,* 2010; Magaji and Chup, 2012; Kabough *et al.,* 2015; Bosede and Omokaro, 2021). All the physicochemical parameters studied in this study are presented in Table 1, along with the standard deviation between the four weekly samples.

Table 1: A physicochemical analysis of liquid waste from the Tillaberi slaughterhouse

		Slaughterhouse wastewater		River water		
Parameters	**Unit**	**Mean**	**Standard deviation**	**Moy.**	**Standard deviation**	**Number of samples**
Temperature	°C	28,6	0,49	29,7	1,3	4
pH	-	7,08	0,15	6,9	0,28	4
Turbidity	NTU	348,25	36,8	31,4	4,3	4
EC	µS/cm	985	184,1	62,5	4,3	4
TDS	mg/l	486	86,08	30	0	4
SS	mg/l	835	258,7	247,5	48,6	4
Cl-	mg/l	81,5	23,3	29,9	31,1	4
Chrome	mg/l	0,83	1,3	0,137	0,13	4
NH_4^+	mg/l	0,19	0,18	0,02	0,01	4
PO_4^{3-}	mg/l	18,2	31,5	2,02	1,6	4
Nitrites-N	mg/l	0,66	0,09	0,141	0,01	4
Nitrates-N	mg/l	10,89	1,23	2,71	0,32	4
Dissolved oxygen	mg/l	0,68	0,17	2,01	0,15	4
DBO_5	mgO_2/l	5338,5	157,20	62,5	4,71	4
DCO	mgO_2/l	12860	383,18	200	11,01	4

3.4. Bacterial population analysis

The results of the bacteriological analyses of the wastewater from the slaughterhouse and the river are presented in Table 2. E. coli ($3.1.10^4$ CFU/ml) in slaughterhouse wastewater is almost as prevalent as fecal coliforms ($3.5.10^4$ CFU/ml). Conversely, the amount of E. coli in river waters is slightly higher than that in wastewater. There are two types of germs sought: Escherichia coli and coliforms (fecal and total). E. coli is a rod-shaped mammalian intestinal bacterium that is very common in humans. There are, however, some strains of E. coli that are pathogenic, causing gastroenteritis, urinary tract infections, meningitis, and sepsis (Françoise, et al 2004). Hassimi (2005) states that they include many microorganisms with fecal origin and serve as markers for food and water hygiene. The results from Tab. 3 found that wastewater has as many E. coli as fecal coliforms. As a result of the discharge of the intestine contents of slaughtered animals, these microorganisms may be present in slaughterhouse wastewater. There is a risk of fecal contamination of these waters because these values are higher than WHO standards (103 CFU/ml) for E. coli and fecal coliforms. They are in agreement with those of Bosede and Omokaro, (2021), Adesemoye *et al*., (2006), and Benka and Olumagin (1995), who also recorded these organisms.

Table 2: Bacteriological analysis of slaughterhouse wastewater and river water

Germs	Slaughterhouse wastewater	River water
E-coli (CFU/ml)	$3,1\ 10^4$	$5,6.10^4$
Fecal coliforms (CFU/ml)	$3,5.10^4$	$5,6.10^4$
Total Coliforms (CFU/ml)	$6,6.10^4$	$11,2.10^4$

IV. Conclusion

A study of the discharge of solid and liquid waste from the Tillaberi slaughterhouse and its impact on the river was conducted in this study. Upon analyzing the results obtained from the study, it was noted that different types of solid waste are rejected by the Tillaberi slaughterhouse in a number that is not insignificant. However, all this waste remains unmanaged, resulting in the pollution of natural environments. In physicochemical and microbiological analyses of liquid discharges from Tillaberi's slaughterhouse, it was found that they exceeded WHO limit values for major pollution parameters for direct discharge into the receiving environment, thus presenting an environmental pollution risk. Therefore, this raw wastewater must be treated. BOD/COD found in these waters is around 0.41, so there is enough biodegradable organic matter to consider biological treatment. In addition, they contain an adequate amount of organic nitrogen for the purification of microorganisms in biological systems. Waters in the river have very high BOD and COD values in comparison with recommended standards for surface waters. In addition, there is also a fairly high level of contamination in these waters, in particular by *E.Coli*. Therefore, slaughterhouse waste is likely to pollute the river.

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