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COMPARATIVE STUDY OF THE PHYSICOCHEMICAL CHARACTERISTICS OF THE SLUDGE FROM THE CITY OF CONAKRY

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ABSTRACT

In many cities in sub-Saharan Africa such as Conakry, large quantities of sewage sludge are generally discharged into the environment without proper treatment. This practice has considerable negative impacts on the environment and further accentuates the deterioration of the health conditions of the populations. The present research concerns the comparative study of certain physicochemical characteristics (T°, pH, MES, COD and N-NH4) of the sludge from the five (5) communes of the city of Conakry. The temperatures are: Matam (32.6°C), Matoto (30.4°C), Ratoma (30.1°C), Kaloum (28.7° C) and Dixinn (28.6°C). The average temperature of these samples is 30.08 ° C. The pH are: Matoto (6.93), Ratoma (6.80) Matam (6.3), Dixinn (6.11) and Kaloum (6.05). The average pH is 6.44. The MES values of the fluid sludge's of the municipalities of Matam, Ratoma, Matoto, Dixinn and Kaloum are respectively 5500 mg/l, 3340 mg/l, 3252 mg/l, 2240 mg/l, 2180 mg/l and what corresponds to an average (3293 mg / l) of MES. The CODs are: Kaloum (32.15 mg/l), Dixinn (1840 mg/l), Matam (857mg/l), Matoto (969 mg/l) and Ratoma (967 mg/l). The N-NH^{4+} concentrations are: Kaloum (32.15 mg/l), Dixinn (33.11 mg/l), Matam (33.86 mg/l) and Matoto (67.72 mg/l), with an average of (41.71 mg/l). These results show that the sludge from the five (5) municipalities of the city of Conakry has relatively the same physicochemical characteristics and requires an adequate treatment (anaerobic digestion or planted beds) before their discharge in the raw state or their use in agriculture.

KEYWORDS: Study, comparative, physicochemical, Drainage, Conakry.

INTRODUCTION

Drainage sludge is the general term to designate fresh (or partially digested) or solid sludge resulting from the storage of valve water or excreta. They are all types of drained sludge from individual sanitation systems such as septic tanks, bucket latrines, pit latrines, on the one hand, and public toilets, on the other.[1]

Data based on the results of several studies show that the typical characteristics of sewage sludge differ from those of municipal wastewater. Sludge can be classified, according to Strauss et al., 1997, into two main categories: type A drain sludge and type B drain sludge.[2]

Type A sewage sludge is relatively concentrated sludge, stored a few days or weeks, biochemically unstable, from public toilets or supermarkets, hotels and others. Type B sewage sludge is, on the contrary, not very concentrated, stored for several years and partially stable coming from autonomous household sanitation devices (septic tanks, latrines). Several studies by different authors report that the characteristics of sewage sludge vary considerably from one region to another, from one country to another, from one city to another and even within the same city.[3]

In 2000, development aid actors still noted with concern that one-third of the world's population, or 2.6 billion, did not have access to improved sanitation.[4] The leaders of the developing countries then resolved to give a helping hand for the resolution of this problem during the millennium summit held in New York. At the summit, they pledged to work to reduce by half by 2015 at the latest, the proportion of the population that does not have sustainable access to a supply of drinking water and adequate sanitation.[5]

Therefore, most development programs support this sector with many significant investments. The latter promote access to infrastructure such as improved latrines, septic tanks, collective or semi-collective sewer

systems, wastewater treatment plants and sewage sludge.[6]

The installation of sewerage networks for sanitation is less suitable for developing countries because they require relatively high discharge rates of wastewater (often caused by a high population density) and a strong financial capacity. Many of the developing countries have therefore turned to autonomous sanitation.

In 2009, Mobéguéré et al., Reported that 65 to 100% of city dwellers in Africa and Asia and 20 to 50% of those in South America use disposal systems that are not connected to a sewer system. These systems consist mainly of latrines and septic tanks.[4]

In West Africa, in some countries such as Burkina Faso, Ghana, Senegal, Ivory Coast, Mali and Guinea, there are initiatives relating to the sludge treatment system. These systems are made up of extensive or low-cost technologies that are either used separately or in combination with others. These are sedimentation / thickening basins, co-composting with solid waste, drying beds, anaerobic digestion with production of biogas, decanter-digester etc.[7]

In Conakry, only sanitation has existed since, thanks to the support of the World Bank and Canada, two (2) sites for the disposal of sewage sludge in Sonfonia and Yimbaya. However, these sites are hardly used because of the high transport costs for the population. As a result, the small quantity of sludge collected does not allow the elimination of bacteria and viruses by the heat of composting and therefore the production of compost for agriculture.[8] The objective of this study is to make a comparative study of the physicochemical characteristics of the sludge from the city of Conakry.

Materials

Presentation of the site

Conakry is a port city opened by a large ledge on the Atlantic Ocean and which counts today more than 2 million inhabitants. This makes it one of the most important African cities with an area of 308 km^2, a length of 34 km and a width of 1 to 6 km. Located in West Africa, Guinea is open to the Atlantic Ocean, bordered to the south by Liberia and Sierra Leone, to the north by Senegal and Guinea-Bissau, to the east by Mali and the Coast ivory.

Its climate is tropical sub-Guinean, characterized by the alternation of two (2) seasons, dry from October to May and wet or rainy from June to September. The local microclimate due to the influence of the ocean which brings the monsoon and the sea breezes is responsible for a very abundant rainfall: with a minimum of 3000 mm and a maximum of 4300mm. The air humidity ranges from 69 to 88%. The minimum annual average temperature is 23°C with a very low thermal amplitude, the maximum is around 32°C.

The city Conakry is located on the narrow peninsula of Kaloum, which stretches into the Atlantic Ocean. Off the coast, the Loos Islands are known for their beaches, their dense palm forests and the water sports that can be practiced there. It is subdivided into five (5) municipalities which are: Kaloum, Dixinn, Matam, Ratoma and Matoto. Each commune is divided into districts and the districts into sectors. All the communes are characterized by an insalubrity materialized by piles of household refuse, the frequent stagnation of waste water.[8]

Equipment

In order to achieve the objectives of this work, we used the following reagents and equipment: reagents (zinc sulphate solution, ether or ethyl acetate, aceto-acetic buffer, detergent solution and filter membrane), equipment (containers made of plastic, adjustable centrifuge, centrifuge tubes with a lid, pipettes, vibrating shaker, hand pump or siphon, test tube or graduated pipette, thermometer, oven, sterile collectors, the membrane filter clamp, Petri dishes, and balance).

Method

Sampling

The sewage sludge samples were taken in the five (5) municipalities of the city of Conakry (Kaloum, Matam, Ratoma, Dixinn and Matoto) on February 15, 2020. The analysis of the physicochemical parameters (Temperature, suspended matter, Chemical Request for Oxygen and Ammoniac Nitrogen) samples were taken at the Water and Hygiene Laboratory of the University of Gamal Abdel Nasser in Conakry.

Temperature and pH

The temperature, the Hydrogen Potential (pH), were measured with the Multi parameters HACH HQ40d fitted with different probes, following the same protocol by simply changing the probes according to the parameter to be measured. The reading is made after stabilization of the display.[9] The method complies with AFNOR 90 008 standard.

Suspended matter

The determination of suspended solids (MES) contents was made by gravimetry after vacuum filtration with a GF/C glass microfiber filter and drying in an oven at 105 ± 2°C, in accordance with French standard NF 90 - 105.[10]

Chemical Oxygen Demand (COD)

The Chemical Oxygen Demand (COD) is determined by oxidation with an excess of potassium dichromate in an acid medium at 150°C, in the presence of silver sulfate as catalyst and mercury sulfate intended to avoid interference from the presence chloride ions, in accordance with standard AFNOR T 90-101. The value is read by HACH DR/2400 spectrophotometry at the appropriate wavelength according to the chosen COD range.[11]

Ammoniacal nitrogen ($N\text{-}NH_4^+$)

Ammoniacal Nitrogen ($N\text{-}NH_4^+$) was determined by the colorimetric method with a Palintest 7100 spectrophotometer reading at the appropriate wavelengths. This method complies with French standard NF T 90-15.

RESULTS

The physicochemical parameters (pH, T°, MES, COD and $N\text{-}NH_4^+$) of the five (5) municipalities (Kaloum, Dixinn, Matam, Matoto, Matoto and Ratoma) of the drain sludge's studied are shown in Table 1 and by the Figures 1, 2, 3, 4 and 5.

Table 1: Physicochemical parameters of the sludge from the city of Conakry.

Commons	Parameter				
	T (°C)	pH	MES (mg/l)	DCO (mg/l)	$N\text{-}NH_4^+$ (mg/l)
Kaloum	28.7	6.05	2180	1870	32.15
Dixinn	28.6	6.11	2240	1840	33.11
Matam	32.6	6.30	5500	857	33.86
Matoto	30.4	6.93	3252	969	67.72
Ratoma	30,1	6.80	3340	967	66.54
Average	30.08	6.438	3302.4	1300.6	46.676

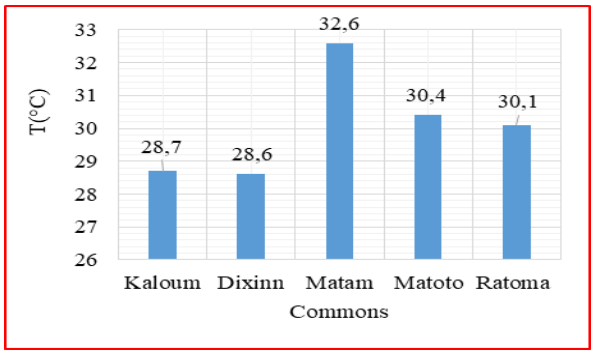

Figure 1: Temperatures

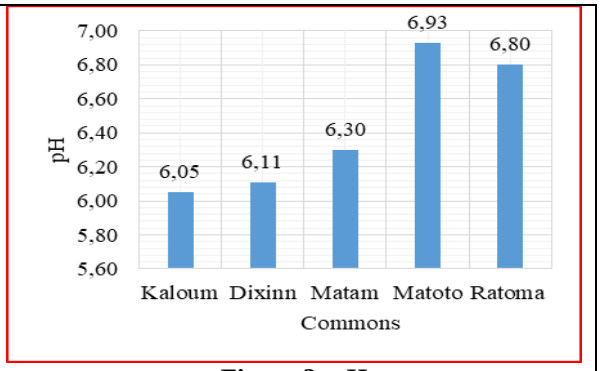

Figure 2: pH

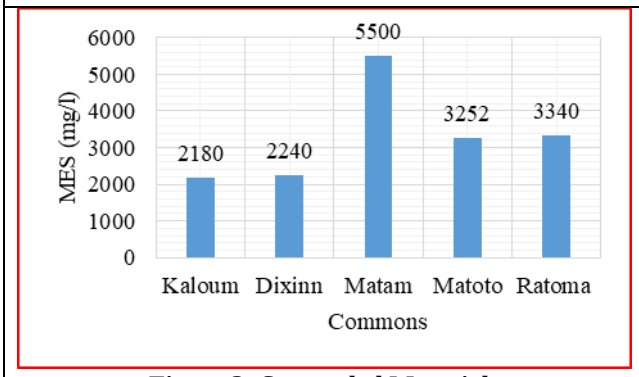

Figure 3: Suspended Materials

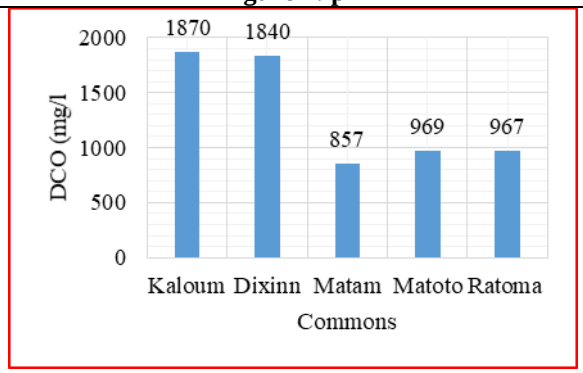

Figure 4: Chemical Oxygen Demand

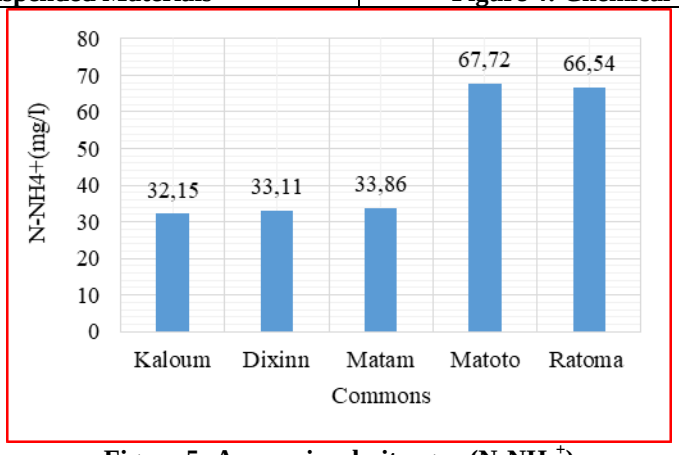

Figure 5: Ammoniacal nitrogen ($N\text{-}NH_4^+$)

DISCUSSION

Temperature

The Matam sludge sample at the highest temperature (32.6°C); followed by Matoto (30.4°C) and Ratoma (30.1°C) and those of Kaloum and Dixinn have almost the same values which are (28.7°C) and (28.6°C) respectively. The average temperature of these samples is (30.08°C), which generally shows that the sewage sludge from the city of Conakry is hot, thus, it remains favorable to biological and chemical processes.

pH

The sludge samples from Matoto and Ratoma have the highest pH respectively 6.93 and 6.80 which correspond approximately to basic media, this is due to the low degree of hydration of the sludge from these municipalities (in actually microbial activity is more intense in aqueous media). The samples from the three other communes Matam, Dixinn and Kaloum have respectively (6.3, 6.11 and 6.05), these values show a certain acidity compared to those of Matoto and Ratoma. The average pH of these five samples is (6.44), this value is very favorable for the development of several microorganisms in the sludge. It falls within the pH ranges of sludge from Cameroon (6.5 - 9.3), Thailand (6.7 - 8.1) and Canada (5.0 - 8.4), reported respectively by.[7, 12, 13]

Suspended Materials (MES)

The Matam sludge sample has the highest MES concentration (5500 mg/l), followed respectively by Ratoma and Matoto samples (3340 mg/l and 3252 mg/l), these concentrations more or less high are due to commercial activities in these three municipalities. For the two other municipalities Dixinn and Kaloum the concentrations are respectively (2240 mg/l and 2180 mg/l). The results of the MES concentrations of the samples of sewage sludge from these five municipalities are very low compared to the results of other authors in Ouagadougou (11,084 mg/l)[11] and in Bangkok (12,900 mg/l).[13] On the other hand, our results are much higher than the average MES value at the start of the sedimentation basin of the Sonfonia sludge treatment station in the town of Ratoma, ie (222.83 mg / l),[8] as well as those reported by[11] which vary between 500 and 2000 mg/l.

Chemical Oxygen Demand (COD)

The COD concentrations of the samples of sludge from Kaloum (1870 mg/l) and Dixinn (1840 mg/l) are much higher than those from Matoto, Ratoma and Matam respectively (857 mg/l, 967 mg/l and 969 mg/l). These results show that the sludge from Kaloum and Dixinn is more concentrated than that from Matoto, Ratoma and Matam. These results obtained from COD (1870 mg/l, 1840 mg/l, 857 mg/l, 967 mg/l and 969 mg/l) of the five (5) communes are much higher than that reported by or (202,765 mg/l). On the other hand, they are much lower than the results of other authors, namely: 13,885 mg/l, 13,500 mg / l, 49,000 mg / l, respectively in Conakry, Ouagadougou and Accra[14], 7,800 mg/l in Accra (Heinss et al. 1999), 15,736 mg/l in Dakar[15] and 15,700 in Bangkok.[13] The results reported by Martine K., et al., 2016, which vary between 1400 and 2760 mg/l, are higher than those of Matam, Matam and Ratoma, on the other hand those of Kaloum and Dixinn fall in this range.

Ammoniacal nitrogen (N-NH_4^+)

The concentration of sludge from Matoto and Ratoma in N-NH_4^+ respectively (67.72 mg/l and 66.54 mg / l) is higher than that of the other three, including: Matam (33.86 mg/l), Dixinn (33.11 mg/l) and Kaloum (32.15 mg/l). These results show that the sludge from Matoto and Ratoma is more concentrated than that from the other three Communes. The results obtained are close to that reported by Diallo B.D., 2015, i.e. (55.15 mg/l).[14] However, they are much lower than the results of Mahamane, 2011 and Koné and Strauss, 2004, respectively (1,230 mg/l and 600 mg/l) in Ouagadougou and of Koné and Strauss, 2004, ie (3,300 mg/l) in Accra.[11, 13]

CONCLUSION

This work made it possible to determine certain physicochemical parameters (T°, pH, COD MES and N-NH_4^+) of the drainage sludge from five municipalities in the city of Conakry. This sludge is characterized by: an average temperature of 30.08°C, an average pH of 6.44, an average MES rate equal to 3293 mg/l, an average COD of 933.03 mg/l and an average concentration in N-NH_4^+ of 41.71 mg/l. Physicochemical analyzes show that the sludge from the city of Conakry is rich in organic matter and nutrients. It is therefore important to comply with certain standards to reduce the risk of disease transmission, by avoiding their discharge into the wild and their use in agriculture without prior treatment.

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