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Alarming Condition of Daha River (Siwan, Bihar, India) Due to Biomedical Waste

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ABSTRACT

Mushroom growth of healthcare facilities (HCF) all over the globe for better health treatment leads to a huge burden upon the whole globe by releasing massive amounts of biomedical waste (BMW) through these HCF. There are so many problems raised nowadays due to these BMWs. Nosocomial infections are raised nowadays due to these BMWs, which are a serious problem. The whole environment is suffering from these infectious and hazardous BMW. The nature of BMW is solid, liquid and gaseous form. All forms are harmful and infectious and need proper and scientific management.

Siwan town is a hub of HCFs, so here a massive amount of biomedical waste, both solid and liquid, is generated daily. This massive amount of solid BMW (more than 3 quintals of biomedical waste are released daily, according to data collection, DHS of Siwan, Bihar) is thrown openly here and there in the town and pollutes the whole environment as well as changes the chemistry of underground water because the chemicals present in it leach out and finally reach the groundwater level. Solid BMW management is under control to some extent by Medicare Environmental Management Pvt. Ltd., Muzaffarpur, Bihar, India. But here there is a lack of proper and scientific liquid BMW management. Liquid biomedical waste is directly released into water ecosystems/city-side rivers without any scientific treatment. In my present study only 10% of healthcare facilities are equipped with an effluent treatment plant (ETP) for the wastewater treatment process (WWTP) in the town, while 90% of the hospital's drainage system is directly mixed into the domestic drainage system without any scientific treatment and finally released into the Daha River of Siwan (Bihar). In this way, potential disease-causing microorganisms reach the Daha River from all over the town and pollute the whole environment of the town and finally change the chemistry of the river water. In my study, the microbiological investigations of Sadar Hospital wastewater (drainage water) and Daha River water both show the presence of total coliforms (TC), faecal coliforms (FC), faecal staphylococcus (FSc), *Pseudomonas aeruginosa*, and E. coli. So, this article linked the microbiological findings between the wastewater sample of HCF and Daha River water. In my study the average value of BOD was 3.96 mg/L, which is higher than the permissible limit, and the average value of COD was 29.33 mg/L, which is very high compared to the permissible limit. The high value of BOD and COD clearly indicates that the Daha River is a polluted river.

Keywords: BMW, HCF, leach-out, permissible limit

INTRODUCTION

Any waste or its by-product which is generated during treatment, diagnosis, immunisation, or testing of human beings or animals is called "biomedical waste", whether it is solid BMW or liquid BMW (Sasmita

Biswal et al., 2013). In the current time liquid BMW has also become a serious issue for its immediate surroundings along with solid BMW. Liquid BMW comprises body fluids, blood, discarded vaccines, antibiotics, hazardous chemicals, and pharmaceutical liquid wastes. Liquid BMW, amongst all categories of BMW, has a severe threat for human health and also for the environment due to their ability to pollute groundwater and drinking water and also their ability to enter watersheds when handled and disposed of improperly (Sasmita Biswal et al., 2013). Water is one of the most polluted natural resources due to uncountable anthropogenic activities. BMW is a potential pollutant for water (Reema Kumari et al., 2012). The potential health hazards concerning biomedical waste became highlighted in the 1980s when biomedical waste was directly washing up on many East Coast beaches. This was the main reason for enacting the Medical Waste Tracking Act (MWTA) in 1989. Biomedical waste is a niche for many diseases, causing harmful pathogens and a major cause of diseases. Improper biomedical waste disposal leads to diarrhoea, tetanus, AIDS, dengue, hepatitis B and D, Japanese encephalitis, tick fever, typhoid, bacteremia, infectious diseases and many more.

MATERIAL AND METHODS

About the solid BMW, Annual Report of BMW of Siwan-2021

Current research has been carried out in Siwan, Bihar, India, within a time period of one year (January 2021 to December 2021).

Primary and secondary data were collected from the District Health Society (DHS) of Siwan.

Data collection of the 'Daily Collection Report of Biomedical Waste' of Sadar Hospital and many private hospitals in Siwan (Bihar) by Medicare Environmental Management Pvt. Ltd., Muzaffarpur, Bihar, India.

Sampling of Daha River water and liquid BMW

The time period of study was 3 months, from July 2022 to September 2022.

Wastewater samples were collected from Shiv-Ghat of the Daha River, Siwan, for finding different physiochemical parameters and disease-causing micro-organisms in the river environment.

Wastewater samples were collected from the drainage of Sadar Hospital Siwan and cultured (Bihar State Pollution Control Board Patna) for the finding of different diseases-causing microorganisms in the hospital environment.

A questionnaire-based survey of 6 months, from July 2022 to December 2022, was done for estimation of processes (like ETP for WWTP) used for proper and scientific treatment of liquid BMW.

Culture of Daha-River Water and Biomedical Liquid Waste

The present study was conducted at a private lab and college lab in Siwan, Bihar, India, for 1 year (2022) in search of microbiological findings in BMW of Siwan, Bihar, India.

We culture the water sample of Daha River, Siwan, on nutrient agar media (NAM) and MacConkey agar media.

Seven water samples were collected from Shiv Ghat and Pulwa Ghat of the Daha River of Siwan, and ten samples were collected from Sadar Hospital Siwan, Bihar. All samples were collected in 20 ml sterilised containers. Samples were collected with all necessary precautions.

Nutrient agar media (NAM) and MacConkey media were used for the culture of micro-organism growth. We used a proper sterilisation method and stuck samples with the help of a loop and then the confirmation of *Escherichia coli* and *Pseudomonas aeruginosa* isolates was done by biochemical characterisations and Gram's staining from Daha River samples.

The confirmation of *Klebsiella pneumoniae*, *Escherichia coli* and *Pseudomonas aeruginosa* isolates was

done by biochemical characterisations and Gram's staining from biomedical waste samples.

RESULTS AND DISCUSSION

In my present study only 10% of health-care facilities (HCF) are equipped with an effluent treatment plant (ETP) for the wastewater treatment process (WWTP) in the town, while 90% of the hospital's drainage system is directly mixed into the domestic drainage system without any scientific treatment and finally released into the Daha River of Siwan (Bihar). In this way, potential disease-causing microorganisms reach the Daha River from all over the town and pollute the whole environment of the town and finally change the chemistry of the river water.

This study shows similarity with Sasmita Biswal, 2013; according to her study, 90% of wastewater released from health-care facilities (HCF) globally is not treated scientifically, which is a major cause of water pollution, and this polluted water is used for irrigation due to water scarcity, especially in low-income countries (Sasmita Biswal, 2013). If polluted wastewater is used directly or indirectly for the purpose of irrigation, then the infectious causative micro-organisms, harmful and hazardous chemicals and antibiotics present in the wastewater reach into the food chain and finally enter into the food web and become a major concern for human and animal health and also its immediate surroundings. Liquid BMW, whether it is liquid pathological or chemical waste, should be treated appropriately and then discharged into the public sewer system (BMW Rule 1998). In India pharmaceutical waste regulations for release into rivers and the environment are negligible (Laxminarayan R et al., 2016). Some evidence shows a linkage between poor BMW management practice and drug-resistant bacteria emergence (Christine Katusiime, 2018). In China a hypervirulent Klebsiella pneumonia was isolated that is resistant to all antibiotics (Gu D., et al., 2018, and Lu Y., et al., 2018). "A clean environment is essential to human health" (Brooke Brown, 2021).

hysiochemical investigations of Daha River

For the study of the extent of pollution of the Daha River, especially due to liquid BMW, water sampling of the Daha River was done (Table 1). Physiochemical parameters and microbiological studies both show that the water of this river is polluted and not fit for drinking by animals.

The temperature of the river varied from 32° to 38°; it is a very important criterion for the metabolism of living organisms present inside water bodies and also affects many parameters of water. Physio-chemical parameters of water are affected by the temperature of rivers and the environment (Reeta Kumari et al., 2008). The pH value ranged from 6.82 to 8.05. While turbidity varied from 11.8 to 35.3 and electrical conductivity varied from 206 to 403. Aerobic respiration depends upon dissolved oxygen in any aquatic environment, and it is essential for metabolism in the aerobic organisms (Wetzel et al., 1975); the range of dissolved oxygen varied from 4.9 mg/L to 5.4 mg/L.

For natural water the permissible limit of BOD is 3 mg/L or less than it, and the permissible limit of COD is 10.0 mg/L. But in my present study the average value of BOD was 3.96 mg/L, which is higher than the permissible limit, and the average value of COD was 29.33 mg/L, which is very high compared to the permissible limit. The high value of BOD and COD clearly indicates that the Daha River is a highly polluted river. While according to the study of Reeta Kumari et al., 2008, of this Daha River, the average values of BOD and COD were 1.89 mg/L and 14.87 mg/L, respectively, indicating only some pollution. High BOD and COD start interfering in respiratory metabolism and are finally noticed in fishes and aquatic organisms' mortality (Venkatarman 1996).

The hardness of water depends upon the quantity of salts of Ca++ and Mg++ combined with bicarbonates, carbonates, sulphate, and chlorides. Overall total hardness of the river varied from 104 mg/L to 188 mg/L, and according to the standard scale, this value comes under slightly hard. The average TDS was estimated to be 192.66 mg/L.

Table 1. Analysis of water sampling of Daha River, Siwan, Bihar, 2022

Name of location	Shiv Ghat Daha River	Shiv Ghat Daha River	Shiv Ghat Daha River
Month of sampling	July-2022	August-2022	September-2022
Parameter	Analysis Report		
Temperature (A/W)	38/30	35/30	32/30
pH	6.82	8.05	7.56
Turbidity (NTU)	14.3	11.8	35.3
Electrical Conductivity	403	206	239
Dissolved Oxygen	4.9	5	5.4
Hardness as CaCO3 (mg/L)	188	116	104
COD (mg/L)	36.0	28.0	24.0
BOD (mg/L)	6.0	2.9	3.0
TDS (mg/L)	272.0	142.0	164.0

Microbiological investigations of Daha River and Sadar Hospital, Siwan, Bihar

Microbiological investigations of the Daha River in the present study were alarming, showing total coliforms (TC) ranged from 22000 MPN/100 ml to 180000 MPN/100 ml, faecal coliforms (FC) ranged from 17000 MPN/100 ml to 98000 MPN/100 ml, faecal staphylococcus (FSc) ranged from 1100 MPN/100 ml to 1500 MPN/100 ml, and E. coli ranged from 54000 MPN/100 ml to 62000 MPN/100 ml (Table 2), and Escherichia coli and Pseudomonas aeruginosa were found (Table 3, Fig. 1) on the culture plate. On the other hand, microbiological investigations of Sadar Hospital wastewater/drainage water have also shown the presence of total coliforms (TC), faecal coliforms (FC), faecal staphylococcus (FSc), and E. coli (Table 4), and Klebsiella pneumoniae, Escherichia coli, and Pseudomonas aeruginosa were found on the culture plate (Table 5). In my findings, Klebsiella pneumoniae, Escherichia coli and Pseudomonas aeruginosa were the predominant microorganisms in biomedical liquid waste; however, according to Park et al. (2009), the most prevalent microorganisms found in clinical solid waste (CSW) were Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa and Bacillus cereus. Many studies show that in hospital waste samples, generally Escherichia coli was found, whether it is liquid BMW or solid BMW, and Escherichia coli is most frequent. That's why "Escherichia coli is an emerging nosocomial pathogen causing problems in health-care settings." (K. R. Lausch et al., 2014).

So, this paper also linked the microbiological findings between the wastewater sample of HCF and the Daha River. There are many diseases caused especially by E. coli: diarrhoea, abdominal cramps, renal damage, pneumonia, UTI (urinary tract infection), bacteremia, and neonatal meningitis; by Klebsiella pneumoniae: pneumonia, UTI, intra-abdominal infection, bloodstream infections (BSI), wound or surgical site infections, pyogenic liver abscess (PLA), and meningitis; by Pseudomonas aeruginosa: pneumonia, septicaemia, meningitis, endocarditis, malignant external otitis, and endophthalmitis; and by Faecal

staphylococcus (FSc): skin and soft tissue infections, bloodstream infections, pneumonia, bone and joint infections, abscesses (boils), furuncles, cellulitis, etc.

Table 2. Microbial Analysis of waste water of Daha River, Siwan, Bihar, 2022

Name of location	Daha River, Siwan	Daha River, Siwan	Daha River, Siwan
Month of sampling	July-2022	August-2022	September-2022
Micro-organisms	Analysis report		
TC (MPN/100ml)	180000	22000	160000
FC (MPN/100ml)	98000	17000	92000
FSc (MPN/100ml)	1500	1400	1100
E. coli (MPN/100ml)	62000	59000	54000

Table 3. Isolation of Bacterial strain of Daha River on Culture plate

Sl.No.	Bacterial strain
1	*Escherichia coli*
2	*Pseudomonas aeruginosa*

Fig.1. Culture Plate of water sample of Daha- River indicating growth of grayish white colony *E. coli* on Nutrient agar medium (NAM)

Table 4. Microbial Analysis of waste water of Sadar Hospital, Siwan, Bihar, 2022

Name of location	Sadar Hospital, Siwan	Sadar Hospital, Siwan	Sadar Hospital, Siwan
Month of sampling	July-2022	August-2022	September-2022
Micro-organisms	Analysis report		
TC (MPN/100ml)	165×10^8	160×10^8	35×10^6
FC (MPN/100ml)	36×10^8	35×10^8	24×10^6
FSc (MPN/100ml)	3565	3300	330
E. coli (MPN/100ml)	29×10^8	28×10^8	7.9×10^6

Table 5. Isolation of Bacterial strain of Sadar Hospital, Siwan, Bihar on Culture plate

Sl.No.	Bacterial strain
1	*Klebsiella pneumoniae*
2	*Escherichia coli*
3	*Pseudomonas aeruginosa*

Biomedical waste, whether it is solid BMW or liquid BMW, is totally different from domestic waste or sewage and is becoming a critical issue all over the globe due to its infectious nature.

Siwan is a highly potential patient belt, having more than 1000 HCF (government and private) in the town and 1500 HCF in this district, and more than 3 quintals of biomedical waste are released daily according to data collection (DHS of Siwan, Bihar), while according to my research study, the estimation of BMW in the town is more than 3 quintals. This difference arises because most of the biomedical waste is generally mixed into domestic waste while the biomedical waste van is running throughout the town. These wastes are scattered here and there all over the town and are a potential source of diseases. Different types of diseases arise due to improper biomedical waste disposal and management. The annual report of BMW of Siwan District of 2021 is shown in table 6. This massive amount of BMW creates stress upon the immediate and whole environment.

Table 6. Annual Report of BMW of Siwan District – 2021

Sl No	Month	No of HCF	Yellow Category in Kg	Red Category in Kg	White Category/Sharp in Kg	Blue Category in Kg	Total
1	JAN-21	185	9467	488	102	768	10825
2	FEB-21	187	7858	487	99	763	9207
3	MAR-21	189	7882	482	106	753	9223
4	APR-21	209	7668	505	111	625	8909
5	MAY-21	198	9518.5	472.5	108	529	10691
6	JUN-21	195	8441.5	460	105	601	9607.5
7	JUL-21	193	7299	456	106	598	8459
8	AUG-21	195	7623	458	105.5	597	8783.5
9	SEP-21	200	7129	508	130.5	661	8428.5
10	OCT-21	201	7583.7	518.5	132	683	8917.2
11	NOV-21	203	7070	522	128	688	8408

12	DEC-21	202	8019	578	133	739	9469
							110927.7

 # Cat. = category
 # HCF-Health-care facilities
Total BMW of 12 months = 110927.7 kg
Average BMW/month = 110927.7/12
= 9243.975 kg
Average BMW/day = 9243.98/30
= 308.13kg
Result of average BMW/day = more than 3 quintals
In the town the BMW management is very poor and showing the grim condition of BMW waste management. On one side, due to the efforts of Medicare Environmental Management Pvt. Ltd., Muzaffarpur, Bihar, India, the solid biomedical waste is under management to some extent, but on the other hand, liquid biomedical waste management is in a critical condition and directly or indirectly affects the water ecosystem and the surroundings. Effort is being carried out by the central government for proper and scientific management of liquid biomedical waste. There are many rules and regulations that come from time to time, but violations of these rules and regulations are clearly visible in many states of our country.

Guidelines for Liquid Biomedical Waste Management - 2019

1. An effluent treatment plant (ETP) should be compulsory in HCF for the treatment of effluent/WWTP.
2. Effluent released during the process of utilisation should be disinfected and then treated in ETP.
3. Treated effluent should be within the standard limit stipulated under the rule of BMW-2016 and by SPCBs/PCCs.
4. Before the ETP sludge is disposed of through the Hazardous Waste Treatment, Storage and Disposal Facility, the ETP sludge shall be analysed and checked for the hazardous constituents, and in case the hazardous constituents are present beyond the prescribed limit as given in the Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2016.
5. Records w.r.t. the wastewater generation, its treatment and its disposal should be maintained.

In Fig. 2 and Fig. 3 we can see the bemoaning condition of Shiv Ghat of Daha River, Siwan, Bihar; wastewater/liquid BMW from all HCFs of the town is directly mixed into the domestic drainage system without any scientific treatment and finally released into Daha River. Also, here we can see a mountain of biomedical waste and domestic waste mixture. It is cringe-worthy that the natural heritage of our environment and human beings is so exploited by itself.

Fig. 2. Dire state of Shiv Ghat of Daha River, Siwan, Bihar. Wastewater from all HCFs of the town is mixed into the domestic drainage system and released into the Daha River at this point. Also, here we can see a mountain of biomedical waste and domestic waste mixture.

Fig. 3. Piles of waste along the Daha riverside, Siwan, Bihar

CONCLUSION

This study was conducted to show that the Daha River is polluted by effluent/wastewater released by different healthcare facilities (HCF) and not fit for drinking due to the presence of different types of harmful and disease-causing microorganisms. In my study, I found only 10% of HCF are using ETP for wastewater treatment (WWT). And almost 90% are releasing their effluents directly into domestic waste without any scientific treatment. The hospital's drainage system is directly released into the domestic drainage system without any proper and scientific treatment and finally released into the Daha River of

Siwan (Bihar). In this way potential disease-causing microorganisms reach the Daha River from all over the town and pollute the whole environment of the town. Along with human beings, the aquatic organisms of the Daha River are in danger. Lack of awareness, knowledge, social dilemma and financial issues are the major reasons behind improper management. The majority of hospitals violating the BMW management rules in the city either due to lack of awareness and knowledge or due to financial issues. So, it is the duty of the state government to implement all BMW rules strictly in all HCF. If any HCF is found violating these rules, then it should pay a penalty. Also, the state government should provide financial support for proper and scientific BMW management. Also, it is necessary to organise public awareness programmes from time to time for proper and scientific management. Until we will not serious about its critical issues, we cannot get a healthy and cleaner environment.

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