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Effect of slaughterhouse waste on sewage channel

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Abstract

The meat producing sector are among primary users of global freshwater resources within the sector of agriculture and livestock. Processing of meat facilities known as MPP's generate substantial volumes of wastewater during both the slaughtering process and facility cleaning. This wastewater, referred to as slaughterhouse wastewater (SWW), requires substantial treatment to ensure safe and environmentally friendly discharge because it contains high levels of organic materials and proteins. As a result, SWW treatment and disposal are crucial for maintaining public health.

In that chapter, we study about the regulatory system pertinent management of slaughterhouse wastewater (SWW), its environmental ramifications, health implications, and the distinctive attributes of slaughterhouse waste. Due to the varying pollutant levels resulting from the type and quantity of killed flora and fauna, which can change within the meat industry, SWWs are typically assessed through bulk parameters. The characteristics of SWW, such as Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), and Total Suspended Solids (TSS), are key pollutant affecting sewage system. When SWW combines with the sewage system, it adds to the burden on both the sewage network and sewage treatment plants (STP). Therefore, employing on-site treatment utilizing integrated processes emerges as the optimal approach for treating and disinfecting slaughterhouse effluents, ensuring their safe discharge into receiving waters.

Keywords: Wastewater; Characteristics; Sewage Channel; Sludge

1. Introduction

The rising global population has led to an escalation in freshwater pollution, primarily driven by insufficient wastewater disposal practices, particularly prevalent in developing nations.

Hence, the importance of water and wastewater treatment has grown significantly, becoming essential for the ongoing progress of society. Furthermore, the increasingly stringent global for effluent discharge standards have under scored need for the development of advanced wastewater treatment technologies. Additionally, the ongoing reduction in the freshwater resources readily available, the wastewater treatment industry's emphasis has shifted from simple disposal to the necessity of reuse and recycling [4]. As a result, there is a greater need to achieve a high level of treatment effectiveness.

Both the slaughtering of animals and the cleaning of its facilities results in a significant amount of Slaughterhouse Wastewater (SWW) being produced by the meat processing industry. Within the larger food and beverage sector, this industry is responsible for up to 26% of the water consumption [7].

The wastewater produced by slaughterhouses and meat processing plants (MPPs), which are essential elements of a global industry, is composed differently depending on the various techniques used in the process of killing animals.

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Slaughterhouse Wastewater (SWW) must therefore be thoroughly treated in order to ensure its safe discharge and environmental sustainability [10].

Through the process of butchering animals and maintaining the facilities, the meat processing industry produces significant amounts of slaughterhouse wastewater. Surprisingly, up to 26% of the water used in the food industry is used for production of meat.

Slaughterhouses and Meat production Plants are integral components of a vast global industry. The wastewater consumed they produce varies significantly, influenced by the diverse practices employed in the slaughtering process.

As a result, it is essential to subject Slaughterhouse Wastewater (SWW) to substantial treatment to ensure its safe and environmentally sustainable release. Prior to 1990, it was common practice for slaughterhouses in India to discharge SWW directly dispose into municipal sewer any prior management [7].

Only a handful of private slaughterhouses equipped with modern technologies take the step of subjecting their SWW to preliminary treatment before discharging it into the municipal sewer system. In contrast, the vast majority of government-operated or illegal slaughterhouses do not engage in on-site wastewater treatment before disposal. The ongoing efforts to boost meat produce to meet protein necessities of the ever-expanding global population are accompanied by pollution challenges.

The production of meat frequently experiences pollution problems as a result of violations of good manufacturing and hygiene practices. Unfortunately, safety precautions are frequently ignored when handling hides and flesh, slaughtering animals, and transporting them to the abattoir. For hygienic reasons, abattoirs use a lot of water in their processing activities, such as cleaning and slaughtering animals, which generates a lot of wastewater. Significant suspended solids, liquid waste, and odor production are the three main environmental issues associated with abattoir wastewater.

It has been determined that the effluent discharged from slaughterhouses is a source of contaminate.

The Chemical Oxygen Demand (COD) of blood, a significant dissolved pollutant in abattoir wastewater, is the highest of all the effluents generated by abattoir operations. To put it into perspective, the effluent load would be equal to the total sewage produced by an average of 50 people in a day if the blood from a single cow carcass was allowed to directly discharge into a sewer line[2]. High organic strength, a surplus of organic biological nutrients, adequate alkalinity, relatively high temperatures (between 20 and 30 °C), and a lack of toxic substances are the main characteristics of abattoir waste.

1.1. Population livestock

The population of livestock worldwide is estimated to be 205 million buffaloes, 1,828 million cattle, 984 million goats, and 1,393 million sheep, according to the Food and Agriculture Organization Statistics (FAOSTAT). These figures are significantly influenced by Asia, which accounts for 97% of the world's buffaloes, 33% of its cattle, 59% of its goats, and 43% of its sheep[14]. In terms of the number of cows, buffaloes, and goats, India stands out as the world leader.

According to the 2011 livestock census, there are 113 million buffaloes, 211 million cattle, 157 million goats, and 74.5 million sheep living in India. These figures correspond to 58%, 15%, 17%, and 7% of the respective populations of the world. the characteristics of the population of animals, especially cattle.

1.2. Production of meat in India

India has emerged as the world's meat supplier 2nd products. By the FAOSTAT data from 2021, India exports approximately 1,849,100 metric tons of meat globally, with a total value of US$ 1,811 million. Buffalo meat production in India alone exceeds 1.5 million metric tons annually, contributing to approximately 30% of the total meat production in the country. Goats, poultry, sheep, and cattle make up 10%, 15%, 5%, and 30% of the meat produces, respectively [18].

While smaller animals like goats and sheep are primarily sold in local markets, their export quantities are relatively small. Export meat products value-added are limited. India's meat exports are mainly directed toward countries in the Middle East, which have a significant ethnic Indian population that prefers Indian meat products. By the Agriculture and Processed Food Products Export Development Authority (APEDA) exported India 1,407,506.24 metric tons of buffalo meat (valued at Rs. 19, 41,289.27 lakhs) and 1,904,691 metric tons of sheep/goat meat (valued at Rs. 62,565.86 lakhs) in the fiscal year 2021-22.

The meat processing industry in India is a rapidly growing sector, with significant water usage in slaughterhouses for various purposes, including preparation, cleaning, and washing. This substantial water usage results in the large volumes of wastewater generation. Unfortunately, much of this wastewater is directly mixed with sewage, leading to contamination of the entire sewage network [20]. To address this issue, pretreatment of slaughterhouse wastewater is essential to control the pollution load in the sewage system.

1.3. Slaughterhouse Characteristics wastewater

Processing of Meat effluents are universally regarded as potentially harmful due to the complex composition of slaughterhouse wastewater (SWW). SWW is characterized by a mixture of pathogens, high organic content, fibers, fats, proteins, and veterinary products. To assess effluents of slaughterhouse effectively, they are using bulk parameters and typically evaluated due to wide variability in SWW composition and sludge loads [19].

Table 1 The slaughterhouse wastewaters have typical characteristics

Parameter	Range	Mean
Ph	4.9–8.1	6.5
BOD (mg/L)	150–8500	3000
COD (mg/L)	500–16,000	5000
TP (mg/L)	25–200	50
TSS (mg/L)	0.1–10,000	3000
TOC (mg/L)	50–1750	850
TN (mg/L)	50–850	450
K (mg/L)	0.01–100	50
Colour (mg/L Pt scale)	175–400	300
Turbidity	200–300	275

The summary of typical characteristics of SWW in Table 1 highlights the diverse and often challenging nature of this wastewater, which necessitates careful management and treatment to mitigate its environmental and health impacts. Proper treatment processes are essential to reduce these pollutant levels and ensure the responsible disposal or reuse of SWW.

1.4. Slaughterhouse wastewater regulation

Table 2 The standards and limits for slaughterhouse wastewater discharge can vary significantly from one jurisdiction to another

Parameter	World Bank	USA	EU	Colombia	Canada	China	Australia	India
TN (mg/L)	10	4-8	10-15	10	1.25	15-20	10-20	10-50
BOD(mg/L)	30	16-25	25	50	5-30	20-100	5-20	30-100
TSS (mg/L)	50	20-30	35-60	50	5-30	20-30	5-20	100
TOC(mg/L)	NA	NA	NA	NA	NA	20-60	10	NA
TP(mg/L)	2	NA	1-2	NA	1	0.1-1	2	5
Temperature	NA	NA	NA	NA	<1	NA	<2	<5
COD(mg/L)	125	NA	125	150	NA	100-300	40	250
pH	6-9	6-9	NA	6-9	6-9	6-9	5-9	5.5-9

Wastewater treatment techniques are a key regulatory requirement. Regulations are necessary to address and reduce the environmental impact of slaughterhouses. In addition to helping to safeguard the environment, adherence to current environmental laws and the use of cutting-edge technologies can also provide economic benefits through resource recovery, such as biogas production employing high-rate anaerobic treatment.

Table 2: provides an overview of discharge limits and current regulation for organic matter and nutrient components slaughterhouse wastewater to ensure its safe release into the environment. These regulations and limits vary across different jurisdictions worldwide and are established by various authorities, including [22].

1.5. Impact on Environment and effects of slaughterhouse wastewater on health

The animal products consumption results in generation of substantial amount of slaughterhouse wastewater. While surroundings possesses a natural capacity to a certain handle when attentiveness of SWW increases these mechanism become overwhelmed, giving rise to contamination issues. The release of untreated SWW into sewage system bodies has detrimental effects on water quality, primarily by reducing Dissolved Oxygen (DO), which can lead to sludge and the death of aquatic life. Additionally, macro nutrients like phosphorus and nitrogen present in SWW can trigger eutrophication events, disrupting aquatic ecosystems. Therefore, proper management and treatment of SWW are crucial to mitigate these environmental impacts and safeguard water quality [15].

The discharge of excess nutrients, such as nitrogen and phosphorus, from slaughterhouse wastewater (SWW) can trigger an overgrowth of algae and subsequent decay. This process, known as eutrophication, can lead to a decline in dissolved oxygen (DO) levels, which is detrimental to aquatic life. The mineralization of decaying algae can further deplete DO levels, negatively impacting aquatic ecosystems.

In addition to nutrient-related issues, SWW contain toxic products like unionized ammonia, and chromium which can harm flora and fauna and organisms [16]. These substances can have toxic effects on aquatic life, disrupting the balance of ecosystems.

Surfactants, commonly found in detergents used for cleaning in meat production industry, may enter aquatic environment if SWW treatment is inadequate. The research examines both short-term and long-term changes in wastewater within ecosystems, assessing their impact on humans, fish, and vegetation.

Furthermore, SWW carries pathogens that persevere in soil and can constantly reproduce. These pathogens could pose a health risk to humans who come into contact with contaminated water bodies. Consequently, areas contaminated by SWW may become unsuitable Due to the possibility of disease transmission; it should not be used for drinking, swimming, or irrigation.

In conclusion, the environmental effects of SWW include pollution from surfactants, nitrate, and other chemical substances as well as by the presence of pathogens that can harm both aquatic life and human health. Proper treatment and management of SWW are essential to mitigate these adverse effects and protect water quality and ecosystems.

The effects on public health stemming from the meat production industry can be attributed to both the direct impacts of slaughterhouse operations on nearby communities and the indirect effects on the environment that may have been caused by improper management of liquid effluents, solid waste, and offensive odors in the past.

Studies, such as the one by Um et al., have shown that conventional treatment processes often have limited effectiveness in reducing Escherichia coli bacteria that are resistant to antibiotics are found in slaughterhouse wastewater (SWW). This emphasizes the serious threats to public health posed by improperly treated slaughterhouse effluents, particularly with regard to the environmental spread of harmful germs and microorganisms resistant to antibiotics [4].

Due to the prevalence of viruses, protozoa, helminthes eggs, and bacteria in SWW, people in underdeveloped nations in South America, Asia, and Africa have suffered from severe gastrointestinal disorders, bloody diarrhea, liver malfunctions, and, in some instances, even death. Additionally, there have been documented cases of hepatitis A and E viruses in sewage from animals in Spain. Therefore, it is essential that SWW receive effective therapy prior to being released into Proper wastewater management and treatments are vital not only for safeguarding the environment but also for protecting public health.

2. Material and methods

Slaughterhouse testing typically involves the analysis of various parameters and characteristics of slaughterhouse wastewater (SWW) to assess its composition, quality, and potential environmental impact. The specific materials and methods used and vary depends on the objectives the testing and regulatory necessities in place. Here are some common materials and methods used in slaughterhouse testing:

2.1. Materials

- **Sample Containers**: Containers made of materials like glass or plastic are used to collect representative samples of SWW.
- **Laboratory Equipment**: The Various laboratory equipments are required for sample preparation and analysis, including pipettes, beakers, filters, and centrifuges.
- **Chemicals and Reagents**: Chemicals and reagents are used for various tests, such as pH adjustment, determination of organic matter, and nutrient analysis. These may include acids, bases, oxidants, and indicators.
- **Analytical Instruments**: Sophisticated analytical instruments are often used for precise measurements. Examples include spectrophotometers for chemical analysis and turbidity meters for measuring suspended solids.
- **Safety Gear**: lab coats, goggles, gloves, PPE and respirators, may be required for handling potentially hazardous samples and chemicals.

2.2. Methods

- **Sampling**: Representative samples of SWW are collected at various points within the slaughterhouse to ensure accuracy. Proper sampling techniques are essential to obtain reliable data.
- **pH Measurement**: The pH level of SWW is determined using a pH meter to assess its acidity or alkalinity.
- **Biochemical Oxygen Demand (BOD)**: BOD tests measure the quantity of oxygen consumed by microorganisms during the biological deprivation of organic matter in the sample.
- **Chemical Oxygen Demand (COD)**: COD tests determine the quantity of oxygen required to chemically rust both inorganic and organic substances in the sample.
- **Total Suspended Solids (TSS):** TSS tests quantify the concentration of solid particles suspended in the wastewater.
- **Nutrient Analysis**: Nutrient analysis includes the measurement of total phosphorus (TP) and total nitrogen (TN) levels, can contribute eutrophication if present in excessive amounts.
- **Pathogen Detection**: Microbiological tests may be conducted to detect and quantify the presence of pathogens, such as bacteria and viruses, in the wastewater.
- **Chromatography and Spectroscopy**: Advanced analytical techniques like chromatography (e.g., HPLC) and spectroscopy (e.g., UV-Vis) may be employed for specific compound identification and quantification.
- **Microscopy**: Microscopic examination can be used to observe the presence of microorganisms, parasites, or other particulate matter in the wastewater.
- **Data Analysis**: Data collected from these tests are analyzed to assess compliance with regulatory standards and identify any necessary treatment measures.

2.3. Slaughterhouse effluent generation

Slaughterhouses rely on a continuous supply of potable and fresh water for various rinsing and washing operations. The amount of water consumed during the meats process varies on the animal type being processed and method of slaughter. All the water used in the slaughtering process eventually becomes wastewater. The sources of wastewater generation in a slaughterhouse are outlined in Table 3.

Table 3 Consumption of water details slaughterhouse waste (No IPC-4V/ Project-S/ 2017-18)

S. no.	Animals	Categories	Specific water consumption m3/tlwk
1	goat/sheep	large	1.2-2.1
		medium	1.3-2.75
		small	
2	buffalo	large	0.3-0.5
		medium	0.1-0.25
		small	0.05-0.25

2.4. Channel analysis of Lucknow Billaouchpora

The sewage channel of Lucknow city is effected by the slaughterhouse and these are tested in laboratory on four location.

- Location 1: the sample collected from the upper side of channel without mixing of slaughterhouse waste water.
- Location 2: the sample collected from after mixing of slaughterhouse waste in the channel.
- Location 3: the sample collected from the STP influent and these are measure interception are ignored and channel flows daily with upper limit of velocity.
- Location 4: the sample collected from the STP effluent where the final disposal of the treated sewage into the river. The analysis of the sewage daily problem in STP and chocking.

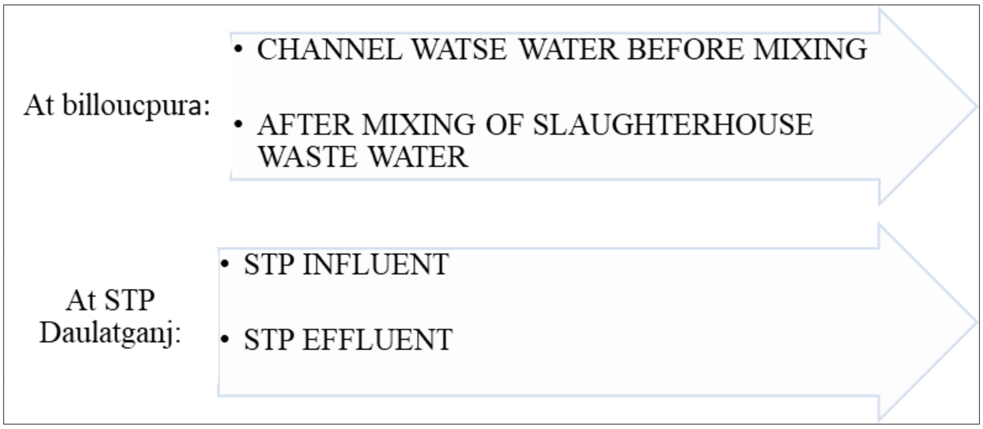

Figure 1 Study area and sample locations**.**

3. Results and discussion

The results of characterized parameter found to be critical at the location 2.

- The COD of channel before mixing of slaughterhouse waste 986 mg/L and after mixing increases 1203 mg/L.
- The BOD of channel before mixing of slaughterhouse waste 675 mg/L and after mixing increases 796 mg/L.
- The TSS of channel before mixing of slaughterhouse waste 296 mg/L and after mixing increases 352 mg/L.

The tightening of effluent standards and the continuous growth in industrial production have led to an increase in wastewater production and its concentration. Consequently, there is a imperative need to enhance performance of existing waste water treatment facilities, both in terms of efficiency and capacity.

It has become more and more difficult to increase a treatment plant's capacity and efficiency without carrying out structural renovations. As load on the sewage treatment plant increases, it often results in more frequent cleaning requirements. This frequent cleaning, in turn, can lead to a reduction in the filtration capacity of the treatment plant.

Additionally, the presence of organic matter from slaughterhouse waste contributes to the generation of more sludge within the treatment process. This increase in sludge production can further strain the capacity and effectiveness of the treatment plant. In response to these challenges, it's essential for wastewater treatment facilities to explore innovative solutions and technologies to optimize their operations. This may include process improvements, advanced treatment methods, and better sludge management practices to meet the demands of stricter effluent standards and growing industrial production.

The prevention measure to disposal of slaughterhouse waste without treatment not allowed. This problem should be reduced by the low cost and effective treatment plan for only slaughterhouse waste deal in the next paper and this will be continuing.

3.1. Laboratory analysis of parameters of channel`s waste water before mixing of slaughterhouse waste water (location 1)

There are collected sample location first and these are lesser affected by the organic matter and its result of BOD, COD and TSS mainly within the range.

These are results of channel which flowing in Lucknow Billauchpura near to slaughterhouse.

Table 4 Parameter of channel before mixing of slaughterhouse wastewater.

S no.	Parameters	Range	Average
1	pH	6.2~8.4	7.4
2	TSS(mg/L)	137~500	296
3	BOD(mg/L)	590~991	675
4	TEMP.	25~30.9	25.6
5	COD(mg/L)	700~1400	986
7	true colour(TCU)	90~400	
6	Oil and Grease(mg/L)	27~92	48

3.2. Laboratory analysis of parameters of channel`s waste water after mixing of slaughterhouse waste water (location 2)

This test result of BOD, COD, and TSS after the mixing of slaughterhouse waste into the sewage channel.

There are important results in front of that increases all the values rapidly.

Table 5 Parameters of channel after mixing of slaughterhouse wastewater.

S no.	Parameter	Range	Average
1	COD(mg/L)	700~1400	1203
2	pH	6.2~8.4	7.7
3	BOD(mg/L)	590~991	796
4	TSS(mg/L)	137~500	352
5	TEMP.	25~30.9	27.7
6	OIL AND GREASE(mg/L)	27~92	59
7	TRUE COLOUR(TCU)	90~400	206

3.3. Laboratory analysis of parameters of slaughterhouse wastewater influent of STP (location 3)

Table 6 Parameters of channel at inlet of STP Daulatganj Lucknow.

S no.	Parameters	Range	Average
1	COD(mg/L)	700~1400	1012
2	BOD(mg/L)	590~991	734
3	pH	6.2~8.4	7.5
4	TEMP.	25~30.9	26.5
5	TSS(mg/L)	137~500	309

6	oil and grease(mg/l)	27~92	51
7	true colour(TCU)	90~400	193

The samples were collected from the point where sewage enters the sewage treatment plant. The values of all parameters should be slightly lower than those at locations where slaughterhouse waste is mixed, but higher in comparison to locations where there is no mixing of sewage in the channel.

3.4. Laboratory analysis of effluent of STP (location 4)

The location of sample collected from where the treated water discharged into the river.

The result shows that the STP efficiency and filter changed frequently because the load of the sewage much and production of sludge more.

All parameter should be in the limit of the river disposal and sludge will be separately deals.

Table 7 Parameters of channel at outlet of STP Daulatganj lucknow.

S no.	Parameter	Range	Average	Av. Removal eff.(%)	Effluent stand.
1	pH	6.8~7.9	7.1		6~9
2	TEMP.	24~31.1	27.2		<35
3	COD(mg/L)	20.7~80	38.9	96	<150
4	BOD(mg/L)	7.7~39	18.9	97	<80
5	TSS(mg/L)	5~59	23	95	<80
7	oil and grease(mg/l)	2.3~9.2	6.7	88	<10
6	true colour (TCU)	18~66	46	77	<550

3.5. Graph representation and analysis

A comparative analysis was conducted for each location to assess the impact of slaughterhouse waste on both the channel and the Sewage Treatment Plant (STP). Location two exhibited significantly higher levels of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Suspended Solids (TSS). This increase was attributed to the direct mixing of slaughterhouse waste into the channel.

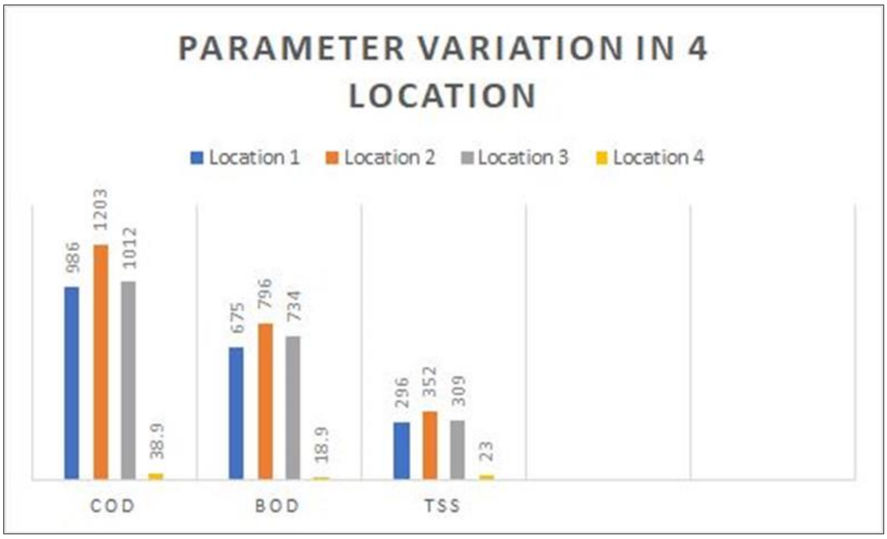

Figure 2 Comparison between channel locations and each parameter.

4. Conclusion

This study reveals that the all characteristics of sewage channel which flowing in the Luckonow Billauchpura. All parameters deal in mg/L. These parameters characteristics and results are found which critical without slaughterhouse wastewater treated disposal into the sewage channel is critical for the STP and environmental also. All characteristics BOD, COD, and TSS in the range of slaughterhouse waste.

Compliance with ethical standards

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Acknowledging the contributions of my mentors, colleagues, and the laboratory where the tests were conducted is a commendable gesture.

Your words reflect a sense of appreciation and the importance of teamwork and collaboration in academic and research endeavors. It's clear that I've a positive experience working with HOD Civil Department IET Lucknow Prof. Virendra Pathak and Asst. Prof. Asit Singh and peers at the Institute of Engineering and Technology in Lucknow, Uttar Pradesh, India, and that their support has been instrumental in the successful completion of your project.

Expressing gratitude and recognizing the efforts of those who have played a role in my academic and research journey is a valuable practice.

Disclosure of conflict of interest

No research has been conducted on the variation of parameters in different locations within Lucknow city, specifically regarding sample collection. The study includes the collection of samples from various locations in the city, including the effluent from Sewage Treatment Plants (STPs) that discharge into the river. The impact of slaughterhouse waste on the channel is evident as the parameters clearly increase when mixed.

Statement of ethical approval

"The study investigates the impact of direct disposal of slaughterhouse wastewater into the channel. Instead of focusing on a specific slaughterhouse, this research examines the effects of the combined effluent mixture in the channel on the environment and sewage system. The Institute of Engineering and Technology Lucknow has provided approval and is responsible for the review and approval process. All tests were conducted at the authorized Ecomen Lab in Aliganj, Lucknow. Ethical approvals have been obtained to ensure that this M.Tech project is environmentally and human-friendly."

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