



DOI:

Paper Submission: 18th Oct, 2023; Paper Acceptance: 10th March 2024; Paper Publication: 15th March 2024

Research Article

LGU J. Life. Sci

Vol 8 Issue 1 January - March 2024

ISSN 2519-9404

eISSN 2521-0130

Abattoir Effluents' Impacts on the Badri Nullah Stream's Water Quality

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ABSTRACT: *This investigation focuses on the Badri Nullah stream's water quality in the Swabi region. The study was conducted concerning effluents released from a nearby Abattoir (slaughterhouse). A total of five samples were taken, two were upstream and two were downstream and one was in the midstream near to slaughterhouse. Different physiochemical parameters were analyzed to find the water quality in both upstream and downstream locations. The results showed that the electrical conductivity, alkalinity, chloride, and sulfide slightly increased in concentration in downstream locations. The highest values for the above four were, E.C (1320 μ S/cm), 440 mg/l of alkalinity, sulfur 2 mg/l, and 48.05 mg/l of chloride for downstream samples. All the parameters were then compared with the WHO, NEQS, and many other international standards, in which the majority of them were within permissible limits, while some were exceeding the permissible limits. Which may cause health and other environmental concerns.*

Keyword: abattoir wastewater, impact, Badri nullah stream, effluent, water quality

INTRODUCTION

Globally, surface water and groundwater systems interact when groundwater is replenished by surface water, exfiltrated onto the soil surface,

or discharged as return flow along stream beds (Safeeq and Fares, 2016). This may result in water contamination or an enhancement in the environment for the life forms that live in these habitats. It is essential to comprehend

groundwater-surface water interaction (GSI) to preserve good water quality and quantity as well as the health of the ecosystem. Utilizing this information can help manage water supplies and protect the environment and the ecosystem. It is crucial for creating effective policies and improving the management of water resources (Khan and Khan, 2019).

All types of water derived from various paths have their unique chemistry imparted by the processes. (Eludoyin and Ijisesan, 2020). Rainwater, overland flow, soil water, and groundwater are all combined to form stream flow in a river channel. The stream flow chemistry will be determined by the relative contributions from each of these channels (Omogbehin and Oluwatimilehin, 2022).

There are certain pollution issues associated with the ongoing endeavor to enhance meat production to meet the needs of the ever-increasing global population for protein (Akinro et al., 2009). Safety procedures are hardly ever taken into account when transporting animals to the abattoir when they are being slaughtered, and when dressing hides and flesh (Singh and Sachan 2011). For hygienic reasons, abattoirs process animals with a lot of water (slaughtering and washing), which

produces a lot of effluent. The greatest harm to the environment comes from the effluent from an abattoir because of the quantity of suspended particles, liquid waste, and odor generation (Gauri, 2006). Additionally, the fact that fat, blood, dung, meat tissues, urine, and other debris are lost to sewer streams during the processing of animals at abattoirs has demonstrated the contaminating nature of slaughterhouse effluent (Bello and Oyedemi, 2009). These abattoir wastes are highly contaminated with organic materials, suspended particles, and other pollutants (Eze et al., 2013). These contaminants have the capacity to override their importance at greater levels, which can lead to a variety of detrimental health impacts, including liver damage, renal failure, and occasionally fish death. These pollutants can be vital at very low concentrations (Sani et al., 2020).

In this research, the results of different substances present in the slaughterhouse were known. Water quality was assessed in both upstream and downstream areas. changes in parameters resulting from slaughterhouse effluents released into streams were discovered.

MATERIALS AND METHODS

Area of Study

In this research, the study area was Badri nullah stream in district Swabi. The stream originates in the Buner district of the north and travels to the Indus River by way of the Swabi region. A total of five locations were chosen to

collect samples from across the stream channel for testing physiochemical parameters in relation to abattoir (slaughterhouse) effluents. In Figure 1, the study area is depicted.

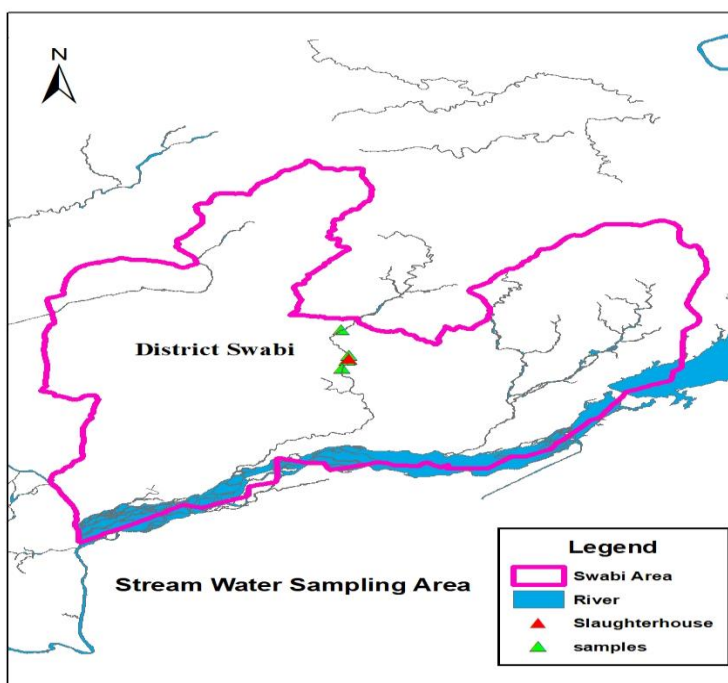


Fig. 1 Study area

Sample Collection

A sampling guide was created before heading out into the field to determine the proper water quality analysis. The instruction includes data, time, place, and the number of sample points. A systematic random sampling procedure was followed. The samples were collected from water near bridges along the stream in a sequence manner from upstream to midstream and downstream.

The Abattoir effluents were released to midstream going downstream.

Water sampling

Every five different locations along the stream had a sample of water taken. One liter of bottles was taken to gather the samples. The samples were taken from the middle of the stream, not too deep to avoid any unnecessary impurities going into bottles. The bottles were first rinsed

with stream water to make the bottles with the samples. Then these samples were taken into the laboratory for testing.

For sulfide test a separate sampling procedure was followed, because the stream water contained a number of surfactants due to which sulfide test was not possible. For this purpose, a solution of zinc acetate was made, which was used as a preservative for samples. The same sampling procedure was applied but this time with preservatives, and was brought to the laboratory for testing.

Data collection

Data was collected of the sampling sites with GPS points. Two out of five samples were taken upstream, one sample was taken midstream near

Abattoir, and two samples were taken downstream.

Sample 1 was taken from Saleem Khan Bridge (Upstream), sample 2 was taken from Maneri Bridge (Upstream), sample 3 was taken from Swabi Bridge (Midstream), sample 4 was taken little below at some distance from Swabi Bridge (Downstream) and sample 5 was taken from Badri Bridge (Downstream). The Abattoir is located near Swabi Bridge from which waste effluents are released. besides Abattoir effluents, sewage from nearby homes and villages were also released into the streams. The data collection sites have been showed in fig 2.

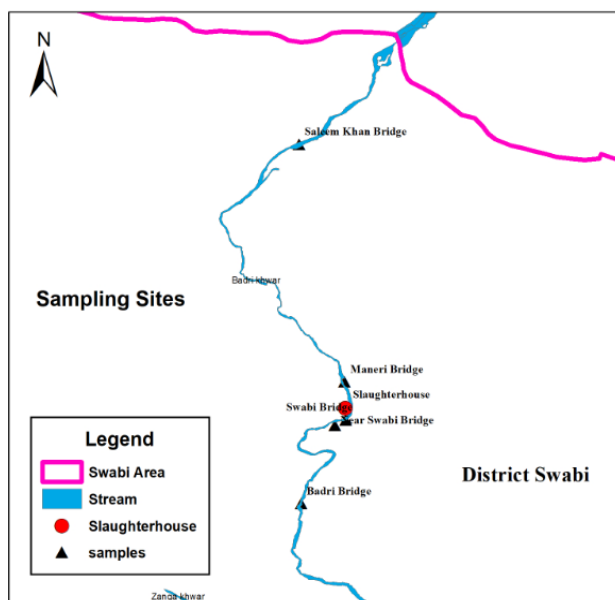


Fig. 2 Digitized map of sampling sites

Analytical methods.

Electrical conductivity (EC), pH, and total dissolved solids (TDS) were all measured utilizing meters (APHA 1985). Titration against H₂SO₄ with a methyl orange indicator was used to measure alkalinity. Chloride (CL), one of the anions, was examined using a potassium chromate indicator in a titration against AgNO₃. Titration against EDTA with the EBT indicator was used to determine the total hardness. Few drops of ammonium buffer PH 10 solutions were added to maintain solution. Calcium (Ca) was determined by titration against EDTA using murexide as an indicator. Total Suspended solids were determined by the method of filter paper and solution passed method, in this method filter paper is weighed and the water is passed through the filter paper and is oven dried for 24 hours at 120°C. Sulfide was analyzed using Iodometric method, it was titrated with starch indicator using Sodium Thiosulfate (Na₂S₂O₃) solution. Turbidity test was done through turbidity meter. First standards were set for turbidity test by applying standard test, which were 1, 10, 100, 1000 respectively.

RESULTS

Table 1 and 2 summarized the physical and chemical parameters of the upstream, midstream and downstream locations.

Physical parameters

The analytical data indicated that pH and TDS of all locations were ranging from 6.82 to 7.24 and 650 to 760 mg/l, respectively. The TDS results were compared with the standards of WHO and PSQCA (Pakistan standard quality control authority) and all were in the permissible limits of these standards. Total suspended solids values ranging from lowest (225 mg/l) to highest (280 mg/l). The lowest value occurred at sample 4 where the water is usually stagnant, so that would be the cause of lower value, while at sample 2 the value is highest, it is because of the high runoff speed of water which contain high number of TSS. They were in permissible limits of WHO standards.

Chemical parameters

The total hardness concentration ranged from 126.6 to 233.3 mg/l and all were in the permissible limits according to WHO standards. While Ca concentration in terms of hardness was reported between 46.6 and 86 mg/l, in range. Sample 3 has more calcium than Sample 2. Because the sample location

is next to an abattoir and the waste from the abattoir contains a variety of chemicals, including a high concentration of calcium, the hardness value is high here. We compared the results with NEQS and WHO standards and they were under the standards limit. The Total Alkalinity ranged from 336 to 440 mg/l. The high alkalinity at sample 4 site may be due to the carbonate ions present in water at high concentration, in the case of WHO, they were in the permissible limit. The Chloride concentration ranged from 32.03 to

48.05 and were in the permissible limits according to WHO. The values for Sulfide concentration ranged from lowest (0.4) of sample 1 (Upstream) to highest (2) of sample 3 (Midstream). The high concentration of sulfide at sample 3 was due to Abattoir (slaughterhouse) waste discharge into the stream, which increased the value of sulfide beyond the permissible limit. The values for Turbidity ranged from lowest (8.6 NTU) to highest (11.9 NTU). All the samples were exceeding the standards limit (WHO).

Table 1: Physical parameters of water samples

Electrical conductivity	Lab Results	WWF Standards (2007)	WHO Standards
Sample 1 (U-S)	1196 μ S/cm	1500 μ S/cm	1200 μ S/cm
Sample 2 (U-S)	1180 μ S/cm	1500 μ S/cm	1200 μ S/cm
Sample 3 (M-S)	1320 μ S/cm	1500 μ S/cm	1200 μ S/cm
Sample 4 (D-S)	1255 μ S/cm	1500 μ S/cm	1200 μ S/cm
Sample 5 (D-S)	1183 μ S/cm	1500 μ S/cm	1200 μ S/cm
pH	Lab Results	PSQCA Standards	WHO standards
Sample 1 (U-S)	6.96	6.5 to 9.2	6.5 to 8.5
Sample 2 (U-S)	7.24	6.5 to 9.2	6.5 to 8.5
Sample 3 (M-S)	6.82	6.5 to 9.2	6.5 to 8.5
Sample 4 (D-S)	6.89	6.5 to 9.2	6.5 to 8.5
Sample 5 (D-S)	7.1	6.5 to 9.2	6.5 to 8.5
Total Dissolved Solids	Lab Results	PSQCA Standards	WHO Standards
Sample 1 (U-S)	690 mg/l	1000 mg/l	1000 mg/l
Sample 2 (U-S)	680 mg/l	1000 mg/l	1000 mg/l
Sample 3(M-S)	760 mg/l	1000 mg/l	1000 mg/l

Sample 4 (D-S)	685 mg/l	1000 mg/l	1000 mg/l
Sample 5 (D-S)	650 mg/l	1000 mg/l	1000 mg/l

Table 2: Chemical parameters of water samples

Total suspended solids	Lab Results	PSQCA Standards	WHO standards
Sample 1 (U-S)	260 mg/l	500 mg/l	500 mg/l
Sample 2 (U-S)	280 mg/l	500 mg/l	500 mg/l
Sample 3 (M-S)	230 mg/l	500 mg/l	500 mg/l
Sample 4 (D-S)	225 mg/l	500 mg/l	500 mg/l
Sample 4 (D-S)	245 mg/l	500 mg/l	500 mg/l
Total Alkalinity as Caco3	Lab Results	NEQS	WHO Standards
Sample 1 (U-S)	336 mg/l	200 mg/l	500 mg/l
Sample 2 (U-S)	346 mg/l	200 mg/l	500 mg/l
Sample 3 (M-S)	430 mg/l	200 mg/l	500 mg/l
Sample 4 (D-S)	440 mg/l	200 mg/l	500 mg/l
Sample 5 (D-S)	410 mg/l	200 mg/l	500 mg/l
Total Hardness (CaCO₃)	Lab Results	PSQCA Standards	WHO Standards
Sample 1 (U-S)	193.3 mg/l	500 mg/l	500 mg/l
Sample 2 (U-S)	226.6 mg/l	500 mg/l	500 mg/l
Sample 3 (M-S)	126.6 mg/l	500 mg/l	500 mg/l
Sample 4 (D-S)	153.3 mg/l	500 mg/l	500 mg/l
Sample 5 (D-S)	233.3 mg/l	500 mg/l	500 mg/l
Calcium Hardness	Lab Results	NEQS	WHO Standard
Sample 1 (U-S)	46.6 mg/l	200 mg/l	250 mg/l

Sample 2 (U-S)	66 mg/l	200 mg/l	250 mg/l
Sample 3 (M-S)	86 mg/l	200 mg/l	250 mg/l
Sample 4 (D-S)	65 mg/l	200 mg/l	250 mg/l
Sample 5 (D-S)	69 mg/l	200 mg/l	250 mg/l
Chloride	Lab Results	NEQS	WHO Standard
Sample 1 (U-S)	32.03 mg/l	<250 mg/l	250 mg/l
Sample 2 (U-S)	36.03 mg/l	<250 mg/l	250 mg/l
Sample 3 (M-S)	44.04 mg/l	<250 mg/l	250 mg/l
Sample 4 (D-S)	46.05 mg/l	<250 mg/l	250 mg/l
Sample 5 (D-S)	48.05 mg/l	<250 mg/l	250 mg/l
Sulfide	Lab Results	Pak NEQS	WHO Standard
Sample 1 (U-S)	0.4 mg/l	1 mg/l	1 mg/l
Sample 2 (U-S)	0.8 mg/l	1 mg/l	1 mg/l
Sample 3 (M-S)	2 mg/l	1 mg/l	1 mg/l
Sample 4 (D-S)	00	1 mg/l	1 mg/l
Sample 5 (D-S)	00	1 mg/l	1 mg/l
Turbidity	Lab Results	PSQCA	WHO Standard
Sample 1 (U-S)	8.6 NTU	5 NTU	5 NTU
Sample 2 (U-S)	11.9 NTU	5 NTU	5 NTU
Sample 3 (M-S)	10.7 NTU	5 NTU	5 NTU
Sample 4 (D-S)	10.8 NTU	5 NTU	5 NTU
Sample 5 (D-S)	10.3 NTU	5 NTU	5 NTU

DISCUSSION

Physical parameters

Water is a crucial component of the environment; but surface water and

groundwater quality have long been deteriorating due to both natural and human-related activities. Natural factors that influence water quality are

hydrological, atmospheric, climatic, topographical and lithological factors. (Uddin et al., 2018)

The values for total dissolved solids were ranging from lowest (650 mg/l) to highest (760 mg/l) for sample 5 (D-S) and sample 3 (M-S). The value of TDS at sample 3 is much greater than rest of the samples because the effluents from the Abattoir (slaughterhouse) are directly released here which contribute much to the greater amount of TDS. We compared the TDS results with the standards of WHO and PSQCA (Pakistan standard quality control authority) and all were in permissible limits of these standards. The pH of water determines the solubility (amount that can be dissolved in the water) and biological availability (amount that can be utilized by aquatic life) of chemical constituents such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, etc.) (USGS 2016). The lowest to highest pH value was (6.82-7.24) in sample 2 and 3. By comparing the pH lab results with the Pakistan standard quality control authority (PSQCA) and with the standards of WHO, all the pH ranges of the samples were in permissible limits.

Water quality can be assessed by various parameters such as BOD,

temperature, electrical conductivity, nitrate, phosphorus, potassium, dissolved oxygen, etc. (Bhateria and Jain, 2016). The electrical conductivity from lowest to highest was (1180- 1320) in sample 2 (Midstream) and 3 (Downstream). By comparing the lab results with the WWF and WHO standards, it shows that EC is in permissible limit according to WWF (world wide fund for nature) standards while in case of WHO, two samples were exceeding the WHO standards. The major reason for this would be slaughterhouse, because it is located near the area where these samples are taken from.

Total solids can be classified as suspended (non-filterable) or dissolved (filterable), by passing a known volume of sample through a glass-fiber filter (Whatman GF/C). (Sabari et al., 2018). Total suspended solids values were ranging from lowest (225 mg/l) to highest (280 mg/l). The lowest value occurred at sample 4 where the water is usually stagnant, so that would be the cause of lower value, while at sample 2 the value is highest, it is because of the high runoff speed of water which contain high number of TSS.

Chemical parameters

Hardness of water is due to moisture and carbon dioxide reacts with calcium

and magnesium ion present on the earth surface (Boyd et al., 2016). Total Hardness as CaCO_3 were ranging from lowest (126 mg/l) to highest (233 mg/l). All the sample were falling in the category of Hard and Very Hard water. We compared the analysis with the PSQCA and WHO standards, and all the samples were falling below the permissible limit. Similarly, Calcium Hardness as CaCO_3 were ranging lowest (46.6 US) to highest (86 M-S). Sample 3 has a higher value of calcium Hardness because the sample site is located near the Abattoir, the waste from Abattoir contains different substances including high calcium concentration, therefore the hardness value is high here. We compared the results with NEQS and WHO standards and they were under the standards limit

Total alkalinity is the concentration of titratable bases in water. A base will react to neutralize a hydrogen ion (H^+), for example, in the reaction $\text{H}^+ + \text{OH}^- = \text{H}_2\text{O}$, OH^- (hydroxyl ion) is the base. The word “total” is added to alkalinity because the contribution of different ions to total alkalinity may sometimes be reported separately, for example, hydroxide alkalinity (Boyd et al., 2016). Total alkalinity as CaCO_3 were ranging from lowest (336 mg/l) to highest (440 mg/l) for sample 1 (U-S)

and sample 4 (D-S). The high alkalinity at sample 4 site may be due to the carbonate ions present in water at high concentration. We compared the results analysis with the National Environmental quality standards (NEQS) and with the WHO Standards. The sample were exceeding in the case of NEQS, while in the case of WHO, they were in the permissible limit.

The tests were performed for the P-Alkalinity to all the samples, with the addition of phenolphthalein and they remained colorless, therefore the P-Alkalinity was zero.

Chloride is mainly obtained from the dissolution of salts of hydrochloric acid as table salt (NaCl), NaCO_2 and added through industrial waste, sewage, sea water etc. Surface water bodies often have low concentration of chlorides as compare to ground water. It has key importance for metabolism activity in human body and other main physiological processes. High chloride concentration damages metallic pipes and structure, as well as harms growing plants. (Meride and Ayenew, 2016). Chloride concentration in five samples were ranging lowest (32.03 mg/l) for sample 1 (U-S) and highest (48.05 mg/l) for sample 5 (D-S). We compared the results with national environmental quality standards and with WHO

standards, all were falling below the permissible limit standards.

The oxidation of sulfide minerals within waste-rock stockpiles can lead to poor-quality drainage that presents an environmental risk and financial liability to mining companies. (Amos et al., 2015). The values for Sulfide concentration were from lowest (0.4 mg/l) of sample 1 (Upstream) to highest (2 mg/l) of sample 3 (Midstream). The high concentration of sulfide at sample 3 was due to Abattoir (slaughterhouse) waste discharge into the stream, which increased the value of sulfide beyond the permissible limit. We compared the sulfide results with the Pak (NEQS) and other countries such as Australia and Malaysia. In case of Pakistan all sample were in guidelines limit except sample 3 which exceeded the permissible limit. In comparison with the other countries, samples which contained sulfide were exceeding its limit standards

Turbidity in drinking water is esthetically unacceptable, which makes the water look unappetizing, (Omer, 2019).

The values for Turbidity were from lowest (8.6 NTU) to highest (11.9 NTU). All the samples were exceeding the standards limit. By comparing with the standards of PSQCA and WHO

standards the Turbidity rate was higher and the water appeared to be turbid.

CONCLUSION

The research study was conducted on stream water for different physiochemical parameters, samples were collected from upstream and downstream with respect to slaughterhouse. Results showed that different parameters were exceeding the standard limits. E.C, Alkalinity, chloride and sulfide showed slight increase in downstream locations, as slaughterhouse waste effluents are entering at midstream location. Although few parameters showed increase in concentration downstream from the slaughterhouse waste effluent entry point. When measured against several standards, the majority of the evaluated metrics fell within the permitted range.

ACKNOWLEDGEMENT

The authors highly acknowledged the Department of Environmental Sciences, University of Peshawar for providing the analytical facilities.

CONFLICT OF INTEREST

There were no hidden conflicts of interest among the authors.

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