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A Study of Toxic Heavy Metals in released Treated/Untreated Waste Water from Slaughterhouses of Khurja, Uttar Pradesh

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Abstract

It has a high amount of wastewater from blood and other animal tissues, cleaning agents, machinery contaminants carrying toxic heavy metals, significant sources of human hazard and environmental risks. The heavy metals used are cadmium, chromium, lead, mercury, and arsenic. Heavy metals cause severe health problems, such as kidney and neurological diseases, cancer, reproductive problems, and respiratory illnesses. Exposure pathways The three major pathways of exposure encompassed include ingestion, inhalation, and dermal contact. Even treated wastewater poses risks due to incomplete metal removal, formation of toxic by-products, and contamination of receiving water bodies. Untreated wastewater poses even greater dangers due to the exposures through direct contact with harmful metals and transmission of waterborne diseases. The case studies are critical and emphasize this situation around the world and most importantly at developing countries. Advanced treatment technologies and close monitoring are relevant to mitigate these risks.

Keywords*:* Health Risks, Toxic, Heavy Metals, Treated/Untreated Wastewater, Slaughterhouses, Human Health.

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Introduction

Pond aquaculture fish output is limited by water quality and availability. Filling the pond requires clean, available, and controlled water. Many nations dump untreated urban, industrial, and rural residential and industrial effluent into the environment, causing major environmental problems. A sustainable water source for aquaculture in Israel, China, Vietnam, and India is treated wastewater. An issue is the safety of fish meat produced this way. Fish and fish products may contain heavy metals, lowering their nutritional value. Untreated stream effluent is the main source of heavy metals in the environment, which are caused by human activities. Through the food web, they pose a threat to both people and aquatic environments. Aquatic ecosystems become polluted when metals bioaccumulate. Reducing the levels of heavy metals in sediment, water, and fish has recently attracted a lot of scientific attention. All the way up the food chain, heavy metals have an impact on people since they are poisonous at low doses and don't biodegrade. Despite numerous authors claiming that fish raised in treated effluent are safe to consume, there is little evidence that these fish bioaccumulate heavy metals.

Chemists shouldn't use harmful and needless lead, mercury, cadmium, and arsenic. Plants, animals, and humans are all impacted by their excessive presence in water. All living things require metals. When taken in excess, the metals zinc, iron, copper, manganese, cobalt, and selenium can cause serious health problems. Metals cause damage over time, not all at once. Industrial mercury contamination in Japan's Minimata Bay and the Minimata disease induced by consuming tainted fish brought heavy metal toxicity through aquatic organisms to the forefront of public consciousness. Subsequently, people were poisoned by cadmium-contaminated fish. Water and the Earth's crust both contain arsenic. Nature displays it in a variety of ways. For the majority of fish, its organic form is less toxic. It has murky physiological effects and is found at low concentrations. Cause cancer and mutations. Cadmium naturally builds up in the body over time. This toxic chemical damage reproductive, urinary, respiratory, and locomotor systems. Mercury is abundant and toxic. Eating mercury-containing fish is harmful. Human nervous and physiological systems are poisoned. It causes mutations and cancer. Mercury crosses the placenta to fetus. Lead is omnipresent and unnecessary. Nature is plentiful in zinc and iron. Life requires zinc, but too much is dangerous.

Literature review

Adegoke, A. A. (2018) reviewed the data on this practice's health risks and epidemiology in order to reach a conclusion. Workers in agriculture and their families, those who consume crops, and those living in close proximity to places that use wastewater for irrigation were all part of the scope of this assessment. Exposure in the agricultural sector is associated with an increased risk of diarrheal disease and helminth infections in children and the immunocompromised, as shown in a meta-analysis with odds ratios of 1.65 (95% CI: 1.31, 2.06) and 5.49 (95% CI: 2.49, 12.10), respectively, for exposed family members and children. Occupational exposure and ingestion were the most common routes of infection, affecting primarily the skin and intestines. A number of food-borne outbreaks have been produced by the irrigation of fruits and vegetables with partially or untreated wastewater. In addition to coliform bacteria, soil-transmitted helminths (STHs), and enteric viruses, crops have also been shown to contain drug residues and antibiotic resistance genes (ARGs). Pelić, M. et. al. (2023) evaluated the integrated system's performance and fish safety by determining the concentration of heavy metals and metalloids in several samples including pond water, sediment, carp tissue, and wastewater from abattoirs. Both spring and autumn were used for sampling. The average concentrations of the following elements in the water samples were measured: Cd (0.12-4.2), Hg (1.14-14.21), Pb (<0.1-17.2), Cu (<0.1-44.6), Fe (17.02-425.2), and Zn (2.91-186.2). The concentrations of these elements were found to be highest in the wastewater, which went beyond the limits allowed for wastewater discharged into natural recipients from slaughterhouses. There was an efficiency rate of 87% to 98% in the wastewater treatment system for metalloids and heavy metals. The pond water may be used to spawn cyprinid fish in the spring and autumn since it contained concentrations of metalloids and class 3 heavy metals. There was water available for irrigation in the canals, and it was class 2/3. Nandomah, S., & Tetteh, I. K. (2023) offered a detailed analysis and narrative review of the ecological risk assessment of heavy metals in abattoir liquid waste for the advancement of knowledge. The narrative review primarily covered abattoir operations, liquid waste features, the health effects of heavy metals in liquid waste, environmental repercussions, and prospective ecological risk index (RI) methods. The literature from these systematic reviews was vital. Fifteen slaughterhouses in Nigeria that fulfilled both inclusive and exclusive criteria were the subjects of a holistic review that included meta-analysis and meta-regression. Differences in abattoir heterogeneity based on standardized RIs (effect sizes) were measured by comparative multiple linear meta-regression analysis using eight tau () estimators in R language. The research looked at how far away slaughterhouses were from Gashaka-Gumti National Park (GNP), an unspoiled habitat, as well as the concentration and quantity of metals.

Material and Methodology

Khurja, a city located in the Bulandshahar district of Uttar Pradesh, India, boasts a rich cultural heritage and historical significance. Founded in 1339 by Raja Khur Singh, the city's strategic location on the Delhi-Kolkata National Highway has made it a crucial hub for trade and commerce. Khurja's history is intricately linked with the Mughal Empire, and its architectural legacy is evident in the city's ancient mosques, temples, and forts. Today, Khurja stands as a testament to India's diverse cultural tapestry, blending Mughal, British, and Islamic influences. Khurja's economy thrives on its pottery industry, earning the city the nickname "Ceramic City." The city's industrial landscape also encompasses sectors like agriculture, textiles, and food processing. Khurja's ceramic products, renowned for their quality and craftsmanship, are exported globally. The city's vibrant cultural scene is marked by festivals like Eid, Diwali, and Navratri, showcasing the harmonious coexistence of diverse communities. With its blend of history, culture, and industry, Khurja continues to evolve as a significant urban center in western Uttar Pradesh. Khurja's pottery industry, renowned for its exquisite craftsmanship, has been a cornerstone of the city's economy for centuries. With over 200 pottery units employing approximately 50,000 people, the industry produces a wide range of products, including tableware, decorative items, sanitary ware, and refractory items. Khurja's potters skillfully blend traditional techniques with modern methods, using high-quality raw materials and advanced firing techniques to create distinctive products. The industry's exports, valued at ₹500-700 crores annually, reach global markets, including the Middle East, Europe, and the United States. Despite facing challenges from international competition and environmental concerns, Khurja's pottery industry continues to thrive, buoyed by government initiatives and innovative marketing strategies that showcase its unique heritage and artisanal expertise.

An overview of the geographical conditions of Khurja City:

Location: Khurja City is situated in the Bulandshahar district of Uttar Pradesh, India.

Latitude and Longitude: 28.25°N latitude and 77.85°E longitude

Topography: Khurja is located in the Ganga-Yamuna Doab region, characterized by:

- Flat to gently sloping terrain
- Average elevation: 194 meters (636 feet) above sea level
- Alluvial plain with fertile soil

Climate: Khurja experiences a humid subtropical climate:

- Hot summers (April-June): 40-45°C (104-113°F)
- Mild winters (December-February): 2-10°C (36-50°F)
- Moderate rainfall (July-September): 80-100 cm (31-39 in)

Geological Features:

- Yamuna River flows approximately 20 km east of Khurja
- Ganga River flows approximately 50 km south of Khurja
- Kali Nadi and Hindon River flow through nearby areas

Soil: - Alluvial soil with mix of clay, silt, and sand

- Fertile soil suitable for agriculture (wheat, sugarcane, potatoes)

Natural Resources:

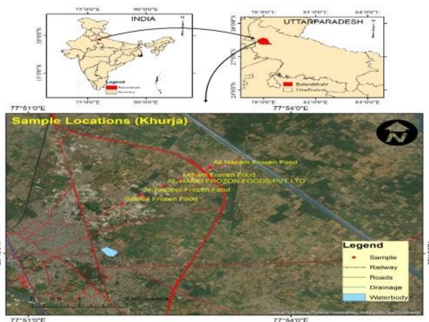
- Water: Yamuna River, groundwater resources
- Minerals: Sand, gravel, limestone

Environmental Concerns:

- Air pollution from industrial activities and vehicular emissions
- Water pollution from industrial effluents and agricultural runoff
- Soil degradation due to intensive agriculture

Demographics:

- Population (2020): approximately 1.5 lakhs (150,000)
- Density: 1,400 people per square kilometer
- Urbanization rate: 30%



Sampling Sites: Details shown in Table 1

Sample Number	Sample Type	Sample Location
1	Ground,river,pond,handpump,Borewell	Madina frozen foods
2	Ground,river,pond,handpump,Borewell	Allhand Frozen Food
3	Ground,river,pond,handpump,Borewell	Leham Frozen Food
4	Ground,river,pond,handpump,Borewell	All Nazam Frozen Food
5	Ground,river,pond,handpump,Borewell	Barkat Frozen Food
6	Ground,river,pond,handpump,Borewell	All Taqdeer Frozen Food
7	Ground,river,pond,handpump,Borewell	Sahiba Frozen Food

Table 1: Study Sites

Sources of Heavy Metals in Slaughterhouse Wastewater

The wastewater results from several processes where heavy metals are introduced into the slaughterhouses. Some of these sources include (shown in table 2)

•Blood and Animal Tissues: Animal blood and tissues may contain trace metals such as lead, cadmium, and arsenic that may have entered through contaminated feed exposure or water exposure over their lifetime.

•Chemical Cleaning Agents and Disinfectants: These are present in abundance in the slaughterhouses. Therefore, mercury and chromium get into the environment as contaminants through detergents or from corrosion of equipment.

•Equipment and Machinery: Hydrolysis in the slaughterhouse equipment, which may contain chromium and lead, is among the factors that contribute to higher metal content in wastewater.

Table 2: Common sources of heavy metals in slaughterhouse wastewater

Source	Heavy Metal	Potential Impact
Blood and animal tissues	Lead, Arsenic	Environmental contamination
Cleaning agents	Mercury, Chromium	Human health risks
Equipment and machinery	Lead, Chromium	Corrosion adds metals to wastewater

Common Heavy Metals Found In Slaughterhouse Wastewater Some of the major heavy metals commonly found in slaughterhouse wastewater include lead (Pb), cadmium (Cd), chromium (Cr), mercury (Hg), and arsenic (As). Lead-related neurotoxic effects have been identified, including deficits at developing ages in children, kidney malfunction, and reproductive impairments. Functional impairments in the kidneys have been found as a result of cadmium exposure, although carcinogenicity is also well documented as a concern. Chromium is highly dangerous, especially as hexavalent state Cr (VI), because it causes respiratory diseases and lung cancer. It causes severe neuropathological conditions in the central nervous system. Another dangerous contaminant that arises from chronic exposure to disease in cancer, cardiovascular diseases, and neurological conditions is arsenic.

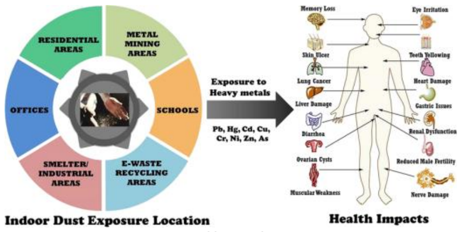


Figure 1: Health effects from heavy metals

1.1. Health Risks Associated with Exposure to Heavy Metals

The bioaccumulation and toxicity of heavy metals make them quite dangerous when exposed to the human body. Major dangers to health include:

- **Neurological Damage:** Lead and mercury, for example, can penetrate the blood-brain barrier and cause neurological damage, including memory loss, cognitive impairments, and even encephalopathy in the worst-case scenario.
- **Harm to the Kidneys:** Chronic accumulation of heavy metals in the kidneys causes nephrotoxicity and eventually renal failure.
- **Cancer:** A number of heavy metals are known to cause cancer. Among the many malignancies that chromium (VI) and arsenic are known to amplify, some of the most common ones include skin, bladder, and lung cancers.
- **Problems with Reproduction:** Decreased fertility and problems with fetal development have been associated with heavy metal exposure, such as lead and cadmium.
- **Respiratory Problems**: Inhalation of aerosolized heavy metals like chromium and lead can lead to chronic respiratory conditions, including asthma, bronchitis, and lung cancer.

2. Exposure Pathways Of Heavy Metals

The main exposure pathways of heavy metals from slaughterhouse wastewater are

- **Ingestion of contaminated water:** Slaughterhouses are known to contribute to the consumption of contaminated water. People in communities have consumed water contaminated with untreated or inadequately treated wastewater from slaughterhouses, whereby they are exposed to chronic heavy metals.
- **Ingestion of contaminated water:** Wastewater can aerosolize heavy metals because sometimes it can happen during treatment processes or through evaporation.
- **Dermal Contact:** Dermal contact is associated with exposure to heavy metals in cases where workers are exposed dermally in slaughterhouses or when people use contaminated water for bathing or irrigation.

Case Example: In the rural areas of developing countries, the treated water from slaughterhouses for irrigation purposes may have multiple pathways for exposure to heavy metals.

2.1. Treated Wastewater Risks-Even if treated, slaughterhouse wastewater can become hazardous in case some heavy metals are not totally removed. The hazards include the following:

Incomplete removal of heavy metals: Methods adopted in various conventional wastewater treatments have little efficacy in the removal of some heavy metals, leaving behind residual concentration that might still cause harm.

Formation of toxic by products: These heavy metals can react with other chemicals during the treatment process and produce even more toxic substances.

Contamination of receiving waters: Residual heavy metals that remain in treated water, when put in natural water bodies, may accumulate in aquatic ecosystems and bioaccumulate in the food chain.

2.2. Untreated Wastewater Risks

Untreated wastewater poses serious threats, especially to communities where the disposal of waste is not regulated:

Direct exposure to heavy metals: Since they draw untreated water directly into them for drinking or irrigation, communities stand to be exposed to toxic heavy metals with a likelihood of chronic health problems.

Environmental contamination: Untreated wastewater can become a source of leaching into soil and groundwater, perpetuating long-term environmental damage.

Waterborne diseases: Apart from heavy metals, water infected with untreated waste material carries pathogens that lead to outbreaks of waterborne diseases in the affected areas.

3. Case Studies

Developing Countries: In most developing countries, there is also a lack of an appropriate treatment facility for wastewater emanating from the slaughterhouses; thereby causing massive heavy metal contamination in the rivers and other water bodies near the slaughterhouses.

Pollution near Slaughterhouses: Contamination of river water downstream from a slaughterhouse with industrial inorganic pollutants has been reported for an industrial area in Nigeria. The levels of chromium and lead found have reportedly been harmful to the health of residents.

4. Mitigation Strategies

Several strategies then come into play in a reduction of the health hazards posed by slaughterhouse wastewater.

Effective wastewater treatment technologies: The treatment technologies to remove heavy metals from wastewater should be advanced; membrane filtration and chemical precipitation.

Regular monitoring and testing: There could be regular testing of wastewater for heavy metals to ensure that the treatment processes are functional and possible contamination can be detected at the early stages.

Proper disposal of waste: Disposal of solid and liquid wastes in slaughterhouses must be done according to state and local ordinances to avoid contaminating the surrounding environment.

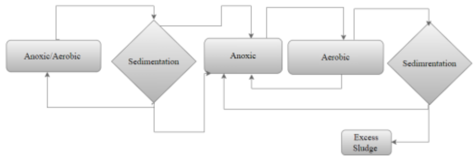


Figure 2: Slaughterhouse wastewater treatment plant flowchart

Conclusion

From the above study, the concentration of toxic heavy metals (Cr, Cd, As, Pb) founded quietly high at all study sites of Khurja, which indicated metal ions making up the effluent of slaughterhouse waste are toxic and harmful to both human life and the environment. Metals found in animal leftovers, cleaning products, machineries, lead, cadmium, chromium, mercury, and arsenic cause brain damage, renal failure, cancer, reproductive disorders, and respiratory diseases. Toxic elements can be exposed to the environment through ingestion, inhalation, and skin contact. Even treated wastewater may not eliminate these elements, while untreated wastewater can also pollute the environment and spread diseases. Case studies on slaughterhouses in developing nations illustrate how rivers that border them become seriously polluted, which underscores the need for strong infrastructure and regulations. To address these concerns, the current wastewater treatment technology must ensure that there is constant monitoring and safe disposal of waste. Companies, government authorities, and communities need to collaborate to help prevent heavy metal contaminations in abattoir wastewater from harming not only humans but also the environment.

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