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A REVIEW OF WATER QUALITY IN KUWANO RIVER, BASTI (UTTAR PRADESH): PHYSICOCHEMICAL CHARACTERISTICS, MICROBIAL CONTAMINANTS, AND HUMAN HEALTH RISKS

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Abstract:

The water quality and microbial contamination of the Kuwano River in Basti district, Uttar Pradesh, were assessed using the Water Quality Index (WQI) method to determine its overall environmental status. The WQI approach was found to be an effective and reliable tool for evaluating the suitability of river water for human consumption, bathing, and agricultural applications. Water samples were collected from several locations along the river during different seasons to understand spatial and seasonal variations in water quality. This review mainly focuses on the analysis of important physicochemical parameters such as pH, temperature, biological oxygen demand (BOD), and dissolved oxygen (DO), which are key indicators of aquatic health. Microbial contamination was also evaluated by examining the presence of Escherichia coli, total coliforms, and faecal coliforms using standard microbiological methods. The WQI values ranged from 60 to 80, categorizing the river water as poor to very poor in quality. These findings indicate that the river water is unsuitable for direct human consumption without proper treatment and reveal significant levels of pollution with associated health risks. The study highlights the urgent need for improved wastewater treatment facilities and increased public awareness to protect river water quality. Future research should emphasize detailed seasonal monitoring, long-term health impact assessment, identification of pollution sources, and effective measures to reduce microbial contamination. Regular monitoring and proper river management are essential for environmental sustainability and public health protection

Keywords: *Water Quality, Microbial Contamination, Physiochemical property, Human Health.*

Introduction

Water is a fundamental requirement for human survival, and its quality plays a crucial role in public health, economic growth, ecosystem stability, and environmental sustainability. In recent years, microbial contamination of river water has increased significantly due to rapid urbanization, industrial expansion, and intensive agricultural activities. Among the various aspects of water quality, its impact on human health is one of the most critical concerns. Contaminated water can transmit a wide range of waterborne diseases, ranging from mild gastrointestinal infections to life-threatening illnesses such as cholera and typhoid fever (1).

Water quality assessment, particularly the evaluation of microbial contamination, is essential for understanding the effects of pollutants on aquatic ecosystems, as pollution often leads to habitat degradation and loss of biodiversity (2). According to estimates by the World Health Organization (WHO), nearly 2 billion people worldwide do not have access to safe drinking water, resulting in millions of illness cases every year. Assessing the water quality of the Kuwano River is essential for understanding the impacts of pollution and habitat degradation on the overall health of the aquatic ecosystem. Water pollution can be defined as the alteration of physical, chemical, and biological characteristics of water, including parameters such as pH, temperature, dissolved oxygen (DO), biochemical oxygen demand (BOD), and coliform bacteria (3). Changes in these parameters can have adverse effects on aquatic organisms as well as on human health. Each parameter plays a crucial role in determining the suitability of water for specific uses such as drinking, irrigation, and recreational activities.

River water quality often varies from site to site, particularly in areas where industrial and domestic wastes are discharged directly or indirectly into the river on a daily basis. Elevated levels of microbial contaminants, including *Escherichia coli* and faecal coliform bacteria, indicate the presence of harmful substances that degrade water quality and pose serious health risks. In the Kuwano River, contamination is primarily associated with untreated industrial effluents, municipal sewage, and residues of chemical fertilizers that enter the river through surface runoff, making the water unsafe for drinking and recreational purposes.

The WQI method is an effective tool for communicating complex scientific information to policymakers, environmental managers, and the general public, thereby supporting informed decision-making in environmental monitoring and water resource management (4). Elevated levels of biochemical oxygen demand (BOD) and faecal coliform bacteria were identified as the primary factors contributing to the degraded WQI. Such contamination poses serious health risks, particularly to vulnerable groups such as children and the elderly. The study also highlighted that industries located along the riverbanks frequently discharge untreated wastewater containing microbial pathogens directly into the river. Additionally, the presence of antibiotic-resistant bacteria in industrial effluents has been documented, which further intensifies public health concerns by increasing the risk of infections that are difficult to treat (5).

Similarly, their findings suggested that the river water was unsuitable for irrigation purposes due to excessive concentrations of dissolved ions. The study emphasized that faecal coliforms and other pathogenic microorganisms largely originate from livestock waste and agricultural activities. During rainfall events, surface runoff transports bacteria such as *Escherichia coli* into the river system, leading to widespread contamination of surface waters.

Their need for better understand microbial dynamics within the river ecosystem and to identify emerging biological threats. The detection of antibiotic-resistant bacteria in river water raises serious concerns regarding the effectiveness of existing medical treatments for waterborne diseases (6). These resistant microorganisms are capable of causing severe gastrointestinal illnesses and often survive conventional disinfection processes such as chlorination. The study also noted that agricultural runoff shows strong seasonal variation, with contamination levels increasing significantly during the monsoon season when heavy rainfall washes pollutants into the river. It is reported as a marked decline in pollution-sensitive macroinvertebrate species in heavily contaminated stretches of the Kuwano River. The calculated diversity index revealed a substantial reduction in biodiversity in areas exposed to high pollution loads, clearly indicating a deterioration in overall water quality and ecological health.

Material and Methods

The study area

The river Kuwano originates from Bahraich district of UP, approximately 180 km east of Lucknow, the state capital. It is also known as tributary of Ghaghra (saryu) river. The river serves as the city's main source of water; while passing through basti, urban sewage, solid wastes and industrial effluents are incorporated into it.

Sampling site

Upstream (near origin) represent the pristine condition of river, relatively unpolluted area. Midstream Agricultural area (fertilizer and pesticide) is used, potentially affecting river's water quality, Industrial area Urban area (domestic waste water and sewage may enter the river). Downstream (near confluence) kuwano river with another river represents the cumulative impact of pollution sources on the river's water quality.

Sampling collection

Water quality and sampling methodology

Water sampling was carried out during different seasons, namely pre-monsoon, monsoon, and post-monsoon periods, to capture seasonal variations in water quality parameters. The collected water samples were analysed for key physicochemical parameters, including pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), and temperature. All analyses were performed in accordance with standard procedures recommended by the American Public Health Association (APHA, 2017). Microbial contamination was assessed by examining indicator bacteria such as *Escherichia coli*, faecal coliforms, and total coliforms. *E. coli* was identified using Eosin Methylene Blue (EMB) agar, while faecal coliforms and total coliforms were quantified at incubation temperatures of 44.5 °C and 37 °C, respectively (7). The Most Probable Number (MPN) technique was employed for bacterial enumeration, and confirmation was carried out in the laboratory using the membrane filtration methods.

Preservation methods

The river water samples are used to prevent from contamination is stored in sterilized glass and polythene bottles with tight - fitting lids. The sample were preserved by adding 1-2ml of concentrated H2SO4 to lower the pH below 2, which help to inhibit microbial growth. The collection of samples are then transported to the laboratory in icebox within 24 hours of collection.

Calculation of water quality index method and Analysis of Microbial Contamination of water

Water quality index method

The Water Quality Index (WQI) is a widely used tool for evaluating overall water quality by integrating several physicochemical and microbiological parameters into a single numerical value. In this method, each selected parameter is assigned a specific weight (wi) according to its relative importance in assessing water quality. Parameters that have a direct impact on human health, such as total coliforms and biochemical oxygen demand (BOD), are given higher weight values compared to less critical parameters.

For each parameter, a quality rating (Qi) is calculated to express how closely the measured value approaches the standard permissible limit. The quality rating is determined using the following equation:

$$Qi = [(Vi - V\ ideal) / (V\ standard - V\ ideal)] \times 100$$

where Vi represents the observed value of the parameter, V ideal is the ideal value (generally taken as zero for most parameters), and V standard is the permissible limit recommended by standards such as those of the World Health Organization (WHO).

After calculating the quality rating, the sub-index (Si) for each parameter is obtained by multiplying the quality rating by its assigned weight:

Si = Wi × Qi , where, Wi is the weight assigned to the respective parameter (9)

Table 1: Interpretation of WQI

WQI Range	Water quality status	Interpretation
0 – 25	Excellent	Suitable for drinking and all users.
26- 50	Good	Minor Contamination safe for most users.
51–75	Fair	Moderately polluted: needs treatment
76–100	Poor	Polluted, restricted users
100	Very poor	Unsuitable for drinking: highly polluted

Analysis of microbial contamination of water

Multiple tube fermentation techniques (MTF) involve inoculating water samples into multiple tubes of culture medium and counting the number of positive tubes. Most probable number method (MPN) involves diluting the water samples and using statistical table to estimate the number of bacteria present. Culture based method involves Polymerase chain reaction (PCR), Next – Generation sequencing (NGS) to identify specific types of bacteria present in a water sample.

Conclusion

The alarming levels of microbial contamination combined with concerning physicochemical assessment of water quality posing a significant risk to human health and highlight the need for effective management strategies. Addressing these challenges requires a multifaceted approach involving improved infrastructure, public awareness initiatives, sustainable agricultural practices, and robust monitoring programs (10). Protecting the kuwano river is not only vital for public health but also for maintaining the ecological balance and economic stability of surrounding communities. By calculating the WQI, changes in water quality can be detected and appropriate measures can be taken to maintain and improve it. The WQI can help in making informed decisions regarding the use of water for different purposes such as, drinking, agricultural practices, industrial activities. WQI can be used to create public awareness about the importance of water quality and the impact of pollution on it.

The stakeholders can work collaboratively to restore the health of kuwano river, ensuring it's sustainability as vital source for future generations while safeguarding public health against water borne diseases and chemical contaminants (11).

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