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AN EXAMINATION OF MICROBIAL WATER POLLUTION WITH SPECIAL REFERENCE TO COLIFORM BACTERIA

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Abstract
In spite of the fact that water is necessary for life, a significant number of people do not have access to potable water that has been purified, and as a result, they succumb to water-related illnesses. Pollution of water that is caused by microorganisms is widely recognised as one of the most significant problems facing aquatic ecosystems all over the world. The number of bacteria that are present in a body of water may be increased by the effluent that is discharged from faeces, hospitals, industries, and livestock farms. Coliform groups of bacteria have, for a considerable amount of time, been commonly utilised as an indicator organism of microbial contamination of the water, which has historically led to the public health security perspective. Escherichia coli is the most reliable sign of faeces contamination among the coliform bacteria. Through the fermentation of lactose sugar, which results in the generation of acid and gas, the multiple tube fermentation technique has been used as a traditional method to detect coliform in water samples. This approach was developed in the 1970s. It is possible to determine whether or not water is fit for human consumption by determining whether or not it contains coliform bacteria in excess of the allowable limit and referring to the most likely number index value (MPN/100 ml). As an alternative to coliform bacteria, faecal streptococci and Clostridium perfringens are often utilised as markers of faecal pollution. These indications have been proven by the use of assays including esculin hydrolysis, catalase negative, and sulfite reduction. In order to identify markers and other enteric isolates in water samples in a timely manner, molecular approaches (based on PCR) and enzymatic methods have been used. The bacterial and organic pollution load in a water sample may also be determined using methods such as the standard plate count (SPC) of heterotrophic bacteria and the biochemical oxygen demand (BOD). Because of this, bacteriological testing of the water revealed that the water is contaminated by sewage to such a degree that it is unfit for consumption and also unfit for use in recreational activities. One of the most significant challenges of the twenty-first century is ensuring that everyone has access to potable or household water that is free from contaminants. The primary purpose of this article is to draw attention to the microbial contamination of water, with a particular focus on coliform, as well as its connection to the surrounding environment.

Keywords: *Coliform bacteria Microbial pollution Fecal contamination E. coli Fecal streptococci MPN Water pollution*

Introduction

In order to sustain life, water is essential. Since the beginning of human civilization, water supply has been an essential component of society for a wide variety of applications, including but not limited to agriculture, industry, home chores, and drinking. There is a lack of access to potable water in developing nations, which contributes to a significant number of the region's health issues [1, 2, 3]. In impoverished nations, the use of dirty drinking water is estimated to be the root cause of eighty percent of all diseases and more than one-third of all deaths. According to a study published by the World Health Organization (WHO), over 600 million episodes of diarrhoea and dysentery, as well as 46,000 deaths of infants, are reported each year as a direct result of contaminated water and a lack of adequate sanitation [4]. Surface water has the potential to be hazardous because it may function as a carrier for harmful bacteria if it comes into touch with sewage or human waste from the surrounding area [5]. As a result, the microbiologically polluted water is rendered exceedingly hazardous for activities such as swimming, bathing, and drinking. In addition to this, the presence of sewage in water largely disrupts the oxygen balance, which is worrisome to the aquatic flora and fauna [6]. In order to determine whether or not a certain water resource is suitable for a specific use, monitoring of the

water's quality was carried out. The appropriateness of water is evaluated in respect to acceptable concentrations of certain water quality characteristics. These concentrations might be specified by recommendations, standards, or the maximum allowable concentration [7]. The presence of faecal coliform bacteria in the body of water indicates that the water was contaminated with the faeces and other waste products of warm-blooded animals. Therefore, the enumeration of bacteria found in faeces is essential for both fundamental and practical research in aquatic microbial ecology, as well as the development of parameter-based systems for evaluating the quality of drinking water. The presence of faecal streptococci, Clostridium perfringens, and Klebsiella is more evidence that the water has been contaminated by faeces. Aside from that, the most common species of bacteria found in sewage samples include Salmonella typhimurium, Salmonella typhi, Salmonella enteritidis, Shigella spp., and Proteus spp. [8-11]. A number of physicochemical parameters, such as conductivity, pH, turbidity, chemical oxygen demand (COD), total suspended solids (TSS), biological oxygen demand (BOD), total dissolved solids (TDS), alkalinity, salinity, and concentrations of heavy metals, all contribute to the overall quality of the water [12, 13]. Within this framework, the evaluation of the water quality of a variety of water bodies has been published concurrently in the relevant body of scholarly research. Because this investigation is specific to the bacteriological study of water, a comprehensive explanation is beyond the scope of what can be included in this review. As a result, the purpose of this particular article is to concentrate on the microbiological contamination of water as well as the many health risks that have surfaced as a result of water contamination.

Water-Borne Diseases

Pathogens that are frequently known to be spread by water include many kinds of gastrointestinal and aquatic bacteria, viruses that affect the gastrointestinal tract, and protozoa. There are a number of enteric viruses that have been linked to diarrhoea, including Rotavirus, Astrovirus, Adenovirus, Norwalk virus, Picobirnavirus, and Enterovirus [14]. A significant mechanism of transmission for Cryptosporidium spp., Blastocystis hominis, Dientamoeba fragilis, Giardia duodenalis, and Entamoeba histolytica [15] is the use of water that has been contaminated by the faeces of both humans and animals. Vibrio cholerae and Salmonella enterica serovar Typhi, which is now known simply as S. typhi, were the first water-borne infections to be identified in the 19th century. Since then, they have been responsible for an enormous amount of sickness and death all over the globe. In the digestive tracts of many animals, both domestic and wild, the bacteria Campylobacter and Salmonella species may be discovered. Therefore, pollution of water by animal excrement presents a danger to human health [16]. [Citation needed] An incident that was linked to drinking water occurred in the United States of America [17]. The bacterial infections that caused the disease were Shigella species, Campylobacter, and Pseudomonas in that order. There is evidence that particular serotypes of Escherichia coli are linked to certain illnesses in both humans and animals [18].

Global Scenario Of Gastro-Enteric Outbreak

Through the consumption of tainted foods or beverages that have been tainted with bacteria, parasites, or viruses that cause disease, an enteric epidemic may be generated. There is a possibility that the epidemic may continue due to nosocomial infections. Not only do gastroenteric epidemics provide a significant public health risk because to the high rates of human illness and death they cause, but they also raise concerns about the proliferation of germs that are resistant to treatment. During the years 1980-1990, multi-drug-resistant Salmonella typhi (MDR S. typhi) played a significant part in the outbreak of gastroenteritis that occurred in Pondicherry, India [27]. An investigation found that an epidemic of enteric fever caused by S. enterica serotype Typhi occurred in a residential neighbourhood in the city of Chandigarh in the Indian state of Punjab [28]. Another research conducted in the year 2006 in Mumbai, India, found that acute gastroenteritis was caused by Enterovirus, Rotavirus A, Norovirus, Rotavirus B, Enteric Adenovirus, Aichivirus, and Human Astrovirus. The primary contributor to this epidemic was the sewage water's introduction into the drinking water supply [29]. Typhoid fever and paratyphoid fever were both reported as systemic infections in Dhaka, Bangladesh in the year 2005 [30]. These infections were caused by multiple different S. enterica serotypes, one of which being S. Typhi. According to the findings of Muthumbi et al. [31], infection with nontyphoidal Salmonella (NTS) was a prominent cause of bacteremia in children less than 2 years old and elderly people younger than 65 years old in China [38]. In underdeveloped nations, enteric fever has a greater propensity to produce considerable morbidity as a result of

socioeconomic factors [39]. The frequent use of whole-genome sequencing (WGS) in enteric disease surveillance, as stated by Besser et al. [40], has significantly improved the capacity to detect and analyse outbreaks, in addition to monitoring illness trends.

Investigation Of Sanitary Quality Of The Aquatic System

Because of the changed circumstances in the environment, the quality criteria for surface water are quite different from one another. In non-drinking water, which is used for activities such as irrigation, swimming, fishing, rafting, boating, and industrial purposes, the presence of toxic substances and a high load of microorganisms may pose a significant threat to one's health. There is a correlation between the hygienic quality of river water and the amount of runoff that occurs from metropolitan areas (Fig. 1).

Due to the large concentration and variety of activities carried out by microorganisms, the essential compartments of aquatic ecosystems are made up of these organisms [41]. The safety of users is directly related to the quality of the drinking water that is provided to them. The contamination of drinking water with pathogens poses considerable hazards to the health of those who consume it, particularly human beings. The sanitary examination of water and the evaluation of its quality are absolutely necessary if one is interested in characterising the microbiological safety of water. The microbiological investigation of water is not complete without the sanitary inspection that comes along with it [42]. Bacterial testing of water reveals that it is contaminated by faecal contaminations to the point that it is unfit for recreational use and also unfit for consumption [43]. This renders the water unfit for use in any capacity, including drinking.

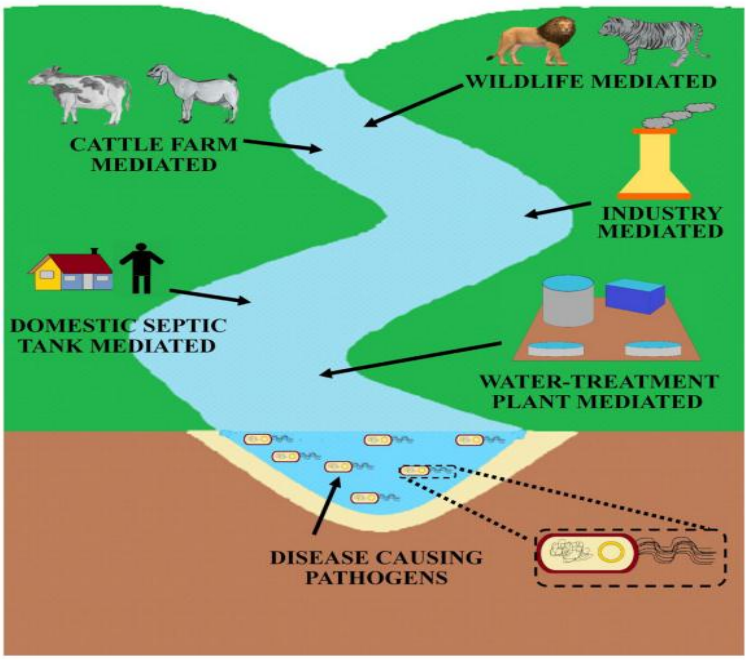

Fig. 1. River water contamination from different sources.

Water Pollution Indicator Organisms

If infectious disease carriers are present among the faecal pollutants in the water, then drinking water containing those contaminants may cause new instances of the illness to appear. These pathogenic organisms are usually always outnumbered by the regular intestinal excremental organisms, which are simpler to identify as a sign of faecal pollution. This is because normal intestinal excremental organisms are found in greater quantities. In the event that disease-causing microbes are not found in the water, it is possible to draw the conclusion that indicator organisms in the water are disease-free [44, 45]. Bacteria, and more especially E. coli or faecal Streptococci, are well-known markers of sewage contamination in both drinking water and water used for bathing. In the field of sanitary microbiology, several bacterial groupings of organisms have been used extensively as a proxy for measuring the degree of water contamination. The total coliform count is often considered to be one of the most helpful markers of water contamination. The term "coliform" refers to a collection of organisms that fall under the umbrella of the family Enterobacteriaceae. Both E. coli and E. aerogenes are well-known members of the coliform group and may be found in high numbers in water that has been contaminated with pollution. Due to the fact that

it is the most common microbe found in human waste, Escherichia coli is an effective indication of the presence of faecal contamination in water [46, 47]. On the other hand, E. aerogenes is a kind of coliform bacterium that is not found in faeces and is part of the natural bacterial flora found in soil and plants. The total coliform count approach has traditionally been used as an indication for determining whether or not the water is safe to drink. According to the World Health Organization (WHO), the acceptable limits of coliform and E. coli in drinking water should be 0/100 ml, whereas the acceptable limits of coliform and E. coli in household and recreational water should be 126 CFU/100 ml [48]. According to the recommendations made by the Bureau of Indian Standards standards, the total and faecal coliform count in drinking water should be 0/100 ml at all times (IS: 10500-2012) [49]. The enumeration approach of faecal bacteria plays an important part in both fundamental and practical research in aquatic microbial ecology, as well as in the development of parameter-based technologies for the assessment of the quality of drinking water [50].

Antibiotic Resistance In Coliform Bacteria

The widespread use of antibiotics in human and veterinary medicine is anticipated to have a primary selective role in the development of drug resistance among a variety of Gram-negative bacteria. It is common practise for members of the Enterobacteriaceae family to exhibit antibiotic resistance that is mediated by extrachromosomal elements or R-plasmid. It was discovered that marine sewage, marine shellfish samples, and saltwater all included high levels of antibiotic resistance in the coliform groups that were tested. Integrons are a sort of mobile genetic element that are associated with antibiotic resistance in bacterial populations. They are made up of one or more gene cassettes that are positioned at a certain location on the genome. According to a study that was published, the water of the Mahananda River in Siliguri, West Bengal, India contains facultative oligotrophic enteric bacteria that are a reliable source of unique genes and potential pools of antibiotic-resistance gene cassettes. These bacteria were isolated from the river. Coliform and faecal coliform bacteria that were identified in drinking water were discovered to be resistant to a variety of medicines, including ampicillin, carbenicillin, cefalotin, and colistin, among others. Antibiotic-resistant strains may be found in the environment because they are spread via the faeces of animals and people. Several different lines of investigation have led researchers to the conclusion that sewage treatment facilities are the primary sources of enteric bacteria that are resistant to several antibiotics. Runoff from hospitals and clinics, as well as agricultural runoff, may all contribute to an increase in the gene pool of antibiotic resistance in the environment. In 1950, Japan was the first country in which it was revealed that bacteria had developed resistance to antibiotics. This report describes the isolation of Shigella sp. from a dysentery patient who was receiving antibiotic treatment. The pathogen was able to transmit its R-plasmid to other bacteria, including E. coli, and demonstrated resistance to different drugs. The spread of antibiotic-resistant bacteria in the environment is facilitated in large part by processes that include horizontal gene transfer.

Conclusion

One of the most significant concerns about the hygienic quality of drinking water and water used for recreational purposes is microbial contamination in the water body. One of the most significant dangers to the health of humans is posed by the existence of harmful bacteria, protozoa, and viruses. There have been several outbreaks of enteric diseases that have been caused by the spread of harmful microorganisms. The contamination of water samples by MAR bacteria has the potential to turn out to be the root cause of the significant outbreak of enteric disorders. In order to safeguard the population against a wide range of illnesses that are transmitted by water, quick action is required to be taken to put an end to the deterioration that has already occurred and to enhance the water's quality. The effluent should be treated first, before it is released into the natural body of water. The water that has been recycled need to be utilised in some kind of irrigation system for ecologically sound farming. It is essential that careful consideration be given to the relationship between a nation's energy supply, its drinking water supply, and its citizens' health in order to ensure the country's socioeconomic development. Due to the fact that water, energy, and food (also known as WEF) all impact one another in some way, either directly or indirectly, it is necessary to examine the WEF nexus from a variety of academic perspectives. As a result, it is of the highest importance to practise water conservation and ensure that the fresh water resources are managed in an appropriate manner in light of the problems that have been outlined above.

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