MICROBIAL/BIOLOGICAL CONTAMINATION OF WATER

Yuhei Inamori
Executive researcher, National Institute for Environmental Studies, Tsukuba, Japan

Naoshi Fujimoto
Assistant Professor, Faculty of Applied Bioscience, Tokyo University of Agriculture, Tokyo, Japan

Keywords: hazardous microorganism, drinking water, biological treatment, infection

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Summary

Microorganisms that affect human health greatly include pathogenic bacteria, pathogenic viruses, pathogenic protozoa, and cyanobacteria. Japanese regulations concerning bacteria levels for drinking water safety require that in 1 ml of test water, the number of colony of general bacteria created is under 100, that no total coliforms are detected, and that residual concentration of free chlorine at the faucet is 0.1 mg・l^{-1} or more. There are approximately 100 kinds of viruses known to infect humans, and many viruses originating from human excrement are contained in sewage water, such as polio, coxsackie, adeno, and the influential hepatitis virus. Growth of cyanobacteria is caused when nitrogen and phosphorus concentration increase by contamination with domestic sewage, industrial sewage, and livestock sewage. Thus it is particularly effective to prevent the production of cyanobacterial toxin by reducing nitrogen and phosphorus in the wastewater. Protozoa and metazoa contribute removal of pathogenic bacteria, pathogenic virus, cyanobacteria and pathogenic protozoa by predation in biological treatment.

1. Introduction

For human beings, the critical issue when using water is hygiene. More than 4 million people die of illnesses contacted through microorganisms, and most cases are caused by water contaminated by microorganisms. There are many forms of water use in daily life, but the greatest threat to human life occurs when there is direct contact between water and human beings, for example bathing spots where sewage is mixed into the water, office

buildings that treat and recycle waste water from toilets for reuse, and water works that use river water as the water supply source. In such cases, microorganisms that affect human health greatly include pathogenic bacteria, pathogenic viruses, pathogenic protozoa, and cyanobacteria (Table 1).

	Microorganisms	**Disease**
Bacteria	*Salmonella typhi*	typhoid
	Salmonella choleraesuis	typhoid, gastroenteritis
	Salmonella enteritidis	typhoid, gastroenteritis
	Shigella sp.	dysentery
	Vibrio cholerae	cholera
	Camplobacter jejuni	enteritis
	intestinal pathogenic coliform	gastroenteritis
	Mycobacterium tuberculosis	tuberculosis
Virus	*rotavirus*	gastroenteritis
	poliovirus	infantile paralysis
Protozoa	*Cryptosporidium*	typhoid
	Giardia	typhoid
	Entamoeba	dysentery
Algae	*Microcystis*	liver disorder
	Aphanizomenon	nervous disorder
	Anabaena	nervous disorder
	Cylindrospermopsis	liver disorder

Table 1: Harmful microorganism in water environment

These pathogenic microorganisms reproduce within the body and infect the body. Cyanobacteria that produce toxic substances, on the other hand, do not reproduce inside the body, but infect the body when more than the tolerable volume of toxic substances that it produces is ingested through contaminated tap water. Water contamination caused by pathogenic microorganisms and microorganisms that produce toxic substances has become a serious problem. Toxic microorganisms are becoming increasingly common in eutrophic or polluted water, and such problems must be solved. This part explains separately at bacteria, viruses, and pathogenic protozoa that cause contamination, and also discusses the elimination of pathogenic microorganisms during biological treatment of sewage water.

2. Bacteria

Bacteria that are currently targeted by Japanese water quality standards are general bacteria, total coliforms, and fecal coliforms. The standards are determined depending on how the water is used. One of the most widely used of the various water standards in Japan is the number of total coliforms. The number of general bacteria is regulated by the Waterworks Law water quality standard (Table 2), while fecal coliforms are regulated only for public recreational waters. This is because in recreational waters, there is a high possibility of water being ingested orally, and so it is important to prevent contamination by pathogenic microorganisms to maintain water quality. It should also be noted that when treated water from sewage works is recycled for use as water for sprinklers or

landscaping, where human beings may come in direct contact with the water, the water quality standard requires that no total coliforms be detected.

Standard	**Objective bacteria**	**value**
World Health Organization, guideline for drinking water quality	Total coliform or	0・100ml-1
	fecal coliform	
Drinking water quality based on waterworks law in Japan	General bacteria	Less than 100・l-1
	Total coliform	No detection
Environmental standards for lakes and reservoirs in Japan	Total coliform	Less than 1000 MPN・100ml-1 for drinking water resource and bathing
Effluent standard based on water pollution control law in Japan	**Total coliform**	3000・ml-1

Table 2: Standard for bacteria in drinking water, water environment and effluent

As seen from these examples, water quality standards depend on how the water is to be used, but in general when human beings come in direct contact, the water quality is confirmed using fecal coliform numbers. When lakes, reservoirs and ground water are contaminated by pathogenic bacteria, or are not completely sterilized by the water purification treatment, they may become a source of infectious diseases. Typical water-borne infectious diseases include cholera and dysentery, which took the lives of many from the 19th century to the first half of the 20th century. Modern water systems and water sterilization efforts have slowed the spread of such water-borne infectious diseases, but there was a major cholera outbreak in 1991 which led to many deaths in Central and South America, and in Africa. The cause is believed to have been poor treatment systems of waterworks and sewage sewer, and deteriorating living conditions. *Vibrio cholerae* is the bacteria causing cholera, while *Shigella* causes dysentery. Pathogenic colon bacillus, *Campylobacter*, *Clostridium*, *Salmonella*, and *Staphylococcus* are some of the bacteria known to cause water-borne infectious diseases. All of these pathogenic bacteria infect the human intestine, are released into the outside environment with excrement, pass through the treatment process, and are released into rivers, lakes and reservoirs. *Escherichia coli* O157 and other fecal coliforms are increasingly causing water-borne infectious diseases in recent years in Japan. O157 is part of the pathogenic colon bacillus which produces verotoxin and causes hemorrhagic colitis, an intense form of diarrhea, hemolytic uraemia syndrome, and thrombotic thrombocytopenic purpura, in cases leading to death. The prevention of infection by such pathogenic bacteria is of utmost importance. Japanese regulations concerning bacteria levels for drinking water safety are detailed in ministry orders on water quality standards, and require that in 1 ml of test water, the number of colony of general bacteria created is under 100, that no total coliforms are detected, and that residual concentration of free chlorine at the faucet is 0.1 mg・l^{-1} or more.

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Biographical Sketches

Yuhei Inamori is executive researcher of National Institute for Environmental Studies (NIES), where he has been at present post since 1990.Yuhei Inamori received B.S. and M.S. degrees from Kagoshima University, Kagoshima Japan, in 1971 and 1973 respectively. He received Ph. D. degree from Tohoku University, Miyagi, Japan in 1979.

From 1973 to 1979, he was researcher of Meidensha corp. From 1980 to 1984, he was researcher of NIES. From 1985 to 1990, he was senior researcher of NIES. His fields of specification are microbiology, biotechnology and ecological engineering. His current research interests include renovation of water environment using bioengineering and eco-engineering applicable to developing countries. He received Award of Excellent Paper, Japan Sewage Works Association in 1987, Award of Excellent Publication, the Journal "MIZU"in 1991, Award of Excellent Paper, Japanese Society of Water Treatment Biology in 1998.

Naoshi Fujimoto is assistant professor of Tokyo University of Agriculture, where he has been at present post since 2000. Naoshi Fujimoto received B.E. and M.E. degrees from Tohoku University, Miyagi Japan, in 1991 and 1993 respectively. He received D.E. degree in civil engineering from Tohoku University in 1996. From 1996 to 1999, he was research associate of Tokyo University of Agriculture. His field of specification is environmental engineering. His current research interests include control of cyanobacteria and its toxin in lakes and reservoirs.