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BACTERIOLOGICAL STATE OF WATER IN THE RIVER OŁAWA AT THE SITE OF ITS UPTAKE FOR THE WATER SUPPLY SYSTEM**

PART I

The purpose of the paper was a bacteriological analysis of the river Oława water. The results obtained revealed a high total number of psychrophilic and mezophilic bacteria, and coli titer exceeding frequently the standards for this kind of surface waters. High number of sporogeneous bacteria, stated in analyses, may create serious difficulties in water treatment processes. Individual bacterial strains isolated from the water samples have been identified as being not only saprophytes, but also absolute and conditional pathogenes. Thus, in case when the treatment and disinfection processes are, even periodically, not satisfactorily efficient, the presence of such bacteria may create a serious hazard of their penetration into drinking water.

1. INTRODUCTION

Resources of ground water in Poland are too scarce to meet the demands for drinking water, that is why surface water is more and more frequently used. A strong bacterial and chemical pollution of this water despite its treatment creates, however, a serious hazard for the health of inhabitants. From the epidemiologic viewpoint this hazard is due to viruses and bacteria, the numbers of which in raw water taken from surface reservoirs, are much greater than in the ground water. When the initial number of microorganisms is high, then the required effects of disinfection are usually achieved by increasing the chlorine doses. Although such a

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procedure allows to establish the number of psychro- and mesophilic bacteria and coli titer according to the binding standards, it has some negative effects, too. It promotes namely the formation of chlororganic compounds dissoluble in water which, as a rule, are more toxic than the initial compounds. In such conditions the bacteriocidal effect must be estimated in the categories other than those normally applied.

In the raw polluted water there are numerous species of sporogeneous bacteria. During the disinfection only the vegetative forms are killed, and the spores remain alive. The bacteria present in such a water may also differ in their sensitivity to chlorine. Thus, all the sensitive strains are killed and the surviving resistant species may comprise saprophytes as well as conditional and absolute pathogenes. At present, according to many bacteriologists, a wrong evaluation of sanitary quality of water is due to the usage of *Escherichia coli* as an indicator. PTAK et al. [15] reports one of the most dangereous mistake that took place in Chicago: tap water, sanitary indices of which (including coli titer) met the required standards, still contained the bacteria of genus *Klebsiella* which caused mass infections. In view of the above facts ENGELBRECHT et al. [8] suggest to use as indicators two species of acid-resistant bacteriae, i.e., *Mycobacterium fortuitum*, *M. phlei* and one species of *Candida*, *C. parapsilosis*. Their resistances to chlorination are much higher than these of pathogenic microorganisms such as sporogeneous bacilli and viruses. According to the above authors, these test-microorganisms should be introduced into the water sample before its chlorination in order to examine their viability after the disinfection process is terminated. If test-organisms are absent, then the water is free of pathogenic bacteria and viruses.

Ozonation is a more efficient disinfection method, sometimes, however, some negative side effects are also observed. Ozone, which is mainly a virusocidal agent, displays also a high bacteriocidal activity, though in some cases it is even lower than that of chlorine [6]. Owing to its reactions with many organic pollutants present in water, ozone improves its organileptic properties. It degrades, moreover, various types of detergents, phenols, polycyclic aromatic hydrocarbons, etc, and by oxidizing iron and manganese compounds it reduces the colour of water [7], [10], [17]. However, it may destabilize water by releasing micropollutants from organic complexes. Although it may degrade pesticides, but being given in too small dosages, it is responsible for the formation of products more toxic than the initial compounds [11], [16].

Low-molecular organic compounds formed during ozonation promote a secondary development of bacteria in water after the disinfection process is terminated [12]. Hence, surface water, when used for water supply systems, creates serious problems connected with technology of its treatment and concerning also health protection.

Not always disinfection process giving the desired virusicidal and bacteriocidal effects improves at the same time chemical composition of water, i.e., it makes it free

of harmful components, in particular of toxic, mutagenic and carcinogenic compounds, or those accumulating in human tissuses [16]. The presence of such compounds in raw water creates a hazard that even small amounts of them will remain in the treated water. Therefore not only the protection of water against its pollution but also the modification and development of the water quality control methods are indispensable for human health.

2. MATERIAL AND METHODS

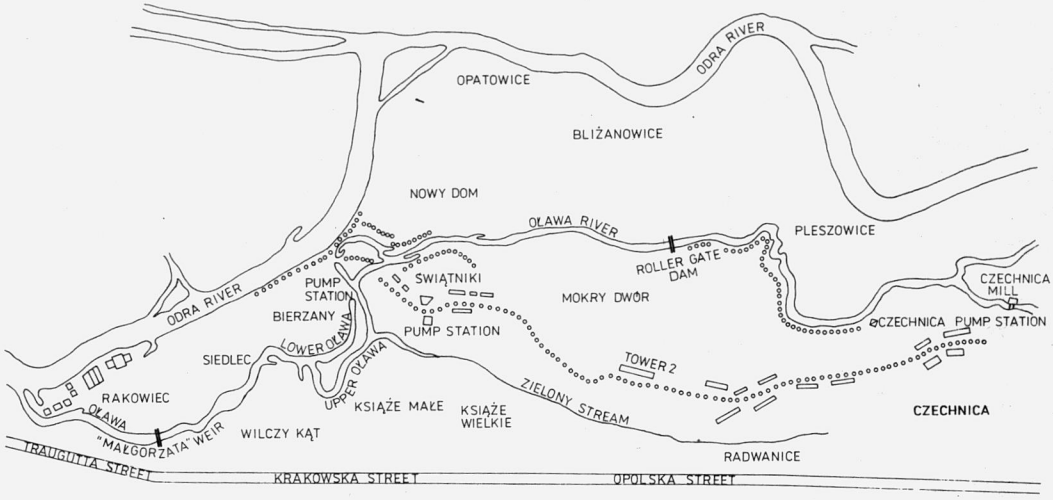
The distribution of water sampling stands is shown in figure. The water was sampled 5 times in various periods of the years 1979 and 1980. The sanitary state of water was determined by:

a) determining the number of psychrophylic bacteriae on agar-agar at 20°C ± 1°C after 72 h incubation;

b) determining the number of mesophylic bacteria on agar-agar at 37°C ± 1°C after 24 h incubation;

c) determining the number of psychrophylic sporogeneous bacteria at 20°C ± 1°C and 37°C ± 1°C after 72 h and 24 h incubation, respectively; the samples before plating on agar-agar were heated at 80°C for 10 min;

d) determining the coli titer value obtained by membrane filter technique.



In samples taken on 5 II 1980, psychro- and mesophylic bacteria have been additionally identified. To this end the following characteristics have been investigated: morphology of colonies, shape of cell, shape and localization of endospores, staining by Gram method, growth at 4°C, 20°C, 37°C, and 42°C,

motility, growth under anaerobic conditions, catalase and oxydase activities, fermentation of carbohydrates (xylose, glucose, arabinose, lactose, saccharose, mannitol), Voges–Proskauer's reaction, methyl red test, hydrolysis of starch, liquefaction of gelatine, reduction of nitrates, ammonification, hydrolysis of urea, deamination of phenylalanine, production of indole and hydrogen sulphide, use of sodium citrate as the only source of carbon, the type of milk decomposition, bacterial growth in different NaCl concentrations (2%, 5%, 7% and 10%) and ability of blood haemolysis ability. In order to complete the identification of some bacterial strains their growth was determined on special media, i.e., Clauberg and MacConkey media, on the medium supplemented with arginine and aesculine and SS medium. The strains of bacteria were identified with the help of special manuals [1], [4], [5].

3. RESULTS AND DISCUSSION

The investigations have revealed a high total number of psychrophylic and mesophylic bacteria in the river Oława water. The coli titer exceeded the admissible standards of surface waters taken for water works (tab. 1). A much intensified bacterial pollution of water observed in autumn and winter was manifested in much higher indices of bacterial contamination (tab. 1).

Table 1

Total number of bacteria in the river Oława water during the period of investigations

Date of sampling	Station	Number of bacteria in 1 cm^3 of water		Coli titer*	Number of sporogeneous bacteria in 1 cm^3 of water	
		Psychrophylic	Mesophylic		Psychrophylic	Mesophylic
May 1979	1	2350	2000	0.9	204	600
	7	500	700	3.0	18	200
August 1979	1	1900	1200	0.1	37	200
	7	4400	1300	0.1	5	100
November 1979	1	33000	4000	0.1	42	160
	7	2200	800	3.0	12	80
February 1980	1	41000	2180	0.1	260	365
	7	13000	2100	0.1	330	730
May 1980	1	3200	1140	0.2	0	200
	7	890	300	0.9	10	41

* Coli titer obtained by membrane filter technique.

Table 2

Bacteria strains isolated from the river Oława water on February 5, 1980

Stand	Number of strain	Genus and species	Characteristics of the species
1	312	*Bacillus brevis*	Saprophyte, originally isolated from soil, present also as food pollutant
	313, 315	*Kurthia* sp.	Saprophyte, present in stagnant water and in food products
	213, 314	*Pseudomonas maltophilia*	Saprophyte, present in water, wastewater from hospitals and in food products
	214, 316, 209	*Micrococcus luteus*	Saprophyte, present in soil, atmosphere and water as well as on human and animal skin as commensal
	209	*Bacillus megaterium*	Saprophyte, isolated from soil, also a contaminant of drugs and dressing materials
	211	*Bacillus firmus*	Saprophyte, isolated from soil
	212	*Sphaerotilus natans*	Saprophyte, characteristic of polluted waters
	216	*Klebsiella rhinosclermatis*	Conditional pathogene, encountered in patients suffering from nasosinusitis
7	243, 245	*Corynebacterium pseudodiphteriticum*	Non-pathogene, found in naso-pharyngial mucus in humans
	244	*Pseudomonas cepacia*	Conditional pathogene, common in soil and wastewater from hospitals; flora accompanying the infections of urinary tracts
	246	*Bacillus stearothermophilus*	Saprophyte, present in soil, cabbage and soure food products; its spores are more resistant to high temperature than those of other species of this genus
	248	*Kurthia* sp.	Saprophyte, encountered in stagnant waters and food products
	164, 165	*Bacillus pumilus*	Saprophyte, encountered in atmosphere, soil and food
	166	*Pseudomonas maltophilia*	Saprophyte, encountered in water, wastewater from hospitals and as a contaminant of food products
	167	*Pseudomonas flava*	Saprophyte, present in soil and atmosphere
	168, 172	*Micrococcus luteus*	Saprophyte, present in soil, atmosphere and water as well as on human and animal skin as commensal
	169	*Bacillus freadereichie*	Saprophyte, encountered in soil, water and hospital wastewater
	170	*Bacillus cirroflagellosus*	Saprophyte, isolated from sea mud
	173	*Acinetobacter lwoffi*	Conditional pathogene, encountered in soil, water as well as in humans and animals

High numbers of psychro- and mesophylic and sporogeneous bacteria as well as low value of coli titer stated in the river Oława give the evidence to its serious pollution. The main sources of pollutants are domestic sewage, wastes from animal farms as well as from the superficial run-offs from farming land. Another pollution source is steel mill at Siechnica, situated close to the water uptake for municipal water works.

Another type of regularity is the elevated number of mesophylic bacteria observed during the whole investigation period. These bacteria, among which there may occur also some pathogenic and conditionally pathogenic strains, are not an autochtonous flora of water and soil, being most probably introduced with municipal sludge and wastes from animal farms.

Among the total number of psychro- and mesophylic bacteria there occur numerous sporogeneous ones. The latter are particularly dangereous due to their high resistivity to normally used disinfectants.

In view of the above facts the water within two uptakes was subject to chlorination (May 1980) which reduced substantially the number of bacteria in station No. 7 if compared with that in station No. 1. From samples taken in 5.02.1980, 26 different species of bacteria isolated were identified (tab. 2). This table shows that besides saprophytic bacteria there were also some conditional pathogenes. The above result worsens the described bacteriological state of the water in the river Oława within the water uptake. The presence of such bacteria is a potential hazard of their penetration to the drinking water, if at least periodically the efficiency of water treatment, disinfection in particular, is not satisfactory. The situation is worsened by the simultaneous pollution of water with organic substances.

In view of the results of bacteriological analyses it should be stated that the wastes from animal farms and municipal sludges situated above the sampling points are the most probable sources of contamination.

4. CONCLUSIONS

1. Rutine bacteriological analyses of water have shown a pollution of the river Oława water at the site of its water uptake.

2. The most important symptomps indicating a serious epidemiologic hazard are the following: relatively high number of mesophylic bacteria with respect to psychrophylic ones, low coli titer ranging within 3.0–0.1, high number of sporogeneous both psychro- and mesophylic bacteria, and the presence of conditional pathogenes.

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STAN BAKTERIOLOGICZNY WODY RZEKI OŁAWY W MIEJSCU UJĘCIA DO CELÓW WODOCIĄGOWYCH

CZĘŚĆ I

Celem badań była analiza bakteriologiczna wód rzeki Oławy ujmowanych do celów wodociągowych. Stwierdzono, że bakterie psychrofilne i mezofilne występowały w dużej liczbie, miano coli niejednokrotnie przekraczało normy ustalone dla tego typu wód powierzchniowych. Liczebność bakterii przetrwalnikujących może sprawiać trudności w procesach uzdatniania wody. W wyizolowanych z wody szczepach bakteryjnych oprócz gatunków saprofitycznych występowały również formy warunkowo patogenne i patogenne. Obecność tego typu organizmów stanowi potencjalne niebezpieczeństwo, gdyż mogą one przedostawać się do wody pitnej, wtedy gdy uzdatnianie i dezynfekcja będą okresowo mało skuteczne.

БАКТЕРИОЛОГИЧЕСКОЕ СОСТОЯНИЕ ВОДЫ РЕКИ ОЛАВЫ В ВОДОЗАБОРЕ ДЛЯ ВОДОПРОВОДНЫХ ЦЕЛЕЙ

ЧАСТЬ I

Целью исследований был бактериологический анализ воды реки Олавы в водозаборе для водопроводных целей. Обнаружено, что психрофильные и мезофилные бактерии присутствовали в большом количестве, коли-титр неоднократно превышало принятые для того типа поверхностных вод нормы. Количество склероцийных бактерий может затруднять в водоподготовке. В изолированных из воды штаммах бактерий кроме сапрофитических пород присутствовали тоже формы условно патогенные и патогенные. Присутствие того типа организмов является потенциальной опасностью, потому что они могут проникнуть в питьевую воду тогда, когда водоподготовление и дезинфекция будут временно мало эффективными.