EVALUATION OF FAECAL POLLUTION IN THE BACHKA REGION (VOYVODINA, SERBIA) OF CANAL WATERS ACCORDING TO MICROBIOLOGICAL PARAMETERS

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Abstract

For the assessment of water faecal pollution, bacterial indicators such as number of total coliforms and Escherichia coli, counted on Chromocult coliform agar, have been used. Our investigation has been done in the course of 2002/2003 and included 20 sampling sites of the DTD Canal network in the Bachka Region (Voyvodina, Serbia). Our results of faecal pollution of canal waters varied depending of season and of the sampling site, but in the most of cases, faecal pollution indicated low or moderate pollution of canal water. These results are important for watershed management activities in order to maintain safe waters for recreational and economic purposes.

Key words:

Bachka Region, Canals, Water quality, Coliforms, E. coli

1. INTRODUCTION

The Danube-Tisza-Danube (DTD) canal system is one of the great river engineering projects executed in Europe [1]. The whole hydrosystem is constructed in the Province of Voivodina (Serbia) and it can be used for flood control and drainage, municipal water supply, irrigation and industrial water supply**,** fisheries and for recreational purposes. DTD system also taking, conveying and dilution of utilised waters from the industry, farms and settlings up to 3 billions cub meter per year [6]. With such activities pathogenic microorganisms can impact the microbiological water quality of the water of DTD system. In the frame of the Project No 1945, “Hydrobiological Investigations of the Danube-Tisza-Danube (DTD) Canal Network with the Aim of a Wise Use and the Sustainable Development of the Resources” supported by Ministry of Science and Technologies of the Republic of Serbia, investigations of the faecal pollution using microbiological parameters have been undertaken.

2. MATERIAL AND METHODS

Sampling

The water samples, obtained from 20 sampling sites along the DTD Canal network in Bachka Region, in the course of 2002 and 2003, were collected seasonally (four times) during one year at the midsteram of canal water in 250 cm^3 sterile glass bottle, placed in 4^oC cooling boxes and processed within 6h of collection.

Enumeration of bioindicating microorganisms

For the determination of total coliforms (TC) water samples were inoculated onto endo agar plates. Total coliforms and *E. coli* were determined using Chromocult Coliform® agar (CCA, Merck). In both of cases the plates were incubated for 48 h on 37^oC. All blue colonies which developed on CCA agar were accounted as faecal coliforms and *E. coli* and with red is accounted as total coliforms [3]

Classification

To facilitate the interpretation of microbiological water qulity data, the results were classified according to EU-Bathing Water Quality Directive 76/160 EEC and new EU expert proposals [7].

3. RESULTS AND DISCUSSION

Fig. 1 shows results considering water quality of the main Canal from Bechey to Bezdan. The quality of water on the first four sampling sites was characterized by high concentrations of total coliforms especially in spring and during the summer season.

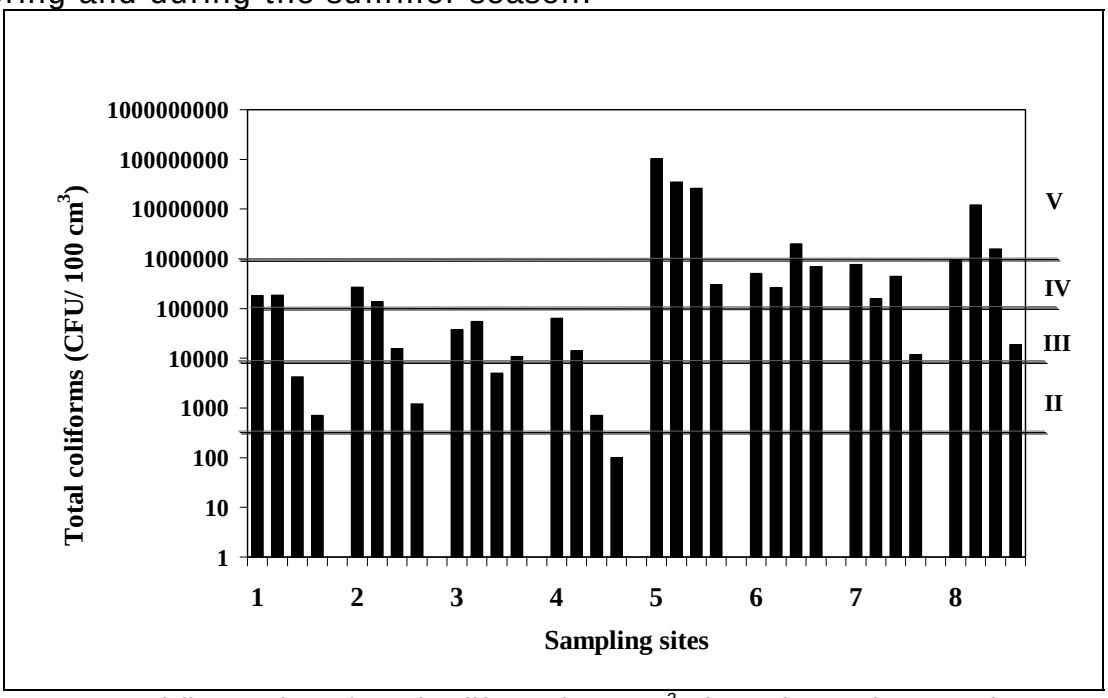

Fig. 1 *Seasonal fluctuation of total coliforms/100 cm^3 along the Bechey-Bezdan stretsh of the DTD canal network (classification system after Kavka, 2002); Sampling sites: (1-Shebesh Fok; 2-Bezdan; 3- Sombor; 4- Vrbas 1; 5- Vrbas 2; 6- Turiya; 7- Bachko Gradishte; 8- Bechey; from left: spring, summer, autumn, winter)*

Recorded values of this parameter indicate critical and strong faecal pollution in this stretch of Canal (classes III and IV). However, durig autumn and winter season, total coliforms indicated moderate faecal pollution.

Results of the microbiological examinations of of the canal water quality of the Bechey-Vrbas stretch (sampling points 5-8) show remarkable fluctuations of the quantitative composition of investigated group of bacteria (Fig 1). According to considerable higher number of total coliforms, the canal water on this section could be categorized into V or IV class except on sampling sites 7 and 8 (Bachko Gradishte and Bechey) during winter season, when the water quality was qualified as III class. This canal section, especially between sampling sites 5 and 6, turned to be excessively polluted (hot spot) because of high influence of industrial and municipal wastewaters of three riparian towns (Crvenka, Kula and Vrbas). Besides coliform bacteria count, high degree of organic pollution were indicated by high number of organotrophic bacteria too [4,10].

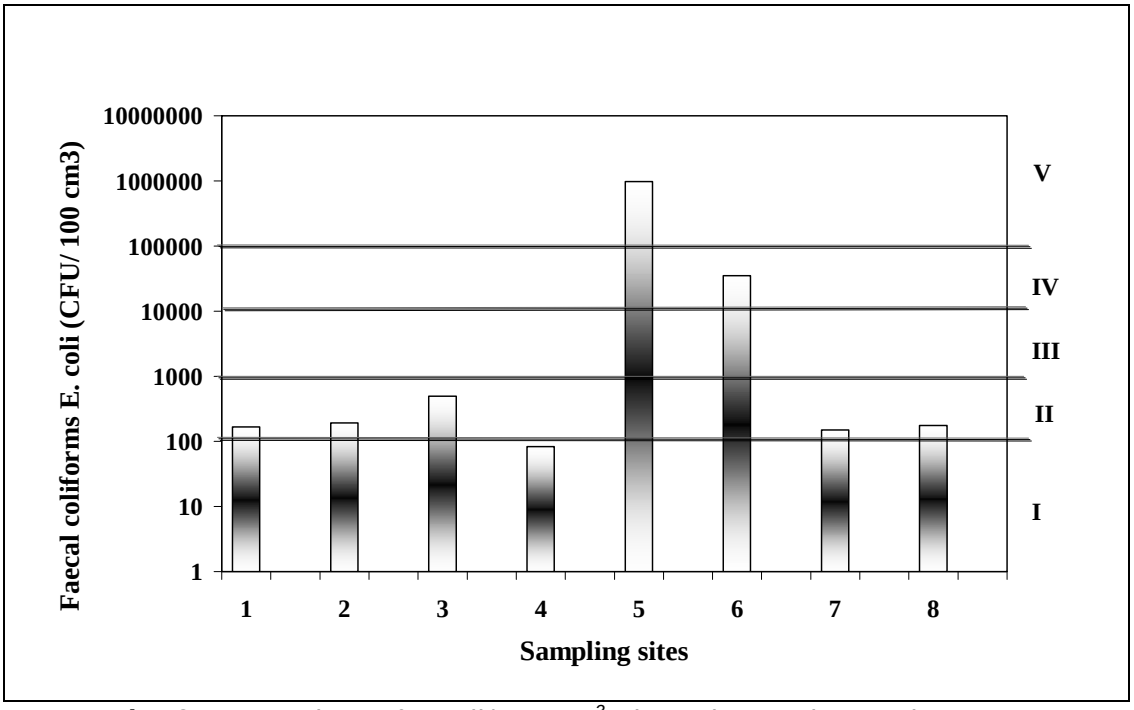

Fig. 2 *Mean values of E.coli/100 cm^3 along the Bezdan-Bechey stretch of the DTD canal (classification system after Kavka, 2002)*

It should, however, be noted that the presence of total coliforms and faecal coliforms in the water may not be a definitive and the only indicators of a faecal origin of the bacteria [9]. For this purpose in this experiment determination of *E. coli* count as one of the best means to evaluate degree of faecal pollution of water has been used. The chromogenic media Chromocult coliform® agar, recommended as viable alternative to the traditional MTF procedure for enumeration of *E. coli* [5] was used. Mean values of CFU/100 cm^3 of *E. coli* indicate second class or even first class or water with moderate faecal pollution on the stretch of the Canal upstream of Vrbas town (*Fig. 2*). Downstream of Vrbas town,

number of CFU/100 cm^3 of *E. coli* shows very strong feacal pollution of the Canal water, as total coliforms did. This water could be characterized as V or IV class, indicating excessive and strong feacal pollution. More downstream of Vrbas town, towards to the Canal mouth into the Tisa river, on sampling sites 7 and 8 (Bachko Gradishte and Bechey), canal water was moderately contaminated by faecal bacteria.

Another twelve sampling sites, situated on canal network around main canal Bechey-Bezdan, turned to be not subjected to the strong impact of big point sources of contamination. Number of total coliforms detected on both of used nutrient media shows that water in this area belonged mainly to the third class [7] of water quality, with exception of sampling sites 13, 15 and 18 (sampling sites: Kucura 2, Ruski Krstur 2, and Novi Sad 1) whose waters was contaminated with higher number of total coliforms (Table 1), probably due to the influence of municipal wastewater.

For better evaluation of faecal pollution, the number of faecal coliforms (*E. coli*) was also used in this experiment. This parameter indicated II class and moderate pollution of investigated waters (Table 1). Colony counts of *E.coli* (mean values) reflect mainly moderate feacal contamination of water (classes I-II).

Table 1*. Microbiological indicators determined at the different sampling sites on the DTD canal (mean values) with classification system according to Kavka and Poetsch (2002).*

No of sampling site	Sampling site	TC (CFU/100cm^3)	TC (CC) (CFU/100 cm^3)	*E.coli* (CFU/100 cm^3)	Class	Pollution level	EC/TC	EC/TC (CC)
1	Bezdan 1	92675	67108	167	II	moderate	0.002	0.002
2	Bezdan 2	104550	17450	192	II	moderate	0.002	0.011
3	Sombor	26750	63354	492	II	moderate	0.018	0.008
4	Vrbas 1	19500	18908	83	I	moderate	0.004	0.004
5	Vrbas 2	$4.1*10^7$	$8.6*10^6$	$9.7*10^5$	V	excessive	0.024	0.112
6	Turiya	860992	916088	35100	IV	strong	0.041	0.038
7	B. Gradishte	342067	310275	150	I	moderate	0.000	0.000
8	Bechey	3657325	2550375	175	II	moderate	0.000	0.000
9	Prigrevica	135525	52958	246	II	moderate	0.002	0.005
10	Srp. Mileticy	58450	19888	338	II	moderate	0.006	0.017
11	Ojaci	26225	45069	100	II	moderate	0.004	0.002
12	Kucura 1	113900	55213	263	II	moderate	0.002	0.005
13	Kucura 2	$2.13*10^6$	$5.85*10^5$	125	II	moderate	0.000	0.000
14	R. Krstur 1	26817	14675	313	II	moderate	0.012	0.021
15	R. Krstur 2	257900	46200	96	I	low	0.000	0.002
16	B. Petrovac	42200	14875	1	I	low	0.000	0.000
17	Novi Sad 1	1393875	243338	1475	II	critical	0.001	0.006
18	Novi Sad 2	101350	41300	375	II	moderate	0.004	0.009
19	Zmayevo	128925	31708	125	II	moderate	0.001	0.004
20	Zhabaly	116350	48975	125	II	moderate	0.001	0.003

TC- total coliforms (endo agar); TC (CC) total coliforms on Chromocult Coliform® agar

In order to identify water faecal pollution of human origin we used the ratio of faecal coliforms (*E.coli*) to total coliforms count. In our case we used ratio of faecal coliforms to total coliforms (FC/TC) counted on endo agar and FC/TC (CC) counted on Chromocult agar (Table 1). According to obtained results, FC/TC ratio in almost all sampling sites did not exceed 0.1 (faecal coliforms participated with less than 10% in total coliforms number). Low water quality according to this parameter was found only at the sampling site 5 (Vrbas 2), where the FC/TC ratio was 0.112, indicating the presence of human faecal contamination [8].

4. CONCLUSIONS

Results of microbiological investigations the DTD canal network water show remarkable fluctuations of the number of TC and FC (*E.coli*), as well as significant differences of bioindicating values of these parameters. According to the number of TC, canal waters belong one or two classes of faecal pollution higher then when estimated according to the number of *E.coli*. Our results confirm that FC are better indicators of faecal pollution than TC. The FC/TC ratio indicates that faecal pollution of human origin generally was not found in investigated canal waters. Concentrations of bacterial faecal indicators (*E. coli*) indicated mainly moderate faecal pollution of canal waters of the Bachka Region, except for those locations downstream of Vrbas city being under the strong influence of municipal and industrial wastewater.

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