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## Season dynamics of changes in water microb structure in some water storage reservoirs of Uzbekistan

**Abstract:** The dynamics of seasonable levels of microorganisms in water samples from some water storage reservoirs of Uzbekistan has been studied in the comparative aspect. In Charvak water storage reservoir (WSR), the quality of water, judging by the microbiological indicators, many-fold exceeded the indicators of Kattakurgan WSR and Tuyamuyun water works facility.

**Keywords:** water storage reservoirs, reservoir water, microbe structure, pathogenic microorganisms, opportunistic microorganisms.

Water storage reservoirs (WSR) are special geographical natural and climatic bodies being an obligatory part of a landscape of territories of many countries of the world. Though they were created by people, they are exposed to a severe impact of many natural factors, hydrometeo-logical ones in particular [1; 7].

Alterations in mineral and chemical composition, water hardness are known to change quantitative and qualitative structure of water microflora. Pathogenic microorganisms (PM) transmitted by water, adapting to these conditions, change the biological properties. It leads to a lower percent of yielding normal microflora representatives (mesophilic aerobes and facultative anaerobes) as well as PM being in the WSR [3–5; 6; 9].

**Aim of the study.** A comparative study of the seasonal dynamics of the cultivation of microorganisms of different WSR.

**Material and methods.** Taking into consideration the three types of WSR in RUz. (bed, off-stream, mixed) three WSR chosen for the research: the bed one — Charvak, the off-stream one — Kattakurgan; the mixed one — Tuyamuyun water works facility (WWF) which include WSR (areas) Ruslovoe, Kaparas and Sulton Sanzhar.

The WSR profiles: Kattakurgan WSR (Kattakurgan district of Samarkand province) — a valley, irrigational WSR of off-stream type, has been used since 1941. The reservoir is located in the left-bank part of the Zeravshan valley 6 km to the south of the city of Kattakurgan. Filling is made through the bringing channel from the Karadarya which is the Zeravshan's inflow. The reservoir surface is 80.5 km<sup>2</sup>, the volume of the WSR over 662 million m<sup>3</sup>, the dead storage is 24 million m<sup>3</sup>. The irrigational aims are gained by water accumulation during the winter-spring period through giving water from the WSR in the time of plants' vegetation. By its external water exchange it is of accumulation and transit one type I [7; 12].

Tuyamuyun WSR (Tuyamuun WWF) started to be filled up in 1984. This WSR is of mixed type (bed and off-stream). It is locat-

ed in Tuyamuyun canyon being on the border of the middle and upper water course of the river Amu Darya 450 km from the Aral Sea. The full capacity of all WSR makes 7.8 km<sup>3</sup>, the useful capacity is 5.28 km<sup>3</sup>. The water — table is over 250 km<sup>2</sup>, the area of the water surface is 780 km<sup>2</sup>. The length is 80 km, water level at the dam is 13 m. By its morphological type it is complex hollow-valley one [7; 12].

Charvak WSR (Bostanlyk district of Tashkent province, 85 km from the city of Tashkent) is a bed, valley WSR constructed in 1978. It was formed by damming the river Chirchik at its exit from the Charvak hollow. The WSR has the full volume of 2,006 km<sup>3</sup>, the useful one is equal to 1.58 km<sup>3</sup>, the surface area with the normal banked up level is 40.1 km<sup>2</sup>. The full reservoir area is over 41 km<sup>2</sup>, the maximum depth by the dam is 150 m, and the water volume is about 2 billion m<sup>3</sup>. Filling with water occurs, basically, in spring owing to snow thawing. The reservoir is used in summer during plants' vegetation. By external water exchange it is of the accumulation-transit type I [7; 12].

The water from WSR was taken by sterile bathometers from the depth up to 20 cm from the water surface in the volume of one liter. When it was necessary to take samples at different depths, benthonic samples were taken at the depth of 30–50 cm from the bottom. In bathing places (Kattakurgan and Charvak WSR), the surface water layer was sampled not immersing the bottle's neck. In the rivers (the Amu Darya) and WSR (Kattakurgan, Tuyamuyun and Charvak) sampling was made using boats. The water samples were delivered following the methodical recommendations specified by S. K. Alieva et al. [2]. The term of the beginning of the tests did not exceed 2.5–3.5 hours after the moment of sampling [13; 14].

All microbiological tests were made according to the recommendations developed by Alieva S. K. et al. [2] and Nedachin A. E. [8]. The total number of saprophile microorganisms (TNMC), the

total coliform bacteria count (TCB), thermo-tolerant coli form bacteria (TTCB), the TTCB number in 1 dm<sup>3</sup> of waters (according to the State Standard (GOST) 950–2011 — coli index), PM (*Shigella* spp., *Salmonella* spp.) and opportunistic microorganisms (OM) (*Escherichia* spp., *Staphylococcus* spp., *Enterococcus* spp.). To carry out the bacteriological tests the standardized culture media produced by “HiMedia” (India) were used. All tests were made in 2012–2014, the samples were taken three times from each study-point, all in all 9 series of tests were made.

Statistical processing was made by the analysis of variance with calculation of arithmetic mean (M), errors of arithmetic mean (m). Significance of differences was calculated according to Fisher — Student criterion (P). The differences were thought to be representative with P < 0.05. All calculations were computered using “Pentium 4” processors with a package of applied programs for medical and biologic research. When organizing and carrying out the research the principles of demonstrative medicine were applied [11].

**Results and discussion.** The obtained findings of microbiological tests of water from Kattakurgan WSR have shown that the total TCB in 1 dm<sup>3</sup> of water in summer was the lowest in the water lower the dam, i. e. 500 CFU/100 ml (means 500 colony forming units per 100 ml of sample). It corresponds to the normal values for WSR of category I but it is twice lower the norm for water reservoirs of category II [10]. In other samples taken from different places of water storage reservoirs, the TTCB values were 2–9 times higher than the indicators determined lower the dam (500 CFU/100 ml), i. e. 1,100 CFU/100 ml (in the middle of the reservoir); 5,200 CFU/100 ml (before the dam) and 9,400 CFU/100 ml (in the recreational zone). In spring this indicator was 2–3 next lower orders than in summer in all the places of sampling.

In all the water samples taken from different places in summer, the TNMC value was above the norm — no more than 100 CFU/100 ml [10]. In particular, it was expressed in the water samples from the recreational zone (250 CFU/100 ml). During the spring these indicators worsened in 1.5–5.2 times in comparison with the standard and were above the summer parameters (P < 0.05).

The research was conducted to study the microbiological indicators in the water samples from Tuyamuyun WWF as well.

The findings show that the TTCB highest parameters in summer were found out in the water samples taken lower the dam in Ruslovoe WSR and in the discharge channel (the river Amu Darya), 1,3000 CFU/100 ml each. The lowest quantity was revealed in the water samples from Sulton Sanzhar WSR (500 CFU/100 ml), this quantity corresponds to the standard values [10].

The parameters of water from Kaparas and Ruslovoe WSR (before the dam) in summer also were above the norm, but they are significantly lower than the indicators before the dam and the discharge channel (P < 0.01). The TNMC indicators in all water samples, irrespectively of the sampling place, were more than 300 CFU/100 ml that exceeded the standard values [10]. A different picture was observed when studying the spring indicators: while there were no significant changes in the TTCB quantity, the TNMC values were dramatically lowered (P < 0.001). TTCB seasonal dynamics greatly differs only in Kaparas and Sulton Sanzhar WSR.

In the water samples from Sulton Sanzhar, this parameter did not exceed the norm. This finding is explained by the fact that the water in Sulton Sanzhar WSR comes from Ruslovoe reservoir through Kaparas reservoir where the water is desilted and the clarified water comes to Sulton Sanzhar. Apparently, microorganisms together with chemical substances and suspended particles from clay and sand gravitate to the bottom of Kaparas WSR. Besides, in

these WSR (Kapas and Sulton Sanzhar) there is almost no movement of water and it excludes raising the suspended particles from the reservoir bottom on to the surface. In spring the quality of water specified by the TTCB parameter does not differ from the norm, the TNMC indicator is significantly better (P < 0.001) almost in all the samples.

By the microbiological indicators, the quality of water in Tuyamuyun WWF is significantly worse than the same indicators of the Kattakurgan WSR — both in TTCB and TNMC.

Microbiological tests were made with water samples from Charvak WSR. The findings show that in water samples from the middle of the reservoir and before the dam, the results of summer tests were below the top borders of the norm for reservoirs of category II [10].

Indicators of the coli index of water samples before the dam (800 CFU/100 ml) were within the normal values for reservoirs of category I — 1000 CFU/100 ml [10], however, in the recreational zone, they were above (1200 CFU/100 ml) the normal amounts.

TNMC indicators in all water samples, irrespectively of the place of sampling in Charvak WSR, were within the specified standard values. Only the TNMC of the recreational zone and lower the dam were above the level of the top borders of the standard, while in other water samples, the TNMC value was 3.3 and 5.0 times lower than the top borders of the norm. In all water samples, irrespectively of the place of sampling, PM were not found out.

The samples of water taken in spring did not differ much from the ones which were taken during the summer; the TTCB and TNMC indicators were significantly lower than not only the norm, but also the summer indicators (P < 0.001).

When comparing microbiological indicators of Charvak WSR to other water objects described above, it was revealed that all the indicators were many-fold lower and are within the specified limits. Apparently, it is the basic difference of water of Charvak WSR in comparison with the water of the Kattakurgan WSR, and especially the water of Tuyamuyun WWF. This demonstrates that Charvak WSR is filled with the mountain rivers with low temperature of water with no evident shoal and small amount of plankton. To study culturing abilities of PM and OM of the water samples of the WSR under comparison was the next step of our research.

The microbiological research was conducted to identify and differentiate *Shigella* spp., *Salmonella* spp., *Escherichia* spp., *Staphylococcus* spp. and *Enterococcus* spp. Causative agents of bacterial intestinal infections, e. g. *Shigella* spp., *Salmonella* spp. and *Escherichia* spp., were studied with a view of substantiation of quality of water in WSR.

In summer, identification of *Shigella* spp., *Salmonella* spp., *Escherichia* spp., *Staphylococcus* spp. and *Enterococcus* spp., irrespectively of the place of water sampling, failed in Kattakurgan WSR. Apparently, it is because the time of sampling water coincided with the reservoir filling up when water movement was considerable. Besides, the zones of sanitary protection of the WSR and regular anti-epidemic measures were strictly followed. However, another picture was observed in spring: in the samples from the middle of the reservoir, the recreational zone and before the dam *Shigella* spp., *Salmonella* spp. and *Enterococcus* spp. were found out.

The similar research was conducted with water samples from Tuyamuyun WWF. The findings show that in summer *Shigella* spp., *Salmonella* spp., *Escherichia* spp., *Staphylococcus* spp. and *Enterococcus* spp. were not found in the water samples from Kaparas, Sulton Sanzhar WSR and from the ones taken before the dam of Ruslovoe WSR. *Escherichia* spp., *Staphylococcus* spp. and *Enterococcus* spp. were found in the water samples taken lower the dam of Ruslovoe WSR and the discharge channel (the river Amu Darya). The indi-

cators of spring tests did not differ greatly from the summer ones, except for *Enterococcus spp.*, which was revealed in all the samples. No certain regularities related to the place of sampling or season were revealed.

The microbiological tests to study culturing profile of the microorganisms from water samples from Charvak WSR have yielded the following results: *Escherichia spp.* and *Enterococcus spp.* were identified in the water samples from the recreational zone. *Shigella spp.* and *Salmonella spp.* were not. The research conducted during spring did not give any positive bacteriological results.

*Enterococcus spp.* and *Staphylococcus spp.* were revealed to be cultured only on banks (at a distance of 1 m from the bank) of the WSR where there were recreational zones or cattle was grazed ( $P < 0.05$ ). Starting from a distance of 5 m and farther as well as and in the depth of 20 cm and more, PM and OM, including *Enterococcus spp.* and *Staphylococcus spp.* were not cultured in all studied water storage reservoirs.

Apparently, *Enterococcus spp.* and *Staphylococcus spp.* can be used as sanitary-indicative microorganisms (SIM) for recreational zones of WSR and their detection even in insignificant quantities can be considered as the factor of microbe contamination and a risk factor for recreational zones of WSR.

#### Conclusions:

1. The results of microbiological tests of Kattakurgan WSR have shown that TTCB in 1 dm<sup>3</sup> in summer exceeded the norm in the

water samples from the reservoir in 2.2 times on average, in the samples taken before the dam, the value was 10.4 times higher, in those ones from the recreational zone the value was 18.8 times higher. In spring, TTCB was 2–3 orders less than in summer and TNMC, on the contrary, was higher.

2. The values of the indicator were 4.5–26.0 times higher in the water of Tuyamuyun WWF. Only in water samples from Sul-ton Sanzhar, this indicator did not exceed the norm. In spring the quality of water TTCB does not differ from the norm, by TNMC it is significantly better than in summer.

3. These parameters in Charvak WSR at the level of the top borders of the norm. Microbiological indicators of the quality of water in Charvak water storage reservoir were manyfold higher than the values of the Kattakurgan WSR and Tuyamuyun WWF.

4. *Escherichia spp.*, *Staphylococcus spp.*, *Enterococcus spp.*, *Shigella spp.* and *Salmonella spp.* were found out in the water samples from Tuyamuyun WWF and the Kattakurgan WSR. The certain regularities related to the place of sampling or season were not revealed. *Escherichia spp.* and *Enterococcus spp.* were found only in the recreational zone of Charvak WSR.

5. *Enterococcus spp.* and *Staphylococcus spp.* can be used to use as sanitary-indicative microorganisms of recreational zones of WSR, their detection, even in insignificant quantities, can be considered as the factor of microbe contamination and a risk factor for recreational zones of WSR.

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