

A STUDY ON THE MICROBIOLOGY OF CUARTO RIVER (CORDOBA ARGENTINA)

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Running title: Microbiology of Cuarto River

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SUMMARY

The Cuarto River (earlier named River Chocancharava) joins the Tercero River to form the Carcarana River, a very important affluent of Parana River.

The aim of this work was to evaluate bacteriological, phycological and physico-chemical variations during the year, and to establish the potential risk for human and animal health. According to the effluents received by this environment, six sampling stations were selected. The MPN / 100 ml of total coliforms and faecal coliforms showed variations during the year, exceed the admissible levels at the stations located downstream from the municipal discharges. A similar situation happened for *Streptococcus faecalis*. Algal counting did not show similar values at the sampling stations evaluated along the year, nevertheless, genera belonging to the *Bacillariophyceae* were predominant. Physical parameters were found between admissible limits, except in those points receiving effluents. Considering the chemical characteristics, the water was classified as hipohaline and sodic bicarbonated. According to the results obtained, the sampling sites at route 8 (Km 597, 587 and Paso del Durazno) do not meet the established limits of quality for recreational waters.

INTRODUCTION

The quality of hydric resources for several uses is affected in different degrees in many basins of Argentina. The causes for the damage include, among others, the discharge to surface water courses of sewage or pluvial effluents, industrial residues, and agricultural wastes such as plaguicides, fertilizers, and many other substances.

The Cuarto River, located at 64 46'W, 32 55'S and 63 16'W, 33 25'S, is one of the more important rivers in the Cordoba Province. It joins the Tercero River, born at the homonymous dam, and form together the Carcarana River, a very important affluent of the Parana River. The characteristic of superior and middle courses of the Cuarto River are highly different from the rest, because of many geological features such as sediments, evaporation, edaphic coverage, biota and anthropic activity. When crossing the city (called also Cuarto River) the river suffers important changes due to effluents from different origins: domestic, garbage, agricultural activities and the effect of erosion (Alovero, 1991). Sewage discharges are made without any previous depuration to the river, at 3 Km downstream of the city.

The object of this research was the evaluation of bacteriological, phycological and physico-chemical variations in the Cuarto River during the year, establishing the potential risk for human and animal health.

METHODS

Sampling stations in Cuarto River:

In order to choose the sampling stations several aspects were considered, including the position of the water pipes to supply the city, places usually used for recreation, and effluent discharging zones. Six stations were established: 1. Tres Acequias (St. 1), Playa Bonita (St. 2), Rio Cuarto University (St. 3), Km 597 (sewage discharge area) (St. 4), Km 587 (St. 5) and Paso del Durazno, located 20 Km downstream main sewage discharge of the city (St. 6). For a better view of the location of these stations see Fig. 1. Samples were collected during 1995 and 1996.

Sample collection:

Bacteriological evaluation: samples were taken in plastic sterile jars at 30 cm. depth and were kept refrigerated until processing. Three samples obtained in 30 days were analyzed, that is, three repetitions for each sampling place at each year station. Total aerobic microorganisms were evaluated at 37 °C (agar plate), total coliforms according to the most probable number technique (MPN / 100 ml.) following APHA directions (1992) and Colilert analysis test. To search for *Streptococcus faecalis*, KF Streptococcus agar was employed (8,9,10). Results are expressed as log. (MPN / 100 ml. + 1) or 1 MPN.

Phycological evaluation: Samples were obtained in 1 l. plastic jars carefully washed in distilled water, at 30 cm. depth. After concentration by decantation, they were fixed with 3 % formaline. (Corigliano et al, 1994; Whitton et al. 1991). The sample counting was made by direct observation, and by means of optical microscopy (Stein, 1973; Soto, 1991). Results are expressed as number of individuals / 25 ul.

Physico-chemical analysis: glass recipients were used. Samples were obtained also at 30 cm. depth. Physical analysis: smell, turbidity, color, and temperature were evaluated, by standardized methods. Chemical analysis: pH, anions and cations, alkalinity, total salts, arsenic and nitrites were considered (APHA, 1992; USEPA, 1976).

The quality of continental waters was evaluated according to the directives of the European Community 76/160 for bathing waters and 75/440 for shallow waters destined to drinking water supply; quality criteria from USEPA (1969), and provisional microbiological criteria for the use of residual waters in aquaculture (Mara and Cairncross, 1990) were also considered.

Physical, chemical and microbiological parameters to measure water quality were established, utilizing imperative and indicative values, considering as the most important those organisms indicating faecal contamination.

Statistical analysis: ANOVA was made on two factors on an aleatorized design, and the test of Scheffe was also applied (Montgomery, 1993) using the STATA statistical software.

RESULTS AND DISCUSSION

Bacteriological analysis: results indicated that main discharges corresponded to the stations located at Km. 597, 587 and Paso del Durazno (Fig. 2 and 3). For total coliforms and in 1995 significant differences ($p < 0.01$) between sampling sites were found, but not for the seasons ($p > 0.01$). In 1996 there were significant differences between sampling sites and seasons. Faecal coliforms in 1995 did not show differences either for sampling sites or for the seasons, while in 1996 there were differences for both. Along the whole study, the higher values were recorded for total coliforms and faecal coliforms bacteria at stations 4, 5 and 6. According to the Colilert Test, stations 2, 4 and 6 in spring and summer showed values above 1100 MPN / 100 ml. for total coliforms and *Escherichia coli*.

The higher levels for *Streptococcus faecalis* were detected at stations 4, 5 and 6. Station 1 always had the lower levels of MPN / 100 ml. for total coliforms and faecal coliforms. Station 1 did not comply with directive 75/440 of the European Community in summer, fall and spring (1967). Along the whole year, stations 2 and 3 did not comply with the established limits of total coliforms.

Results showed that the higher charges were registered at those sampling stations receiving untreated effluents. These results are consistent with those of Soto (1991).

Phycological analysis:

Algal counts were different for each sampling station along the years, but *Bacillariophyceae* (Diatoms) were dominant in general, especially the genera *Calloneis*, *Amphora* and *Navicula*. During winter, *Microcystis aeruginosa* was observed at stations 4 and 5 (representing 3 and 11 % respectively), while *Phormidium sp.* was found at 20 and 48 % in the same sites. Both species are Blue-green Algae or Cyanobacteria. This last one also occurred at station 6 with a 10%, but during the rest of the year *Bacillariophyceae* and *Chlorophyceae* were dominant. *Spirulina platensis* was observed at station 4 (0.6%) and the genus *Lyngbya* at station 4, in fall (5%) and at station 5 in spring (2%). Also in spring, *Anabaena flos-aquae* was present at stations 3 and 5 (17 and 1 %). Genera belonging to Cyanobacteria were not very frequent in previous works by Corigliano et al. (3), which is consistent with this study. The highest diversity was found in stations 2, 4 and 5, being generally lower in spring and summer, probably due to higher levels of precipitation and eutrophication. These low levels of Cyanobacteria are not dangerous for the recreational use of the river.

Physico-chemical analysis:

Physical parameters evaluated were all between admissible limits, except at stations 4 and 5. The same occurred regarding pH values. Temperatures were closely correlated with incident radiation, and seasonal variations during the sampling period. Along the samplings, and according to the season, the other observed parameters showed variations, because chlorine and sulfate contents may be affected by pollution from urban or industrial origin, but an increase of them was repeated at stations 4, 5 and 6. The average levels found were: for sulfates 28.3 mg/l; 24.7 mg/l and 24.15 mg/l, while for chlorides they were 29.12 mg/l; 14.9 mg/l and 12.09 mg/l respectively. It is interesting to remark that the first values are obtained from the place where city effluents are discharged; those values are lowered in the other

following stations. Total alkalinity showed the lowest measures at station 1, with 98 mg CO₃ Ca / l, and the highest ones at station 4, with 212 mg / l. There was also a direct relation between alkalinity and turbidity. Considering the chemical characteristics, water was classified as hypohaline and sodic bicarbonated (Fig. 4). Arsenic was not found in any of the samples.

The intensive use of the river from a recreational point of view occurs during summer, with a marked peak in December and January. On the absence of seasonal epidemiological data continued along the time, the chemical and bacteriological limits from the European Community are recommended (1967), for primary contact with recreational waters. Also, the average values of 1000 MPN / 100 ml. for faecal coliforms should be adopted for secondary contact activities. The high counts of *Escherichia coli* like the ones found in this study make a necessitate the routine search for this bacterium to know its origin and the potential risks involved. In general, it would be preferable and more useful to test for *E. coli* rather than for faecal coliforms. According to our results, the sampling sites at Km. 597, 587 and Paso del Durazno do not accomplish the guidelines recommended for the recreational use of water. Therefore, this work encourages the necessity for a continued control of the evaluated parameters, especially bacteriological indicators, in order to establish preventive measures.

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