INVESTIGATION OF BACTERIAL POPULATIONS PRODUCING ELEVATED MPN VALUES AND FALSE POSITIVE FECAL COLIFORM COUNTS AND APPLICABLE DISINFECTANTS IN AN INDUSTRIAL WASTEWATER

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ABSTRACT

This poster presents data on the types of bacteria which produced elevated, most probable number (MPN) fecal coliform values in an industrial waste treatment plant effluent. The principal influent stream, a pulp and paper mill wastewater, contained principally *Klebsiella* species of environmental, not enteric origin. Fecal streptococci and enterococci were low in numbers. Eight disinfectants were tested on a small (currently acid disinfected) municipal wastewater incoming stream and on the main plant effluent.

KEYWORDS

Fecal coliforms; fecal streptococci; enterococci; *Klebsiella*; industrial wastewater; MPN; disinfection.

INTRODUCTION

A 50 mgd (2.19 m³/sec) industrial wastewater treatment plant (WWTP) includes 30 mgd (1.31 m³/sec) of a pulp and paper mill wastewater, several other small industrial (non-sewage) streams and a small flow of municipal wastewater. Permit requirements mandate that the municipal wastewater be disinfected. For all intents and purposes, therefore, no raw sewage enters the main WWTP. Routine reconnaissance of the effluent showed MPN values for fecal coliforms that averaged 562,000/100 mL and had a range of 79,400 to 1x10⁷/100 mL (n=14). The fecal coliform MPN values for the pulp and paper mill averaged 3,160/100 mL and had a range of <30 to 251,000/100 mL. Some earlier investigators (Bordner and Carroll, 1972; Bagley, 1977; Caplenas and Kanarek, 1984) reported on the significance of these apparent fecal coliforms in industrial wastewaters and recreational waters. The principal objective of this investigation was to attempt to identify the source or sources of these bacteria and differentiate enteric (fecal coliform positive, FC pos.) from FC negative genera. The second objective was to test disinfectants on the municipal wastewater and main plant outfall for applicability.

METHODS

Apparent coliforms were enumerated by the membrane filter method (MF) according to *Standard Methods* (1989) with subculture tests with BHI agar/oxidase testing and MacConkey Agar followed by API 20-E strip
(Analytab) tests plus EC broth reactions (Bergey, 1984). Fecal streptococci and enterococci were tested using MF and m-Enterococcus agar and mE agar. Disinfectants tested included acid, base, chlorine, chloramine, bromine, peracetic acid, peroxide, ozone, and salinity.

RESULTS

The initial work involved fecal coliform and streptococci enumeration through the plant in the pulp and paper mill wastewater (WW), municipal WW (disinfected), mixed streams, primary clarifier effluent, and secondary clarifier effluent (plant effluent, or outfall). Subculture testing showed that, with only two exceptions, the pulp and paper mill WW had non-enteric origin Klebsiella morphotypes present. Those apparent fecal coliforms averaged 3,500/100 mL and ranged from 200 to 316,000/100 mL by the MF plate method. Secondary clarifier sludge is recycled just prior to the mixed streams point. Above this the Klebsiella were all FC negative but after addition of sludge and in the primary clarifier effluent no Klebsiella were isolated and the fecal coliforms were both FC positive E. coli and FC negative Enterobacter. In the mixed streams FC positive E. coli Enterobacter agglomerans and Klebsiella (pos.) were found along with FC negative Klebsiella. Interestingly enough, the fecal coliforms found after the secondary clarifier and in the effluent were FC positive E. coli and FC negative Enterobacter and Klebsiella. This testing occurred over a 16-hour hydraulic retention time through the plant. Very low counts of Enterococcus durans and E. faecium were found concurrently. These organisms can be either enteric or environmental in origin. The conclusion that was reached by this kind of testing over a 6-month period was that the sludge recycle was acting as a point of introduction of FC positive species and in a sense the substantial nutrient content of the wastewater was enough to not only sustain, but promote, growth of FC positive organisms downstream in the WWTP.

The dilemma that presented itself in this investigation is this. The municipal WW influent is acid disinfected to pH 1-2 for 5 minutes and neutralized. No indicator bacteria of any kind were found in that stream. The pulp and paper mill WW had no sewage in it, yet it contained up to 316,000/100 mL (apparent) fecal coliforms, proven to be of environmental origin. The MF method showed the main effluent to contain an average FC concentration (n=21) of 850/100 mL and a range of 5 to 501,000/100 mL. Other FC tests run on the main effluent by the MPN method showed (n=14) a mean value of 562,000/100 mL and a range of 79,400 to 1x10^7/100 mL. False positives were appearing and counted by both methods. The question that arises is whether or not the FC positives reintroduced in the sludge recycle actually can be termed enteric origin or fecal sources when no recordable actual sewage was entering the plant.

Regarding the disinfection research, the main plant effluent was more refractory to disinfection than was the municipal WW stream, in all cases. Ozone and hydrogen peroxide showed no ability to reduce FC and fecal streptococci (FS) in either stream at any concentration tested. Sodium hydroxide to pH 12 showed some reduction of FC but had virtually no effect on the streptococci. All other disinfectants showed some degree of effectiveness.

REFERENCES