Quantifying Adsorption of an Indicator Bacteria in a Soil–Water System

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Abstract. *Two experiments were conducted to investigate and quantify the weak and strong adsorption of an indicator bacterium (*Escherichia coli*) in soil–water systems composed of Tangi silt loam (14% clay) or Commerce clay loam (35% clay). Percent adsorption of* E. coli *was significantly higher in Commerce clay loam than in Tangi silt loam for both weak and strong adsorption. The distribution coefficient of weak adsorption of* E. coli *in the Commerce soil–water system was found to be significantly higher than that of strong adsorption. However, the distribution coefficient of weak adsorption of* E. coli *in the Tangi soil–water system was found to be significantly lower than that of strong adsorption. For strong adsorption, together with literature data, a high correlation (R^2 = 0.89) was found between percent adsorption and clay content. Significant correlation (R^2 = 0.67) was found between distribution coefficient and clay content. The relationships developed may be used for modeling purposes.*

Keywords. *Bacteria,* E. coli, *Runoff.*

Microbial pollution of surface and groundwater is of great concern to the public due to the potential for disease transmission (Pell, 1997). *Escherichia coli* is the predominant component of fecal coliform, and it is a specific indicator of microbial pollution of water. Quantitative determinations of sorption of microorganism to soil particles and the partitioning of microorganisms between aqueous and solid phase have direct application in such areas as land treatment of wastewater, land application and disposal of municipal and animal waste, and animal grazing of pastures. Studies of the adsorption of indicator bacteria or pathogens as a function of the physical properties of the soil could provide insight into the management of water resources both for drinking and recreational purposes. For surface runoff from exposed soil, adsorption is the predominant cause of retention of bacteria during rainfall. To model the movement of bacteria from land surface to runoff, the extent of adsorption of bacteria by the soil involved must be known. Researchers (Reddy et al., 1981; Vilker, 1981) have expressed the need for a relationship between adsorbed bacteria and soil properties.

Most studies indicate that sorption of microorganism increased with increasing clay content (Britton et al., 1974; Gromyko et al., 1986; Marshall, 1971; Weaver et al., 1978). Weaver et al. (1978) reported that adsorption of *E. coli* increased with increasing clay content of the soil and that clay content was more important than organic matter in determining adsorption. Weaver et al. (1978) studied bacteria adsorption both by mixing bacteria with soil and washing the weakly bound bacteria with physiological saline and by passing bacteria suspension through soil columns of 1 to 15 cm length. *E. coli* adsorption ranged from 7% in Arenosa loamy sand (10% clay) to 90% and higher in Houston black clay and Beaumont clay (≥50% clay) in a soil–water mixture. For the column studies, *E. coli* retention in the first 1 cm ranged from 44.6% in Arenosa loamy sand to 99.5% in Houston black clay. Marshall (1971) in his review reported adsorption of different bacteria species such as *Bacillus sp.*, *Pseudomonas sp.*, *Serratia sp.*, *Chromobacteria sp.*, and *E. coli* var. *communis* on soils and reported that strains of *E. coli* were poorly sorbed by different soils.

Downward movement and retention of different bacteria in different media such as soil, aquifer sand, clean quartz sand, and glass beads have been studied extensively. Bitton et al. (1974) studied the movement and retention of *Klebsiella aerogenes* in 11.5 cm saturated soil columns of different clay content (7% to 50%) and different pH (3.0 to 3.5, 6.5 to 7.0) eluted by 0.01 N $CaCl_2$. The study found that the percent retention ranged from 27% to 100% for capsuled bacteria and 44% to 100% for bacteria with no capsule, and the higher the clay content, the higher the retention. Gromyko et al. (1986) studied adsorption of *E. coli* by eight Serozem soils of Central Asia. *E. coli* was adsorbed by all soil samples, and adsorption increased with increasing clay content.

Smith et al. (1985) studied the movement of *E. coli* strain K–12 in intact and disturbed soil columns of 28 cm length by irrigation. For the different loam soils studied, disturbed soil cores retained at least 93% of the cells, while undisturbed soil cores retained 21% to 78% of the bacteria. Gannon et al. (1991a) studied the movement of 19 strains of bacteria through a column of Kendaia loam (22.5% clay) of 5 cm

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