

SORPTION OF TYLOSIN ON GOETHITE

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ABSTRACT

As one of the widely used antibiotics in the world, the environmental behavior of tylosin (TYL) received more and more attentions. In order to assess its environmental and ecological risks accurately, it is necessary to understand the sorption properties of TYL on the soils/sediments. The sorption of TYL on goethite at different conditions were investigated through a series of batch experiments and the sorption data of TYL were fitted by Freundlich model and dual mode sorption model. It was obvious that sorption was strongly dependent on pH and ionic strength. Sorption capacity of TYL increased as the pH increased and ionic strength decreased. The pH and ionic strength-dependences might be related with the specific complexation between cationic/neutral TYL and goethite. Spectroscopic evidence indicated that tricarbonylamide and hydroxyl functional groups of TYL might be accounted for the sorption on mineral surface. The experimental data of TYL sorption could be fitted by surface complexation model (FITEQL), indicating that $\equiv\text{FeOH}$ with TYL interaction could be reasonably represented as a complex formation of a monoacid with discrete sites on goethite. It should be noticed that the heterogeneous of sorption affinity of TYL on goethite at various environment to assess its environment risk

Keywords: sorption, antibiotic, tylosin, goethite

1. Introduction

Tylosin (TYL), a widely used veterinary antibiotic, was often employed ad feed additives in poultry and swine farms. During the application of livestock wastes on agricultural fields, TYL might be persistent in soils or transport to groundwater and contribute to the growth or development of antibiotic-resistant microbial populations (Klare *et al.*, 2003), it was necessary to understand the fates of such antibiotics in environmental systems. Prior studies revealed that the fate and transport of antibiotics in the environment would be affected by minerals (Gao *et al.*, 2012). In order to understand the contribution of goethite on the environmental fate of TYL and assess the sorption behavior and mechanism of TYL on goethite accurately, we investigated the influences of solution chemical factors (pH and ionic strength) on the sorption of TYL on goethite.

2. Materials and methods

Sorption experiments of TYL on goethite were conducted with completely mixed batch reactor (CMBR) systems. The initial TYL concentration was set from 0.5 to 50 mg/L. The pH of system was adjusted with potassium hydroxide and HNO₃ solution, while the ionic strength was adjusted with KNO₃. The reactors were shaken at 150 rpm and 25 ± 2 °C. After mixing for 5 h, they were centrifuged at 2,800 g for 15 min and then set upright for 12 h to allow the sorbent particles to settle. The aqueous concentrations of TYL were detected by a reverse-phase high-performance liquid chromatography (Agilent 1200) with C18 column (5 μm, 4.6×250 mm; Agilent) and diode array UV detector (wavelength at 290 nm).

3. Results and discussion

3.1. Sorption equilibrium

The sorption data were fitted by Freundlich model and dual-mode model (DMM) and equilibrium parameters were listed in Table 1.

Table 1: The sorption and desorption isotherm parameters of TYL on goethite

model	Freundlich model			DMM model			
	n	$k_f(\text{mg/kg})/(\text{mg/L})^n$	R^2	$k_d(\text{L/kg})$	$q_m(\text{mg/kg})$	b	R^2
goethite	0.16	380.98	0.960	4.14	553.96	1.49	0.995

The sorption of TYL on goethite was significant nonlinear and both Freundlich and DMM models could fit the sorption data well ($R^2 > 0.96$). The best fitting result of DMM models indicated that sorption of TYL on goethite was complicated and might be related with surface sorption process.

3.2 Effects of pH and ionic strength

The sorption isotherms at different pH and ionic strength were shown in Fig. 1. Sorption increased as pH increased, which might be due to the various species of TYL at three pH levels. At acidic condition, TYL^+ was dominant and goethite particles were also positively charged. However, TYL was still adsorbed through H bonding between functional groups ($-\text{OH}$) of TYL and goethite. At neutral system, TYL^0 might be attracted by goethite through H bonds and van der Waals forces (Gao *et al.*, 2012). The pH-dependent sorption behavior observed in this study was consistent with surface complexation of cationic/neutral TYL species with goethite. The sorption of TYL on goethite in the alkaline system was strongest, indicated that the neutral counterpart could connect with goethite through $-\text{NH}_2$ and $-\text{OH}$ groups.

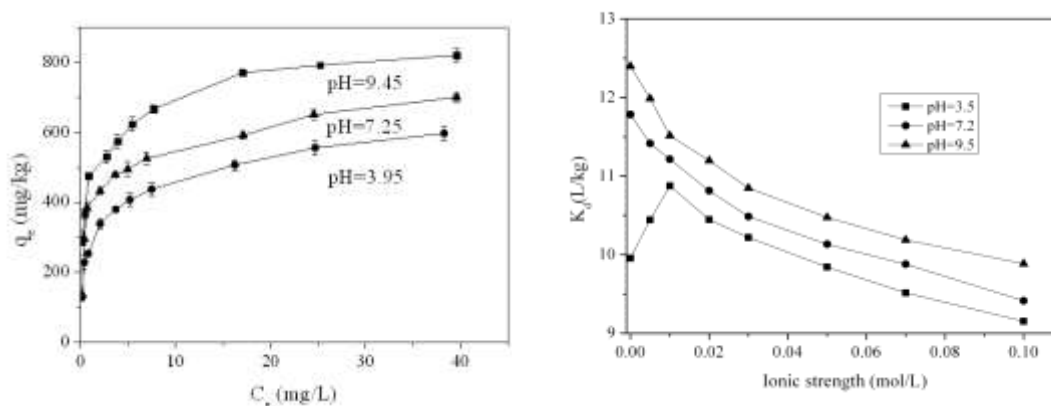


Figure1: Sorption of TYL on goethite at different pH values and ionic strength.

From Fig. 1, it could be observed that the sorption of TYL decreased as the ionic strength increased. Stronger ionic strength could reduce electrostatic repulsions between positively charged molecules and goethite surfaces, resulting from the screening effect of surface charges produced by the added salt (Wu *et al.*, 2011). At the same time, both TYL and goethite were positively charged in acidic condition and cation exchange might be also contribute to the sorption of TYL on goethite. The slightly increased sorption of TYL in acidic system might be related with the coexistence of K^+ and TYL^+ .

4. Conclusions

Tylosin could be uptaken by goethite significantly and exhibited obviously nonlinear. Sorption capacity was influenced by pH and ionic strength of solution. Neutral and alkali condition could enhance the sorption. The sorption of tylosin could be related with surface complexation,

electrostatic repulsion and H-bonding on goethite. It should be noticed that the heterogeneous of sorption affinity of antibiotics on goethite at various environment to assess its environment risk.

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