Ionophore sorption in coastal plain soils

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INTRODUCTION

Veterinary anticoccidials are biochemically known as Ionophores. They are used in poultry feed at therapeutic levels to treat disease and at sub-therapeutic levels for growth-promotion. They have been found in significant quantities in animal manure including poultry in many parts of the world (Hansen et al, 2009; Biswas et al, 2012).

Little published research exists on ionophore persistence after manure is land applied. Yet, they are rapidly becoming identified as an emerging contaminant as they can cross the biological membrane causing toxicity in flora and fauna including mortality in humans at higher levels.

Therefore, our objectives were to determine the effect of soil texture on sorption of monensin, a commonly used ionophore, in coastal plain soils. A sorption batch equilibrium study was conducted as a pilot study, using 5 soil textures found on the Delmarva Peninsula. The study was conducted on soils collected from the A and B horizons separately. Liquid chromatography-triple quadrupole mass spectrometer was used to quantify the amount of monensin sorbed during the study. Variation in the sorption patterns based on different soil textures, % organic matter, cation exchange capacity and pH have been found and presented here.

MATERIALS AND METHODS

Soil Collection

- Five research farms representing Delmarva Peninsula soils, were selected for sampling (Fig 1). They were not known to have any manure application in the past decade.
- Web soil survey and GIS tools were used to identify different map units that were targeted for sampling on each of the farms.
- Soil samples were collected separately from A and B horizons.
- Samples were collected using a Giddings probe (Fig. 2) and location was recorded by GPS.
- Soil samples were air dried, ground and sieved and characterized for texture, cation exchange capacity, pH and organic matter (loss on ignition method) using standard procedures as presented in Fig 4.

Batch Equilibrium

- In our pilot study, 25 mg/L of monensin sodium salt solution was made in methanol and 20 mL added to 1 g of each soil, to make a final concentration of 500 µg/g. Controls were also made with no analyte. Each sample had 3 replicates.
- Samples were shaken for 24 hours, and centrifuged at 10,000 Xg for 15 mins.
- The supernatant was transferred to vials, to be measured on the HPLC-MS/MS.

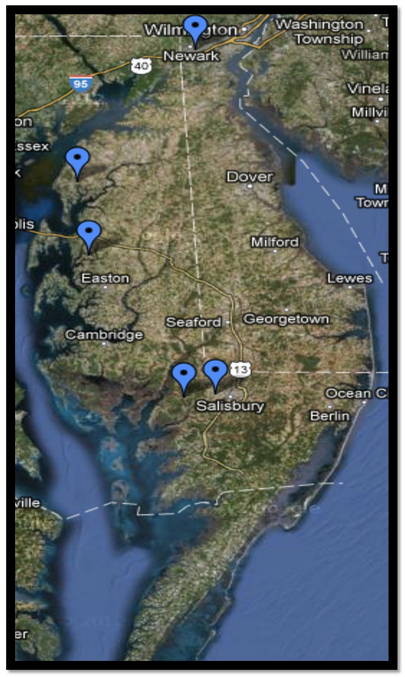


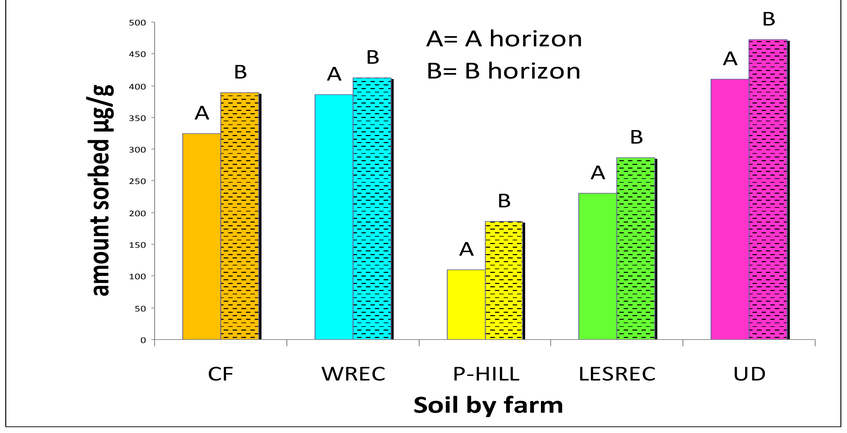
Figure 1. Five farms were sampled across the Delmarva Peninsula in order to represent common soil textures.

Figure 2. A hydraulic Gidding's probe was used to collect soil samples from the A and B horizons.

Table 1. Soil characteristics.

Farm	Horizon	Map Unit	pHw	CEC meq $100g^{-1}$	Silt	Sand	Clay	OM
					----------%----------			
CF	A	Sassafras sandy loam	4.9	7.9	21.3	68.4	10.2	1.2
	B		4.5	6.8	25.2	58.2	16.5	0.4
WREC	A	Nassawango silt loam	5.8	10.2	70.5	16.2	13.3	1.2
	B		4.9	12.7	68.2	13.7	18.1	0.5
P-HILL	A	Evesboro sand	5.5	3.9	5.1	90.5	4.9	0.8
	B		5.1	3.6	11.2	82.5	6.3	0.3
LESREC	A	Fort Mott loamy sand	6.2	5.4	12.0	82.3	5.8	1.5
	B		5.4	3.2	11.6	79.7	8.7	0.5
UD	A	Mattapex silt loam	6.1	9.2	63.1	22.6	14.3	2.4
	B		4.8	8.6	59.3	15.4	25.4	0.6

Figure 4. Monensin sorption in A and B horizons



MATERIALS AND METHODS (Cont.)

HPLC tandem Triple quad MS/MS

- Multiple reaction monitoring mode with positive electro-spray ionization used. Stable erythromycin isotope and Nigericin ionophores, were used as internal standard and surrogate to account for sample loss during experiment.
- 0.1% aq. formic acid and pure HPLC grade acetonitrile mobile phases.
- Chromatographic runs were isocratic, total runtime 10 mins.
- Chromatogram of Monensin from batch equilibrium study of soil samples have been presented below in Fig 3.

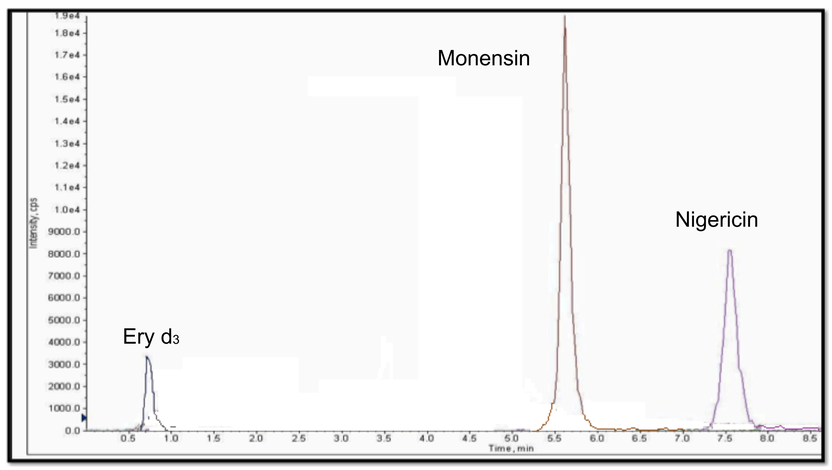


Figure 3. Chromatogram of Monensin from batch equilibrium study of soil sample.

RESULTS AND DISCUSSION

- Monensin sorption was found to vary with soil texture and type as illustrated in Fig. 4. Sorption tended to decrease with increasing sand content and decreasing silt, clay, or organic matter content.
- As pKa of Monensin is ~ 6.5 and our soil samples had pH below that, Monensin is expected to be in protonated form, sorbing more to negatively charged clay and organic matter.
- B horizons in general had more sorption capacity than A horizon.

FUTURE WORK

- Planning a series of batch sorption – desorption studies to include a range of Monensin concentrations and more soil textures
  - ✓ Soils will be irradiated and made sterile, to remove microbial degradation, that could have affected the mass balance, especially in lower concentrations of Monensin
  - ✓ pH of the soil will be varied, to study the effect of pH on sorption
  - ✓ Desorption study will follow sorption study to see if hysteresis occurs

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