Arsenic in soils from poultry litter application

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Introduction

The use of organoarsenicals in poultry feed additives has raised a concern about air, water and soil quality in regions of poultry production. This study examined the impact of poultry litter application on the distribution of As and other trace elements in soils. Soils from fields with varying litter applications in the Shenandoah Valley, Virginia, a region of intense poultry production, were collected, digested and analyzed for trace elements of interest. Data were statistically analyzed to examine relationships between litter application rates and trace element concentrations.

Methods

Sixteen cores were collected from the Frederick series, a well-drained silt loam. Sites were selected to represent soils with different histories of litter use: no litter use (control), and low, moderate and high litter use. The three litter amended sites had the following estimated litter application rates: 1.5 tons/acre/year (low), 3 tons/acre/year (moderate) and 6 tons/acre/year (high). At each site, four locations were chosen randomly for soil core collection. Soils in 15 cm increments were collected the surface to 120 cm depth. A total of 128 soil samples were collected for analysis. Soil samples were dried and ground, measured for particle size, organic matter and pH. Subsamples were digested for both Mehlich-extractable elements and acid-extractable elements (As, P, K, Ca, Mg, Zn, Cu, Fe). Statistical analysis was conducted on the dataset using several techniques, including correlation analysis, 1-way ANOVA comparison of means, and principal component analysis using JMP.

Results and Conclusions

Statistical analysis revealed that As does not concentrate in litter-amended soils, in contrast to litter-derived species P, Cu and Zn. While P, Cu, and Zn concentrations decrease with depth in the soil profile, As concentrations increase with depth in all soils and are correlated with iron and clay content, suggesting that As is adsorbed to iron oxides and clays, even in control soils that have not received litter application. At the highest litter application rate (20,000 kg/hectare/year; equivalent to 6 tons/acre/year), an As litter concentration of 40 mg/kg, a soil density of 1.6 m^3/kg, and a 30 year period of litter application, As concentrations in the top 20 cm of litter-amended soil are predicted to be only 4.5 mg/kg above background concentrations, assuming conservative behavior. This low level of As may be difficult to detect, especially in heterogeneous soils. Transport of As in due to competitive desorption by phosphate and DOC, complexation, or adsorption onto mobile particles may also contribute to the lack of observed accumulation of As in soils.

Growth of *Streptomyces mirabilis* P16B1 in heavy metal contaminated soil and impact to Soil Organic Matter formation

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It has been shown that streptomycetes are a dominant group of bacteria in heavy metal contaminated soil and that growth of soil bacteria had positive effects on bioremediation, on bioavailability of metals in soil and on biogeochemical cycles.

The former uranium mining site Wismut in Eastern Thuringia, Germany, shows extreme environmental conditions such as scant nutrients, intense salt load and low pH, followed by high metal content. Such habitats only can be colonized by microbes which are adequately adapted. Actinobacteria isolated from this hostile environment show high resistances against a range of heavy metals like nickel, cobalt, cadmium or zinc. Growth of *Streptomyces mirabilis* P16B1 was investigated in mesocosms of contaminated soil from the especially nickel and zinc contaminated sample sites K7 (WISMUT area Ronneburg, Germany). As control uncontaminated soil PaO (paradise parc Jena, Germany) was used. Heavy metal sensitive *S. lividans* TK24 was used as control in both types of soil as well as dead biomass from both used strains. This experiment gave insight in growth and contribution to soil organic matter (SOM) formation of the strain, as well as its impact to heavy metal availability. Scanning electron microscopy and XRD analysis were used to detect the mycelium, spore production, as well as dead bacterial biomass and its attachment to soil particles as patchy fragments. The metal content of soil from the samples was determined by SE methods and MS. Superoxide-dismutase (SOD)-production of *S. mirabilis* P16B1 under natural conditions was detected via native PAGE and qualitative SOD-staining as well as quantitative Assay with extracted protein. Auxine production and siderophore production were measure via MS.

It could be shown that inoculation with the strain has an effect of SOM formation in soil, as well as heavy metal availability in mobile and specifically adsorbed fraction. Due to Fenton reaction and elevated concentration of heavy metals SOD expression could be seen as an important resistance factor of strains. Auxine and siderophore production by streptomycetes could be shown directly in soil. Thereby application of extremely heavy metal resistant strains from WISMUT area for microbial enhanced phytoremediation could be recommended.