Exploring organic P in sequentially-extracted hydrochloric acid fractions of soil and animal manure

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Abstract
Hedley et al. (1982) sequential fractionation has been widely used for investigating the forms and transformations of soil P under various environmental conditions. Where this approach considers both inorganic and organic P (difference between total P and inorganic P) to exist in water, NaHCO3 and NaOH fractions, inorganic P is assumed to only exist in the HCl fraction. In this study, we determined the concentrations of inorganic P, enzymatically hydrolyzable organic P, and total P of sequentially-extracted 1 M HCl fractions in 15 soils and 8 animal manures to evaluate the validity to categorically excluding organic P components in 1 M HCl fractions in the Hedley sequential fractionation method. Our data indicate that whereas some samples did contain zero to negligible amounts of organic P in HCl fractions, other samples contained significant quantities of organic P. The concentrations of organic P were even greater than those of inorganic P in one soil and two manures. Determination and monitoring of HCl extractable organic P species with other sequentially extracted P forms may provide insight into the fate and interconversion of P species in soil and animal manure.

Materials and Methods
Soil samples were obtained from Alabama, Maine, and Oregon. Two swine (Sus scrofa) manure, cattle (Bos taurus) manures, and four poultry litters were collected from farms in Maine and Alabama. Each sample was sequentially extracted with H2O, 0.5 M NaHCO3, 0.1 M NaOH and 1 M HCl. The pH of the filtered 1 M HCl fraction was adjusted to 2.5. Each 0.45 mL of pH-adjusted and properly-diluted extract was mixed with 0.5 mL of deionized water (control) or 0.5 mL of Aspergillus fumigatus 3-phosphate solution (final concentration 0.25 U activity/mL mixture). These mixtures were incubated on a rotating shaker (250 rpm) at 37 °C for 1 h. The Pt concentration in the control was designated as inorganic P. Enzymatically hydrolyzable organic P was calculated as the increase of Pt after 3-phosphate incubation. Total P was determined in the same way after persulfate digestion of diluted extracts.

Purpose
This research was conducted to clarify the ambiguity of whether organic P should be categorically excluded from the sequentially extracted HCl fractions.

Conclusions
Our data indicated that whereas some samples contained negligible amounts of organic P in HCl fractions, other samples contained significant amounts of organic P. The concentrations of organic P were even greater than those of inorganic P in a soil and two manure samples. Thus, we believe that results and findings would be more definitive if the significance/insignificance of organic P in the HCl fractions were experimentally determined. Alleviating this methodological misconception would allow researchers to more accurately investigate the P compositions within the Hedley sequential fractionation method, thus gaining novel insights into the fate and transformation of P species in soil and animal manure under various environmental conditions.

References

Modified Hedley sequential fractionation procedure

As shown above, this approach assumed that only Pt exists in the HCl fraction. This assumption has been widely accepted, leading many researchers to measure only P in the HCl fraction and disregarding the possibility that organic P might also be present in HCl extracts.

P detected in 1 M HCl extracts of Alabama soils

Detectable levels of inorganic P and total P were not observed in the HCl fraction of the pastoral Haustell soil without poultry litter application. Higher concentrations of P were detected in the HCl fractions of the soil with a 15-y and 20-y poultry litter application. Enzymatic incubation and autoclaving increased P concentrations in these samples, in addition to inorganic P. There were also organic P forms in the HCl fractions of these soils.

The 1 M HCl extracts from the Decatur soils under no-tilled cropping managements contained inorganic P only. However, enzymatically hydrolyzable organic P species were observed in soils with conventional tilled cropping managements.

P detected in 1 M HCl extracts of Maine and Oregon Soils

P detected in 1 M HCl extracts of animal manures

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