

# The Adsorptive Interactions between Phenolic and Amino Acids by Forming MOAs

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## DESCRIPTION

Phenolic (PAs) and Amino Acids (AAs) contribute to the stabilization of Organic Matter (OM) in soil by forming Mineral-Organic Associations (MOAs). However, less knowledge is known about how natural OM coating affects the adsorption of those compounds and their mutual interaction upon adsorption. Therefore, adsorption experiments were executed to check how coatings of minerals with Dissolved Organic Matter (DOM) obtained from forest leaf litter (L-DOM) and from the O horizon (O-DOM) have an effect on the adsorption of phenolic acids (salicylic, syringic, ferulic and vanillic acid) and amino acids (lysine, glutamic acid, leucine and phenylalanine) at pH 6. Moreover, the adsorption of PAs on OM-coated minerals was tested once preconditioned by AAs.

Adsorption of DOM is based on the mineral (goethite >> kaolinite > montmorillonite) and sources of DOM (O-DOM > L-DOM for goethite). Coatings of all minerals with each DOM sources reduced the adsorption of PAs and also the acidic glutamic acid however increased that of the fundamental essential amino acid i.e. lysine. The adsorption of PAs weakened with increasing OM coating of the minerals. Strong bonds between AAs and OM-coated minerals usually increased the adsorption of PAs with preconditioning by AAs. This indirectly indicates a multilayer model of MOA. Adsorption of AAs, however, was seldom influenced by preconditioning with PAs [1]. Competition between AAs and PAs usually suppressed the adsorption of AAs on coated minerals, whereas the PAs were hardly affected. These results emphasize that the quantity and composition of OM coating should be thought of once finding out the adsorption of PAs and AAs in soil.

The degradation products of lignin and proteins, PAs and AAs, severally, are active components within the cycling of C and N in soil. So far, data regarding the adsorption patterns of aromatic and nitrogenous compounds together with PAs and AAs on soil samples or model soil minerals have been obtained either in mono-component systems or by the changes within the composition of Dissolved Organic Matter (DOM) following adsorption [2]. The outcome of interactions between PAs and

AAs throughout adsorption for the formation of MOAs has seldom been studied, yet they're crucial for assessing the validity of the multilayer adsorption model. They are often expected that these interactions between PAs and AAs won't solely be suffering from the nature of the mineral surfaces (e.g. oxides with variable charge versus seldom charged 1:1 clay minerals versus permanently charged 2:1 clay minerals), but also by the surface adsorption of natural OM.

Adsorption of DOM depends on its composition, and also the DOM derived from decomposed OM which has larger adsorption than that from fresh litter. Adsorption of OM will modify the surface properties of soil minerals, like specific area, surface charge and hydrophilicity. Such changes in surface properties are vital for DOM cycling as a result of the modified qualitatively and quantitatively the adsorption and stabilization capability of the mineral part. However, the results of those changes on the adsorption of PAs and AAs are not understood [3].

Therefore, the objective of our study was to clarify how the coating of mineral surfaces with OM affects adsorptive interactions between PAs and AAs. Iron ore ( $\alpha$ -FeOOH), mineral and montmorillonite were chosen as model minerals, representing the most vital fine-sized minerals in several soils (Fe oxides, and 1:1 and 2:1 clay minerals, respectively). These minerals have totally different surface properties: iron ore, variable charge; mineral, very little isomorphous substitution; montmorillonite, rich isomorphous substitution and permanent negative charge. We tend to study (i) the adsorption behaviour of various AAs (glutamic acid, leucine, lysine, representing acidic, neutral, basic and aromatic AAs, respectively) and PAs (salicylic, syringic, ferulic and vanillic acids, representing lignin degradation products) on minerals coated with OM, (ii) changes within the adsorption behaviour of PAs on OM-coated minerals once surface acquisition by AAs, (iii) changes within the adsorption behaviour of AAs on OM-coated minerals once surface acquisition by PAs and (iv) the competition effects between PAs and AAs on their adsorption on OM-coated minerals. Herein, 'coating' and its derivatives refer to the adsorption of DOM on minerals; 'conditioning' and its

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derivatives discuss the adsorption of PAs and AAs on pure and OM-coated minerals.

The adsorption of natural DOM on soil minerals depended mostly on both the charge characteristics of mineral surfaces and also the composition of natural DOM. Organic matter coatings on mineral surfaces had a marked influence on the surface charge properties and on the adsorption of PAs and AAs [4]. Coating of various kinds of mineral surfaces (goethite, mineral and montmorillonite) by natural DOM systematically increased their negative charges and consequently altered the adsorption of PAs and AAs, promoting adsorption of basic AAs and suppressing the PAs and acidic AAs underneath slightly acidic conditions. Binding sites on metal oxides however occupied by OM (positive charges) were significantly important for adsorption of PAs and acidic AAs, whereas the retention of basic AAs depended strongly on the number of negative charges of clay minerals, which might be increased additionally by adsorption of DOM.

The binding of basic AAs like Lys was significantly strong on OM-coated mineral surfaces. These stable bonds of adsorbate Lys on OM-coated mineral surfaces resulted in increased adsorption of PAs, so providing indirect evidence for the multilayer model [5]. Coating mineral surfaces with DOM changes the competition between totally different organic elements and also the additional competitive strength of AAs

disappears. The amount and composition of OM coatings on mineral surfaces were quantitatively more vital for the adsorption of PAs and AAs than the competition between single molecules or effects of surface conditioning by the opposite category of compounds. Future studies should concentrate on evidence of the formation of a multilayer structure and also the functions of specific compound categories using molecular chemical analysis (e.g. infrared or X-ray electron spectroscopy) and modelling approaches (molecular dynamics).

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