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Effects of Humic Substances on Transport of Petroleum Hydrocarbons from Soils to Vegetables

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Extended Abstract

Petroleum hydrocarbons (PHs) mainly consist of aliphatic hydrocarbons (AHs) and polycyclic aromatic hydrocarbons (PAHs), whose concentrations are enhanced in soils resulted from various human activities [1]. Various pathways of transport of organic contaminants from soils to plants were discussed in previous studies, including passive absorption, plant transpiration, and reactions with root lipid content [2,3]. Moreover, soil organic matter (SOM), main components in soils, preferentially adsorbed the lipophilic organic contaminants like PHs, which have important effects on behaviors of PHs in soils [4-7]. Most previous studies studied the effects of SOM on behaviors of the contaminants by removing the endogenetic soil humus fractions or adding exogenous soil humus fractions [5,7,8]. However, these methods changed the soil internal structure and soil endogenetic fractions. A mild and successive extraction method has been suggested by Doick et al., [6] and He et al. [9], which can provide more information about the influencing mechanisms of various soil humus fractions on in-situ distributions of organic contaminants. Therefore, in this study, AHs and PAHs that bind to endogenetic soil humus using successive extraction methods, soil basic properties, as well as AHs and PAHs in *Brassica chinensis* (*B. chinensis*) were comprehensively studied. The relationships between PHs in *B. chinensis*, PHs in soils and soil basic properties were built using multivariate analysis methods. Finally, the possible mechanisms of PHs taken up by leafy vegetables from soils were figured out. The results showed that the 3-benzenering PAHs (low molecular weight PAHs) were dominant in *B. chinensis*. Moreover, significant positive correlations were found between 3-ring PAHs in *B. chinensis* and soil moisture/3-ring PAHs that bind to fulvic acids (FA) in soils. FA can increase mobility and solubility of lipophilic organic contaminants in soils because they possess many acidic functional groups that increase their solubility at any pH [4,5,10]. We also found FA preferentially adsorbed 3-benzene ring PAHs. Therefore, we concluded that FA facilitates uptake of the 3-benzene ring PAHs by *B. chinensis* together with water and nutrients. On the contrary, AHs from C_{21} to C_{34}, so called high molecular weight AHs (HMWAHs), was dominant in soils and *B. chinensis*. Most of the HMWAHs in soils were adsorbed onto/into soil humic acids (HA), which possess characteristics of high aliphatic content, high hydrophobicity, and high molecular weight by forming associations linked by H-bonds and hydrophobic inter-actions [11]. Adsorption of HMWAHs on HA can further reduce mobility and solubility of HMWAHs and enhance their retention in the top soil layers [5]. At the same time, HMWAHs in *B. chinensis* were found positively correlated with fine soil particles (clay and silt), whereas they were negatively correlated with coarse particles (sand). Therefore, we concluded that HMWAHs associated with fine topsoil particles could be transported to *B. chinensis* via the soil-air-plant pathway, including re-suspension by either wind, rain, or artificial disturbance, and then aboveground plant cuticle capture. There are different mechanisms of PAHs and AHs taken up by leafy vegetables from soils and thus different measures should be taken to control different components of PHs from petroleum contaminated soils.

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