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Soil humic substances hinder the propagation of prions

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Prions are infectious pathogens causing fatal neurodegenerative disorders, known as transmissible spongiform encephalopathies (TSEs), or prion diseases, which affect different mammalian species. TSEs include scrapie in sheep, bovine spongiform encephalopathy (BSE) in cattle, chronic wasting disease (CWD) in mule deer, elk, and moose (cervids), and Creutzfeldt-Jakob disease (CJD) in humans. The prominent, if not only, component of prions is a misfolded conformer (PrPSc) of a constitutive sialoglycoprotein, the cellular prion protein (PrPC).
A notable feature of prion diseases is horizontal transmission between grazing animals, implying that contaminated soil may serve to propagate the disease. In this respect, it has been reported that grazing animals ingest from tens to hundreds grams of soil per day, either incidentally through the diet, or deliberately in answering salt needs, and that mule deer can develop CWD after grazing in locations that previously housed infected animals. Prions may enter the environment through different routes, including animal excreta and secreta which mainly contribute to soil contamination.
Recent studies have proven that prions can be retained in soil, which could act as a carrier of infectivity even several years after the contamination. However, within the large spread of potentially infected lands, prion diseases have become endemic only in geographically limited regions. The reasons for this geographical distribution remain unknown, but it suggests a role of the different kinds of soil in either enhancing or attenuating prion infectivity.
The extent of prion transmission from the contaminated environment is unknown. Several studies have tried to address the issue of prion interaction with soil, but, at the present, different approaches show several drawbacks and technical difficulties, as soil is a complex, multi-component system of both mineral and organic interacting substances. Most research has focused on the adsorption capacity of clay minerals; however the contribution of soil organic components in adsorption has so far been neglected, as they represent a minor soil fraction on a weight basis.
Among organic molecules, humic substances (HSs) are natural polyanions that result among the most reactive compounds in the soil and possess the largest specific surface area. Humic substances make up a large portion of the dark matter in humus and consist of heterogeneous mixtures of transformed biomolecules exhibiting a supramolecular structure. HSs are classified as humic acids (HAs), which are soluble only in alkaline solutions, and fulvic acids (FAs), which are soluble in both alkaline and acid solutions. The amphiphilic characteristics confer to HAs and FAs great versatility to interact with xenobiotics and reasonably also with prion proteins and/or prions too, leading to the formation of adducts with peculiar chemical and biophysical characteristics, thus affecting the transport, fixation and toxicity of prion.
Results from our chemical, biophysical and biochemical investigation will be presented and results on anti-prion activity exerted by HAs and FAs will be provided, thus suggesting that amendment of contaminated soil with humic substances could be a strategy to contrast prion diffusion.