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Interaction between a recombinant prion protein and organo-mineral complexes as evidenced by CPMAS 13C-NMR

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Prion proteins (PrP) are the main responsible for Transmissible Spongiform Encephalopathies (TSE). The TSE etiological agent is a misfolded form of the normal cellular prion protein. The amyloidal aggregates accumulated in the brain of infected animals and mainly composed of PrPSc exhibit resistance to protease attack and many conventional inactivating procedures.

The prion protein diseases cause an environmental issue because the environment and in particular the soil compartment can be contaminated and then become a potential reservoir and diffuser of TSEs infectivity as a consequence of (i) accidental dispersion from storage plants of meat and bone meal, (ii) incorporation of contaminated material in fertilizers, (iii) possible natural contamination of pasture soils by grazing herds, and (v) burial of carcasses.

The environmental problem can be even more relevant because very low amounts of PrPSc are able to propagate the disease. Several studies evidenced that infectious prion protein remains active in soils for years. Contaminated soils result, thus, a possible critical route of TSE transmission in wild animals.

Soil can also protect prion protein toward degradation processes due to the presence of humic substances and inorganic components such as clays. Mineral and organic colloids and the more common association between clay minerals and humic substances can contribute to the adsorption/entrapment of molecules and macromolecules. The polymerization of organic monomeric humic precursors occurring in soil in the presence of oxidative enzymes or manganese and iron oxides, is considered one of the most important processes contributing to the formation of humic substances. The process is very fast and produces a population of polymeric products of different molecular structures, sizes, shapes and complexity. Other molecules and possibly biomacromolecules such as proteins may be involved.

The aim of the present work was to study by CPMAS 13C-NMR the interactions between a non pathogenic ovine recombinant prion protein and a model soil system represented by a manganese oxide in the form of birnessite (-MnO2), coated with a polymerized catechol. To better understand the effect of the polymerization process, PrP was added to the birnessite-cathecol system either before or after the polymerization processes.

The NMR spectra of the prion protein interacting directly with birnessite revealed disappearance of the signals due to the paramagnetic nature of manganese oxide or abiotic degradation. Conversely, the signal pattern of the protein re-appeared as it is mixed to the soil-like system either during or after the catechol polymerization process. Results suggested that the possible interactions of the prion protein on soil systems can be mediated by natural organic matter. However, deeper studies on more complex real soil systems are needed to definitely confirm such hypothesis.