

SUMMARY OF FINDINGS

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Occurrence and fate of pharmaceuticals and personal care products within sewage sludge and sludge-enriched soils

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The potential threat of pharmaceuticals and personal care products (PPCPs) to the environment has emerged as a topic of concern in recent years. To date, there exists a dearth of analytical methods to empirically determine their occurrence in solid media. This 3-year research and development project focused on a number of topics surrounding the exposure of pharmaceuticals to the terrestrial environment through land-spreading of municipal biosolids (sludges) on agricultural land. Specifically, the project entailed the development of laboratory-based analysis methods of sludge materials and receiving agricultural soils. Secondly, by using chemical analysis and computational modelling, the mobility and persistence of such compounds in the soil environment was examined.

Background

Pharmaceuticals and personal care products (PPCPs) have benefited our society as a whole by enhancing both the quality and length of life. Compounds included within this classification are those used either for human or veterinary health reasons. They are categorised predominantly based on their specific biological activity and comprise a diverse range of chemical structures, modes of action and therapeutic classes deriving from over-the-counter or prescribed medications and cosmetics.

According to the Industrial Development Agency (IDA), the pharmaceutical sector in 2008 was one of the most significant contributors to the Irish economy with over € 29.7 billion in exports (~40 % of total manufacturing exports), 17,000 in direct employment and the largest payer of corporation tax. Over 6,000 human and over the counter and 1,000 veterinary medicinal products are currently authorised for sale in Ireland.

Key Points

- Highly sensitive laboratory-based analytical methods were developed and applied to the determination of 61 pharmaceutical residues in digested sludge, dried biosolid fertiliser and soils.
- Residues identified in digested sludge from Ireland were carbamazepine (antipsychotic agent), warfarin (anticoagulant) and triclosan (antibacterial agent). Analysis of the dried biosolid fertiliser showed levels of carbamazepine and triclosan and soils revealed levels of triclosan and nimesulide (a non-steroidal anti-inflammatory drug)
- An inter-laboratory comparison of Irish digested sludges with Scandinavian sludges showed fewer occurrences in Irish sludge overall.
- It was found that the thermal drying process for the production of pellicular biosolid fertiliser had a reductive effect on the observed PPCP levels, but that the antibacterial agent triclosan, was still observed at relatively high concentrations and detectable in soil 3-4 months after sludge spreading.
- Some PPCPs were found to be far more likely to partition into sludge than others (in particular, the antidepressants) leading to a possible “concentration” effect.
- When digested sludges from Irish wastewater treatment facilities were applied to soil, some PPCPs were present more in topsoils even after an extended period of time and ~6 months average rainfall. These included some antibiotics.
- A study into the persistence of drugs retained by soil indicated a significant degree of chemical or biological transformation, but the mechanisms involved and the overall effect on biodiversity and resistance still needs to be determined.
- This work has resulted in 4 peer reviewed publications in high impact scientific journals. Additionally, 17 conference papers were presented since 2006 at high-profile science meetings in Ireland, UK, Sweden, Spain, Austria, Australia, France, Belgium and Norway.

Concluding Remarks

It is clear from the results generated during this project that PPCPs are indeed present in the solid environment and their ecotoxicological effects need to be further addressed.

Chemical analysis in this area still proves to be very challenging, primarily due to the complexity of sludge. Those PPCPs with a high affinity for soils should be considered more as a possible threat to the soil environment in particular. Overall, this work has highlighted that emerging pollutants such as PPCPs warrant much further study, particularly with relation to altered potencies as a result of a complex “cocktail” of PPCP exposure arising from sludge. Chemical analysis still constitutes the only unambiguous means to measure bioavailability of such compounds in the environment. There still is no concrete conclusion as to the threat of pharmaceuticals to the environment, but more focus should be certainly placed on the analysis of solid materials.

For Further Information

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The full report:

‘Occurrence and fate of pharmaceuticals and personal care products within sewage sludge and sludge-enriched soils’ by Dr. Leon Barron (DCU), Ms. Martha Purcell (DCU), Prof. Josef Havel (MSU), Dr. Kevin Thomas (NIVA), Dr. John Tobin (DCU), Prof. Brett Paul (DCU) is published by the Environmental Protection Agency and is available from:

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