CAFOs and Hormones, Overview of ARS Research

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Related Activities on PPCPs

• USDA representative to Pharmaceutical in the Environment workgroup, PiE.
  – Identify topic areas and data needs to better assess human and ecological risk from human and veterinary pharmaceuticals in the environment.
  – Recommend areas for federal collaboration to address those priorities.
• Inventory of activities are compiled and a document is in preparation.
• CAFOs are an important contributor.
Background statements

• Clearly, CAFOs provide elevated releases of EDCs to the environment.

• An important USDA/ARS mission is to develop and evaluate methods for controlling these releases.

• Given the value of animal manure, ARS is committed to developing practices and technologies for safe use of manure w/o endangering public health and the environment.
Focus of research at ARS

• Methods to measure these compounds in complex media (manure, soil, water, air, etc.)
• Develop and evaluate new or existing manure management practices and control technologies to degrade EDCs and/or prevent their movement to water and food sources
• Document the effectiveness and environmental benefits of these practices and technologies
• To develop decision support tools to predict the fate and transport of EDCs.
On-farm treatment options for controlling EDCs.

- Composting (ND- & MD-ARS)
- Minimal management – Manure Piling-(CA-ARS, others)
Windrow Composting

Poultry Litter from a commercial egg-laying operation in Pennsylvania was composted at the ARS Beltsville compost facility to produce soil amendment.
Composting Study

- Inputs (by volume) included:
  - Poultry layer manure: 3.3 parts
  - Hay, 2 parts
  - Straw: 2 parts
  - Leaves: 4 parts
  - Starter Compost: 2 parts

- Handling
  - Moisture initially: 60%
  - Compost duration: 12 weeks
  - Windrows turned weekly for weeks 2-6; bi-weekly for weeks 8-12.

- Immunoassay Kits for estradiol and testosterone testing.

J. Environ. Qual. 34:943-950 (2005)
Mean natural logarithm (ln) of the concentration of water-extractable 17β-estradiol and degradation rate constant.
Composting results for estradiol and testosterone in poultry waste.

- Half-life estimates for \(17\beta\)-estradiol and testosterone in compost were 69 d and 46 d, respectively.

- An 84 and 90% reduction, respectively for \(17\beta\)-estradiol and testosterone over 139 days.
Swine Farrowing Facility, North Carolina A & T University

Open Wetland 1 (lft) Covered Wetland 2 & 3 (rt)
Storage Pond (lft)
Lagoon 1 (Rt)
Lagoon 2 (bhd 1)

Covered Wetland 3 and 4 looking towards storage pond
Wastewater Composition: Lagoon Thru Wetlands

November 2004

- E₂ Eq
- TKN
- PO₄
- Cl

- Lagoon 1
- Inlet Wetland Open
- Inlet Wetland Cov.
- Outlet Wetland Open
- Outlet Wetland Cov.

mg/l, pM E₂ Equivalents
Wetland Water Composition
LC MS-MS

November 2004

- Estradiol
- Estriol
- Estrone

pMolar

Inlet Wetland
Open
Inlet Wetland
Cov.
Outlet
Wetland
Open
Outlet
Wetland
Cov.
Findings, Lagoon/Wetland Study

- Estrogenic activity of swine wastewater was greatly reduced by the lagoon/constructed wetland system.
- TKN was reduced by the wetland system -- but to a lesser extent than estrogenic activity (60-75 % vs 83-93%).
- There was good agreement between E2 Equivalents obtained by E-Screen and LC MS-MS.
- Estrone was identified as the most persistent estrogenic compound.
- Estradiol equivalents released from the wetlands were always below the Lowest Observed Effect Concentration for estradiol.
**Minimal Management - Manure Piling**

<table>
<thead>
<tr>
<th>compounds</th>
<th>fresh manure (µg/kg)</th>
<th>piled manure (µg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>17α -estradiol</td>
<td>1415.5 ± 103.6</td>
<td>171.8 ± 8.9</td>
</tr>
<tr>
<td>17β -estradiol</td>
<td>153.1 ± 25.2</td>
<td>36.7 ± 2.9</td>
</tr>
<tr>
<td>estriol</td>
<td>N.D.</td>
<td>N.D.</td>
</tr>
<tr>
<td>estrone</td>
<td>534.7 ± 61.6</td>
<td>696.8 ± 82.2</td>
</tr>
<tr>
<td>progesterone</td>
<td>&lt; LOQ</td>
<td>195.6 ± 36.6</td>
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<tr>
<td>total</td>
<td>2103.3 ± 123.1</td>
<td>1100.9 ± 93.2</td>
</tr>
</tbody>
</table>

Zheng et al., (submitted)
ARS Fate studies

- Ferrate treatment of dairy lagoon hormone wastes (MD-ARS) - Rice and others, in press.
- BMP validation studies on Choptank watershed. Hormone monitoring (MD-ARS, NOAA) - Rice and others, in press.
- Poultry litter, surface runoff studies, pathogen and hormones. (Watkinsville, GA- NRCS) -Jenkins and others, 2005.
ARS, other EDCs

• Alkylphenols
  – Nonylphenol (NP) and NP-ethoxylates in effluent-dominated streams. Fish, ongoing