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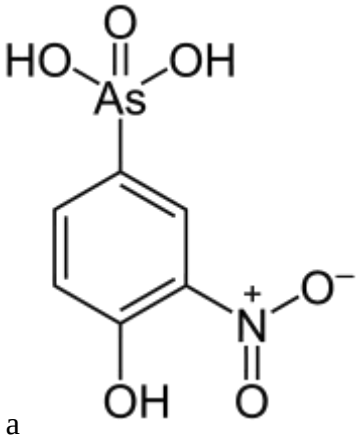
Fact Sheet FS-947
2012

The Environmental Concerns of Arsenic Additives in Poultry Litter

And the Maryland Ban on Arsenic Additives in Poultry Feed



Roxarsone

On May 22, 2012 Maryland Governor Martin O'Malley signed a bill into law to ban the use of arsenic additives in poultry feed. This is the first such ban passed in the United States.

The Maryland State Legislature, through the Harry R. Hughes Center for Agro-Ecology, Inc., requested researchers from the University of Maryland to conduct a literature review on the Environmental Concerns of Arsenic Additives in Poultry Litter. This review proved useful to the legislators in their discussions on banning the use of arsenic in poultry feed. A short summary of the findings of the 43 page review are presented below.

An important point to remember when reading this Fact Sheet is that organic arsenical compounds contain carbon and arsenic (e.g., Roxarsone) while inorganic arsenic compounds contains no carbon (e.g., elemental arsenic). The chemical term organic as used in this Fact Sheet has nothing to do with the term organic as used to infer healthful, environmentally friendly food production.

Major findings of a recent literature review by Fisher et al., 2011 on the Environmental Concerns of Arsenic Additives in Poultry Litter (http://agroecol.umd.edu/Arsenic%20Report.cfm).

- Litter produced by chickens fed roxarsone amended food contains total arsenic concentrations ranging from 2.9 to 77 mg/kg. Litter from chicken fed food not amended with roxarsone contains only trace levels of arsenic (< 1 mg/kg).

- Fresh poultry litter produced by chickens fed roxarsone contains predominately organic roxarsone. **Aged litter contains predominately inorganic arsenic (As(III) and As(V))** which is of greatest concern because it is a known human carcinogen and has been implicated in other adverse health consequences including cardiovascular disease, type 2 diabetes, neurocognitive deficits, adverse birth outcomes, and endocrine disruption.

- Roxarsone converts rapidly to inorganic arsenic both within litter piles as well as after field application as fertilizer. This conversion is mediated through bacteria and through photolysis. Very little arsenic from poultry litter remains as organic roxarsone after introduction to the environment.

- Inorganic arsenic accumulates in soils once applied in poultry litter compared to control soils receiving no litter. On the Delmarva Peninsula, some areas that have received poultry litter for decades have accumulated soil arsenic concentrations above both the Maryland (3.6 mg/kg) and Delaware (11 mg/kg) soil arsenic background remediation standards.
    - Some researchers indicate that the use of arsenic as a feed additive is **not a sustainable practice** since arsenic concentrations continue to accumulate over time and soil levels will eventually increase to concentrations above these background remediation standards.

- Based on current information, surface applied roxarsone has no influence on deeper drinking water arsenic concentrations on the Delmarva Peninsula because, once applied to soils, arsenic binds tightly and does not leach to these deeper aquifers.
    - In some areas in Southern Maryland and on the Delmarva Peninsula, deep drinking water aquifers are contaminated with arsenic at levels above the current drinking water standard (10µg/L) but this appears to be from geological (i.e., natural) sources of arsenic.

- Once applied to fields in poultry litter, arsenic can be transported as runoff into receiving waters after rain events, **predominately as inorganic arsenic**. A recent study in the agriculturally dominated Pocomoke, MD watershed also indicated transport of arsenic from very shallow groundwater (10 ft.) to nearby receiving streams.
    - Concentrations of arsenic in field ditches and receiving streams were **not above water quality criteria for the protection of aquatic life** but sometimes **exceeded criteria for the protection of human health for fish consumption.** These human health criteria assume that the arsenic is being accumulated by fish, that the arsenic is in a toxic form, and that people are consuming the fish from these streams.

- The magnitude and number of criteria exceedances were dependent on the varied criteria employed by the different state and/or federal regulatory agencies; more stringent criteria resulted in more frequent and greater exceedances.
- Arsenic levels in aquatic sediments of the Pocomoke, MD watershed were above sediment screening criteria used by Delaware and the U.S. EPA but not above criteria set by Maryland. In contrast, an extensive sampling and toxicity study of sediments in the Inland Bays of Delaware indicated that sediment arsenic concentrations were **below levels of concern** for bottom dwelling organisms.

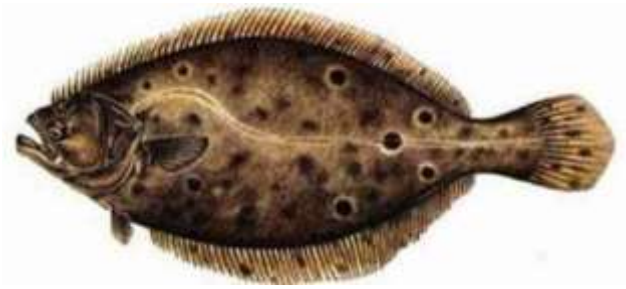
➢ Runoff from poultry litter containing 15.6 mg/kg total arsenic applied to no-till fields at the Wye Research and Education Center (WREC) in Queenstown, MD in 2011 contained 4.5 µg/L (±1.61 µg/L) total arsenic. The majority of arsenic (77%) in the runoff was inorganic As(V) while the rest was inorganic As(III).

Poultry litter prior to application on WREC no-till field

Run off from WREC poultry litter amended No-till field

➢ A recent study of aquatic life in the Inland Bays of Delaware indicated that arsenic in fish and shellfish was **largely organic** in nature. This is consistent with a large US EPA nationwide survey of freshwater lakes predator and bottom dwelling fish species. **Organic arsenic is much less toxic than inorganic arsenic and is less of a concern for human health**.

Hard Clam (*Mercenaria mercenaria*)



Summer flounder (*Paralichthys dentatus*)

A few of the species sampled in the Delaware Inland Bay arsenic study

- An arsenic reference soil background value of 3.6 mg/kg was recently established by the Maryland Department of the Environment for eastern Maryland. This value is consistent with other studies conducted on the Delmarva Peninsula in areas that have had no arsenic applied with poultry litter.

- Atmospheric deposition of arsenic is approximately 300 times less annually than application of arsenic in poultry litter.

- Biosolids from sewage treatment plants are also used as fertilizer on Maryland's Eastern Shore. In general, concentrations of arsenic in biosolids are less than concentrations in poultry litter. In addition, arsenic in biosolids appears to be more tightly bound and less water soluble than the arsenic in poultry litter.

- Arsenic and phosphorus have similar behavior in litter and soil. Arsenic in poultry litter is highly water soluble, creating potential for short-term losses with water moving across the soil where litter is surface applied, and movement downward through the soil profile immediately after poultry litter application. Although there is a wide range in binding capacity, most Maryland soils have a high capacity for binding arsenic and most applied arsenic soon becomes unavailable for leaching. Excessive soil phosphorus concentrations will reduce the ability of soil to retain both phosphorus and arsenic as binding capacity becomes saturated.

- Although most arsenic in surface soils is tightly bound, as surface soils become more enriched in arsenic and phosphorus, the potential for downward movement of both increases but the movement is generally limited in most soils due to the high capacity for binding of arsenic to clay minerals and oxides of iron and aluminum in subsoil horizons. However, since soil phosphorus and arsenic enrichment often has co-occurred on sites with a long history of poultry litter application, extremely enriched sites will have a greatly reduced potential for retaining arsenic. In these areas, additional applied arsenic can be lost through leaching to shallow ground water or runoff.

- Phosphorus based nutrient management will tend to limit the applications of any waste material that previously was applied at rates that over applied phosphorus relative to crop needs.
    - Rates of arsenic application and accumulation will tend to decrease in fields where poultry litter was formerly applied.
    - However, if the overall amount of arsenic in poultry litter remains constant, phosphorus based nutrient management will not change the total amount of arsenic applied to Maryland cropland.

- Biosolids phosphorus application as fertilizer is increasing as the population grows and more sewage is treated.
    - Arsenic to phosphorus ratios in biosolids tend to be lower than historic levels in poultry litter, although they can be highly variable.

- Decreasing phosphorus in poultry litter will tend to increase arsenic application rates if arsenic feeding practices remain the same.

- The most difficult issue faced today with determining the environmental effects of arsenic is related to the **levels of arsenic in soil and water that are thought to pose an environmental threat**. Currently there are varying criteria used by the states and the federal government (U.S. EPA) covering arsenic in soil, water and sediment so making judgments regarding what levels of arsenic are problematic depends on the chosen criteria.

- There is considerable ongoing debate on this topic but generally, the discussion seems to be moving toward a more restrictive approach to managing arsenic in the environment.

- It is important to note in this discussion that McDonald's does not sell chicken grown on feed containing arsenic, Perdue Farms, Inc. stopped using arsenic in poultry feed in 2007, and the European Union does not use arsenic in poultry feed.

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This publication, The Environmental Concerns of Arsenic (FS- 947), is a series of publications of the University of Maryland Extension and Environmental Science and Technology Department. The information presented has met UME peer review standards, including internal and external technical review. For more information on related publications and programs, visit: http://enst.umd.edu/. Please visit http://extension.umd.edu/ to find out more about Extension programs in Maryland.