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Review article

Hygienic and ecological risks connected with utilization of animal manures and biosolids in agriculture☆

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Abstract

In recent years the fate of human and animal pathogen microorganisms as a potential pollutant of the environment has been paid increased attention. Substantial quantities of these compounds and their metabolites are excreted, flushed down the drain, discarded as waste, or left over in animal feedlots. After passing to the sewer, several of these compounds are not adequately eliminated by the methods that are currently used in sewage treatment. Substantial quantities of biosolids and livestock manure end up on agricultural land. Effective sanitation of the environment, particularly of some of its special parts, which can be a source of spreading of diseases, plays an important role in prevention of infectious diseases. In this respect special attention should be paid to the disinfection of infected farm animal excrements. Sanitation of excrements should, on the one hand, ensure effective inhibition of infectious agents and, on the other hand, comply with the requirement of preserving the composition of the manure so it can be used in agricultural production.

Keywords: Biosolids; Pathogens; Wastewater treatment plant; Animal and human excrements

1. Introduction

Livestock manure has been spread on the land for many centuries not only for disposal but also as fertilizer. Before the advent of inorganic fertilizers, it was the principal source of plant nutrients added to the soil. Manure and other wastes of various agricultural animals often contain high concentrations of human pathogens. Moving manures from region to region represents a seemingly simple solution to the environmental problems of those areas with excess nutrients. However, this approach is fraught with problems based on the scale of the operation, nutrient monitoring and, in some cases, disease risks. The scale of the problem is mostly attributable to the

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volume of liquid slurry and requirements on its storage before it can be applied to the soil. The solid wastes (e.g. farmyard manure) could be beneficially used without problem on the farm or locally. Treatment has a clear role in the overall management package, but only some of the systems emerging are both practicable and effective at the farm level.

Land application of biosolids provides agricultural benefits and presents a cost-effective method of sludge disposal following wastewater treatment. However, reuse of this product presents health concerns that must be addressed and satisfied before land application becomes an accepted practice. Health concerns include pathogen transmission to food or agricultural workers, contamination of ground water or surface water with fecal material from field runoff, and build-up of heavy metals or organic contaminants.

2. Pathogens in animal manures and in biosolids

Manure pathogen levels depend on the source animal, the animal's state of health, and how the manure was stored or treated before use. Non-point (diffuse) sources of contamination by manure are pastured animals, roaming wild animals and leaching or runoff from agricultural areas. Point sources of manure contamination include animal feedlots, animal housing facilities, and manure storage areas, such as lagoons. Special attention should be paid to the pig slurry solids collected in the first stage of manure treatment plants on farms as they are used almost exclusively for agriculture purposes and require proper sanitation (Venglovsky et al., 2005). The point sources may also contribute to diffuse contamination of soil and water by manure (runoff or leaching).

Infected animals shed more than 30 causative agents of public health importance, and many of these are of special importance in faeces and wastewater. The use of faeces and wastewater in agriculture may result in public health risk only if all of the following prerequisites concur:

(a) if an infective dose of an excreted pathogen reaches the pond or a natural water body, or if the pathogen multiplies in an intermediate host residing in the pond or in the aquatic environment to form an infective dose;
(b) if this infective dose reaches a human host through contacts or consumption of the aquacultural products;
(c) if this host becomes infected;
(d) if this infection causes disease or further transmission.

A different group of pathogens are present in human wastes and in animal manures (Table 1).

2.1. Bacteria

Many pathogenic bacteria are present in animal manures. The bacterial pathogens most important with regard to human health include, for example, *Salmonella* sp., *E. coli* O157 H7, *Campylobacter jejuni*, *Yersinia enterocolitica* and *C. perfringens*. *Salmonella* are *Enterobacteriaceae* which are widely distributed in the environment and include more than 2000 serotypes. They are one of the most predominant pathogenic bacteria in wastewater and include serotypes that cause typhoid, paratyphoid fever and gastroenteritis. It has been estimated that 0.1% of the population excretes *Salmonella* at any given time. This pathogen produces an endotoxin that causes fever, nausea and diarrhea and may be fatal if not properly treated by antibiotics (Bitton, 1994). Serotypes implicated in food contamination are *S. paratyphi* and *S. typhimurium*. These serotypes can grow readily in contaminated foods and cause food poisoning (Cabadaj et al., 1995). Shiga-like-toxin-producing *Escherichia coli* strains are major foodborne bacterial pathogens that have been implicated in diarrhea, hemorrhagic colitis, and the hemolytic-uremic syndrome. Because *E. coli* is common in biosolids and has the potential for regrowth (Straub et al., 1993), it is important to assess its survival in biosolids.

2.2. Parasites

At the present, helminthic pathogens play a minor role in industrialised countries. Many helminths are, however, endemic in most tropical, less industrialised countries, and have, via waste-fed aquaculture, various potential transmission patterns. *Ascaris* (roundworms),