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EVALUATION OF TREATMENT PROCESSES FOR THE CONTROL OF PATHOGENS IN ORGANIC WASTES

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SUMMARY

Recycling to agricultural land is an important outlet for sewage sludge and other organic wastes but it must be controlled in order to obtain agricultural benefit from the operation whilst protecting human and animal health and the environment at large. Current practices in Europe are based on the requirements of the 1986 Directive on the use of sewage sludge in agriculture (86/278/EEC). Since that time new technologies have become available for sludge treatment, more pathogens associated with the foodchain have been identified and the concerns of the public relating to acceptable risk have changed. Treatment processes and controls on land use developed for sewage sludge are relevant also to other wastes recycled to land especially animal waste from intensive units. Farm animal waste has been identified as the main source in the environment of *Cryptosoridium* and *E.* coli O157.

IDENTITY OF PATHOGENS

A wide range of phyla, genera and species are likely to be present in sludges, particularly those that contain large amounts of faecal material.

There is little evidence to suggest the respiratory diseases may be transmitted by sludges, or that toxins may present a problem.

The identity of the pathogens and their numbers will be dependent upon the health of the contributing population.

Human or animal pathogens are unlikely to be present in sludge from vegetable processing, but plant pathogens may be present.

Pathogens are unlikely to be present in waste from paper processing or tannery waste.

PARAMETERS AFFECTING THE KILL OR INACTIVATION OF PATHOGENS

Thermophilic temperatures are lethal to pathogens if they are exposed for sufficient time such as: 7 minutes at 70°C; 30 minutes at 65°C; or 4 hours at 55°C in digesting conditions. However plant design constraints indicate that the minimum time for exposure should be 30 minutes.

At mesophilic temperatures the products of digestion e.g. fatty acids, enhance the lethal effect of temperature.

The effect of ambient temperatures on sludges which have been spread on land is dependent upon the local climate.

Thermal drying at temperatures in excess of 80°C with the final water content at less than 10% is an effective means of eliminating pathogens.

Generally simple drying is not an effective treatment, except in Mediterranean climates.

The use of quicklime to raise the pH to at least 12 and the temperature to at least 55°C for at least 2 hours will produce a hygienised sludge.

Irradiation has potential but probably is not acceptable.

TREATMENT NEEDS

The principle for defining the quality of treated sludge should be on the basis of risk to human, animal and plant life. The level of pathogens should not exceed the ambient levels in the environment. In practice this means for the purposes of quality control realistic limits of defined pathogens must be set.

Table 1. Summary of advanced treatments for organic waste.

Process	Parameters
Windrow composting	Batches of sludge (+/- bulking agent) to be kept at 55^0 C for 4 hours between each of 3 turnings, followed by a maturation period to complete the composting process.
Aerated pile and in-vessel composting	The batch to be kept at a minimum of 40^0 C for at least 5 days and for 4 hours during this period at a minimum of 55^0 C. This to be followed by a maturation period to complete the composting process.
Thermal drying	The sludge should be heated to at least 80^0 C for 10 minutes and moisture content reduced to < 10%.
Thermophilic digestion (aerobic or anaerobic)	Sludge should achieve a temperature of at least 55^0 C for a minimum period of 4 hours after the last feed and before the next withdrawal. Plant should be designed to operate at a temperature of at least 55^0 C with a mean retention period sufficient to stabilise the sludge.
Heat treatment followed by digestion	Minimum of 30 minutes at 70^0 C followed immediately by mesophilic anaerobic digestion at 35^0C with a mean retention time of 12 days.
Treatment with lime (CaO)	The sludge and lime should be thoroughly mixed to achieve a pH value of at least 12 and a minimum temperature of 55^0 C for 2 hours after mixing.

To produce pathogen-free sludge from sewage sludge or sludge from meat processing waste it needs to be treated for the time-temperature conditions cited above; or raised to 55°C for 2 hours whilst the pH is above 12; or raised to 55°C for 4 hours during a

thermophilic stabilisation process; or raised to 55°C for 4 hours during a satisfactory composting process.

In windrow composting systems the material should be turn at least three times to ensure that all material is exposed to the time-temperature conditions.

The level of *E. coli* in treated sludge released for land use should not exceed 1000 per gram (dry weight). The tentative level of *C. perfingens* spores of not more than 3000 per gram (dry weight) is suggested.

Advanced treatment process should demonstrate a 4 log10 reduction in numbers of added *Salmonella*, and Ascaris ova should be rendered non-viable.

Plant pathogens will be inactivated by temperatures at the upper end of the mesophilic range (about 40°C).

Sludges from paper processing and tanneries should not need special measures to destroy human or animal pathogens.

CONSTRAINTS ON THE USE OF SLUDGES IN AGRICULTURE

Sludges treated to the suggested standards for advanced treatment will not add to the pathogen burden of the environment and present no risk to human, animal or plant health.

Sludges that may contain the BSE agent should not be applied to land where animals have direct access.
Sludges from paper waste, vegetable waste and tannery waste should present no risk if treated by mesophilic digestion or a similar standard.

Table 2. Suggested constraints on land use of treated organic waste.

Crop	Advanced treatment	Conventional treatment
Pasture	Yes	Injection and 3-week no-grazing
Forage	Yes	3-weeks no-harvest
Arable	Yes	Injection or plough-in
Vegetables in ground contact	Yes	10-month no-harvest
Fruit & vegetables eaten raw [salads]	Yes	30-month no-harvest
Fruit trees, vineyards	Yes	Injection and 10-month no-access
Parks & urban open spaces	Well stabilised and odourless	No
Land reclamation	Yes	10-month no-access

Planting, grazing or harvesting constraints will have to be applied to land that has received sludge which has not been hygienised from sewage treatment plant or from meat processing plants.

These constraints should be sufficient to allow at least 2 log10 reduction in pathogen numbers as evidenced by reduction of numbers of *E. coli*.

The rate of reduction depends upon local climatic conditions, which vary widely across the European Community.

Constraints on land use after sludge application will depend upon the level of sludge treatment, and the nature of the crop or the use of the land. In most instances 'Advanced' treated sludge can be used with few restrictions but 'Conventional' treated sludge must be distanced from the harvested material by time, and where crop maturation is a short period, by incorporating the sludge into the soil.

Workers treating, transporting or spreading sludge must receive adequate training and briefing on the risks and precautions to be observed.

QUALITY ASSURANCE

It is not practicable to monitor treated sludge for the presence of pathogens and surrogates should be used for routine evaluation of the treatment plant performance and sludge quality.

Surrogates should be organisms commonly found in sludges and have similar resistance to treatment as pathogens. *E. coli* (or enterococci) and *Clostridium perfringens* are suggested. Numbers of *E. coli* should not exceed 1000 per gram (dry weight) and it is tentatively recommended that spores of *C. perfringens* should not exceed 3000 per gram (dry weight)

Because of the diversity of micro-organisms and hosts it is not possible to suggest suitable surrogates for systems treating vegetable waste. However, a treatment plant designed to hygienise sewage sludge or sludges of animal origin will also destroy plant pathogens.

VALIDATION OF NEW PROCESSES AND NEW TREATMENT PLANTS

New treatment processes and plants need to be validated.

A reduction of at least 4 $\log_{10}$ of added *Salmonella* and the destruction of viability of *Ascaris* ova together with a level of *E. coli* not exceeding 1000 per gram (dry weight) of sludge and a level of *Clostridium perfringens* spores not exceeding 3000 per gram (dry weight) in the treated material is suggested for plants treating sewage sludge or animal waste.

For treatment plants receiving solely vegetable waste the use of Tobacco mosaic virus, the fungus *Plasmodiophora brassicae* and the seeds of *Lycopersicon lycopersicum* (cultivar St Pierre) has been suggested.