Disinfection of Sewage Sludge with Gamma Radiation

L.N. MELMED AND D.K. COMNINOS
[CITY HEALTH DEPARTMENT, LABORATORY AND TECHNICAL SERVICES BRANCH,
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Abstract

Disinfection of sewage sludge by means of gamma radiation to render it suitable for unrestricted reuse as a fertiliser or soil conditioner in the urban environment, was investigated. Inactivation of *Ascaris lumbricoides* ova was used as the criterion of disinfection.

It was found that a total radiation dose of 1 kGy effectively reduced the development of potentially infective larvae in a sludge containing 20% solids, by 99%. The 1% of larvae developing after radiation were infective to white mice. Higher doses of radiation up to 10 kGy did not achieve a 100% kill.

Complete inactivation could be obtained when 0.5 kGy radiation was applied at 50°C to a sludge containing 3% solids and when 0.4 kGy radiation was applied at 55°C to a sludge with 20% solids.

Introduction

The recycling of sewage sludge as a valuable resource is being given increasing attention throughout the world. In the Republic of South Africa, the Health Act No 63 of 1977 makes provision for promulgation of regulations to control the disposal of sewage sludge and consequently standards to permit safe reuse are earnestly being sought. Conventional sludge treatment by anaerobic digestion or aerobic stabilisation does not inactivate all pathogenic bacteria, virus and parasite ova, including *Ascaris lumbricoides* which can survive for 7 years or more in soil (Muller, 1975). The incidence of Ascariasis in the Republic, is very high, therefore it becomes essential to disinfect sludge before it can be released for unrestricted reuse in the urban environment.

Disinfection of sludge can be accomplished successfully by pasteurisation at 70°C for 30 minutes (Stern, 1974) and it is claimed that similar disinfection can be attained by a 3 kGy dose of gamma radiation with 60Co (Suts et al., 1974). 4 kGy of high energy electron irradiation (Trump et al., 1975) and thermoradiation with 0.4 kGy at 47°C (Sivinski, 1975).

To test these claims under local conditions, experiments aimed at sludge disinfection by ionising radiation, thermoradiation and radiation combined with oxygenation were carried out, using sludge from the Johannesburg Olifantsvlei Wastewater Purification Works, which receives domestic sewage from Soweto. Sewage treatment at Olifantsvlei is either biological filtration with mesophilic digestion of the solids or alternately extended aeration activated sludge treatment of the unsettled raw sewage. The waste activated sludge is thickened by dissolved air flotation and then belt pressing. The *Ascaris* ova content of both the digested and waste activated sludge averages 3,000 eggs per gram (dry). Inhibition of development of *Ascaris* ova to the potentially infective larvae stage on embryonation, was used as an indication of successful disinfection.

Irradiation of the experimental material was carried out by staff of the Radiation Technology Division of the Atomic Energy Board at Pelindaba and viability studies were then conducted at the Johannesburg City Health Department Laboratory. When it was decided to test larvae which had developed subsequent to radiation for the ability to infect susceptible animals, these studies were done in the parasitology laboratory of the Onderstepoort Veterinary Research Institute.

The objectives of the experiment were:-

1. To establish the lowest dose of gamma radiation which would prevent embryonation of *Ascaris lumbricoides* ova in sludge.
2. To determine whether eggs containing embryonated *Ascaris* larvae differ from unembryonated ova in sensitivity to gamma radiation.
3. To ascertain whether a synergistic effect could be obtained when radiation was applied simultaneously with heat (thermoradiation) or oxygen.