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INFLUENCE OF SLUDGE AEROBIC EXOTHERMIC STABILIZATION ON THE VIABILITY OF *Ascaris suum* EGGS

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ABSTRACT

A laboratory aerobic exothermic stabilization of the primary sewage sludge within a mesophilic and a thermophilic temperature range and at constant aeration of 0.7 l.min⁻¹ was studied for its lethal effect on *Ascaris suum* eggs.

The mesophilic aerobic stabilization reached the maximum temperature of 33.3 and 38.7°C, with 37.2 to 33.4% of eggs surviving. The thermophilic aerobic stabilization with the maximum temperature of 48.5°C destroyed all eggs. Controls showed from 84.6 to 91.5% of viable eggs.

A statistical evaluation has proved the dependence of the percentage of viable eggs and the temperature, pH and dry matter (P<0.01) as well as on chemical oxygen demand (COD) (p<0.05). We have not determined the relation of the surviving eggs either to the content of ammoniacal nitrogen, total nitrogen and phosphorus or to the percentage of organic substances throughout the aerobic exothermic stabilization.

Key words: aerobic exothermic stabilization; *Ascaris suum* eggs; physico-chemical parameters

INTRODUCTION

The aerobic processes accompanied by the buildup of biomass are exothermic, which means that part of organic matter is converted into thermal energy and released into the environment. Throughout the stabilization, there is a reduction in the number and viability of pathogenic microorganisms and endoparasitic propagative stages, occurring in biological substrates. In general, the most important physicochemical factors affecting their viability include: effect of temperature and changes in pH and ammonia concentration. No other physicochemical factors have been known to influence their viability during aerobic exothermic stabilization. The changes in physico-chemical factors affecting the viability of the model nonembryonated eggs of *Ascaris suum* were followed during the aerobic exothermic stabilization of sewage sludges.

MATERIALS AND METHODS

The aerobic stabilization of crude (primary) sludges was carried out in a laboratory equipment of our own design (Hotař, 1974). We used a modified laboratory fermenter.

The crude sludge was taken from a septic tank at the Poprad municipal sewage treatment plant (STP). The sludge dry matter, organic matter and sludge pH were determined by the methods consistent with the standard CSN 83 0550. COD, total nitrogen, ammoniacal nitrogen and total phosphorus were measured by standard methods (Horáková *et al.*, 1986).

Nonembryonated eggs of *A.suum* were isolated from the distal portion of the uteri from mature females. The eggs were inoculated into polyurethane carriers (Plachý and Juriš, 1995) and at the beginning of the experiment, inserted into plastic sheaths of the fermenter.

The effect of the stabilization physico-chemical factors on the model pathogens was evaluated by a regression analysis.

RESULTS

The aerobic exothermic stabilization of sludges was taking place within two temperatural ranges: the mesophilic (Experiments 1 and 2) and thermophilic (Experiment 3). The highest stabilization temperature reached in Experiments 1 and 2 was respectively 33.3°C and 38.7°C and in Experiment 3 48.5°C. The highest sludge dry matter reduction was recorded in Experiment 3, namely 31.25%. In Experiments 1 and 2 the dry matter reduction ranged between 13.9 and 21.9%. After mesophilic stabilization, only 37.2 and 33.4% (Exp. 1 and 2) of *Ascaris suum* eggs remained viable. Control showed 84.6 and 91.5% of viable eggs. Nonembryonated eggs of *Ascaris suum* were completely destroyed in sludges aerobically stabilized within thermophilic temperatural range (Exp. 3).

The statistics have proved the dependence of the percentage of viable eggs on the temperature, pH and sludge dry matter ($P<0.01$) and on COD ($P<0.05$). An indirect correlation was detected between the viability of eggs and temperature and pH, while a direct correlation was determined between the viability of eggs and dry matter and COD. Other physico-chemical parameters (ammoniacal nitrogen, total nitrogen, total phosphorus, per-centage of organic matter) showed no relation to the viability of eggs.

DISCUSSION

The aerobic thermophilic stabilization resulted in a 100% destruction of the *Ascaris suum* eggs. It has proved effective against (Kabrick and Jewell, 1982; Scheuerman *et al.*, 1991; Ponti *et al.*, 1995a, b) and helminth eggs.

A lower lethal effect was recorded in experiments carried out within the mesophilic temperature range (Experiments 1 and 2).

It has been statistically proved that the sludge temperature and pH, COD and dry matter are principal factors affecting the viability of helminth eggs. The increase in temperature and pH reduces the viability of eggs. The values of the coefficient of determination suggest that the lethal effect connected with pH ($R^2 = 0.3738$) was slightly higher than the lethal effect connected with temperature ($R^2 = 0.2122$). In addition to these factors, we should like to point out that our experiments have proved the relationship between COD and the viability of eggs, with the coefficient of determination reaching the value of $R^2 = 0.4593$. The reduction in viable eggs was in direct correlation with the reduction in COD values. This parameter is used to express the chemical oxidizability of organic matter and partially also of inorganic matter subject to oxidation during the sewage treatment processes. This means that the reduction in sludge organic matter subject to oxidation (with reduced COD) entails the reduction in the viability of eggs. According to the findings of Strauch *et al.* (1985), sludge particles have a protective effect on potential pathogens. Strauch *et al.* (1985) reports that this protective effect is

higher at temperatures below 53°C and it becomes less potent above this temperature. He therefore recommends working at the highest possible temperatures to suppress the protective effect of sludge particles expressed by the content of dry matter. This finding has also been confirmed by Pontti *et al.* (1995b), who reported the direct correlation between the content of sludge dry matter and survival of *Escherichia coli* after inoculation during the aerobic exothermic process.

Despite the fact that with the increase in pH and temperature ammonia is released from the medium (Pontti *et al.*, 1995a), ammoniacal nitrogen and total nitrogen have no effect on the viability of eggs. No correlation was found to exist between total phosphorus and the viability of eggs.

Our results cannot be compared with those of other authors. None of the literature available deals with this problem in terms of the effect of physico-chemical parameters on the viability of eggs.

The papers devoted to these problems provide data on temperature or pH during stabilization and on their effect on nematode eggs without a statistical evaluation of their interrelationships. Furthermore, some authors have not used the process of aerobic exothermic stabilization (wet composting), and to reach thermophilic temperatures they heated sludge in heat exchangers. Such data can be found in the paper of Carrington *et al.* (1990), who studied the survival of *Ascaris suum* eggs during a 4 hr thermophilic aerobic stabilization at 55°C. This stabilization had a 100% lethal effect on the model nematode eggs. These data on the intensity of lethal effect are consistent with the results of Kabrick *et al.* (1979), Jewell and Kabrick (1980), Kuchenrither and Benefield (1983) and fully correspond with our own results.

These experiments suggest that the effect of aerobic stabilization of different biological substrates (sewage sludges, animal liquid excrements) on the viability of eggs is determined primarily by the physico-chemical parameters during stabilization (temperature, pH, COD and sludge dry matter) and not by the kind of the fermented substrate. It is, however, difficult to confirm this assumption exactly because of different substrate input values and consequently of different course of stabilization.

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