ORIGINAL ARTICLES AAEM
Ann Agric Environ Med 1997, 4, 175–176

MODELLING COMPOSTING PLANT DUST EXPOSURE IN A NEIGHBOURING POPULATION*

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Déportes I, Zmirou D, Benoit-Guyod JL: Modelling composting plant dust exposure in a neighbouring population. *Ann Agric Environ Med* 1997, **4**, 175-176.

Abstract: A model has been developed for the assessment of the exposure to airborne dust emitted by composting plant in a neighbouring population. The validity of the model was confirmed by air sampling data.

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Key words: compost, dust, exposure modelling, exposure risk.

OBJECTIVES

The aim of this study is to assess dust exposure in a neighbouring population of a municipal solid waste (MSW) composting plant. Inhalation of fine compost particles might pose a microbial or toxicological risk [4, 5] which is generally acknowledged in the occupational setting, but so far there are comparatively few studies dealing with neighbouring populations [2, 3].

METHODS

A gaussian-type air dispersion model was used (POLAIR), which allows modelling aerial dispersion of fine particles (D < 5 µm) [1]. For this, an estimate of the emission rate (ER) is needed. The study aimed at estimating a representative ER for the MSW composting plant under the hypothesis that the storage phase takes place in the open air or, at least, in an open shed. To evaluate ER for particles below 5 µm we calculated the weight distribution of particles in compost at different stages of maturity and humidity.

For this purpose, we used several sieves with mesh diameters decreasing from 500 µm down to 32 µm. Different composts were used with age ranging from 0 to 11 months and humidity from 7 to 31% (Tab. 1). After sieving, each fraction was collected, weighed, and expressed in percent of the total mass recovered after sieving. In order to maximize exposure estimate, we considered the total compost weight proportion for 32 µm

Table 1. Characteristics of compost samples.

Sample	Mean temperature at collection time (°C)	pH	H_2O %	Age, days
1	N.m.	6.80	20.7	0
2	N.m.	8.75	22.3	0
3	74	7.79	22.7	15
4	65	7.89	23.3	30
5	66	6.90	13.5	45
6	52	7.15	31.2	60
7	78	6.24	13.5	75
8	50	7.62	21.9	90
9	52	8.20	15.4	125
10	44	6.92	7.1	360

N.m.: Not measured.

Received: 4 November 1996
Accepted: 20 December 1996

*Presented at the International Meeting: "Waste Collection and Recycling - Bioaerosol Exposure and Health Problems", Køge, Denmark, 13-14 September 1996.

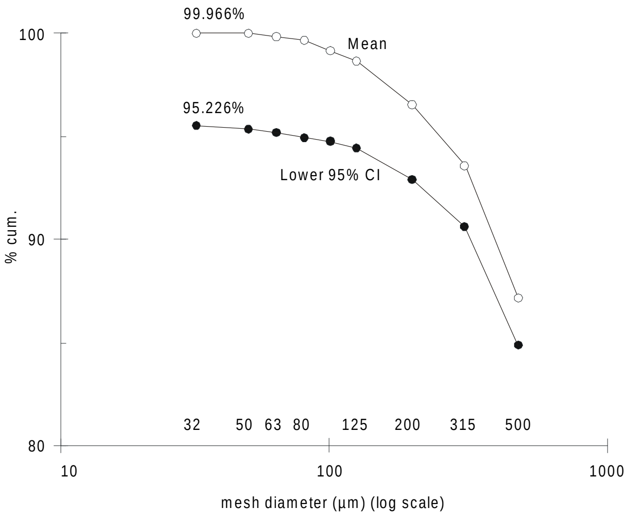

Figure 1. Percentage of recovered compost by weight in sieving experiments (n = 10) in relation to mesh diameter.

particles and less as representative of particles smaller than 5 µm. For each mesh size, the weight percents are meaned for the 10 composts. The ER is then computed for this theoretical average compost and dust dispersion is modelled by POLAIR. To make sure that sieving is a way to assess the ER, a validation is done at a composting plant. The aerial dust concentration is measured during compost handling by a GRIMM sampler. Samples from the compost heap are sieved, and ER is computed and the aerial dust concentration is assessed with POLAIR. Both concentrations are then compared.

RESULTS

Figure 1 shows the average compost mass proportion for increasing particle size starting at 32 µm, the finest mesh diameter that could be used. In order to provide conservative estimates of exposure, we used the lower 95% confidence limit of the curve, which shows that 95.23% by weight of the compost consists of particles greater than 32 µm. For a typical 100 tons/day composting plant that would operate the storage handling phase two hours daily, these data can be converted into ER in g/s. When fed into the air dispersion model, this ER may yield fine dust concentrations ranging from 2 to 20 mg/m^3 at a distance of 250 m and as high as 300 mg/m^3 at 50 m from the dispersion source.

Validation of the method was made by comparing the results of the modelling approach with data obtained with a GRIMM particles sampler for dust below 5 µm diameter. While the GRIMM sampler showed a concentration of 0.4 mg/m^3 at the emission point, the estimated value was 0.18 mg/m^3, which is reasonably close.

CONCLUSION

The model is of interest for a first assessment of compost dust dispersed in the vicinity of MSW composting plants. It is readily used as only information on the quantity and duration of handling is needed to derive the ER. Further measurements at different distances are needed for a more complete validation of the model.

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