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Report: the decomposition of putatively degradable nappy pads in three systems

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The degradation of putatively degradable Weenee® nappy pads was monitored relative to commercially-available plastic nappies in soil, earthworm compost and in a septic tank used by a villa complex. Extrapolated data gave times for elimination of the degradable pads (under temperate summer conditions) of 134 days in soil, 71 to 80 days in earthworm compost and 110 days in the septic tank. The polyacrylate absorbant material in the degradable pads was not toxic to earthworms or to soil microbiota.

In contrast, control "plastic" nappies remained largely intact, with plastic components showing no significant degradation at the termination of the trials. Plastics comprised 37% of the dry weight of the new product, with the balance being primarily cellulosic flock. Estimated times for the elimination of the flock components were 148 days, 140 days and 143 days for soil, earthworm compost and the septic tank, respectively.

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Introduction

Nappy disposal poses a major problem in waste management, due largely to the poor degradability of the plastics used in them. The disposal and composting of nappies in domestic refuse has been reviewed by De-Ryke *et al.* (1993). Regarding the fate of the polyacrylate absorbant material, only minor decomposition was reported in simulated landfill (Pohland *et al.* 1992; Stegmann *et al.* 1993), although the latter authors reported no adverse effects of polyacrylate on the biological processes under compost conditions. This report summarizes recent work undertaken in Australia to determine the biodegradability of putatively degradable nappy pads used as disposable absorbent liners in washable covers, these potentially being an environmentally-preferred alternative to plastic nappies.

Approach

The degradation of nappy pads (Weenee®, Kuver Designs Pty Ltd., PO Box 158, Sandy Bay, Australia, 7005) was compared with that of commercially-available disposable "plastic" nappies, typical of those found in municipal wastes. Nappy pads and plastic nappies were placed in a fertile soil mix, in an earthworm compost under field conditions and in a commer-

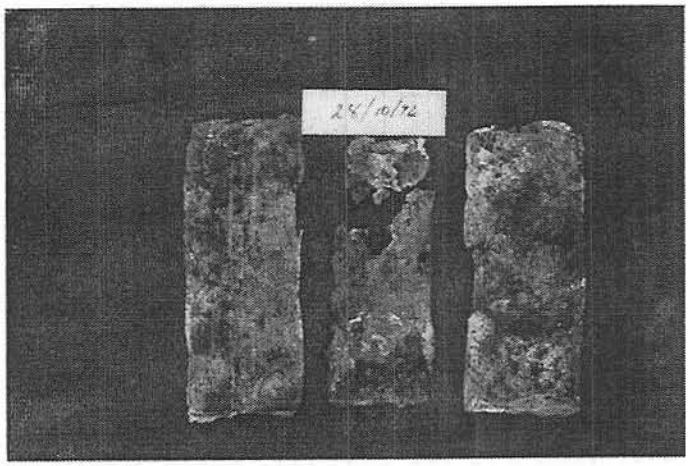

Fig. 1. Biodegradable nappy pads after three months in soil.

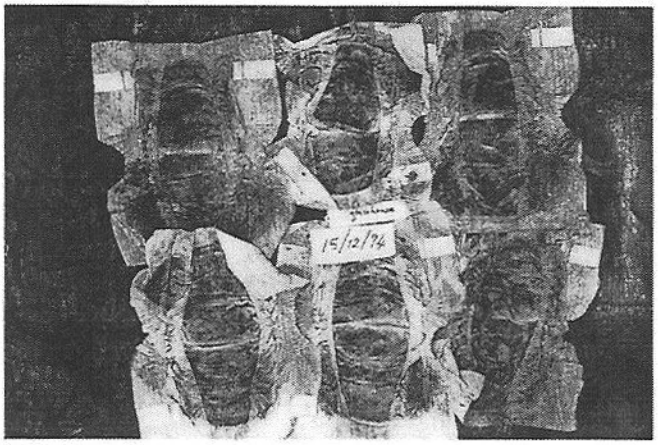

Fig. 2. Plastic disposable nappy pads after four months in soil.

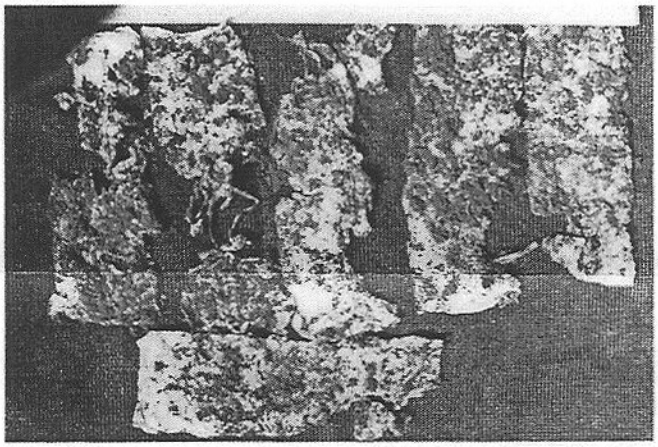

Fig. 3. Biodegradable nappy pads after seven weeks in earthworm compost

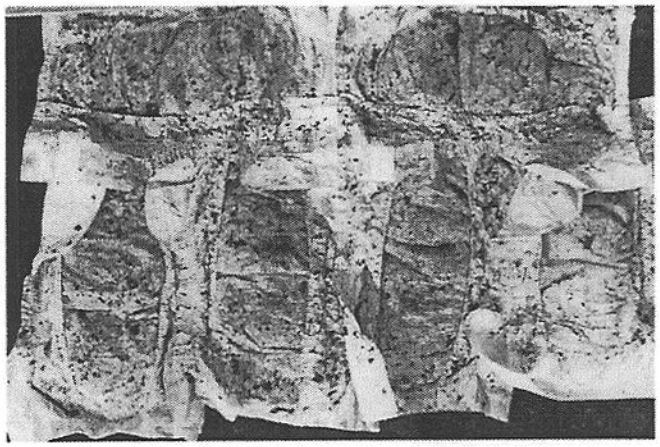

Fig. 4. Plastic disposable nappies after eight weeks in earthworm compost.

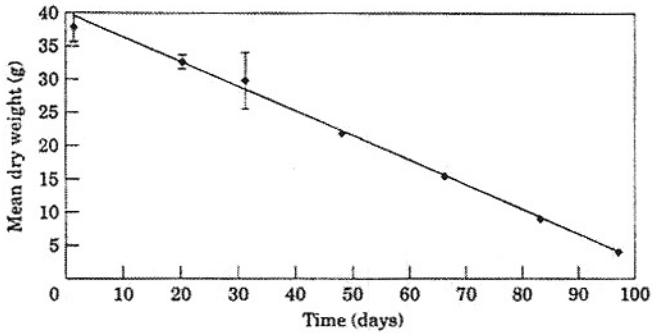

Fig. 5. Weight loss of degradable nappy pads in a commercial septic tank. Bars show ± standard deviations. Loss of pad integrity precluded these determinations after the first three intervals.

cially operated septic tank. In the latter case, the products were contained within tethered nylon mesh bags. Mean daily temperatures in all systems averaged approximately 19°C and pH levels in all systems were approximately neutral. Products were withdrawn from the three systems at intervals (six at each interval) for photographic assessment of decay and for determination of weight loss following drying at 100°C.

The effect of the polyacrylate material on earthworms (*Lumbricus rubellus* and *Eisenia foetida*) was monitored after one months vermicomposting when the pads and nappies were heavily colonized. At this time the pads were removed to laboratory incubation at 25°C under moist conditions, with observation of earthworm health for one week.

To dermine the effect of absorbent material from pads on the soil microbiota, dilutions of garden soil were made to 10^{-6} in sterile saline and aliquots of these plated onto trypticase-soy agar (TSA, comprising 0.3% BBL trypticase soy broth powder, 0.1% yeast extract, 1.5% agar) with and without 2% (w/w) addition of flock/polyacrylate filler. Plates were incu-

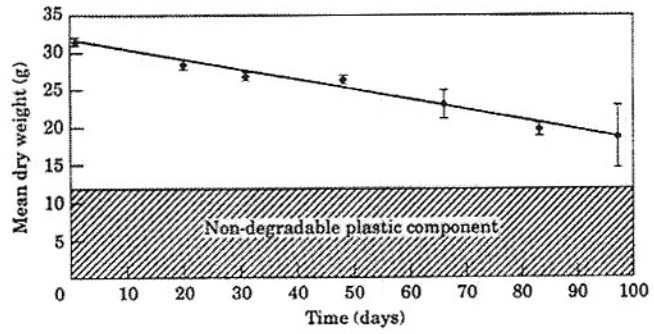

Fig. 6. Weight loss of plastic nappies in a commercial septic tank.

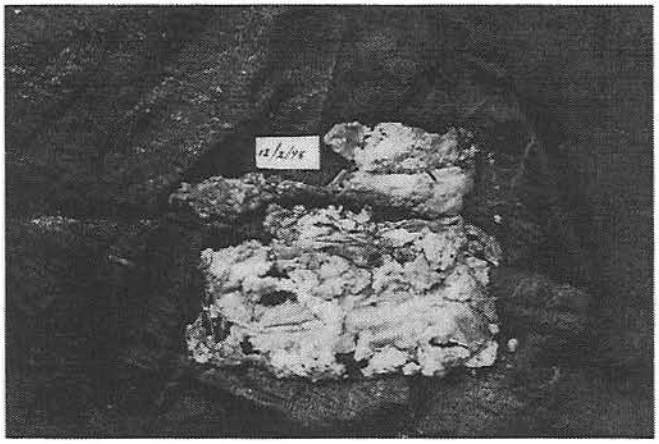

Fig. 7. Biodegradable nappy pads after 12 weeks in a commercial septic tank.

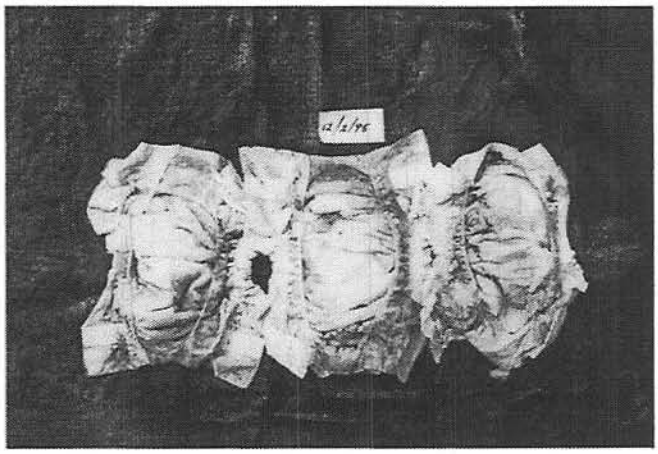

Fig. 8. Plastic disposable nappies after 12 weeks in a commercial septic tank.

bated for one week at 25°C prior to assessment of colony numbers and characteristics.

Results

An increasing rate of decay of degradable components of pads and nappies was apparent in the simulated soil mix and in the vermicompost as the trials progressed, consistent with logarithmic degradation kinetics. The rate of degradation of the degradable absorbent component of plastic nappies (this being 62.8% (S.D.-0.6%) of the initial dry weight) was lower than that of the pads in all of the systems tested, which may have been due to its enclosure in non-degradable plastic/polymer liner.

Estimated half-life times in the fertile soil were 118 days for the pads and 123 days for the degradable components of the plastic nappies. Extrapolation of the degradation curves gave times to achieve total degradation of 134 days for the pads and 148 days for the degradable component of the nappies (Figs. 1 and 2).

Some difficulty was encountered in separating vermicompost from the product materials, thereby increasing the error of estimation of degradation rates. However, the estimated half-life of the pads in this system was 58 to 66 days, that of the degradable component of plastic nappies was 102 days. Extrapolation of the data gave times to achieve total degradation of 71 to 80 days for the pads and 140 days for the degradable component of the nappies. No significant change in the plastic components (including the soft inner membrane) of the control nappies was observed after 196 days in vermicompost (Figs. 3 and 4). Dry weights of plastic nappies, with attached detritus removed as far as possible, were determined at this time to average 12.4 g, marginally above the mean value for the plastic components of uncomposted nappies, of 11.7 g (S.D.-0.1 g).

The degradation of the pads and of the degradable component of plastic nappies in the septic tank situation was linear with time, indicating zero-order kinetics (Figs. 5 and 6) rather than the logarithmic kinetics observed in the other two systems. The half-life of the pads in the septic tank was 55 days, with the equivalent half-life of the degradable flock component of the plastic nappies being 71.3 days. Extrapolation of the data gave times to achieve total degradation of 110 days for the pads and 143 days for the degradable component of plastic nappies (Figs. 7 and 8).

No ill effects of earthworm exposure to polyacrylate was apparent after monitoring for one week at 25°C. Due to the heavy earthworm colonisation of the pads, their ingestion of the polyacrylate was inevitable. The material was therefore considered to be non-toxic to earthworms.

With regard to the effect of the polyacrylate on soil microbiota, no difference was apparent in the colony numbers, diversity or size following cultivation on TSA plates with or without the filler material (both indicated numbers of approximately 10^8 bacteria g^{-1} soil). Curiously, increased pigmentation of colonies was apparent on the plates with added filler than those without it.

Acknowledgements

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