Effect of moisture content on the composting of pig-manure sawdust litter disposed from the pig-on-litter (POL) system

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Introduction

The pig-on-litter system, known as *in-situ* composting, has been developed as one of the recommended methods in Hong Kong to treat pig waste. The system utilizes a mixture of sawdust and a commercial bacterial product as the bedding material on which the pigs are raised, and the pig excreta are decomposed within the bedding material. After 10-13 weeks, the spent pig-manure sawdust litter is removed from the pig pens. This spent litter contains high concentrations of organic matter, nitrogen, phosphorus, potassium and trace elements, and also a significant amount of active microbial biomass, which is similar to an immature compost. In order to improve the quality of the spent litter, further composting to reach maturity is essential. Moisture is one of the most critical factors in controlling the rate of composting and the maturity of the product. Water provides a medium for the transport of dissolved nutrients for the metabolic and physiological activities of microorganisms. Very low initial moisture values would mean early dehydration of the pile which will arrest the biological process giving a physically stable but biologically unstable compost (Bertoldi *et al.*, 1983). On the other hand, high moisture values may produce anaerobic conditions due to water logging. However, the effect of different moisture contents on composting of spent litter and their changes throughout the composting process are not yet understood. Therefore, the study aimed (1) to investigate the changes in the nutrients and organic matter of the spent litter at different stages of composting, and (2) to evaluate the effect of different initial moisture content of the spent litter on this composting process.

Materials and Methods

The spent litter was collected from pig pens employing the pig-on-litter system (Tam and Vrijmoed, 1990) for 12 weeks with 40 piglets raised inside the pig pen. The spent litter was mixed homogeneously and piled up in an open shed for further composting and maturation. Three piles of the spent litter with initial moisture content adjusted to 50% (Pile A), 60% (Pile B) and 70% (Pile C) were set up. Each pile was triangular in shape, about 2 m in width at the base and 2 m in height. The piles were turned over twice a week using a front loader tractor. The changes of air temperature and the temperature of each pile at a depth of 60 cm were monitored twice a week (before turning). Composite samples taken from 5 symmetrical locations of each pile were collected immediately after piling (pre-expt.), right after the initial adjustment of the moisture (Day 0), then weekly until the end of the composting process (91 days). The spent litter was analyzed for the content of cation-exchange capacity (CEC) (Inoko and Harada, 1981), ash and total carbon, ratios of C:N humic:fulvic (HA:FA) acid, and different forms of N (Page *et al.*, 1982)

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Results and Discussions

The temperature values of piles A, B and C were 50°C, 44°C and 30°C respectively after the moisture content of each pile was adjusted at day 0 (Fig. 1a). Thereafter, the patterns of temperature changes in piles A and B were similar. Temperatures of both piles rose dramatically to about 64-69°C by day 4 and these readings were maintained until day 21 (thermophilic stage). The temperatures declined slightly and were maintained at a lower level from day 26 to day 57 (cooling stage), but then further dropped slowly to 30°C (ambient temperature) from day 60 until day 91 (maturing stage). Pile C followed the same trend of changes but the maximum temperature achieved during the thermophilic stage was significantly lower (56-59°C). Its temperature also dropped more rapidly at day 57 and started to level off by day 67.

The changes in total carbon, ash and total nitrogen of all piles were very similar during the whole composting period. The carbon content decreased as composting proceeded, from an initial value of 52% to about 51% during the first 56 days of composting (Fig. 1b). This decrease was due to the disappearance of easily decomposable organic constituents (Tam and Vrijmoed, 1990). From day 63 onwards, the carbon contents of all piles stabilized at around 50% until the end of the composting period. On the other hand, the ash content increased gradually with time from an initial 9.8% to 12.3% during the first 56 days of composting and stabilized at a level of 12.5% until the end of the composting period. It has been reported that the increase in the ash content of composted materials is due to the accumulation of minerals and rapid degradation of organic materials during composting (Tam and Vrijmoed, 1993). The initial total N of all piles was about 1.8-2.0% (Fig. 1d). As composting proceeded, the total N of all piles increased. The total N values increased from an initial 1.8% to about 2.9% by day 60 and were maintained at this level until the end of the composting process. The NH_4^+-N content decreased (Fig. 1e) while the NO_x^--N increased (Fig. 1f) revealing that the spent litter became more mature. In general, Pile C had lower Total N, ash and NH_4^+-N content throughout the composting process than piles A and B, indicating that the higher moisture content reduced the rate of composting. During the composting, the CEC increased while C:N decreased with time (Table 1). The CEC values of all piles rose to a value greater than 60 meq 100 g^{-1} by day 35 indicating that the spent litter became mature. The HA:FA values of all piles were stabilized after day 56 in all piles with values of about 0.36-0.39. Starting from day 60 onwards, the content of CEC, ash and total carbon, and ratios of C:N and HA:FA became stabilized in all piles, suggesting that all 3 piles reached maturity at day 60. Initial moisture content did not significantly affect the quality of the mature product.

Conclusion

In general, all piles had very similar chemical properties during the whole composting period despite of differences in initial moisture content. Two months is sufficient for converting a spent litter from the POL system to a mature compost for land application.

References

Bertoldi, de M. G. Vallini and A. Pera (1983) *Waste Management and Research*. 1: 157-176.
Harada, Y. And A. Inoko (1980) *Soil Science and Plant Nutrition*. 26:123-134
Page, A.L., R.H. Miller and R.D. Keeney (1982) Methods of Soil Analysis Part 2.
Tam, N.F.Y. and L.L.P. Vrijmoed (1990) *Waste Management and Research* 8:353-373.
Tam, N.F.Y. and L.L.P. Vrijmoed (1993) City Polytechnic of Hong Kong Research Report.

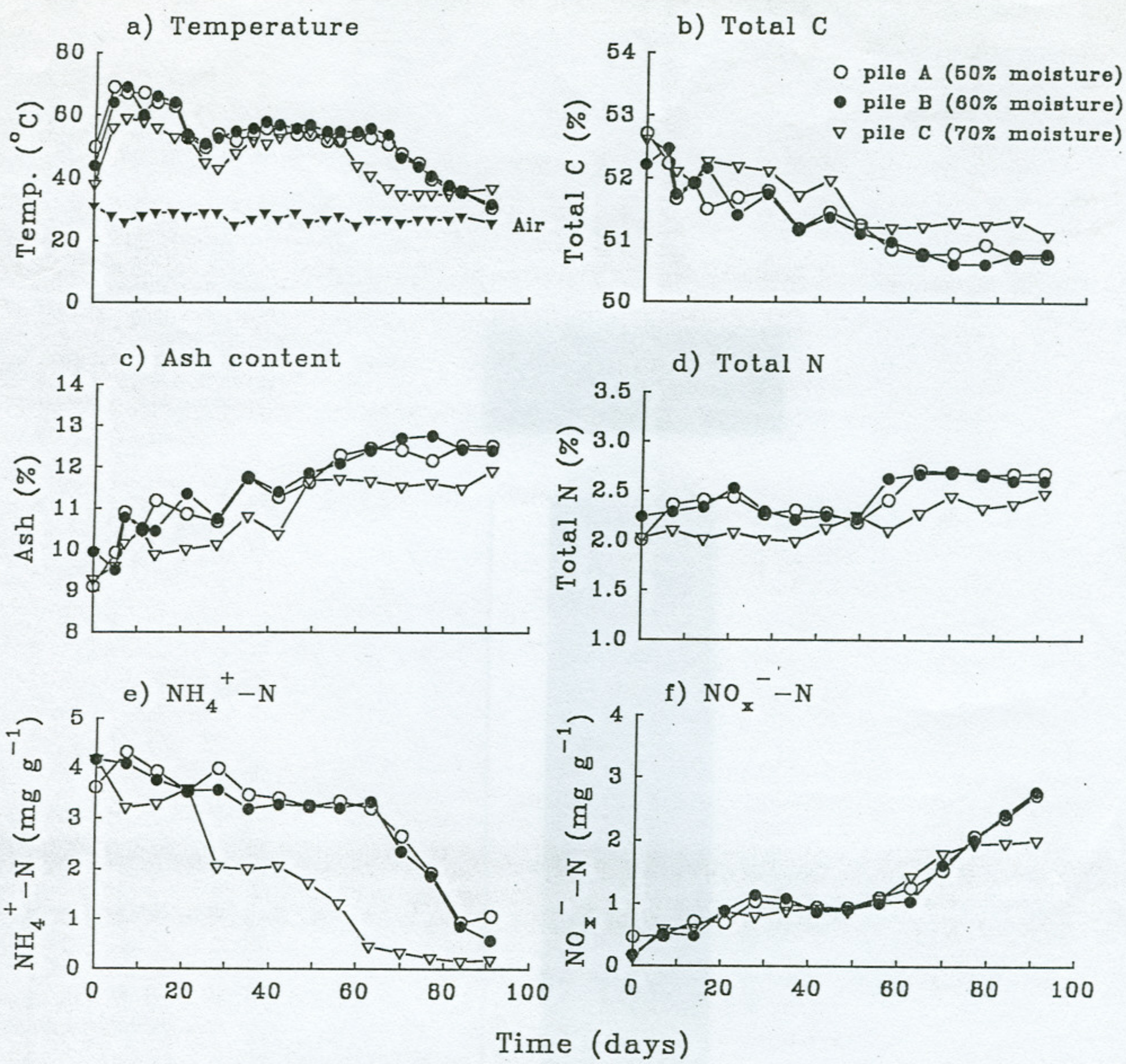

Figure 1. Chemical changes of the spent pig litter during the composting process.

		Day 0	Day 14	Day 21	Day 35	Day 56	Day 77	Day 91
CE C	Pile A	39.19	49.27	53.29	81.44	93.35	98.89	97.14
	Pile B	38.87	47.47	50.06	85.72	95.27	93.13	95.63
	Pile C	39.27	49.24	50.01	77.78	87.78	91.23	88.70
C:N	Pile A	26.19	21.32	21.33	22.18	21.06	19.06	18.93
	Pile B	23.26	22.24	22.24	23.06	19.37	18.88	19.50
	Pile C	25.87	25.91	25.91	25.93	24.30	21.95	20.60
HA:FA	Pile A	0.43	0.28	0.30	0.29	0.39	0.38	0.39
	Pile B	0.37	0.37	0.32	0.35	0.39	0.37	0.40
	Pile C	0.32	0.30	0.25	0.23	0.36	0.37	0.38

Table 1. Changes in CEC, C:N and FA:HA ratios of the spent pig litter during composting.