6 COMPOST QUALITY ANALYSIS

6.1 INTRODUCTION

The types and quantities of waste inputs are potentially important factors influencing the chemical properties of home produced composted residues in small-scale composters. Samples of composted materials (layer C) collected each year during the dismantling of the compost bins (Plate 6.1) were analysed for a suite of chemical determinands (Section 3). The key characteristics of compost end products in relation to waste material inputs and compost management treatments are examined in this chapter.

Plate 6.1 Compost end-product (layer C) collected after dismantling a small-scale home composter

6.2 CHEMICAL CHARACTERISTICS OF HOME COMPOST

The minimum and maximum and the median and mean values of the chemical properties of compost samples taken at the end of each monitoring year are presented in Table 6.1. In general, the nutrient contents (Total N, P and K) were larger than those typically reported for centralised composting (TCA, 2001) (Table 6.2). This could be explained because woody plant remains of low nutrient status are generally excluded from small-scale home composters, which are mainly supplied with only soft plant tissues of higher potential nutrient value as a feedstock for composting. Characteristics from a range of centralised composted end products from organic wastes including vegetable and kitchen and garden waste materials are shown in Table 6.3 Lopez-Real and Vere (1991) found substantial variation in end-product parameters in the different range of organic waste types analysed.

Reduction of the volatile solids content (VOCs) and a low C:N ratio produces a final stabilised compost product. In addition, these characteristics, avoid the problems of emanation of unstable products as odours and N removal from soil following amendment. The home produced compost from this study was expected to contain similar chemical characteristics to kitchen and garden waste composts (Lopez-Real and Vere, 1991), but the total N and C concentrations and pH characteristics were similar to those obtained with poultry 1 waste compost. Variation was observed with conductivity due to the minerals released following cell and substrate degradation and conductivity values were similar to the kitchen and garden waste results shown in Lopez-Real and Vere (1991). A possible explanation for some of the low conductivity levels in home compost material could be due to continuing microbial biomass activity and consequently immobilisation of nutrients.

Table 6.1 Summary of chemical properties of home composts for each study year

Parameter	Year	Minimum	Maximum	Median	Mean
Dry matter (% FW)	1	17.2	63.2	27.9	29.9
	2	21.3	75.4	34.8	36.6
Organic Matter (% dm)	1	7.9	69.3	29.9	32.9
	2	6.6	65.3	23.7	28.2
pH	1	5.6	8.6	6.8	7.0
	2	5.9	9.3	7.4	7.5
Conductivity (mS cm^{-1})	1	462.0	1618.0	766.0	855.0
	2	513.0	1383.0	805.0	864.0
Total N (% dm)	1	1.1	6.1	3.1	3.2
	2	1.5	6.0	3.3	3.5
Total P (% dm)	1	0.1	3.4	0.4	0.6
	2	0.1	2.4	0.6	0.7
Total K (% dm)	1	0.42	4.15	1.88	1.94
	2	0.56	2.93	1.20	1.27
Total Mg (mg kg^{-1} dm)	1	166.0	626.0	336.0	356.0
	2	67.0	265.0	193.0	196.0
NH_4-N (mg kg^{-1} dm)	1	0.9	20.9	9.9	9.8
	2	8.4	37.7	18.5	18.6
NO_2-N (mg kg^{-1} dm)	1	0.1	3.4	0.4	0.6
	2	0.1	2.4	0.6	0.7
NO_3-N (mg kg^{-1} dm)	1	8.8	79.1	31.8	32.9
	2	11.6	96.9	47.1	49.5
Extractable P (% dm)	1	0.02	0.2	0.05	0.06
	2	0.02	0.1	0.07	0.06

Table 6.2 Properties of composts (median values) produced in the UK (TCA, 1998)

Property	Fine compost (<10mm)	Coarse compost (10-25mm)
Total nitrogen (%)	1.0	1.4
Total phosphorus (%)	0.2	0.2
Total potassium (%)	0.5	0.5
pH	8.4	8.5
Electrical conductivity (mS cm^{-1})	715.0	592.0
C:N ratio	12.6	12.1
NO_3 N (mg kg^{-1} dm)	44.0	37.5
NH_4-N (mg kg^{-1} dm)	12.0	2.0
Mg (mg kg^{-1} dm)	902.0	78.0
Organic matter (%)	26.0	28.0

Table 6.3 Selected characteristics of composting end products from a range of organic wastes (adapted from Lopez-Real and Vere, 1991)

Parameter	Organic Waste type						
	Seaweed	Veg waste	Poultry 1	Poultry 2	Grain	Sewage sludge	Kitchen and garden
C (% dw)	13.4	16.3	28.6	18.1	44.0	23.0	19.6
N (% dw)	1.6	1.1	3.3	2.4	2.2	2.1	1.3
C:N ratio	8.1	15.1	9.0	7.4	20.0	20.0	15.0
pH (1:2.5 H_2O)	7.5	7.6	7.3	8.1	6.9	6.2	7.4
VOCs	29.0	37.0	64.5	42.0	89.0	49.0	41.0
EC (mS cm^{-1})	213.0	58.0	156.0	8.5	4.3	58.0	12.0

The activity of N is reflected in the range of NO_3-N, NO_2-N and NH_4-N concentrations (Table 6.1). The NH_4-N results were greater in home compost (Table 6.1) compared to the commercial composts (Table 6.2 and 6.3) and large concentrations of NH_4-N in composts indicated unstabilized organic matter or anaerobic conditions within the material (Zucconi and de Bertoldi, 1987). The values of NH_4-N presented here (Table 6.1) could be explained by storage of compost materials in sealable bags, which restricted air exchange, such that anaerobic conditions may have develop. These conditions would also be conducive to the production of volatile fatty acids, which could inhibit plant growth following soil amendment (Wong, 1985; Hirai, 1986).

6.3 CHEMICAL QUALITY AND WASTE RELATIONSHIPS

The relationships between chemical quality with food, paper and garden waste deposits in compost samples from each year of the monitoring period are presented in Figures 6.1 – 6.12.

Overall, the chemical quality results indicated that there were small variations in compost between each monitoring year. Food and paper waste deposits showed marginal variation between each monitoring year, although fresh garden waste deposits were significantly reduced by approximately 37 % in the second year indicating a possible impact on the chemical quality of compost produced during this monitoring period.

There were no statistically significant correlations between dry matter content of composted residues and any of the waste deposits (Figure 6.1). Indeed, dry matter contents in relation to paper and garden wastes were similar for each monitoring year although garden waste deposits were associated with higher dry matter contents deposits during the second year due to an increase of woody material In the first monitoring year food waste and dry matter contents were in the range: 20 – 30 % whereas in the second year this varied between 20 – 60 %.

Organic matter contents of composted residues were independent of food, paper and garden wastes for each year (Figure 6.2). There was a wide variability in the composted residues measured, which were in the range of 17.2 – 75.4 % FW (Table 6.4). However, there was little difference between the different types of waste deposits during the monitoring years. Descriptive statistical analysis of organic matter contents of home composts showed that values were marginally lower in the second monitoring year (Table 6.1).

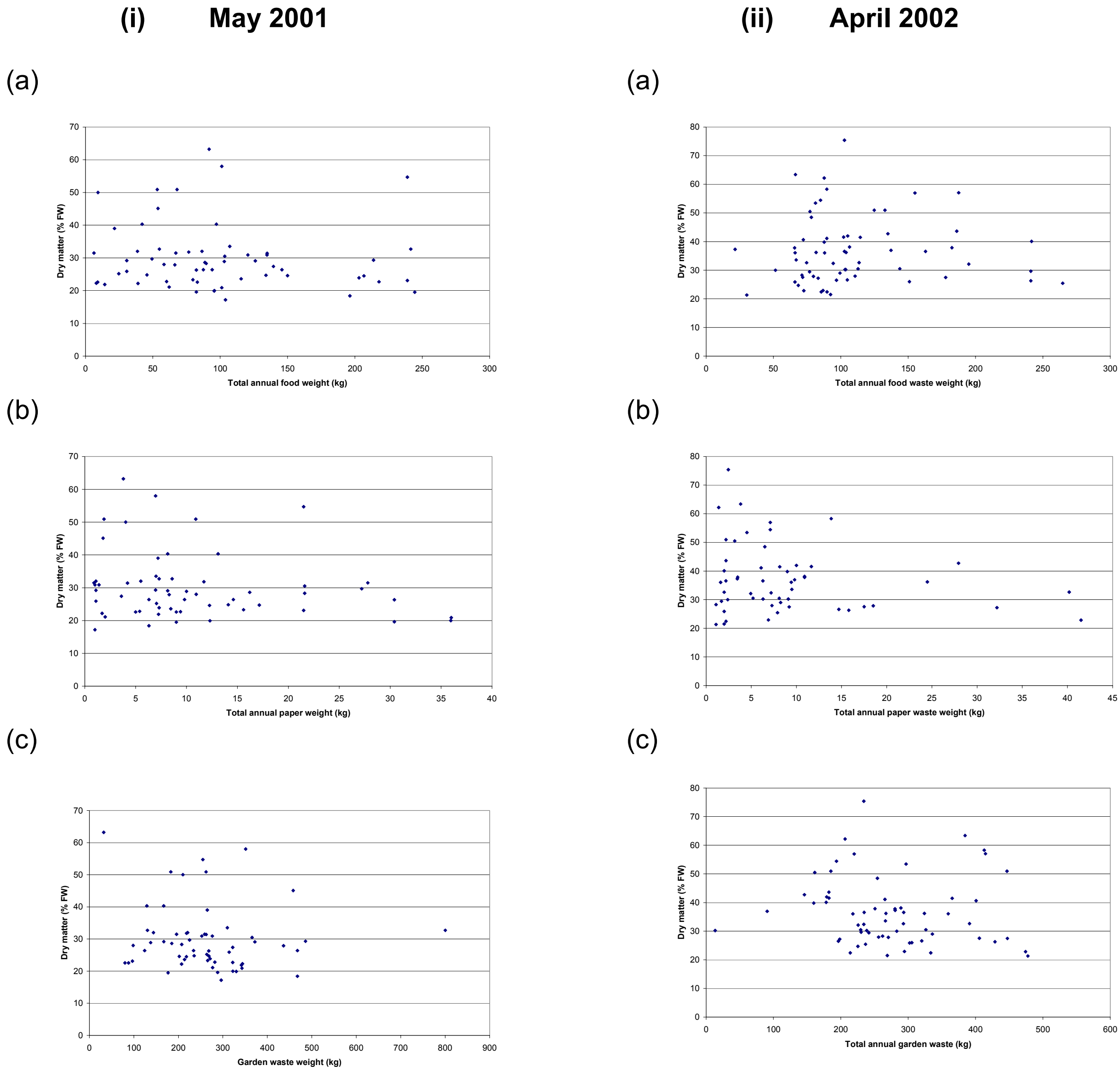


Figure 6.1 **Dry matter content of composted residue removed from the bins in (i) May 2001 and (ii) April 2002 in relation to total annual (a) food, (b) paper, (c) garden wastes deposits**

(i) May 2001 **(ii) April 2002**

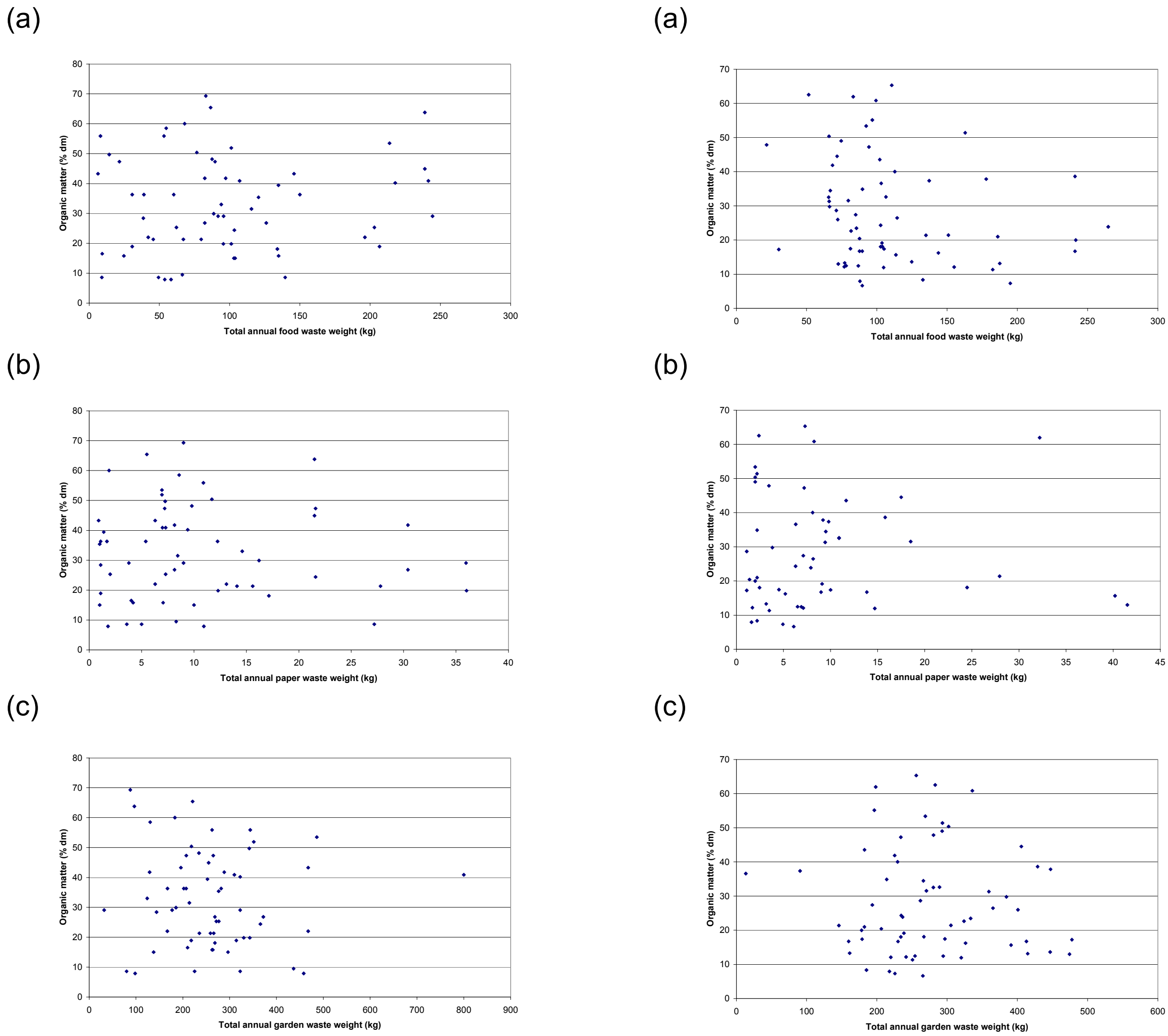


Figure 6.2 Organic matter content of composted residue removed from the bins in (i) May 2001 and (ii) April 2002 in relation to total annual (a) food, (b) paper, (c) garden wastes deposits

(i) May 2001 **(ii) April 2002**

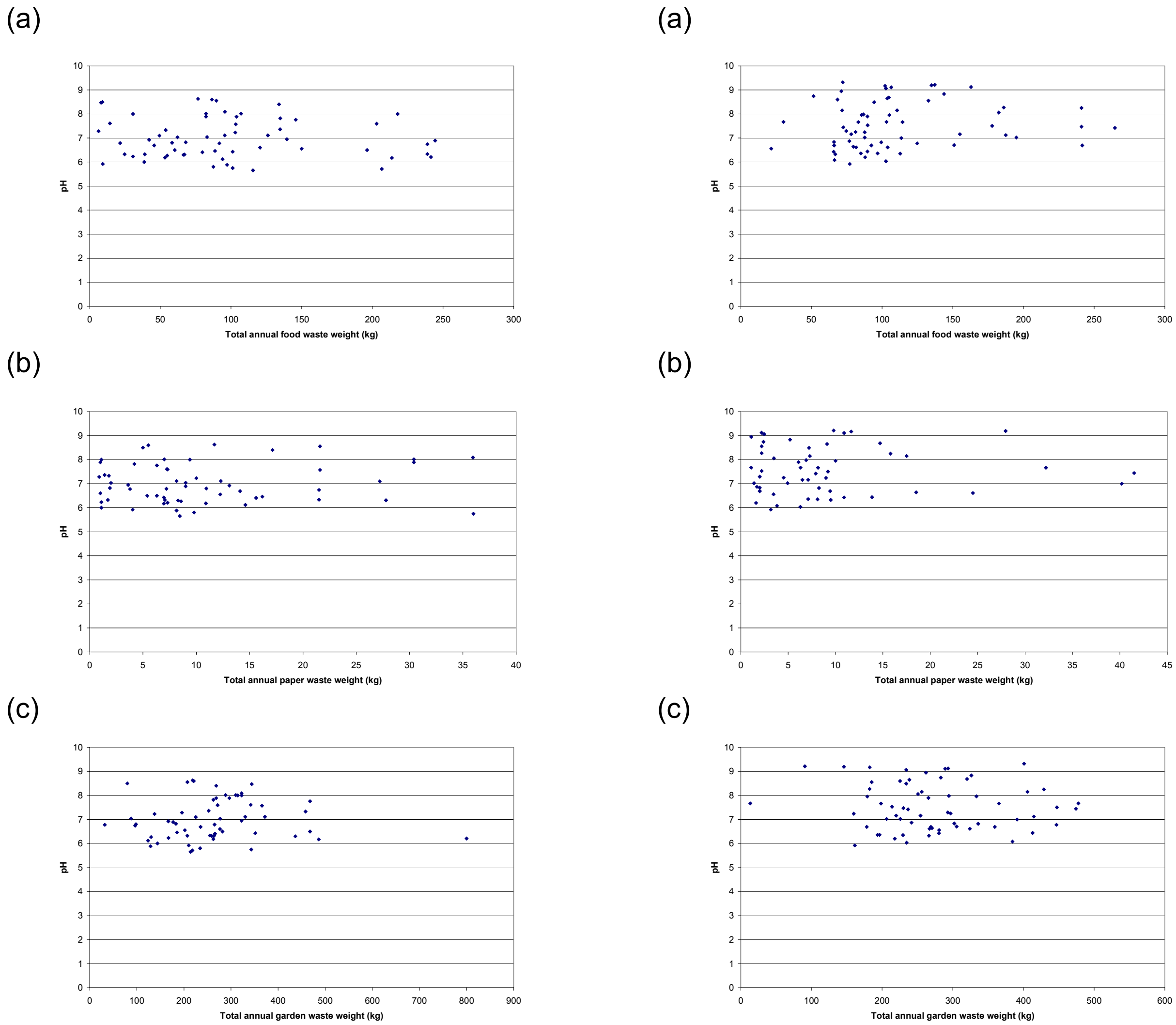
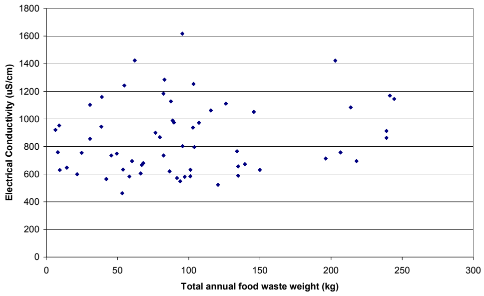


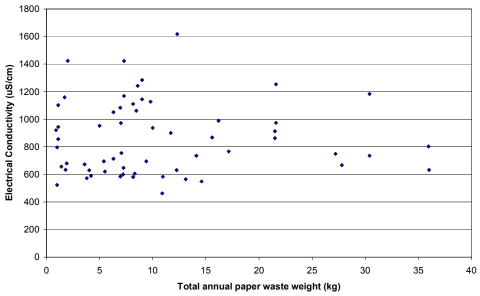
Figure 6.3 **pH values of composted residue removed from the bins in (i) May 2001 and (ii) April 2002 in relation to total annual (a) food, (b) paper, (c) garden wastes deposits**

(i) May 2001 **(ii) April 2002**

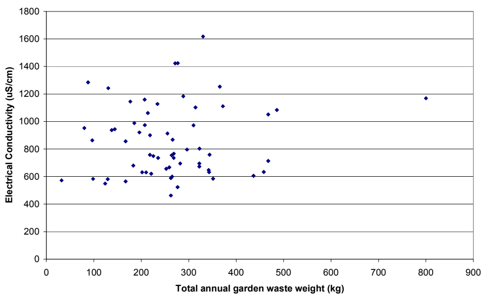
(i) (a)



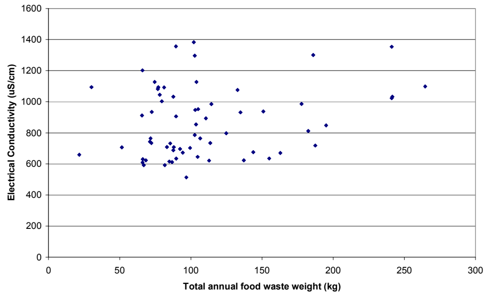
(i) (b)



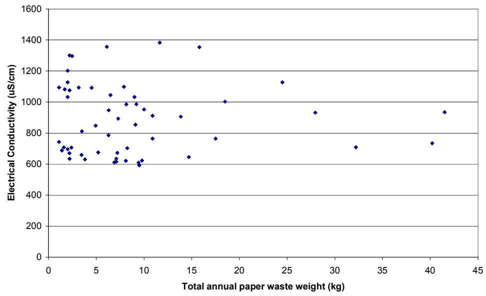
(i) (c)



(ii) (a)



(ii) (b)



(ii) (c)

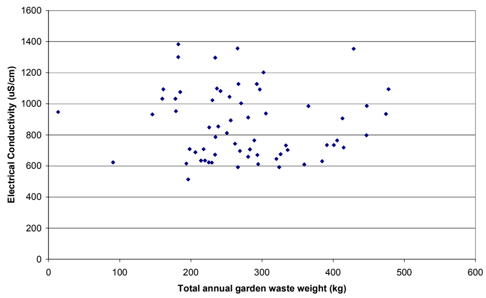
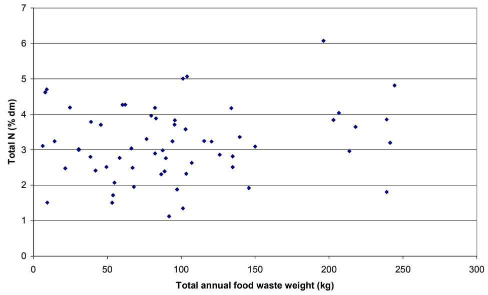


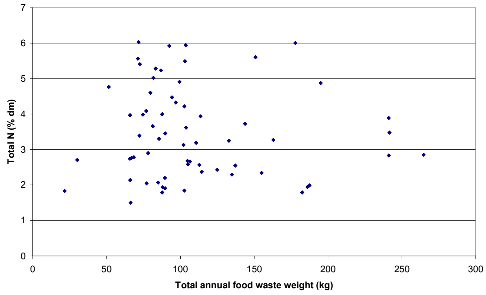
Figure 6.4 Conductivity values of composted residue removed from the bins in (i) May 2001 and (ii) April 2002 in relation to total annual (a) food, (b) paper, (c) garden wastes deposits

(i) May 2001 **(ii) April 2002**

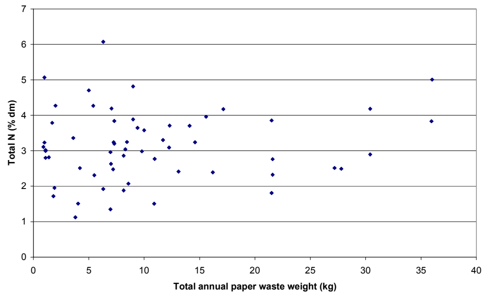
(a)



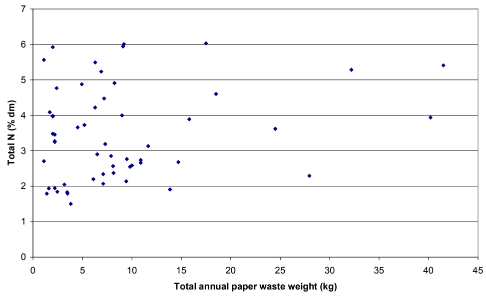
(a)



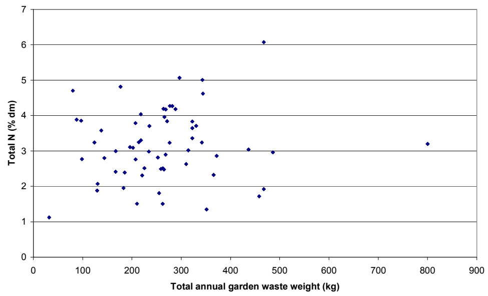
(b)



(b)



(c)



(c)

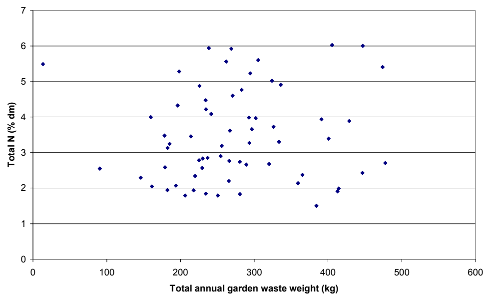


Figure 6.5 Total N content of composted residue removed from the bins in (i) May 2001 and (ii) April 2002 in relation to total annual (a) food, (b) paper, (c) garden wastes deposits

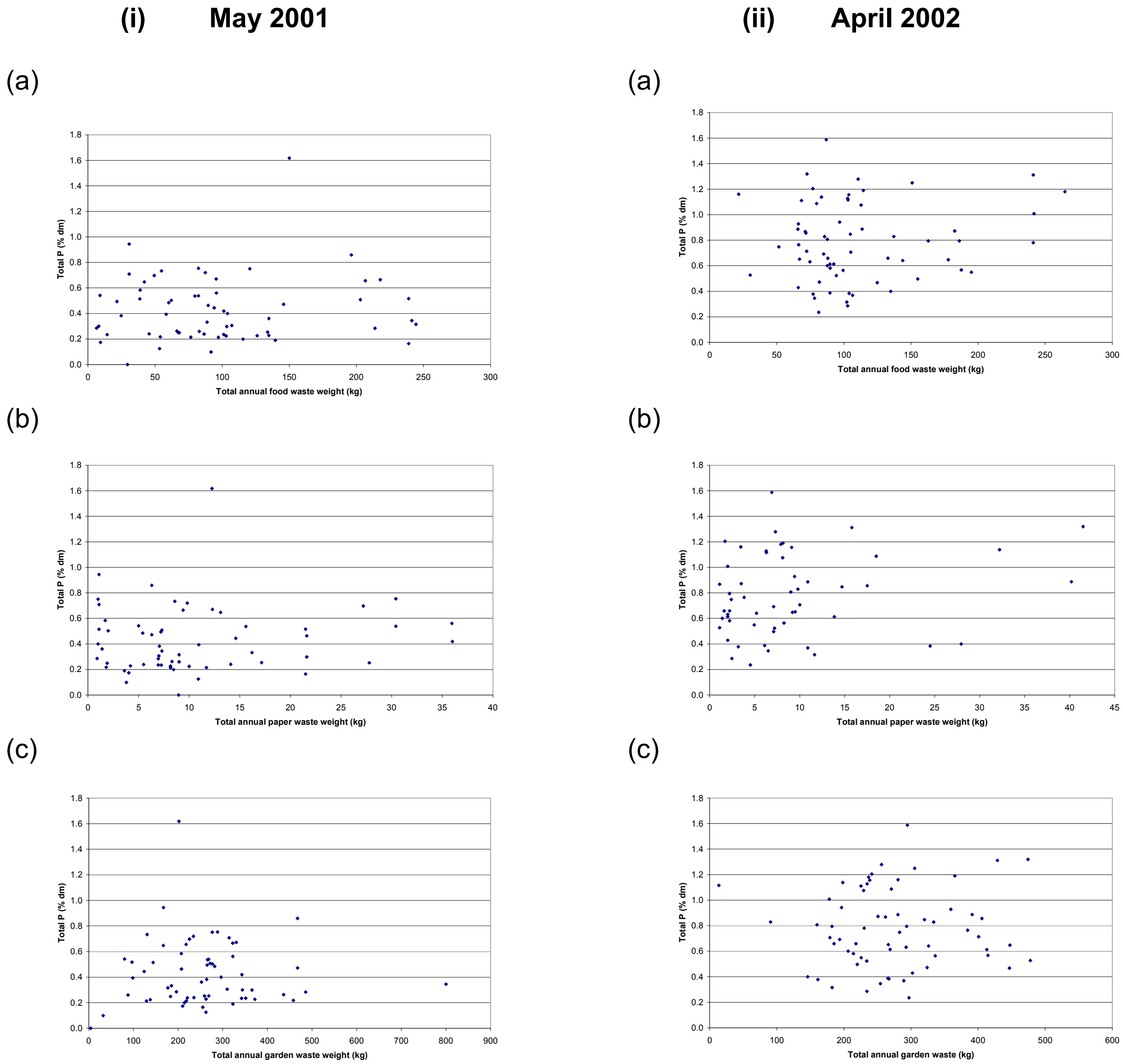
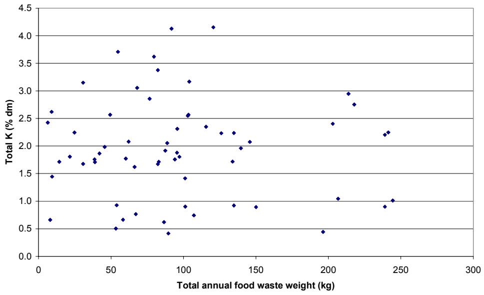


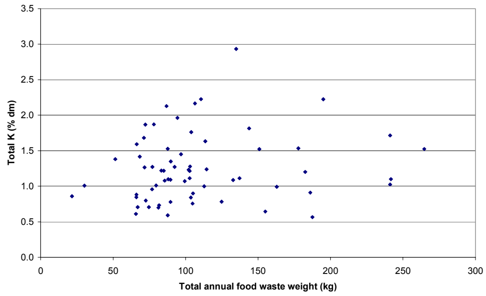
Figure 6.6 Total P content of composted residue removed from the bins in (i) May 2001 and (ii) April 2002 in relation to total annual (a) food, (b) paper, (c) garden wastes deposits

(i) May 2001 **(ii) April 2002**

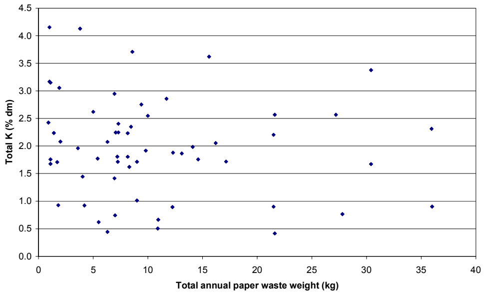
(a)



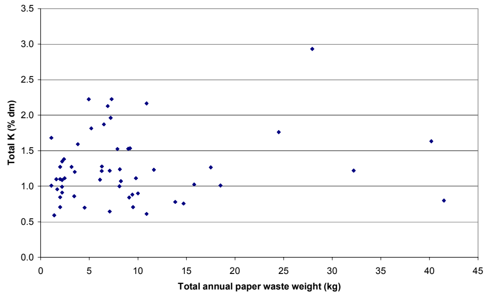
(a)



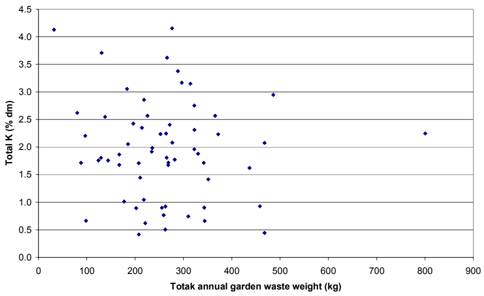
(b)



(b)



(c)



(c)

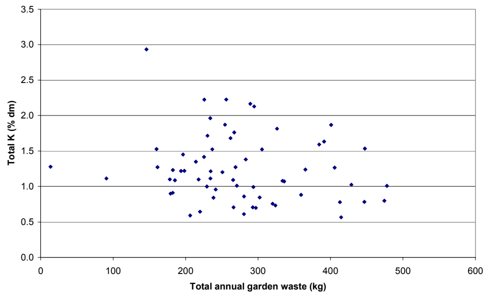
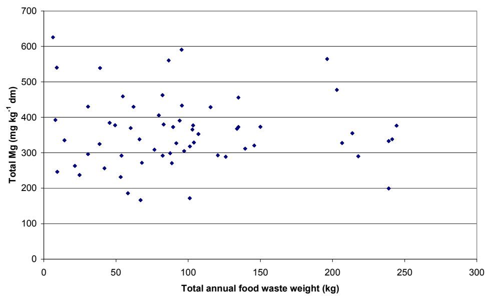


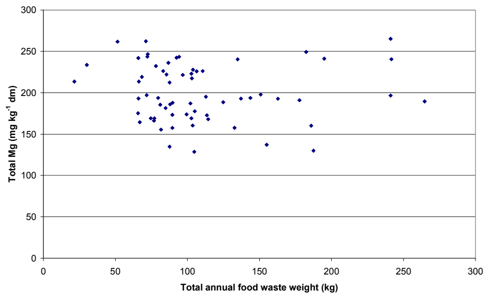
Figure 6.7 Total K content of composted residue removed from the bins in (i) May 2001 and (ii) April 2002 in relation to total annual (a) food, (b) paper, (c) garden wastes deposits

(i) May 2001 **(ii) April 2002**

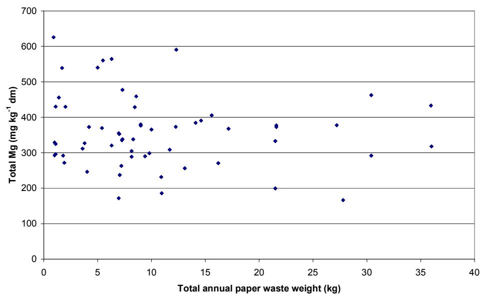
(a)



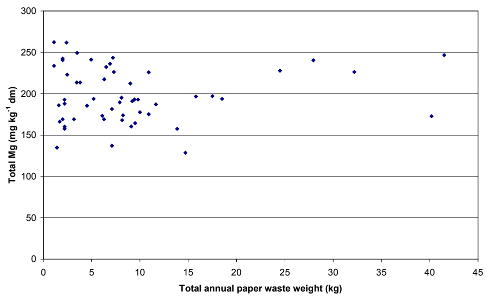
(a)



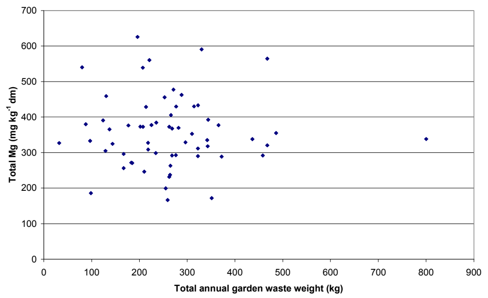
(b)



(b)



(c)



(c)

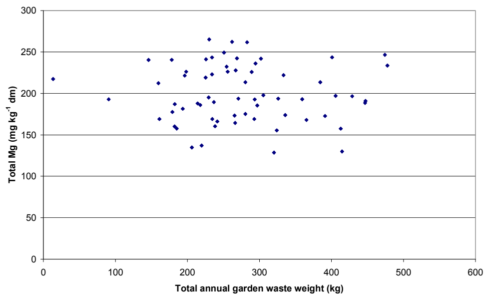


Figure 6.8 Total Mg content of composted residue removed from the bins in (i) May 2001 and (ii) April 2002 in relation to total annual (a) food, (b) paper, (c) garden wastes deposits

(i) May 2001 **(ii) April 2002**

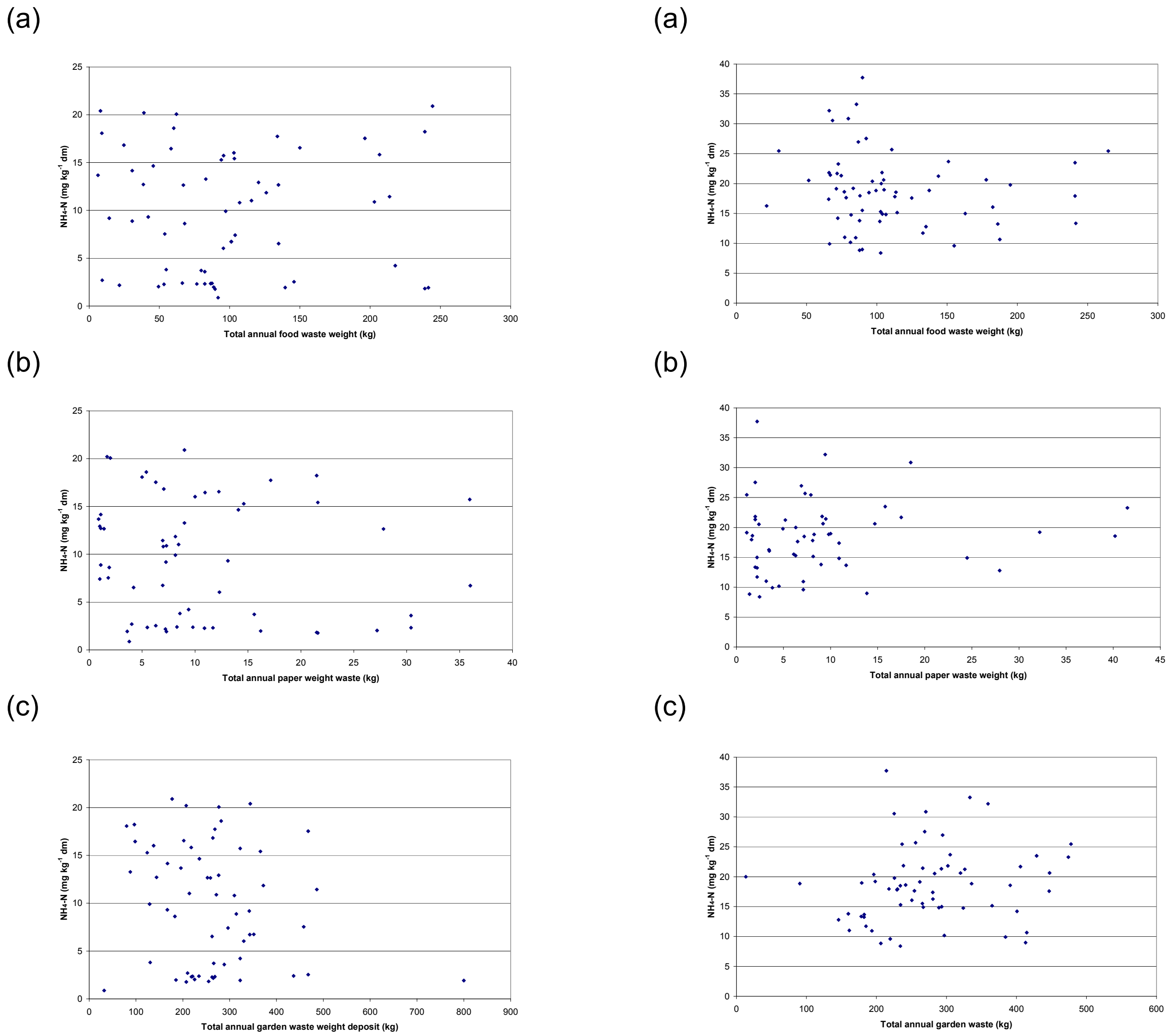


Figure 6.9 **NH_4-N content of composted residue removed from the bins in (i) May 2001 and (ii) April 2002 in relation to total annual (a) food, (b) paper, (c) garden wastes deposits**

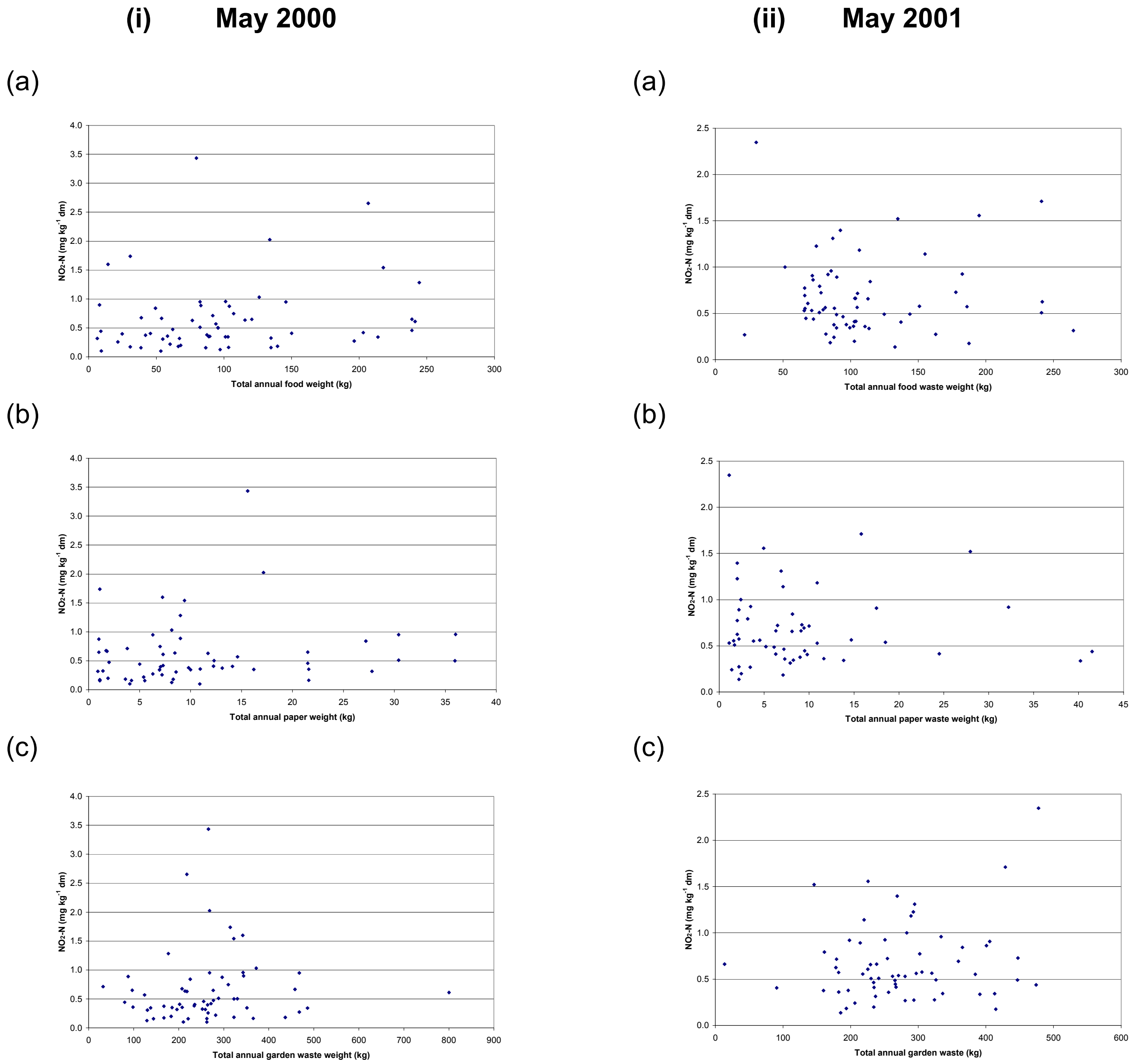
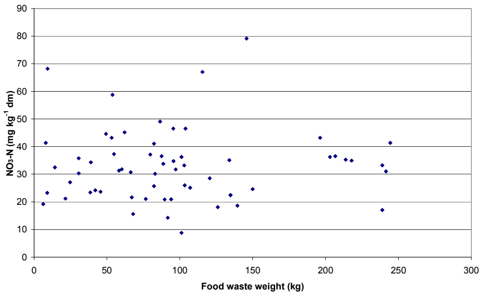


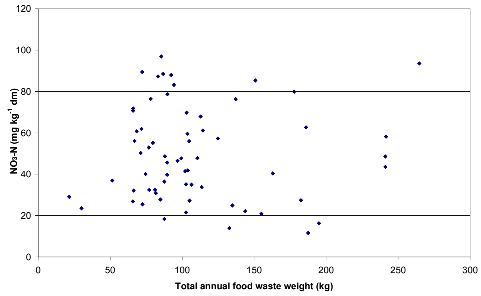
Figure 6.10 **NO_2-N content of composted residue removed from the bins in (i) May 2001 and (ii) April 2002 in relation to total annual (a) food, (b) paper, (c) garden wastes deposits**

(i) May 2001 **(ii) April 2002**

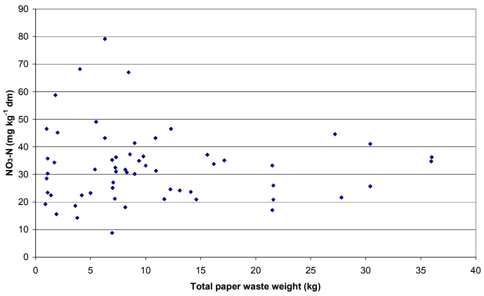
(a)



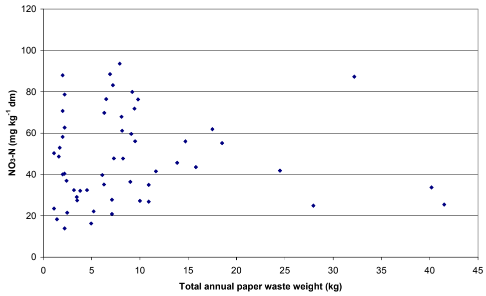
(a)



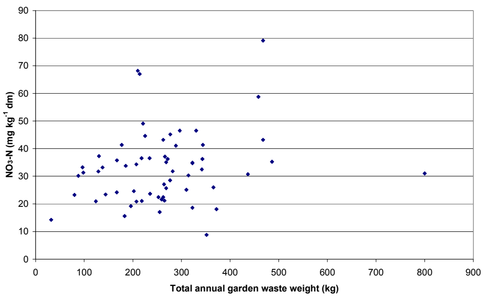
(b)



(b)



(c)



(c)

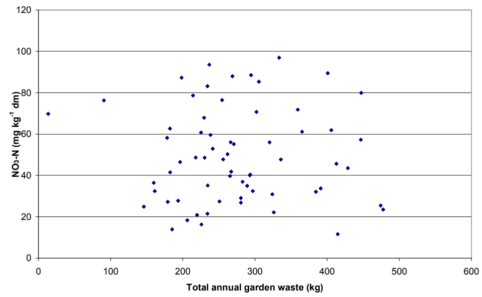


Figure 6.11 NO_3-N content of composted residue removed from the bins in (i) May 2001 and (ii) April 2002 in relation to total annual (a) food, (b) paper, (c) garden wastes deposits

(i) May 2001 **(ii) April 2002**

(a) (b) (c)

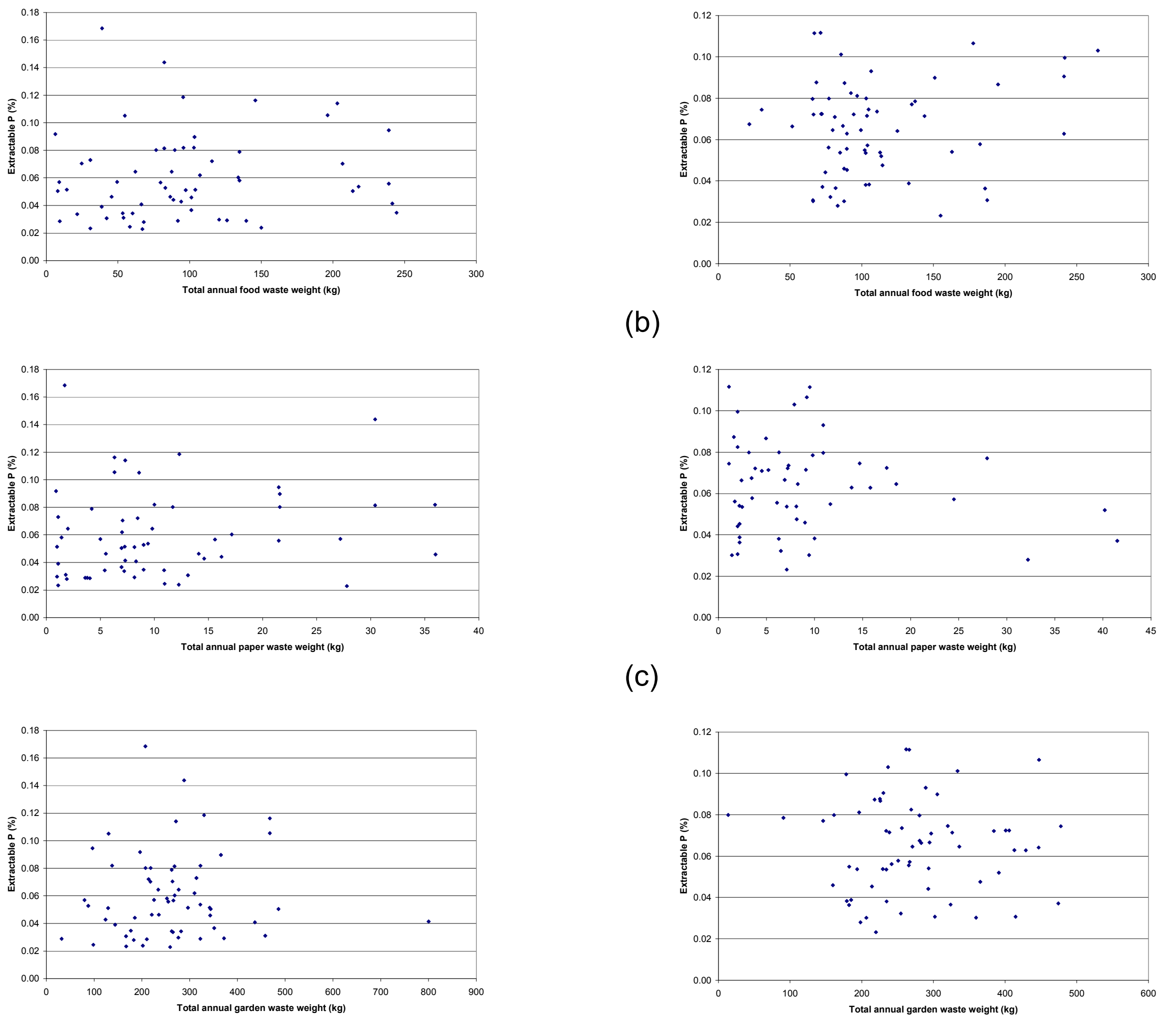


Figure 6.12 Extractable P content of composted residue removed from the bins in (i) May 2001 and (ii) April 2002 in relation to total annual (a) food, (b) paper, (c) garden wastes deposits

The mean and median pH values of composted residues were approximately neutral (pH 7) during years 1 and 2, although values ranged between a minimum of pH 5.6 and a maximum of pH 9.3 (Table 6.4). There was some variability between pH values and the different waste deposits (food, paper and garden) and pH values measured in year 2 were more alkaline than during the first monitoring year. However, overall pH values of composted residues were independent of food, paper and garden wastes for each monitoring year (Figure 6.3).

There was no relationship between electrical conductivity (EC) and the composted residues of either food, paper and garden wastes for either monitoring year (Figure 6.4). The mean EC of the materials examined was smaller in the first year compared to the second but this was most likely attributed with the greater variability between the minimum and maximum values measure (Table 6.4)

In general, concentrations of total and extractable nutrients (N, P, K, Mg, NH_4-N and NO_3-N increased in the second year compared to Year 1 (Table 6.1). In several cases there was up to 10 fold variation in the minimum and maximum concentrations of nutrients measured in the composted residues across both years of the monitoring programme. Non of the chemical properties of the composts were correlated to the input amounts of food, paper or garden waste.

6.4 COMPOST QUALITY AND MANAGEMENT TREATMENT EFFECTS

There were relatively few significant correlations between compost chemical quality and the main experimental treatment factors (garden size, accelerator addition, earthworm inoculum and mixing) and in general, these were inconsistent between monitoring years (Table 6.4). For example, garden size had a highly significant effect on Total P concentrations during year 1 but did not have a significant effect in year 2. In general, in year 1 garden size had a significant effect on P, NH_4 and NO_3 concentrations and Mg values were significantly related to addition of the accelerator. In the second monitoring year earthworm incoulum and mixing were the only experimental parameters that had a significant effect on the chemical properties, which in this case was dry matter, organic matter, pH, K, Mg, No_2 and worm count. Nevertheless, some significant effects were consistent between monitoring years such as addition of the accelerator on EC and earthworm inoculum and extractable P concentrations.

The data presented here suggests that the reliability of these associations is reduced due to the large residual variation in the chemical characteristics data of compost residues. However, the differences and inconsistencies within the data are likely to be an artefact of the restricted control of experimental factors. For example, the frequency of accelerator addition and mixing was under homeowner control and the accelerator formulation (Garotta) added in the second monitoring year had an undisclosed content. Earthworm inoculum was administered at the beginning of the study trial and a reduction of their activity was indicated by the small reduction in worm count (Table 6.4). Furthermore, although garden size was relatively consistent throughout the trial, the extent of fertiliser used by the individual homeowner and the differences in plant debris added to the bin would be highly variable.

6.5 SUMMARY

Chemical properties of home produced composted residues varied between each monitoring year. They were generally larger than reported values for centralised composting (TCA, 2001), but were similar to compost produced from vegetable and kitchen and garden waste materials (Lopez-Real and Vere, 1991).

The quantities and types of waste inputs to the composter are potentially important factors influencing the extent of composting activity in the bin. However, this study has shown that there was no correlation between food, paper and garden waste inputs and chemical properties measured in small-scale compost systems.

The effects of compost properties in relation to compost management treatments were variable and inconsistent. This was attributed to the differences in plant material input, fertilizer use, earthworm activity and the frequency of mixing and accelerator addition.

Table 6.4 Mean chemical properties of home compost in relation to compost bin management treatment (May 2000-March 2002)

Property	Year	Garden size			Accelerator			Earthworm inoculum			Mixing		
		Large	Small	F prob	No	Yes	F prob	No	Yes	F prob	No	Yes	F prob
Dry matter	1	30.5	29.0	0.56	29.3	30.2	0.72	28.5	30.9	0.34	29.9	29.6	0.90
(% FW)	2	36.2	37.1	0.72	37.8	35.5	0.39	40.4	32.8	0.01	35.4	37.8	0.37
OM	1	32.3	33.8	0.72	34.6	31.5	0.45	34.7	31.4	0.42	30.1	36.0	0.15
(% dm)	2	33.1	26.4	0.09	29.9	29.6	0.93	22.7	36.8	<0.01	27.7	31.8	0.29
pH	1	6.98	6.98	0.98	6.98	6.98	0.99	7.10	6.85	0.18	7.15	6.80	0.06
	2	7.55	7.50	0.78	7.52	7.53	0.94	7.17	7.88	<0.01	7.56	7.49	0.76
Conductivity	1	896	818	0.20	938	777	0.01	890	825	0.28	883	832	0.40
($mS\ cm^{-1}$)	2	883	845	0.47	934	795	0.01	873	856	0.74	901	827	0.16
Tot N	1	3.04	3.34	0.24	3.27	3.11	0.52	3.26	3.12	0.58	3.09	3.29	0.43
(% dm)	2	3.40	3.54	0.68	3.43	3.51	0.79	3.20	3.74	0.10	3.37	3.57	0.55
Tot P	1	0.35	0.51	<0.01	0.41	0.45	0.44	0.38	0.48	0.07	0.39	0.48	0.11
(% dm)	2	0.78	0.78	0.93	0.72	0.84	0.13	0.73	0.82	0.26	0.77	0.78	0.91
Tot K	1	2.03	1.85	0.45	1.99	1.89	0.68	1.90	1.98	0.76	2.05	1.83	0.36
(% dm)	2	1.21	1.29	0.38	1.23	1.27	0.70	1.26	1.25	0.91	1.43	1.07	<0.01
Mg	1	359	36	0.87	386	329	0.03	359	356	0.90	347	368	0.40
($mg\ kg^{-1}$ dm)	2	202	197	0.54	199	200.0	0.93	192.2	207.1	0.06	212.6	186.6	<0.01
NH_4-N	1	8.23	11.83	0.01	11.00	9.06	0.16	9.42	10.64	0.38	9.25	10.81	0.26
($mg\ kg^{-1}$ dm)	2	18.98	18.30	0.67	18.05	19.23	0.46	17.31	19.97	0.10	18.18	19.11	0.55
NO_2-N	1	0.57	0.73	0.30	0.67	0.63	0.83	0.69	0.61	0.65	0.74	0.56	0.26
($mg\ kg^{-1}$ dm)	2	0.73	0.61	0.25	0.73	0.62	0.30	0.66	0.68	0.83	0.79	0.55	0.02
NO_3-N	1	37.1	28.6	0.01	30.9	34.8	0.23	32.6	33.1	0.87	33.3	32.4	0.79
($mg\ kg^{-1}$ dm)	2	51.4	47.7	0.50	46.5	52.5	0.28	44.6	54.4	0.07	47.5	51.6	0.45
Extract P	1	0.06	0.06	0.43	0.07	0.06	0.13	0.07	0.05	0.02	0.06	0.06	0.81
(% dm)	2	0.07	0.06	0.72	0.06	0.07	0.05	0.06	0.07	0.03	0.07	0.06	0.30
Worm count	1	41.3	47.0	0.62	38.7	49.6	0.35	42.2	46.1	0.74	52.2	36.0	0.17
	2	43.0	32.9	0.30	36.7	39.2	0.80	33.5	42.5	0.36	49.6	26.4	0.02