Biochemical and Microbial Characteristics of Mature Food and Animal Composts

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Introduction

Studies of composted materials usually focus on the active composting phase and define maturity as the point where the product becomes stable. Compost stability has been correlated with a reduction in microbial biomass, a C/N ratio less than 25, reduction or change in odor, and reduction in carbon dioxide efflux among other parameters. The primary goal of composting is to convert organic waste products into humus or soil like materials. We investigated mature animal and food composts of various ages to evaluate their biochemical and microbiological soil quality characteristics.

Materials and Methods

Compost samples ranging in age from 6 months to 3.5 years were collected from composting operations in Manhattan, Kansas (food and greenhouse waste streams, Figure 1 below) and Martin, Tennessee (food, animal, leaf and bedding material waste streams, Figure 2 below). The age of each compost was determined by talking with the operators at each location and corresponded to individual piles at each location. A composite sample of compost material was collected from each pile in February 2015 and stored at room temperature. Within a week of collection the samples were subdivided for distribution to various laboratories for analysis. All analyses were conducted in duplicate.

One set of samples was dried and sent to the Soil Testing Laboratory at Kansas State University. Analyses performed at the KSU lab included pH (1:1 slurry), cation exchange capacity by ammonium displacement, 1 M KCl extractable ammonium and nitrate, and total N and C using a LECO CN 2000 combustion analyzer. A second set of samples was frozen and sent to UT Martin for analysis of total organic matter by loss on ignition and soluble carbon with a COD digestion. Another set was frozen and sent to Ward's Laboratories, Inc in Kearney, NE for characterization of the soil microbial community by PLFA (phospholipid fatty acid) analysis.

Figure 1: Food and greenhouse waste compost at Kansas State University; waste is stacked and periodically turned.

Figure 2: Food waste compost at UT Martin; waste is collected and covered with used bedding daily.

Results

Table 1: Selected chemical characteristics of compost materials. Data presented are averages of duplicate analyses.

Sample	Age months	pH	CEC meq/100g	NH4-N ppm	NO3-N ppm	Total N %	Total C %
Kansas	6	6.86	24.53	1348	439	0.85	6.41
Kansas	12	7.22	19.93	754	402	0.71	5.54
Kansas	18	6.87	24.69	742	628	0.90	6.98
Kansas	24	7.10	22.53	1010	500	0.95	6.41
Kansas	30	6.75	23.65	67	657	0.70	5.54
Kansas	36	6.46	26.25	86	711	0.73	5.19
Kansas	42	7.00	23.29	89	637	0.97	6.20
TN animal	6	5.46	19.71	640	3065	0.84	14.87
TN animal	12	6.58	19.54	83	414	0.62	11.77
TN food	10	6.87	12.36	328	1	0.62	6.37
TN food	12	7.18	37.26	348	81	1.23	20.02
TN food	20	7.31	17.02	283	4	0.80	8.91
TN food	24	6.48	19.84	104	95	0.73	10.7
TN food	36	7.10	18.83	226	7	0.48	6.45
TN leaf	36	7.04	60.74	97	165	1.14	20.47
$LSD_{.05}$		0.45	11.19	390	738	0.19	5.07

Discussion

All of the samples had characteristics of mature compost as indicated by C/N ratios below 25 (Figure 3) and soluble C values in the range of 100-200 mg C/g (Figure 4), values that are typical of organic rich soils. With the exception of expected variations in the concentrations of NH_4-N and NO_3-N, the data in Table 1 show little temporal variability in the chemical parameters associated with each compost type.

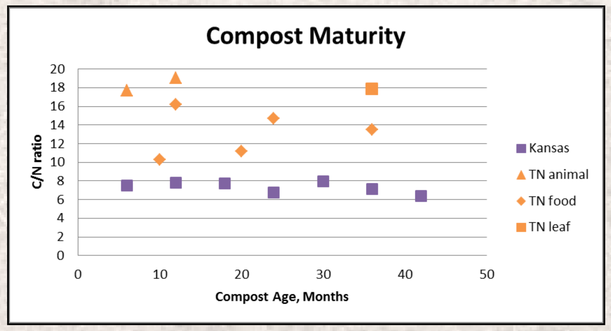


Figure 3: Compost maturity as indicated by C/N ratio. As shown here the Kansas State product is a more consistent material.

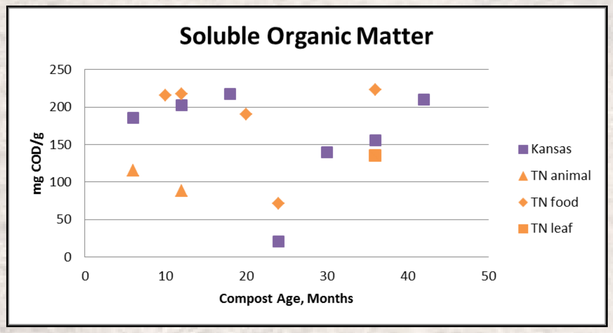


Figure 4: Soluble organic matter extracted from the compost materials.

Although the composts were mature according to chemical and biochemical evaluations they were still changing as evident in the microbial community data presented in Figures 5 and 6. According to Ward Laboratories' classification of these data all of the samples are given a 'very good' to 'excellent' rating (values greater than 3500 ng PLFA/g) for living microbial biomass.

In Figure 6 there was a noted decrease in the amount of total fungi and gram(-) bacteria with age of compost.

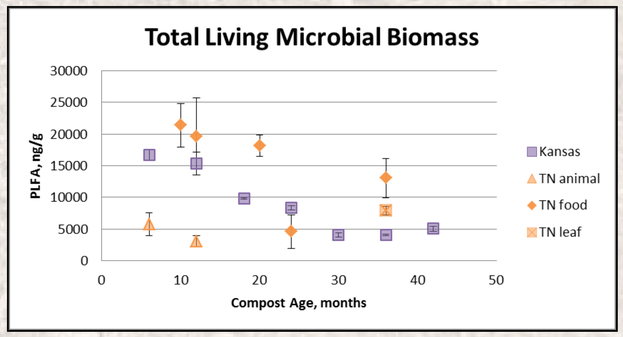
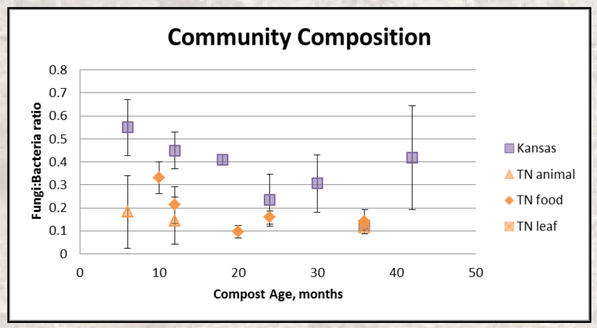
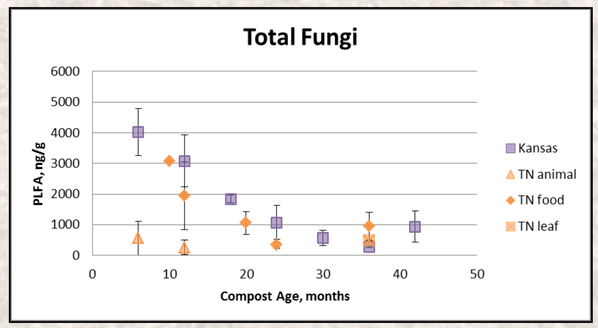
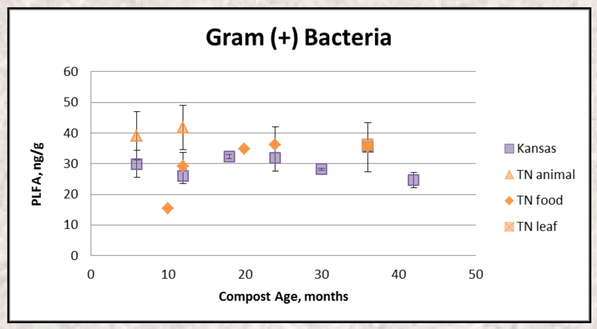


Figure 5: Total living microbial biomass of the compost samples as measured by PLFA analysis.







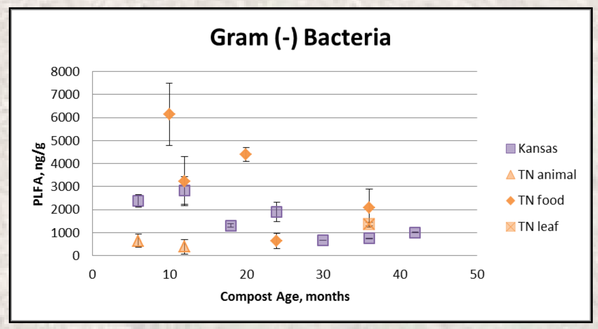


Figure 6: Distribution of living microbial biomass of the compost samples as measured by PLFA analysis. Data points are averages of split samples and error bars represent ± one standard deviation.

Conclusions

These data demonstrate that compost maturity can be evaluated using a variety of chemical and biochemical parameters. Soil microbial community testing using PLFA analysis can add a new dimension or quality evaluation to compost maturity. Future studies will look at the genomic DNA extracted from these samples.

Acknowledgements

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