

# Fate of Pesticides in Calcutta's Municipal Solid Waste: Effect of Composting

## INTRODUCTION

The solid waste arising from human activities has become one of the major environmental problems causing extensive pollution and posing many threats to human health (1). About 3500 Mg of municipal solid wastes (MSW) are generated daily in the city of Calcutta (2). Composting MSW is becoming increasingly recognized as a viable and economical method for waste management throughout the world, causing less environmental pollution than other waste management methods. There are, however, some concerns about potential health hazards related to organic contaminants contained in compost (3). The potential impact of toxic organic compounds on the environment is a function of the levels of concentration of these compounds, many of which are toxic not only to humans and animals, but also to plants.

Feedstock used for the composting process may originate from a number of different sources, including yard trimmings, manure, biosolids, and agricultural residues. These materials may contain a number of xenobiotics, including heavy metals and pesticides. These toxic compounds in the MSW compost mainly stem from the disposal of industrial, commercial, and household wastes. Household wastes discharged into the MSW stream contain oils, solvents, pesticides, and many other toxic organic compounds. Data on toxic organics in MSW composts are limited. Much is known about the behavior of pesticides in the environment; however, relatively little is known of the content and composition of pesticides in wastes and composts. The purpose of the present study is to characterize the compost generated from the Calcutta MSW with respect to its different pesticide contents.

Ten samples of MSW and compost were collected from an East Calcutta

landfill site. The MSWs were composted aerobically by a fast-fermentation method using a selected microbial culture at the Calcutta landfill site.

Reaction (pH, 1:2.5 water) of wastes and composts were determined with a pH meter. Total organic carbon was determined by the method of Nelson and Sommers (4). Total extractable carbon, humic acid carbon, and fulvic acid carbon were determined according to the method of Kononova (5). The degree of humification (DH) was calculated by the method of Ciavatta et al. (6) (1993) as follows:

$$DH(\%) = (HA + FA)TEC \times 100 \text{ Eq. 1}$$

where HA, FA, and TEC represent the humic acid, fulvic acid and total extractable carbon respectively. Statistical analyses were performed with the help of IRRISTAT statistical package (version 3/93) developed by IRRRI, Philippines.

The compost samples (50 g) were extracted for 6 hr using a Soxhlet apparatus fitted to a 250 mL round-bottomed flask containing a 200-mL mixture of dichloromethane, acetone, ethyl acetate, and cyclohexane (2:1:1:1 vol:vol:vol:vol) and few antibumping granules. The extract was evaporated by a rotary vacuum evaporator at 40°C. The concentrated mass was transferred to a silica column prewashed with hexane. The column was eluted with 150 mL hexane:ethyl acetate (1:1) mixture. The organic fraction was collected by passing through anhydrous sodium sulphate. The eluate was evaporated to dryness, redissolved in hexane, passed through 0.45 µm-membrane filter and analyzed using gas chromatography. A gas liquid chromatograph (Hewlett Packard 5890 series) equipped with a 3392A integrator and Ni<sup>63</sup> electron capture detector was used for final determination utilizing a DB 1701 capillary column. The column temperature was fixed initially at 160°C for 1 min and then

increased to 250°C at the rate of 3.5°C min<sup>-1</sup>; the final temperature was maintained for 10 min. The temperature of injector and detector were maintained at 230°C and 250°C, respectively. The flow rate of carrier gas (N<sub>2</sub>) was adjusted to 60 mL min<sup>-1</sup>.

A comprehensive study was carried out on the contents of 15 different pesticides from 10 different batches of MSW compost, collected in different periods of time. The detailed results are shown in Table 1.

During composting, pH value significantly increased due to degradation and mineralization of organic compounds (Table 1). Total organic carbon decreased during composting; this was due to microbial oxidation of the most labile forms of carbon, causing part of the carbon to be given off as carbon dioxide. One of the main aims of the composting process is that of modifying the fresh organic matter to stabilize it by means of accelerated processes of humification. It therefore seemed interesting to verify possible variations in the distribution of organic carbon between the two most commonly studied parts of the organic matter, FA and HA. Composting significantly increases HA with respect to FA indicating the stabilization of organic matter. Composting also significantly increases the degree of humification.

The total pesticide contents are given in Table 2. The analysis of total content of different pesticides helps in the assessment of the degree of pollution. The present studies have shown significant decreases in detectable pesticides after composting. Lemmon and Pylypiw (7) had similar findings. According to Epstein in a Minnesota study (8), out of the 129 priority pollutants analyzed for MSW, most were detected in the compostable fraction but not in the compost. Most of the compounds were lower in the composted material than in the fresh feedstock.

**Table 1. Organic carbon, pH and different carbon fractions in municipal solid waste and compost.**

Sample	pH	Organic-C (g/kg)	TEC	TEC /Organic-C (%)	HA (g kg <sup>-1</sup> )	HA /Organic-C (%)	FA (g/kg)	HA / FA	DH (%)
Waste	7.0	115.0	25.4	22.0	9.0	8.0	4.0	2.3	51.0
Compost	7.2	108.0	33.2	31.0	15.0	13.8	5.0	2.8	60.2
LSD at 0.05P	0.035	0.52	0.55	0.42	0.35	0.45	0.38	0.04	0.46