CO-COMPOSTING SEWAGE SLUDGE AND FATS. OPTIMAL RATIOS AND PROCESS EVOLUTION

T. Gea, A. Artola, A. Sánchez
Escola Universitària Politècnica del Medi Ambient (Universitat Autònoma de Barcelona)
Rbla. Pompeu Fabra 1, 08100 - Mollet del Vallès (Barcelona, Spain) asanchez@eupma.uab.es

ABSTRACT

At present, composting is used in the treatment of a wide number of organic wastes. Among them, fat from food processing industry or slaughterhouses comprises a waste considered as difficult to be composted. The main problems associated with fat composting are: low water content and solubility, lack of porosity and a relatively low biodegradability of some fats. In the present work, laboratory experiments using sewage sludge as basic substrate for composting and increasing amounts of a typical fat waste are presented. Values of routine parameters for composting process, fat content and lipolytic enzymatic activity were monitored in aerated static lab-scale composters. In general, fat content could be increased up to 40 %, showing positive effects on the composting of sewage sludge. Thermophilic period was maintained for longer times, which contributed to achieve a complete sanitation of the material. For higher amounts of fat content, however, oxygen diffusion was severely hampered. On the other hand, high lipolytic activities were an evidence of production of specific enzymes to degrade the fat-enriched material. In conclusion, co-composting with sewage sludge or other organic substrates can be considered as a viable alternative to treat fat wastes in high proportions up to 40 % although a maximum proportion of 20% may be recommended to avoid large composting periods.
Keywords: *fat, sludge, composting, lipolytic activity.*

INTRODUCTION

Composting has proved to be a suitable technology for succesfully treating and recycling a wide number of organic wastes into compost. Fat from food processing industry or slaughterhouses comprises a waste considered as difficult to be composted. The main problems associated with fat composting are: low water content and solubility, lack of porosity and a relatively low biodegradability of some fats. Few literature about fat, oils and greases (FOG's) composting can be found. Composting experiences dealing with FOG's are refered mainly to vegetal oil or greases from wastewater treatement plants (WWTP) (Lemus and Lau, 2002a). To our knowledge composting experiences with those wastes have been undertaken with FOG content below 20% (Lemus and Lau, 2002b).

At this moment composting plants are receiving organic wastes from agroalimentary industries, food processing industries, slaughterhouses, etc., with a high fat content. The lack of information about the effect of fat content in the composting process means a problem for plant managers. The aim of this work is to do a preliminar study on the effect of fat content in the composting process. Anaerobically digested sludge was choosen as basic substrate. Animal fat was added to sludge in increasing amounts from 0 to 80% wet basis. The composting process of these mixtures was studied in terms of temperature profiles, weight reduction, fat content evolution, and lipolytic activity.

MATERIALS AND METHODS

Animal fat was added and mixed to anaerobically digested sludge in amounts ranging 0 to

80% in wet weight. Wood chips were added to the sludge-fat mixture as bulking agent in a volumetric ratio 1:1, previously found as optimum (Gea et al., 2003). Experiments of fat-enriched sludge composting were carried out in two trials. In the first trial, fat contents from 0 to 40% were tested, composting 1200 g of total mixture for 30 days. 60 and 80% fat content tests were undertaken in a second trial, during which 1600 g of material were composted in each experiment for 21 days. All mixtures were hand made.

Composting experiments were performed in isolated 4.5L static lab-scale reactors, monitoring temperature and oxygen content. Air was supplied to the vessels to ensure aerobic conditions during the composting period.

Water content, total organic matter content (TOM) and Respirometric Index were determined according to standard procedures (U.S. Department of Agriculture, 2001). Lipid content was measured by Soxhlet extraction method using n-heptane as organic solvent. Lipolytic Activity analysis was based on the lipase colorimetric assay LIP (Roche kit 1821792) (López et al., 2002) after extraction of lipase from a compost sample using Tris 400mM $CaCl_2$ 10mM buffer at 30ºC and pH 8.0.

RESULTS AND DISCUSSION

As said above, sludge composting experiments were carried out with different added amounts of fat. The initial parameters for the different mixtures studied are shown in Table 1 as well as the results obtained in the composting process.

Table 1. *Initial and final parameters and weight and fat content reduction in fat composting experiments.*

Experiment	Initial water content (%)	Inicial TOM content (%)	Fat content reduction (%)	Weight reduction (%)	Final Respirometric Index (mg O_2• g MOT^{-1}•h^{-1})
Control	55.2	82.6	29.5	12.6	1.18
10% fat	52.8	86.2	63.2	17.6	
20% fat	47.0	88.6	56.6	19.8	
40% fat	34.4	92.7	70.6	28.8	3.95
60% fat	22.8	95.9	33.6	10.7	5.23
80% fat	12.5	98.1	12.2	1.8	1.75

Figure 1 shows the temperature profile for the composting experiments undertaken. Breaks in figures f and g correspond to system failures. Temperatures near 60ºC were reached in all the experiments except the control experiment with no fat added and the experiment with 80% fat content where temperatures over 48ºC were not achieved due to the low water content and the lack of porosity of the resulting mixture. Mixtures with 40% and 60% fat content also presented low initial water content, but the energy content of the mixtures allowed the proper development of the composting process. Longer thermophilic periods were observed for increasing amounts of fat up to 60% mainly due to the high energy content of animal fat.

Table 1 shows the respirometric index obtained at the end of the experiments. Mixtures with fat presented a high level of biological activity after the studied composting period while control experiment with no fat added showed lower values. The high energy content and low biodegradability of fats compared to other organic substrates commonly used for composting implying longer composting times requirements for complete substrate biodegradation and stabilisation. For that reason a maximum value of fat content about 15-20% should be recommended.

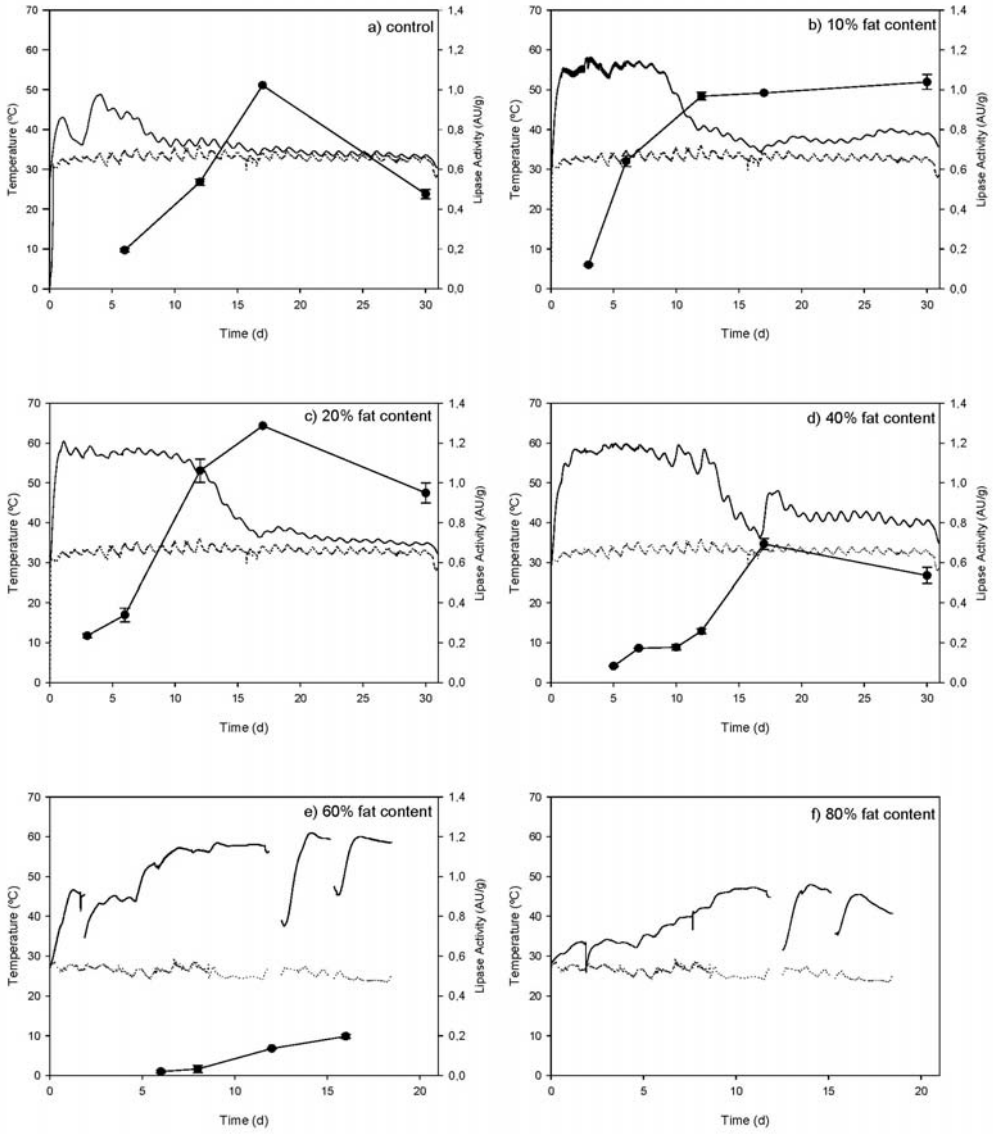

Figure 1. *Temperature evolution (solid line), room temperature (dotted line) and lipolytic activity (circles) obtained in fat composting experiments.*

Figure 1 also shows the lipolytic activity measured for the different experiments. The detected lipolytic activity increases with fat content to decrease when fat content over 40% is reached. In the experiment with 80% fat content no lipolytic activity was detected. Enzymes are linked to the solid phase were their substrate may be found (Boczar, 2001) When increasing the organic phase (e.g. fat content increased), the extraction method used was not efficient in the extraction of the enzyme adsorbed in the organic phase and a more efficient enzyme extraction method should be used (Gessesse, 2003). The detected lipolytic activity increases with composting time reaching maximum values at the end of the process in the maturing mesophilic phase. This can

be due to the fact that lipolytic activity was measured at 30ºC and thermophilic enzymes working in the earlier phases of composting process may not show significant activity at these temperatures. A reliable and fiable lipolytic activity determination analysis should be carried out at the process temperature at the moment of sampling, indicating the real biodegradation activity which is taking place in the composting environment.

CONCLUSIONS

Composting is a suitable technique for treatment of wastes with high fat content. Fats can be co-composted with other wastes with complementary characteristics, for example, low C/N ratios.

The higher the fat content is, the longer the thermophilic phase is maintained in the composting matrix. Maximum fat content around 20% may be recommended, as bigger amounts would lead to long composting periods not viable for industrial composting.

Fat can also be used for co-composting materials with low energy content so thermophylic range can be reached and hygienization of these materials can be achieved.

A more efficient lipase extraction method must be used when treating wastes with high amounts of fat content.

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