SEWAGE SLUDGE DISPOSAL: THE COMPOSTING OPTION

Thesis presented in fulfillment of

the requirements for the

Degree of Master of Technology

in Biotechnology

at Massey University

Carlo Bogoni

October 1988

ABSTRACT

The objective of the present studies was to explore the possibility of employing composting as a mean of sewage sludge stabilization. A series of composting experiments were performed using dewatered secondary activated sewage sludge from a domestic wastewater treatment plant in New Plymouth, New Zealand. These trials have been carried out treating the sludge in both open and closed composting systems on a laboratory scale. Two open system methods, one aerated windrow and one static pile, and three closed experiments using a compostumbler were performed. Throughout the whole study woodchips (in varying ratios) were used as a bulking agent.

An initial moisture content of nearly 60% in the sludge - woodchips mixture produced the highest degree of composting activity over a three week period.

Biological drying during the process was indicated by an increase in total solids up to values between 17% and 27%.

Partial stabilization of the organic fraction was indicated by a decrease in volatile solids of 28% - 50%. In two closed system trials a total carbon decrease of 26% - 42% was observed, serving as an additional indication that there had been a reduction in organic matter.

Total nitrogen losses were substantial in all experiments. Reductions were in the range of 14% - 58% with the highest

losses observed in the static pile experiment.

Phosphorus was found to be stable with only minor concentration changes observed.

Temperature development in the composting material followed the well known pattern, provided that the factors influencing the composting process were close to optimal. Temperatures approaching 70°C in the initial stage of the process were measured.

Bacteriological studies indicated, that the final composted product was not free from microbial hazard. In one closed system trial, however, no entero-streptococci were observed, indicating a complete inactivation of these indicator microorganisms.

Ongoing development of the composting systems used, including improvements of methodologies employed is necessary in conducting further investigations.

ACKNOWLEDGEMENTS

I acknowledge the assistance of many people within the Department of Biotechnology, Massey University, during the course of this work. In particular Dr R. Bhamidimarri and Dr G. Manderson for their advice and guidance throughout; Dr R. Chong for his suggestions concerning parts of this work; Messers J. Alger and B. Collins for their assistance in setting up the experimental equipment; Mr M. Stevens and all the laboratory technicians from the Biotechnology Department for their help in familiarizing me with the laboratory and its equipment; Mr J. Sykes for performing the carbon analyses; the laboratory staff in the Food Technology Department for their patience and never ending humour in coping with rather unfamiliar smells caused by the special and often quite unpleasant characteristics of the samples treated in their laboratory. I also acknowledge the assistance of Mr L.D. Currie and his laboratory technicians in the Soil Science Department at Massey University for sharing their competence in performing the analytical work in their laboratory.

The thesis could not have been finished in a relatively short time without the guidance of my friend Peter McAllister. His continuous support in helping me use the different software packages during thesis preparation is deeply appreciated. All our innumerable, often quite humorous and certainly always useful discussions throughout these studies will always be remembered.

I also would like to acknowledge Dr L. Broad from the Dairy Research Institute for his advice concerning the statistical analysis and Beverly Hawthorn, Patty Comiskey and Lucy Cruz for their patient help in completing the final typing work.

There are many people outside Massey University who really contributed in an invaluable manner to make my stay here in New Zealand a great and successful experience. It would be impossible to mention all the names at this occasion, nevertheless I am very grateful to all of them. Among them I would particularly like to express my deepest appreciation to Mrs D. Harrison and her extended family and also to Mr W. & Mrs J. Barnett, all from Palmerston North. Finally I wish to thank my family back home for their continued encouragement and also my dear friend Dianna Tawharu, from Palmerston North, for her kind company and support during my stay in New Zealand.

This work was granted by a scholarship from the City Council of New Plymouth, New Zealand. This support is sincerely acknowledged.

TABLE OF CONTENTS

TABLE OF CONTENTS: continued

TABLE OF CONTENTS: continued

TABLE OF CONTENTS: continued

TABLE OF CONTENTS: continued

TABLE OF CONTENTS: continued

TABLE OF CONTENTS: continued

TABLE OF CONTENTS: continued

LIST OF TABLES

LIST OF FIGURES AND PLATES

LIST OF FIGURES AND PLATES: continued PAGE

LIST OF FIGURES AND PLATES: continued PAGE

ABBREVIATIONS AND SYMBOLS USED IN THE TEXT

$B_{95\%}$: 95% confidence interval on the mean

BEA: Bile Esculin Azide

C: Carbon

^{o}C: Degree Celsius

CFU: Colony Forming Units

C/N: Carbon to nitrogen ratio

F: F-ratio of mean sums of squares

g: Gram

h: Hour

kg: Kilogram

l: Liter

m: Meter

ml: Milliliter

MPN: Most Probable Number

N: Nitrogen

P: Phosphorus

PCA: Plate Count Agar

s: Standard deviation

TS: Total solids

VS: Volatile solids

v/v: Volume/Volume

w/w: Weight/Weight