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The Biological properties of the compost produced from Sawani Composting Plant

Salah A. Belkher

Department of Soil and Water, Faculty of Agriculture, University of Tripoli, Tripoli – Libya

Abstract
The biological properties (pathogen content) of four compost, composite samples produced from Al Sawani Composting Facility were studied during December 2004, January, February and March 2005, and the results indicated that these samples contained pathogenic bacterial species such as Enterobacter, Escherichia. Spp, Salmonella. Spp, Vibrio. Spp, Proteus. Spp, Klebsiella. Spp, Shigella. Spp, Citrobacter. Spp, Serratia. Spp, Staphylococcus. Spp, Pseudomonas. Spp, Streptococcus faecalis, bacteria forming - spores.
Fungal species that are pathogenic to humans and plants, include Aspergillus flavus, Aspergillus niger, Penicillium Sp, Cladosporium Sp, Geotrichum Sp, Ulicladium Sp.
The results were compared with the international specifications or standards for the quality of compost produced from municipal solid waste, it became clear and all samples were found to be biologically contaminated with bacterial and fungal pathogens in the humans, animals, and plants. This can be attributed to the failure of the operational process to produce mature compost which should end through the final treatment stage, as it is essential to destroy all pathogens.

Regarding the detection of nematodes, ascaris and some parasites, the tests did not show any positive results confirming their presence in the samples studied.

Keywords: Municipal solid waste; Composing; compost; Mature; pathogenic bacterial species; fungal species.

1. Introduction

Composting is an environmental-friendly method to tackle the disposal problem of sewage sludge and municipal solid waste. with appropriate nutrients, porosity, density and moisture content.

(Garcia et al 2000) explained that, the application of compost to the soil may increase microbial biomass and enzymatic activity.

Composting is a biological decomposition process which microorganisms convert raw organic materials into relatively stable humus-like material. During decomposition, microorganisms assimilate complex organic substances and release inorganic nutrients (Metting, 2003).

composting pathogens such as Salmonella typhi, Escherichia coli etc. will be destroyed and the organic matter will be stabilized producing a compost product that can contribute directly to soil fertility and conditioning (Razak, June 2003).

Temperature is generally a good indicator of the biological activity. Temperature above 60°C - 65°C should be prevented because the more sensitive microorganisms may be killed and the decomposition process may be slowed. Nevertheless, a continuing high temperature of 55°C -60°C, lasting beyond 5 to 6 weeks, indicates an abnormally prolonged decomposition and a delayed transition to the stabilization stage (Legg, December 1990).

2.Materials and Methods

2.1 Sampling and preparation:

Samples were taken from the compost produced at the end of December 2004, January, February and March 2005, these samples were taken at three different times (morning, afternoon, evening) homogeneously mixed with same volumes to form one composite sample, then it was placed in a tightly sealed plastic bag and wrote numbers and symbols indicating the sample collecting date then transferred to Microbiology Laboratory for Biological tests and examinations.

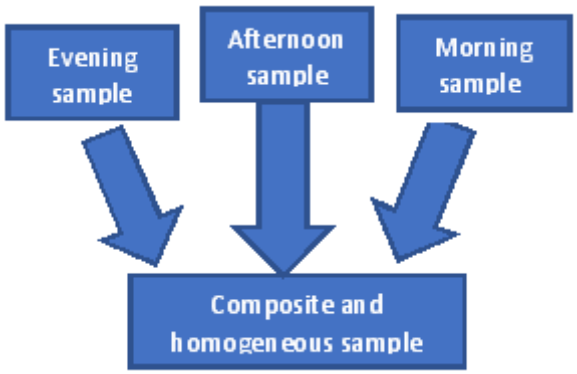

Fig. 1. Sampling Method

2.2 Biological Tests:

2.2.1 **Detection of bacteria**

2.2.1.1 Primary tests

- Bacteria total count (Most Probable Number).
- Total coliforms (MPN).
- Total faecal coliforms (MPN).

2.2.1.2 Basic tests

- **Define the members of Enterobacteriaceae.**
  - Isolate E. coli.

Take 0.1 ml from the cultures of each month (four months), These cultures were streaked onto plates of Eosin methylene blue ager (EMB) and incubated at 37 C° for 24 – 48 h. The results were negative, but shown positive on the 10 ml.

- Differentiation tests between members of the Coliforms group.

  Due to the inability to distinguish between the types of this group by the shape of the colonies, four important tests (IMViC tests) were executed (23), which are:

  i. Indole Test.
  ii. Methyl Red Test.
  iii. Voges Proskauer Test.
  iv. Citrate Utilization Test.

  Other types were also detected by a scheme to distinguish the enteric bacteria family through Biochemical Identification of Enterobacteriaceae tests, which include:

  i. Citrate Utilization Test.
  ii. Urease Test.
  iii. Indole Production Test.
  iv. Triple Sugar Iron Ager Test.
  v. Mannitol Motility Test
  vi. Carboxyl group Test.
  vii. Fermentation of Rhamnose sugar Test
  viii. Ortho - Nitrophenyl – Beta - Galactosidase Test.
  ix. Xylose Fermentation Test.

2.2.2 **Detection of Fungi**

Some fungi species have been detected which include:

Chalara elegans, Cylindro carpodestructans, Fusarium oxysporum, Phythophtora cryptogea, Plasmodiophora brassicae, Pythium ultimum, Rhizoctonia solani, Sclerotinia sclerotiorum.

These Fungi were isolated without specifying a group or type.

- Dilution Plate Method.

  This method is suitable for species that produce spores in large quantities, such as, Aspergills, Penicillium.

- Soil Plate Method.

  In this method, compost particles were scattered on a petri plate containing a culture (P.D.A) and incubated at a temperature of 24 °C for 48 – 72 hours, then examine the growing fungi with microscope.

2.2.3 Detection of Parasites

extracting nematodes by Berman cones method, then examine it with special types of microscopes intended for this purpose.

3. Results and discussion

The results indicate the total numbers of some bacterial species present in compost samples as recorded in table (1) the total number of coliform bacteria is high during January, February and March 2005, while

the total number of fecal coliform bacteria ranges between 23 and 240 cells / g, while there are no Streptococcus bacteria in all samples, Table No. (2) shows the results of IMVC tests.

Table No. (1) total number of bacteria present in the compost samples produced from Sawani Plant.

Month / Year	Bacteria total count	Total coliform	Total faecal coliforms	Total Strepto-coccus
	Cell / g			
12/2004	4×10^{11}	918	31	0
01/2005	5.3×10^{11}	>2400	23	0
02/2005	1.89×10^{11}	>2400	240	0
03/2005	8.47×10^{11}	>2400	31	0

It has been noted from the results of Table (2) that the Enterobacter aerogenes is the dominant Bacteria in all samples except the sample No. (1) which being representing month of March 3 / 05 was dominated by Citrobacter freundii.

Table (2) bacteria species vs IMVIC tests

Sample / Test	December		January		February		March	
	24h1	48h2	24h1	48h2	24h1	48h2	24h1	48h2
I	-	-	-	-	-	-	±	+
MR	-	±	-	-	±	-	+	-
VP	+	+	+	+	+	+	-	+
CI	+	±	+	±	±	±	+	+

(-) No reaction occurred (test is negative).

(+) reaction occurs (test is positive).

(±) Sometimes a reaction occurs and sometimes it does not happen (the result of the test is mixed) .

Fig. 2. Indole Production Test

Fig. 3. Urease Test.

Fig. 4. Methyl Red Test

Fig. 5. Citrate Utilization Test

Fig. 6. Triple Sugar Iron Ager Test

The presence of these pathogenic bacterial species reflects their predominance only under certain conditions Whereas, the other species could be existing but may not be shown by these conditions.

The percentage of oxygen, ventilation, thermal range, pH, humidity, and the type of nutrition source (carbon and nitrogen supply), in addition the biological competition that normally takes place in such conditions are the limiting factors of the bacterial growth.

When comparing the results with the international standards or specifications regarding the quality of the compost produced from municipal solid waste, which stipulated that, the total number of fecal coliform bacteria should not exceed 1000 cell / gram (dry mass in the oven) and no Salmonella Spp, and to completely free of other pathogenic bacteria.

It is clear that all the compost samples that were tested during this study contained pathogenic bacteria, and this is due to the fact that the final product did not pass through the curing phase, which is an important stage to eliminate all pathogenic microorganisms, where temperatures must rise to Thermal death point (55 – 65 C°) for a period ranging 7 – 14 days.

Table No. (3) Pathogenic bacterial species identified in compost samples produced from Sawani Plant during the study.

No.	Genus	Species
1-	Citrobacter	Freundii (others) spp
2-	Enterobacter	Aerogenes Cloacae
3-	Escherichia	Coli
4-	Klebsiella	Spp
5-	Proteus	Spp
6-	Salmonella	Spp
7-	Serratia	Spp
8-	Shigella	Spp
9-	Pseudomonas	Spp
10-	Bacillus	spp
11-	Staphylococcus	. S. epidermidis . S. saprophyticus

Fig. 7. Salmonella spp and Citrobacter freundii

on B.G.A. medium

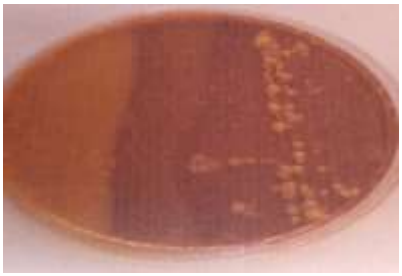

Fig.8. Pseudomonas spp on Deoxycholate

Citrate Ager medium

Fig.9. E. coli and Enterobacter on E.M.B

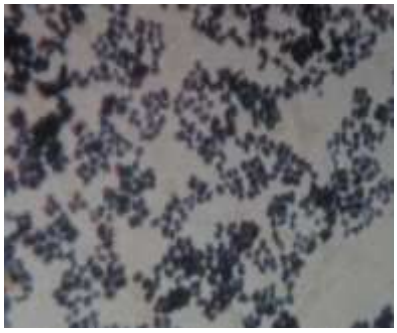

Fig.10.Staphylococcus. Spp

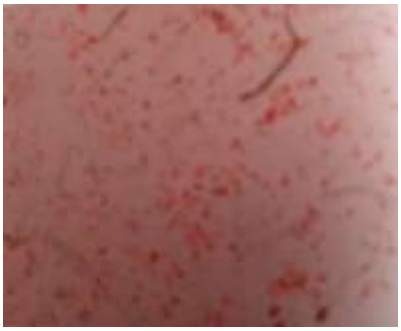

Fig.11.Klebsiella pneumonia

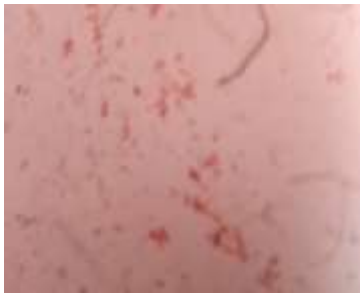

Fig.12.Serritia spp

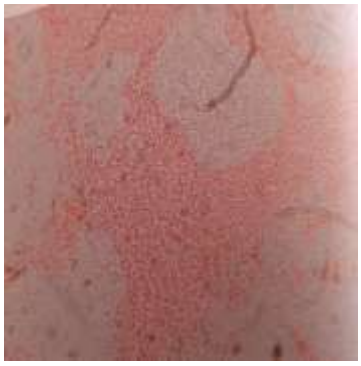

Fig.13. Enterobacter cloacae

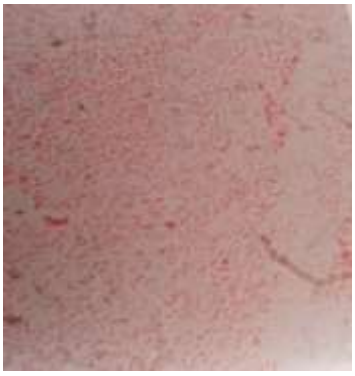

Fig.14. Enterobacter aerogens

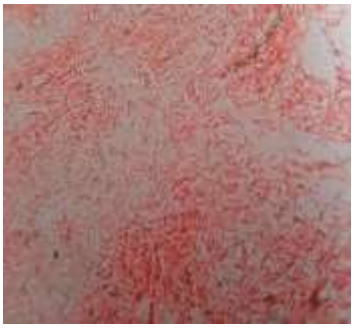

Fig.15.Citrobacter freundii

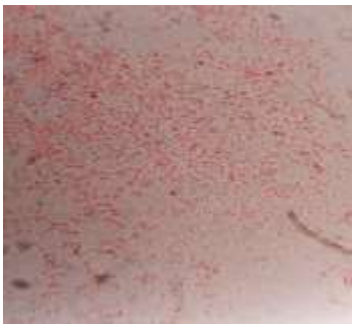

Fig.16.Proteus spp

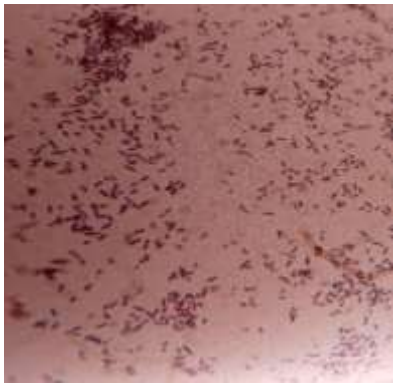

Fig.17.Bacillus spp

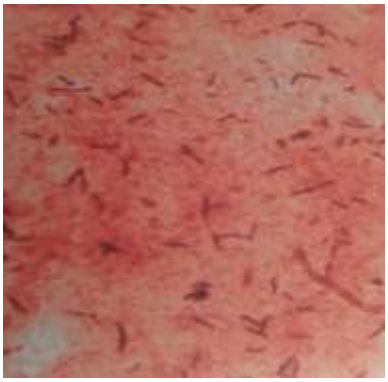

Fig.18. Complex bacterial diversity in

the compost sample - Sawani Plant

As for fungi, it was found after detection the compost samples contained some fungal species as shown in Table (4).

Table No. (4) the fungal species found in the compost samples during the study period.

No.	**fungal species**
1	Aspergillus flavus
2	Aspergillus Niger
3	Penicillium sp
4	Cladosporium sp
5	Geotrichum sp
6	Ulicladium sp

The dominance of these pathogenic fungal species reflects their ability to survive under these particular conditions Whereas, the other species may not could exist due to, the bio competition that takes place between the different fungal species, as the most of them are producing antibiotics and toxins, moreover, the limiting factors such as ; Oxygen supply , nutrition source , pH , …. , etc. are usually determine the growth rate and reproduction period .

As for the detection of nematodes, ascaris and eggs of parasites, no positive results confirming their presence in the studied samples.

Fig.19.Aspergillus niger (front)

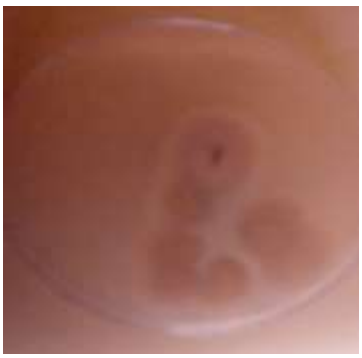

Fig.20.Aspergillus niger (back)

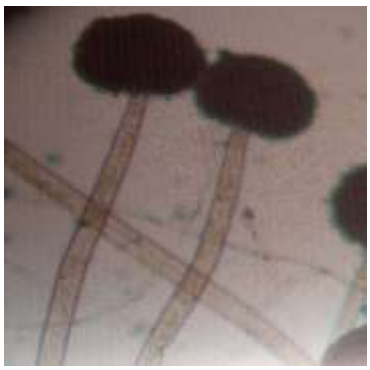

Fig.21.Microscopic view of

Aspergillus niger

Fig.22.Aspergillus flavus (front)

Fig.23.Aspergullis flavus (Back)

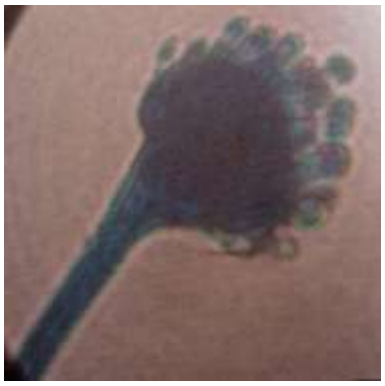

Fig.24.Microscopic view of Aspergillus flavus

Fig.25. Microscopic view of Aspergillus sp

Fig.26.Penicillium sp (front)

Fig.27.Penicillim sp (Back)

Fig.28. Microscopic view of Penicillium sp

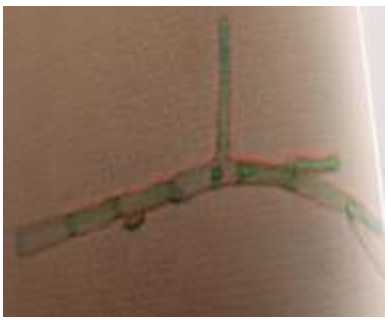

Fig.29. Microscopic view of Cladosporium sp

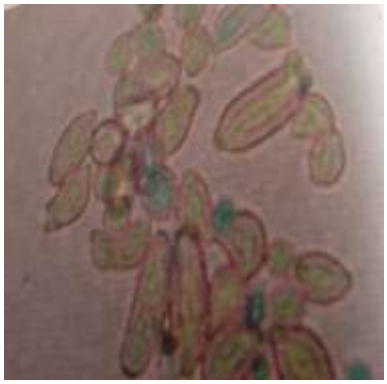

Fig.30.Spors of Cladosporium sp

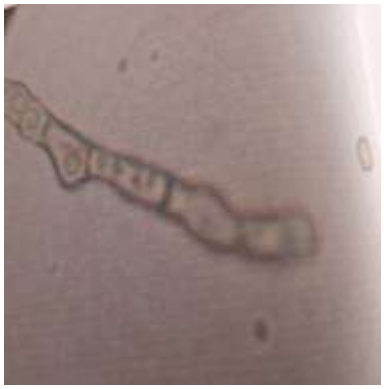

Fig.31. Microscopic view of Ulicladium sp

Fig.32.Spors of Ulicladium sp

Conclusion

It has been found through the study that, the compost content of pathogenic microorganisms (humans, animals, and plants) such as; bacteria and fungi is high.

This result was expected due to, the weak control of the air decomposition process which is namely relay on ventilation (turning the compost windrows), humidity, C/N ratio, and temperature.

for good management of the operational process, the mature compost must go through the curing phase which is important stage to produce final product free of Pathogenic microorganisms.

Thus, it is not recommended to use this compost under these conditions.

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