

**MAIN MICROBIAL GROUPS KINETICS IN COMPOSTING AND  
VERMICOMPOSTING PROCESSES OF CATTLE MANURE**

by

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**Summary**

Microbial kinetics of main microbial groups (bacteria, actinomycetes, and fungi) in composting and vermicomposting of cattle manure were evaluated. Temperature, electrical conductivity (EC) and N and P content were also determined. Bacterial numbers decreased while actinomycetes and fungi populations increased with time. Proliferation of microbial salt-alkaline tolerant species and consumption of easily decomposable compounds and accumulation of complex chemical structures, as well as, deleterious environmental conditions that occurs as temperature decreases and pH and EC increases, could explain the above mentioned changes.

Vermicomposted cattle manure showed higher bacteria and actinomycetes populations than regular composted manure which was attributed to earthworms activity that supplied better microbial growth conditions: higher N content and lower EC and pH.

**Keywords:**

bacteria, actinomycetes, fungi, microbial kinetics

## MAIN MICROBIAL GROUPS KINETICS IN COMPOSTING AND VERMICOMPOSTING PROCESSES OF CATTLE MANURE

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### INTRODUCTION

Intensive cattle production with confined cows and pigs, is generating considerable amounts of farmyard manure in Mexico (around 70 million t year<sup>-1</sup>)<sup>1</sup>. Most of this manure is accumulated outdoors occupying extensive land areas, producing unpleasant odors, fleas, and rats, and undesirable runoffs and infiltrations. All these factors represent pollution risks.

Farmyard manures can be transformed with microbial and earthworm activity in composts<sup>2</sup> and vermicomposts<sup>3</sup>, which are chemically stable, innocuous, and non-toxic. This microbial-mediated biodegradation permits to recycle and to increase the economic value of the farmyard manures. Microbial community influences composting and vermicomposting processes. Biodegradation rate can be modified if the kinetics of microbial population involved and factors-affecting it, are known. At present there is scarce knowledge about microbial communities sucesion.

Total populations of bacteria, actinomycetes, and fungi were evaluated in order to establish the microbial kinetics of main microbial groups in composting and vermicomposting of cattle manure. Some physical and chemical properties, as temperature, electrical conductivity (EC) and nitrogen and phosphorus content, were also determined.

### MATERIALS Y METHODS

The kinetics of bacteria, actinomycetes, and fungi in composting and vermicomposting of cattle manure were determined. Cattle manure was aerobically pre-composted for a month until its temperature reached 20 °C. Beds (20 cm height) of precomposted material were prepared in experimental units consisting of a wooden frame (0.9 m width X 2.4 m length) covered with galvanized iron mesh (6 mm<sup>2</sup>). Half of the beds were inoculated with *Eisenia fetida Sav andrei* (1150 g earthworms m<sup>-3</sup>) and the other half were used as controls. The experiment lasted for 130 days. Temperature (< 20° C) and moisture (70 - 85%) conditions were controlled during this period<sup>4</sup>. Total bacteria, fungi and actinomycetes populations were determined 70, 100 and 130 days after earthworm inoculation. Ten random samples were aseptically collected with a plastic sampler (5 cm diameter and 20 cm depth) and air-dried under shadow. Samples were mixed, ground and sieved

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(mesh 10) and kept in refrigeration before the analysis.

Samples were ten-fold diluted in distilled and sterilized water. An aliquot (0.1 ml) of an appropriate dilution (previously tested) was dispersed over agar plates (Nutrient agar for bacteria, Martin for fungi and Czapek for actinomycetes). The plates were incubated at 28 °C during 3, 7 and 10 days, respectively. Typical morphology colonies were counted<sup>5</sup>. Temperature, EC (conductivity bridge, with 1:5 organic matter:water relation), pH (potenciometric, with 1:5 organic matter:water relation), total nitrogen (microKjeldahl) and phosphorus (molybdo-vanadate in extract, digested with perchloric:nitric acids (4:2)) content, were also determined<sup>6,7</sup>.

## RESULTS AND DISCUSSION

In general, bacterial population decreased while the actinomycetes and fungi increased with time (Figure 1). This changes can be explained by a proliferation of salt-alkali tolerant actinomycetes<sup>8</sup>, a decrease of easily decomposable compounds, and accumulation of complex chemical structures<sup>9</sup>. In addition, deleterious environmental conditions occurred as temperature decreases<sup>10</sup> and pH and EC increases<sup>11</sup> (Table 1).

Vermicomposted cattle manure showed higher bacteria and actinomycetes populations than regular composted manure (Figure 2) which was attributed to earthworms activity that supplied better microbial growth conditions<sup>12</sup>: higher N content and lower EC and pH (Table 1).

Changes along earthworm gut were described as follows<sup>13</sup>: in the anterior part, water and soluble organic matter (mucus with CaCO<sub>3</sub>) are added to the ingested material, so microflora and pH increase. In the median and posterior parts of the gut, where a micro-aerophilic conditions exists, the activated microflora digests soil and organic matter. However, nutrients starvation and aerobic conditions decrease microflora activity in casts<sup>14</sup>. The previous behavior is showed by *Allolobophora*

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*molleri*<sup>13</sup>, *Milsonia anomala* and *Pontoscolex corethrurus*<sup>15</sup>, *Amyntas corticis* and *A. gracilis*<sup>14</sup>, *Hyperiodrilus africanus* and *Eudrilus eugeniae*<sup>16</sup>. In earthworm gut there are microbicidal and microbiostatic substances<sup>17</sup>, also.

The number of bacteria, actinomycetes and fungi is also affected by microbial adaptation to drilosphere conditions<sup>12,17,18</sup>. As instance, it has been shown that total bacteria and fungal propagules were higher in casts than gut of *Pheretima* sp<sup>19</sup>. Similarly, bacteria and actinomycetes populations increased after passing the gut of *Lumbricus terrestris*, *Allolobophora caliginosa* and *A. longa*, while fungi decreased<sup>20</sup>. In spite of earthworm predation habits<sup>21</sup>, *E. fetida* in rabbit manure, selectively, increased four times fungi and reduced 82% bacteria populations<sup>10</sup>.

Progress in maturity of compost and vermicompost determined temperature dropping<sup>22</sup>. Relatively higher acid production in vermicompost than compost (Table 1) were imputed to organic acids, produced by metabolic activity of actinomycetes and fungi populations, which were enhanced due to earthworm (Figure 2).

## CONCLUSIONS

Microbial succession studies in composting and vermicomposting are important in defining the microbial groups that can modify biodegradation process rate. The control of factors affecting microbial activity could help to recycle waste organic residues, whose accumulation represents a pollution trouble.

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Table 1. Physical and chemical properties 70 and 130 days of Cattle Manure Composting and Vermicomposting.

Type	Temp (°C)	pH <sup>§</sup> (1:5)	EC <sup>¶</sup> (1:5) (dS m <sup>-1</sup> )	N <sup>‡</sup> (%)	P <sup>#</sup> (%)
<u>70 days</u>					
Compost	16	9.0	19.2	2.2	0.7
Vermicompost	16	9.0	8.3	2.0	0.7
<u>130 days</u>					
Compost	11	8.9	18.8	2.1	0.7
Vermicompost	11	8.8	10.0	2.0	0.7

<sup>§</sup> potentiometric, organic matter:water relation (1:5)

<sup>‡</sup> Kjeldahl

<sup>¶</sup> conductivity bridge, organic matter:water relation (1:5)

<sup>#</sup> molybdo-vanadate in extract digested with perchloric: nitric acids (4:2)

Microbial number, cfu g<sup>-1</sup> dry matter

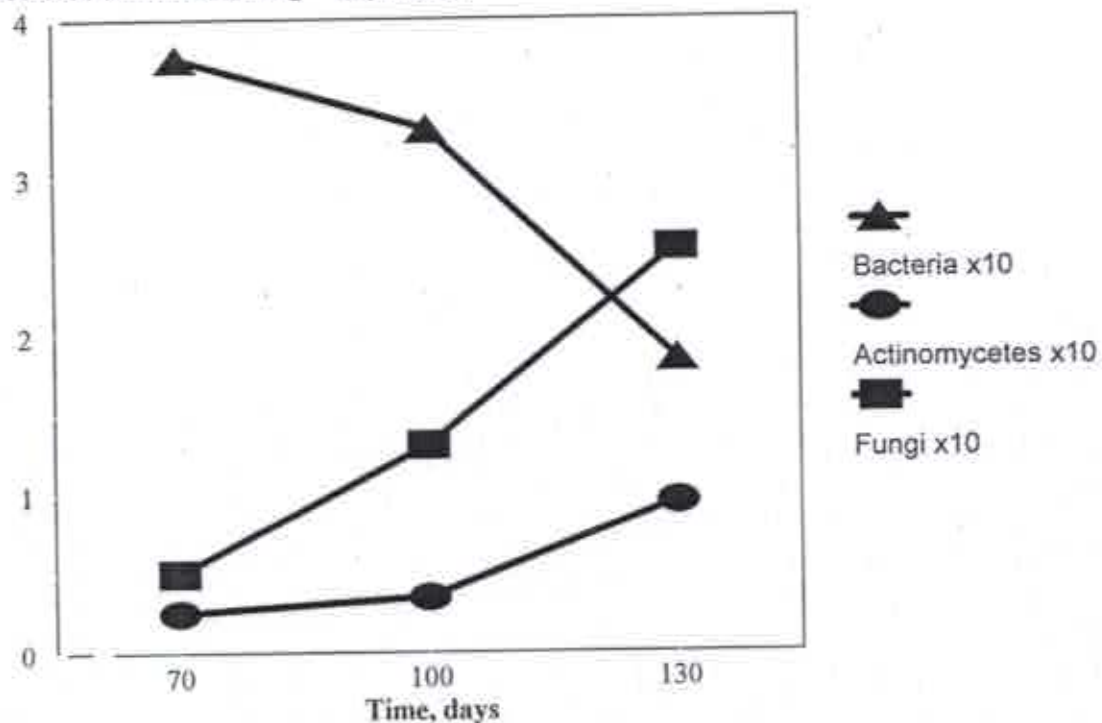


Figure 1. Main microbial groups kinetics during compost and vermicompost production (cfu = colony forming units).

Microbial population (cfu g<sup>-1</sup> dry matter)

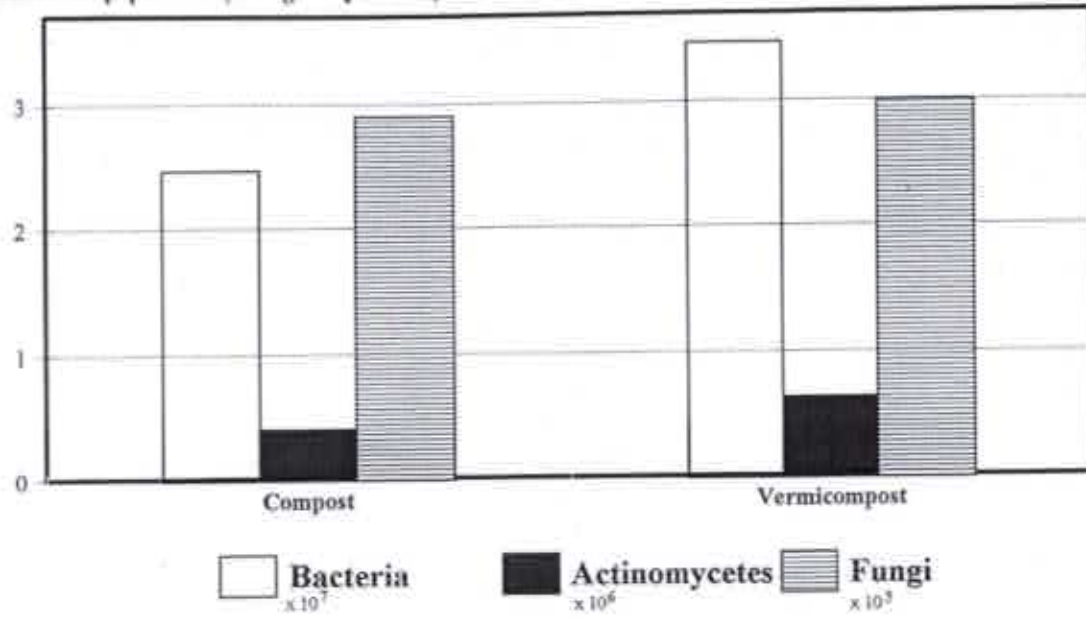


Figure 2. Main microbial populations in farmyard manure compost and vermicompost (cfu= colony forming units).