Carbon dioxide and methane emissions during composting and vermicomposting of sewage sludge under the effect of different proportions of straw pellets

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1. Introduction

- Sewage Sludge(SS) is a residual, semi-solid material that produced as a by-product during WWT/MWW

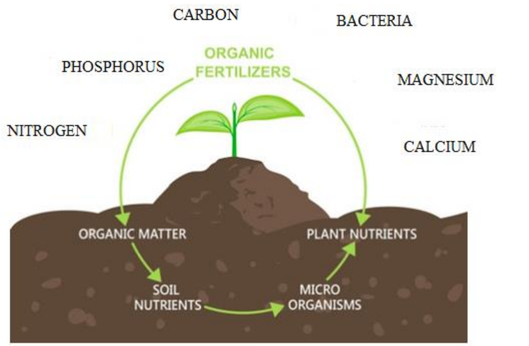
- Currently, annual production of SS in

  - ✓EU 10.96 million tons
  - ✓China is 2.97 million tons,
  - ✓USA 6.51 million tons and
  - ✓Japan 2 million tons.

- Historically, SS has been disposed by incineration, Landfilling, ocean disposal.

- Nowadays, the most widespread method for SS has become an agricultural application, because

- ✓ It is the most economical outlet for sludge compared to incineration and landfilling.



- SS is rich in OM, plant macro & micro-nutrients

- Therefore, SS can potentially substitute fertilizer and increase dry matter yield of many crops.

- But, its usage as a fertilizer is limited due to a large number of toxic organic and inorganic pollutants.

- Composting and Vermicomposting are the two methods for removal of these toxic pollutants.

- However, one of the most important issues related to SS composting/vermicomposting is associated with
  - ✓ NH3 and
  - ✓ GHGs such as CO2, CH4 and N2O, which can contribute to
    - ➢ global warming and stratospheric ozone depletion.
- Several studies investigated various types of additives to decrease the emissions of gases, during
  - ✓ composting /vermicomposting of various organic waste types.
- However, the optimal mixing rate has not yet been discussed.
- Further studies of compost additives are required to provide proper strategies to mitigate the loss of gases in SS during composting/vermicomposting.
- The aim of this study was to evaluate the CO_2 and CH_4 emissions during composting/vermicomposting of SS under the effect of different proportions of straw pellets.

2. Materials and Methods

Experimental Setup

- A recently deposited SS was used for the experiments
- The experiment included four treatments:
  - (T1) 100% sewage sludge(control),
  - (T2) 75% sewage sludge + 25% pelletized wheat straw,
  - (T3) 50% sewage sludge + 50% pelletized wheat straw,
  - (T4) 25% sludge + 75% pelletized wheat straw (w/w).
    - ✓composting,
    - ✓Vermicomposting(*Eisenia andrei* was used)
- Composting was conducted in aerobic fermenters with adjustable intensity of aeration.




Compost/vermicompost

Table 1. Selected chemical properties of initial materials

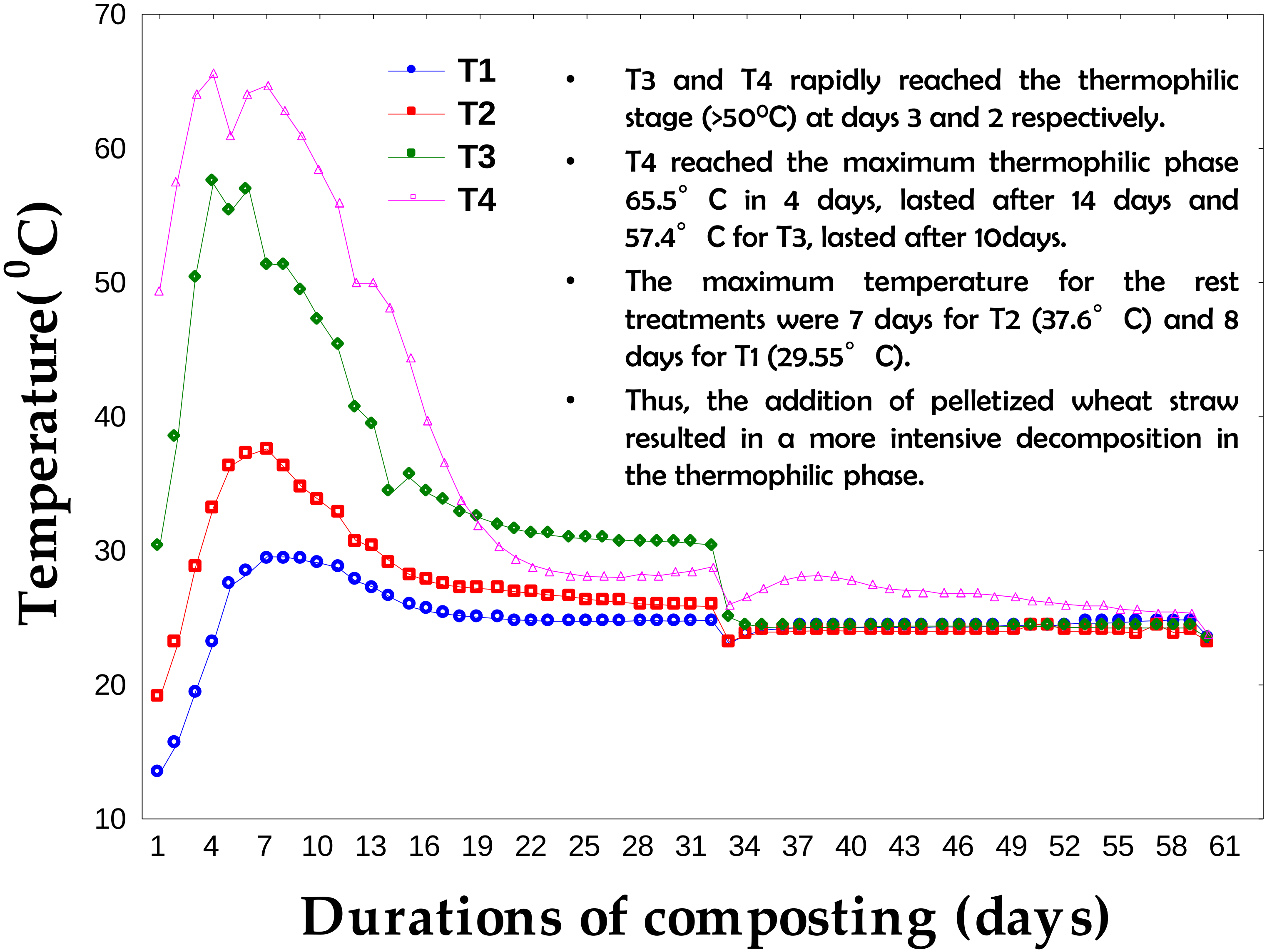
Parameters	Sewage Sludge(SS)	Pelletized wheat Straw(PWS)
pH-H_2O	6.99±0.03	8.30±0.52
EC(mS/cm)	0.617±0.11	0.680±0.07
TOC (%)	32.95±0.26	42.6±0.36
TN (%)	5.36±0.03	0.8±0.12
C:N	6.15±0.04	53.2±7.60

Table 2. Selected chemical properties of treatments at the initial (day-0)

Treatments	pH-H_2O	EC(mS/cm)	TOC (%)	TN (%)	C: N
T1	6.99±0.03	0.617±0.11	32.9±0.26	5.36±0.03	6.14±0.04
T2	7.32±0.11	0.633±0.08	35.36±0.23	1.98±0.21	18.03±1.92
T3	7.64±0.25	0.649±0.06	37.77±0.24	1.34±0.07	28.17±1.43
T4	7.97±0.38	0.664±0.05	40.18±0.29	1.05±0.05	38.36±2.03

3. Results and Discussions

3.1.Temperature during composting



- T3 and T4 rapidly reached the thermophilic stage (>50⁰C) at days 3 and 2 respectively.
- T4 reached the maximum thermophilic phase 65.5° C in 4 days, lasted after 14 days and 57.4° C for T3, lasted after 10days.
- The maximum temperature for the rest treatments were 7 days for T2 (37.6° C) and 8 days for T1 (29.55° C).
- Thus, the addition of pelletized wheat straw resulted in a more intensive decomposition in the thermophilic phase.

Initial materials

Composting

Vermicomposting

Emissions of CO2 & CH4

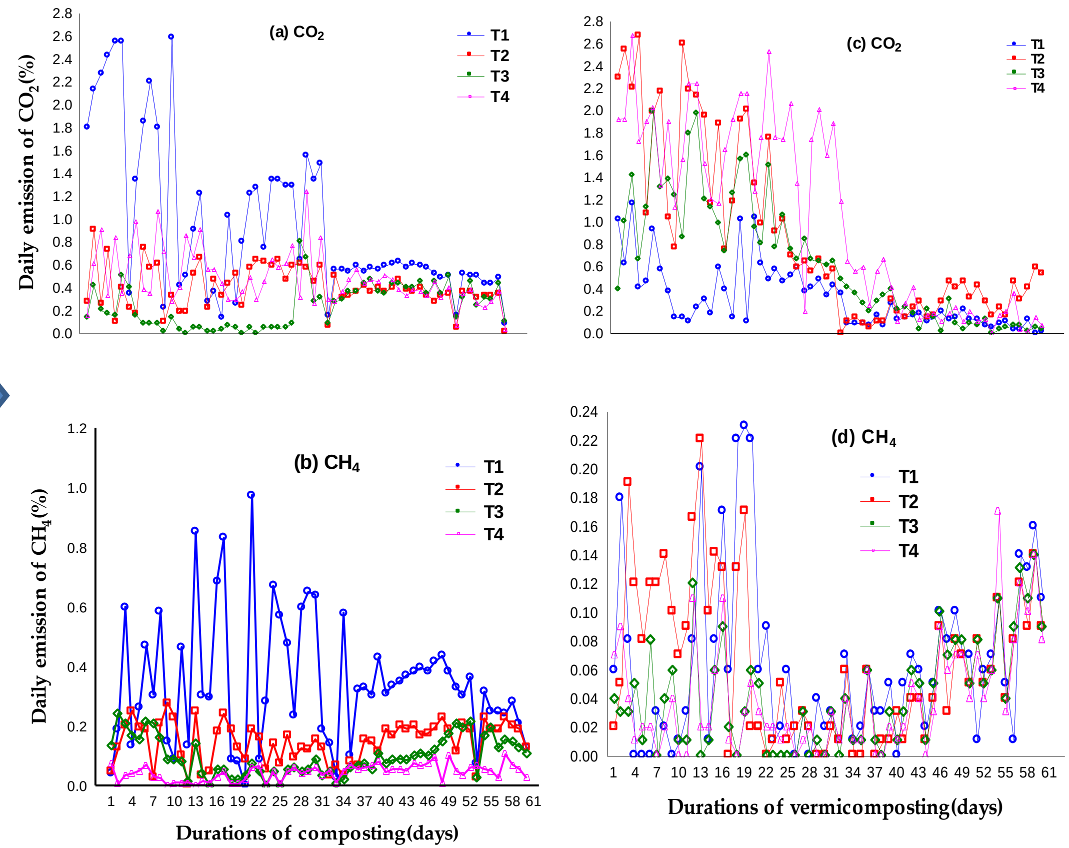


Table 3. Selected chemical properties of compost and vermicompost

Processes	Treatments	pH-H_2O	EC(mS/cm)	TOC (%)	TN (%)	C:N
C	T1	8.43±0.12	1.90±0.17	29.52±0.73	4.55±0.14	6.50±0.04
	T2	8.32±0.09	1.43±0.09	32.43±0.79	3.69±0.03	8.84±0.32
	T3	8.35±0.08	1.94±0.14	34.45±1.53	3.27±0.05	10.57±0.65
	T4	8.01±0.06	0.80±0.06	37.95±0.02	2.76±0.15	13.88±0.80
VC	T1	6.66±1.16	0.644±0.04	28.43±0.32	4.22±0.20	6.77±0.26
	T2	6.47±1.5	1.186±0.22	31.96±0.89	3.58±0.04	8.94±0.35
	T3	6.50±0.14	0.802±0.39	34.38±1.13	2.95±0.15	11.72±0.93
	T4	6.65±0.31	1.21±0.12	35.32±0.37	3.08±0.06	12.15±0.32

Total cumulative emissions of CO2 and CH4 during composting and vermicomposting

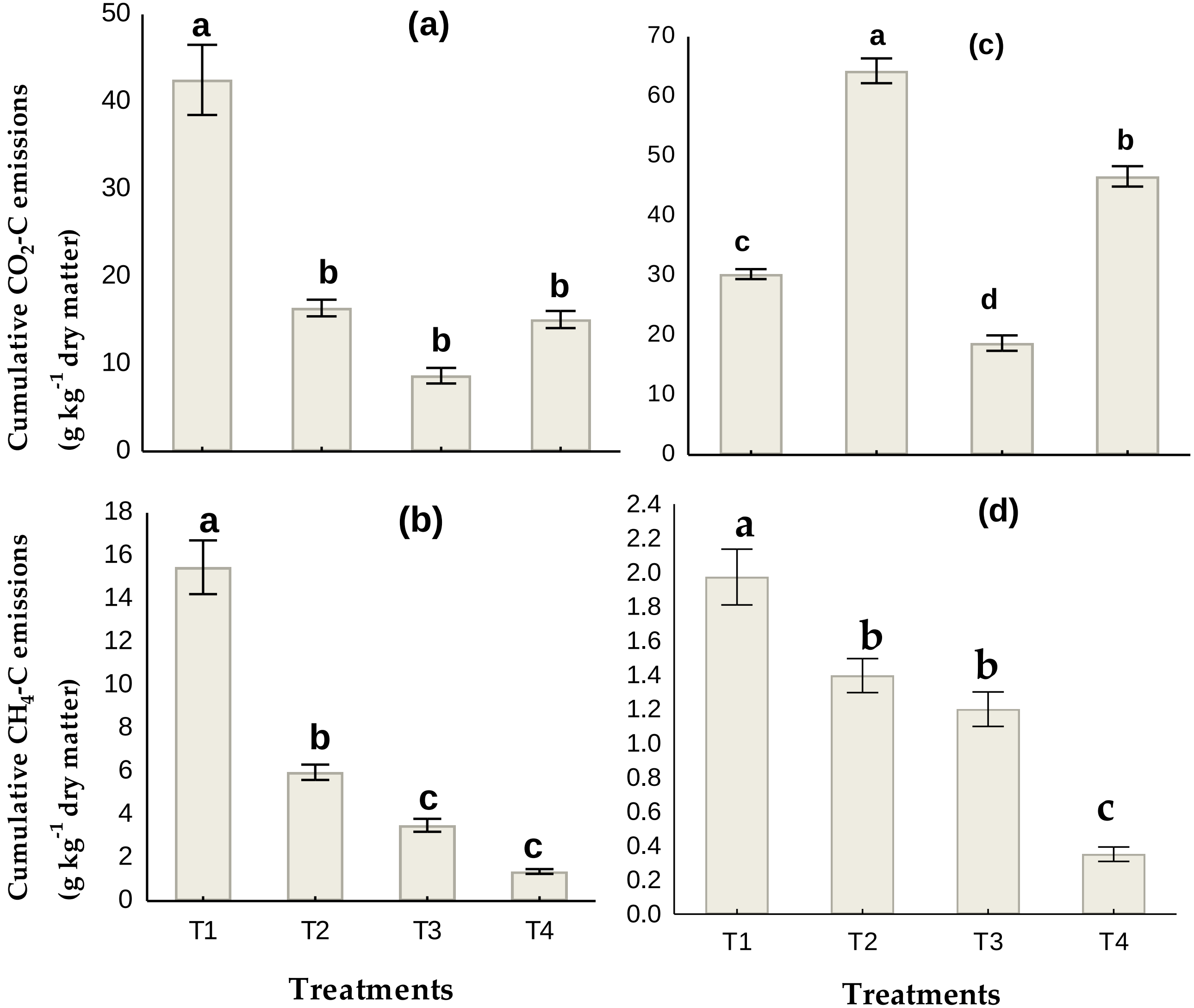


Fig.3. Total cumulative emissions of CO2(a), CH4(b) after 60 days of composting CO2(c),CH4(d) during vermicomposting. Bars indicate the standard error of the means (n=3). Different letters indicate significant differences among the treatments (*p<0.05*).

4. Conclusions

- The composting and vermicomposting processes of sewage sludge emit a considerable amount of
  - ✓ CH_4 and CO_2, the main environmental threat to global climate change.

- The highest values were at the beginning of the experiment and gradually decreased.

- The emission of CH_4&CO_2 during composting and vermicomposting is linked to the fate of C present in the waste substrate.

- Vermicomposting reduces CH_4 emissions and accelerates the decomposition process.

- The addition of different proportions of PWS increases CO_2 and CH_4 emissions during composting.

- Vermicomposting increases CO_2 emissions, implying that vermicompost is at a more advanced stage of decomposition than thermophilic compost.

- From this finding, as an additive of pelletized wheat straw, both composting and vermicomposting processes are recommended depending on the target gas to be reduced.

Acknowledgment

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Turn Off The CO_2 & CH_4 Now!!

Thank You!!!!