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EVALUATION OF DIFFERENT OPTIMIZED PARAMETERS DURING COMPOSTING PROCESS

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ABSTRACT
Composting process can be increased and improved by optimizing different parameters. These important parameters include pH, C: N, Moisture %, temperature, aeration and weight of the windrow. The reading of the temperature and oxygen was taken on daily basis while the reading of other optimized parameters was taken weekly. It was concluded that the variation in the reading of these optimized parameters were observed at the start and end of the process and this variation in the value of the optimized parameters was a positive sign of early degradation of organic waste.

KEYWORDS: pH, C: N, Moisture %, temperature, aeration and weight.

INTRODUCTION
Composting is a process in which biological breakdown of organic waste under different controlled conditions takes place. While breakdown of organic waste occurs naturally but it can be increased or enhanced by optimization and regulation of different parameters (Kostov and lynch, 1998). Composting process stabilize the organic matter, and produces end product that is called humus. Composting process is very important for producing a high-yield product and it also preventing many problems. Aerobic composting consists of a controlled biological process and mechanical screening thereafter. The biological process is the most critical component of aerobic composting process. Hence it is to be properly understood and regularly monitored to derive maximum benefits from the composting process. During the process of aerobic composting Rapid decomposition normally completed within 8-10 weeks if the important parameters are optimized and regulated. During this period high temperatures are attained leading to speedy destruction of pathogens, insect eggs and weed seeds. Production of foul smelling gases like methane, hydrogen sulphide is minimized. Nutrients are fairly preserved. When the compost is properly prepared and used, it results in low input agriculture system (Somarathne et al., 2013). Many parameters are optimized to induce early compost maturation. These parameters include C: N, oxygen, Temperature, windrow weight, and pH of the organic waste that is used to produce compost.

Methodology
The 50 ton windrow of organic waste was divided in 6 parts and each heap than was treated with inoculum and one remained control without any inoculum. The treatment A, B, C was inoculated with some type of microorganisms and treatment D was without inoculation of microorganisms.

Moisture content
Moisture meter with probe was used to determine the moisture % at the start of composting process. The moisture content was adjusted in all treatments at 50.06%-60% by adding some dry leafs and grass. The average range of moisture content should not exceed from 45 to 60%. The moisture content of the compost windrow was 50.6 at the start of composting process (Tom et al., 2013).

Temperature
OT meter was used to determine the value of temperature. The probe of OT meter was 1ft and 4ft long. The temperature of the compost windrow of all the treatments was adjusted at 60.8- 60 C by providing proper turning and aeration to the windrow. The initial temperature of the compost windrow must be thermophilic. Thermophilic stage takes place at the first week of composting (Liange et al., 2003).

pH
The special type of pH meter was used to determine the pH of the windrow. The sample of organic waste was collected from the windrow in 9:1 mixed with water and the pH was determined. The length of pH meter is 1.5

feet used to find the pH of compost windrow. The pH value depend on the nature of organic waste, as it was basic in all treatments so the pH value was ranging from 6.25-7.08 at the start of composting process (Nakasaki et al., 1993).

Windrow weight

The weight of the windrow was ranging from 60.9-57.4 in all treatments at the start of composting. The bulk density was determined of the windrow and it was 750kg cubic meter. The windrow weight was determined on weekly (Michel et al., 1996).

Oxygen

The initial oxygen value was determined in the range of 11- 9.96 in all treatments at the start of composting process. The oxygen was determined by using OT meter probe and its value was taken at different heights 4ft and 1ft. The oxygen was checked daily at different heights (Suler and Finstein, 1977).

C: N

The C: N of the windrow was adjusted at 27.9 by using C: N calculator. According to the calculation the amendments were made. The C: N of individual waste component was checked and then the calculator was used to adjust it in the windrow. The C: N was checked weekly (Huang et al., 2004).

RESULTS AND DISCUSSION

To check the efficiency of the composting in response to different treatments windrow weight, pH, Moisture and C: N ratio of the compost samples was calculated at the end of week. The other Pysico-chemical characteristics of the compost i.e. oxygen and temperature was recorded on daily basis.

Temperature profile of compost heap

The variation in temperature profile was observed during composting process. It is evident from figure 1 and 2 that an increase in the temperature with an increase in time interval. In general, the highest temperature was recorded in the first week of composting in treatment A which had the value of 60.8 at the start of composting and 51.4 at the end of the process. There was a decline in the value of temperature at the end of experiment from 60 to 47. The table 1 and 2 shows the effect of treatments on the temperature profile. The results shows that the composting process was started with the thermophilic temperature and it was decreased eventually at the end of process, these results are in line with the findings Hassen et al., (2001) that the temperature of the compost windrow is thermophilic and it decreases as the bacterial count decreases in the windrow.

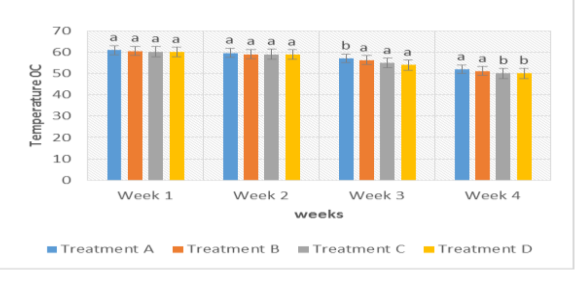
Effect of different treatments on Temperature profile of compost during 1st month

Treatments	Temperature (°C)			
	Week 1	Week 2	Week 3	Week 4
A	60.8±0.80	59.6±1.00	56.9±0.97	51.9±0.78
B	60.5±0.81	59.0±1.10	56.2±0.95	51.1±0.73
C	60.2±0.84	59.0±0.90	55.0±0.97	50.0±0.75
D	60±0.74	58.9±0.87	53.9±0.83	50±0.74
Significance with 3 and 7 df	NS	NS	NS	NS

Effect of different treatments on Temperature profile of compost during 2nd month

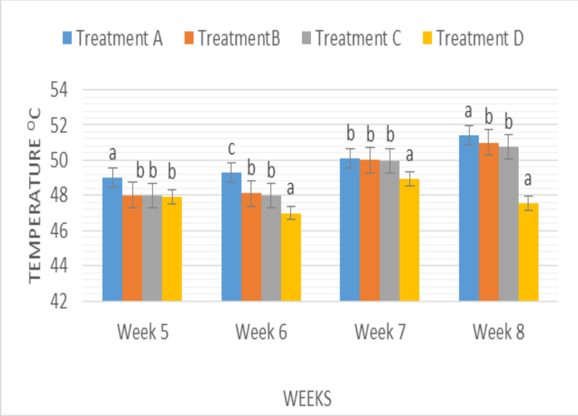
Treatments	Temperature (°C)			
	Week 5	Week 6	Week 7	Week 8
A	49.00±0.80	49.3±0.78	50.1±1.90	51.4±0.74
B	48.00±0.80	48.1±0.76	50.00±1.99	51.00±0.72
C	48.00±0.90	47.98±0.89	49.98±1.20	50.76±0.72
D	47.9±0.97	47.00±0.96	48.90±0.95	47.56±0.70
Significance with 3 and 7 df	NS	NS	NS	NS

Temperature variation of compost heap after different treatments during 1st month of composting



The standard error of mean value is represented by error bar. Different superscript showing mean difference is significant at the level of ($p \leq 0.05$) by Duncan's new multiple range tests.

Temperature variation of compost heap after different treatments during 2nd month of composting



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Profile of compost Oxygen

The variation in oxygen profile was observed during composting process. It is evident from figure 3 and 4 that an increase in the oxygen with an increase in time interval and then it was stabilize at the end. In general, the highest oxygen was recorded in the 4 week of composting in treatment A which had the value of 11.6% and 11.00% at the end of the process. There was an increase in the value of oxygen at the middle of experiment from 11.00% to 11.6% and then a decline at the end from 11.6 to 11.00. The table 3 and 4 shows the effect of treatments on the oxygen profile. The results of all treatments shows the amount of oxygen is directly proportional to temperature, when the temperature of windrow started to increase, there was a decline in the amount of oxygen. To provide the proper aeration, turning of windrows is important. (Ghao et al., 2010; Pace et al., 1995) reported that the large amount of oxygen should be provided at the start to initiate the aerobic composting and it can be achieve by proper turning.

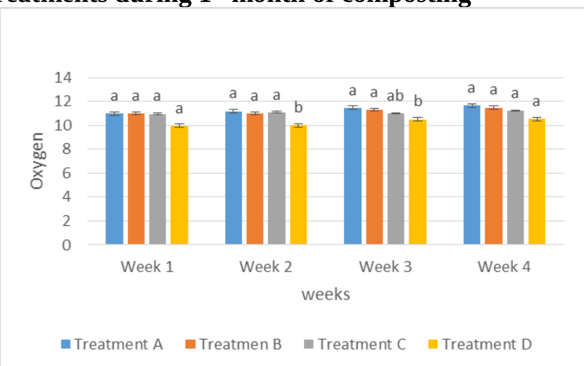
Effect of different treatments on Oxygen profile of compost during 1st month

Treatments	Oxygen (%)			
	Week 1	Week 2	Week 3	Week 4
A	11.00±0.80	11.18±0.90	11.46±1.00	11.67±1.10
B	11.00±0.80	11.00±0.92	11.29±1.02	11.49±1.01
C	10.96±0.91	11.10±0.94	11.00±1.034	11.23±1.05
D	9.96 ± 0.95	10.00±0.97	10.5±1.040	10.54±1.09
Significance with df 3 and 7	NS	NS	NS	NS

Effect of different treatments on oxygen profile of compost during 2nd month

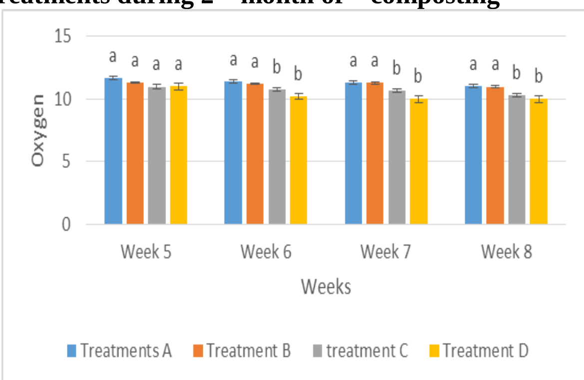
Treatments	Oxygen (%)			
	Week 5	Week 6	Week 7	Week 8
A	11.67±1.27	11.42±1.00	11.33±0.94	11.01±0.79
B	11.33±1.20	11.24±1.00	11.29±0.90	11.00±0.75
C	11.00±1.21	10.76±1.01	10.67±0.81	10.28±0.79
D	11.01±1.00	10.23±1.00	10.00±0.80	10.00±0.70
Significance with df 3 and 7	NS	NS	NS	NS

Oxygen % variation of compost heap after different treatments during 1st month of composting



The standard error of mean value is represented by error bar. Different superscript showing mean difference is significant at the level of ($p \leq 0.05$) by Duncan's new multiple range test

Oxygen % variation of compost heap after different treatments during 2nd month of composting



The standard error of mean value is represented by error bar. Different superscript showing mean difference is significant at the level of ($p \leq 0.05$) by Duncan's new multiple range tests.

Profile of moisture content

The change in substrate moisture content for each treatment during composting is shown in Figure 5 and 6. In treatment D the highest moisture content 60.5% was recorded at week one and lowest moisture content was recorded in Treatment A was 49.8% at the first week of composting. It is evident from the figure 5 that there was a decline in the percentage of moisture in all treatments with the interval of time. The table 5 and 6 shows the effect of treatments on moisture content of the windrows. The moisture is inversely proportional to microbial activity and temperature. The decrease in moisture content will increase the temperature of the windrow. Moisture content is a dominant factor in aerobic composting (Liang et al., 2003).

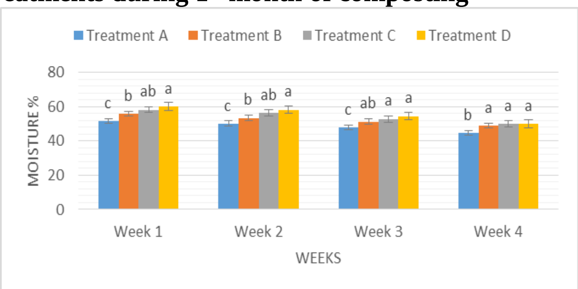
Effect of different treatments on Moisture profile of compost during 1st month

Treatments	Moisture content (%)			
	Week 1	Week 2	Week 3	Week 4
A	51.60±1.80	50.10±2.60	47.900±0.14	44.70±1.20
B	55.90±1.79	53.40±1.80	51.20±1.90	48.90±1.80
C	58.22±0.41	56.29±0.52	52.86±0.69	50.03±0.74
D	60.16±0.29	58.12±0.23	54.50±0.70	49.96±0.84
Significance with df 3 and 11	*	NS	NS	NS

Effect of different treatments on Moisture profile of compost during 2nd month

Treatments	Moisture content (%)			
	Week 5	Week 6	Week 7	Week 8
A	50.33±1.10	48.90±1.31	45.53±1.20	43.00±1.53
B	54.23±1.47	52.46±0.90	49.86±1.15	47.63±1.10
C	58.20±0.50	56.30±0.52	53.16±0.30	50.23±0.51
D	60.30±0.50	57.90±0.50	54.83±0.50	52.90±0.50
Significance with df 3 and 11	*	*	*	*

Moisture % variation of compost heap after different treatments during 1st month of composting



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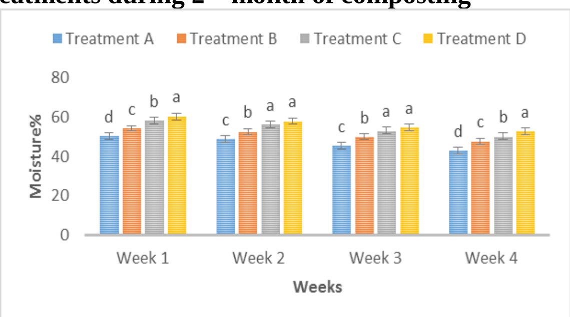
Moisture variation of compost heap after different treatments during 2nd month of composting



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pH profile of compost

There were varied pH values for samples obtained from each treatment windrow as summarized in Table 7 and 8 and displayed in Figure 7 and 8 with the majority showing alkaline pH. The lowest pH obtained was 6.25 in treatment D and the highest 7.08 in treatment A at the first week of composting. The increase in the pH value was observed in each treatment with the interval of time. The pH of all treatments was increased with the time interval. All the treatments at the end of composting process showed alkaline pH. The pH of mature compost of all treatments was alkaline and these results are in line with the earlier findings of Sundberg et al., (2004) the pH of the compost should be alkaline throughout and end of the composting process.

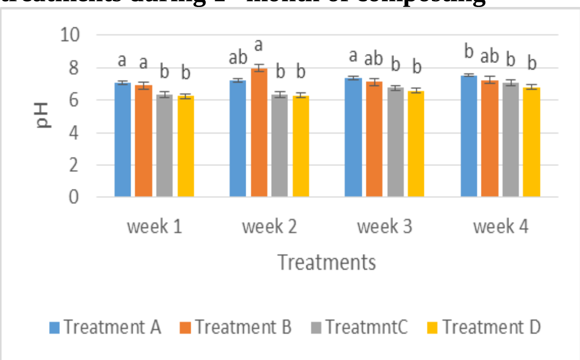
Effect of different treatments on pH profile of compost during 1st month

Treatments	pH			
	Week 1	**Week 2**	**Week 3**	**Week 4**
A	7.08±0.09	7.21±0.13	7.38±0.14	7.54±0.22
B	6.89±0.60	7.98±0.89	7.11±0.12	7.24±0.90
C	6.36±0.37	6.32±0.44	6.75±0.38	7.05±0.10
D	6.25±0.27	6.30±0.35	6.59±0.44	6.81±0.41
Significance with df 3 and 11	NS	NS	NS	NS

Effect of different treatments on pH profile of compost during 2nd month

Treatments	pH			
	Week 5	**Week 6**	**Week 7**	**Week 8**
A	7.08±0.85	7.25±0.78	7.33±0.21	7.48±0.31
B	6.72±0.33	7.62±0.47	7.11±0.11	7.22±0.11
C	6.42±0.38	6.62±0.26	6.79±0.39	6.76±0.56
D	6.44±0.10	6.51±0.17	6.88±0.10	7.18±0.11
Significance with df 3 and 11	NS	NS	NS	NS

pH variation of compost heap after different treatments during 1st month of composting



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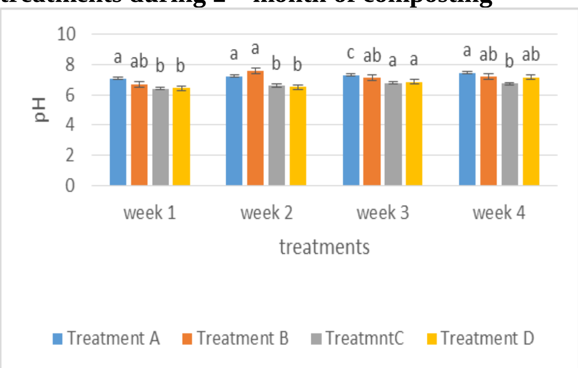
pH variation of compost heap after different treatments during 2nd month of composting



The standard error of mean value is represented by error bar. Different superscript showing mean difference is significant at the level of ($p \leq 0.05$) by Duncan's new multiple range tests

Windrow weight profile of compost

The change in substrate windrow weight for each treatment during composting is shown in Figure 9 and 10. In treatment D the highest windrow weight 60.09 was recorded at week one and lowest windrow weight was recorded in Treatment A was 57.48 at the first week of composting. It is evident from the table 9 and 10 that there was a reduction in the weight of windrows in all treatments with the interval of time. The table 9 and 10 shows the effect of treatments on the weight of windrows. The decrease in the weight of windrow indicates the degradation rate is high and process of composting is efficient, the results are in line with the findings of Michel et al., (2003) that the reduction in the weight of windrow indicating high degradation rate and it was observed in all treatments.

Effect of different treatments on windrow weight profile of compost during 1st month

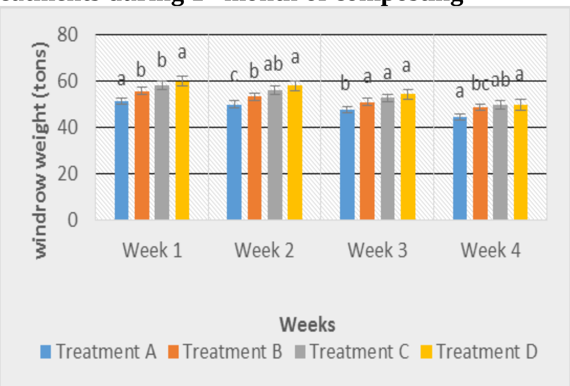
Treatments	Windrow weight (tons)			
	Week 1	**Week 2**	**Week 3**	**Week 4**
A	57.48±0.44	57.13±0.37	56.36±0.88	54.85±1.44
B	58.90±0.19	58.55±0.60	57.86±0.69	56.45±0.84

C	59.32±0.30	58.98±0.72	58.22±0.22	57.26±0.36
D	60.09±0.25	59.63±0.41	58.70±0.43	58.60±0.54
Significance with df 3 and 11	NS	NS	NS	NS

Effect of different treatments on windrow weight profile of compost during 2nd month

Treatments	Windrow weight (tons)			
	Week 5	Week 6	Week 7	Week 8
A	57.66±0.47	56.97±0.19	55.95±0.44	54.19±0.72
B	58.58±0.50	58.18±0.32	57.39±0.40	56.07±0.42
C	59.41±0.23	58.67±0.55	58.18±0.25	57.27±0.37
D	60.20±0.15	59.40±0.49	58.78±0.38	58.15±0.10
Significance with df 3 and 11	NS	NS	NS	NS

Windrow weight of compost heap after different treatments during 1st month of composting



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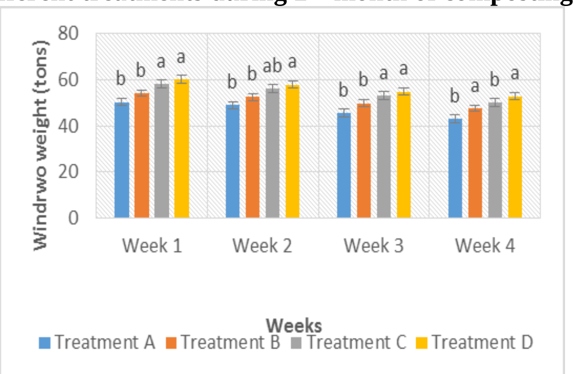
Windrow weight variation of compost heap after different treatments during 2nd month of composting



The standard error of mean value is represented by error bar. Different superscript showing mean difference is significant at the level of ($p \leq 0.05$) by Duncan's new multiple range test

C: N profile of compost

The variation in C: N profile was observed during composting process. It is evident from figure 11 and 12 that a decrease in the C: N profile with an increase in time interval. In general, the highest C: N was recorded in the first week of composting in treatment D which had the value of 29.02 at the start and 27.4 at the end of the process and lowest was recorded in the Treatment A 27.96 at the first week and 24.76 at the end of the process. There was a decrease in the value of C: N at the end of experiment. The table 11 and 12 shows the effect of treatments on the C: N profile. The C: N of all the treatments was optimized below 30 and it was decreased slightly in all the treatments with the interval of time, Kavitha and Sabramarian, (2007) reported that the optimum C: N at the start of composting process should be below 30:1 and at the end it should be decreased to 20:1. The results are in the line of earlier findings of Azim et al., (2014) that the initial C: N ranging 25 to 30 produced the more mature compost.

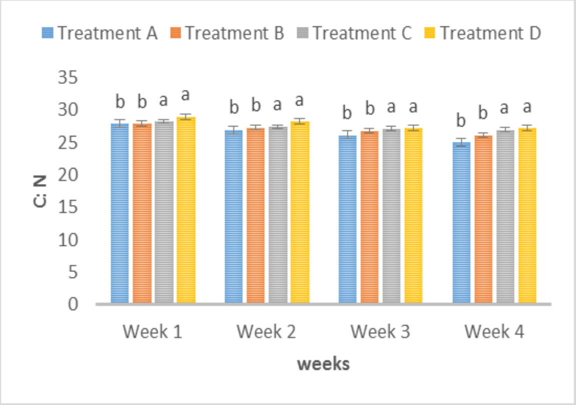
Effect of different treatments on C: N of compost during 1st month

Treatments	C: N			
	Week 1	Week 2	Week 3	Week 4
A	27.96±0.96	26.97±0.62	26.18±1.13	25.07±0.92
B	27.92±0.58	27.37±0.48	26.86±0.49	26.18±0.42
C	28.27±0.27	27.47±0.42	27.17±0.16	26.99±0.02
D	29.02±0.03	28.3067±0.27	27.27±0.61	27.25±0.16
Significance with df 3 and 11	NS	NS	NS	NS

Effect of different treatments on C: N of compost during 2nd month

Treatments	C: N			
	Week 5	**Week 6**	**Week 7**	**Week 8**
A	27.63±0.57	26.76±0.35	25.80±0.65	24.76±0.53
B	27.72±0.33	27.21±0.27	26.69±0.28	26.04±0.24
C	28.26±0.00	27.86±0.00	27.16±0.12	26.97±0.00
D	29.06±0.00	28.52±0.43	27.98±0.12	27.44±0.00
Significance with df 3 and 11	NS	NS	NS	NS

C: N variation of compost heap after different treatments during 1st month of composting



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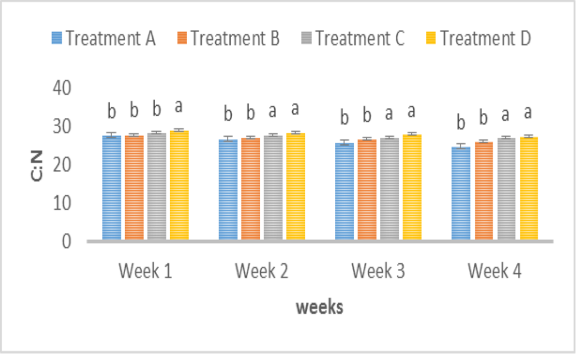
C: N variation of compost heap after different treatments during 1st month of composting



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