O 47. COMPOST PRODUCTION FROM CHICKEN MANURE AND ENRICHED WITH DIFFERENT MATERIALS OBTAINED FROM AGRICULTURAL WASTES FOR THE IMPROVEMENT OF DEGENERATED AGRICULTURAL LANDS

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ABSTRACT: The most important problem of agricultural lands in recent years is the increasing sensitivity to erosion. In agricultural production techniques; Applications that improve soil quality, provide soil with organic matter and increase soil aggregate stability should be supported. The movement and balance of water, air and plant nutrients in the soil should be sustainable. The main reason for the reduction of soil organic matter in agricultural ecosystems is the release of carbon dioxide into the atmosphere through carbon oxidation. When the carbon lost from the soil cannot be replaced, erosion increases even more. The addition of organic matter increases the aggregation in the soil and increases the resistance of the soil against water and wind erosion, increases the soil quality and increases the plant yield. In Konya Closed Basin (KCB), it is known that the stubble of corn, sunflower wastes from agricultural wastes are burned after harvesting in areas where intensive agriculture is carried out. The organic carbon amount of these agricultural wastes must be recycled to the soil by composting. In addition, it should be aimed to reduce the loss of nitrogen in its content by enriching chicken manure with different materials with composting techniques and to ensure its recycling to the soil and to improve and increase the soil quality. Within the scope of the TAGEM project named "Determining the Effects of Chicken Manure Enriched with Different Materials and Compost Obtained from Agricultural Wastes on Soil Quality and Growth of Corn (Zea mays L.)", organic materials obtained from chicken manure and agricultural wastes, Composting operations were carried out in an open heap environment. Providing carbon and nitrogen mineralization in soils by composting chicken manure with agricultural wastes with different materials such as leonardite, clinoptilolite, biochar in problematic, marginal semi-arid areas that are devoid of organic matter, and which have suffered wind erosion in the sustainable land management (SAY) planning in the basin. It is aimed to increase the organic matter content, increase the microorganism activity and aggregate stability, increase plant growth and productivity, and ultimately reduce erosion. The composting process of the project has been evaluated in this study.

Keywords: *Chicken manure, Agricultural waste, Organic matter, Compost, Aggregate, Erosion, Karapınar*

INTRODUCTORY

Desertification refers to land degradation/land deformation caused by various factors, including climate changes and human activities, especially in arid, semi-arid, and low rainfall areas. Desertification/land deformation and drought directly affect 4 billion hectares which is 25% of the world's land area 168 countries, and 1.5 billion people. While 250 million of this population is at serious risk, about 10 million of them have had to migrate due to desertification/land destruction and drought. 12 million hectares of agricultural land is degraded and 5.6 million ha of forest land is decreasing every year in the world due to desertification/land destruction and drought. Although there is no natural desert in Turkey; its geographical location, climate, topography, and soil conditions increase the sensitivity of the country to land degradation and drought, which cause it to be among the countries most affected by desertification and drought. In general, 65% of our country's land has arid, semi-arid, and semi-humid climate characteristics. In these ecologically sensitive areas, the destruction of vegetation and the deterioration of the natural balance led to erosion of the soil and subsequently the parent material (ÇEM, report 2018). The areas, which is generally arid and semi-arid, where wind erosion is effective are the southern half of Central Anatolia (especially Konya, Aksaray, Niğde, Kayseri) and the eastern part (within the borders of Kars, Iğdır province) in Turkey, there is a problem of wind erosion from mild to very severe in an area of 465.913 hectares as a dune. Approximately 70% of this area (322.474 ha) is located within the provincial borders of Konya. 103.000 ha of this area is located in Konya Karapınar district and this area constitutes 22.1% of the country-level wind erosion area (TOPRAKSU 1975; Şimşekli, 2012).

In order to prevent these negative effects of the wind, the most used method in agricultural areas to correct the unsuitable physical properties of the soil is the addition of various organic materials to the soil. The increase in a small amount of organic matter in the soil has a significant positive effect on the physical, chemical and biological properties of the soil. Physical properties such as a good structure of the soil, increased aggregation in the soil, increased water holding capacity of the soil, reduction of soil compaction, formation of coarse pores filled with air and formation of ideal seed bed depend on the organic matter content of the soil (Mücevher et al., 2018). The most important problem of our soils is the lack of organic matter. Within the scope of the TOVEP project between1982-1991, the organic matter content of the soils of Turkey was 21.47% (< 1% very little); 43.78% (1-2%, few); 22.62% (2-3%, moderate); 7.57% (3-4% good); It has been reported as 4.55% (>4% high) (Eyüpoğlu, 1999). According to this report, 65.25% of the organic matter content of our country's soils is lower than 2%. Provinces in the Konya Closed Basin (KCB) Region are the cluster of Provinces with the lowest organic matter in our country.

It is technically possible to transform environmental wastes, plant and animal production outputs of organic origin into processes that increase organic matter in the fastest process. In this process, it is enough for human beings to imitate nature as in the ecosystem. The aim of this project is to enable the population living in rural areas to be able to produce applicable organic matter in the countryside.

In the same (KCB), it is known that the stubble of corn, sunflower wastes from are burned after harvesting in areas where intensive agriculture is carried out. The organic carbon amount of these agricultural wastes must be recycled to the soil by composting. In our country's crop production, corn planting area is 638.829 ha, sunflower planting area is 752.632 ha; In the TR52 (Konya, Karaman provinces) Region of the KCB, there is an agricultural land area of 1.323.669 da of corn cultivation area and 794.352 da of sunflower plant cultivation area (TUİK, 2020). The proportion of TR 52 Region in the corn planted area in Turkey is 20.72%; the rate of the cultivated area of sunflower is 10.55%. In the amount of agricultural residue formed on an areal basis, 0.391 tons/da in corn plant; based on the sunflower plant as 0.153 tons/da (Başçetinçelik ve ark. 2005). Therefore, the annual agricultural residue potential in our country is 2.497.821 tons of corn residue and 1.151.527 tons of sunflower residue; In TR 52 Region, the annual agricultural residual potential was calculated as 517.555 tons for corn residue and 121.536 tons for sunflower crop residue. Therefore, in this compost study, corn and sunflower plants, which are plant varieties that are intensively cultivated in KCB and form agricultural residues, were preferred.

The number of brood hen in our country is 258.046.340 and the number of laying hens is 121.302.869 (TUIK, 2020). It was estimated by Turkish statistical institute that the amount of wet chicken manure in Turkey would be approximately 10 million tons in total, wich was 7.848.910 tons/year in brood hen and 2.031.823 tons/year in laying hens. In addition, in laying hens, TR 52 Region has 9.99% of Turkey's laying hen assets (2020 TUIK). The number of laying hens in the TR 52 Region is 12.114.651 and the number of broiler chickens is 318.250. It is estimated that there are approximately 210.000 tons of wet chicken manure in the region. Therefore, it is important to bring this organic material to the economy by composting with an environmentally friendly application. In addition, by enriching the chicken manure with different materials with composting techniques, it should be aimed to reduce the loss of nitrogen in its content and, in this way, to ensure its recycling to the soil and to improve and increase the soil quality.

Agricultural plant wastes also have C-rich content. Moist chicken manure contains approximately 5-6% N (Aydeniz and Brohi 1991), nitrogen-rich content and composting of chicken manure with vegetable (park-garden, agricultural, etc.) wastes is the most appropriate solution to balance the C/N ratio. The first high moisture content in chicken manure affects N loss through NH_3 evaporation (Cabrera and Chiang 1994). N mineralization and NH_3 evaporation occur during standing, and the low NH_4-N values indicate that mineralization is rapid. Therefore, it is considered to add different materials such as biochar, leonardite, clinoptilolite due to their adsorbing properties in order to prevent the reduction of nitrogen loss in moist chicken manure in the composting technique.

Within the scope of the TAGEM project, "Determination of the Effects of Compost Obtained from Chicken Manure Enriched with Different Materials and from Agricultural Residues on Soil Quality and Corn (Zea mays L.) Plant Development", carried out and concluded in Konya-Karapınar in 2019, composting processes of the organic materials obtained from chicken manure and the agricultural wastes were carried out in open stack environment. Providing carbon and nitrogen mineralization is aimed in soils by composting chicken manure with agricultural wastes with different materials such as biochar, leonardite, clinoptilolite in problematic, marginal semi-arid areas that are devoid of organic matter, and which have suffered wind erosion in the sustainable land management (SLM) planning in the basin. Also, with this study, it is aimed to increase the organic matter content, increase the microorganism activity and aggregate stability, increase plant growth and productivity, and ultimately reduce erosion. The composting process of the project has been evaluated in this study.

Ecology of Konya Karapınar region, where wind erosion is most common

Karapınar is on the Konya-Adana highway and is 95 km from Konya. Its population is around 49.000 and its surface area is 4315 km^2. It is the continuation of the Konya Plain in the north and west and is surrounded by Karacadağ from the east and Andıklı, Küçük and Büyük Tartan hills from the south. The climate of the region is described as semi-arid continental, with hot and dry summers and cold and rainy winters. Most of the snowfall falls in January and February. The average annual precipitation is 275 mm, 40% of which falls during the winter months. The average precipitation from July to September is 15 mm (Şimşekli, 2012). In the Karapınar area, the high temperature in the summer months and the low humidity in the soil profile throughout the year negatively affect the decrease in the amount of organic matter in the soil and ultimately the physical and chemical quality of the soil (Bot and Benites, 2005). These reductions in vegetation due to the temperature difference play an increasing role in degradation, desertification, and ultimately wind erosion due to the decrease in the organic matter cycle to the soil. The physical, chemical properties, and biological productivity of sandy textured soils that are exposed to wind erosion in semi-arid areas are low. The only thing that needs to be done in the improvement of such areas is to increase the organic matter content in the soil. Ozdemir et al. (2005), it was determined that organic and inorganic soil conditioner applications increase the resistance to erosion by increasing aggregation in the soil, decreasing the dispersion rate and wear factor values. Since organic matter contributes significantly to aggregate formation, the increase in organic matter prevents soil erosion by water and wind (Jones, 1991).

MATERIAL AND METHOD

Pre-compost preparation processes

Chicken manure and corn and sunflower wastes from agricultural residues as compost materials were used in the trial within the scope of the project in the Karapınar Desertification and Erosion Research Center affiliated to Konya Soil Water and Combating Desertification Research Institute of the General Directorate of Agricultural Research and Policies of the Ministry of Agriculture and Forestry.

In addition, as an absorbent feature that reduces nitrogen loss in chicken manure, three different materials, biochar, leonardite, clinoptilolite were also used. Biochar material was obtained from the spindle pruning residue obtained from the study land (Mücevher et al., 2018). In the project, clinoptilolite, leonardite, biochar, sunflower and corn residues, and chicken manure materials required for composting were procured. In composting, since the small size of the particle reduces the compost time and allows the compost to mature in a shorter time, Sunflower and corn residues were passed through a crusher grinder (<6mm size) before composting. For the compost pile, 540 kg sunflower residue (1/3 ratio) and 1620 kg corn residue material were prepared. On 13.06.2019, these materials for the compost test, C and N analyzes were performed at the Leco device in the Soil Section at the S.Ü. Faculty of Agriculture. Based on the C and N analysis results, the composting process was started (Table 1).

Table 1. C and N contents of the materials used

Materials	Moisture avg. %	C avg. %	N avg. %	C/N
Corn residue	9,00	91,30	0,67	137,29
Sunflower residue	11,00	76,90	0,76	100,66
Biochar	11,00	78,90	2,70	29,22
Clinoptilolite	16,04	1,40	0,19	7,37
Leonardite	25,70	23,24	0,64	36,31
Chicken manure	50,59	43,50	6,08	7,15

Composting process

The stages of the composting process carried out on the land of the same Research Center can be explained as follows. On 02.07.2019-03.07.2019, mixing (1/3 ratio) and moistening (approximately 70% moisture) of sunflower and corn residues as agricultural waste plant pile was carried out before composting. The mixing and moistening process was repeated 3 times to assimilate the moisture better into the plant piles. On 08.07-09.07.2019, after 4 equal amounts of plant piles were made for 4 different compost subjects, wet chicken manure was added equally to each plant pile. Therefore, 4 equal 876 kg compost piles (531 kg of agricultural residues, 345 kg of animal residues) were prepared for 4 different compost subjects. These 4 equal compost heaps are adjusted so that the C/N mix ratio=25/1. Mixtures were calculated on dry matter (DM).
The compost formula is given by the researchers as follows (Demir, 2012).
R = [Q1*C1*(100- M1) + Q2*C2*(100- M2) + Q3*C3*(100- M3)] / [Q1*N1*(100- M1) + Q2*N2*(100- M2) + Q3*N3*(100- M3)]

R: C/N ratio of the mix	
Q1: Amount of base material of sunflower residue (g)	Q3: Amount of base material of chicken manure (g)
C1: Organic carbon content of sunflower residue (%)	C3: Organic carbon content of chicken manure (%)
M1: Moisture content of sunflower residue (%)	M3: Moisture content of chicken manure (%)
Q2: Amount of base material of corn residue (g)	N1: Nitrogen content of sunflower residue (%)
C2: Organic carbon content of corn residue (%)	N2: Nitrogen content of corn residue (%)
M2: Moisture content of corn residue (%)	N3: Nitrogen content of chicken manure (%)

After obtaining the C/N ratio as 25/1, compost mixtures were added 10% additional enriched materials (biochar, leonardite, clinoptilolite according to their subjects) over DM according to the subjects of 4 different composts. On 09.07.2019, in the open pile, the composting process of the project was started on 4 different compost subjects and only chicken manure was added, as stated in the project, in 5 different subjects (Table 2).
The initial compost piles were adjusted to be h=1,30 m high, a= 2,40 m wide, and L= 4 m long. Compost piles were covered for about 1 week. Moisture and temperature data of the composts were recorded every 2 days. The compost is covered at night and left open during the day. Mixing and aeration of compost piles were carried out at certain date intervals (average 4 days). A total of 27 mixing processes were carried out in compost formation. Maximum effort was made to keep the conditions equal in the mixing and moistening processes of the composts. Composting processes were terminated when the internal temperature of the composts was close to the outdoor air temperature. Composting became the final product on 25.10.2019 after 109 days (Figure 1 and 2).

Table 2. Compost trial topics

Compost Matters	Agricultural waste (sunflower/corn; 1/3) /	Animal waste (chicken manure)	Enriched Material by weight (dry matter)
Compost 1 (K1)- compost+biochar	C/N =25/1 compost		%10 biochar
Compost 2 (K2)-kompost+leonardite	C/N =25/1 compost		%10 leonardite
Compost 3 (K3) kompost+clinoptilolite	C/N =25/1 compost		%10 clinoptilolite
Compost 4 (K4) compost	C/N =25/1 compost		

Compost 5 (K5)-chicken manure compost


Figure 1. at the beginning view of composts-09.07.2019; **Figure 2.** the end view of composts-21.10.2019

Analysis measured in compost piles

The following parameters from the compost piles were measured. Temperature, moisture, pH, EC, C/N change, N loss, organic matter loss (OML), color change, bulk density, specific weight, porosity, and micro and macro elemental analysis processes were followed in compost piles.
Compost temperature measurements were made from 6 different points of the heap with a Teslo 925 brand temperature measuring device. Moisture values of the compost were also analyzed in 3 replications after taking samples from 6 different points of the pile until they reached a constant weight in the oven (TMECC, 2001). In the moisture analysis of the compost samples in the oven, it was seen that the process took 5 to 6 days to reach a constant weight at 70 ºC.
pH and EC (dS m^{-1}) analyzes were carried out in the laboratory of Konya Soil Water and Combating Desertification Research Institute once a week on compost issues (TMECC, 2001).
C/N analyzes of the composting head and middle and final compost products were carried out in the LECO device in Selçuk University Soil Department laboratory. Changes in C (%), N (%), and reductions in % N loss were calculated at the beginning and end of compost subjects.
In the composting process, organic matter loss (OML) due to decomposition as a result of microorganism activities was also calculated. Organic matter loss in the final compost obtained in the muffle furnace in the laboratory of our institution was revealed (Table 9). Changes in the organic matter ratio (OM) of the material during the composting process were used to calculate the organic matter loss (Haug 1993).
The moisture values of the material were calculated by drying the samples in an oven at 70 ºC until they reach their constant weight. As a result of the drying process, the following equation was used to calculate the moisture content over the weight loss, for example (TMECC, 2001).
Moisture (%) = (wet sample weight-dry sample weight) / wet sample weight*100
Organic Matter in Dry Matter (OM) (%); The weight loss of the samples burned at 550 ºC in the muffle furnace is equal to the amount of volatile matter. Volatile matter is considered as total organic matter (Kocasoy 1994).
Ash (%) = 100-(OM) (%); Organic Matter Loss (OML) (%) = [$OM_{initially}$ (%)-OM_{end} (%)] *100 / [$OM_{initially}$ (%) * (100-OM_{end} (%))]
Bulk density (BD) (g/cm^3), specific weight (SW) (g/cm^3), and porosity in other words free air ratio (%) values of compost subjects were measured once a week in the laboratory of the same Research Institute (TMECC, 2001). In the calculation of porosity in compost, % Porosity or (Free Air Ratio) = (SW-BD) / SW*100 is excluded from the formula.
In the laboratory of our institution, the initial and final compost products were burned in the wet burning process according to the Mars 6 wet burning device (EPA 3051a) method, and after the extraction processes were completed on the Whatman 42 filter papers, elemental analysis readings were made in the ICP OES 5100 SVDV device.

FINDINGS AND DISCUSSIONS

Composting temperature and moisture values analysis results

The graphical representation of compost temperature measurements and compost moisture values of 5 different composting processes carried out in the same Research Center are given in Figures 3 and 4.

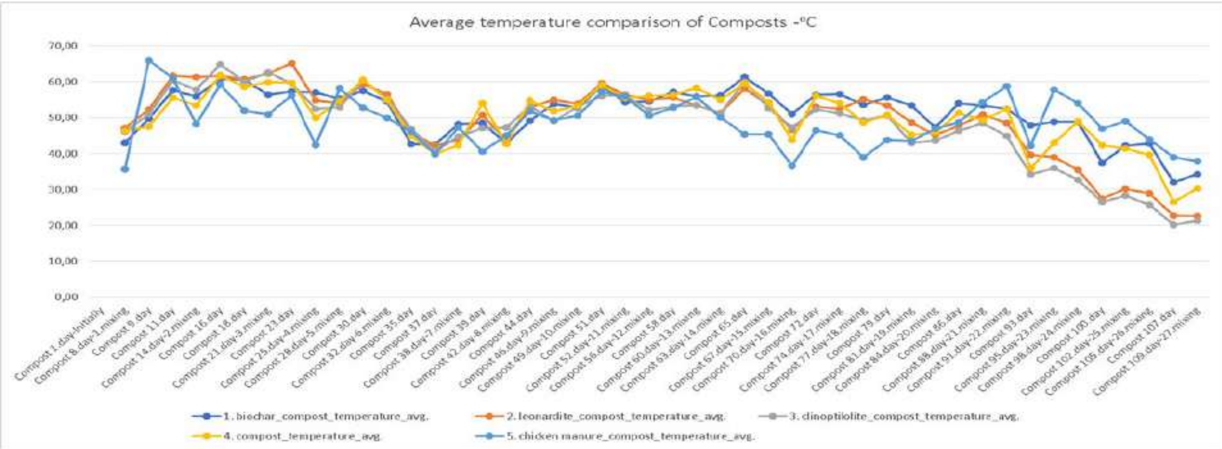

Figure 3. Temperature changes according to days in composts-°C

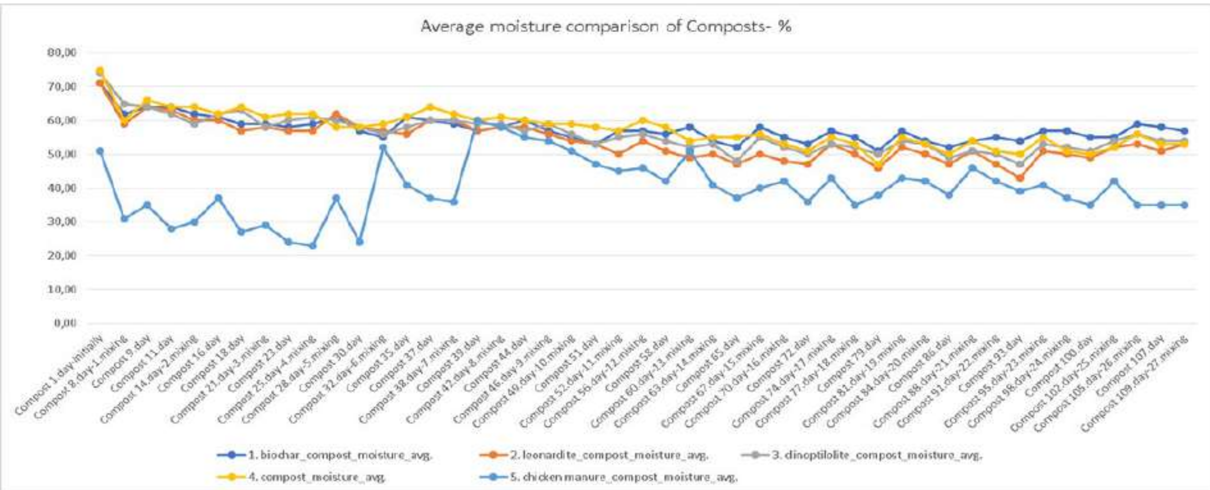

Figure 4. Moisture changes according to days in composts-%

According to the "Compost Quality Communiqué" published in the Official Gazette dated 05.03.2015 and numbered 29286 by the Republic of Turkey Ministry of Environment and Urbanization, the hygiene value is uninterrupted for 2 weeks at 55 ºC, 1 week at 60 ºC, 5 days at 65 ºC. will be processed at 70 ºC for 1 hour. According to Canadian composting criteria, the compost pile must be subjected to aerobic decomposition for 3 days above 55 °C (Epstein, 1997). Although mesophilic temperatures provide appropriate composting, many experts recommend that the compost temperature should be between 43-65 °C (Camcı Çetin et al., 2004). In thermophilic phases, pathogens, weed seeds, and fly larvae are killed, and legal practices state that the temperature should be 55 °C to kill human pathogens (RYNK, 1992; Keener et al., 2000).

In the study, if we look at the temperature parameters in the compost pile, we see a sinus fluctuation curve in the temperature curve. In general, we see that there is an initial increase in the temperature curve, followed by a decrease, and a further increase in temperature with re-humidification. The change in this temperature fluctuation is equivalent to the loss of organic matter in the compost, and the temperature decreases over time. To ensure better combustion throughout the compost, it has been taken care of keeping the temperature values constant, generally between 50-60 ºC. It was observed that there was a decrease in temperature values towards the maturation stage of the compost. The composting

process was terminated when the outdoor air temperature was closed the indoor temperature of the compost. The composting process started and ended equally in 5 different compost piles.
In compost subjects, the temperature values are respectively, K1 (biochar compost) at an average of 55.58 °C for 16 days, for K2 (leonardite compost) at an average of 54.18 °C for 16 days, for K3 (clinoptilolite compost) at an average of 52.79 ºC for 14 days, K4 (compost) at an average of 54.27 ºC for 16 days and K5 (chicken manure compost) was at an average of 54.32 ºC for 11 days. It has been observed that the temperature of the compost piles is at an average of 62.21 °C for 6 days for K2 (leonardite compost) and at an average of 60.98 °C for 6 days for K3 (clinoptilolite compost). The highest temperatures occurred for K4 (compost) at 70 ºC and for K2 (leonardite compost) at 69.2 ºC. When evaluated in terms of temperature among compost subjects, it is seen that K3 (Clinoptilolite compost) and K2 (leonardite compost) subjects complete the composting process the fastest and show early compost maturation. K5 (chicken manure compost) shows that it matures at the latest and does not lose its temperature.
One of the desired parameters in compost conditions is ventilation conditions which is humidity and mixing. The oxygen required for aerobic composting is usually supplied with air. The water vapor formed by the ventilation process is also removed from the process. Since oxygen (O_2) is used by microorganisms and CO_2 is released during the process, the amounts of O_2 and CO_2 in the compost pile can be used to control aeration (Suess 1985).
In this study, moistening and mixing processes of compost piles were generally carried out together. The moisture content of compost affects microorganism activities, temperature, and decomposition rate (Bernal et al., 2009). The moisture content should be between 50-60% in order to continue the composting process effectively (Epstein, 2011). Therefore, care was taken to keep the humidity between 50-60% stably in the experiment. In compost moisture adjustment, the liquid part should be in a consistency that will not flow when we squeeze the compost pile in our hands. If there is excessive moistening, the desired burning and temperature increase will not be achieved, since porosity will not form in the compost piles. Therefore, when the mixing is increased and humidity values are kept between 50-60%, it will be seen that the temperature values are between 50-60 ºC by themselves. Aeration and mixing were occurred 27 times in compost piles. Each time, the mixing process was done by turning the side of the heap over and over. In the next stage, better combustion was achieved by doing the opposite. If we look at the humidity values, it is seen that the humidity is best kept and the humidity is the highest in K1 (biochar compost). It is seen that the humidity is at the lowest level in the case of K5 (only chicken manure compost). Although the humidification and mixing processes were carried out equally in all compost matters, it was observed that K5 did not absorb moisture at the beginning. After the 38th day, the humidity was kept in the stable range (50% humidity). The order of moisture in the compost was K1 > K4 > K3 > K2 > K5.

Composting pH and EC values analysis results

During composting, pH and EC parameters were monitored weekly on composts (TMECC, 2001). The analysis results are graphically shown in Figures 5-6 below.

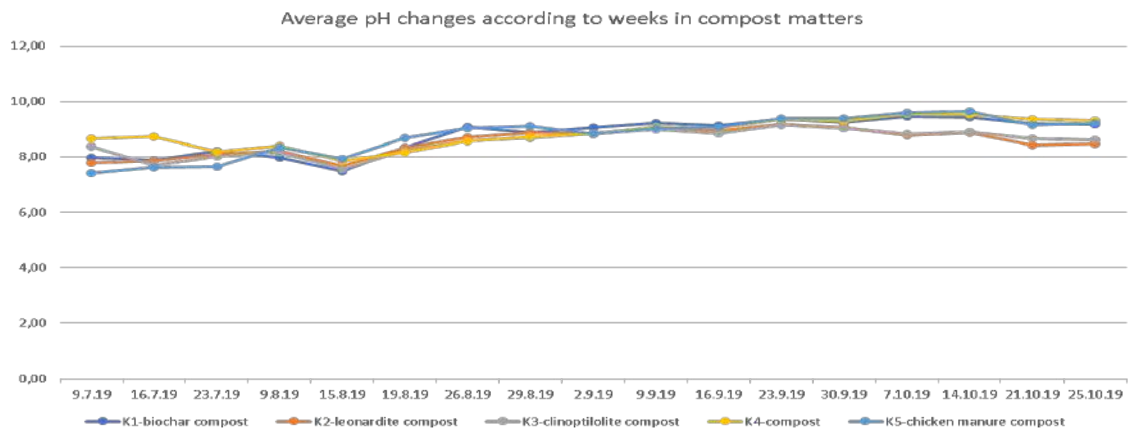

Figure 5. Average pH changes according to weeks in composts

According to the same "Compost Quality Communiqué", it has been reported that the pH value should be between 5.5 and 8.5 for compost to be applied. As a result of composting, it is seen that the pH value in the final compost heaps is generally between 8 and 9. A slight increase in pH was observed over time with the composting process. The reason for this may be the possibility of lime in the content of the chicken manure material used in the compost. At the beginning of the compost, pH of composts were K1-7.98, K2-7.78, K3-8.38, K4-8.65, K5-7.40, respectively, while at the end of the compost, pHs were K1-9.16, K2-8, 47, K3-8.60, K4-9.30, K5-9.21. The pH value was lower for K2 (leonardite compost) and K3 (clinoptilolite compost) compared to other subjects and the pH was close to 8.5.

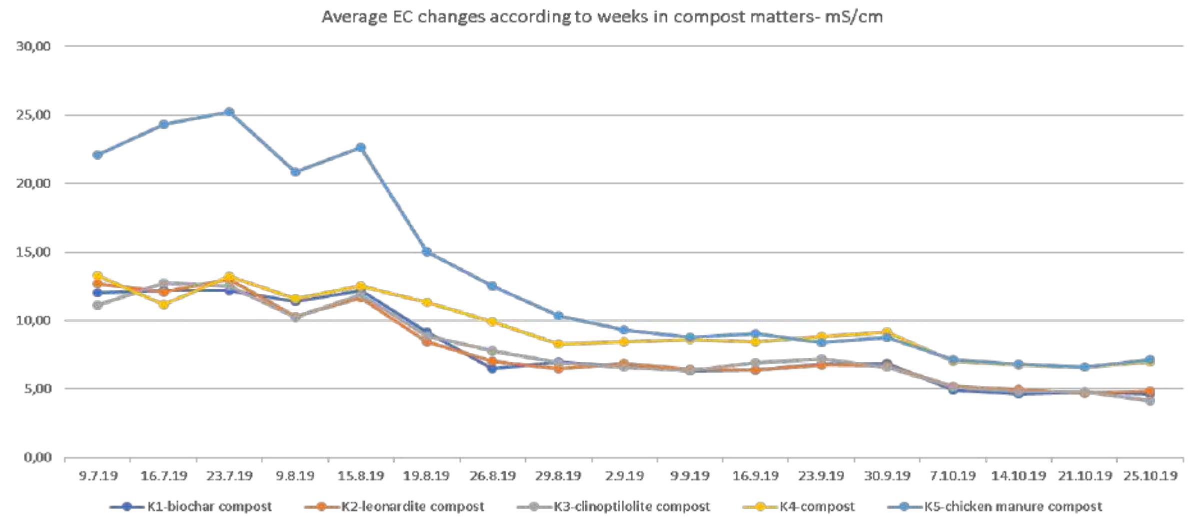

Figure 6. Average EC changes according to weeks in composts-($mScm^{-1}$)

With the composting process in compost piles, decreases and improvements in EC value have been observed over time. At the beginning of the compost, EC of K1, K2, K3, K4, and K5 ($mScm^{-1}$) were 12.04, 12.67, 11.10, 13.29, 22.06, while at the end of compost, they were 4.66, 4.90, 4.15, 6.99, 7.16 respectively. EC values are ordered from lowest to highest as K3>K2>K1>K4>K5 in EC values. According to soil quality standards, soil salinity in terms of EC (dSm^{-1}) is 0-4 unsalted and 4-8 slightly salty (Richards, 1954). It is seen that especially the subject of K3 (clinoptilolite compost) is suitable for soils close to the salt-free class.

Composting end %C, %N, C/N analysis results

One of the most important factors for successful composting in the composting process is considered to be the C:N ratio (Poincelot, 1977). While the preferred limits for rapid composting are 25:1-30:1 in the C:N ratio, 20:1-40:1 is predicted as acceptable limits (RYNK, 1992). In this study, C/N analysis results of the final compost formed as a result of compost were made on the LECO device on 25.12.2019 (Table 3). The C/N change over the composting period in composts is graphically indicated in Figure 7.

According to the same "Compost Quality Communiqué", C/N 10-30 is required. If we look at the C/N changes in compost subjects, it is seen that the K1, K2, K3 and K4 compost subjects decreased from approximately C/N 25/1s initially over time.
It has been observed that K3 (clinoptilolite compost) is C/N-10.89 and K2 (leonardite compost) is C/N-11.66 and that more mature composting is provided in these compost subjects and is also suitable for the same Compost Quality Communiqué. In the project, an evaluation was made in terms of nitrogen loss (%N) in composting (Table 3).

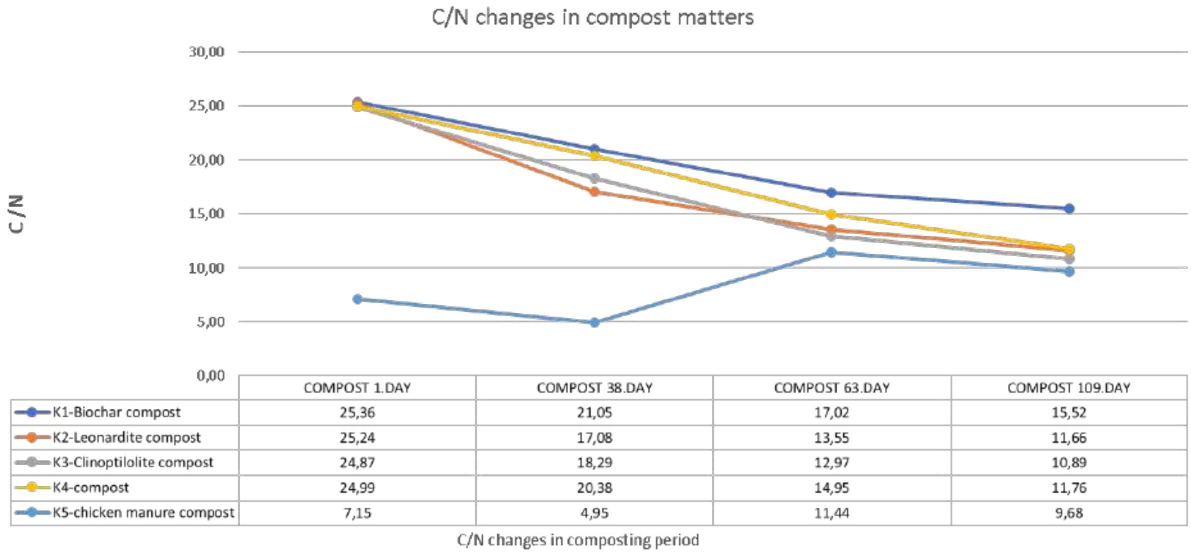

Figure 7. C / N changes in composts

Table 3. Reduction in N loss (%) and C, N (%) changes at the beginning and end of compost in composts

Compost matters	C, N (%) changes in compost subjects at the beginning and end of compost						
	At the beginning			Finally,			Reduction in N loss-%
	C	N	C/N	**C**	**N**	**C/N**	
K1	71,08	2,80	25,36	37,96	2,44	15,56	12,96
K2	66,02	2,62	25,24	29,16	2,50	11,66	4,43
K3	64,03	2,58	24,87	21,33	1,96	10,88	23,88
K4	69,62	2,79	24,99	28,34	2,41	11,76	13,51
K5	43,50	6,08	7,15	22,37	2,31	9,68	62,01

When the nitrogen (%N) loss in compost matters is ordered from the highest loss to the least, they are listed as K5 > K3 > K4 > K1 > K2. The most N loss was in K5 (chicken manure compost). Nitrogen loss was found to be less in other compost subjects than in K5 subjects. The least nitrogen (%) N loss was in K2 (leonardite compost) and K1 (biochar compost).

Organic matter loss (OML) analysis results in composting

In the muffle furnace, organic matter loss was revealed in the final compost issues (Table 4).

Table 4. OM and OML calculation at the beginning, middle, and end of composts

Date	**9.07.2019**	**15.08.2019**	**9.09.2019**	**25.10.2019**	**15.08.2019**	**9.09.2019**	**25.10.2019**
Matter	OM %	OM %	OM %	OM %	OML-%	OML-%	OML-%
K1	73,52	70,20	60,87	56,18	15	44	54
K2	67,10	59,04	50,68	37,21	29	50	71
K3	59,24	50,86	42,19	37,08	29	50	59
K4	66,82	64,89	56,25	47,95	8	36	54
K5	67,13	55,54	47,41	37,07	39	56	71

According to the same "Compost Quality Communiqué", Organic Matter (in dry matter) should be > 35%. OM (%), in terms of evaluation, respectively; the subject of K1>K4>K2>K3>K5 comes up. In all compost matters, organic matter (DM) is more than 35% and is considered appropriate.
OML (%), Organic matter loss, were highest in K5 and K2. The least happened in K1. The reason for the low loss of organic matter in K1 (biochar compost) here may be due to the resistance of biochar to decomposition by microorganisms. OML (%), Organic matter loss respectively; It comes as K5=K2>K3>K1=K4. In addition, weighings (DM) were made at the beginning and end of the compost in the project. Organic matter loss (OML) was determined and is indicated in Table 5 below.

Table 5. Organic matter loss (OML) between at the beginning and end of the composts

Compost matters	At the beginning compost 1.day-kg	At the end compost 109.day-kg	Organic matter loss-%
K1	964,13	440,62	54,30
K2	964,13	431,94	55,20
K3	964,13	428,44	55,56
K4	876,48	338,82	61,34
K5	1.531,38	572,15	62,34

About 2 times of organic matter loss (OML) occurred in the all compost matters. In OML, they are ordered from most to least as K5> K4> K3> K2> K1.

Colour change in composting

During the composting process, while the yellowish color was dominant in the compost heaps at the beginning, it was observed that with the burning event, it turned light brown over time and then dark brown. It was observed that the color changed to black in the final compost piles. It was observed that the fastest blackening in color change was K2 (leonardite compost) and K1 (biochar compost).

Analysis results of bulk density, specific weight, and free air ratio (porosity) values in composting

In the project, on composts, Bulk density (BD), Specific Weight (SW), and free air ratio (porosity) analyzes were followed once a week. Graphical representation of BD, SW, and porosity changes during the composting period is shown in Figures 8-10. Karapınar sandy soil was used as well as compost subjects in the evaluation of the comparison of composts in porosity change.

Bulk density (BD) in Composts–(g/cm^3)

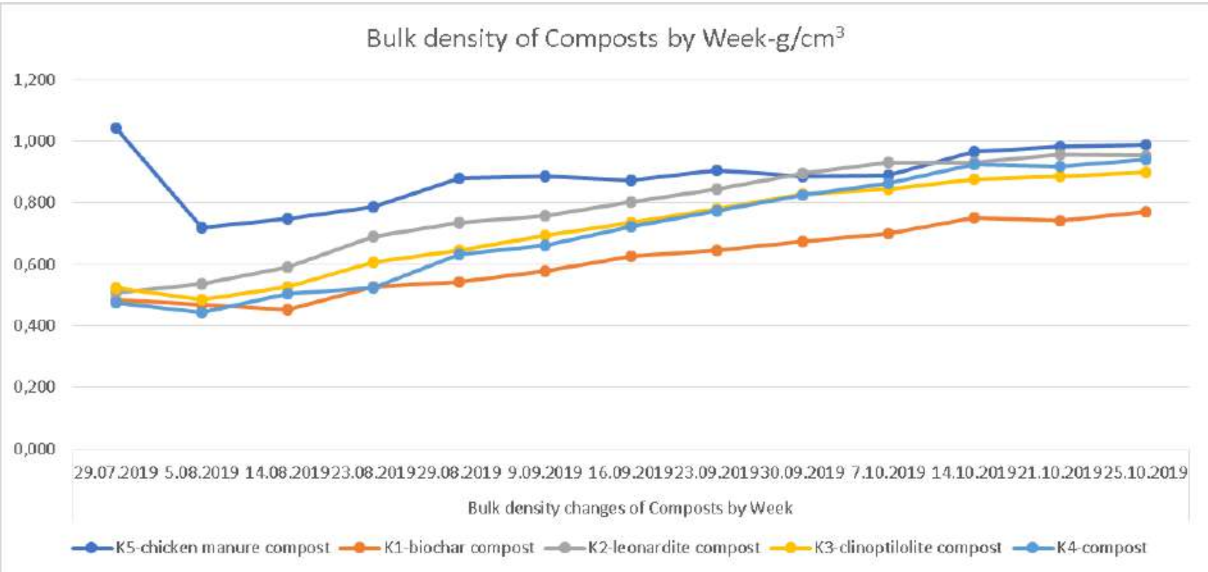

Figure 8. Bulk density (BD) changes in composts by week

K1 (biochar compost) is lower in BD. The BD value of K5 (chicken manure compost) is higher than other composts. In compost matters, there is an increase in BD values over time. In terms of bulk density, a change is observed in the form of K1<K3<K4<K2<K5< Karapınar Sandy Soil.

Specific Weight (SW) in Composts–(g/cm^3)

The highest SW value occurred in K5 (chicken manure compost). K5 (chicken manure compost) SW value is greater than other compost subjects. K1 (biochar compost) is lower in SW. In compost matters, there is an increase in SW values over time, as in BD. The results were summarized as K1<K4<K3<K2<K5< Karapınar Sandy Soil.

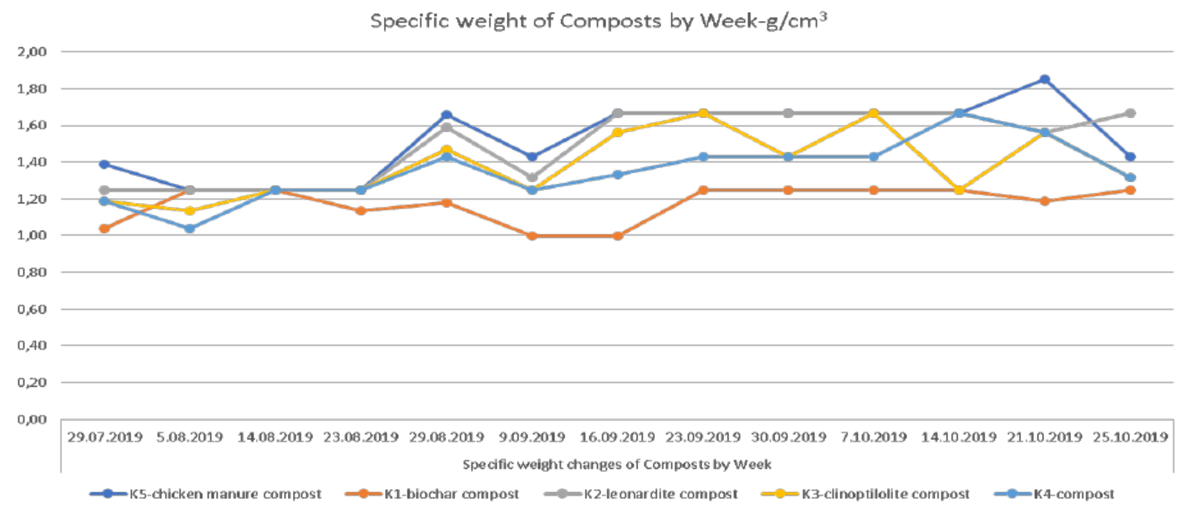

Figure 9. Specific weight (SW) changes in composts by week

Free air ratio or (Porosity) in Composts -(%)

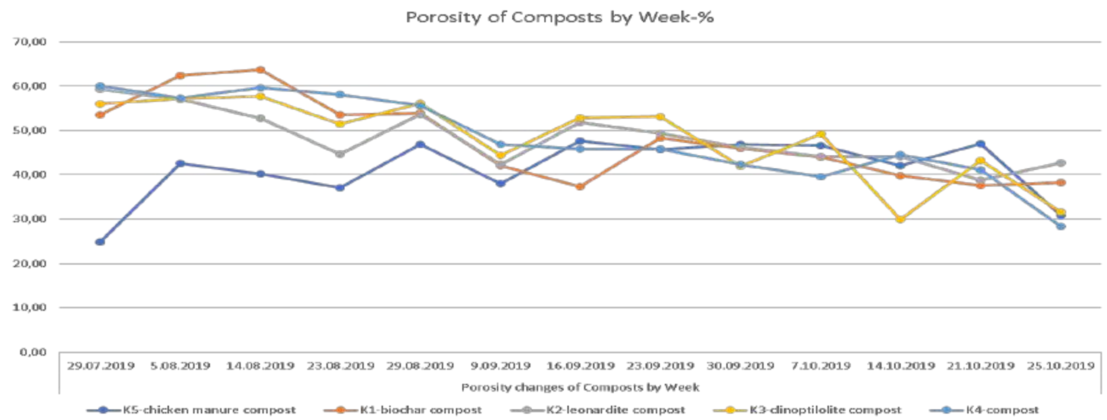

Figure 10. Porosity changes in composts by week

In the composting environment, there should be enough porosity to allow the necessary air to spread to the microorganisms. Free air ratio in the range of 20-35% as an indicator of the amount of free air in the material is suitable for composting (Jeris and Regan 1973, Külcü and Yaldız 2003). When the porosity (free air ratio) of the compost subjects during the composting period is examined, it is seen that the % porosity decreases in the other composts except for K5 (chicken manure compost). The porosity decreases as the compost matures. This is because, in the compost matters during the composting period, as BD increased higher than SW over time, the porosity decreased in the final composts compared to the initial state in the porosity values. In the final compost dated 25.10.2019, Porosity status was formed as K4<K5<K3<K1<K2.

Elemental analysis results of wet burning in initial and final composts in composting

The composts formed as a result of the 109-day process in the composting process were read on the ICP OES SVDV 5100 device for elemental analysis after the wet burning process. Analysis results are given in Table 6 below. In the results of the analysis, for example, when examining the initial and final K5 (chicken manure compost), there was an approximately 2-fold increase in plant nutrient concentration inversely proportional to the organic matter loss. Similarly, increases in plant nutrient element concentration are observed in all compost subjects. According to the same "Compost Quality Communiqué", it is seen that those trace elements are well below the limit values in all final composts.

Table 6. Elemental analysis results in initial and final compost products

Elemental analysis results in final and initial compost products-ppm																
Compost matters	Al	B	Ca	Cd	Co	Cr	Cu	Fe	K	Mg	Mn	Na	Ni	P	Pb	Zn
K1_09Temmuz19_compost	203,6	22,95	47695,7	0,11	0,54	2,97	16,36	229,9	14211,7	3681,3	163,49	805,4	5,97	3486,0	6,90	102,60
K2_09Temmuz19_compost	917,5	21,92	53472,6	0,11	1,04	7,85	20,34	1408,0	14794,7	3686,1	174,75	909,8	7,16	3399,0	2,15	114,65
K3_09Temmuz19_compost	2260,2	21,45	57757,3	0,09	0,89	3,92	20,07	637,8	19014,6	4149,8	236,10	1033,8	6,42	4020,1	5,66	134,62
K4_09Temmuz19_compost	249,8	24,20	60971,5	0,11	0,67	3,56	20,26	272,6	17788,6	4227,3	211,70	997,9	4,89	5062,8	1,40	140,90
K5_09Temmuz19_compost	145,1	30,43	70853,5	0,12	0,64	3,96	33,87	156,0	18136,6	3065,9	292,38	1737,5	6,13	9213,4	0,45	213,78
K1_25Ekim19_compost	304,5	38,22	80836,8	0,10	0,80	4,57	27,26	349,3	23035,6	5139,0	268,85	1624,3	6,95	7670,7	1,67	184,81
K2_25Ekim19_compost	1248,5	33,10	86920,9	0,16	1,28	7,91	33,22	1899,8	23138,3	4876,9	295,83	1674,2	8,56	7810,2	2,34	198,81
K3_25Ekim19_compost	3318,4	32,93	84170,3	0,14	1,22	5,57	28,94	1029,3	27522,7	5227,0	359,86	1849,4	8,19	7249,0	8,91	198,85
K4_25Ekim19_compost	375,8	42,73	98453,1	0,13	1,02	5,91	37,52	384,4	29845,1	5361,5	360,15	2232,8	7,59	10572,6	1,79	247,39
K5_25Ekim19_compost	296,3	51,29	124817	0,25	1,18	6,84	61,31	322,0	29683,7	5061,1	562,85	3326,9	7,98	17317,1	1,00	386,46

CONCLUSION AND EVALUATIONS

When the compost analysis data is evaluated, according to the temperature values, it is seen that K3 (clinoptilolite compost) and K2 (leonardite compost) complete the process and mature the fastest. K5 (chicken manure compost) shows that it matures at the latest and does not lose its temperature. If we look at the humidity values, it is seen that the humidity is best kept and the humidity is the highest in K1 (biochar compost).

If we look at the humidity values, it is seen that the humidity is best kept and the humidity is the highest in K1 (biochar compost). It is seen that the humidity is at the lowest level in the case of K5 (only chicken manure compost).

The pH value was lower for K2 (leonardite compost) and K3 (clinoptilolite compost) compared to other subjects and the pH was close to 8.5. With the composting process in all compost piles, decreases and improvements in EC value have been observed over time. It was observed that it was close to 4 ($mS\ cm^{-1}$) especially in K3.

Considering the C/N changes in compost subjects, it was seen that K3 (clinoptilolite compost) C/N-10.89 and K2 (leonardite compost) C/N-11.66 were found to be more mature composting in these compost subjects. In terms of nitrogen (% N) loss in compost subjects, the most N loss was in K5 (chicken manure compost). Nitrogen loss was found to be less in other compost subjects than in K5 subjects. The least loss of N was in K2 (leonardite compost) and K1 (biochar compost). OML (%), Organic matter loss was highest in K5 and K2 and least in K1. The reason for the low loss of organic matter in K1 (biochar compost) here may be due to the resistance of biochar to decomposition by microorganisms.

As for the colour change, it was observed that the fastest blackenings were K2 (leonardite compost) and K1 (biochar compost). Similarly, in all composts, increases in BD and SW; a decrease in porosity values were observed. When looking at the porosity of composts during the composting period, it is seen that the % porosity decreases in other composts except for K5 (chicken manure compost). Similarly, increases in plant nutrient element concentration are observed in all compost subjects.

In the light of all the evaluations, we can briefly say that during the composting period, we see that the composting process of K2 (leonardite compost) and K3 (clinoptilolite compost) compost subjects among all composts, in temperature parameters, completes the composting process more quickly and matures. In the C/N evaluation, it was seen that K2 (leonardite compost) and K3 (clinoptilolite compost) are better and lower C/N ratio in compost formation due to their high absorbency and nitrogen retention, high porosity in the compost, thus keeping air and water well, increasing ventilation and providing better combustion. In addition, it has been observed that K1 (biochar compost) retains well moisture, nitrogen loss is low, and organic matter loss is also low due to its resistance to decomposition by microorganisms.

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