Science Arena Publications
Specialty Journal of Agricultural Sciences
ISSN: 2412-737X
Available online at www.sciarena.com
2019, Vol 5 (2): 15-24

Effect of Municipal Solid Waste Compost Modified by Tea Pulp on Soil Physical- Chemical Properties

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Abstract: *Recent years in order to tackle environmental problems there have been a lot of concentration on recycling and using the compost in agricultural fields. In order to investigate the effect of tea pulp on the improvement of physical and chemical properties of municipal waste compost, field experiment was conducted at the faculty of agriculture, Tabriz Azad University. For conducting this research two type of modified urban garbage compost prepared of waste tea powder. The garbage factor consisting two levels (Segregated garbage and integrated garbage) and modified waste tea powder was in three levels (60.40, 80.20, 100.0). The produced compost in form of totally random plan in six treatments added to soil and a plot without compost considered as a sample treatments and in 3 times repetition. Among the parameters studied in soil, potassium and moisture curve at the turning point in the probability level of 1 %, phosphorous and cadmium and mean weight of aggregate diameter were significant at 5% probability level. Also the results showed that the segregated compost was more effective in the improvement of physical-chemical properties of the soil. also by examination comparing the average counter effects of garbage and modified material, it was observed that the segregated compost was richer that the integrated compost in elements like sodium and potassium and phosphorus and organic Carbon and total Nitrogen.*

Keywords: Compost, Segregated, Integrated

INTRODUCTION

Soil is the most important natural source of sustainable food production for the ever-growing population of humans. Since plant grows in soil, soil is the most important source of food, medicine, housing and clothing for human beings. Todays, the excessive consumption of natural resources and the unreasonable consumption of artificial man-made materials, such as fertilizers, in order to produce more agricultural units and existing land are considered as fundamental problems in terms of environmental degradation and loss of known biological equilibrium.

For sustainable yield, the plant nutrients which are taken up by plants or removed by some other factors from the soil should be returned to the soil. In organic farming, these nutrients should be presented in natural organic forms instead of chemical fertilizers. Thus, the use of municipal solid waste compost in agricultural areas is gradually increasing (Hergroise et al., 2008; Madrid et al, 2007).

The use of municipal solid waste compost is a common method for improving the physical, chemical and biological properties of poor soils through the provision of organic materials (Rosa-Perez et al., 2009; Baldantini et al., 2010).

Many studies indicated that adding municipal solid waste compost improves the physical and chemical properties of soil (Arthur, 2012, Mayalavarapu and Zinati 2009) because municipal solid waste compost contains high levels of organic matter and increases soil organic matter (Bozayan et al., 2014; Madrid et al., 2007). However, besides the positive effects, municipal solid waste composts may have negative effects which should be considered. The most important concern is the solid municipal waste compost associated with heavy metals (Bozayan et al., 2014). However, there were some studies indicating that the use of municipal solid waste compost did not increase the total amount of heavy metals in soils (Montmorou, 2005; Zhao and Deo, 2015).

Although compost is often used for horticulture and agronomic purposes, it can also be used for land reform (Hey et al., 2000). Compost can improve soil stability and reduce the risk of erosion, and can also increase soil porosity and soil water retention (Gioskevini et al., 1995). In addition, compost can increase the long-term soil buffering properties (Bangton and Corent, 1973) and release the nutrients needed for the plant (Tejada and Gonzalez, 2003). Soil quality is one of the issues attracting a lot of attention. Quality was considered from three physical, chemical and biological aspects. Soil physical quality is determined in different forms. Since the 1950s, various soil properties or behaviors have been used as qualitative indicators, including MWD (Kemperforosena, 1986), which is essentially used for qualitative description of soil structure. Aggregate stability has a positive correlation with organic matter and total carbon content (Lui et al., 2005; Cheno et al., 2000). Soil organic matter is one of the most important indicators of soil quality because it affects the physical, chemical, and biological properties and soil processes (Spasini et al., 2004).

In a study conducted on the frequency of wheat, corn and sugar beet by using municipal compost over a period of six years, it has been shown that zinc increased in wheat while and copper increased in sugar beet. However, the elements such as cadmium, chromium, and nickel showed no increase (Kortelini, 1999). Therefore, if the amount of heavy elements in the compost does not exceed the global standards, it can be used to improve soil properties without any problems. Since municipal waste compost causes some problems, tea pulp was used to modify its properties. The present study aimed to investigate the effect of municipal waste compost modified with different ratios of tea pulp waste on two levels of segregated and integrated on the physical and chemical properties of soil under cultivation, eliminate salinity, and improve the compost characteristics of municipal waste. The effects of different levels of municipal waste compost with different ratios of tea pulp were investigated on the measured parameters.

Materials and Methods

This research was carried out at the Research Farm of Faculty of Agriculture, Islamic Azad University, Tabriz Branch. This research was carried out in two stages. The first stage of compost production as performed in a completely randomized design with three replications in a factorial arrangement of 3 * 2. The waste was transferred from the municipal waste collection center to the college and then was separated from the basic composting organic materials through physical analysis of mineral elements or non-degradable materials by living organisms such as metals, glass, rocks, plastics, rubber, textiles and other inert materials. For this purpose, the material was passed through a standard 37 mm sieve. Then, for the collection of segregated household waste, the fully segregated household waste, as well as in fruit and vegetable areas located in Tabriz, the fruit grocery waste including waste from fruits and vegetables and wastes of juice shops were collected. Therefore, two types of waste (segregated and integrated) were used to produce compost. The waste was mixed with the accompanying material in this study, which was tea pulp as follows:

A. 100% waste and the material with 0% accompanying material

B. 80% waste and the material with 20% accompanying material
C. 60% waste and the material with 40% accompanying material

In order to produce compost, the above-mentioned treatments were placed in a greenhouse with warm and humid conditions. For this purpose, special pockets of 15 * 26 cm were used with a height of one meter. The temperature control was shaking and aeration of the envelopes. After the complete decomposition of the waste and conversion to the modified compost, the physical parameter of the water retention and the chemical parameters of acidity, saturation, electrical conductivity, organic carbon, organic matter, nitrogen, potassium, sodium, phosphate, calcium, magnesium, cadmium for the volatile solids in the produced compost were measured. The second stage of this research was conducted on a soil with a class of loamy surface texture in a completely randomized design with seven treatments and three replications. 24 plots in size (1 * 1) square meters were considered in the field. The compost was planted in plots which were sampled after four months. The samples were prepared at a depth of 0-30 cm. After air drying and passing through the sieve No. 10 (with a diameter of 2 mm), some soil was transferred to the laboratory for testing. Then, the parameters including physical parameters such as soil structure stability (MWD) by van Bowl (1949) and using a series of sieve numbers with different numbers of grain mass fractal dimension (Dm) from Byrd et al. model was calculated using the following equation: $M_s(d \leq d_i)=cd_i^{3-Dm}$
In order to measure the gradient of the moisture curve (Si), the intact samples were taken from the experimental plots and the Van Genuchten model parameters were obtained using the following equation and compression chamber in 4 suctions of 100-300.500.1000 cm with the help of RETC software.

$$S_i = -n\,(\theta_s - \theta_r)\,[1+1/m]^{-(1+m)}$$

The bulk density was determined by using the core method and a metal cylinder. Chemical parameters including pH, EC, phosphor were determined by Olsen method, Organic carbon by Walkley and Black method, Nitrogen by Kjeldahl method, Sodium and Potassium by flame photometric method, Magnesium and calcium by titration, and Cadmium by atomic absorption system . Meanc omaprison was conducted by LSD test at 5% probability level. Statistical analysis were performed by SPSS software and drawing charts was performed through EXCEL software.

Results and Discussion

The results of variance analysis of factorial based on a completely randomized design for municipal waste compost were presented in Table 1. Thec mean comaprison of these treatments was also presented in Table 2. Based on the results of the analysis of variance on the traits examined in the compost, the mutual interaction of waste × fertilizer on organic carbon traits, total nitrogen, sodium and potassium, phosphorus, electrical conductivity, saturation extract, cation exchange capacity, calcium and magnesium, water holding capacity and volatile solids was significnat.
The results of variance analysis of completely randomized design of the treatments were presented in Table 3. The mean comparison of these treatments was also presented in Table 4.
Based on the results of variance of treatments, the difference between different treatments in terms of potassium and gradient of moisture curve at the turning point at 1% probability level and phosphorous and cadmium and mean weight of aggregate diameter were significant at 5% probability level (Table 3). The mean comparison of different treatments showed that the highest amount of potassium was observed in treated waste compost with a ratio of 80/20 tea pulp (Table 4 and Figure 1). Azarmi et al. (2008) showed that vermicompost had a positive effect on the soil

characteristics of the tomato field, especially the absorption of nitrogen and potassium. In an experiment, clay and silty soils were placed with and without municipal waste compost for 12 months and it was observed that the exchange rate of potassium increased significantly in compost treatment compared with control (Gio Sikwani et al., 1988). The highest amount of phosphorus was observed in the compost treated waste with a ratio of 100/0 of tea pulp nd waste compost treatment with a ratio of 60/40 tea pulp (Table 4 and Figure 2). Santos et al. (2011) in a study on the effect of compost from sewage sludge and organic residues on bean and density of Mycorrhiz Arbusco fungus showed that the compost from the mixture of municipal sewage sludge, paper pulp, waste of beer and sauce factoris, and corn stalk caused significant increase in soil phosphorus. The use of compost in the soil increases the absorption of phosphorus, which is similar to the results of Gallardo Larah and Nogales (1978). Rossa-Perez et al. (2009) reported that the use of municipal solid waste compost increased the quality of soil in two soils from Spain, and increased soil organic matter, nitrogen and phosphorus and aggregate stability in both modified soils. The lowest amount of cadmium was observed in segregated waste compost with a ratio of 80/20 of tea pulp and integrated waste compost with a ratio of 80/20 of tea pulp (Table 4 and Figure 3). There has been no consensus among the reserachers on the effect of organic matter on reducing or increasing the bioavailability of cadmium. Some researchers believe that the increase in organic matter increases the CEC and the formation of a complex with cadmium and consequently decreases its vailability (Haqiri 1974, Kizilkaya and Skin 2002, Hans et al., 2009). Adding organic matter to soil to eliminate the toxicity of cadmium is one of the principle and safe methods because organic matter increases the soluble carbon content in soil (Kizilkaya and Skin 2002, Hans et al. 2009).

The highest average weights of aggregate diameters were observed in segregated waste compost with a ratio of 80/20 of tea pulp (Table 4 and Figure 4). Barzegar et al. (2002) in a study showed that the addition of organic matter increases the weighted average diameter of aggregates and the stability of aggregates, and there is no significant difference between different organic materials, although their effect is different. Bruce et al. (1992) showed that soil organic matter has a positive linear relationship with the weighted average diameter of aggregates and increases the stability of aggregates in dry state.

The highest amount of gradient of moisture curve at the turning point was observed in segregated compost waste with a ratio of 100/0 nd 60/40 of tea pulp qand integrated compost with a ratio of 100/0 of tea pulp (Table 4 and Figure 5).

Treada and Gonzalez (2008) reported the reduction of bulk density and increase of soil pores using organic fertilizers of compost, vermicompost and manure in soil and attributing the most effect to compost. The studies by other researchers (Agulides Vollvander, 2000; Oadorg et al., 2001; Sumare et al., 2003) showed that by adding compost, the chemical properties of two types of loamy and clay soils were indirectly affected, so that pH and EC They increased with the use of different amounts of compost. Geljazko and Vermen (2004) concluded that the long-term use of municipalcompost would increase soil pH.

Conclusion

The compost from segregated waste has a greater effect on the physical and chemical properties of the soil and increases integrated waste (MWD). As a result, it is effective in improving the sustainability of the soil structure. In addition, segregated compost in soil is increased in soil and affects soil permeability which is due to organic matter present in the compost. The compost was separated from the waste because it was made up of home-made food. The salinity of the compost was more thann the integrated waste which reduced by using the modified matter of tea pulp. The modified matter of tea pulp increases organic carbon and total nitrogen, water retention capacity, volatile solids, and the capacity for exchange of cationic and cadmium in the compost while reduces acidity, electrical conductivity, sodium, phosphorus, potassium, calcium and magnesium. Tea pulp reduces the pH of the compost due to the acidic properties of tea.

Table 1. Analysis of variance of the factorial experiment based on a completely randomized design for compost

average of squares						Degree of freedom	Sources of change
P	K	Na	%N	%OM	%OC		
1479568.028**	2.244E9**	1.287E9**	5.311**	2124.433**	714.546**	1	Waste
186762.317**	1694420.143**	2906305.786**	1.005**	402.047**	135.260**	2	modified matter
232315.162**	2847024.354**	1391801.44*	0.337*	134.619*	45.294*	2	Waste* modified matter
1862.116	218400.411	350579.71	0.054	21.479	7.223	12	Experimental error

Continuation of Table 1. Analysis of variance of the factorial experiment based on a completely randomized design for compost

average of squares							Degree of freedom	Sources of change
Water retention capacity	Volatile solids	Mg+Ca	Cd	CEC	pH	EC		
42340.500**	1.427E11**	5976.889**	1.015**	1576.598**	0.046 ns	0.203 ns	1	Waste
6875.362**	4.893E10**	1225.722**	0.294**	249.310**	0.225**	108.051**	2	modified matter
2732.407**	2.576E10**	1112.389**	0.082 ns	79.773**	0.104 ns	10.814*	2	Waste* modified matter
148.287	9.302 E8	28.222	0.026	1.277	0.028	2.168	12	Experimental error

ns, *, and ** are significnat and insignificant at a probability level of 5% and 1% respectively.

Table 2. The mean comparison of the studied traits in waste and modified matter

K(mg/kg)	Na(mg/kg)	%N	%OM	%OC	Treatments
28788.9	34548.2	1.37058	27.41	15.9	Waste A1 * modified matter b1
30568.2	33543.3	2.38004	47.6	27.61	Waste A1 * modified matter b2
28447.5	32203.6	2.57403	51.4767	29.86	Waste A1 * modified matter b3
6541.31	16687.9	0.823863	16.4767	9.56	Waste A21 * modified matter b1
6820.08	16604.2	1.10065	22.01	12.77	Waste A2 * modified matter b2
7451	16269.2	1.14086	22.8167	13.2367	Waste A2 * modified matter b3
831.45	1053.43	0.41	8.24	4.78	LSD 5%

Continuation of Table 2. The mean comparison of the studied traits in waste and modified matter

Water retention capacity	Volatile solids (mg/kg)	Mg+Ca (meq/l)	CEC(meq/ 100grsoil)	EC(dS/m)	P(mg/kg)	Treatments
130.33	333893	40	20.21	26.6	1252.09	Waste A1 * modified matter b1
212	575523.1	35	34.9233	18.1167	677.245	Waste A1 * modified matter b2
235	624775.3	23.67	39.3333	17	577.764	Waste A1 * modified matter b3

82.3333	303855.5	92	9.9	24.1333	225.481	Waste A21 * modified matter b1
95.0667	350562.9	40	12.4067	21.52	359.215	Waste A2 * modified matter b2
108.933	345562.6	76	16.0067	17.2	202.194	Waste A2 * modified matter b3
21.66	54262.496	9.45	2.01	2.62	76.77	LSD 5%

A1 and A2 respectively indicate the segregated and integrated waste, and b1, b2 and b3 respectively represent the ratios of 100/0, 80/20 and 60/40.

Table 3. Results of analysis of variance for completely randomized design of the treatments

							average of squares			
Cd	PH	EC	P	K	Na	%N	%OM	%OC	Degrees of freedom	Sources of change
0.033*	0.076 ns	2.896 ns	29.987*	32992.159**	24477.873 ns	0.001 ns	0.079 ns	0.27 ns	6	Treatment compounds
0.011	0.108	5.164	6.933	6265.429	11666.143	0.001	0.05	0.017	14	Experimental error

Continuation of Table 3. Results of analysis of variance for completely randomized design of the treatments

							average of squares			
Si	Θv (1 bar)	Θv (0.5 bar)	Θv (0.3 bar)	Θv (0.1 bar)	ρb	Dm	MWD	Mg+Ca	Degree of freedom	Sources of change
0.003**	0.011 ns	0.01 ns	0.008 ns	0.007 ns	0.018 ns	0.003 ns	0.039*	4.602 ns	6	Treatment compounds
0.001	0.004	0.004	0.003	0.004	0.008	0.003	0.01	3.413	14	Experimental error

ns, *, and ** are significnat and insignificant at a probability level of 5% and 1% respectively.

Table 4. The mean comparison of the tested treatment compounds

Si	MWD	Cd(mg/kg)	P(mg/kg)	K(mg/kg)	teratment compounds
0.162	0.946	1.416	20.100	430.000	A_1 b_1
0.113	1.136	1.100	17.800	632.670	A_1 b_2
0.159	0.860	1.366	23.133	432.000	A_1 b_3
0.128	0.876	1.300	13.533	357.670	A_2 b_1
0.062	0.763	1.266	15.200	336.000	A_2 b_2
0.121	0.880	1.366	16.700	322.330	A_2 b_3
0.120	0.893	1.356	17.433	411.000	Sample
0.055	0.175	0.183	4.609	138.629	LSD 5%

A1, A2, b1, b2, and b3 respectively indicate the segregated and integrated waste as well as the ratios of 100/0, 80/20 and 60/40.

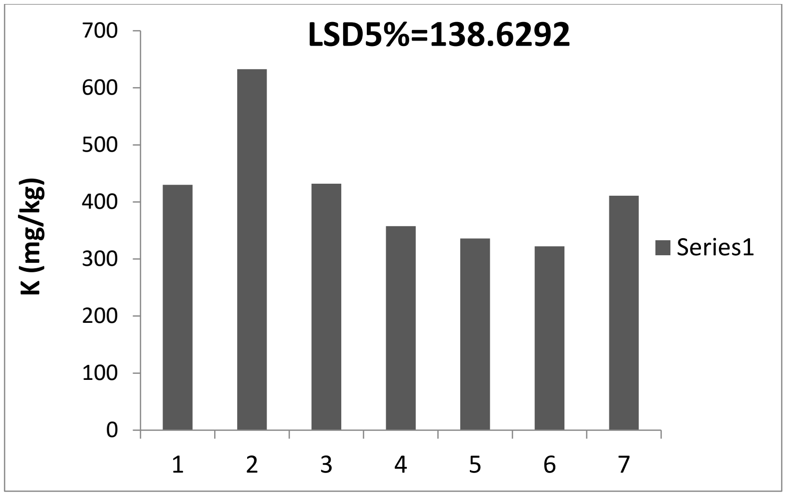

Figure 1: The mean comparison of different composts

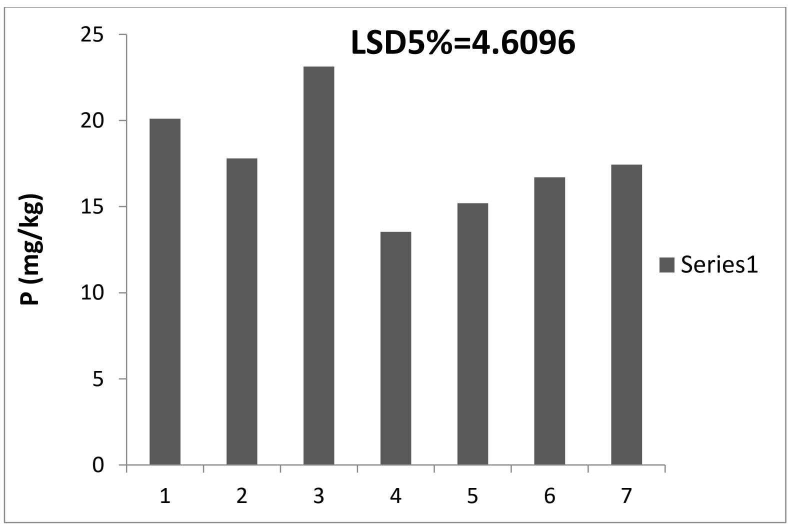

Figure 2: The mean comparison of different composts

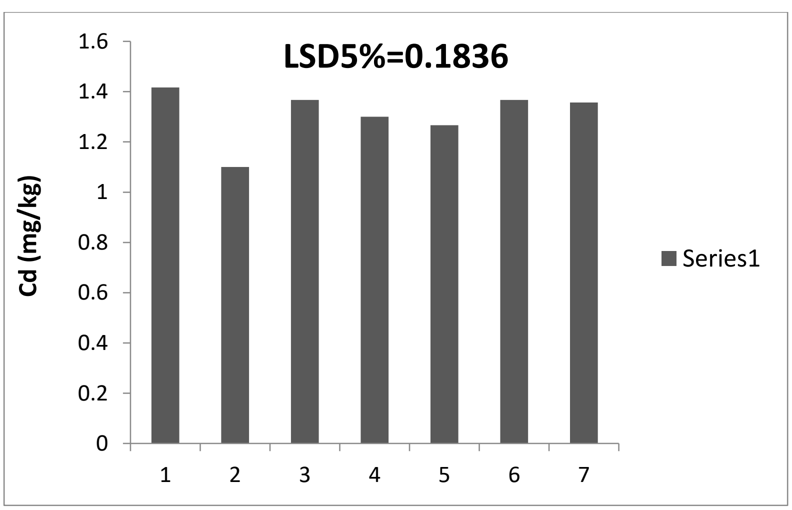

Figure 3: The mean comparison of different composts

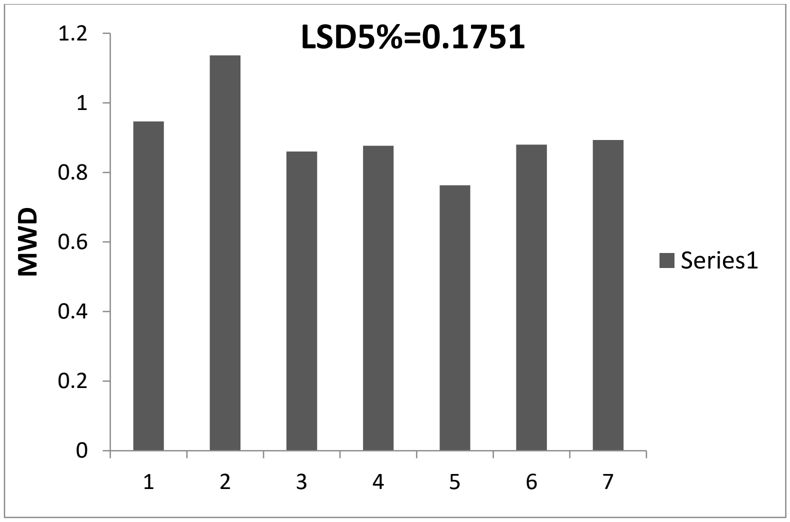

Figure 4: The mean comparison of different composts

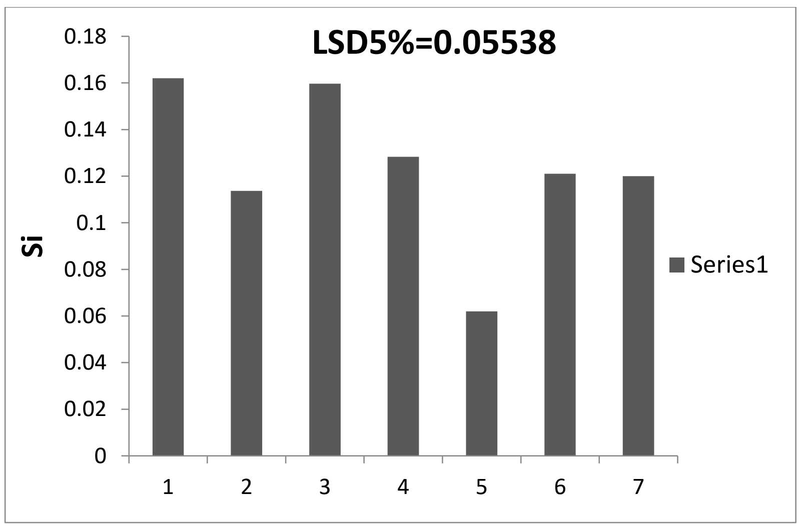

Figure 5: The mean comparison of different composts

1, 2, 3 are respectively the segregated compost with ratios of 100/0, 80/20, and 60/40 of modified matter and 4,5,6 are respectievly the integrated compost with ratios of 100/0, 80/20, and 60/40 of modified matter while 7 is the soil without compost as the control.

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