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The effects of thermal process solid product on development of "Cicer arietinum L." and "Allium ascalonicum"

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Abstract

Today, the number of wastewater treatment plants is rapidly increasing. Accordingly, there is a large increase in the amount of sewage sludge. The sewage sludge obtained should be disposed of in such a way as not to damage the environment. Among these methods, disposal of sewage sludge by landfill is one of the most suitable methods in terms of environment and economics. In this study, the effects on the development of "Cicer Arietinum" and "Allium Ascalonicum" plants were investigated by adding municipal solid waste compost, brewery sludge, pyrolysis solid product of brewery sludge and chemical fertilizer at certain rates to the soil in order to improve the soil and increase the yield. As a result, it can be seen that the materials used can be used for remediation of the soil and contribute to the development of the plant. As a result of the study, it was observed that the soil mixture obtained by mixing the pyrolysis solid product with soil at certain ratios positively affected plant growth. Soil and pyrolysis solid product (25%) provided the highest yield for "Cicer Arietinum".Soil and brewery sludge (25%) provided the highest yield for "Allium Ascalonicum".

Keywords: Waste water treatment sludge, Pyrolysis, Plant growth

Introduction

Sewage sludge is a type of solid waste, and it contains 0.25-12% solids by weight, depending on the treatment applied, which is odorous, semi-solid in the liquid formed as a result of wastewater treatment. The micro and micro nutrients in the sludge that emerged as a result of the treatment are a beneficial fertilizer to this waste; and organic substances provide a good soil improvement feature, many authorities support the use of these products in agriculture and applications are spreading in many countries (Strauch,1991; Düring and Gäth, 2002). Within the framework of the European Union Directives; composting, biometanization and landmass application with energy recovery and recovery methods to reduce the storage of biodegradable waste in landfills. It is also appropriate to use treatment sludge not only for agriculture but also for green space, land recreation and urban landscape (Debosz et al., 2002). Nowadays it is a very common practice to supply the treatment sludges having suitable properties to agricultural areas and to use them. Both the final disposal and the plant nutrients in the sludge become natural cycles of the soil (Kocaer et al., 2003) by applying the treatment sludges to the soil in accordance with the agriculture. Waste incineration / gasification (thermal conversion) is the process of converting combustible waste to an inert residue (ash, slag) at high temperatures. By means of the method, while the space required for the storage of solid wastes is reduced, energy recovery is achieved by using the heat that is present in the waste and which is produced as a result of the treatment (Öngen et al., 2019). Pyrolysis is a process based on thermal decomposition of waste in a completely oxygen-free environment. With the pyrolysis method, coke, tar, volatile oils, condensable hydrocarbons, water and pyrolysis gases are released as a result of disposal of wastes. In the gasification method, a certain amount of air is given but the amount of oxygen in the environment is kept below the stoichiometric ratio (Saltabaş et al., 2011). Biochar produced by carbonization of biomass with pyrolysis are used for

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soil remediation and as a plant fertilizer to store carbon in the soil, increase soil fertility, reduce climate change (reduce CO_2 and CH_4 emissions), dispose of waste causing environmental pollution in waste management and generate energy (Akgul, 2017). In this study, the effect of compost, brewery sludge, biochar obtained by pyrolysis of brewery sludge and chemical fertilizer on the development of "*Cicer Arietinum"* and "*Allium Ascalonicum"* plants was investigated.

Materials and Methods

In this study, Tropical brand 100% organic soil was used. Compost which is recycled from the domestic solid waste obtained from Istac Kemerburgaz Recovery and Compost Facility. Ammonium sulphate containing 21% Nitrogen obtained from Gübretaş as chemical fertilizer. Treatment sludge (from a brewery waste water treatment plant) and heat treatment solid product (pyrolysis product of brewery sludge) were used. These contents mixed at the ratios indicated in Table 3 and placed in a pot. As a plant material, natural field crop "*Cicer Arietinum*" (chickpeas) and "*Allium Ascalonicum"* (shallot) were used. Soil samples were prepared to contain 25% compost, 50% compost, 1.5% chemical fertilizer, 2.5% chemical fertilizer, 10% brewery sludge, 25% brewery sludge, 10% biochar, 25% biochar, mixture of 10% biochar and 25% compost. All of the percentages are as volume/volume (v/v).

Prior to addition of chemical fertilizer to samples, a two-week waiting period was applied to obtain the reaction between the soil and compost for reclamation. Only irrigation was employed at this stage. Also, plant seeds were planted in the soil with no additives. The prepared pots were placed under artificial light and constant temperature environment with timer control, for 16 hours day and 8 hours night. The change in the size of the plant (body and root), weight of the plant were measured after a period of 40 days. At the beginning and end of the experiment, the pH values of the mixtures in the pots were measured.

For determining the pH values of the samples, for compost pH; distilled water was added to the samples at a 5:2 (v/w) ratio (Page et al. 1982), for soil pH; solution KCl 0.1 N was added to soil samples at a 1:2.5 (v/w) ratio (Paradelo et al. 2011).Then mixed by a magnetic stirrer for 10 minutes. The pH values were measured using a Jenway 3040 Ion Analyzer.

For Elemental analysis of the compost and soil samples (C, H, N, S determination) Thermo-Flash 2000 CHN-S elemental analyzer in the laboratory of Istanbul University-Cerrahpasa, Environmental Engineering Department was used (ASTM-D5373 (2016) method). The organic matter (%) determination of the compost samples was performed in Halic Cevre Laboratory.

For the determination of the total metal concentrations and some elements (Mg, Ca, Na and K), the samples from the soil and the compost were thoroughly ground with porcelain mortar. Then, 0.5 g of air-dried sample was placed in microwave tubes and mixed with 9 mL of concentrated HNO_3, 3 mL of concentrated HCl, 2 mL of concentrated HF and microwaved (Berghof MWS-2 microwave-system) (EPA Method 3051A, 2013). During the digestion of the microwaves, the temperature was gradually increased and 10 minutes were left at 185 ° C. After digestion, the samples in Teflon containers were filtered (MN 640 de, 125 mm Macherey-Nagel fitler paper) and the filtrate was taken to HDPE containers and their volumes were completed to 50 mL. The determination of concentrations of metals and some elements was measured using ICP optical emission spectrometer (Perkin Elmer Optima 7000 DV) combined with autosampler (Perkin Elmer S10 Autosampler) in Bahçeşehir University Environmental Engineering laboratory. Using the reference soil, the accuracy of the measurement results was checked. NCS Certified Reference Material NCS ZC73002 was used as reference soil.

Results

Table 1 shows the composition of the soil and compost used in the study. When the results in Table 1 were examined, it was found that the pH of the soil was slightly acidic. The pH value of the compost is a slightly basic value.

Table 1. Composition of soil and compost

Parameters	Soil	Compost
pH	5.5-6.5	7.9
NO_3	50-100 ppm	-
EC	0.5-0.8 mmhos/cm	-
Ca	30-50 ppm	22727 mg/kg dryweight
P	10-20 ppm	-
K	40-100 ppm	7995 mg/kg dryweight
OM(%)	-	1.36
Na	-	17525 mg/kg dryweight
Mg	-	5100 mg/kg dryweight
S(%)	-	0.17
C(%)	-	11.07

Table 2 shows the characterization of the brewery sludge and biochar used in the study. When the results in Table 2 were examined, it was seen that the C (%) and N(%) contents in the brewery sludge not subjected to pyrolysis were higher than the C (%) and N (%) contents of biochar obtained from pyrolysis sludge.

Table 2. Characterization of brewery sludge and biochar

Parameters	Brewery Sludge	Biochar
C	17	9.30
H	3.15	0.20
N	3.20	0.12
S	-	-
Calorific Value (kcal)	1470	720

Table 3. Plant height, root length, weight and pH measurements at the end of the study for *Cicer Arietinum*

Soil mixture	pH	Body height (cm)	Root lenght (cm)	Weight (gr)
Soil	6	19	9	0.11
Soil+ 25% compost	7	19.25	5.5	0.88
Soil+ 50% compost	7.5	13.5	6.5	0.92
Soil +1.5% chemical fertilizer	5.5	-	-	-
Soil+2.5% chemical fertilizer	6	-	-	-
Soil+10% brewery sludge	5	19.75	9	0.64
Soil +25% brewery sludge	5.5	16.25	5.85	0.3
Soil +10% biochar	7	23.5	13.25	1.07
Soil + 25% biochar	7	25.5	11	1.0595
Soil+ 10% biochar + 25% compost	7	21	9	0.95

When the changes in pH values of soil mixtures were examined, it was seen that the addition of compost and biochar to soil increased soil pH slightly (Table 3 and 4). When the results in Table 3 are examined, it is seen that the best plant growth for *Cicer Arietinum* plant is in biochar added soil mixtures. *Cicer Arietinum* plant growth was not observed in pots where chemical fertilizer was added. When the development of *Cicer Arietinum* plant was evaluated, it was observed that the results were similar for plant development as a result of using compost and brewery sludge (Table 3).

Table 4. Plant height, root length, weight and pH measurements at the end of the study for *Allium Ascalonicum*

Soil mixtures	pH at the end of study	Body height (cm)	Root lenght (cm)	Weight (gr)
Soil	6	25.75	9	1.6
Soil + 25% compost	7	29.9	12.15	2.4
Soil + 50% compost	7.5	18.5	11.75	1.23
Soil + 1.5% chemical fertilizer	5.5	27.75	5.85	2.038
Soil + 2.5% chemical fertilizer	6	13.85	1	0.7
Soil + 10% Brewery sludge	5	28.25	7	2.75
Soil + 25% Brewery sludge	5.5	31	2.5	3.5
Soil + 10% biochar	7	36.5	17	2.829
Soil + 25% biochar	7	-	-	-
Soil + 10% biochar + 25 % compost	7	2.09	9.5	1.5

In the study, when the results of the experiments related to the growth of *Allium Ascalonicum* plant were examined, it was seen that 10% compost added soil growth in the soil was better than no remedial soil. Best plant growth was observed in soil mixtures with 10% biochar added. It was observed that plant *Allium Ascalonicum* did not develop in soil added to 25% biochar. It was observed that *Allium Ascalonicum* plant growth was also very good in the soil mixtures where brewery sludge was added. It can be said that *Allium Ascalonicum* plant root growth and plant weight in soil mixtures with 25% brewery sludge is better than the growth of plants growing in soil mixtures using 10% biochar (Table 4).

According to Lehmann and Joseph (2009), biochar not only enhances water and nutrient retention properties, but also contributes to creating favorable micro-environments to accommodate microorganisms. Addition of biochar in soil may affect soil composition, soil diversity and microbial activity (Doan et al., 2014; Purakayastha et al., 2015; Wang et al., 2015; Pan et al., 2016). In this study, it was found that adding 10% biochar to the soil positively affects plant development. The reason for this is thought that the biochar added to the soil increases the water and nutrient retention properties of the soil as stated in the studies in the literature.

Conclusions

In this study, it has been determined that the waste sludge from the brewery's wastewater treatment plant can be used as a soil conditioner in the agricultural sector. While the yield is highest in the soils where the heat treatment is included in the solid product (biochar), it is followed by beer sludge which is included raw in terms of yield. Thus, the use of so-called waste sludges as soil conditioners after pyrolysis is considered to be good in terms of "zero waste" approach. However, it is thought that it is necessary to deepen the research with laboratory scale studies where more parameters related to soil and plant are observed before the implementation.

Compliance with Ethical Standards

Conflict of interest

The authors declare that for this article they have no actual, potential or perceived the conflict of interests.

Author contribution

The contribution of the authors is equal.
All the authors read and approved the final manuscript.
All the authors verify that the Text, Figures, and Tables are original and that they have not been published before.

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References

Akgül, G., 2017. Biochar: Production and Usage Areas. RTEU. Journal of Engineering Science and Technology, 5(4): 485-499 [Google Scholar]

American Society for Testing and Materials (ASTM) (2016). Standard Test Methods for Determination of Carbon, Hydrogen and Nitrogen in analysis samples of coal and carbon in analysis samples of coal and coke, ASTM-D5373, ASTM International, 11. [Google Scholar]

Debosz, K., Petersen, S.O., Kure, L.K., Ambus, P. (2002). Evaluating Effects of Sewage Sludge and Household Compost on Soil Physical, Chemical And Microbiological Properties, Appl. Soil Tech., 19, 273-248. [Google Scholar]

Doan, T.T., Bouvier, C., Bettarel, Y., Bouvier, T., Henry-des-Tureaux, T., Janeau, J.L., Lamballe Nguyen, B., Jouquet, P. (2014). Influence of buffalo manure, compost, vermicompost and biochar amendments on bacterial and viral communities in soil and adjacent aquatic systems. Appl. Soil Ecol. 73, 78–86. [Google Scholar]

Düring, R.A., Gäth, S. (2002). Utilization of Municipal Organic Wastes in Agriculture Where Do we Stand, Where will we go? J. Plant Nutr. Soil Sci., 165, 544-556. [Google Scholar]

EPA, METHOD 3051A (2013). Microwave assisted acid digestion of sediments, sludges, soils, and oils. http://www.epa.gov/osw/hazard/testmethods/sw846/pdfs/3051a.pdf (Accessed on 15 May 2013)

Kocaer, F.O., Kemiksiz A., Başkaya, H.S. (2003). A Research on Mineralization of Organic Nitrogen in a Soil with Treatment Sludge. Ekoloji, 46, 12-16.

Lehmann, J., Joseph, S. (2009). Biochar for environmental management: an introduction. In: Lehmann, J., Joseph, S. (Eds.), Biochar for Environmental Management: Science and Technology. Earthscan, London, 1–12. [Google Scholar]

Öngen A., Özcan H. K. , Elmaslar Özbaş E., Pangaliyev Y. (2019). Gasification of waste tires in a circulating fixed-bed reactor within the scope of waste to energy. Clean Tech. Environ. Policy., 21, 1281-1291. [Google Scholar]

Page, A.L., Miller, R.H., Keeney, D.R. (1982). Chemical and Microbiological Properties. Agronomy Series no. 9, In: Methods of soil analysis part 2 second edition, American Society of Agronomy, Madison, Wisconsin USA, ISBN 0-89118-072-9. [CrossRef]

Pan, F., Li, Y., Chapman, S.J., Khan, S., Yao, H. (2016). Microbial utilization of rice straw and its derived biochar in a paddy soil. Sci. Total Environ., 559, 15–23. [Google Scholar]

Paradelo, R., Villada, A., Barral, M.T. (2011). Reduction of the short-term availability of copper, lead and zinc in a contaminated soil amended with municipal solid waste compost, J. Hazard. Mater., 188 (1-3), 98-104. [Google Scholar]

Purakayastha, T.J., Kumari, S., Pathak, H. (2015). Characterization, stability, and microbial effects of four biochars produced from crop residues. Geoderma, 239-240, 293–303. [Google Scholar]

Saltabaş, F., Sosyal, Y., Yıldız, Ş., Balahorli, V. (2011). Municipal solid waste thermal disposal methods and its applicability in Istanbul. J. Engineer. Natural Sci,. Sigma 3, 109-116. [Google Scholar]

Strauch, D. (1991). Survival of pathogenic micro-organisms and parasites in excreta, manure and sewage sludge. Rev. Sci. Techn. Off. Int.Epiz. 10, 813–846. [Google Scholar]

Wang, X., Song, D., Liang, G., Zhang, Q., Ai, C., Zhou, W. (2015). Maize biochar addition rate influences soil enzyme activity and microbial community composition in a fluvoaquic soil. Appl. Soil Ecol., 96, 265–272. [Google Scholar]