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Utilization of Wastewater Treatment Sludge and Agricultural Wastes Together as A Compost[#]

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Abstract: While the use of sewage sludge is common for agriculture application in worldwide, the case is reverse in in Turkey. Incentive studies will be made about the use of sewage sludge in agriculture land, country economy will be improved and disposal of sewage sludge will be provided in Turkey. In addition, as a result of unsuitable production techniques on agricultural land, the soil loses with its elements which are important for the plant growth in the course of time, leading to inefficiency of the soil. The most important reason for this inefficiency arises from the release of atmospheric carbon. In this context, the use of sewage sludge in agriculture can regulate the structure of the soil as well as provide the disposal of sewage sludge. Since the nutrient elements in the sludge contain the necessary elements for the soil which they can regulate the structure of the land. The use of this sewage sludge in agriculture will make the land in the inadequate regions more efficient in terms of organic matter for the soil.
Keywords: sewage sludge, solid waste, recycling, soil quality

INTRODUCTION

Waste production rates ascend rapidly by depending on growth technology and population increase. This lead to both uncontrolled waste generation and many environmental problems as well[1]. One of these problems, which is composed treatment of domestic and industrial wastewater, which also must be treated separately due to their properties, which being liquid and solid mixture causing damage to environment that no treat; is collecting, transporting, disposal and waste management of sewage sludge[2]. In order to overcome this problem, sewage sludge must be evaluated with different environmentalist approaches. One of these environmentalist approaches can be achieved by applying sewage sludge to agricultural land.

The increase in the number of treatment plants has unearthed more research and implementation about studies on how to remove the sewage sludge. It is presented to not only unloading to sewage sludge the waste landfill areas of sewage sludge operators but also unconscious use of farmers who want to use sludge on land, for it isn't become accumulation sufficient knowledge and finding research about sewage sludge in Turkey. In case of more conscious use of sewage sludge, which are a large source of organic matter, environmental pollution can be prevented and besides the country's economy will be contributed as well[3].

Among the researches on sewage sludge disposal, disposal by giving to the soil of sewage sludge is cheaper and more convenient than other applications. Sludge disposal can be provided with regain to land of sewage sludge in suitable properties and nutrients required for the soil can be also recycled naturally [4].

Petroleum raw materials are needed in the production of commercial fertilizers. But these products are not enough for soil fertility alone. In order to maintain soil fertility, the soil should be monitored in terms of organic matter and reinforced when necessary [5]. The development of soil structure depends on environmental factors and is affected by wetting – drying – freezing - dissolution events. The amount of organic matter in sustainable agriculture has important contributions. In addition, the organic matter properties of the plant which will be recycled from organic matter affect the change in soil structure [6].

DEFINITION AND PROPERTIES OF SEWAGE SLUDGE

Sewage sludge is called, containing weight of 0,25-12% solids and odor, dried and dehydrated by passing from physical, chemical, biological processes of domestic and domestic quality industrial wastewater [4-7-8]. In other words, the stabilization of raw sludge and making it suitable for use is called sewage sludge or biomass [7].

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The disposal of sewage sludge resulting from the operation of wastewater treatment facility covers 20-30% of total investment costs and 40-60% of operating costs [9]. Treatment sludge is known which changes according to industry, wastewater content, treatment method applied. Accordingly, it contains many substances such as Fe, Cu, Al, Hg, Cd, As, Co, Pb, Cr, sulphates, hydrocarbons, oils, phenols, metal salts, acids, alkalis, organic substances, nitrogen oxides, hydrocarbons [8-10].

Potassium, nitrogen, phosphorus, sulphur and metal compounds in high carbon organic structure are observed in the sludge formed according to the type of application in the treatment facility. In addition, the sludge coming out of the facilities is very difficult in terms of both volume and disposal [11].

Physical properties of sludge [12]*;*

- The specific gravity of sludge is considered to approximate the specific gravity of water and is considered to be 1 in calculations.
- Dark sludge colour is due to septic conditions. If the sludge colour is light enough air is not provided.
- The pre-settling sludge in the plants is generally grey-brown and bad odour. The sludge in the aeration tank is shaped brown and flocks.
- The solid-liquid mixture in sludges are expressed as solid matter concentration and calculated as mg/L or %.

In terms of chemical properties of sludge [12]*;*

- In the treatment sludge contain many contaminants such as organic and inorganic substances, kitchen, dishwashing, bathroom and toilet waste, industrial wastewater, solvents, micro organic pollutant chemicals, pesticides.
- The chemicals used in the treatment plants include organic and mineral materials, except for metals from homes and industrial plants.
- It can be used as fertilizer in agricultural fields because this sludge is rich in nitrogen, phosphorus and organic matter.

WHAT IS COMPOSTING? WHAT ARE THE PARAMETERS?

Composting is a degradation process that allows the final product to be obtained by the formation of suitable stable conditions as a result of the aerobic bacteria or other microorganism activities of the raw waste [13]. In order to achieve this degradation, the water content of the trash should be around 45-60% [14].

The biological treatment plant sludge is defined as compost fertilizer the process of transforming the compost, which is formed by the help of microorganisms of waste such as leaves, paper, and food. If necessary conditions are provided in composting process, organic substances can be decomposed more rapidly [15].

The factors that are effective in composting affect the efficiency, speed and quality of the compost. These effective factors can be listed as pH, moisture content, grain size [16]. In order to achieve a good compost, the parameter values are given in Table 1.

Table 1. The parameter values

C/N ratio	Microorganisms use nitrogen to multiply and carbon to cater energy needs. The optimum value for composting is in the range of 25 - 30[16]. If the C / N ratio is low, ammonia is released. If high, soil is poor in terms of nitrogen [17].
Moist	It is ideal to have moisture content between 60-70%. Moisture provides a balance between microbial activity and oxygen supply [18-19].
pH	For many microorganisms, the optimum range is 6.5< pH <7.5. In addition, the fact that pH less than 5 may hinder bio-control factors [20].
Temperature	It is optimum temperature which decomposition temperature in between 55-60°C depending upon the oxygen usage rate [21].
Aeration	It is a necessary parameter for microorganism activities and is done by mixing it with manual or machine [17].
Grain size	The grain size varies according to the area of use.

WHY SHOULD SEWAGE SLUDGE BE USED IN AGRICULTURAL LANDS?

It is an important environmental problem because it contains many substances in sewage sludge. In order to evaluate in terms of agricultural, of these sludge is necessary to evaluate such as nutrients content, salinity, pH, heavy metal content, electrical conductivity increase material, and salt excess[14-22].

Organic matter content, nutrients, pathogens, metals, toxic organic substances are the factors that affect sludge disposal and use in the land. Nitrogen is of commercial importance because it meets the nutrients required for plant growth by gaining the feature of phosphorescence-rich sludge fertilizer [22]. In order to can use sewage sludge with high water content from agriculturally it is necessary to utilize by mixing with bulking agent materials (materials such as wood wool, corn stalk, corn cone, hazelnut, sawdust)[14].

In the world, while significant studies are being carried out on the evaluation of sewage sludge in agriculture, there are not enough studies in Turkey yet. Many sludge disposal methods, such as mud removal, etc., can be expensive in terms of cost, so the use of sludge in the field can be seen as the most economical method[23].

In the EU harmonization process, it is mentioned that waste is removed by a disposal method where environmental impacts are less. The amount of sludge used and discharged in the European Union and Turkey is given in Table 2[4]. Looking at the table 3 the usage of sludge in the fields of agriculture of EU countries is quite high. Looking at Turkey, it is around 8.2% to usage in agricultural areas.

Table 3: The amount of sludge used in the European Union and Turkey

Countries	**Total (10^3dry t/year)**	**Agricultural %**	**Land Storage %**	**Burning %**	**Sea Outfall %**
Belgium	35	57	43	0	0
Denmark	150	43	29	28	0
France	900	27	53	20	0
Germany	2750	25	65	10	0
Greece	200	10	90	0	0
Ireland	23	23	34	43	0
Italy	800	34	55	11	0
Luxembourg	15	80	20	0	0
Netherlands	280	53	29	10	8
Portugal	200	80	12	0	8
Spain	300	61	10	0	29
Britain	1500	51	16	5	28
Turkey	3180	8.2	33.5	0.3	12.7

In many studies, the compost obtained by mixing of the sludge and plant forms has been shown to have the regulatory effects of soil structure. The sludge was also obtained yield, although generally studies were made on food industry waste.

MATERIAL- METHOD

The present study is carried out in the Büyükaşma neighborhood of Çumra District of Konya province. The main materials of the study are the sludge obtained from Çumra Sugar Factory and the cornstalk waste remaining after harvesting of farmers.

It is prepared to be 5 different mixtures and also 3 different samples for each mixture properly 100 kg from the sludge, 50kg from the cornstalk. Each example has 1 set to area and have been formed a part of 15 set areas, and the distance between these sets is regulated to be 0.5 m. For each set, an area of 2*2 square-meter calculation has been set. The study plan area to be done in the general outline is given in Table 4. Images related to the current study area are given in Photograph 1.

Table 4. The study plan area

SS- CS	0-0	0-CS	SS-CS2	SS-0
SS-CS2	SS-0	SS-CS	0-0	0-CS
0-CS	0-0	SS-CS2	SS-0	SS-CS

- ✓ Sewage sludge (SS) + Cornstalk (CS) **1x1** / (3 samples)
- ✓ Sewage sludge (SS) + Cornstalk (CS2) **1x2** / (3 samples)
- ✓ Sewage sludge (SS) + Cornstalk (CS) **1x0** / (3 samples)
- ✓ Sewage sludge (SS) + Cornstalk (CS) **0x1** / (3 samples)
- ✓ Sewage sludge (SS) + Cornstalk (CS) **0x0** / (3 samples)

Photograph 1: Images of June, July, August, October respectively

Because tractors cannot be entered into the land, the mixture of the sludge-cornstalks-soil was ventilated by hand. The results and methods of analysis are given below.

pH and Electroconductivity (EC) Value

Measurements were made with PH meter and EC meter [24].

Dry Matter and Moisture Content

The dry matter and moisture content were calculated according to Formula 1 and Formula 2[25-26].

$$\%\ total\ dry\ matter\ = \frac{(W_3 - W_1)\times 100}{W_2} \quad \text{.....(Formula 1)}$$

W1 = tare weight of container in grams.
W2 = dry weight of sample as received in grams
W3 = dry weight of sample and container in grams

$$\%\ moisture = \frac{(\text{dry soil weight in the air} - \text{dried soil weight in oven})\times 100}{\text{dried soil weight in oven}} \quad \text{.....(Formula 2)}$$

Organic matter

After weighing 105±5°C dried samples, weighing was done for organic matter at 650°C in ash oven. According to Formula 3 was done calculating [25].

$$OM = 100- \left(\frac{\text{Burnt ash weight at 650 °C} - \text{tare weight}}{\text{Dried soil weight in oven at 105°C} - \text{tare weight}}\right) \quad \text{(Formula 3)}$$

COD (Chemical Oxygen Demand)

Solution preparation for COD was calculated according to standard methods [27].

Nitrate Analysis

KIT method was used for one of the samples in the same group and spectrophotometer was read.

RESULT

The most important problem of our soils is the lack of organic matter. unconscious burning of stubble also causes the reduction of organic matter and other nutrients in the soil. it also damages plant growth. In composting studies, pH and temperature are two important parameters [28]. During the composting process, the pH value for each parcel have changed between 7-9. In composting, changes in COD, dry matter, organic matter and nitrate were measured in different time intervals. The analysis results are given in Table 6. The required parameter values for compost are given in Table 5[29].It appears to be in the appropriate range for other parameter values except moisture when analysis results compared to Table 5In the samples SS-CS2 and SS-0 were found to be richer in nitrate. This situation shows that nutrients pass through the soil.

Tablo 5: Parameter values required for composting

Parameter	**Range**	**Recommended range**
Carbon/Nitrogen (C/N) ratio	25:1-50:1	25:1-30:1
Moisture	%30-75	%50-60
Oxygen concentration	%5	>>%5
Particle size (cm diameter))	0,32-1,27	Değişebilir
pH	5.5-9	6.5-8
Temprature (°C)	44-66	55-60

Table 6. The analysis result values

	Parcel number	**pH**	**EC(µS/cm)**	**COD($\frac{mg}{L}$)***	**NO^3(mg/L)***	**Dry matter %**	**Moist %**	**Organic matter %**
0-0	1	8.85	134	12	0.462	93.56	6.88	12.56
	9	8.86	125	3	0.473	94.58	5.74	13.10
	12	9.06	136	42	0.481	91.34	9.48	15.52
0-CS	2	8.91	108	24	0.499	88.28	13.28	14.70
	10	8.87	97	21	0.463	89.29	12.01	12.80
	11	8.93	107	12	0.493	87.13	14.77	13.46
SS-CS	3	8.83	116	30	0.341	81.55	22.63	15.35
	7	8.97	118	21	0.356	75.48	32.49	13.98
	15	8.86	115	21	0.381	81.37	22.89	**16.89**
SS-CS2	4	8.85	107	24	0.578	84.58	18.23	15.01
	6	8.88	123	15	0.560	83.50	19.75	14.45
	13	8.93	156	9	0.543	87.99	13.65	**17.19**
SS-0	5	8.89	118	3	0.758	91.29	9.54	13.92
	8	8.85	127	30	0.719	87.34	14.50	15.92
	14	8.72	166	15	0.729	85.58	16.85	**16.88**

* Calculated value for 0.1 grams

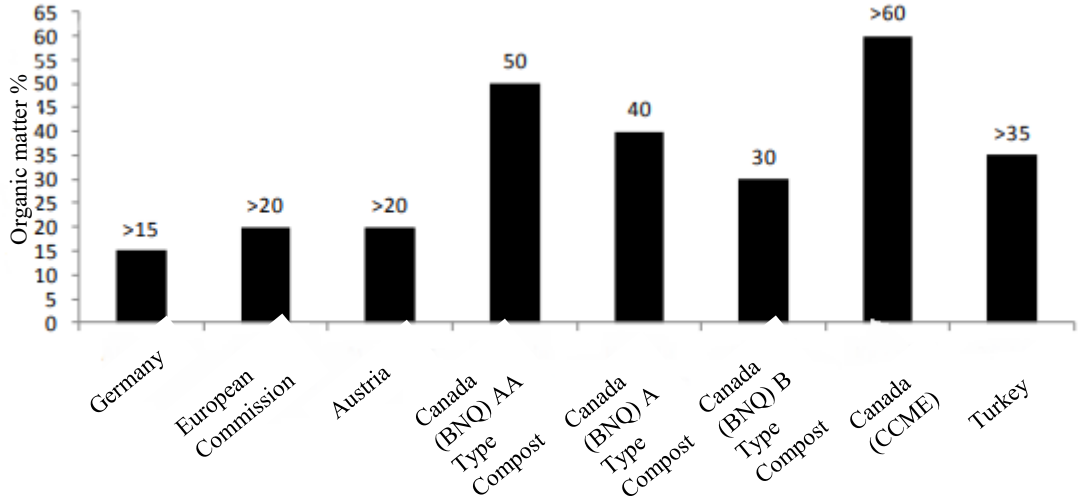

Figure 1. Percentage of organic substances defined in some countries' standards [30]

The percentage of organic matter belonging to some countries is shown in Figure 1[30]. The study shows that the percentage of organic matter provides standards. In terms of organic matter 13,14,15 parcels are seen to be more efficient than others. This indicates that organic matter has passed from cornstalk and the sludge to soil.

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