EXPERIMENTAL INVESTIGATION FOR ALTERNATIVE USE OF AGRICULTURAL AND DOMESTIC WASTES

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ABSTRACT

Along with the reduction of fossil fuels, various studies are being carried out on the availability of alternative energy sources. Within the scope of this study, we can evaluate as agricultural and domestic waste; hazelnut shell, maize silage and domestic sewage sludge. Mixtures of these, either singly or in different proportions, are also included in the scope of the study. In this context, alternative conditions were investigated to determine the drying characteristics at different drying conditions, to determine the calorific values and to use them as soil conditioner (low quality fertilizer). Mixtures and ratios with appropriate results were determined for each case. It has been shown that it can be used as an alternative supplemental fuel when it is mixed with high heating value agricultural wastes with a porous structure to reduce high moisture content. In addition, it can be used as a soil conditioner in low-heavy-duty domestic wastes.

Key words: Sewage sludge, drying, soil conditioner, hazelnut shell, maize silage.

ÖZET

Fosil yakıtların azalmasıyla birlikte alternatif enerji kaynaklarının kullanılabilirliği konusunda çeşitli çalışmalar yapılmaktadır. Bu çalışma kapsamına tarımsal ve evsel atık olarak değerlendirebileceğimiz; fındık kabuğu, mısır silajı ve evsel arıtma çamuru ele alınmıştır. Bunların tek ya da farklı oranlardaki karışımları da çalışma kapsamına dahil edilip incelenmiştir. Bu bağlamda; farklı kurutma şartlarındaki kurutma karakteristiğinin ortaya konulması, kalorifik değerlerinin belirlenmesi ve toprak şartlandırıcısı (düşük nitelikli gübre) olarak kullanılması koşulları araştırılmıştır. Her bir durum için uygun sonuç veren karışımlar ve oranlar belirlenmiştir. Yüksek nem içeriğinin düşürülmesi için gözenekli yapıya sahip yüksek ısıl değerli tarımsal atıklarla karıştırıldığında alternatif ek yakıt olarak kullanılabileceği gösterilmiştir. Ayrıca, düşük ağır metal içerikli evsel atıklarda toprak şartlandırıcısı olarak kullanılabilirliği öngörülmüştür.

Anahtar kelimeler: Arıtma çamuru, kurutma, toprak şartlandırıcısı, fındık kabuğu, mısır silajı.

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1. INTRODUCTION

In general terms solid waste management is an important area of activity that is multifaceted with technical, economic and social disciplines. Along with the developing world, the shortage of energy resources has become the most important problem. In this case, the most effective and efficient use of natural resources is important. To do so, it is necessary to maintain industrial production with minimum waste, as much as possible to recycle and reuse waste [1]. In the scope of the study, it is mentioned in the above definition how wide and extensive the process is to take different kinds of agricultural and domestic solid wastes. In our recent developing world, waste sludge disposal is seen as an economic and environmental problem. In general, the disposal or reuse of waste sludge from around the world is one of the challenging issues that many researchers have investigated. Thermal and chemical utilization techniques play an important role in waste use. These techniques are basically classified under seven headings: a) anaerobic digestion, b) incineration and co-incineration, c) gasification, d) pyrolysis, e) wet air oxidation, f) supercritical wet oxidation and g) hydrothermal treatment. Experimental studies have been carried out on post-graduate theses related to sewage sludge in the literature survey [2-4]. It has been investigated that sewage sludge which can be taken from these plants respectively, usability as an additional fuel in cement production, bacterial species changes and conversion to compost product. With the results obtained, it has been revealed that every work reaches its goal and the waste sludge can be recovered and used for various purposes in the end.

The general situation in the world of waste incineration technology, which is widely used as a domestic solid waste disposal method in developed countries, and its applicability to Istanbul have been evaluated. It has been found that the waste calorific value should be at least 2000-2500 kcal / kg for energy, and 1500-1600 kcal / kg for combustion without additional fuel [5].

It has been researched to use all dried organic wastes in clean and combustible gases and use them in electricity and heat energy production systems. The gas obtained by the gasification process has an energy value of about 4-7 MJ/Nm^3 depending on the type of the solid waste incinerator used and it can be used in the production of electric energy when passed through a gas turbine system [6]. Considering the cereals, legumes, industrial plants, oil seeds and tubers obtained in one year in Malatya province, it is seen that there is an average of 3.991.966 tons biomass potential of 145.162,4 hectares of total cultivated area. The average heating value of

these dry biomass is estimated to be 1,596,786.4 tons equivalent oil (TEP) [7]. Ozer has made feasibility studies for a facility that can be installed here by determining the potential of electricity generated from animal wastes for the province of Tekirdag [8, 9]. In his work in Ardahan, she investigated the potential of clean and sustainable energy to be produced from different types of organic wastes. It is also anticipated that the installation of biogas incinerators will reduce CO_2 emissions by about 2 million tons annually. Studies conducted in order to demonstrate the drying characteristics of the wastes handled generally provide an overview of the sludge drying process. Chai [10] presented a statistical structure for analyzing physical reactions. Kasukura et al. [11] have shown a study of the conventional drying methods and equipment of demineralized sludge bubbles. Peregrina et al. [12] investigated the thermal drying process for waste sludge. Different studies have been carried out in order to determine the effects of sewage sludge on some physical and chemical properties of soils [13-15]. The use of anaerobic sludge has been shown to result in significant changes in both physical and chemical soil properties when the organic matter content of the high sewage sludge is applied to the saline-alkaline soil. It has been demonstrated that sludge disposal can be realized as well as economic gain can be achieved in agricultural production through the use of sewage sludges having suitable properties as organic fertilizer and soil regulator. By using the composting process, the waste has been biodegraded without harming the environment, reducing the volume, mass and moisture of the waste and converting it into a valuable soil conditioner. For this, the results of the heavy metal analyzes carried out in previous studies [16] have been examined. These results showed that; is below the limit values when compared to the heavy metal values in the inorganic pollutant list in the "List of Generic Pollutant Limit Values" in the pollution control regulation.

2. CURRENT OVERVIEW OF WASTES

It causes significant environmental problems due to the heavy metal content in sewage sludges resulting from wastewater treatment systems. Developed World countries have begun to attach increasing importance to the recovery of wastes in the last 20 years, realizing that wastes have harmed natural resources and great economic value has been destroyed. This understanding in Turkey, though now also has started development activities are underway for the recovery of

various waste. According to the information which received from the Ministry of Environment and Urbanism, "Domestic/Municipal Sewage Sludge Project" aims to establish a treatment sludge management system. That will consist of the bases to be determined in the country scale of processing and disposal of sludges originating from domestic/municipal wastewater treatment plants, starting with June 2010 and ending with June 2013. As a result of these studies; 191 biological treatment plants were evaluated. The amount of sludge from waste water treatment plants in Turkey average KM 1087 ton/day was obtained. The amount of sludge formed on a regional basis was found to be 15.9 ton/day in KB and 336 ton/day in MB with the highest treatment capacity, which is the lowest treatment capacity. In other regions, it was calculated that 30.7 tons KM/day in DAB, 79.2 tons KM/day in GAB, 236 tons KM/day in EB and 215 tons KM/day in IAB. Disposal and recovery methods of sewage sludge formed in our country are given in Figure 1.

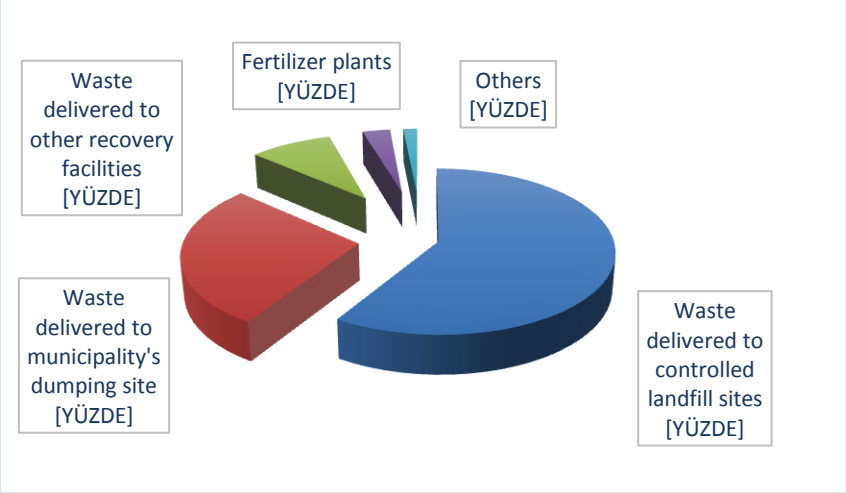

Figure 1. Disposal/Recovery Methods and The Amount Of Municipal Waste in Turkey [17]

When the reuse of domestic sewage sludge energy recovery potential in Turkey is examined reached 25.55 million tons of sludge annually and the value of 1417 MW of electricity. The heating value of the treatment sewage sludge is between 9-13 MJ/kg, depending on the social and economic factors. The high moisture in the sludge is the most important parameter for the above mentioned heating values. The work should be to accelerate drying and increase the heating value. Grain, oilseeds and lump crops are widely grown in our country's agricultural production

areas. Depending on the area of production, the most abundant amount of these crops is grown from corn, wheat and cotton cultivation. In the total available residue, maize is the main product with the highest share with 31,72%, wheat 27,01% and cotton 16,12%. The greatest share of total residue value of field crop residues in the regions belongs to the Mediterranean Region with 57 PJ and 25%. The total annual energy equivalent level of agricultural residues in Turkey is 50-65 MTEP. The amount of agricultural waste that can be used to produce energy in our country is around 13 million tons and the heat energy of these residues is approximately 228 PJ [18]. In order to use this energy potential more effectively and efficiently, it is necessary to convert the wastewater and agricultural wastes, which are known to have high moisture content, to be usable with some additional processes. In the next section, for the purpose of determining the characterization of the investigated products; drying, energy potential, heavy metal content and components were investigated. The study has also been expanded for different mixing ratios of agricultural and domestic waste.

3. MATERIAL AND METHOD

Preliminary experimental studies were carried out to determine the drying characteristics of the sewage sludge, hazelnut shell and maize silage from the agricultural wastes handled in the scope of the study. To do this, an instrument drying test was performed in a laboratory environment with a temperature setting of 105 °C. Here, the dried specimens, calcium chloride, etc., the amount of moisture was reduced again after drying by using desiccants containing moisture-attracting substances. Each sample was monitored for 24 hours to measure mass loss, moisture contents and total energy consumption. The following figures show samples which prepared before drying.

Figure 2. Mixtures Of Sewage Sludge, Hazelnut Shell and Maize Silage

Later, this work was expanded to obtain moisture quantities for different mixtures. The test data are the mean of 3 different samples obtained for 1 day and at 105 °C. These mixtures were carried out in different quantities, with a total mass of 100, 250, 500 and 1000 g, and the uncertainties were removed by two experiments.

In the scope of the study, agricultural and domestic wastes, which are considered for the examination of energy potentials of the products, were compared with other potential energy sources such as coal and wood. Using the ASTM D 5865 and ISO 1928 methods, the heating value of the hazelnut shell, maize silage and sewage sludge and their mixtures was determined.

4. RESULT & DISCUSSION

The time-mass characterization of the moisture values of the samples is shown in Fig 3. As can be seen here, the maize silage and sewage sludge have a high moisture content and the hazelnut shell has a low moisture content.

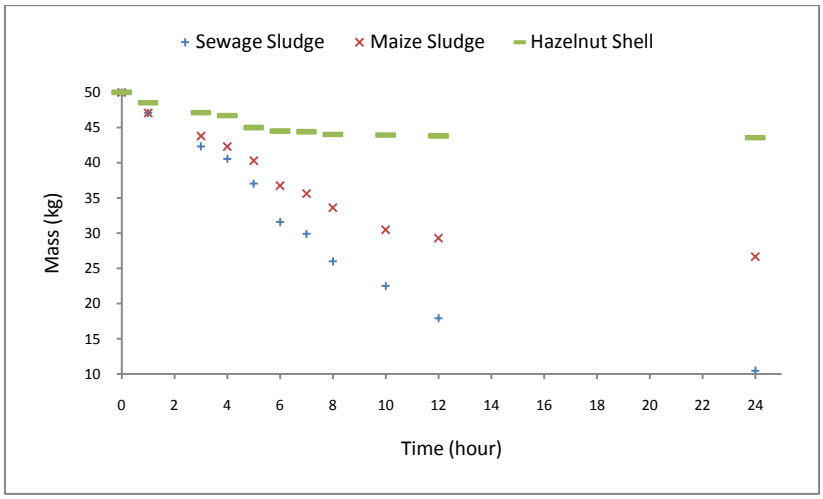

Figure 3. Time-Mass Characteristic

After these results, new samples were made in different mixtures and new experiments were made. In this context, as shown in Table 1, mixtures of 2 and 3 different samples were formed to determine the moisture content of the material drying oven. Since the hazelnut shell has a low moisture content and a porous structure, the drying characteristic is high. Mixing with the most highly moistened sludge and other high moisture corn silage should not be preferred due to the poor drying characteristics.

Table 1. Moisture Ratios of Waste and Mixtures
(Sewage Sludge: SS, Hazelnut Shell: HS, Maize Sludge: MS)

Waste	SS	MS	HS	HS+SS				MS+SS				HS+MS+SS		
				20HS+ 80SS	40HS+ 60SS	60HS+ 40SS	80HS+ 20SS	20MS+ 80SS	40MS+ 60SS	60MS+ 40SS	80MS+ 20SS	15HS+ 15MS+ 70SS	25HS+ 25MS+ 50SS	35HS+ 35MS+ 30SS
Moisture ratio %	79,06	46,62	12,84	65,42	52,16	38,7	25,46	72,88	66,4	61,1	56,84	27,98	55,26	45,68

When looked at the heating values that make up our other comparison criterion, we have hazelnut shell with the highest heating value and the lowest is maize silage. In this table, hazelnut shell and sewage sludge are mixed at certain ratios and new energy values are compared. This is

compared to the heating values of coal and wood, which are widely used and have high energy potential, and are shown in Fig 4.

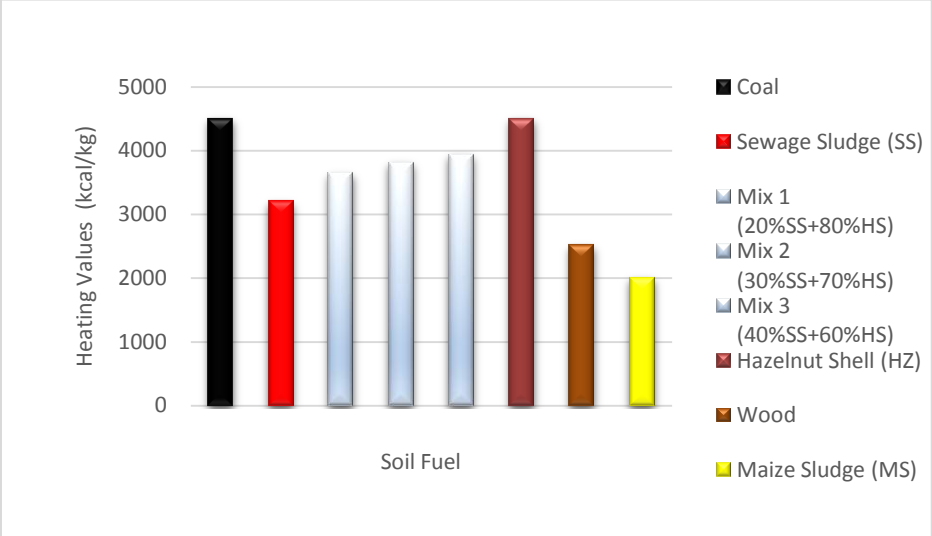

Figure 4. Heating Values of Solid Waste and Materials

Dried sewage sludge can be considered as renewable energy sources due to low emissions and energy potential if economic, environmental and social impacts are managed appropriately. For example, cement industry consumes high energy and sewage sludge is used as an alternative fuel. Sewage sludge contains about 70 - 80% moisture. Sludge drying reduces the mass and volume of the product and allows storage, transportation and sludge burning. On the other hand, this process requires evaporation of an energy of 900 - 1300 kWh per ton, depending on the drying technique. The high moisture content of the sewage sludge is an important parameter. Whether used as fuel or in environmental regulations, thermal drying has an important place in the assessment of sewage sludge. When the agricultural applications of the sewage sludge are examined; organic matter and nutrients to the poor soil, forest areas to heal and to the fields, as a source of phosphorus in plants, grass plants such as assessment of ornamental plants have been made. In these studies, the effect of organic materials and heavy metals on the physical and chemical properties of plants and soils in the sewage sludge was investigated. As a general conclusion, it was concluded that they should be disposed of and disposed of by other methods instead of applying to soil. In addition, studies have been focused on community health. It emphasizes that sewage sludge contains microorganisms such as Fecal coliform, Salmonella, Shigella, Enteric

virus, Helmint egg [19], which must be stored before being used in ornamental planting and environmental regulations and subjected to high pH and heat applications according to the legal regulations of the countries. Chemical and elemental analyzes of the sludge mixtures were carried out and the heavy metal contents (Fe, Cu, Ni, Zn, Pb, Cr, Cd) in the mixtures were found to be below the limits determined by the soil pollution control regulation. These results is listed below the limit values in the list of "generic pollutant limit values" in the soil pollution control regulation [20] in the list of inorganic pollutants compared with the heavy metal values.

5. CONCLUSION

Within the scope of this study, the potentials of the sewage sludge, hazelnut shell and maize silage and their mixtures as energy potential, drying characteristics and agricultural soil were investigated. For this purpose, hazelnut shells have been added from agricultural secondary products in order to reduce the high moisture content in the sewage sludge quickly and to increase the energy value. Hazelnut shells at different ratios were mixed homogeneously and dried. As a result of the analyzes, heating values of 14.5 - 20 MJ/kg were obtained. In the light of these results, it is predicted that the mixtures can be used as alternative fuel after drying. The high moisture in the sludge is the most important parameter for the above mentioned heating values. The work should be to accelerate drying and increase the heating value.

Sewage sludges from waste water treatment systems cause significant environmental problems. When the disposal sludge is decided to be disposed of, the amount of moisture and the content of heavy metals are in the foreground. From the results obtained, it has been determined that the sewage sludge mix can be used in green areas, land recreation, urban landscape, organic fertilizer, germination environment, growing environment. It has been determined that the resulting blends of light produced as an alternative fuel after drying or as a soil conditioner (low quality fertilizer) are two outstanding options.

Local governments and non-governmental organizations should support their use in these areas. It has become imperative for your government to increase sanctions in conjunction with the law to prevent environmental threats and to transform them into economic benefits, as the wastes threaten the Earth all along.

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