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Characteristics of Some Turkish Lignites and Potential of Using in Agricultural Sector

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Abstract

Recently, a lot of progress have been obtain towards progress on the quality and quantity in agriculture. The advances and development in agriculture depend on mechanisation and the development on the soil characteristic which also help to increase the product efficiency. This study aims to determine some Turkish low rank coal samples for applications in the agricultural sector and assesses the suitability of a certain coal either as soil conditioner or as raw material for manufacturing organic fertilizers. They improve the soil structure and improve physical properties of soil by increasing the exchange capacity and buffening qualities, promoting the chelation of many elements and making these available to plants. Humic substances can ameliorate negative soil properties; improve the plant growth and nutrients uptake. Twenty-six samples of subbituminous coal obtained from several Turkish coal deposits such as Arguvan, Çayırlı, Artova and Zile, Kangal-Gemerek-Divriği were studied. When optimum parameters were used, the most promising samples for utilization are the coal samples from Arguvan, Artova and Zile, since they yielded high HA contents (≥30 wt). Although the Artova and Arguvan samples display high HA contents, they are also rich in S and release Fe, which might be threatening for the plants.

Key words

Coal, fulvic acid, humic substances, humic acid, organic fertilizer, Turkey

1. INTRODUCTION

People have tried different techniques and supportive products to increase the agricultural productivity and to get higher quality. In this context, the usage of chemical fertilizers is the most leading methods for decades. By means of this technics, the plant provides many nutrients necessary for them. However, especially in the production phase, because of the additional cost and polluting the groundwater, rivers and lakes, the chemical fertilizers have also become a current problem in terms of environment and ecology with their harmful sides. For this reason, new techniques have also started to be investigated to increase vegetative productivity, which is not harmful for both environment and the livings.

Organic materials are important soil additives to improve soil physical, chemical and biological properties. It has been scientifically proved that fulvic and humic acid, the most important organic component of the soil, make important effects to the growth of the plant materials in terms of physical, chemical and microbiologically [1].These natural components have supported the plant yield and quality, by increasing the flowering and the root and stem development, providing more water and air from the soil. At the same time,

as well as economic benefits, humic and fulvic acids have been helped to protect the environment by increasing the effectiveness of the chemical fertilizers and inhibiting the excessive fertilizer usage [2, 3]. This is important to sustain the productivity of soils particularly in semi-arid regions (such as Turkey) where there is low input of organic materials. Therefore, usage of organic-based materials has gained importance within the last few years for sustainable agriculture and preventing soil degradation.

Due to Turkish agricultural lands have alkaline reaction (85%), and are poor in terms of organic matter (94%), and has a chalky structure (58%), insufficient water storage results in mudslide together with soil loss with erosion and quality impairment in vegetative production, depending on the insufficiency of the elements (phosphorus, potassium, iron, and zinc) feeding the plant [3]. In many regions in Turkey, especially in Central Anatolia, the organic matter content of soils has fallen below 2 or 1 %. For this reason, the agricultural production in such areas must be supported with fertilizer.

Humic acids and their salts, derived from coal and other natural sources, which have modes of action similar to synthetic fertilizer, have been evaluated as potential eco-friendly soil fertilizer. The advantage of humic substances is the refractory nature of their chemical structures that makes them more resistant to microbial attacks. However, at the end of a certain period of time, no matter how much fertilizer is used, the danger of desertification is also in question because it will be difficult to get the soil productivity. Since the addition of sufficient amount of organics fertilizers to whole lands of the country is not possible, it has been determined that productivity potentials might be increased by applying the lower amounts of humic and fulvic acids, which is active fraction of organic matter and humus, when compared to organic fertilizers. The structure of the organic fertilizer consists of humus containing humic and fulvic acid, which is the result of the microorganism action [4, 5, 6].

Humic substances are the most widely found organic components on the Earth crust. These are a general category of naturally occurring, biogenic, heterogeneous organic matters that can generally be characterised as being yellow to black in colour, of high molecular weight and refractory. These components form most of the organic ingredient of soil, peat and natural waters, they effect the process of genesis of fossil fuels, and play a major role in the global carbon cycle. In the same time humic substances (especially humic acids) may be regarded as a valuable item which may found various uses for different purposes and their industrial production and application is growing. Humic and fulvic acid are present in the composition of the all organic materials in the nature. However, with the ratio ranging between 40% to 90%, organic material containing the highest amounts of humic and fulvic acid is brown coal, with its other name “leonardit”. At present, low-rank coals are used for the production of HA, which are in the form of alkali-soluble humate salts or as N-rich coal HA (ammonium nitrohumates) [5, 6].

In our country, there is low-quality lignite (20-40% humic and fulvic acid of composition) to be used in the production of 5 million tons of leonardite, which has more than 40% of humic and fulvic acid and 7-8 million tons of solid and liquid K-Humate. However, because the leonardit having these properties and low-quality lignites have an energy amount of 800-1000 kcal/kg, they do not provide any economical returns and are removed as mine waste material. But, when assessed these materials having an estimated reserve of 12-13 million tons as resources of leonardit, solid and liquid humic-fulvic acid in agricultural lands, soil productivity can be increased and soil loss with erosion can be decreased [5, 6]. All of these will result in an increase in the vegetative production and economic benefits. In this study, it has been aimed the determination of humic components of some Tertiary aged and low-quality coals and their usage in agricultural lands.

1.1. Experimental

For this study, 26 samples were collected from the tops to the bases of the seams in the various coal fields (Arguvan-Malatya, Çayırlı-Erzincan, Artova-Tokat, Zile-Tokat, Kangal-Sivas, Gemerek-Sivas, Divriği-Sivas). These samples were taken from along ~ 1 m lines using the channel-sampling technique. Coal-quality data (total moisture, ash, volatile matter, fixed carbon, gross calorific value) were obtained using an IKA 4000 adiabatic calorimeter; elementary contents were determined using a LECO analyzer. For the determination of humic acids (HA) and fulvic acids (FA) contents a method combining the procedures proposed by ISO 5073 (1985) and the International Humic Substances Society [7] was followed.

2. RESULTS AND DISCUSSION

2.1. Proximate and Ultimate analysis

Moisture, ash yields and pH values of bulk samples are listed in Table 1. Most of the samples reveal ash yields between 20 and 50 wt.% and are very low-grade coals. The majority of the samples show an acidic to slightly acidic character (pH 4.5–7.4); samples Arguvan and Artova are strongly acidic (pH< 4.5), whereas samples Zile, Çayırlı, Kangal, Gemerek, and Divriği display neutral pH values (6.6–7.4).

The total C contents range from 42.52–80.2 wt.% (Table 1), with the majority of the samples showing contents greater than 50 wt.%. The H and N contents range from 3.46–5.79 wt.% and up to 2.1 wt.%, respectively. Sulphur contents range from 2.0–6.3 wt.%.

2.2. Humic substances content

Humic substances (HS) are the most widespread natural organic compounds. These are complex organic compounds and have endurance to degradation. Humin (HU) and Humic acid (HA) generally represent the major fraction of HS and appear to display similar analytical characteristics and chemical structures.

Table 1. Some proximate ve ultimate analyses results of investigated coal samples.

Area	**Moisture (db) wt%**	**Ash (db)wt%**	**C wt.%**	**H wt.%**	**N wt.%**	**S wt.%**
Arguvan	23.3	32.28	43.25	3.46	1.1	6.3
Çayırlı	10.38	14.43	80.20	3.95	1.5	2.0
Artova	29.69	43.43	57.1	4.34	1.1	3.6
Zile	25.75	47.97	53.98	4.28	1.2	4.7
Kangal	43.22	22.11	42.52	5.79	2.1	5.3
Gemerek	31.09	17.45	65.66	4.03	1.8	4.0
Divriği	10.68	24.04	60.02	4.32	1.0	5.6

HA occur naturally in low–rank coals and can account for an important fraction of the organic matter. The HS contents of the studied coals are shown in Table 2. The HA contents range between 4.12 and 57.55wt.% with Çayırlı coal sample shows the lowest value, due to the higher rank (Ro; 0.61). The highest HA content was measured in Artova coal sample. Fulvic acid (FA) contents range between 3.2 and 33.33 wt.%. In general, the Çayırlı coal samples show the lowest HS contents (Table 2). The total concentrations of HA and FA in the studied samples indicate that, coal samples of Arguvan, Artova, Zile areas contain the highest amount of HS (HA+FA>50 wt.%, on a dry basis).

Table 2. Humic substance composition of the investigated coal samples.

Area	Humic Acid (wt.%)	Fulvic Acid (wt.%)	pH	Humic Substances (wt.%)
Arguvan	39.70	12.10	2.3	51.8
Çayırlı	4.12	3.20	6.0	7.32
Artova	57.55	15.12	2.4	72.67
Zile	45.28	12.84	5.4	58.12
Kangal	21.45	23.55	6.7	45.00
Gemerek	5.30	33.33	7.1	38.63
Divriği	8.60	11.33	7.4	19.93

3. RESULTS AND DISCUSSION

The usage in the agricultural areas of the low-quality coals which is economically not very valuable is very important in terms of the prevention of the environmental hazards by minimizing the usage of chemical fertilizers. At the same time, this kind of material can improve the quality of soil and contribute the plant growth and yields. Coal samples used in this study had occurred in similar precipitation conditions and geological age range. But it has been seen that humic composition is different depending on the effect of coalification degree to the precipitation conditions or the type of organic material during the precipitation together with the physicochemical conditions and the tectonic activity. The most promising samples for utilization are the coal samples Arguvan, Artova and Zile, since they yielded high HA contents (≥30 wt). Although the Artova and Arguvan samples display high HA contents, they are also rich in S and release Fe, which might be threatening for the plants. Additionally, samples with pH values between 6 and 7 (Çayırlı, Kangal, Gemerek, Divriği samples), could be applied in heavily degraded, acidic soils such as mine spoils; this can promote the biotic activities.

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