U.P.B. Sci. Bull., Series 69, Vol. 69, No. 3, 2007 ISSN 1454-2331

POSSIBILITIES OF IMPROVEMENT OF SOIL QUALITY BY SOFT BROWN COAL DUST INTRODUCTION

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În lucrare se prezintă un studiu comparativ al caracteristicilor cărbunelui brun inferior (pământos) de la Roşia (Jiu) şi ale unui sol sărac, în vederea stabilirii posibilităţilor de îmbunătăţire a calităţii solului pentru condiţiile de creştere a plantelor.

Se evidenţiază valorile specifice pentru conţinutul de acizi humici extractibili, caracteristicile chimico-tehnice şi elementale şi compoziţia petrografică ale cărbunilor bruni cu conţinut redus de sulf şi azot şi ale solului. Se constată o diferenţă mare între valorile procentuale ale masei organice la cărbune şi sol, dar şi similitudinea tipurilor de componenţi organici evidenţiaţi prin analiza petrografică. Aceasta oferă un argument în favoarea amestecării unui sol sărac, nisipos, cu tipul de cărbune cercetat.

Se studiază, de asemenea, comportarea în procesul de uscare a celor două tipuri de materiale, sub forma probelor medii de cărbune şi pământ, precum şi posibilitatea de a creşte plante atât în praful de cărbune, cât şi în solul îmbunătăţit prin amestecare cu cărbune.

Concluziile cercetărilor recomandă introducerea de praf de cărbune brun pământos în solurile sărace pentru creşterea conţinutului de masă organică, de acizi humici şi de microelemente în sol.

The paper presents a comparative study on the properties of the Roşia (Jiu) soft brown coal and of a poor soil, in order to find out the possibilities of soil quality improvement for better plant growing conditions.

There were determined the specific values of extractible humic acids content, technical and elemental characteristics and also petrographic composition of soft brown coal with low sulphur and nitrogen and of the poor soil.

It is revealed a big difference between the organic mass values of coal and soil but a similarity between organic components types of the two samples, as determined by petrographic analysis. These findings offered one reason for mixing-up a sandy soil with the studied coal.

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There was also investigated the behavior of the two types of materials, coal and soil, during the drying process as well as the possibility to grow up plants both in coal dust and improved soil.

The research conclusions recommend the introduction of soft brown coal dust into the poor soils, in order to increase the content of organic mass, humic acids and microelements in soil.

Keywords: soft brown coal; soil; humic acids; petrographic composition; ecological fertilizer; drying rate.

1. Introduction

The problem of poor soils enrichment in order to obtain a propitious medium for growing different types of plants, represents an ecological and inovator preoccupation with favourable results for cultivated spaces enlargement. It is interesting to find out if carbonaceous materials without another possibilities of utilisation can be used in this aim [1].

It was performed a comparative study on specific characteristics of some young brown coals [2] with xyloidic intercalations [3] and some soil samples colected from the green spaces between blocks in Bucharest. The purpose was to establish the possibilities of improving poor soil quality (especially sandy soil), by soft brown coal dust addition.

2. The Research Methods and Apparatus

The investigation of the two media – soft brown coal and soil – was carried out from the point of view of physico-chemical, technical and elemental characteristics and petrographic composition.

The methodology and apparatus used for these analyses are in accordance with the romanian standards (STAS) and the respective international ASTM and ISO [4].

The petrographic maceral composition [5, 6] was determinated on polished blocks in normal reflected light (RL). For photomicrographs has been used a photo- apparatus Exakta Varex.

3. Results and Discussions

There were examined Roşia soft brown coal and soil samples. The results are presented in the Tables 1 and 2, reported to the initial (i), partial dried (with 16% W^a , a - analytical), dried (water free - wf) and organic matter (combustible mass - waf) samples

It was noticed an essential difference in organic ratio (especially humic) of coal and soil (coal : A^{wf} = 44,55%, humic acids extractible with NH_4OH = 10,04; soil : A^{wf} = 83,19%, humic acids extractible with NH_4OH = 3,75), but a good similarity between coal and soil from the point of view of elemental content of combustible mass. This fact is important because it is favorable for soil organic matter improvement.

In the Table 3 petrographic composition is presented as macerals of organic and mineral matter [7], comparatively for coal and soil. The analytical data confirm the organic coal to soil ratio of about 64 : 24%.

Petrographic composition revealed qualitative similarities between the constituents types for Roşia coal and soil. This fact suggests the possibility of using the waste coal as substituent of soil organic matter.

Table 1

Chemico-technical and elemental characteristics of Roşia coal, wt%

Specification	Initial coal		Coal partial dried -16% W^a (analytical)		Dried coal (anhydrous: water free)		Organic matter (combustible mass: water and ash free)	
	Symbol i	Value	Symbol a	Value	Symbol wf	Value	Symbol waf	Value
Moisture	W^i	41.52	W^a	16.00	-	-	-	-
Ash	A^i	26.05	A^a	37.41	A^{wf}	44.55	-	-
Carbon	C^i	18.90	C^a	27.15	C^{wf}	32.33	C^{waf}	58.53
Hydrogen	H^i	1.91	H^a	2.74	H^{wf}	3.27	H^{waf}	5.90
Sulphur	S_c^i	0.73	S_c^a	1.05	S_c^{wf}	1.23	S_c^{waf}	2.25
Nitrogen	N^i	0.52	N^a	0.75	N^{wf}	0.88	N^{waf}	1.32
Oxygen	O^i	10.37	O^a	14.90	O^{wf}	17.74	O^{waf}	32.00
Total	-	100.00	-	100.00	-	100.00	-	100.00
Humic acids extractible with NH_4OH 30%	-	6.36	-	8.43	-	10.04	-	18.11

Table 2

Chemico-technical and elemental characteristics of soil, wt%

Specification	Initial coal		Coal partial dried -16% W^a (analytical)		Dried coal (anhydrous: water free)		Organic matter (combustible mass: water and ash free)	
	Symbol i	Value	Symbol a	Value	Symbol wf	Value	Symbol waf	Value
Moisture	W^i	20.22	W^a	16.00	-	-	-	-
Ash	A^i	66.37	A^a	69.88	A^{wf}	83.19	-	-
Carbon	C^i	7.52	C^a	7.92	C^{wf}	9.43	C^{waf}	56.09
Hydrogen	H^i	0.80	H^a	0.85	H^{wf}	1.01	H^{waf}	6.02
Sulphur	S_c^i	0.11	S_c^a	0.12	S_c^{wf}	0.14	S_c^{waf}	0.85
Nitrogen	N^i	0.25	N^a	0.26	N^{wf}	0.31	N^{waf}	1.84
Oxygen	O^i	4.73	O^a	4.97	O^{wf}	5.92	O^{waf}	35.20
Total	-	100.00	-	100.00	-	100.00	-	100.00
Humic acids extractible with NH_4OH 30%	-	3.00	-	3.15	-	3.75	-	22.31

Table 3

Petrographic composition of soft brown coal and soil, wt %

Maceral subgroup	Macerals	Roşia coal	Soil
Telohuminite (Wooden components)	Textinite	2.5	-
	Textoulminite	21.5	1.5
	Ulminite	15.0	4.8
	Total wooden components	39.0	6.3
Detrohuminite (Detritic components)	Attrinite + Densinite	10.0	4.8
Gelohuminite (Gelifiated components)	Gelinite	10.0	9.3
	Corpohuminite	2.5	0.9
Another organic components	Liptinite	1.5	0.7
	Inertinite	1.0	1.7
Total organic components		**64.0**	**23.7**
Anorganic components	Clay minerals	34.8	69.4
	Ferrous minerals	1.2	6.9
Total anorganic components		**36.0**	**76.3**

Microstructural characteristics of the main maceral and mineral constituents of the two types of studied materials were recorded as photomicrographs, in the plates I, II and III, in reflected white light (RL).

The petrographic constituents of Roşia coal, Plate I – Figs. 1-6, show their structural genetic nature of soft-brown earthly type, with xyloide intercalations specific for its low rank.

The wooden structure (39%) is represented by textoulminite (21%), that alternates with ulminite (15%). The detritic components (detrohuminite 10%) and the gelified components (gelohuminite 12.5%) are abundantly impregnated with minerals (36%), mainly clay (34,8%). The liptinite and inertinite are rarely met (1.5 and 1 %) and do not influence coal quality.

The soil sample has a specific petrographic composition showed in Plate II - Figs. 1-6 and Plate III – Figs. 1-4. The participation of organic matter (23.7%) is represented by unstructurated huminitic constituents, ulminite and gelinite. Porous gelinite is partial oxidated and fissured. It often shows mineral, clayey and ferrous impregnation.

The similar structure of organic components in Roşia coal with low carbonification degree, and soil, supports the idea of introducing this coal dust in order to enrich the poor soil. In this way the waste coal becomes an ecological fertilizer, that enhances the plants growth conditions.

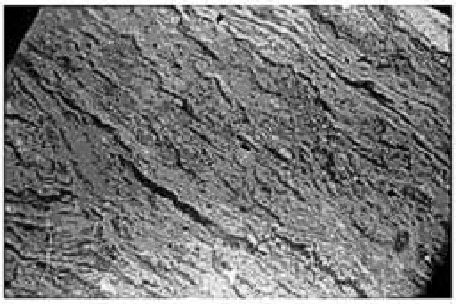
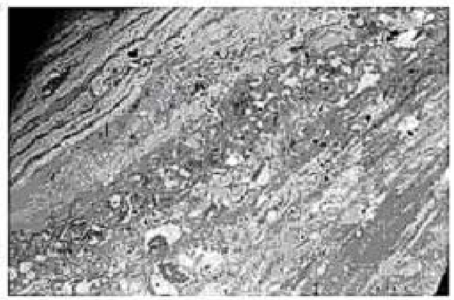


Fig. 1

Fig. 2

Fig. 3



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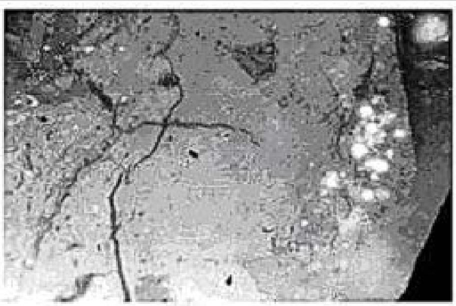

Fig. 5

Fig. 6

Plate I, Figs. 1-6

Microstructural aspect in reflected white light of specific petrographic constituents of Roşia coal. RL, imm., 375x

Fig. 1 - Textoulminite with shrinkage fissures;
Fig. 2 - Ulminite band (middle) bounded of corpohuminite (left);
Fig. 3 - Textoulminite and ulminite grains (left);
textoulminite grains with corpohuminite (right);
ferrous and clayey impregnated humic mass (right);
little inertinite grain (up, left);
Fig. 4 - Alternating strips of a complex microstructure: textoulminite (left); gelinite with partial porous corpohuminite (middle) and textoulminite impregnated with liptinite (right);
Fig. 5 - Fissured gelinite with granular pyrite (right);
Fig. 6 - Ulminite with some fissures, liptinitic impregnation (dark grey) and ferrous minerals (light grey – white).

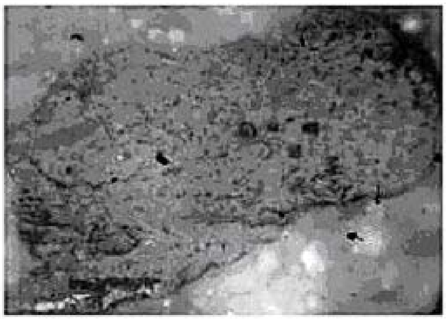

Fig. 7

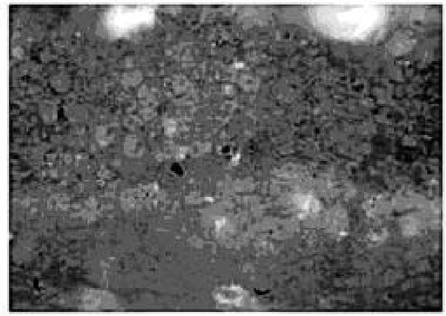

Fig. 8

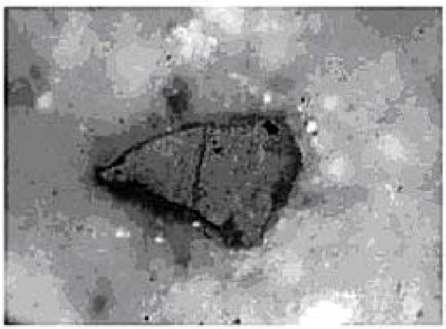

Fig. 9

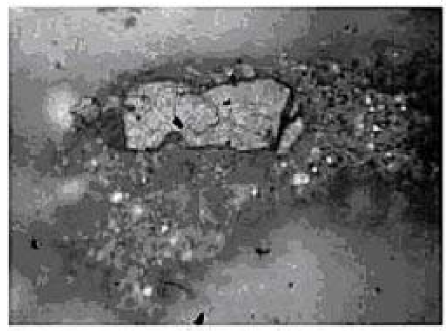

Fig. 10

Fig. 11

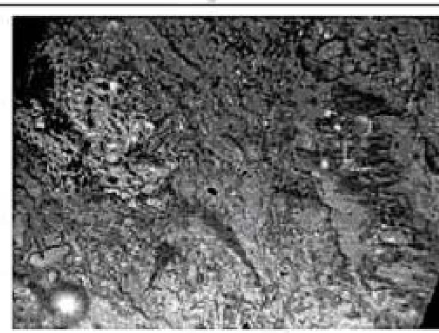

Fig. 12

Plate II, Figs. 7-12
Microstructural aspects in reflected white light of main organic constituents from mineral groundmass of soil sample. RL, imm., 375x; 500x

Fig. 7 - Grains of porous gelinite in a predominant ferrous groundmass;
Fig. 8 - Gelinite with corpohuminite and ferrous impregnation;
Fig. 9- Ulminite grain (middle) in a ferro-calcic groundmass;
Fig. 10 - Little grain of oxidated and cracked gelinite, included in a polymineral particle;
Fig. 11 - Fragment of a very reflectant fusinite;
Fig. 12 - Densinite with some porous inertinite (light grey - left) and clayey impregnation (right); 500x.

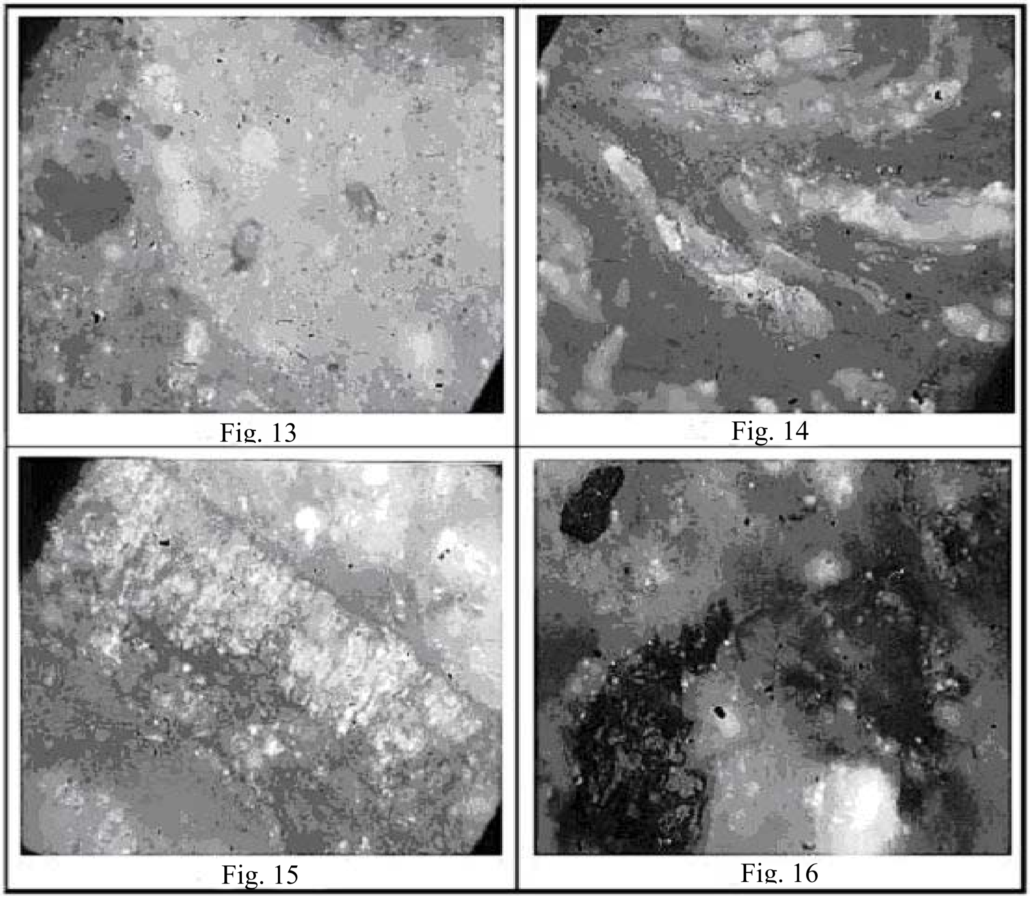

Plate III, Figs. 13-16
Microstructural composition of mineral groundmass from soil sample, RL, imm., 375x

Fig. 13- Ferrous groundmass with impregnations of clay and quartz;
Fig. 14 Clayey-ferrous groundmass with abundant ferrous impregnation (white);
Fig. 15 Grain of clayey soil highly impregnated with ferrous material (white);
Fig. 16 Groundmass with complex mineral composition: ferrous, clayey and calcic; grain of very porous gelinite, impregnated with clay (top - right).

Another aspect of our research was focused on the influence of coal introduction in soil in order to maintain its humidity, according to weather conditions in our country. Therefore it was established the variation in time of the drying rate, both for coal and soil [8]. It was determinated by gavimetric method, maintaining the sample in static conditions at a temperature of 60 ºC.

The results are presented in Fig. 17:

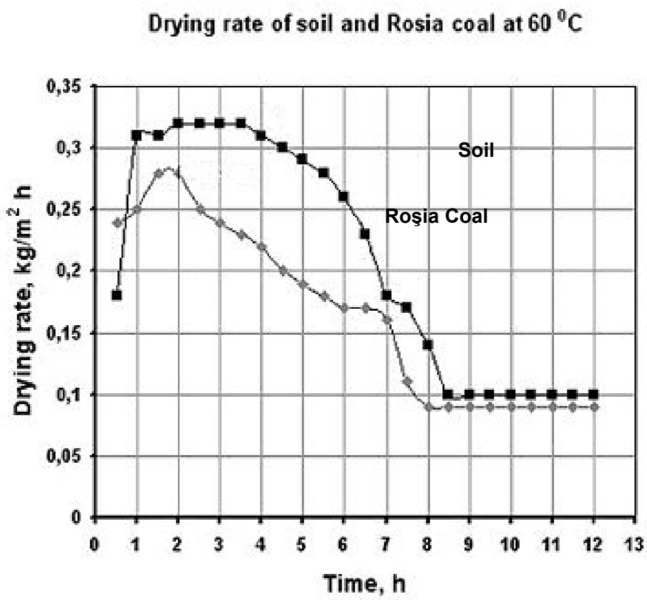

Fig. 17 – Variation in time of coal and soil drying rate.

From the graphic data the following findings result:

- the drying rate of soil is higher than that of coal;
- the coal dust introduced in soil helps to maintain more time the soil humidity, even at 60ºC (maximum possible in our country).

4. Conclusions

The chemical composition of soft brown coal dust and soil are similar, but with superior values for the percent of soil mineral material. The humic acids content referred to the combustible matter (waf), is aproximately the same in soil and in the coal dust. Even at a high percentage of sterile, the coal waste has a higher organic content, comparatively with the soil one. Petrografic composition of the two media presents qualitative similarities of organic and mineral constituents type, but thez are different from the quantitative point of view. This fact justifies the study aspect of using soft brown coal waste to supplement the soil organic matter. The drying rate of coal dust is smaller than that of soil, contributing to maintain more time the water in soil. The plants growth is similar, in coal dust and soil. The soft brown coal dust characteristics correspond to the quality of soil, without to produce any ecological change in it (its introduction in soil is entirely environmentally friendly). These results also suggest the possibility of introduction the Roşia soft brown coal waste into the poor soil for maintaining the soil moisture and fertility.

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