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PHYSICOCHEMICAL CHARACTERIZATION OF MINERAL MUD FROM SPA VRUJCI

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Abstract

Mineralogical and physicochemical analysis of healing mud from spa Vrujci was performed by ICP-OES analysis and FTIR and micro-Raman spectroscopy. The therapeutic effect of mud was improved by plant extracts implementation.

Introduction

Spa Vrujci is situated on the banks of the Toplica River. Thermal water (temperature 27^{o}C) brings the finest mud (rich in minerals) from the depths. For therapeutic purposes peloid mud, combined with exposure to the sun, is used for different treatments (various rheumatic diseases, sciatica, varicous veins, and skin diseases). Medicinal mud consists of tiny, fine particles that enable close contact with the skin and strong therapeutic effect. These therapeutic effects are improved by plant extracts implementation.

For the explanation of the therapeutic effects it is indispensable to perform the complete analysis of mineral water and mud. In this study detailed mineralogical and physicochemical analysis of healing mud from spa Vrujci is performed.

Experimental

The healing mud from two sources in spa Vrujci was analyzed. The chemical composition was determined by inductively coupled plasma optical emission spectroscopy (ICP-OES), using a Thermo Scientific iCAP 6500 Duo ICP spectrometer. Prior to analysis by ICP-OES, the microwave-assisted acid digestion of samples was performed by means of ETHOS 1 Advanced Microwave Digestion System (Milestone, Italy) using HPR-1000/10S high pressure segmented rotor. The acid mixture consisting of 5 mL H_3PO_4 85%, 3 mL HCl 37% and 0.5 mL HF 40%. was used for the acid digestion. The sample dissolution procedures of microwave-assisted wet-acid decomposition and acid attack in open beaker were compared. The analytes were determined using multi-element matrix matched standard solutions. The accuracy of the method was checked by use of the standard reference material NCS DC73302, which has a chemical composition very close to the analyzed mud. Besides the main components, Si, Al, Fe, Ca, Mg, Ba, K, Na and Ti, essential and beneficial elements, Cu, Zn, Mn, Ni, Co and Se and heavy and toxic elements such as Pb, Cd, Hg, As, Sb, Tl, Bi and Te were determined.

The mineralogical composition of the mud was determined by FTIR and micro-Raman spectroscopy. FTIR spectra of the powdered samples, dispersed in potassium bromide and compressed into pellets, were recorded in the range of 4000–400 cm^{-1}, at 64 scans per spectrum, with 2 cm^{-1} resolution, using a Nicolet 6700 FTIR Spectrometer (Thermo Scientific). Micro-Raman spectra were recorded on a DXR Raman Microscope (Termo Scientific). The 532 nm line of a diode-pumped solid state high brightness laser was used as the exciting radiation and the power of illumination at the sample surface ranged between 3 and 10 mW.

Results and discussion

The water content of crude mud was 31,4 % and 32.6% for the source 1 and 2 respectively; pH of mud slurries was 7.8. The organic component was determined to be only about 5%. The microbiological analysis was performed as well.

The influence of matrix elements Al, Fe, Ca, Mg and K on determination of trace elements Cd, Co, Cr, Cu, Mn, Ni V and Zn was investigated. It is shown that matrix elements present in concentration corresponding to analysed mud have negligible effect between 1.5 and 6% on Cd, Zn and Ni.

The results of spectrochemical analysis determined for the main, minor and trace components are presented in Table 1.

Analysis of FTIR and micro-Raman spectra of crude mud from both source presented in Fig. 1, indicates that the most abundant mineral component is quartz. Broad band at 3440, and band in the region about 1630 cm^{-1}, assigned to water, is indication of some clay minerals which were identified as kaolinite and montmorinollite. Calcite identified by the broad band at 1433 cm^{-1} and sharp band at 877 cm^{-1} in FTIR spectra, is present in relatively low concentration in accordance with spectrochemical results (Table 1). On the basis of Raman spectra albite, hematite, rutile and anatase were also identified in healing mud.

Table 1. Chemical composition of main and trace components of healing mud

Source	Concentration, %									
	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	BaO	MnO	K_2O	Na_2O	TiO_2
1	64.8	13.1	5.9	1.1	3.5	0.5	1.7	2.5	1.5	1.1
2	60.4	13.2	6.2	1.0	3.5	0.5	1.4	2.5	1.4	1.1
Source	Concentration, ppm									
	Cr	Cu	Zn	V	Co	Ni	Pb	Cd	Zr	Ce
1	235	52	116	92	13	122	52	32	69	91
2	238	50	120	100	13	122	58	31	74	92

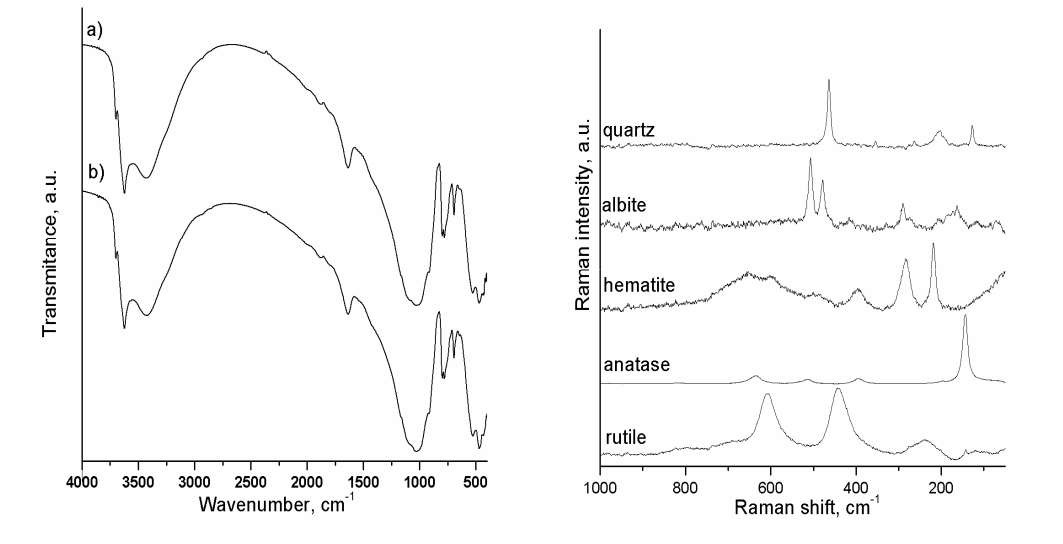

Fig.1. FTIR spectra of mud from: a) source 1 and b) source 2 (left) and micro-Raman spectra of minerals identified in mud (right).

On the basis of all presented results, it can be concluded that healing effects of mud from Vrujci is based on its very rich minerological composition and convenient morfological and textural characteristics. Therefore this mud after sterilization by γ radiation was used in combination with plant extracts for preparing of various healing phytopreparations. The pharmacological activity of the new preparations is determined by carefully selected plants extracts combination and their composition of bioactive substances.