Chemical and pharmacological study of the coal humic substances by the Genesis company from the Kansk-Achinsky deposit (Pereyaslovsky open-pit)

Zykova M.V.¹, Ivanov V.V.¹, Bratishko K.A.^{1,2}, Buyko E.E.^{1,2}, Logvinova L.A.¹, Danilets M.G.³, Ufandeev A.A.¹, Gorbunov A.S.¹, Trofimova E.S.^{1,3}, Ligacheva A.A.³, Mikhalyov D.A.¹, Tsupko A.V.¹, Zima A.P.¹, Lasukova T.V.⁴, Perederina I.A.¹, Rabtsevich E.S.^{1,5}, Perminova I.V.⁶, Belousov M.V.^{1,2}

¹Siberian State Medical University, Tomsk, Russia, huminolog@mail.ru

²Tomsk Polytechnic University, Tomsk, Russia

³Research Institute of Pharmacology and Regenerative Medicine by E.D. Goldberg, Tomsk, Russia

⁴Research Institute of Cardiology, Tomsk, Russia

⁵Tomsk State University, Tomsk, Russia

⁶Lomonosov MSU, Department of Chemistry, Moscow, Russia

Keywords: humic substances, biological activity, pharmacological, microbiological and chemical safety

DOI:10.36291/HIT.2021.075

Today, a difficult moment in the study of humic substances (HS) is the impossibility of non-experimental prediction of their biological activity, because HS are characterized by a multifaceted pharmacological activity and a nonavailability of the strict constancy by the chemical composition. There are many examples in the literature when HS can be sources of new diverse biologically active molecules depending on the origin of raw materials (peat, coal, sapropel, mumiyo) and methods of production. It is this fact that determines the need for constant biological and chemical standardization of each specific humic product.

Chemical-pharmacological study, testing of the chemical, microbiological and pharmacological safety of the coal HS by the Kansk-Achinsky deposit (by Genesis company, Russia) were done.

The structural parameters of HS were studied by ICP-MS, electronic, fluorescence, infrared, ¹³C-NMR spectroscopy, elemental C,H,N,O-analysis, gel chromatography. The 10 essential elements were established - K, Ca, Mg, Mn, Fe, Cu, Zn, Mo, Co, Se. Microbiological (pathogenic microorganisms, molds and yeasts) and chemical (heavy metals, arsenic, radionuclides) safe parameters were corresponded to requirements of the Russia State Pharmacopoeia.

According to the results of the toxicity testing with the introduction of a single dose (acute toxicity) and the introduction of repeated doses (28-day toxicity) were established that administered intragastrically HS didn't have a toxic effect on the organs and systems of the experimental animals, and belong to the V hazard class - substances low-hazard (according to GOST 32644-2014). The irritant effect and sensibilization tests were established that HS didn't have the allergenic properties. According to the toxicological testing on cell culture in vitro was established that HS also didn't have a cytotoxic effect in a wide range of doses.

According to the results of the intracellular distribution study on cell culture, the HS ability to penetrate cell barriers and accumulate in the intracellular compartment, mainly in the perinuclear compartment and the cell nucleus was established.

The results of testing the specific pharmacological activity in various experimental models were established the antioxidant, immunotropic, cardiotropic, cytoprotective and antihypoxic properties of HS. The cytoprotective properties of HS were established due to

they reduced the intracellular reactive oxygen species level after induction of oxidative stress by prooxidants (tertbutyl hydroperoxide, hydrogen dioxide, and Fe^{2+}), which point at the HS stimulation of the antioxidant cell self-defense system.

Therefore, the coal HS by the Kansk-Achinsky deposit (by Genesis company, Russia) are safe and promising substances for dietary supplements with protective, antihypoxic, antioxidant and immunomodulatory properties.