3.

STUDY OF THE IRON STATE IN PHARMACEUTICAL PRODUCTS USING MÖSSBAUER SPECTROSCOPY

Belyaev D.V.[1], Moskvitin V.S.[1], Alenkina I.V.[1], Oshtrakh M.I.[1]

[1)] Department of Experimental Physics, Institute of Physics and Technology, Ural Federal University, 620002, Ekaterinburg, Russian Federation
E-mail: danil.belyaev08@gmail.com

This work is devoted to study of the iron state in iron-containing pharmaceuticals using Mössbauer spectroscopy. Obtained results showed useful application of Mössbauer spectroscopy for characterization of the iron state in various pharmaceutical products.

Iron is the metal of life. Iron can be found in various iron-containing proteins which provide vitally important processes, e.g., oxygen transport, electron transport and others. Iron deficiency causes severe pathological consequences in the body known as the iron deficiency anemia. Various iron-containing pharmaceuticals are used to treat or prevent anemia. These pharmaceutical products may contain ferrous and ferric compounds such as ferrihydrite $5Fe_2O_3 \cdot 9H_2O$, akaganéite β-FeOOH, ferrous sulfate $FeSO_4$, ferrous fumarate $FeC_4H_2O_4$, iron chelates and several other compounds. ^{57}Fe Mössbauer spectroscopy could be a useful technique for evaluation of the iron state, control of possible iron-containing contamination and product aging [1–4]. Therefore, in the present work we have studied the iron state in the following pharmaceutical products Tardiferon® containing $FeSO_4$, PreNatal containing $FeC_4H_2O_4$, Iron Complexes containing iron glycine and iron citrate, Ferrum Lek and Maltofer® containing β-FeOOH. The Mössbauer spectrum of Tardiferon® demonstrates the presence of several minor quadrupole doublets corresponding to ferrous compounds in addition to quadrupole doublet associated with the main ferrous compound. The Mössbauer spectrum of PreNatal [Figure 1] indicates the presence of two quadrupole doublets related to the main ferrous compounds and one quadrupole doublet assigned to the minor ferric compound. The Mössbauer spectra of Maltofer® [Figure 1] and Ferrum Lek show several quadrupole doublets corresponding to different layers/areas of the β-FeOOH nanosized iron cores, i.e., structural heterogeneity (see the heterogeneous iron core model in [5]). Obtained results showed useful application of Mössbauer spectroscopy for characterization of the iron state in various pharmaceutical products to reveal additional iron-containing contaminations and ferrous compound oxidation that may be useful for the analysis of these products quality.

The authors wish to thank Dr. I.N. Antsigin for useful comments and support. This work was supported by the Ministry of Science and Higher Education of the Russian Federation, project # FEUZ-2020-0060

1. Oshtrakh M. I., Milder O. B., Semionkin V. A. Determination of the iron state in ferrous iron containing vitamins and dietary supplements: application of Mössbauer spectroscopy //Journal of Pharmaceutical and Biomedical Analysis. – 2006. – V. 40. – P. 1281–1287.
2. Barrero C. A. et al. Enhancing the possibilities of 5[над]7[над]Fe Mössbauer spectrometry to the study of chemical and physical properties of iron in medicines //Polyhedron. – 2016. – V. 105. – P. 27–34.
3. Oshtrakh M. I. et al. The 5[над]7[над]Fe hyperfine interactions in the life sciences: application of Mössbauer spectroscopy with a high velocity resolution in the study of iron-containing biomolecules and pharmaceutical compounds //Journal of Radioanalytical and Nuclear Chemistry. – 2016. – V. 309. – P. 317–332.
4. Belyaev D. V. et al. Testing of the iron state in outdated pharmaceuticals using Mössbauer spectroscopy //Hyperfine Interactions. – 2021. – V. 242. – P. 1–10.
5. Oshtrakh M.I. et al. Different 5[над]7[над]Fe microenvironments in the nanosized iron cores in human liver ferritin and its pharmaceutical analogues on the basis of temperature dependent Mössbauer spectroscopy //Spectrochimica Acta, Part A: Molecular and Biomolecular Spectroscopy. – 2017. – V. 172. P. 14–24