International Symposium on Polyelectrolytes
From Basic Science to Biological Applications
Research Workshop of the Israel Science Foundation
Ein Gedi, Israel, January 20-23, 2014

Novel Hemo-and Enterosorbents Based on Lignin

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At present use of renewed sources of raw materials for creation of novel functional biomaterials is perspective for development of science and technique. We have developed novel nano- and macroporous ion-exchangers based on renewable natural raw material by two-step process including catalytic o-alkylation of hydrolyzed lignin by epoxide resin ED-20 and followed by amination of formed α-oxide derivative with the help of polyethyleneimine (PEI) and polyethylenepolyamine (PEPA). The optimal conditions of synthesis, composition, structure and physical chemical properties of nano-, macroporous ion-exchangers were investigated by FTIR, SEM, TEM, XRD, DSC and porosimetry methods. Textural characteristics of natural polymeric materials and sorbents were also studied. The results show that alkaline activation and modification of natural biomaterials leads to an increase in surface area and enhancement of mesoporosity. Maxima of mesopore size distribution curves shifted from 2.27 nm (extracted sample) to 4.17 and 5.28 nm (activated and modified samples respectively) indicating the increase of mesopore by a factor of 1.8-2.3. The modified sorbents mainly contained a pore size of 10.56 nm. Existence of sorption-active mesopores and transporting macropores in ion-exchangers plays important role in sorption, selectivity and kinetic properties of synthesized ion-exchangers.

Mechanical durable and pH resistant ion-exchangers with amine ligands, grafted on lignin, are used for removal of water- and lipidsoluble toxic metabolites from pathological blood serum of diabetic retinopathy patients. After contact with sorbents the total cholesterol level and average concentration of LDL-C, VLDL-C decreased to the level of optimum compensated diabetes (<4.8–6.0 mmol/L, <3.0–4.0 mmol/L respectively). The degree of HDL-C extraction insignificantly decreased from 0.68 to 0.47 mmol/L. Purification of serum blood proceeded not only by removal of atherogenic fractions of cholesterol, but also by adsoption of large amounts of triglyceride (TG) and glucose. After hemosorption the concentration of TG decreased from 3.14 mmol/L to 1.71–1.89 mmol/L that corresponds to level of optimum compensated diabetes (<1.7–2.2 mmol/L). The most indicative criteria of biological liquid detoxification from lipid substances is cholesteric index of atherogenicity. Its value is significantly decreased from 10.81 to 8.33 after contact of serum with samples. This is caused by the high adsorption degree of atherogenic fractions of cholesterol and a very low degree of HDL-C removal. As a result of effective uptake of glucose its content decreased from pathological levels (7.50 mmol/L) to 5.2 – 6.1 mmol/L that corresponds to physiological norm (< 4.2 – 6.1 mmol/L). Considerable hypolipidemic and hypoglycemic effects of nano-, macroporous ion-exchangers have potential application in medicine, biology and biotechnology as immune-stimulating and organ-protection agents. They can be used as hemo-, enterosorbents for detoxification and purification of biological liquids including the metabolic treatment of diabetes, decreasing risks of diabetic retinopathy and normalization of the carbohydratelipid status of organisms.