antidote drug against heavy metal and radionuclide ions. Unithiol was found to have good solubility in water and strong chelation by virtue of sulfhydryl group [17]. Despite these additional features, unithiol has a disadvantage due to its high price.

Thus, using the positive features of both chitosan and unithiol materials, the novel chitosan-unithiol composite was synthesized. The sorption of heavy metal ions by chitosan-unithiol composite was investigated. This work was done with the purpose to establish the effect of concentration of metal ions and kinetics of sorption process. In our work was also shown the capability of chitosan-unithiol to sorb copper, lead and chromium ions during their simultaneous presence.

## Materials and methods

Chitosan flakes with the deacetylation degree of about 85% and molecular weight of 3,00,000 produced from crab shells (Tokyo Chemical Industry UK Ltd) were used for experiments. Uniothiol in ampoules with a concentration of 50 mg/ml ("Belmed drugs", Belarus) were used as a modifier.

Preparation of chitosan-unithiol composite was carried out as follows:

An aqueous solution of chitosan was prepared by dissolving chitosan (0.25 g) in 5 ml of acetic acid (75 wt. %) for 30 min. And then 5 ml of $H_20$ and 5 ml of acetic acid (75 wt. %) were added in course of stirring. Chirosan after keeping 1 day at room temperature was put on 100 $cm^3$ solution of unithiol with concentration of 1 mg/ml.

All the experiments were carried out under bath conditions with solutions containing $CuCl_2$, $Pb(NO_3)_2$, $K_2Cr_2O_7$. Sorption was performed in 100 ml vessels by pouring metal ions containing solutions onto 1 g of chitosan-unithiol composite and occasional stirring.

The concentration of Cu (II) and Pb (II) before and after sorption was determined by the AAS method using an atomic absorption spectrophotometer «Shimadzu 6200». Cr (VI) concentrations were determined photometrically on the Specord 200 (Analytic Jena) at λ=530 nm using 1,5 -diphenylcarbazide as an indicator.

## Results and discussion

The removal degree is an important characteristic because it shows efficiency of the sorbent. Sorption of Cu2+, Pb2+ and Cr 6+ ions by initial chitosan and unithiol-chitosan was investigated at 25 °C in the time interval from 0 to 180 min and results are provided in Figure 1. The addition of a modifier to the sorbent composition significantly increased the recovery of metal ions, practically reaching 100 %, while the initial chitosan recovered only about 80 % of the ions. On the course the time the initial concentration of metals was reduced. After 3 hours removal degree of ions were achieved the maximum extent. Hence 3 hours was found to be equilibrium sorption time.

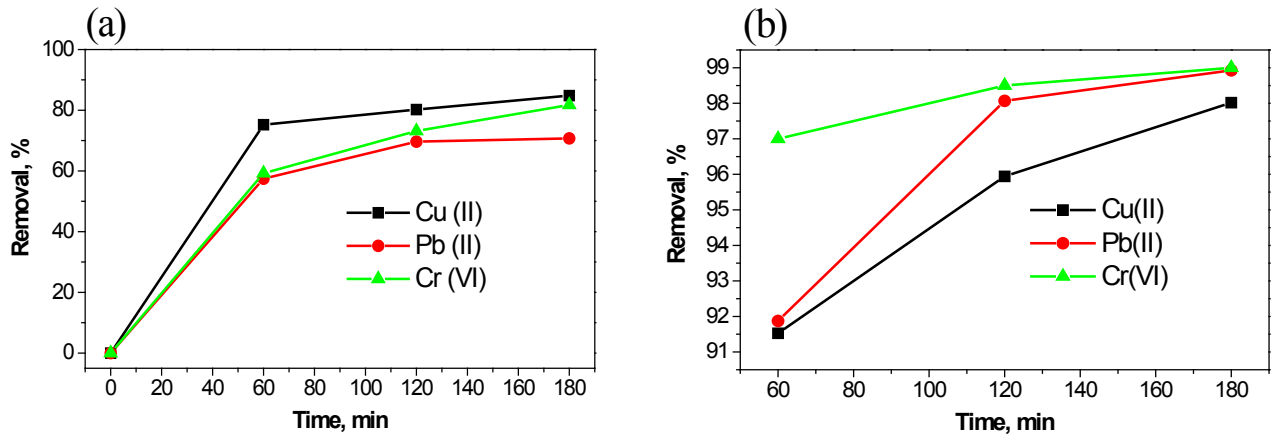


**Figure 1 –** Adsorption characteristics of (a) chitosan and (b) chitosan-unithiol composite for Cu (II), Pb (II) and Cr (VI) ions