Biosorption of lead ions by cyanobacteria *Spirulina platensis*: kinetics, equilibrium and thermodynamic study

Nikita Yushin[1,2]

[1]*Joint Institute for Nuclear Research, Joliot-Curie Str., 6, 1419890 Dubna, Russia*

[2]*Dubna University, 19 Universitetskaya Str., 141982 г. Dubna, Russia*

Inga Zinicovscaia[1,2,3], E.N. Rodlovskaya[4], I.Z Kamanina[5],

Marina Frontasyeva[1]

[1]*Joint Institute for Nuclear Research, Joliot-Curie Str., 6, 1419890 Dubna, Russia*

[2]*Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering, 30 Reactorului Str. MG-6, Bucharest - Magurele, Romania.*

[3]*The Institute of Chemistry of the Academy of Sciences of Moldova, 3, Academiei Str., 2028 Chisinau, R. Moldova*

[4]*A.N.Nesmeyanov Institute of Organoelement Compounds of Russian Academy of Sciences, Moscow, Russia*

[5]*Dubna University, 19 Universitetskaya Str., 141982 г. Dubna, Russia*

The aim of the work:

- To examine the effect of different operational parameters on the efficiency of lead biosorption by dry spirulina biomass

Sorbents

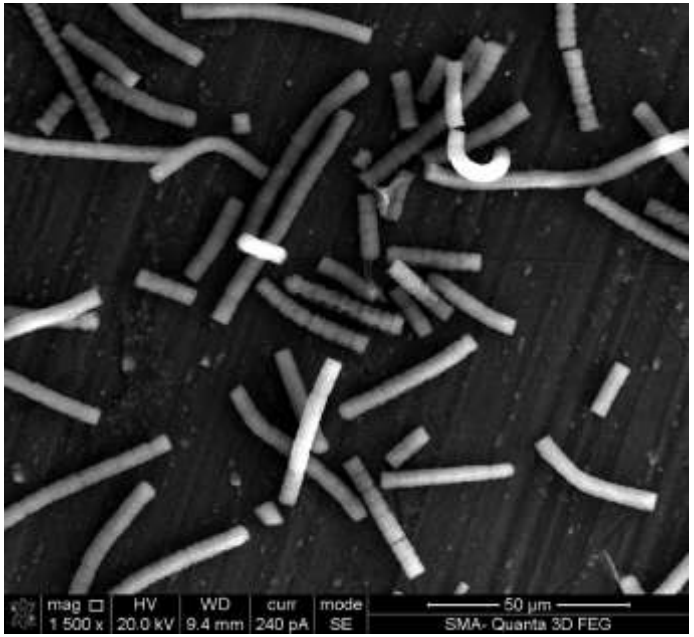
Expensive

- **Specially obtained (Activated carbon, Metal oxides, etc.)**

Cheap

- **Obtained from the environment**
- **Waste, rough products (Plants, Alga, Microorganisms)**

Object of study



Spirulina is a filamentous plankton cyanobacteria (gram-negative), or a multicellular helical filamentous alga. biomass purchased from "Biosolar MSU" company was dried in an oven at 80°C for 24 h. Then the biomass was homogenized in a homogenizer at 600 rpm for 10 min.

The scheme of the experiment

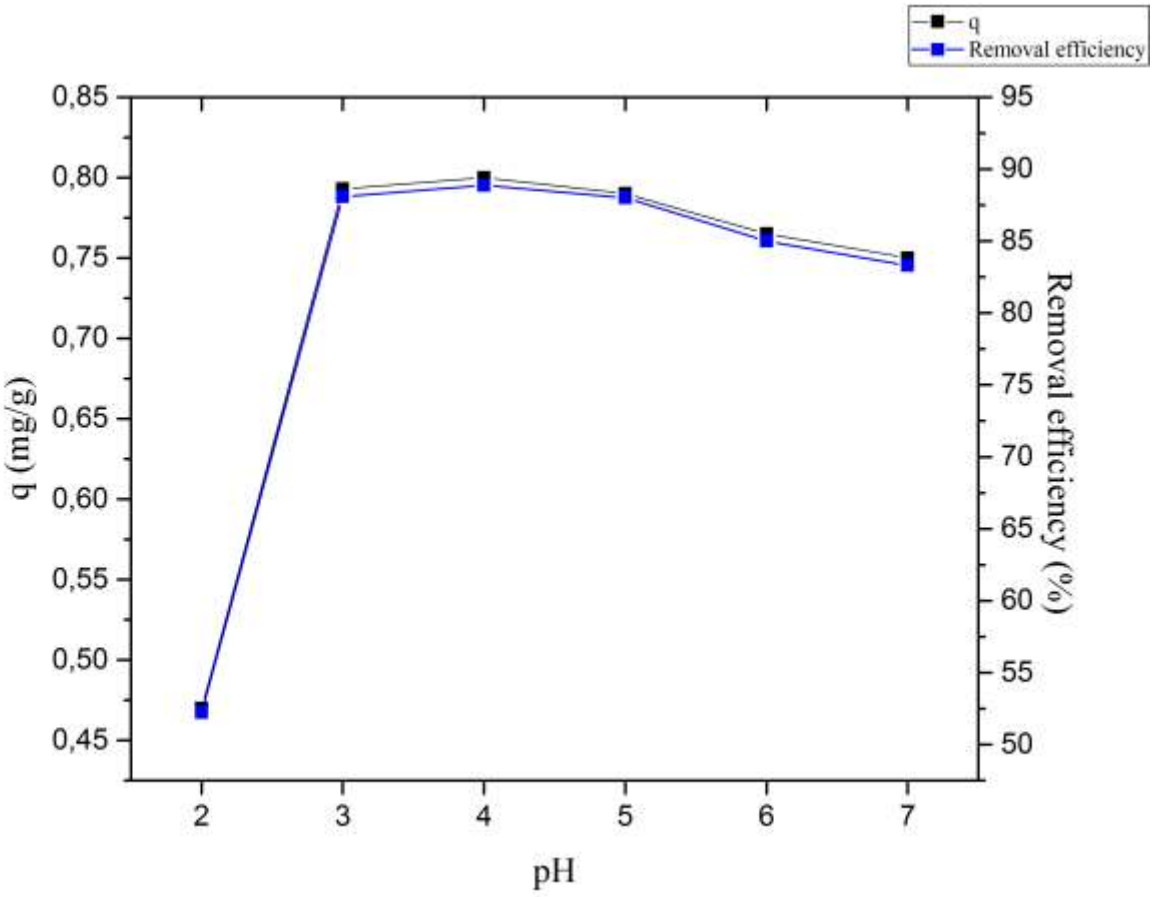
$Pb(NO_3)_2$   

V = 50 ml
C = 10 mg/L

m = 0.5 g

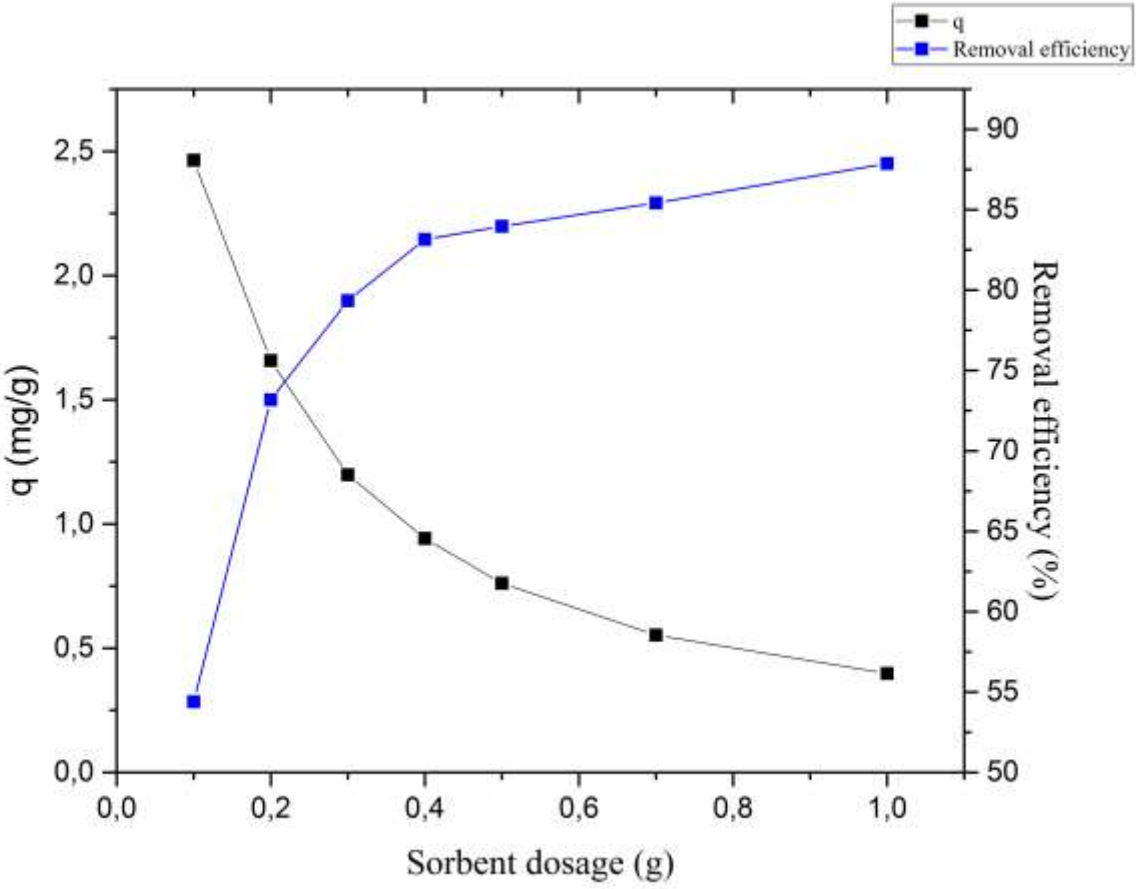
t= 1 h
v=200 rpm

Effect of pH value on biosorption



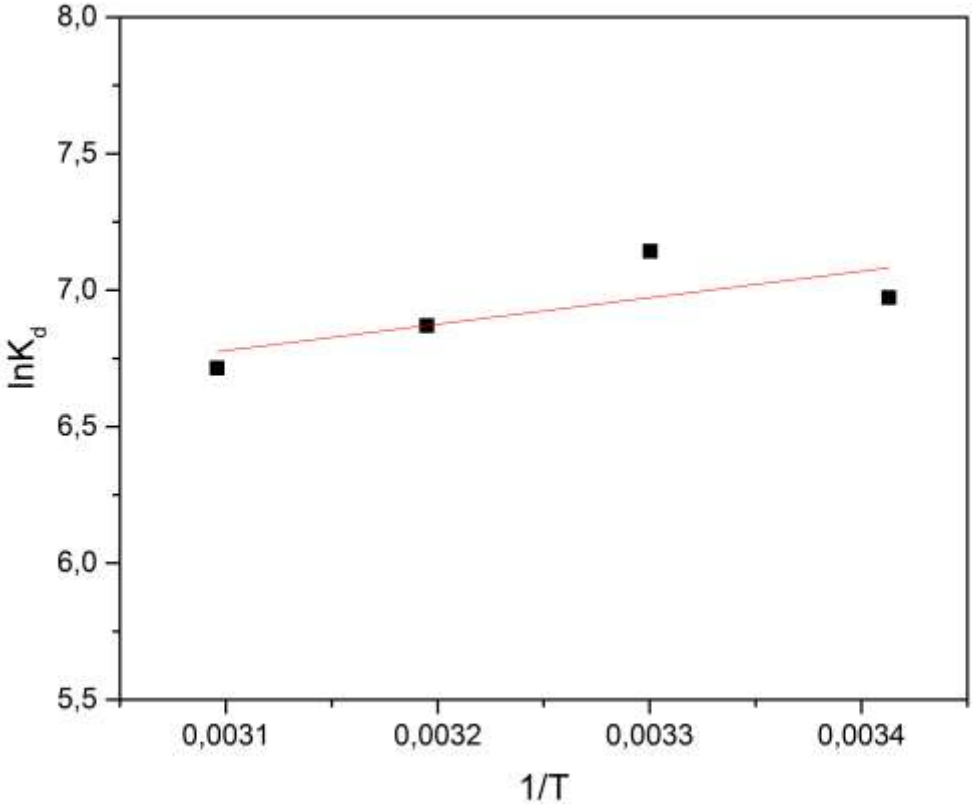
T 20°C; C_0 10 mg/L; sorbent dosage 0.5 g; adsorption time 1 h

Effect of sorbent dosage on biosorption



T 20°C; C_0 10 mg/L; pH 5; adsorption time 1 h

Thermodynamic study

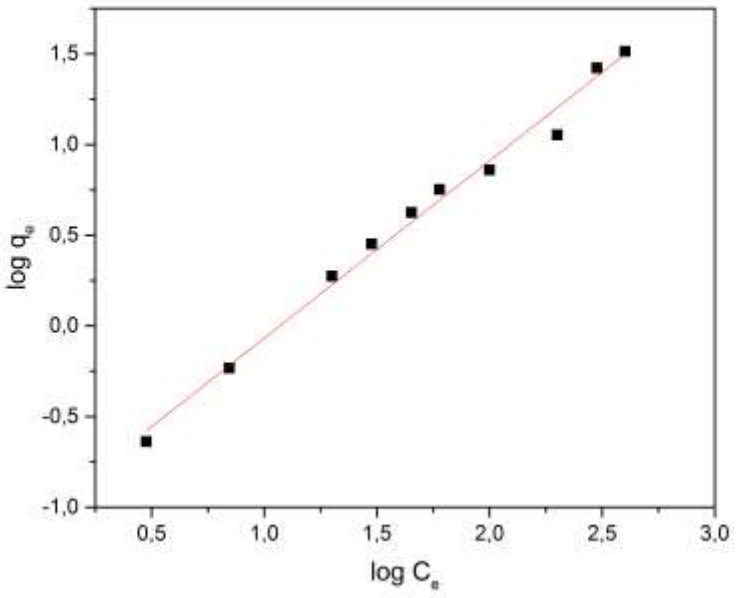


Dependence of lnKd vs. 1/T

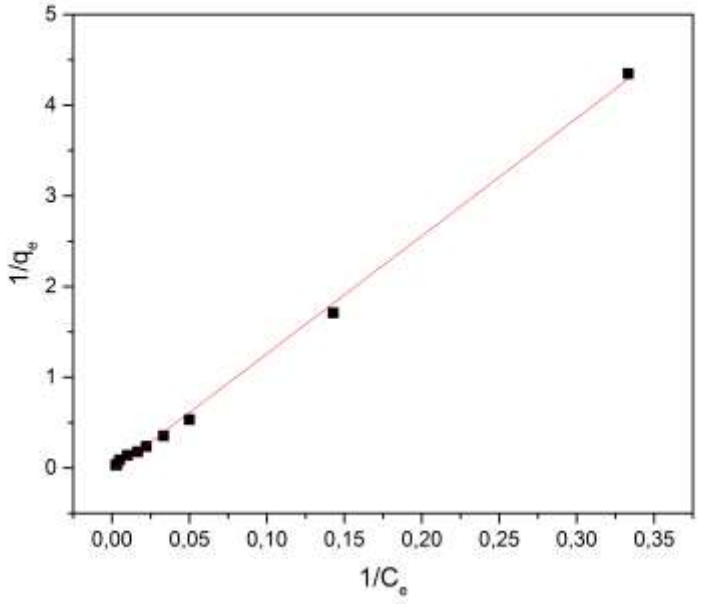
Thermodynamic study

Temperature K	ΔG° kJ/mol	ΔH° kJ/mol	ΔS° J/mol·K
293	-16.99	-8.06	31.37
303	-17.40		
313	-16.74		
323	-16.36		

Biosorption equilibrium modeling



Freundlich isotherm model

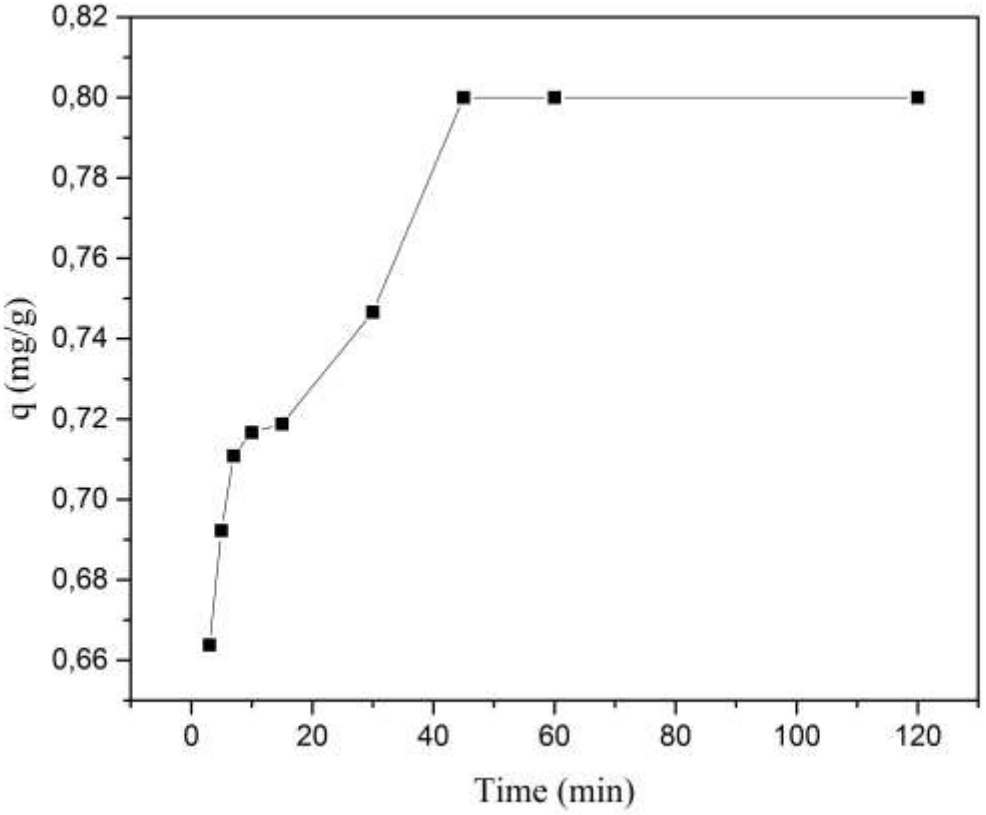


Langmuir isotherm model

Biosorption equilibrium modeling

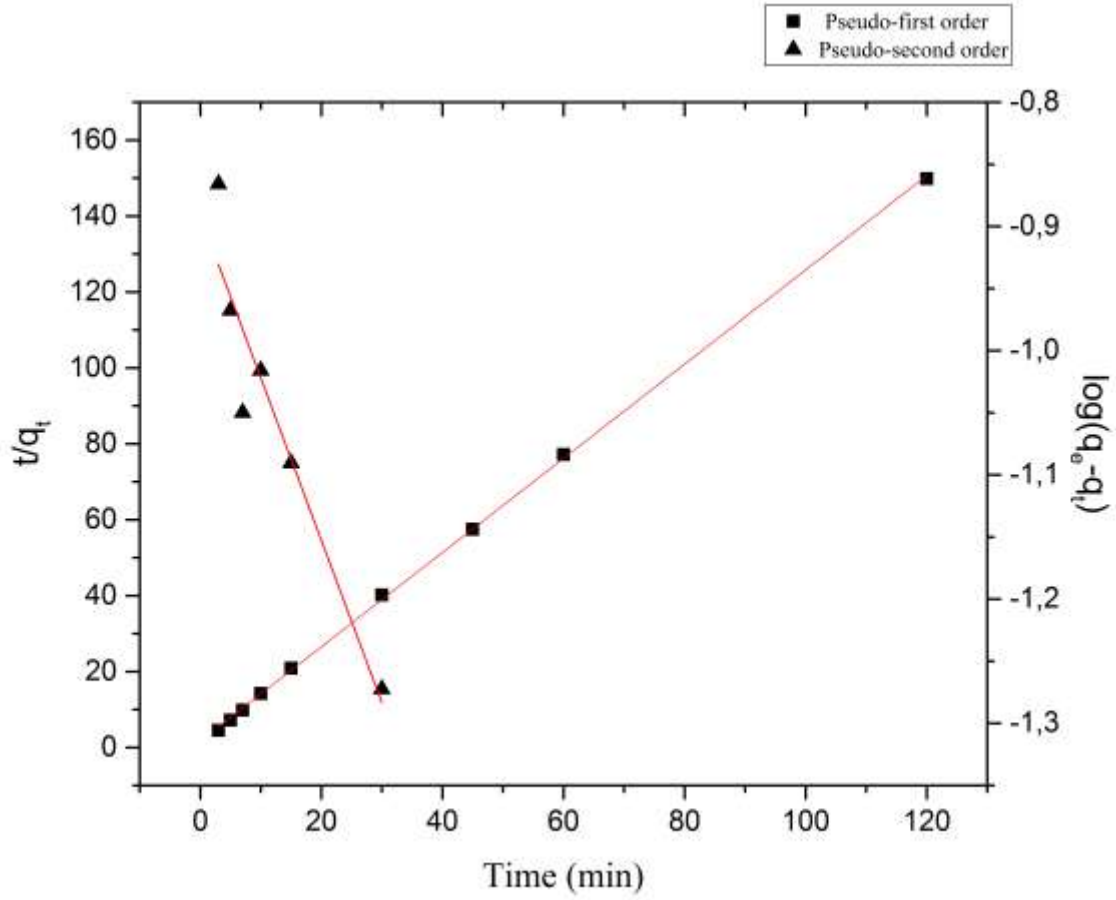
Langmuir isotherm		Freundlich isotherm	
R^2	0,999	R^2	0,995
Q_{max}	-25,84	K	0,09
b	-0,003	n	1,02

Biosorption kinetics



T 20°C; C_0 10 mg/L; pH 5; sorbent dosage 0.5 g

Biosorption kinetics



The pseudo-first- and pseudo-second order plots of kinetic study of lead biosorption on *S. platensis*

Biosorption kinetics

Pseudo-first-order model				
C_e, mg/L	$q_{e\ (exp)}$, mg/g	$q_{e\ (cal)}$, mg/g	k_a, min^{-1}	R^2
10	0,78	0,13	0,03	-0,950
Pseudo-second-order				
C_e, mg/L	$q_{e\ (exp)}$, mg/g	$q_{e\ (cal)}$, mg/g	K_b, g/mg·min	R^2
10	0,78	0,81	1,05	0,999

Conclusions

- The potential of spirulina biomass application for lead removal in aqueous solutions was demonstrated in the present work.
- The optimum operating conditions for lead adsorption was found to be 0.5 g biomass, at pH 5, for 30 min. Biosorption equilibrium data fitted very well to both the Langmuir and Freundlich models.
- Analysis of the data showed that the process involves second-order kinetics.
- The biosorption of lead by Spirulina biomass is an exothermic and spontaneous process. The presence of iron ions in the solution affected lead biosorption by spirulina biomass.
- Spirulina platensis can be applied for lead removal from industrial effluents or wastewater posttreatment.

Thank you for attention!