



# Lithium biosorption by *Spirulina platensis* biomass

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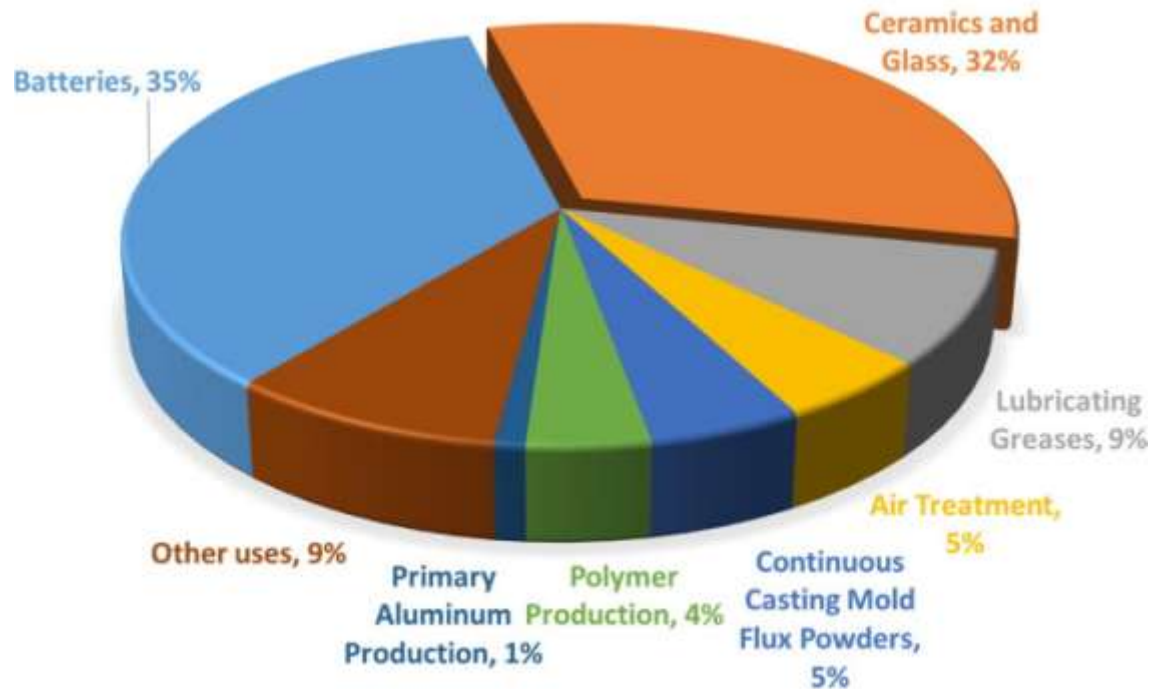


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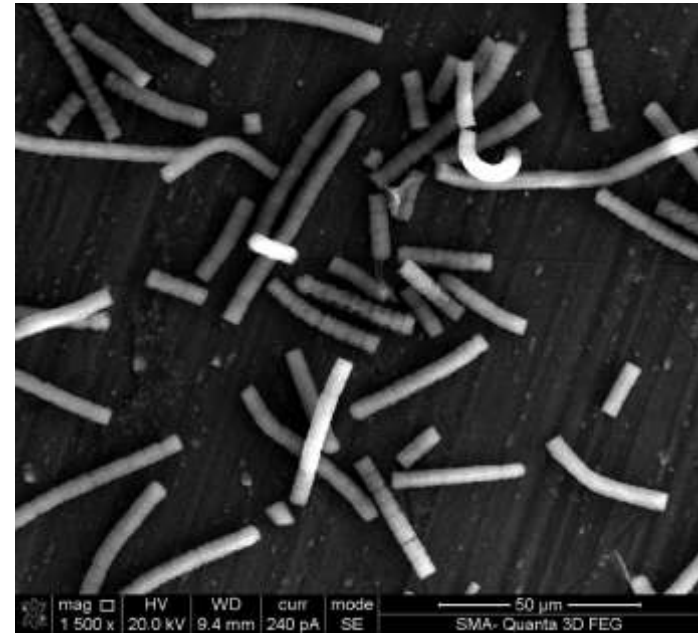
# Applications of lithium



# Traditional techniques used for lithium removal

- Solvent extraction
- Ion-exchange
- Precipitation
- Membrane processes
- Adsorption

# Object of study



*Arthrospira (Spirulina) platensis* 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 at 600 rpm for 10 min.

# The scheme of the experiment

$\text{Li}_2\text{CO}_3$



$V = 50 \text{ ml}$   
 $C = 10 \text{ mg/L}$

$m = 10 \text{ g/L}$

$t = 2 \text{ h}$   
 $v = 200 \text{ rpm}$

# Proton Induced Gamma Emission (PIGE)

**Periodic Table of the Elements**

1 1A 1A <b>H</b> Hydrogen 1.008	2 2A 2A <b>He</b> Helium 4.003																	18 VIII 8A
3 <b>Li</b> Lithium 6.941	4 <b>Be</b> Beryllium 9.012																	10 <b>Ne</b> Neon 20.180
11 <b>Na</b> Sodium 22.990	12 <b>Mg</b> Magnesium 24.305	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 VIII 8	9 VIII 8	10 VIII 8	11 IB 1B	12 IIB 2B	13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A	
19 <b>K</b> Potassium 39.098	20 <b>Ca</b> Calcium 40.078	21 <b>Sc</b> Scandium 44.956	22 <b>Ti</b> Titanium 47.867	23 <b>V</b> Vanadium 50.942	24 <b>Cr</b> Chromium 51.996	25 <b>Mn</b> Manganese 54.938	26 <b>Fe</b> Iron 55.845	27 <b>Co</b> Cobalt 58.933	28 <b>Ni</b> Nickel 58.693	29 <b>Cu</b> Copper 63.546	30 <b>Zn</b> Zinc 65.38	31 <b>Ga</b> Gallium 69.723	32 <b>Ge</b> Germanium 72.631	33 <b>As</b> Arsenic 74.922	34 <b>Se</b> Selenium 78.971	35 <b>Br</b> Bromine 79.904	36 <b>Kr</b> Krypton 83.798	
37 <b>Rb</b> Rubidium 85.468	38 <b>Sr</b> Strontium 87.62	39 <b>Y</b> Yttrium 88.906	40 <b>Zr</b> Zirconium 91.224	41 <b>Nb</b> Niobium 92.906	42 <b>Mo</b> Molybdenum 95.95	43 <b>Tc</b> Technetium 98.907	44 <b>Ru</b> Ruthenium 101.07	45 <b>Rh</b> Rhodium 102.906	46 <b>Pd</b> Palladium 106.42	47 <b>Ag</b> Silver 107.868	48 <b>Cd</b> Cadmium 112.414	49 <b>In</b> Indium 114.818	50 <b>Sn</b> Tin 118.711	51 <b>Sb</b> Antimony 121.760	52 <b>Te</b> Tellurium 127.6	53 <b>I</b> Iodine 126.905	54 <b>Xe</b> Xenon 131.294	
55 <b>Cs</b> Cesium 132.905	56 <b>Ba</b> Barium 137.328	57-71	72 <b>Hf</b> Hafnium 178.49	73 <b>Ta</b> Tantalum 180.948	74 <b>W</b> Tungsten 183.84	75 <b>Re</b> Rhenium 186.207	76 <b>Os</b> Osmium 190.23	77 <b>Ir</b> Iridium 192.217	78 <b>Pt</b> Platinum 195.085	79 <b>Au</b> Gold 196.967	80 <b>Hg</b> Mercury 200.592	81 <b>Tl</b> Thallium 204.383	82 <b>Pb</b> Lead 207.2	83 <b>Bi</b> Bismuth 208.980	84 <b>Po</b> Polonium [209]	85 <b>At</b> Astatine 209	86 <b>Rn</b> Radon 222.018	
87 <b>Fr</b> Francium 223	88 <b>Ra</b> Radium 226	89-103	104 <b>Rf</b> Rutherfordium [261]	105 <b>Db</b> Dubnium [262]	106 <b>Sg</b> Seaborgium [266]	107 <b>Bh</b> Bohrium [264]	108 <b>Hs</b> Hassium [269]	109 <b>Mt</b> Meitnerium [278]	110 <b>Ds</b> Darmstadtium [281]	111 <b>Rg</b> Roentgenium [282]	112 <b>Cn</b> Copernicium [285]	113 <b>Nh</b> Nihonium [286]	114 <b>Fl</b> Flerovium [289]	115 <b>Mc</b> Moscovium [289]	116 <b>Lv</b> Livermorium [293]	117 <b>Ts</b> Tennessine [294]	118 <b>Og</b> Oganesson [294]	

Lanthanide Series	57 <b>La</b> Lanthanum 138.905	58 <b>Ce</b> Cerium 140.116	59 <b>Pr</b> Praseodymium 140.908	60 <b>Nd</b> Neodymium 144.242	61 <b>Pm</b> Promethium 144.913	62 <b>Sm</b> Samarium 150.36	63 <b>Eu</b> Europium 151.964	64 <b>Gd</b> Gadolinium 157.25	65 <b>Tb</b> Terbium 158.925	66 <b>Dy</b> Dysprosium 162.500	67 <b>Ho</b> Holmium 164.930	68 <b>Er</b> Erbium 167.259	69 <b>Tm</b> Thulium 168.934	70 <b>Yb</b> Ytterbium 173.055	71 <b>Lu</b> Lutetium 174.967
Actinide Series	89 <b>Ac</b> Actinium 227.028	90 <b>Th</b> Thorium 232.038	91 <b>Pa</b> Protactinium 231.036	92 <b>U</b> Uranium 238.029	93 <b>Np</b> Neptunium 237.048	94 <b>Pu</b> Plutonium 244.064	95 <b>Am</b> Americium 243.061	96 <b>Cm</b> Curium 247.070	97 <b>Bk</b> Berkelium 247.070	98 <b>Cf</b> Californium 251.080	99 <b>Es</b> Einsteinium [254]	100 <b>Fm</b> Fermium 257.095	101 <b>Md</b> Mendelevium 258.1	102 <b>No</b> Nobelium 259.101	103 <b>Lr</b> Lawrencium [262]

Elements detectable by PIGE method

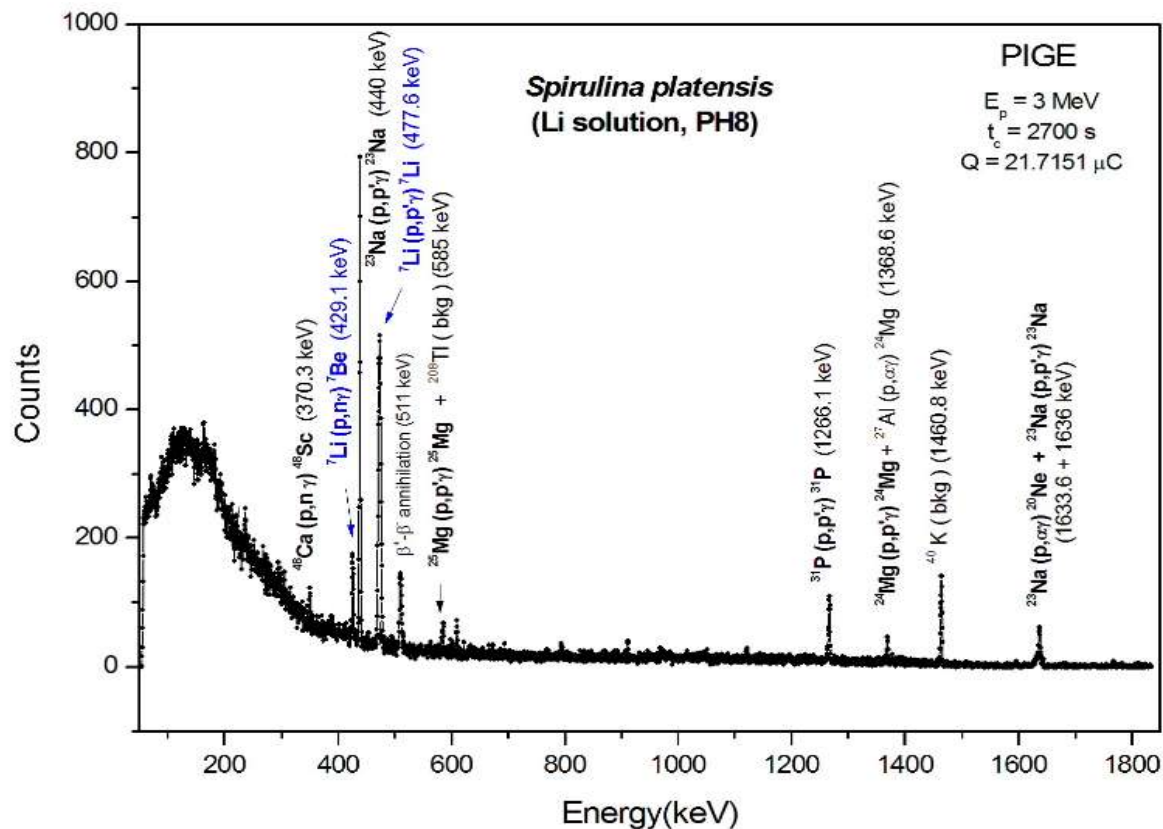
# Proton Induced Gamma Emission (PIGE)



Sample support for proton beam irradiation

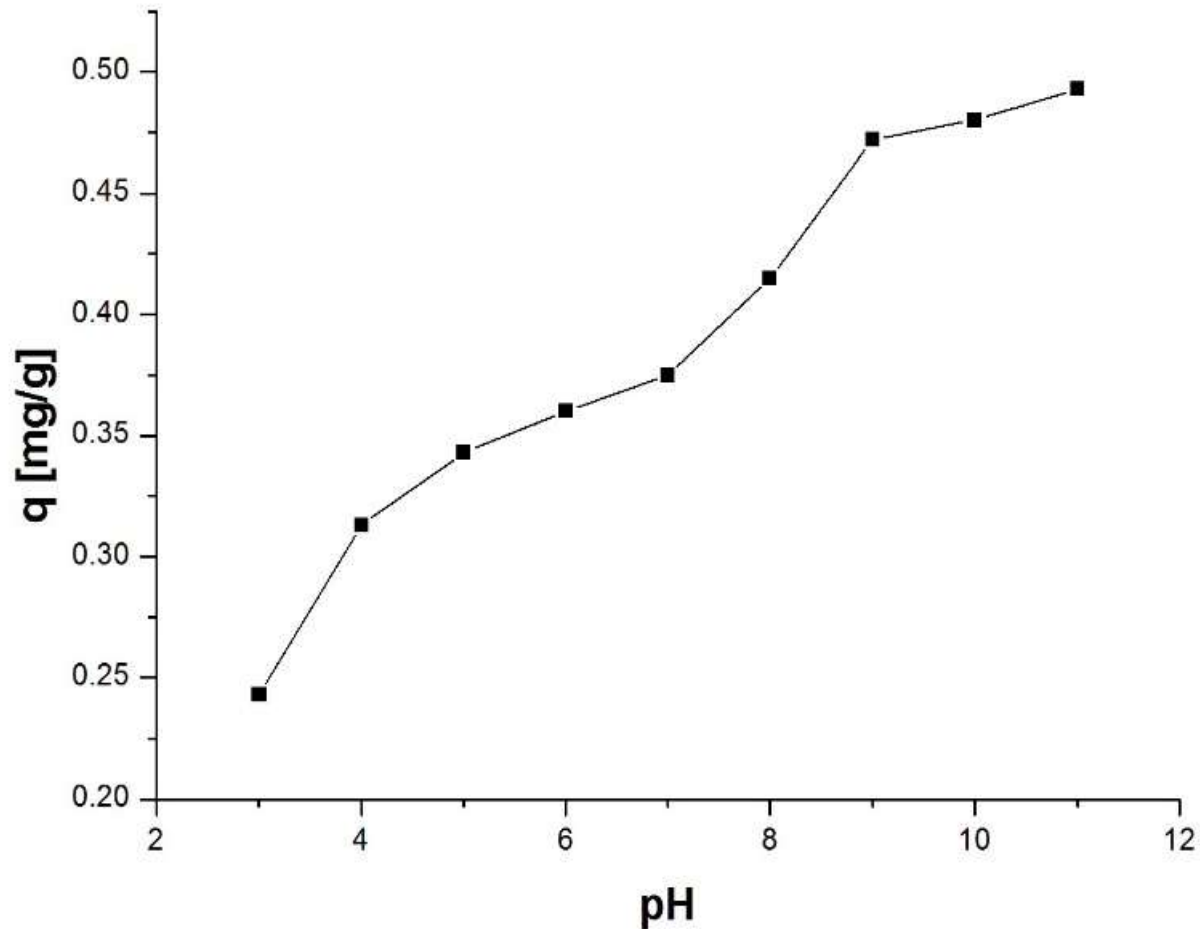


# Proton Induced Gamma Emission (PIGE)



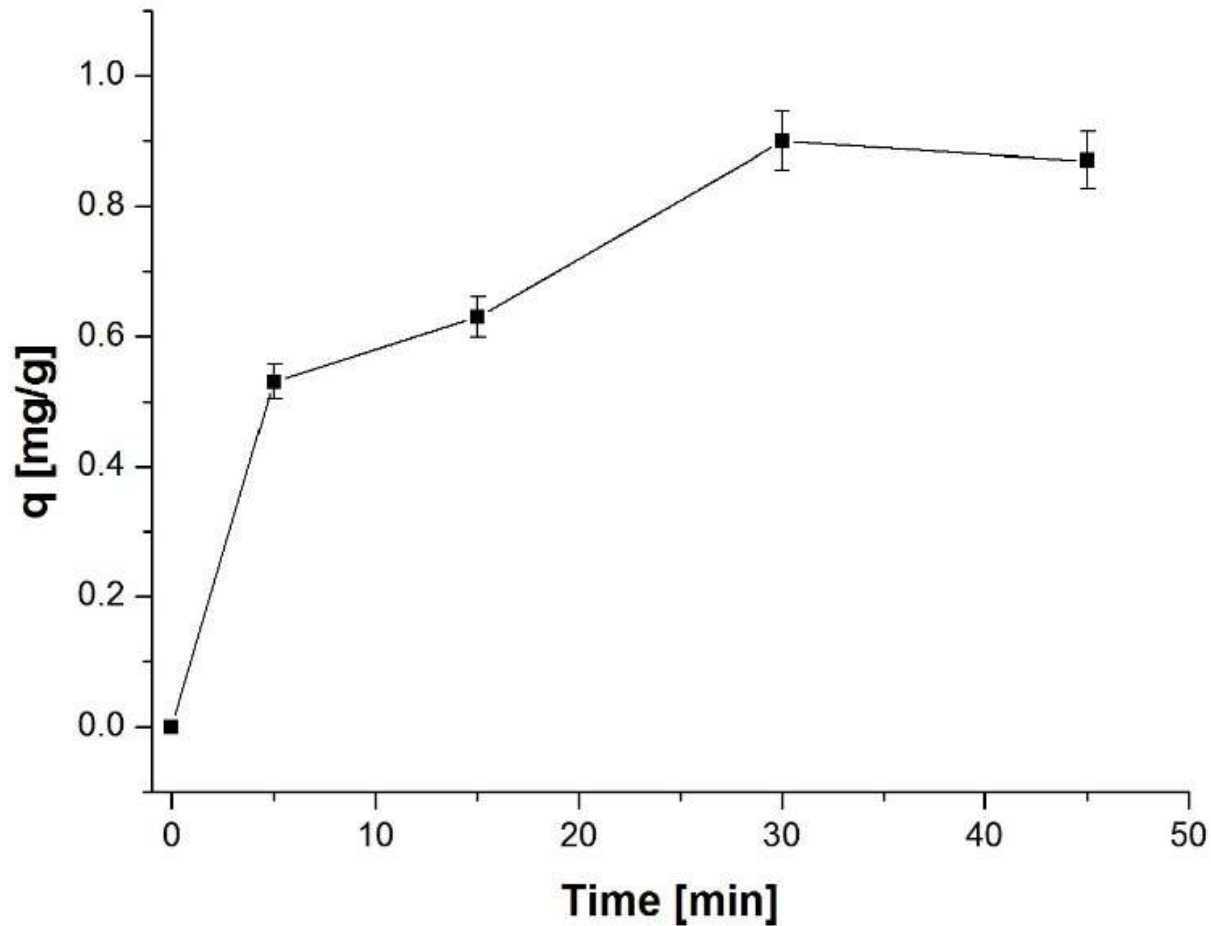
Sample support PIGE spectrum of Li-loaded *Spirulina platensis* biomass

# Effect of pH value on biosorption



Experimental conditions: T 20°C;  $C_i$  10 mg/L; sorbent dosage 10 g/L; adsorption time 2 h

# Effect of time on biosorption

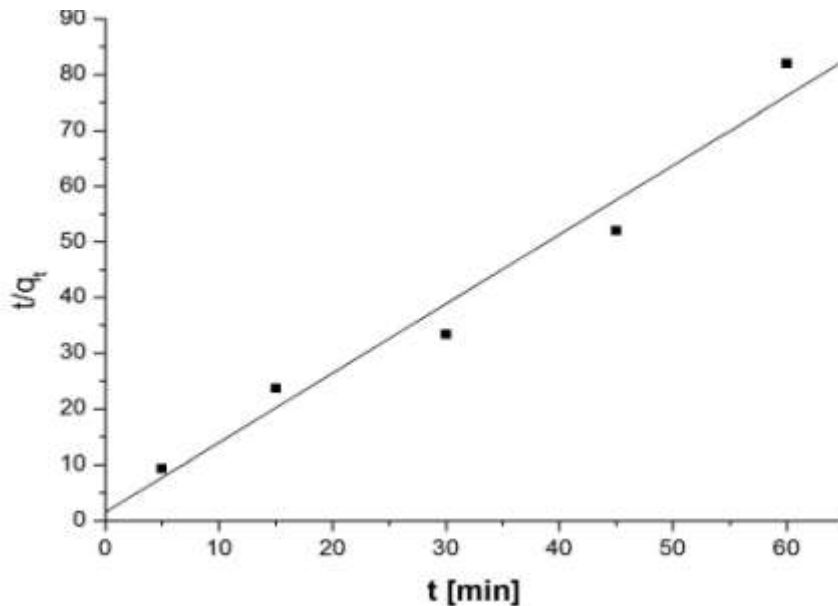


Experimental conditions: T 20°C;  $C_i$  10 mg/L; pH 11; sorbent dosage 10 g/L

# Biosorption kinetics

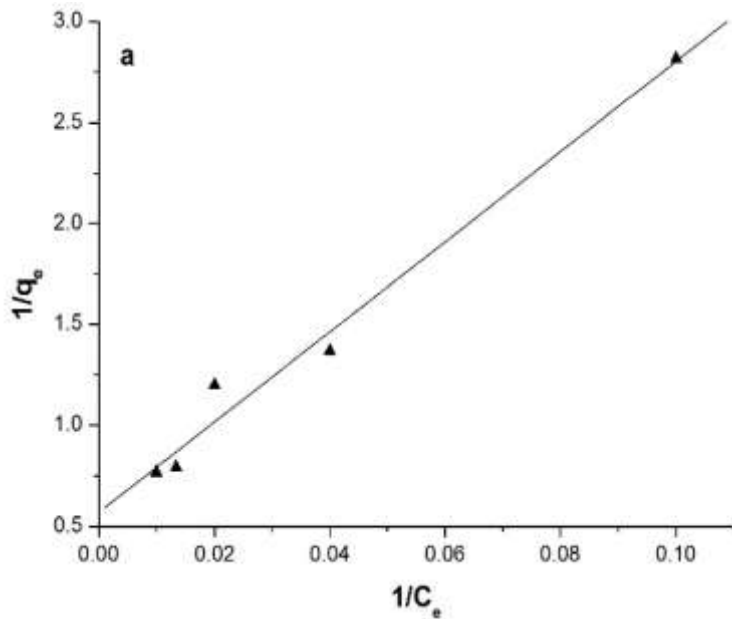
The pseudo-second order model parameters

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	0.87	0.9	1.97	0,99

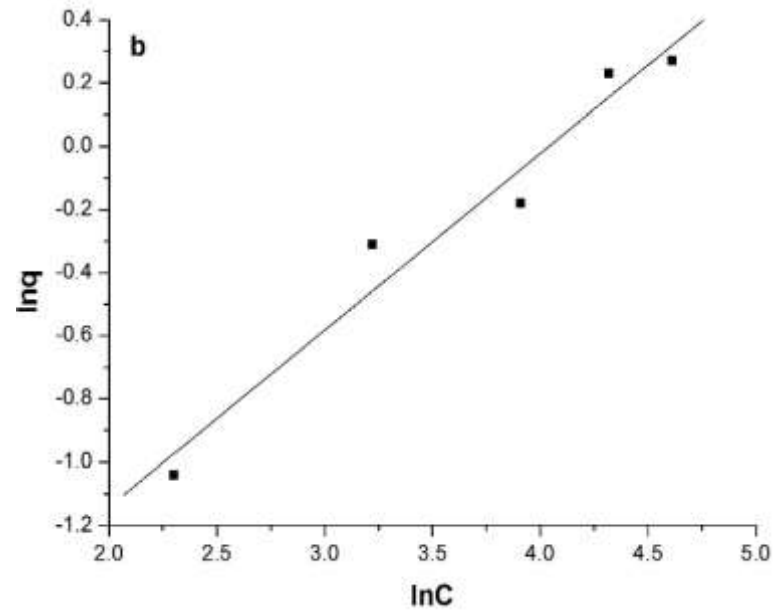


The pseudo-second order plot of kinetic study of lithium biosorption on *A. platensis*

# Biosorption equilibrium modeling



Langmuir isotherm model



Freundlich isotherm model

Isotherm parameters for the biosorption of lithium ions on *A. platensis* biomass

Langmuir isotherm		Freundlich isotherm	
$R^2$	0,99	$R^2$	0.97
$Q_{\max}$	1.75 mg/g	K	0.1
b	0.015 L/mg	n	1.78

# Conclusions

- *A. platensis* biomass can be applied as biosorbent for lithium removal from batch solutions.
- The maximum biosorption capacity of lithium 1.75 mg/g was achieved at pH 11.0 and sorbent dosage 10 g/L.
- Langmuir isotherm model and pseudo-second-order kinetic model described better the biosorption process under consideration.

**Thank you for attention!**