IBSC International BioScience Conference November Novi Sad, Serbia 2021

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KINETIC STUDY OF MOLASSIGENIC METAL IONS BIOSORPTION ON SUGAR BEET PULP

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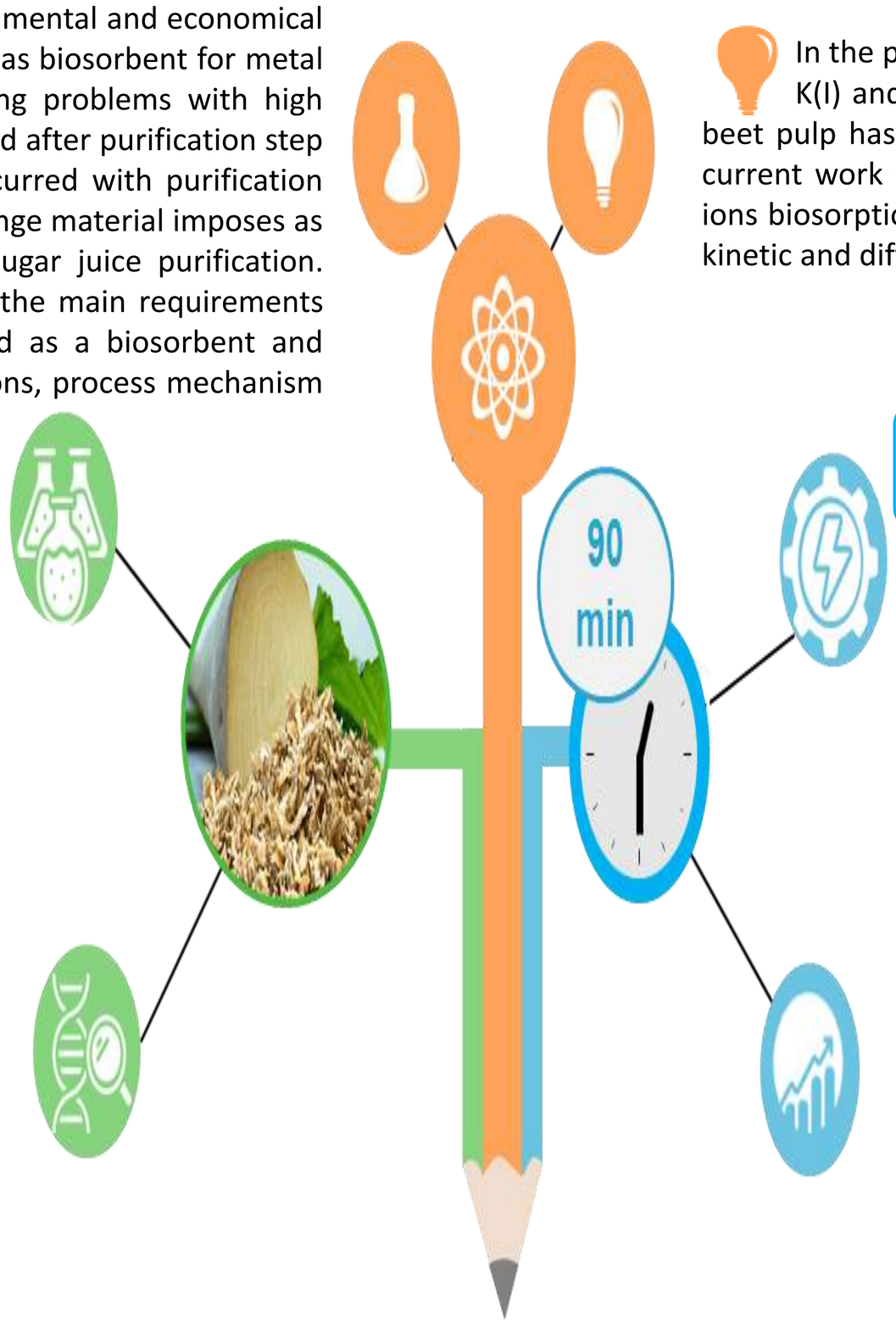
INTRODUCTION

Sugar beet pulp (SBP) as a cheap and abundant sugar industry solid waste from the environmental and economical point of view is appropriate for valorization as biosorbent for metal ions removal. The sugar industry are facing problems with high amount of molassigenic metal ions' remained after purification step in sugar juice. To overcome challenges occurred with purification stage, utilization of biomass as cation-exchange material imposes as a potential solution for more successful sugar juice purification. Modeling of biosorption kinetics is one of the main requirements for characterization of novel biomass used as a biosorbent and describing efficient sequestering of metal ions, process mechanism and dynamics.

METHOD / DESIGN

Batch biosorption experiments were performed at temperature (70°C) and pH (10.5) of alkalized juice similar to industrial conditions. The molassigenic metal ions content in sugar juice was determined by atomic absorption spectrometer (AAS). Removal effect (%) was calculated from the difference in molassigenic metal ions amount in alkalized sugar juice before and after the applied process.

Nature of the biosorption process was evaluated by using kinetic models (pseudo-first, pseudo-second and Elovich) and diffusion model (Weber - Morris).



OBJECTIVE

In the present study, the biosorption of Na(I), K(I) and Ca(II) from alkalized sugar juice on sugar beet pulp has been investigated. The main objective of current work was to study kinetic aspects of the metal ions biosorption on sugar beet pulp including non-linear kinetic and diffusion models.

RESULTS

Table 1. Kinetic parameters for the biosorption process

Pseudo first model			Pseudo second model		
Metal ion	Variable	Estimated	Metal ion	Variable	Estimated
K (I)	q_e	10.047	K (I)	q_e	15.159
	k_1	0.021		k_1	0.001
	SSE	0.966		*SSE*	1.113
	R^2	0.976		R^2	0.972
Na (I)	q_e	10.584	Na (I)	q_e	12.116
	k_1	0.052		k_1	0.006
	SSE	3.464		*SSE*	1.390
	R^2	0.814		R^2	0.916
Ca (II)	q_e	61.254	Ca (II)	q_e	107.12
	k_1	0.006		k_1	3.4E-05
	SSE	30.404		*SSE*	31.894
	R^2	0.966		R^2	0.964
Average R^2		0.919	Average R^2		0.951
Elovich model			Weber and Morris model		
Metal ion	Variable	Estimated	Metal ion	Variable	Estimated
K (I)	*b*	0.129	K (I)	k_{id}	0.966
	a	1.079		*C*	-0.722
	SSE	1.655		*SSE*	1.628
	R^2	0.958		R^2	0.959
Na (I)	*b*	0.202	Na (I)	k_{id}	0.619
	a	7.239		*C*	4.578
	SSE	0.612		*SSE*	0.534
	R^2	0.962		R^2	0.957
Ca (II)	*b*	0.029	Ca (II)	k_{id}	4.254
	a	2.361		*C*	-13.535
	SSE	22.740		*SSE*	21.118
	R^2	0.970		R^2	0.972
Average R^2		0.964	Average R^2		0.963
Average R^2 (K)	0.966		Average R^2 (Na)	0.915	Average R^2 (Ca) 0.968

Figure 1. Removal effect of Ca(II), Na(I) and K(I) from the alkalized sugar juice onto sugar beet pulp during 90 min contact time

CONCLUSIONS

- ✓ The results of this study indicate that the sugar beet pulp is suitable biosorbent for the biosorption of Na(I), K(I) and Ca(II) from the alkalized sugar juice. Sugar beet pulp can be valorized in effective and environmental-friendly way.
- ✓ Elovich kinetic model was observed to provide the best correlation of the experimental data among the kinetic models studied due to the highest coefficient of determination. The applicability of this kinetic model indicated that biosorption process involved chemical adsorption and ion-exchange mechanism.
- ✓ The obtained results show maximum amount of retained metal ions after 90 min of contact time for all investigated metals.

ACKNOWLEDGEMENT: This research is financed by the Ministry of Education, Science and Technological development of the Republic of Serbia 451-03-9/2021-14/200222.