The adsorption of ciprofloxacin on modified sodium alginate gel beads

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- **There is an increasing concern on the poluttion of antibiotics all over the world, and thus different kinds of absorbents are developed to remove antibiotics from water.**
- **In this paper, new sodium alginate porous gel beads with high specific surface area (PAPGB) were prepared by using sodium alginate and procyanidins as raw materials and aluminum sulfate and calcium chloride as complex crosslinking agents in order to remove ciprofloxacin from water.**

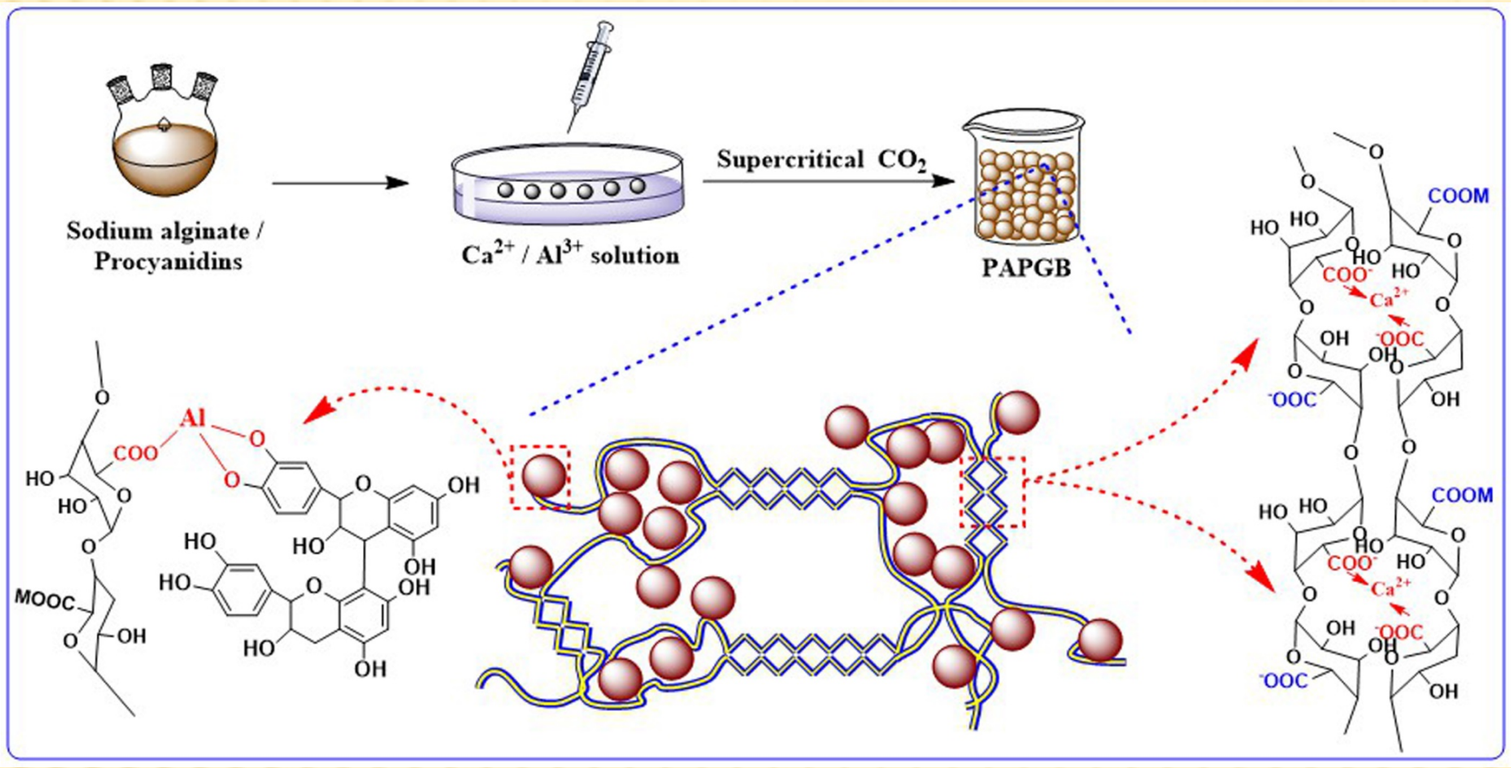

Fig. 1 Schemetic of the preparation of sodium alginate gel beads modified with procyanidins (PAPGB)

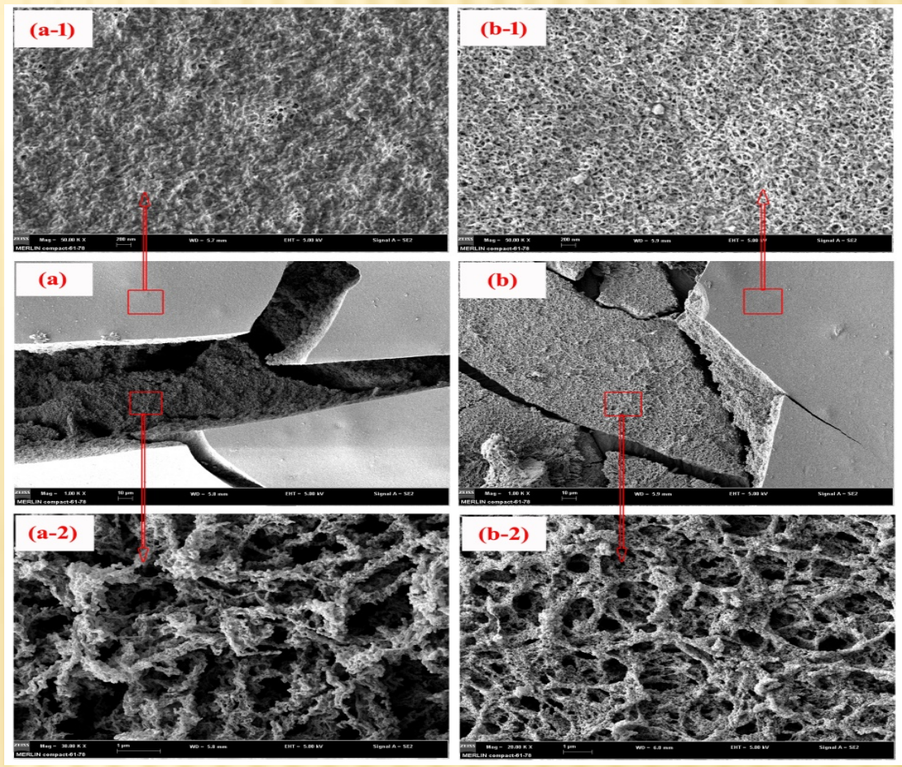

Fig. 2 SEM images of gel spheres: (a) SAG, (a-1) surface of SAG, (a-2) inner of SAG ; (b) PAPBG , (b-1) surface of PAPBG, (b-2) inner of PAPBG

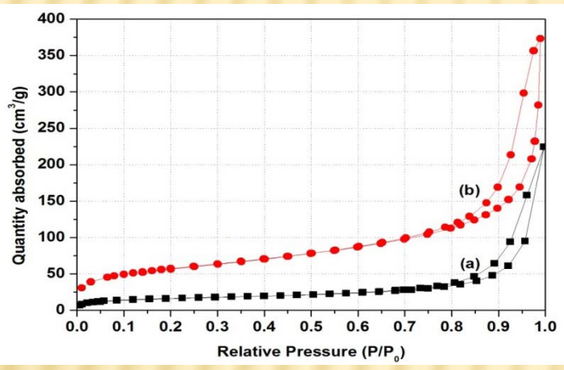

Fig. 3 Nitrogen adsorption–desorption isotherm: (a) SAG , (b) PAPGB

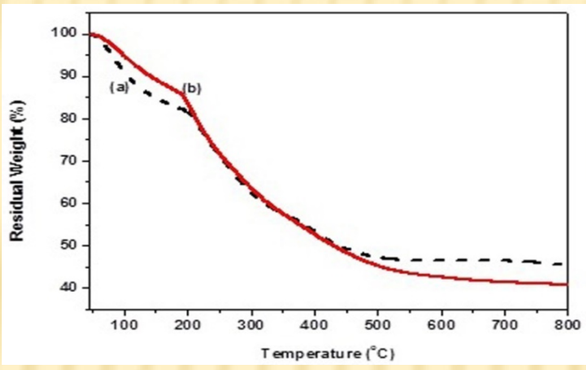

Fig. 4 TG curves of: (a) SAG and (b) PAPBG

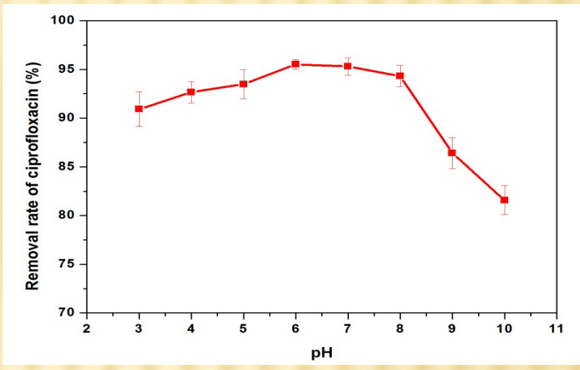

Fig. 5 The effect of initial pH of solutions on the remove rate of ciprofloxacin by PAPGB from water

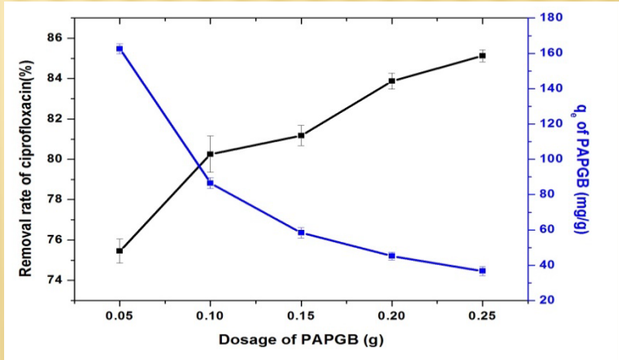

Fig. 6 The effect of SABG dosage on the remove rate of Nofloxacin from water

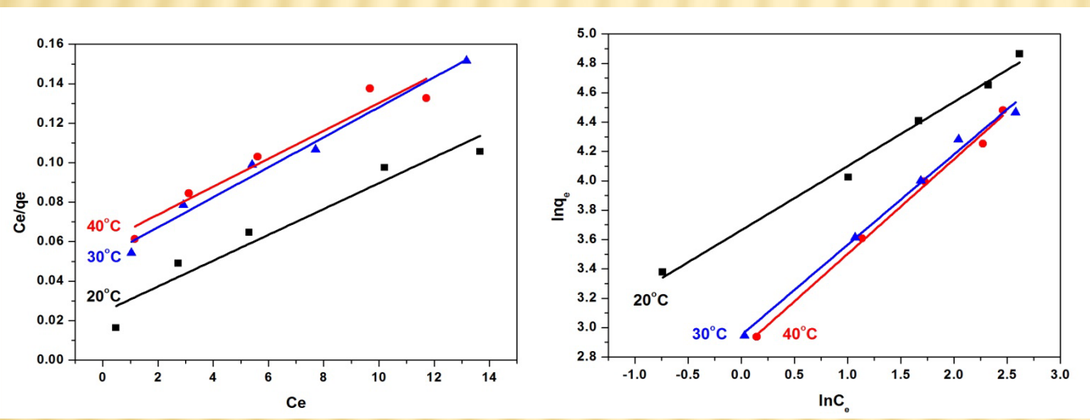

Fig. 7 Langmuir and Freundlich fitting curves

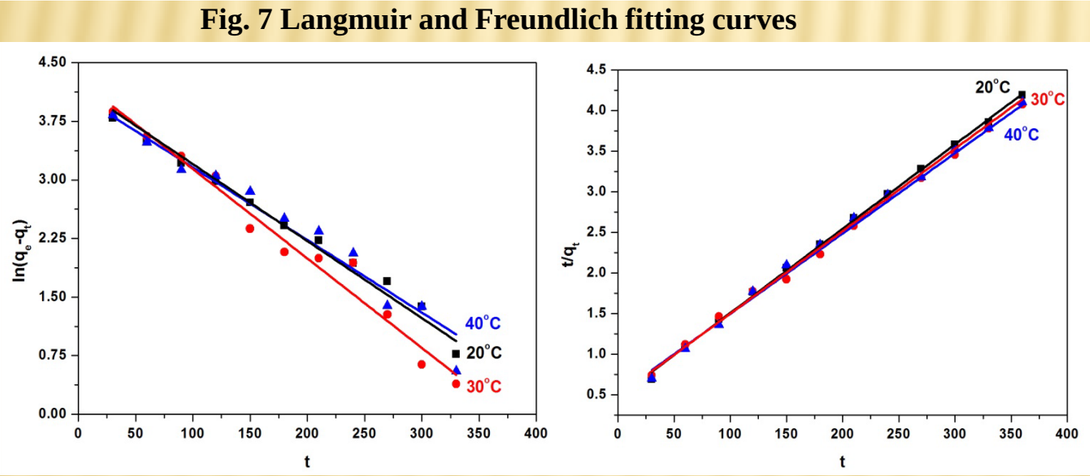

Fig. 8 Fitting curves of pseudo-first-order and pseudo-second-order kinetic model

Table 1 Langmuir and Freundlich constants for ciprofloxacin on PAPGB

Equation	Parameters	293K	303K	313K
Langmuir	K_L	0.269	0.119	0.146
	q_m/(mg/g)	153.84	140.85	131.58
	R^2	0.9418	0.9395	0.9807
Freundlich	K_F	39.021	17.402	19.087
	1/n	0.437	0.6454	0.6153
	R^2	0.9912	0.9951	0.9921

Table 2 Pseudo-first-order and pseudo-second-order kinetic model constants for for ciprofloxacin on PAPGB

Temperature	Pseudo-first-order			pseudo-second-order		
	K_1	q_e（mg/g）	R^2	K_2	q_e(mg/g)	R^2
293K	0.0101	67.762	0.9901	0.000240	95.238	0.9996
303K	0.0115	72.704	0.9752	0.000217	99.01	0.9986
313K	0.0091	57.323	0.9679	0.00241	96.154	0.999

- **After being modified with procyanidins, both of the surface and inner of gel beads were porous and the BET surface area increased from 56.1 to 198.6 m^2/g, which supplied sufficent adsorption sites for antibiotics.**
- **The results show that PAPGB has a porous structure, and the removal rate of ciprofloxacin is the highest when the pH value is at 6.**
- **The adsorption thermodynamics of ciprofloxacin on PAPGB's could be described by Freundlich adsorption model well. The adsorption kinetics can be described well by the pseudo-second-order model.**