FACULTY OF BIOSCIENCE ENGINEERING

Adsorption performance of fixed bed column for the removal of benzoic acid from hydroponic wastewater

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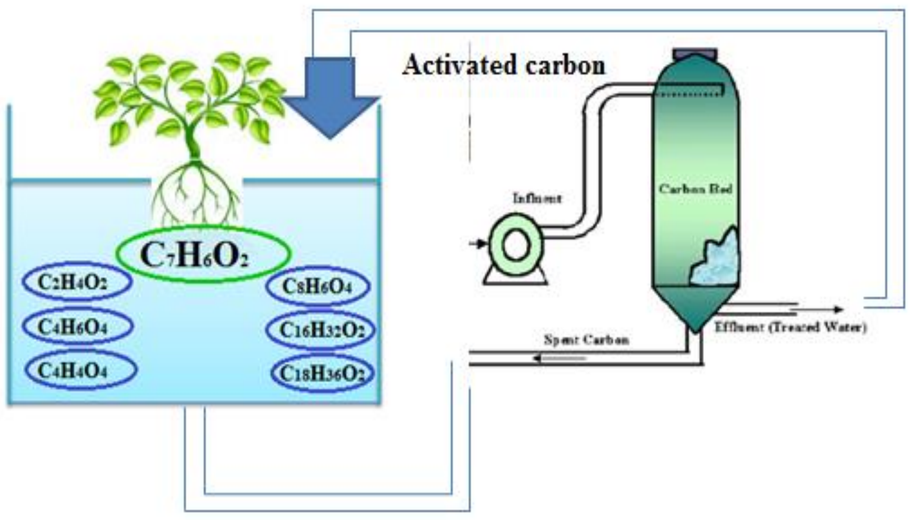
INTRODUCTION

Closed hydroponic cropping is a resource-efficient system for producing high-quality leaf vegetables. In this cropping system, plants can suffer from autotoxicity, due to the accumulation of root exudates in the nutrient solution. So far several methods has been found to be effective in removing or degradating the phytotoxic substances such as adsorption by activated carbon, electrodegradation of root exudates and TiO_2 photocatalysis.

In this research, the performance of adsorption of benzoic acid present in reused nutrient solution from hydroponic culture on granular activated carbon (GAC) was evaluated.

Material and Methods

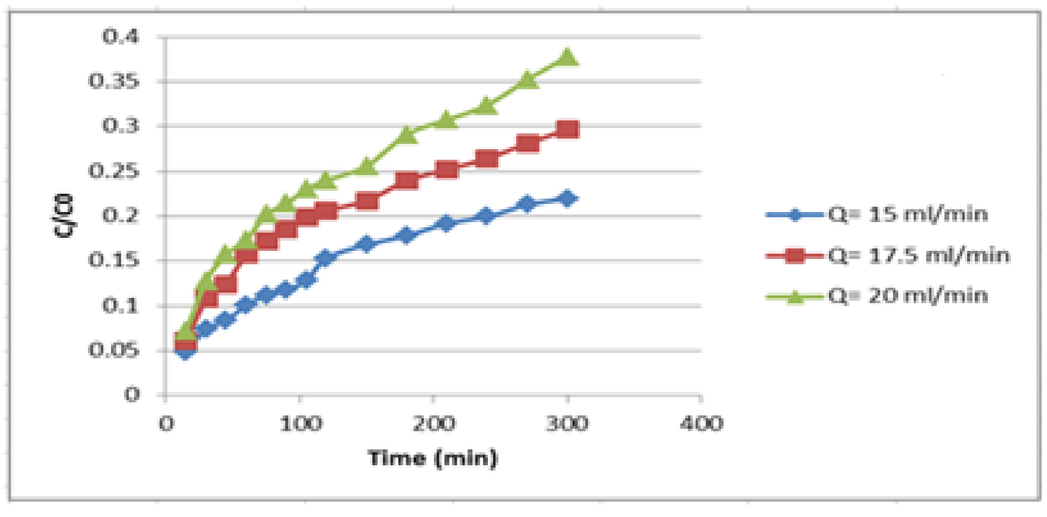


- Variation of Bed height (8,10,12 cm)
- Variation of flow rate (15,17,5,20 mL/min)
- Evaluation based on HPLC, COD and UV_{254} analysis

Results and Discussion

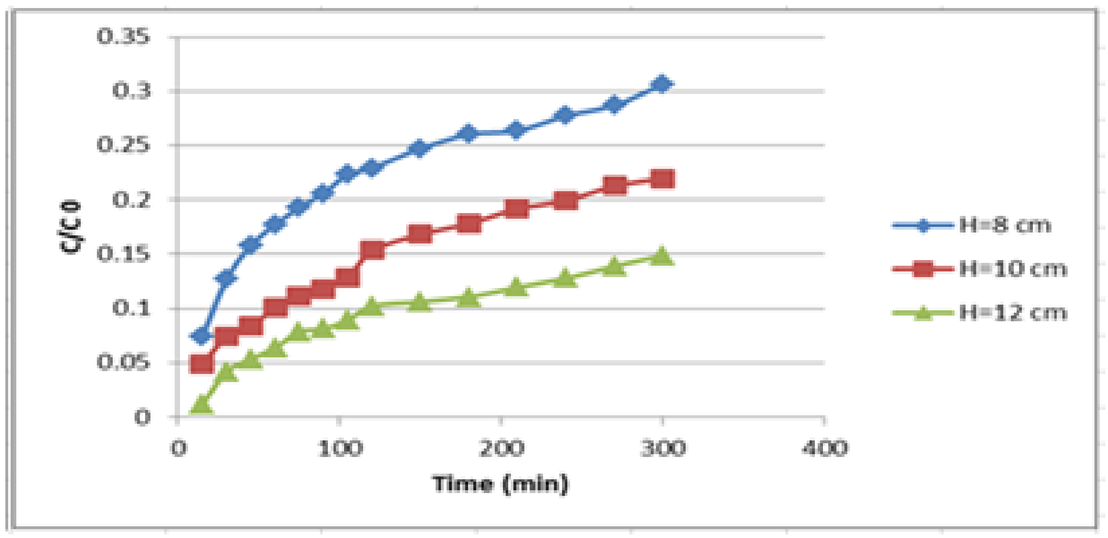
- **Effect of the flow rate:**

For higher flow rate, the curve was steeper resulting in a smaller removal of benzoic acid. It means that when the contact time between adsorbate and adsorbent is minimized leading to early breakthrough.



- **Effect of the bed height:**

An increase in bed height increased the treated volume due to high contact time. The breakthrough time would be more for the higher bed height as more binding sites were available for sorption.



- **COD, UV_{254} and benzoic acid removal (After 30 min)**

Treatment condition (mg/L),(cm),(mL/min)	COD removal (%)	UV_{254} removal (%)	Benzoic acid removal (%)
50,10,20	41	23	41
50,10,17.5	68	28	70
50,10,15	69	31	75
50,12,15	79	53	85
50,8,15	65	43	66

- **The Yoon–Nelson model:**

The adsorption kinetics was analyzed using Yoon-Nelson kinetic model. The time required for 50% breakthrough was estimated for different experimental conditions. The time required for 50% breakthrough was found to decrease with increase in flow rate.

Initial concentration (mg/L)	Bed height (cm)	Flow rate (mL/min)	K_{YN} (L/min)	$t_{50\%}$ (min)	R^2
50	10	20	0.0047	385.8	0.94
50	10	17.5	0.0040	489.9	0.89
50	10	15	0.0045	543.7	0.91
50	12	15	0.0043	678.5	0.86
50	8	15	0.0034	511.6	0.86

Conclusions

The results from dynamic studies showed that the best fitted result (R^2= 0.94) was achieved for an initial concentration of 50 mg/l, bed height of 10 cm and flow rate of 20 ml/min. In this conditions 50% breakthrough was estimated 386 min. The evaluated parameters from breakthrough curve were used to design a packed column using the scale up approach.

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