Nutrients Removal from Eutrophic Water Using Water Hyacinth [Eichhronia crassipes (Mart.) Solms] Magnesium Modified Biochar Via Adsorption

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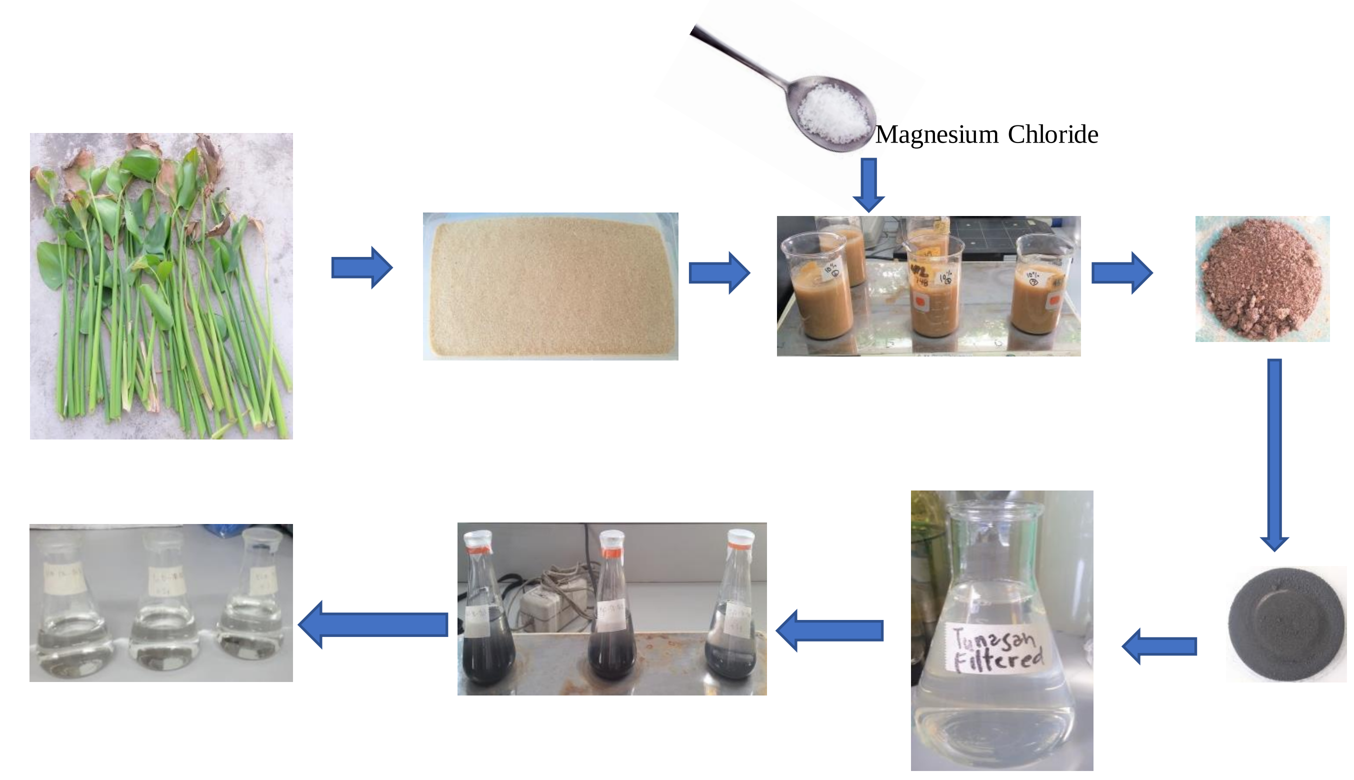
ABSTRACT

Water hyacinth [*Eichhornia crassipes* (Mart.) Solms] surge has been a recurring problem in the Laguna lake caused by eutrophication. The utilization of these abundant aquatic plants into a useful products and addressing the nutrient pollution in the Lake was a major challenge. In this study, water hyacinth from Laguna Lake was utilized as feedstock for the production of magnesium modified biochar for the removal of phosphate and ammonia from simulated and actual river water sample. The effect of initial phosphate concentration, adsorbent dose, pH and % Mg concentration on phosphate and ammonia removal were evaluated using 2^k factorial design. Results showed that the initial phosphate concentration and adsorbent dose have positive significant effect while pH and % Mg concentration have negative effects on the phosphate removal. Initial phosphate concentration had positive significant effect while pH had negative effect on ammonia removal during batch adsorption. The efficiency 5%Mg-modified biochar was compared to pristine water hyacinth biochar using the actual river water sample from one of Laguna Lake's tributary river while employing a 0.005g of adsorbent material/mL of sample. Results showed that 99.432% phosphate removal and 5.590% ammonia removal were achieved using 5%Mg-modified biochar while 17.131% phosphate removal and 33.188% ammonia removal was obtained using pristine water hyacinth biochar. This proves that the addition of magnesium in the biochar improves the phosphorus removal efficiency of water hyacinth biochar.

INTRODUCTION



METHODOLOGY

The study followed a 4-stage process . Stage I was the biomass preparation of *Eichhornia crassipes (Mart.) Solms* (EC). Stage II included the preparation of Magnesium oxide *Eichhornia crassipes (Mart.) Solms* biochar (MgO-ECB) adsorbent material. The Stage III was the batch adsorption study using simulated river water while stage IV was the test of actual river water sample.

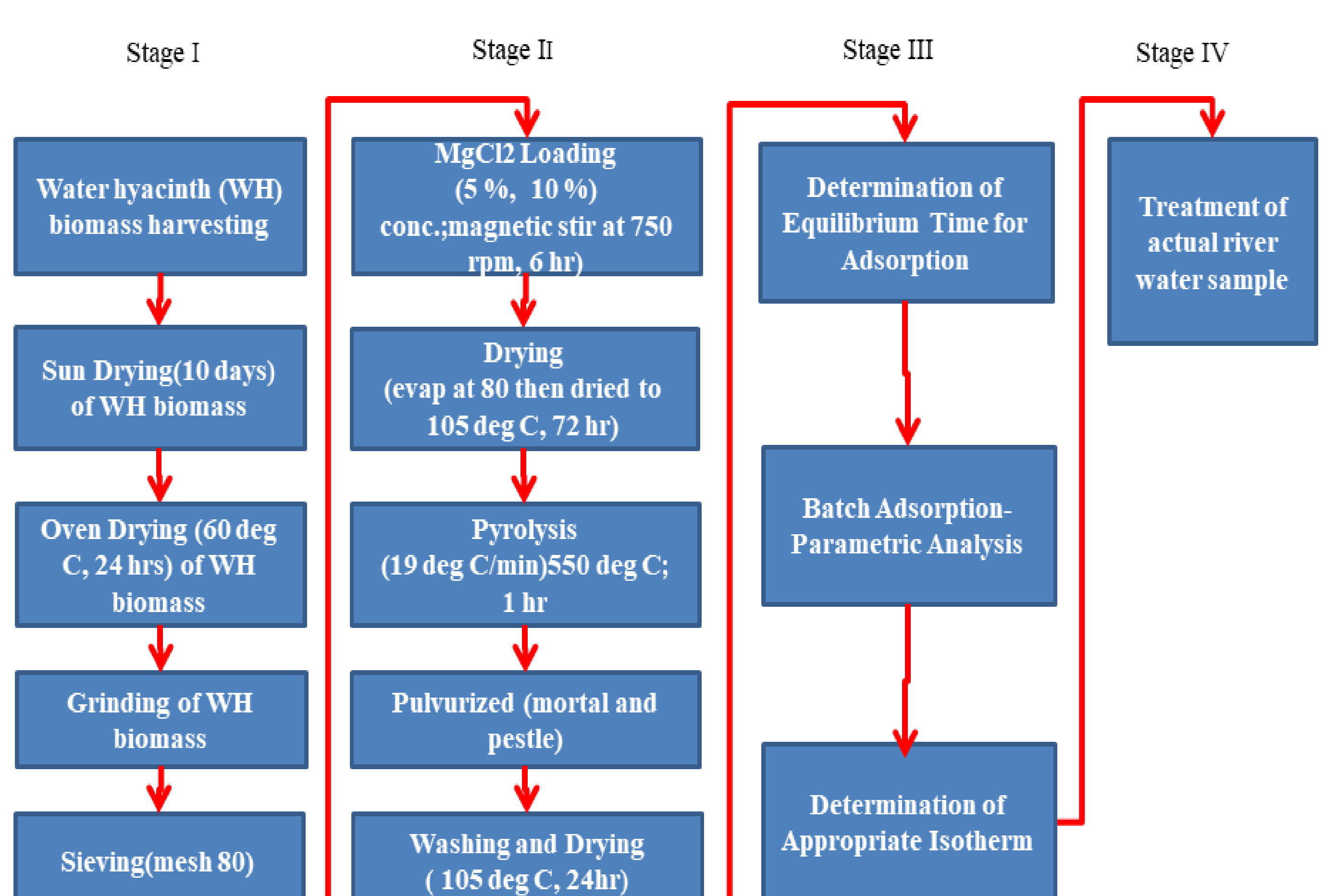


Figure 1. Experimental flow of the proposed MgO-ECB for the removal of nutrients from simulated and actual river water

CONCLUSIONS

The comparison of EC biochar and Mg modified EC biochar using an actual river water sample proves that the use of magnesium modified EC biochar improves significantly the adsorption of phosphate while ammonia was significantly removed using pristine water hyacinth biochar.

RESULTS AND DISCUSSIONS

Table 1. Analysis of Variance table for % phosphate removal response of the 2^k factorial experiment

SOURCES	SUM OF SQUARES	DF	MEAN SQUARES	F-VALUE	p-VALUE	REMARKS
Model	8213.3328	9	912.5925	171.8675	<0.0001	Significant
A-Initial Phosphate Conc.	2886.4083	1	2886.4083	543.5941	<0.0001	Significant
B-Ph	1150.4044	1	1150.4044	216.6544	<0.0001	Significant
C-Adsorbent dose	1833.1591	1	1833.1591	345.2368	<0.0001	Significant
D-% Mg conc.	1073.2386	1	1073.2386	202.1218	<0.0001	Significant
AB	542.7790	1	542.7790	102.2210	<0.0001	Significant
AC	355.9215	1	355.9215	67.0303	<0.0001	Significant
AD	184.0621	1	184.0621	34.6642	<0.0001	Significant
BC	25.6197	1	25.6197	4.8249	0.0372	Significant
CD	161.7401	1	161.7401	30.4603	<0.0001	Significant
Curvature	1466.7206	1	1466.7206	276.2259	<0.0001	Significant
Residual	138.0563	26	5.3099			
Lack of Fit	24.2792	6	4.0465	0.7113	0.6446	Not significant
Pure Error	113.7771	20	5.6889			
Cor Total	9818.1098	36				
POST ANOVA						
R-squared						0.9835
Adjusted R-squared						0.9777
Predicted R-squared						0.9663

Table 2. Analysis of Variance table for % ammonium removal response of the 2^k factorial experiment

SOURCES	SUM OF SQUARES	DF	MEAN SQUARES	F-VALUE	p-VALUE	REMARKS
Model	1113.5461	7	159.0780	6.84062	<0.0001	Significant
A-Initial Phosphate Conc.	156.7944	1	156.7944	6.74242	0.0148	Significant
B-Ph	616.6144	1	616.6144	26.51543	<0.0001	Significant
C-Adsorbent dose	7.1444	1	7.1444	0.30722	0.5838	Not significant
AB	161.9068	1	161.9068	6.96226	0.0134	Significant
AC	12.5332	1	12.5332	0.53895	0.4690	Not significant
BC	56.1907	1	56.1907	2.41629	0.1313	Not significant
ABC	102.3622	1	102.3622	4.40174	0.0451	Significant
Curvature	568.8273	1	568.8273	24.46051	<0.0001	Significant
Residual	651.1380	28	23.2549			
Lack of Fit	208.8466	8	26.1058	1.1805	0.3581	Not significant
Pure Error	442.2914	20	22.1146			
Cor Total	2333.5113	36				
POST ANOVA						
R-squared						0.6310
Adjusted R-squared						0.5388
Predicted R-squared						0.3485

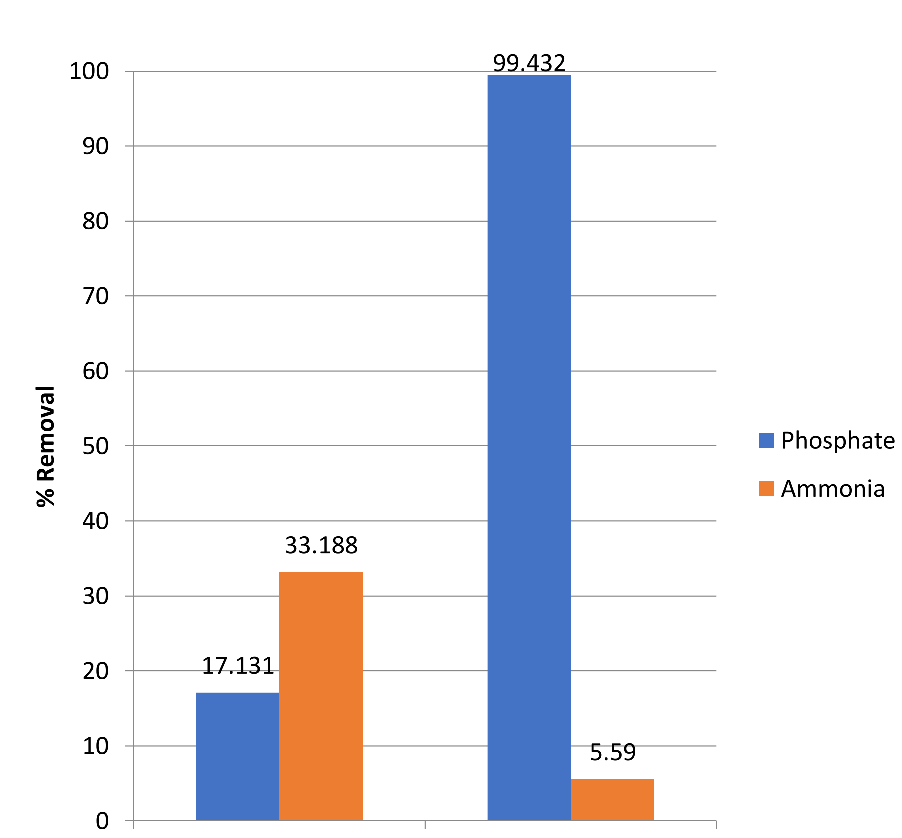


Figure 2. Comparison of ECB and MgO-ECB on phosphate and ammonia removal

The comparison of pristine EC biochar and 5% Mg biochar on the removal of phosphate and ammonia revealed that 99.43% phosphate removal was achieved using magnesium modified biochar compared to 17.13% on pristine EC biochar. On the other hand 5.59% ammonia removal was found using magnesium modified biochar compared to 33.19% on pristine EC biochar.