Bamboo charcoal as a lactic acid bacteria carrier for phosphate removal

EM 10

Takahiko NAKAMURA and Narong TOUCH

Department of Bioproduction and Environment Engineering, Faculty of Regional Environment Science, Tokyo University of Agriculture, Tokyo, Japan

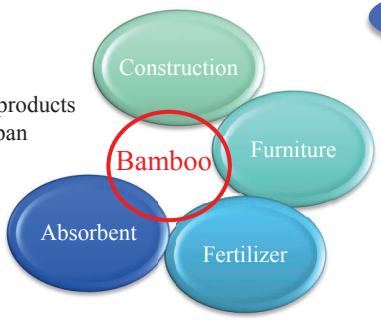
Background / Aim

Background :

A decrease in the demand for bamboo products has led to abandoned bamboo forests in Japan

⇩ One of the countermeasures

Bamboo biochar (BC) has been used as an absorbent for contaminant removal (Liu et al., 2012; Mohamed et al., 2015)



⇩

BC for phosphate removal (our proposal)

- Negative charges at the surface (Yigit and Mazlum, 2007)
- Release of phosphate (Jung et al., 2015)
  - Modify the biochar surface ➡ Microbial attachment

Aim of this study :

- Examines the potential of BC as a microbial carrier for lactic acid bacteria (LAB) and its phosphate removal capabilities.
- Focuses on deciphering the effects of the pretreatment of BC, oxygen supply (aeration), and solution pH on phosphate removal.

Materials / Methods

Materials:

Bamboo charcoal (BC): readily available product

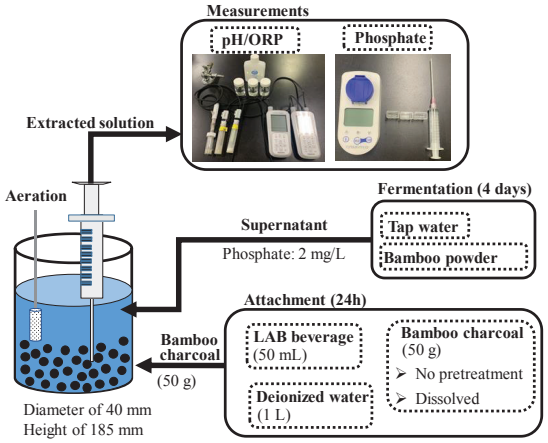
- Without pretreatment
- Dissolved in tap water (50 g of bamboo charcoal in 500 mL of water): the solution was mixed until no further release of phosphate was observed.

Bamboo powder: readily available product

The bamboo powder was fermented for four days, and then the supernatant was extracted and used in the experiments.

Procedures:

First, approximately 50 g of BC was placed in a LAB solution for 24 h to attach LAB to the BC, and then the BC was placed in the bamboo supernatant to assess the phosphate removal. The LAB solution was produced by mixing 50 mL of LAB beverage with 1 L of deionized water. The experiments were conducted with and without aeration to examine the effects of oxygen on LAB for phosphate removal.

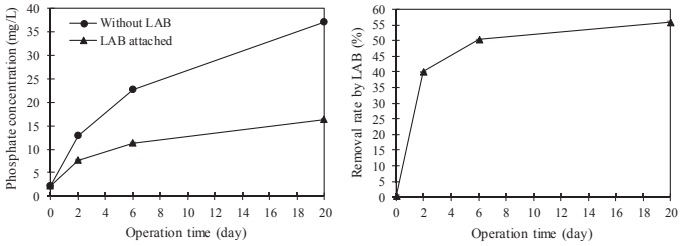


Measurements:

- pH and redox potential (ORP): A D-50 pH/ORP meter (Horiba, Japan) was inserted directly into the solution.
- The solution in the bamboo charcoal layer was extracted using a syringe, and the phosphate concentration in the extracted solution was measured using a digital Packtest (Kyoritsu, DPM2-PO4-D)

Results / Discussion

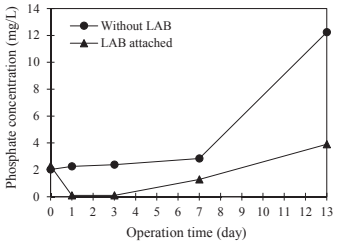
Bamboo charcoal (no pretreatment) without aeration



- Phosphate increased temporally ➡ Release of phosphate from BC
- Phosphate was smaller when LAB-attached BC was used

Dissolved bamboo charcoal with aeration

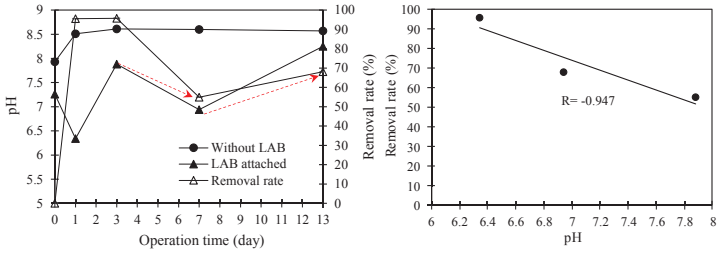
- A decrease in the phosphate for LAB attached
  ➡ Phosphate removal by LAB
- An increase in the phosphate after day 3
  ➡ pH and ORP may also had an influence on the phosphate removal



Even though the LAB is attached to the BC, they are effective at removing phosphate from the aqueous solution. LAB-attached BC can be an absorbent for phosphate removal.

Effects of ORP and pH on Phosphate Removal

- ORP was maintained at 275 mV when using BC without LAB, and 245 mV with LAB-attached BC at day 13
  ➡ ORP has no effect on phosphate removal if aeration is provided



- The dissolution of the bamboo charcoal increased the solution pH
- pH was lower with LAB-attached BC ➡ LAB released lactic acid
- The removal rate and pH were strongly correlated (R=-0.947)

The solution pH should be maintained in an acidic state (lower than 6.5) to achieve a higher removal rate.

Summary

Without aeration, a negative redox potential (ORP) was observed, indicating a large consumption of oxygen by LAB. Thus, aeration is needed when using LAB. Even with dissolved bamboo charcoal, the release of phosphate was observed, indicating that bamboo charcoal alone is not an effective absorbent for phosphate removal. When LAB-attached bamboo charcoal was used, a decrease in the phosphate concentration was observed. This suggests that LAB-attached bamboo charcoal is an effective absorbent for phosphate removal. With aeration, the ORP was maintained in an oxidizing state, which had no impact on phosphate removal. However, the removal rate was found to depend on pH, where the removal rate decreased with an increase in the solution pH. Therefore, the phosphate removal should be conducted under acidic conditions (pH lower than 6.5) to obtain a higher removal rate.

References

Liu, Y., Gan, L., et al. 2012. J. Hazard. Mater., 229, 419- 425.
Mohamed, I., Zhang, G., et al. 2015. Ecol. Eng., 84, 67-76.
Jung, K.W., Hwang, M.J., et al. 2015. Int. J. Environ. Sci. Technol., 12, 3363-3372.
Yigit, N.O., and Mazlum, S. 2007. Environ. Technol. Lett., 28, 83-93.

Contact

1-1-1 Sakuragaoka Setagaya-Ku, Tokyo156-8502, Japan
Faculty of Regional Environment Science, Tokyo University of Agriculture
E-mail: nt207118@nodai.ac.jp
ntaka@nodai.ac.jp