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Urine Addition as a Nutrient Source for Biological Wood Oxidation at 40 °C

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Abstract:

Biological wood oxidation (BWO) offers great potential for sustainable heat generation, and our previous work has shown that nutrient addition (especially nitrogen; N) is necessary for fast BWO. To reduce the cost and environmental impacts of chemical nutrients, human urine was chosen as a source of nutrient in this study. We investigated the factors including urine dilution ratio, the types of urine (fresh urine and synthetic urine), and urine readdition, by studying their effects on oxygen consumption and dry weight loss of the wood. After 42-day incubation, synthetic urine with five times dilution (corresponding to 1.2 ‰ N dry basis of wood) showed the best performance; it improved the oxygen consumption by 3.8 times and wood weight loss by 3.3 times than that without urine addition (analysis of variance (ANOVA), $P < 0.05$). At the same N level, fresh urine addition was able to enhance the BWO more efficiently than synthetic urine addition, further improving the oxygen consumption by 64 % and weight loss by 47 % (ANOVA, $P < 0.05$). During the BWO process, the decrease in wood degradation rate was possibly due to the decrease in nutrient availability. With the readdition of synthetic urine, the total oxygen consumption and wight loss after 100-day incubation increased by more than 40 % compared with the group without readdition. However, readdition of only N-containing components did not increase the BWO, showing that elements (other than N) were important. To this end, we demonstrated the feasibility of human urine as a waste-based nutrient source for fast BWO and the possibility of long-term BWO operation via urine readdition.

Keywords: Biological wood oxidation, synthetic urine, fresh urine, oxygen consumption, weight loss, heat production