Effects of Fish Waste Addition on Anaerobic Co-digestion of Sludge with Food Waste

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In South Korea, the total production of fish was about 2.3 million tons in 2019, and domestic consumption of fishery products was 65.9 kg/person/year (KOSTAT,2019). Fish waste (FW) is considered a potential substrate for anaerobic digestion (AD) as it contains high proteins and lipids. However, high proteins and lipids can cause instability of the AD system because of ammonia and LCFA accumulations. There are approximately 70 full-scale anaerobic digesters in South Korea and more to be constructed (Tongco et al., 2017). The addition of FW to the existing stable anaerobic digesters is challenging as it may cause shock to the system, which leads to process failure. Therefore, optimum FW input amount that not only ensures the stability of the process but also improves biogas production is important for full-scale operation. In this study, we aim to input FW into the stable anaerobic co-digestion of sludge with food waste (ratio 80:20). Therefore, the experiments were firstly conducted under mesophilic condition (37 ºC) in batch mode with 3.3% v/v of sludge and food waste mixture as the primary substrate to mimic the normal operation of full-scale AD. The effects of the addition of 1, 5, 10, 15, and 20% v/v of FW as the secondary substrate were observed. FW solution (362.7 gCOD/L), consisting of fish waste, squid gut, and other leftovers, was used to represent fish restaurant waste. The results showed that 5% v/v of FW addition increased methane production by 31% (494.4 mL $CH_4/gCOD_{added}$) compared to control (378.6 mL $CH_4/gCOD_{added}$), while 1% v/v FW addition did not enhance methane production (342.7 mL $CH_4/gCOD_{added}$). However, methane production reduced 36.6, 55.7 and 94.4% when 10, 15, and 20% v/v of FW were added (240.1, 167.6, and 21.3 mL $CH_4/gCOD_{added}$, respectively) (Fig.1). When 5% v/v FW was added, a slight pH drop to 7.27 was observed but it recovered after 2days of operation as total volatile fatty acids (TVFA) concentration decreased. pH of 10, 15, and 20%v/v of FW addition dropped below 7.0. However, pH of 10 and 15% of FW addition recovered after 5 and 11 days of operation after TVFA concentration decreased. On the other hand, pH of 20% v/v FW addition dropped to 6.35, and TVFA concentration accumulated to 26.3 g/L, which led to the failure of the process. Further study on semi-continuous mode was conducted to get more insights on how the system reacts to the sequentially feeding of FW that will be useful information for full-scale operation. Based on the batch mode results, 5% v/v FW was suddenly added as the unexpected substrate to the stable reactor operated with HRT 30d of sludge and food waste mixture. FW was again added when the system showed a similar performance to control. The result showed that 5% FW did not cause the inhibition to the stable system and improved methane production (Fig.2). These results suggested that 5% v/v FW can be periodically co-digested with sludge and food waste without causing the failure of the AD system.

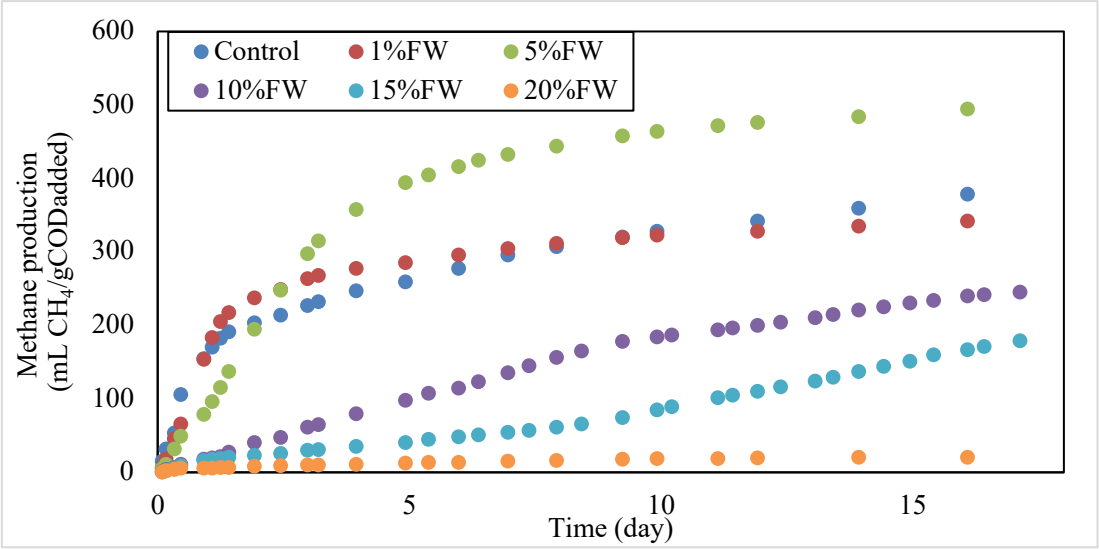

Fig.1 Cumulative methane production of 1, 5, 10, 15, and 20% v/v of fish waste and control in batch mode

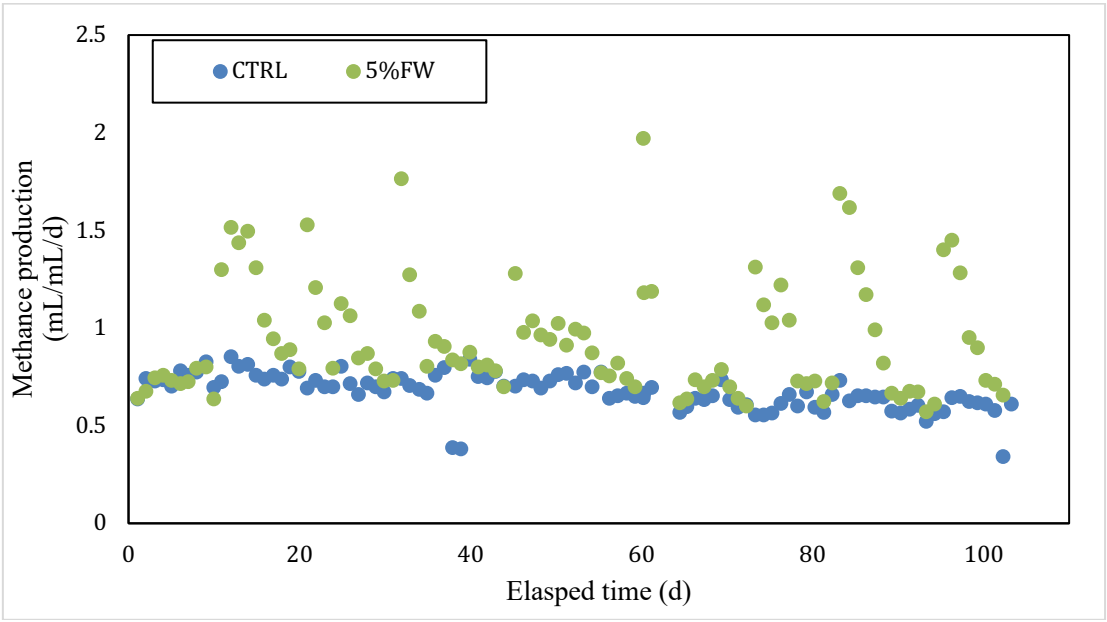

Fig.2 Daily methane production of 5% v/v of fish waste and control in semi-continuous mode

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Acknowledgments

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