to be co-digestion (254.02 mL CH_4/g VS) > food waste (247.04 mL CH_4/g VS) > feces (220.01 mL CH_4/g VS).

Meanwhile, food waste was shown high methane production from single substrate among the other, co-digestion was shown the highest methane production potential from BMP test. It is suggested that co-digestion offset the lack of nutrients and dilute harmful substances and promotes methane gas production.

3.2 kinetic constants

Table 2 and Fig. 2 showed the experimental data, simulation results of kinetic constants. First-order kinetics can only be applied when the rate limiting factor is the surface of the particulate substrate, and bioavailability or biodegradability related phenomena do not interfere (Sanders 2003).

$$\frac{\mathrm{dS}}{\mathrm{dt}} = -kS \tag{2}$$

Where, k is kinetic constant, S is substrate concentration.

Eq (2) integral expresses the expression Eq (3).

$$\ln\left(\frac{S}{S_0}\right) = -kt \tag{3}$$

The concentration of biodegradable VS inside the reactor generated directly biogas was related as follows Eq (4).

$$\left(\frac{S}{S_0}\right) = \left(\frac{B_0 - B}{B_0}\right) \tag{4}$$

The combination of the above Eq (2) and Eq (4);

$$\left(\frac{B_0 - B}{B_0}\right) = \exp\left(-kt\right) \tag{5}$$

where, B_0 is the maximum methane production, B is the cumulative methane production

Table 2 indicated that the first order kinetic constants followed the first order equation well. The correlation coefficient was feces (0.9694), food waste (0.9638), and co-digestion (0.9503).

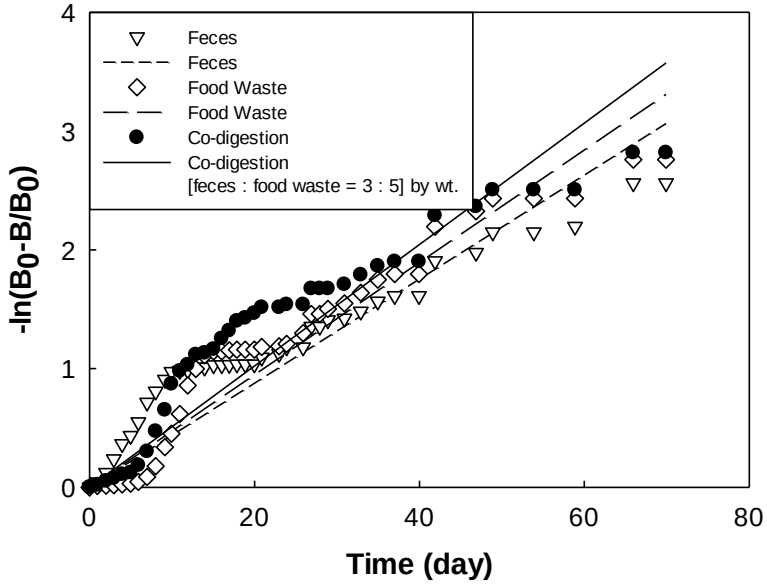

Fig. 2 kinetic constant (k) according to three different substrates

Table 2 summarizes the ultimate methane production and kinetic coefficients for three different substrates. A range of values of the first-order rate coefficient can be seen for the correlation coefficient. This range of values can be explained by different experimental conditions.

Table 2 kinetic constant (k) and ultimate methane production

	Correlation coefficient	k (d^{-1})	Ultimate methane production (mL CH_4/g VS)
Feces	0.9694	0.0438	220.01
Food waste	0.9638	0.0474	247.04
Co-digestion	0.9503	0.0511	254.02

4. Conclusion

This study demonstrated that anaerobic co-digestion of feces and food waste proved to be a potential substrate for biogas production. Anaerobic co-digestion showed higher methane production than feces and food waste in single substrate conditions. The highest methane production and rate found at co-digestion compare to single digestion. The first order kinetics fitted experimental value well. The first order kinetics had a high correlation for simulating cumulative methane production and higher kinetics constants than the others. Thus, co-digestion is expected to be more favorable for methane gas production.

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