Supporting information

Dual-biocatalytic L-lactate production from gaseous CO_2 and acetaldehyde

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1. The determination of the amount of L-lactate using ion chromatography

The concentration of L-lactate was determined using ion chromatography system (Metrohm, Eco IC; electrical conductivity detector) with an ion exclusion column (Metrosep Organic Acids 250/7.8 Metrohm; column size: 7.8 × 250 mm; composed of 9 μm polystyrene-divinylbenzene copolymer with sulfonic acid groups). The 1.0 mM perchloric acid and 50 mM lithium chloride in aqueous solution were used as an eluent and a regenerant, respectively. Flow rate of eluent solution was adjusted to be 0.5 mL min^{-1}. The retention time for L-lactate was detected at 12.0-13.2 min. The electrical conductivity changes in the various L-lactate concentrations (0 – 100 μM) during the ion chromatograph analysis were shown in **Figure S1(a)**. **Figure S1(b)** shows the relationship between the detection peak area and the L-lactate concentration using ion chromatograph.

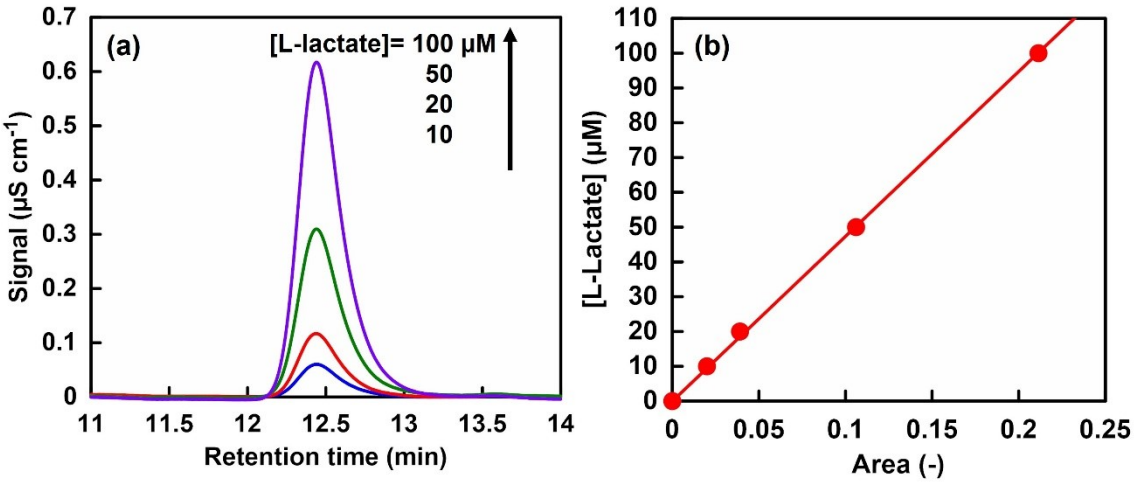

Figure S1(a). A chart of ion chromatogram of L-lactate (0-100 μM) in 200 mM phosphate buffer (pH 7.0). **(b)**: Relationship between the detection peak area and the L-lactate concentration.

As shown in **Figure S1(b)**, the detected peak area and the L-lactate concentration showed a good linear relationship (correlation coefficient: r^2=0.99) as following equation [Eq. (S1)].

$$[\text{L-lactate}]\ (\mu M) = 4.74 \times 10^2 \times \text{Area} \qquad \text{(S1)}$$

2. The determination of the amount of acetoin using UV-vis absorption spectroscopy

Acetoin (0 – 500 μM) was added to 0.5% creatine and 5% 1-naphthol-4 M NaOH, and the mixture was incubated at 30.5 ºC for 10 min. The reaction solution was then diluted four times with ultrapure water, and the UV-vis absorption spectrum was measured to estimate the concentration from the absorbance at 525 nm based on the derivatized acetoin. **Figure S2(a)** shows the UV-vis absorption spectral change in the various acetoin concentrations. **Figure S2(b)** shows the relationship between the absorbance at 525 nm and the acetoin concentration using UV-vis absorption spectrometer (SHIMADZU, MultiSpec-1500).

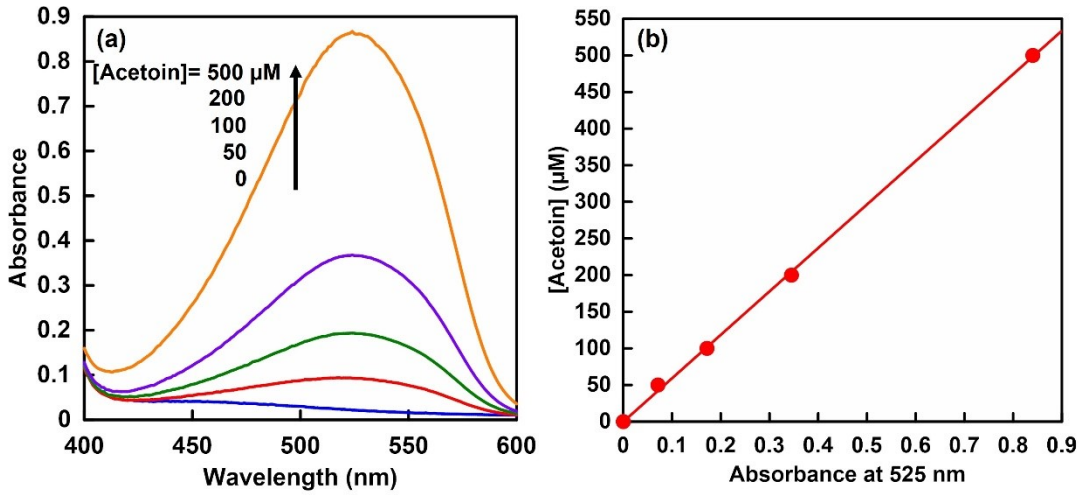

Figure S2(a). UV-vis absorption spectral change in the various acetoin concentrations (0 – 500 μM). **(b)**: Relationship between the absorbance at 525 nm and the acetoin concentrations.

As shown in **Figure S2(b)**, the detected peak area and the L-lactate concentration showed a good linear relationship (correlation coefficient: r^2=0.99) as following equation [Eq. (S2)].

$$[\text{Acetoin}]\ (\mu\text{M}) = 5.93 \times 10^2 \times \text{Absorbance} \qquad \text{(S2)}$$