

Study of the electrical response of culture media during bacterial growth on a paper-based device

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■ Introduction

Food contamination poses severe health risks, with worldwide more than 300,000 deaths each year and over 500 million food-borne diseases [1]. One of the most common food-related diseases is diarrhea threatening especially infants and elderly people. For example, in northeast Thailand where the people consume raw foods acute cases of diarrhea were reported [2]. To control comestible goods strict hygiene inspection processes are required, however they take long time and still require specialists and complex equipment. Therefore, we aim to improve the hygiene inspection process by developing a device which is easy to use, low cost, and can efficiently detect bacteria contamination in the foods and biomaterial. In this work we demonstrate that it is possible to correlate the different grow phases of the bacteria with the electrical response, here the surface potential, by measuring the I - V characteristics of the contaminated substrate.

■ Experimental

1. Sample preparation

The grid of electrodes were designed and printed on photo paper (High grade 1440 dpi) with black toner by using a commercial laser printer. Then the gold leaf (24K) was put on the printed areas and covered with frieze and pressed with 20 N at 170 °C for 120 s.

The LB agar gel sheet (65 mm x 35 mm x 3 mm) was prepared [3] and soaked in water for 30 min to equilibrate. Then, the gel sheet was put on the gold electrode.

2. Measurement of the I - V characteristics

The 200 μ L of fecal bacterial suspension was dropped on the surface of the gel. Then the gel sheet was covered with a clean plastic box to prevent contamination (Fig. 1) and the I - V characteristic was measured every 4 h under the condition: applied electric field -1.0 V to 1.0 V with 0.1 V step size (Keithley 4200-SCS).

■ Result and discussion

The agar gel shows a non-ohmic behavior in most of the measured voltage range. LB agar gel forms an electric double layer at the electrode-electrolyte interface. Thus,

the surface potential was determined as $-V_0$ at $I(V_0)=0$. Here, we focus on the relation between the electric surface potential and the bacterial growth. The bacterial digestive products might affect the electrochemical properties of the gel. We found that the surface potential can be correlated with the bacterial growth phases. It increases during the exponential growth phase, remains roughly constant in the stationary phase, and eventually decreases in the death phase.

■ References

- [1] WHO, *Food safety*, Fact sheet N° 399, <http://www.who.int/mediacentre/factsheets/fs399/en/>
- [2] A. Vongkamma and S. Hinoi, *Acute diarrhea report in 2015*, Department of Disease Control Ministry of Public Health, www.boe.moph.go.th
- [3] T. Srimongkon, T. Ishida, K. Igarashi, and T. Enomae, *Development of a bacterial culture system using a paper platform to accommodate media and an ink-jet printing to dispense bacteria*, The American Journal of Biochemistry and Biotechnology, 2014, vol.10(1), pp. 81-87.



Figure 1. The LB agar gel sheet on electrodes for I - V characteristic curve was tested.

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(3) surface potential

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