DEVELOPMENT OF POINT OF CARE TESTING DEVICE FOR USE IN AGRICULTURAL FIELDS

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Point of care testing (POCT) devices are expected for daily healthcare, bedside monitoring and so on. They also expected for agricultural fields such as health monitoring of livestock. For example monitoring of progesterone concentration in blood or milk of cow is important to detect estrus cycle, pregnancy, matstitis, and so on [1]. The detections contribute to improve the production efficiency of cattle. In this field, immunosensor, which is inexpensive, available in the fields, easy to use even by farmers and quantitative capability, is required. Therefore, we developed POCT device by combining immunochromatography and electrochemical method, and measured progesterone with the POCT device.

Figure 1 shows photograph (Fig. 1a) and schematic of cross-sectional view (Fig. 1b) of developed POCT device [2]. The device consists of nitrocellulose membrane, absorbent pad, electrochemical detector, and two polymethylmethaclylate (PMMA) plates. Nitrocellulose membrane is attached to the electrochemical detector and they are sandwiched with two PMMA plates. Figure 1c shows schematic of electrochemical detector. Gold working electrode (WE), Ag/AgCl reference electrode (RE), and gold counter electrode (CE) are displaced in order from upstream with 0.5 mm intervals. WE and RE has 1 mm width and CE has 2 mm width.

Figure 2 shows experimental procedure to measure progesterone. Progesterone was measured by competitive immunoassay. At first, progesterone and biotin labeled progesterone were injected to nitrocellulose membrane. Unlabeled progesterone competed with labeled progesterone to bind to antibody. Unbound progesterone were washed away by next washing step. After that, streptavidin labeled alkaline phosphatase (ALP) was injected. The streptavidin bound to biotin and formed conjugate. Unbound ALP was also washed away by second washing step. Finally, *p*-aminophenyl phosphate (*p*APP) was injected and reacted with ALP and produced *p*-amino phenol (*p*AP). The amount of *p*AP was measured by electrochemical detector. Chronoamperometry with applied potential was 0.2 V vs Ag/AgCl was started when the *p*APP was injected to the membrane. Figure 3a shows amperometric signal of each concentration of progesterone. Each signal shows peak signal. It is considered that the peak signal obtained when *p*AP reached to the detector. The height of peak oxidation current was correlated with concentraton of progesterone (Fig. 3b). This results suggests that our device can measure the concentration of progesterone.

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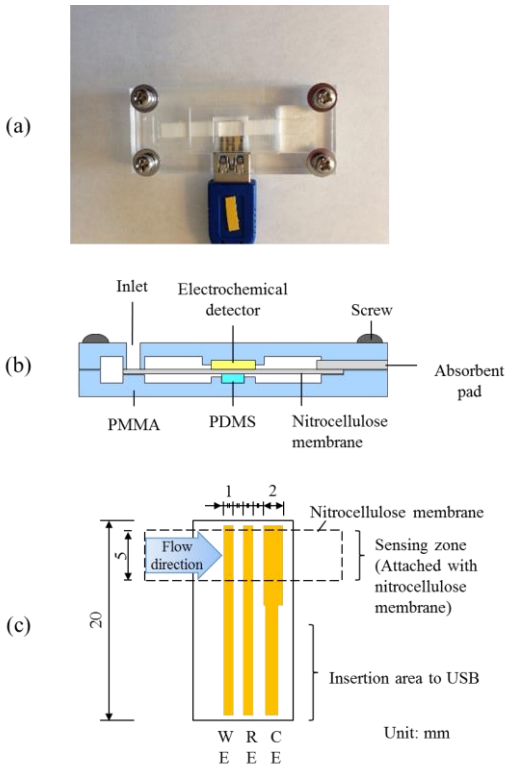

Fig. 1 Photograph (a) and schematic of cross-sectional view (b) of electrochemical immunochromatography platform and schematic of electrochemical detector (c).

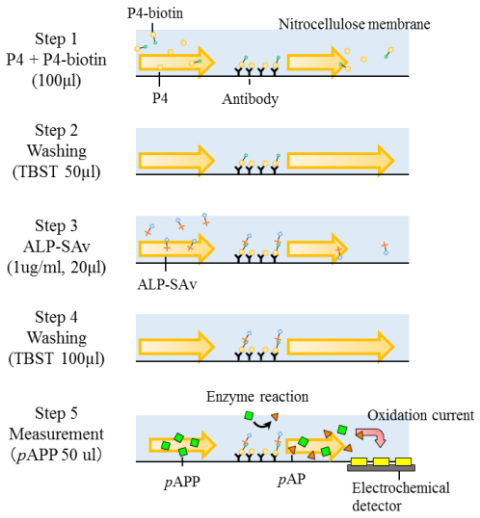

Fig. 2 Schematic of measurement protocol.

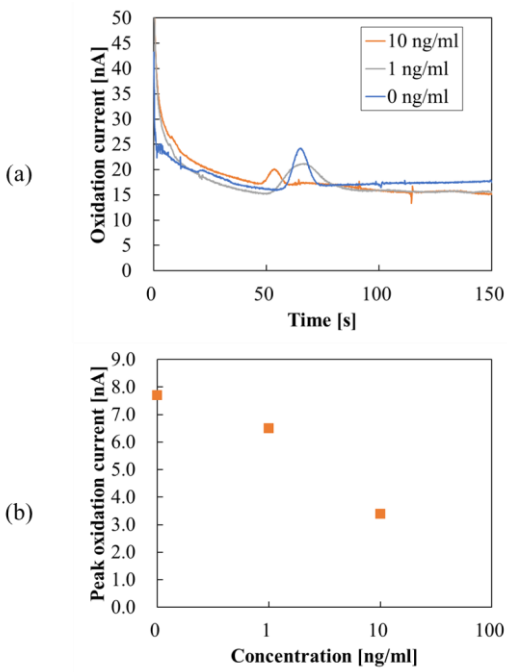

Fig. 3 Chronoamperogram measure by electrochemical immunochromatography (a) and its height of peak signal (b) at each concentration of progesterone.

REFERENCES:

[1] D. J. Matsas, R. L. Nebel and K. D. Pelzer, "Evaluation of an on-arm blood progesterone test for predicting the day of parturition in cattle," Theriogenology, **1992**, 37, 859-868.

[2] W. Iwasaki, R. R. Sathuluri, R. Kurita, O. Niwa, M. Miyazaki, "Effects of Electrode Placement and Measurement Time on Electrochemical Signal of Redox Species Flowing through Porous Material," Sens. Materi., **2016**, 28, 1329-1335.