A Centrifugation-Assisted Lateral Flow Assay Platform for Bioassay Sensitivity and Visualization Enhancement

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***Abstract*— This study presents a centrifugation-assisted lateral flow assay (CLFA) platform that addresses the limited sensitivity and uncontrollable incubation time of traditional lateral flow assays (LFA). The CLFA platform generates a centrifugal force by controlling the motor to improve the flow rate controllability and optimize incubation time at the test line (T line). As a proof-of-concept, human chorionic gonadotropin (hCG) was chosen for quantification to validate the sensitivity and visualization enhancements. The centrifuged experiment group exhibits better linearity (R^2=0.9795) with the logarithm of the concentration (0-2000 mIU/mL) than the uncentrifuged control group. And the T line intensity enhances by an average of 8.23%. Our CLFA platform potentially improves early screening and advances point-of-care testing development.**

I. Introduction

Lateral flow assay (LFA) is one of the most promising techniques for point-of-care testing (POCT) due to its user-friendliness and cost-effectiveness [1]. However, the limited sensitivity and uncontrollable incubation time of LFA are its main challenges [2, 3]. Therefore, we developed a simple centrifugation-assisted LFA (CLFA) platform to improve flow rate controllability and optimize incubation time. As a proof-of-concept, we demonstrated the low-level human chorionic gonadotropin (hCG) quantification on this platform to validate the improved sensitivity and visualization.

II. Methods

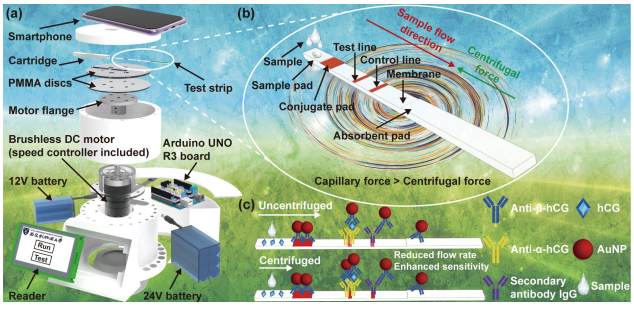

Figure 1. Schematic diagram of CLFA platform and working principle.

Fig. 1(a) shows the CLFA platform we developed, which can provide different rotation speeds for precise control of flow rates. And the detected results can be displayed on the reader. Figs. 1(b) and 1(c) show the structure of LFA test strips and the working principle of CLFA. The CLFA platform achieves flow rate control by generating a controlled centrifugal force radially opposite to the capillary force. Furthermore, the hCG liquid sample flow rate can be reduced, optimizing the incubation time at the test line (T line). The optimized incubation time allows the gold-labeled probe (Anti-β-hCG-AuNP) with hCG antigen to form a sandwich structure more fully with the Anti-α-hCG. This provides a higher intensity of the T line. Then, the excess gold-labeled probe flows rapidly at the control line (C line) and binds to the secondary antibody IgG. Finally, the test strip shows color at T and C lines.

*Research supported by XJTLU Foundation (KSF-E-39, RDF-18-02-20).

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III. Results

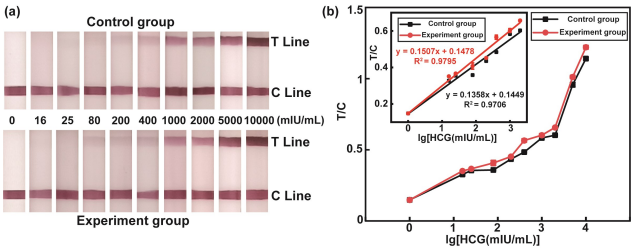

Figure 2. The results of hCG test strips with different concentrations (n=5).

Fig. 2(a) shows the test strip results of the control and experiment groups taken by the smartphone. Fig. 2(b) shows the ratio of the mean grayscale of the T line to that of the C line. The centrifuged experiment group indicates a better linear relationship with the logarithm of the concentration from 0 to 2000 mIU/mL (R^2=0.9795) than the uncentrifuged control group. The results showed that the experiment group enhanced by an average of 8.23% in the T line intensity (visualization effect) than the control group at the same hCG concentration.

IV. Discussion & Conclusion

We developed a CLFA platform that enhances the sensitivity and visualization of quantitative bioassays, potentially improving early screening and advancing POCT development.

References

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