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An Investigation of the Applicability of Sugar and Wax Valves for rapid molecular diagnostics

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1. ABSTRACT

Paper-based Loop-mediated Isothermal Amplification (LAMP) of nucleic acids is a low-cost molecular diagnostic method to detect biological pathogens and has been successfully combined with lateral flow devices. This invention is a low-cost visual detection technique of various disease. However, existing assays require multiple user-activated steps and are relatively complicated to use at the point of care due to steps like the heating process. This project aimed to investigate an ideal valve for integrating LAMP onto the lateral flow assay. An ideal valve needs to be able to stop the fluid flow for 20-60 minutes under 65 degree to complete the amplification and release the water flow automatically. Sugar and wax were examined as potential valve materials. The sugar valve was tested by pipetting various concentrations of sucrose solution onto paper strips and drying the strips. For these valves, the time it took for water to dissolve the sugar was the total valve timing. The wax valve was made by dipping the paper strips into melted wax and then cooling. The melting point of the wax was higher than 65 degree so that after the heating process, the wax valve could be “opened” by increasing the temperature and allowing the fluid to flow. The sugar valves lacked repeatability due to environmental conditions such as humidity and difficulty of distributing the sugar solution evenly on the paper strips. In contrast, the wax valve was demonstrated to have incredible reliability and control over fluid flow. We managed to stop the water flow completely with wax valve and open it within 2 minutes. This paper proved that wax has potential to be a good valve for paper-based loop-mediated isothermal amplification.