

LabTube - a novel centrifugal microfluidic lab-on-a-chip platform for operation in standard laboratory centrifuges



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Summary

The “LabTube” is a novel centrifugal lab-on-a-chip platform that uses a standard laboratory centrifuge as processing device. It automates multistep protocols such as nucleic acid extraction or protein purification, decreasing the hands-on-time from > 6 to 1 minute per extraction. Future applications will include point-of-care sample-to-answer nucleic acid analysis. The LabTube approach lowers the market entry barrier for microfluidics as the user only requires to purchase disposable parts without the need to invest in specialized processing devices.

Motivation

Microfluidic lab-on-a-chip platforms offer the perspective of miniaturized, automated and integrated liquid handling. As a major drawback, the vast majority of lab-on-a-chip cartridges require dedicated processing instruments posing significant investment costs to the user. A laboratory centrifuge (Fig. 2), however, is typically available.



Figure 1: Reagent kit and disposables for manual nucleic acid extraction.



Figure 2: Standard laboratory centrifuge for automated processing of up to 16 centrifuge tubes (50 ml).

Design

Key element of the novel “LabTube” platform is a disposable cartridge that enables i) **prestorage of reagents**, ii) automated liquid handling by **centrifugally actuated pen mechanics**, and iii) **liquid collection** (e.g. eluate) in a removable reaction tube.



Figure 3: Laboratory centrifuge with LabTube and Barcode interface.

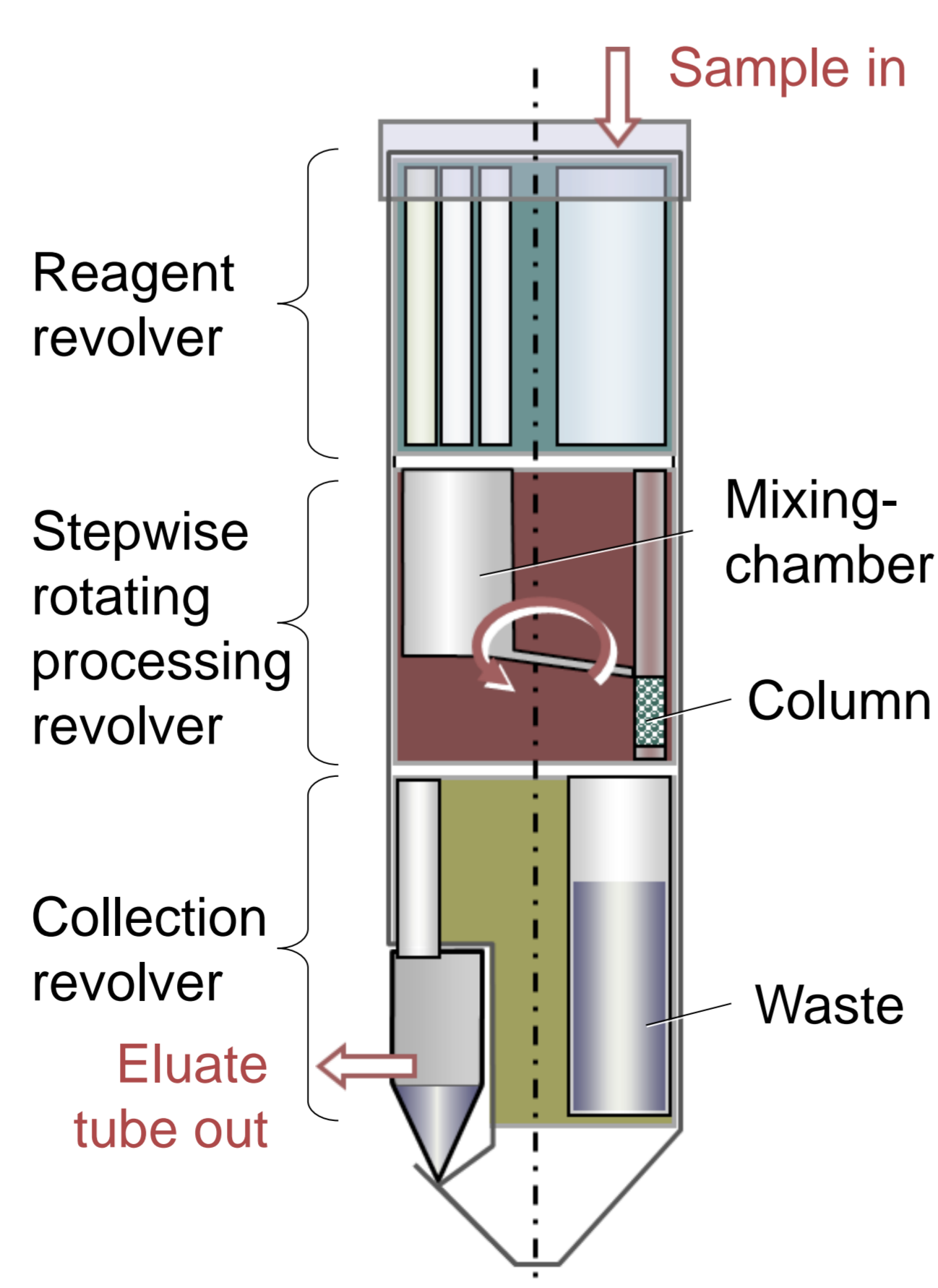


Figure 4: LabTube - design and liquid handling elements. The processing revolver is actuated by pen mechanics.

Results

Demonstrated are successful liquid routing (Fig. 5), DNA-extraction and protein purification (Fig. 6).

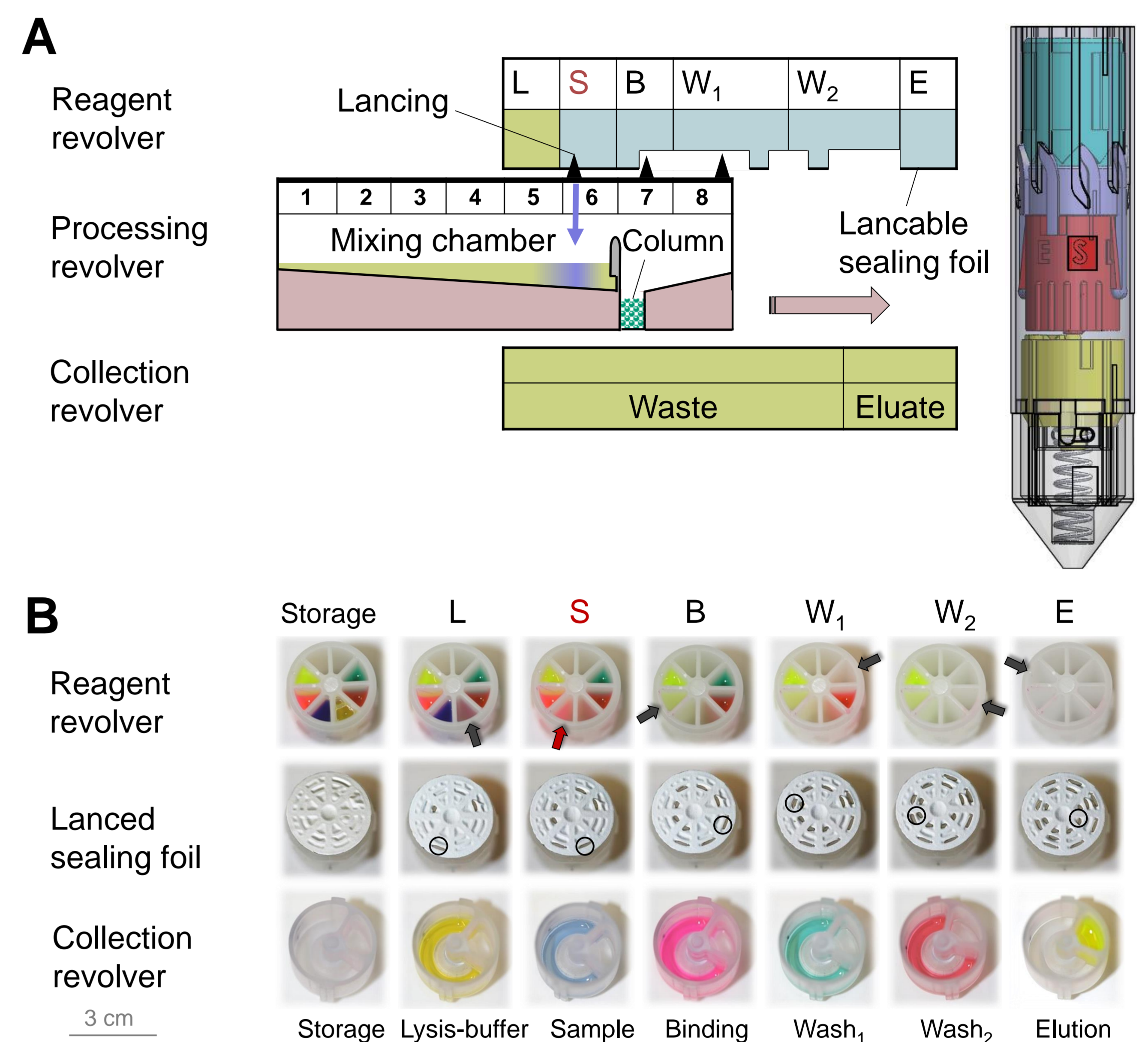


Figure 5: Control of liquid handling. **A)** Lancing and rotation of processing revolver actuated by pen mechanics. **B)** Experimental demonstration of liquid routing steps required for nucleic acid extraction.

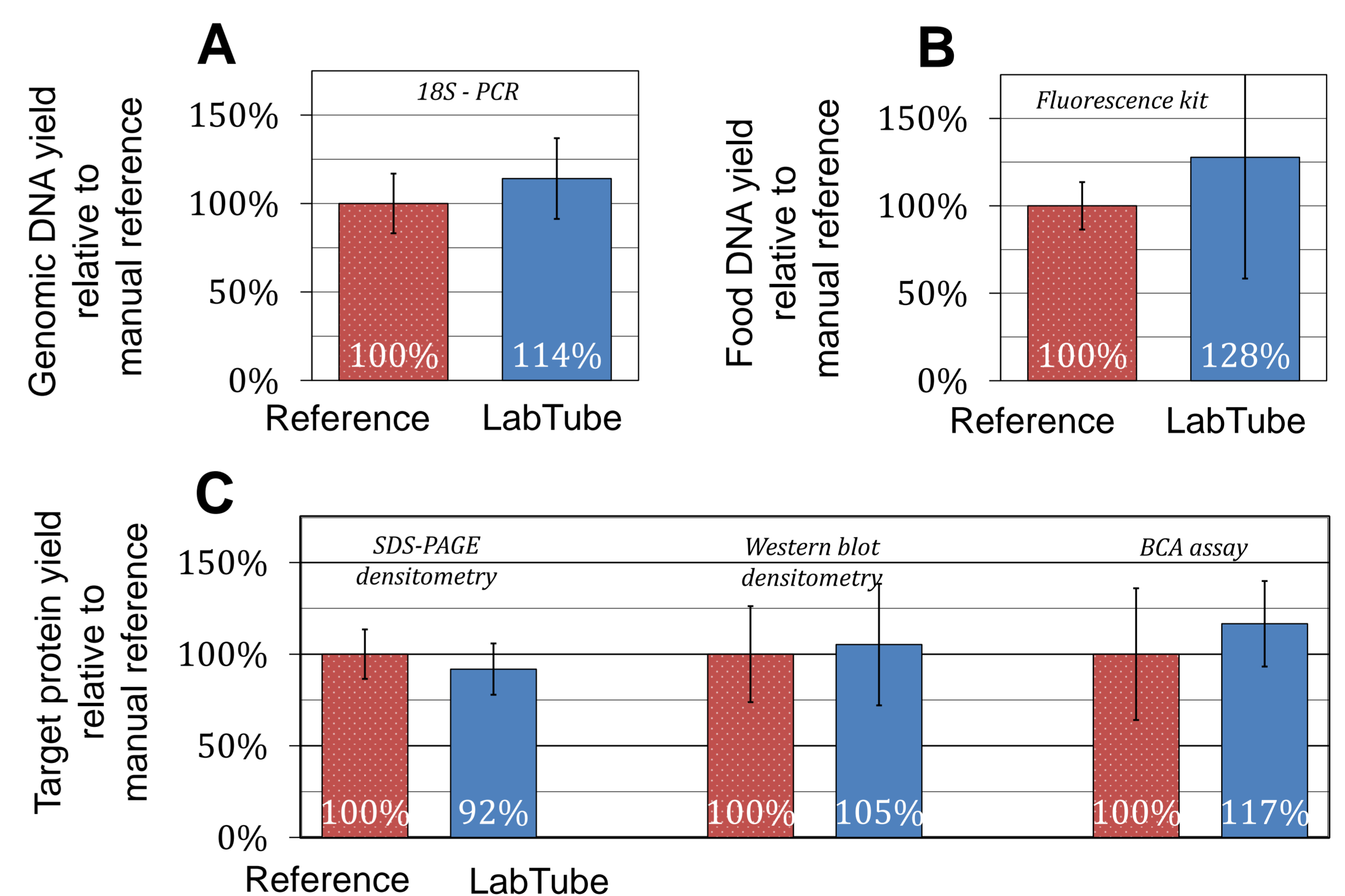


Figure 6: **A)** Extraction of genomic DNA from blood samples. **B)** Extraction of DNA from rape lysate. **C)** Protein purification from insect cells (Histidyl tRNA synthetase). See also: A. Kloke et al. LabChip 2014, 14, 1527.

Conclusions

The LabTube enables fully-automated processing of multistep assays. It can be operated in a standard laboratory centrifuge which may lower the market entry barrier for this lab-on-a-chip approach. Nucleic acid and protein purification have been demonstrated. In addition, the platform offers potential for point of care sample-to-answer nucleic acid testing.

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