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Supplementary Material

Dual-Modal Assay Kit for the Qualitative and Quantitative Determination of the Total Water Hardness Using a Permanent Marker Fabricated Microfluidic Paper-Based Analytical Device

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Table S1. Calculations of the stoichiometric expectations for the test results of the spiked water samples with Mg^{2+} and Ca^{2+} using the paper-based device. (a) Soft water with the total hardness less than 60 mM; (b) moderately hard water with the total hardness between 0.61-1.20 mM; (c) hard water with the total hardness between 1.21-1.8 mM; (d) very hard water with the total hardness more than 1.81 mM.

Channel	Hardness of the water sample (mM) "Volume = 11 µL"	Concentration of the applied EDTA (mM) in the reaction (R) zone "volume = 5.5 µL"	Hardness of water moving to the detection (D) zones (mM)	Color output at the detection (D) zones
		a) Soft water		
Channel 1 (C)	0.40	0.00	0.40	Pink
Channel 2 (S)	0.40	0.40	0.20	Pink
Channel 3 (MH)	0.40	1.22	0.00	Blue
Channel 4 (H)	0.40	2.42	0.00	Blue
Channel 5 (VH)	0.40	3.62	0.00	Blue
		b) Moderately hard water		
Channel 1 (C)	0.81	0.00	0.81	Pink
Channel 2 (S)	0.81	0.40	0.61	Pink
Channel 3 (MH)	0.81	1.22	0.20	Pink
Channel 4 (H)	0.81	2.42	0.00	Blue
Channel 5 (VH)	0.81	3.62	0.00	Blue
		c) Hard water		
Channel 1 (C)	1.40	0.00	1.40	Pink
Channel 2 (S)	1.40	0.40	1.20	Pink
Channel 3 (MH)	1.40	1.22	0.79	Pink
Channel 4 (H)	1.40	2.42	0.19	Pink
Channel 5 (VH)	1.40	3.62	0.00	Blue
		d) Very hard water		
Channel 1 (C)	2.00	0.00	2.00	Pink
Channel 2 (S)	2.00	0.40	1.80	Pink
Channel 3 (MH)	2.00	1.22	1.39	Pink
Channel 4 (H)	2.00	2.42	0.79	Pink
Channel 5 (VH)	2.00	3.62	0.19	Pink

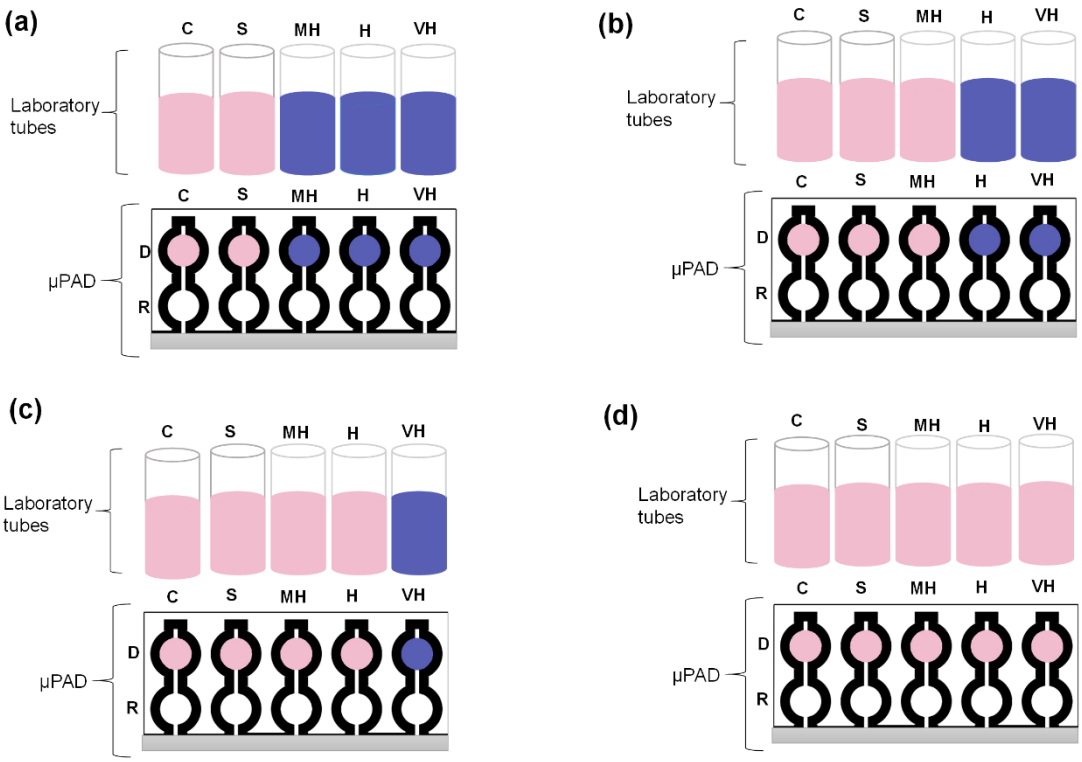

Figure S1. Schematic of the complexometric titration in the solution phase in laboratory test tubes and the expectations on the paper-based device according to the stoichiometric calculations which were presented in Table S1: (**a**) soft water, (**b**) moderately hard water, (**c**) hard water, and (**d**) very hard water (D: detection zone; R: reaction zone; C: control; S: soft; MH: moderately hard; H: hard; VH: very hard).

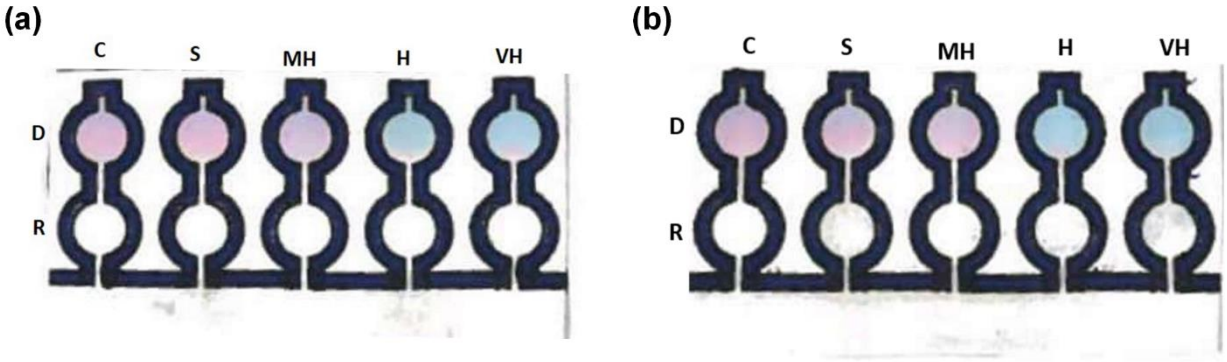

Figure S2. Qualitative detection of total hardness of water containing only a single ion of calcium and magnesium ion. (**a**) 0.81 mM calcium ion, and (**b**) 0.81 mM magnesium ion.

Maximum allowable concentration (MAC) of ions in water

The maximum allowable concentration of some common ions in water includes; manganese ion (2.19 μM), iron (II) ion (5.38 μM), ammonium ion (5.56 μM), chloride ion (56.34 μM), fluoride ion (78.95 μM) and copper ion (31.25 μM) [1].

References

1. Health Canada. Guidelines for Canadian Drinking Water Quality—Summary Table. Available online: https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table.html (accessed on 7 October 2020).