A smartphone-based dual-channel flame photometric platform and application in ratiometric determination of potassium ions

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Contents

Reagents and instrument

All the reagents were analytical pure and used directly without further purification. All aqueous solutions in the experiment were prepared with ultrapure water as solvent. Potassium chloride (KCl) and cesium chloride (CsCl) purchased from Sinopharm Chemical Reagent Co. Ltd. (Shanghai, China). The emission spectrum of the flame was measured using the Hitachi F-7000 fluorescence spectrometer with the transmission of a plastic optical fiber with the outside diameter of 10 mm. The reference method for K^+ and Cs^+ analysis is the commercial atomic absorption spectrometer PE-AA800 equipped with an air-acetylene flame.

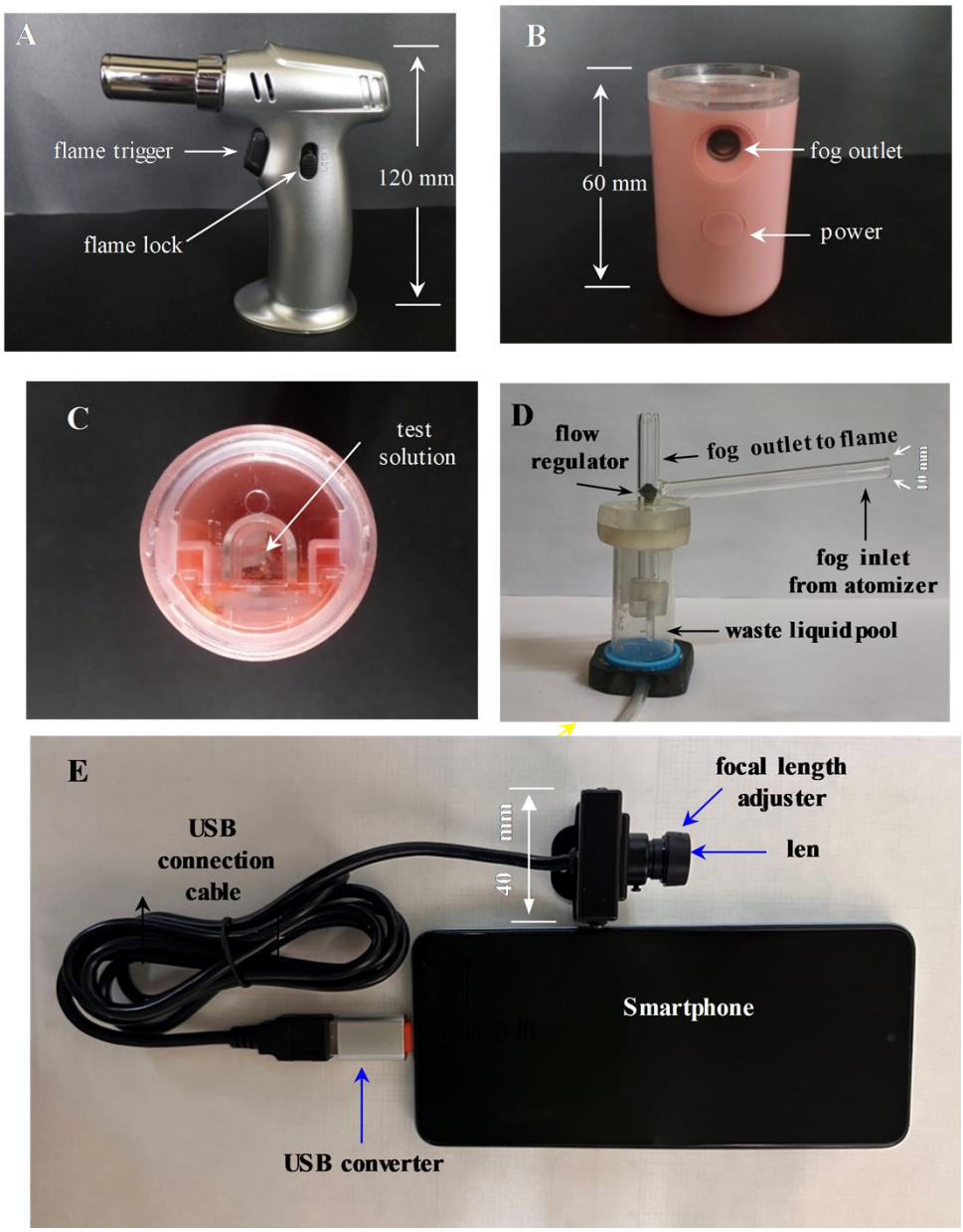

Fig. S1 Pictures of a windproof lighter (A), cosmetic ultrasonic nebulizer (B,C), T-glass tube assembly for aerosol to flame (D), infrared camera controlled by smartphone (E).

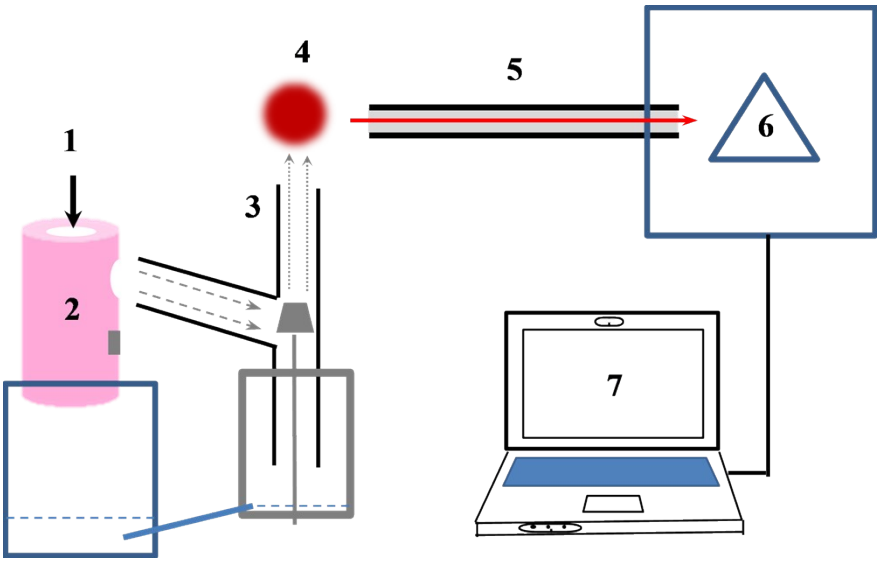

Fig. S2 Schematic drawing for the measurement of the emission spectrum of the flame by a fluorospectrophotometer. (1) test solution, (2) cosmetic ultrasonic nebulizer (3), T-glass tube assembly for aerosol to flame, (4) flame for atomic emission, (5) optic fiber, (6) fluorospectrophotometer, (7) computer.

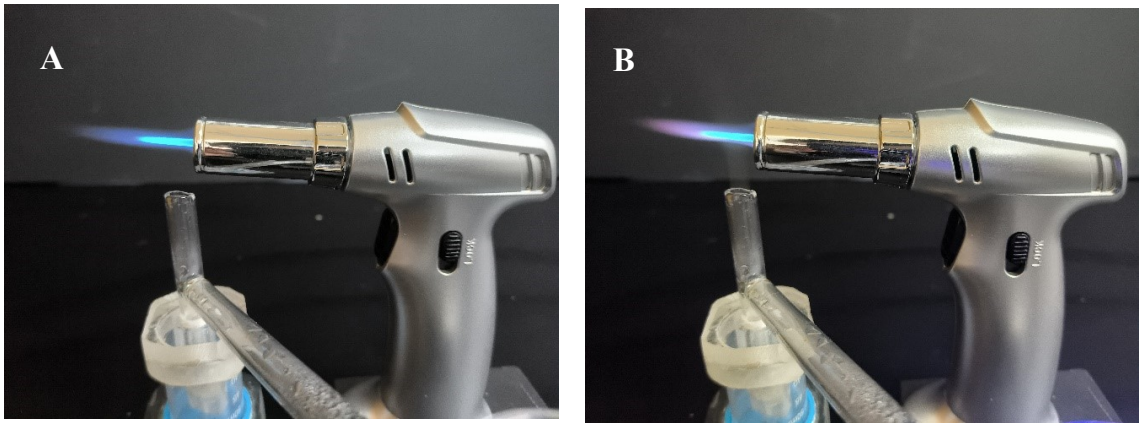

Fig. S3 Pictures of blank flame (A) and the flame with the spray of the mixture of 5.0 mM KCl and 5.0 mM CsCl.

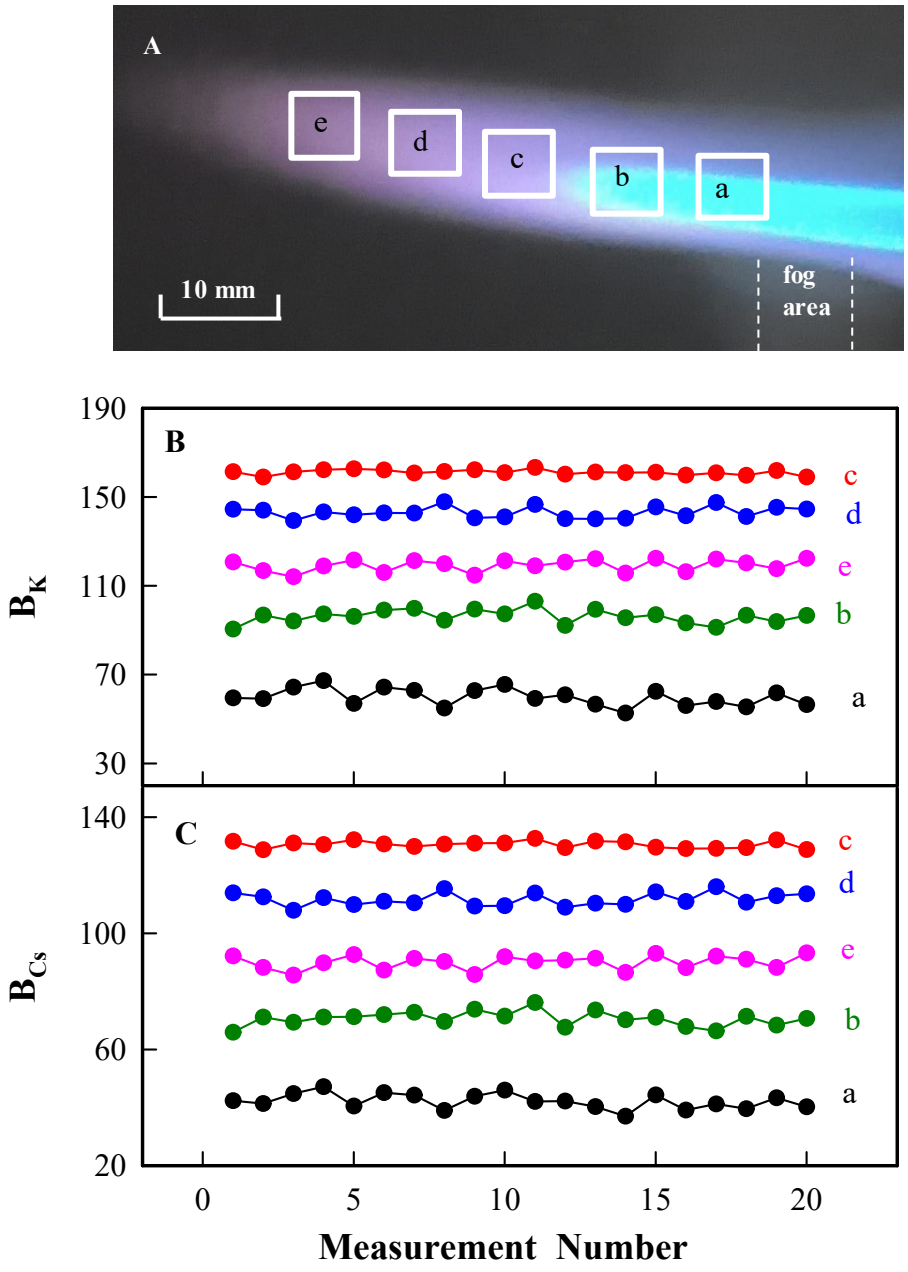

Fig. S4 Sampling areas in the frame (A), brightness values of K (B) and Cs (C) channels at different detection areas (a→e) of the frame. Experimental conditions: EV= –10, 100 μM K^+ and 100 μM Cs^+.

Table S1. Recovery for the determination of K^+ by the portable flame photometric device in ratiometric mode (n=3).

Solutions	Detected (mM)	Recovery (%)
100.0 μM KCl	99.5 ± 2.3	99.5
100.0 μM KCl + 10 mM NaCl	103.1 ± 3.4	103.1
100.0 μM KCl + 10 mM $NaNO_3$	95.4 ± 3.9	95.4
100.0 μM KCl + 10 mM $NaNO_2$	101.3 ± 3.6	101.3
100.0 μM KCl + 10 mM Na_2SO_4	97.6 ± 3.6	97.6
100.0 μM KCl + 10 mM Na_2CO_3	102.8 ± 4.3	102.8
100.0 μM KCl + 10 mM Na_3PO_4	95.7 ± 4.5	95.7
100.0 μM KCl + 10 mM Na_2SO_4	103.5 ± 3.4	103.5
100.0 μM KCl + 10 mM LiCl	99.1 ± 3.1	99.1
100.0 μM KCl + 10 mM RbCl	104.9 ± 3.5	104.9
100.0 μM KCl + 10 mM NH_4Cl	98.2 ± 2.5	98.2
100.0 μM KCl + 10 mM $CaCl_2$	102.1 ± 3.9	102.1
100.0 μM KCl + 10 mM $MgCl_2$	97.8 ± 3.3	97.8
100.0 μM KCl + 10 mM $BaCl_2$	103.8 ± 4.1	103.8
100.0 μM KCl + 10 mM $SrCl_2$	104.3 ± 3.8	104.3
100.0 μM KCl + 10 mM $CuCl_2$	97.8 ± 3.5	97.8
100.0 μM KCl + 10 mM $ZnCl_2$	95.1 ± 3.4	95.1
100.0 μM KCl + 10 mM $MnCl_2$	102.8 ± 3.3	102.8
100.0 μM KCl + 10 mM $FeCl_3$	96.3 ± 4.3	96.3
100.0 μM KCl + 10 mM $AlCl_3$	101.7 ± 4.5	101.7

Table S2. Determination of K^+ in actual samples by the portable flame photometric device and AAS method (n=3).

Samples	Proposed method (mM)	AAS (mM)	Relative error (%)
Tap water	0.249 ± 0.05	0.239 ± 0.02	4.2
River water No.1	0.351 ± 0.07	0.363 ± 0.03	-3.3
River water No.2	0.289 ± 0.06	0.276 ± 0.02	4.7
River water No.3	0.189 ± 0.05	0.198± 0.02	-4.5
Human urine No.1	17.8 ± 0.5	17.2 ± 0.2	3.5
Human urine No.2	13.2± 0.4	13.9 ± 0.2	-5.0
Human urine No.3	10.8 ± 0.3	10.4 ± 0.2	3.8
Orange juice No.1	52.9 ± 1.2	50.6 ± 0.4	4.5
Orange juice No.2	45.4 ± 1.1	47.9 ± 0.4	-5.2
Orange juice No.3	41.7 ± 1.0	40.2 ± 0.3	3.7

Table S3. Determination of dissolvable potassium in compound fertilizer samples by the portable flame photometric device and AAS method (n=3).

Samples	Proposed method (% w/w)	AAS (% w/w)	Relative error (%)
High potassium	23.2 ± 0.4	23.9 ± 0.2	-2.9
Universal ternary	11.3 ± 0.2	11.8 ± 0.1	4.2
Special ternary	14.6 ± 0.3	14.3± 0.1	-3.6