Supporting Information

Low-Temperature and Atmospheric Sample Digestion Using Dielectric Barrier Discharge

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Author Contributions

The manuscript was written through contributions of all authors. All authors have given approval to the final version of the manuscript.

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1. The power, voltage and frequency of AC voltage

Table S1. The power, voltage and frequency of AC voltage

Power (W)	Voltage (V)	Frequency (Hz)
10	15	0.85
15	20	0.95
20	30	0.85
30	40	0.95
35	45	1.00
40	55	0.90
50	65	0.95
55	75	0.90

2. Schematic diagram of digestion and analytical procedure

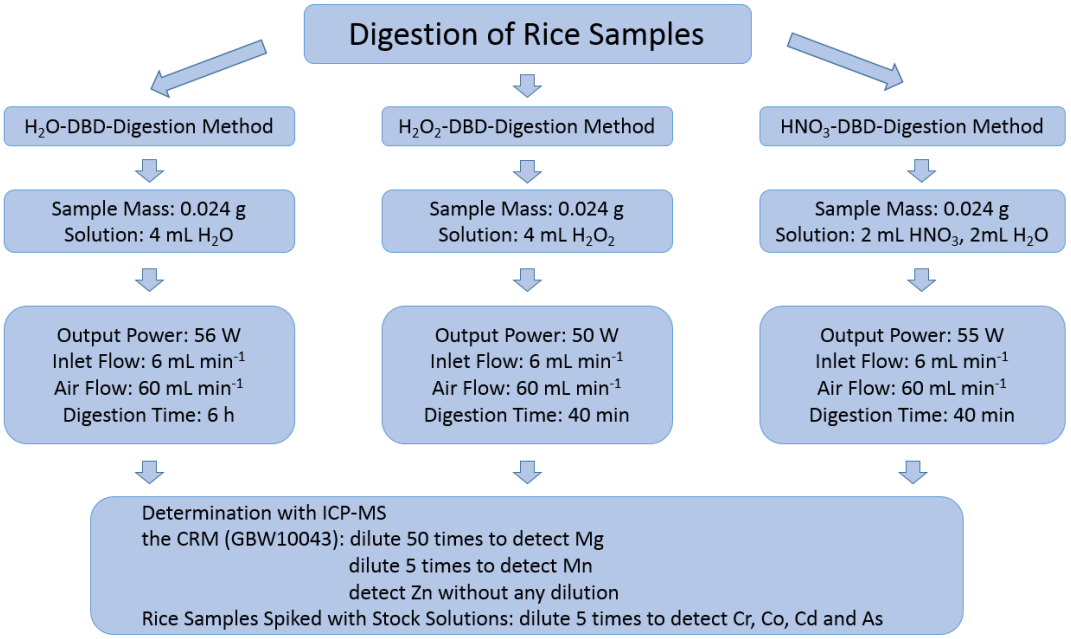

Figure S1. Schematic diagram of digestion and analytical procedure.

3. The instrumental parameters of ICP-MS

Table S2. The Instrumental Parameters of ICP-MS

Parameter	Values
RF power (W)	1550
Nebulizer gas flow rate (L min^{-1})	1.0
Auxiliary gas flow rate (L min^{-1})	1.0
Plasma gas flow rate (L min^{-1})	15.0
Scanning mode	Peaking hopping
Dwell time (ms)	30

4. Instrumental parameters of EPR experiments

DMPO (5,5-dimethyl-1-pyrrolidine-N-oxide) was used as the spin-trapping agent in the EPR experiment. H_2O_2 and deionized water were mixed (4 mL) and digested by DBD. 40 μL DMPO was added immediately as soon as discharge stopped. The mixture adding DMPO was transferred into a 200 μL capillary tube, which was then inserted into the cavity of the EPR spectrometer.

The EPR spectra were obtained at room temperature with center field of 3480.00 G, sweep width of 100.00 G, receiver gain of 10 dB, modulation frequency of 100 kHz, microwave power of 20.00 mW, and sweep time of 60.00 s.

5. Effects of operation conditions on the sample digestion

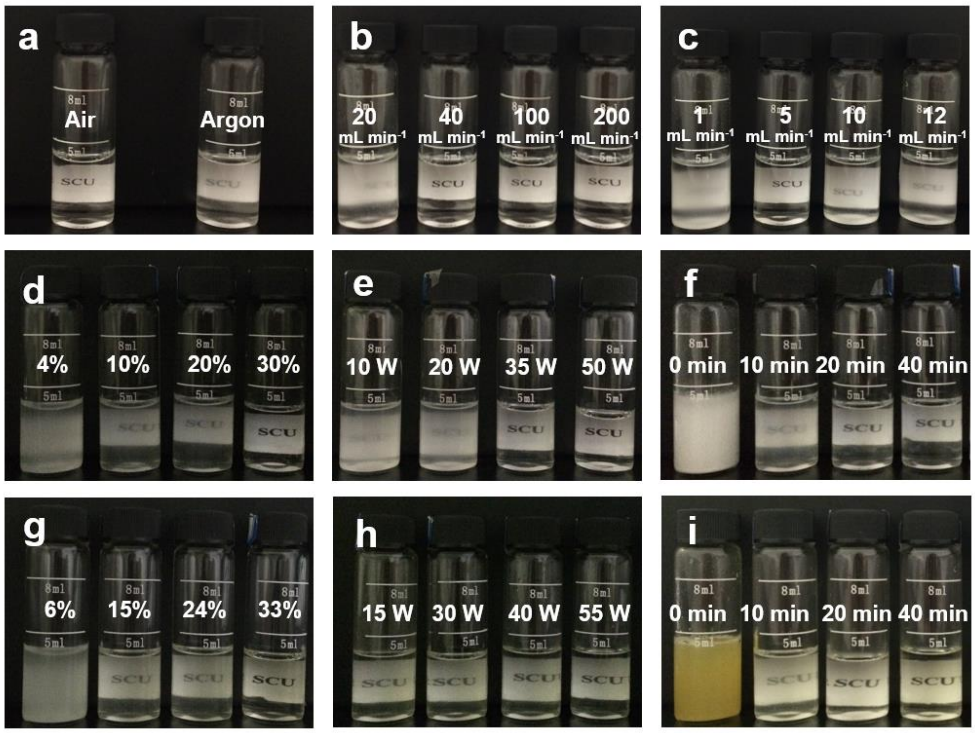

Figure S2. Effects of operation conditions on the sample digestion. (a) Effect of carrier gas: air (left), argon (right). (b) Effect of gas flow rate: 20, 40, 100, 200 mL min^{-1}, respectively. (c) Effect of speed of peristaltic pump: 1, 5, 10, 12 mL min^{-1}, respectively. (d) Effect of concentration: 4%, 10%, 20% and 30% H_2O_2 (v/v). (e) Effect of output power: 10 W, 20 W, 35 W and 50 W. (f) Effect of digestion time: 0 min, 10 min, 20 min and 40 min. (g) Effect of concentration: 6%, 15%, 24% and 33% HNO_3 (v/v). (h) Effect of output power: 15 W, 30 W, 40 W and 55 W. (i) Effect of digestion time: 0 min, 10 min, 20 min and 40 min. Conditions in all experiments above: 0.0240 g rice power in 4 mL solutions.

6. The effects to COD detection

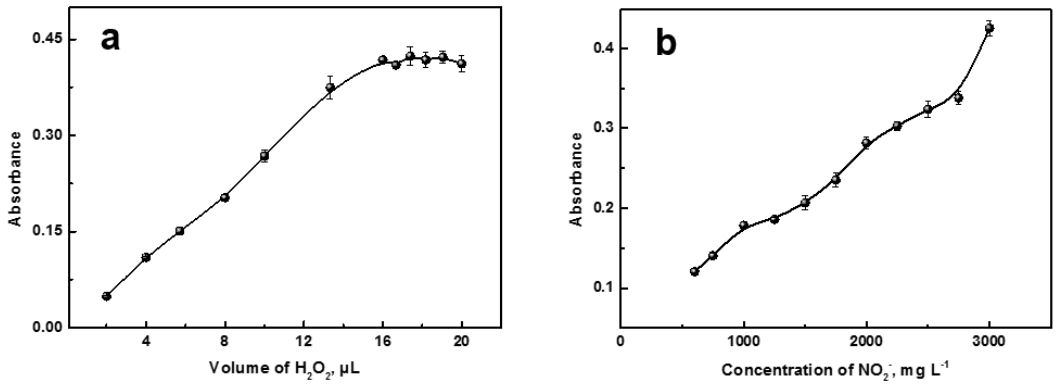

Figure S3. The effects to COD detection. (a) The interferences of reaction between hydrogen peroxide and dichromate. (b) The interferences of reaction between nitrite and dichromate.

7. The ion chromatogram for solutions of HNO_3-DBD-digestion method

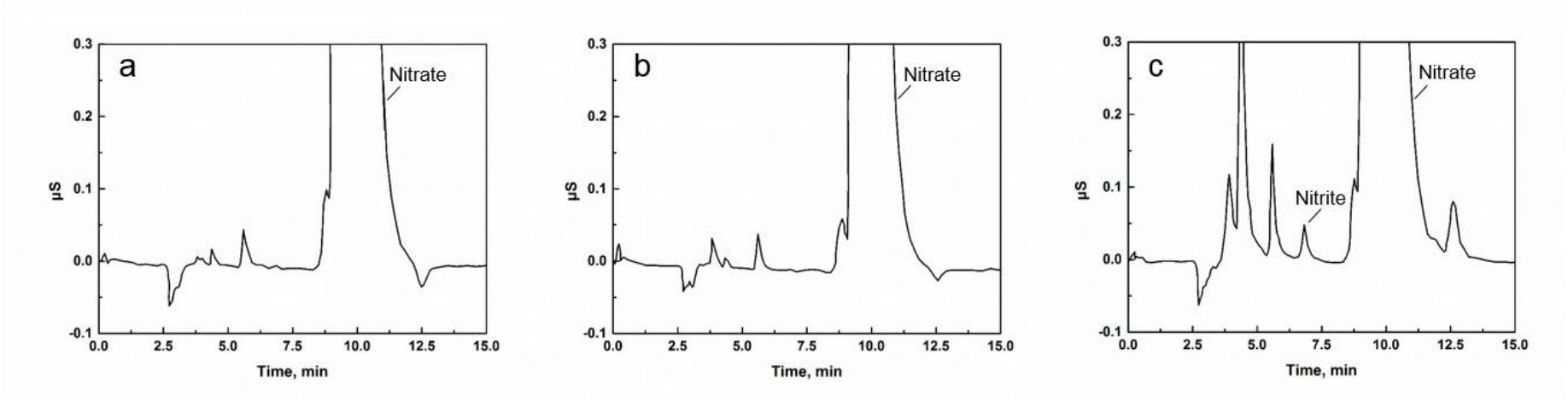

Figure S4. The ion chromatogram for solutions of HNO_3-DBD-digestion method. (a) HNO_3 blank solution before digestion. (b) Rice powder dissolved in HNO_3 before digestion. (c) Rice powder dissolved in HNO_3 after digestion.

8. The comparison of intensities of elements of digestion blanks of H_2O-DBD-digestion method, H_2O_2-DBD-digestion method, HNO_3-DBD-digestion method and microwave digestion method, respectively

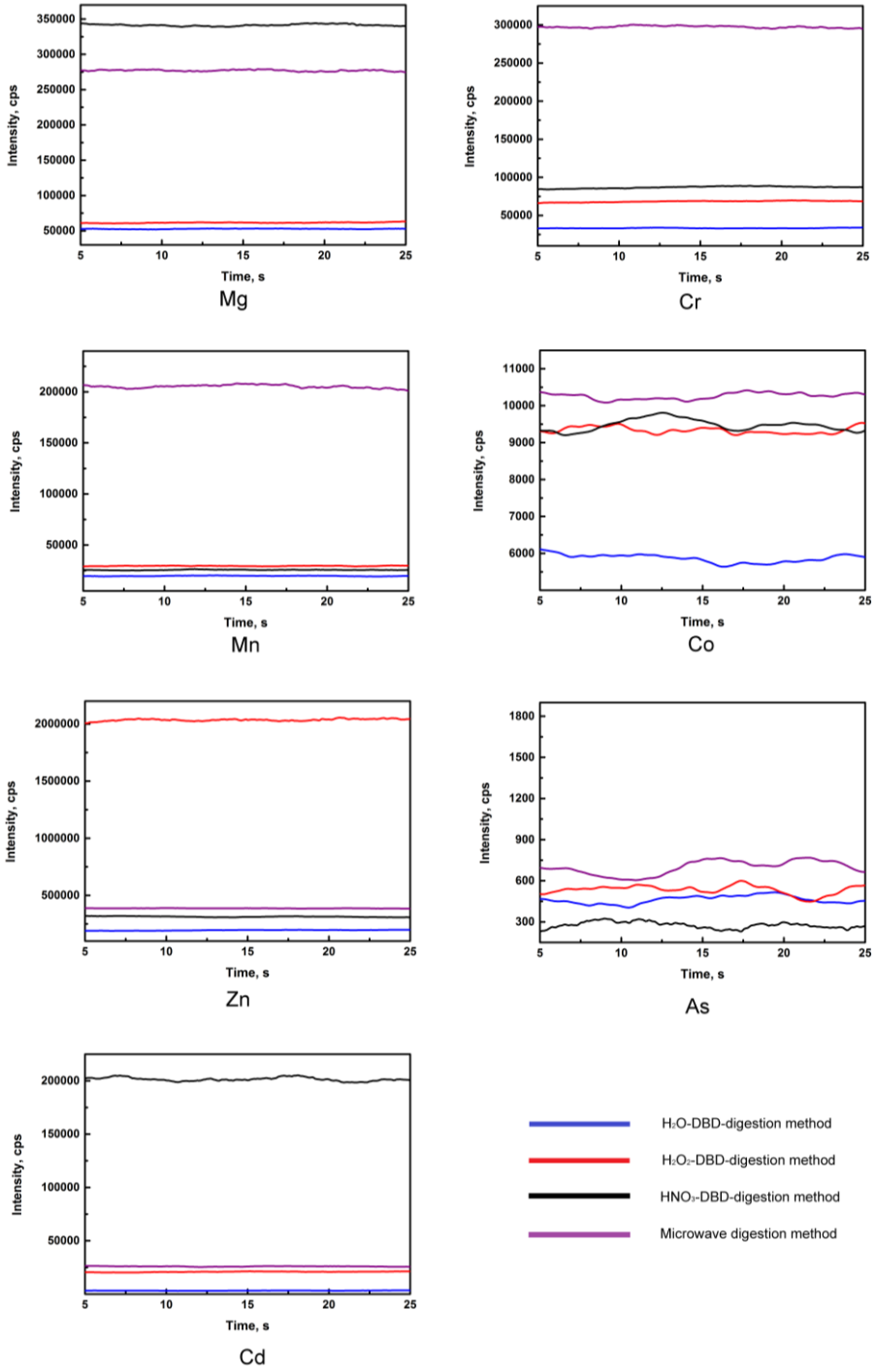

Figure S5. The comparison of intensities of elements of digestion blanks of H_2O-DBD-digestion method, H_2O_2-DBD-digestion method, HNO_3-DBD-digestion method and microwave digestion method, respectively.

9. Comparison of performance with other similar digestion methods

Table S3. Comparison of performance with other similar digestion methods

Digestion method	Sample	Digestion regents	Digestion conditions	Detection	LOD	Reference
Focused Microwave-Induced Combustion (FMIC)	Commercial medicinal plant: 100-1500 mg	50 μL NH_4NO_3 (6 mol L^{-1}) for ignition, 10 mL HNO_3 (4 mol L^{-1}) as the absorbing solution	(i) 5 s at maximum power for sample ignition; (ii) oxygen flow rate was increased from 2 to 15 L min^{-1}; (iii) after cooling 10 min, 10 mL HNO_3 (4 mol L^{-1}) was added and a reflux step was performed under focused microwave radiation, at 125℃ for 5 min.	ICP-OES	Al, 0.09[a]; Ba, 0.05[a]; Ca, 0.03[a]; Fe, 0.01[a]; Mg, 0.02[a]; Mn, 0.01[a]; Sr, 0.01[a]; Zn, 0.03[a]	1
MW-UV	Chocolate, 0.6 g	10 mL HNO_3 (4 mol L^{-1})	550 W, ramp 20 min and hold for 40 min; cooling, ~ 15 min.	ICP-MS	As, 0.87[b]; Cd, 0.98[b]; Ni, 29.7[b]; Pb, 7.85[b]	2
Fe_3O_4 MNPs accelerated MWD	Fish samples, DORM-3 or DORM-4, 0.1 g	HNO_3, 100 μL; H_2O_2, 6 mL	Irradiation at 80℃, 6 min	HG-AFS, ICP-MS	HG-AFS: As, 0.01-0.06[a]; Sb: 0.03-0.08[a] ICP-MS: As, 0.002-0.005[a];	3

					Sb: 0.005-0.01[a]	
UV-assisted Fenton digestion	Rice samples, 0.05 g	0.2% (m/v) Fe^0, 18% (v/v) H_2O_2 and 0.75%HNO_3	Ultraviolet radiation with ultraviolet lamp for 50 min, separate excess Fe^0 and dilute solutions to 2 mL	HG-AFS	Cd, 0.02[a]	4
MWD	Hydrogenated fats and chocolate bars, 0.5 g	HNO_3, 3 mL; H_2O_2, 1 mL	800 W, ramp 2 min and hold for 15 min; cooling, ~ 1 h	Graphite furnace AAS	Ni, 1.14[b]	5
PHB-DEA accelerated MWD	Water and food samples, 0.1 mL for liquid samples and 0.1 g for solid samples	HNO_3, 6 mL; H_2O_2, 2 mL	6 min for 250 W, 6 min for 400 W, 6 min for 550 W, 6 min for 250 W, ventilation: 8 min	AAS	Pb, 1.05[b], Cd, 0.42[b], Zn, 0.13[b]	6
MWD	Exotic food: 0.25 mL of liquid samples and 0.25 g for solid samples	HNO_3, 6 mL; H_2O_2, 1 mL	Increasing the temperature up to 200℃ in 15 min; holding it at 200℃ for 15 min; cooling at room temperature	ICP-MS	Mg, 0.5[a]; Mn, 0.15[a]; As, 0.15[a]; Cd, 0.035[a]; Co, 0.01[a]; Cr, 0.2[a]; Zn, 0.2[a]	7
Dry-ashing	Infant formulas:	Dry ashing:	Dry ashing: 500℃ for 6 h, heating	ICP-MS;	ICP-MS: Mo, 0.06[b]; Se, 0.13[b];	8

Wet-digestion MWD	dry-ashing, 2 g; wet-digestion, 2 g; MWD, 1 g	H_2O_2, 1 mL; H_2SO_4, 2 mL; HNO_3, 1 mL. Wet-digestion: 25 mL HNO_3, 1 mL H_2O_2. MWD: 7 mL HNO_3, 1 mL H_2O_2.	again after adding 1 mL each of H_2O and HNO_3. Wet-digestion: start form 50 ℃ to 150-160℃ for 10-12 h, cool at room temperature. MWD: 190℃, 15 min; 1000 W, 30 min; cooling ~ 15 min.	ICP-OES	Cr, 0.06[b] ICP-OES: Mo, 0.91[b]; Se, 5.89[b]; Cr, 4.44[b]

[a] μg g^{-1}, [b] ng g^{-1}.

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