

## Supplementary Information

### **Development of an Analytical Method for the Determination of Metals in Chicken Breast by Microwave Induced Plasma Optical Emission Spectrometry (MIP-OES)**

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**Table S1.** Instrumental operating conditions

Analyte	Wavelength /	Viewing	Nebulization gas flow rate
	nm	position / mm	/ (L min <sup>-1</sup> )
Al	396.152	-10	1.00
C	247.856	0	0.75
Ca	393.366	10	0.60
Cd	228.802	10	0.55
Cr	425.433	-10	0.95
Cu	324.754	0	0.60
Fe	371.993	0	0.75
Hg	253.652	0	0.75
K	766.491	10	1.00
Mg	285.213	10	0.70
Na	588.995	0	1.0
Zn	213.857	0	0.55

**Table S2.** Factors and their respective levels in the central composite design

Factor	Levels				
	-1.68	-1	0	+1	+1.68
HNO <sub>3</sub> volume / mL	5	6	7.5	9	10
Decomposition time / min	60	85	120	155	180
Temperature of digester block / °C	80	95	120	145	160

**Table S3.** CCD matrix of the acid decomposition with reflux system for Al, Ca, Cu, Fe, K, Mg, Na and Zn in chicken breast sample (n = 3)

Independent variable				Dependent variable								
Trial	A / mL	B / min	C / °C	Intensity								
				Al	Ca	Cu	Fe	K	Mg	Na	Zn	C <sup>a</sup> / %
1	6	85	95	0	602748	6069	395	3234805	1177260	2747285	0	8.72
2	9	85	95	0	515295	3727	271	3205627	1163051	2724177	1915	8.74
3	6	155	95	1628	537220	5702	256	3164785	1195149	2657108	1863	8.10
4	9	155	95	0	735820	3092	215	3219838	1253794	2769321	2101	7.79
5	6	85	145	0	713784	5710	435	3151351	1243172	2611579	2128	6.66
6	9	85	145	0	488693	4300	158	3121645	1288925	2619028	2435	6.51
7	6	155	145	1619	575611	13857	2534	3060402	1344515	2466025	49984	5.77
8	9	155	145	5746	742774	28456	7481	3277415	1333659	2644144	144211	5.08
9	5	120	120	6024	578409	28250	7454	3203254	1300024	2640512	142663	6.86
10	10	120	120	6175	576962	28194	7582	3257601	1318592	2660689	146433	6.34
11	7.5	60	120	7337	734657	28037	7589	3226854	1324906	2722130	144529	7.39
12	7.5	180	120	6289	623884	28197	7590	3257939	1384355	2674910	145696	5.60
13	7.5	120	80	5737	596813	27789	7298	3148945	1272493	2684291	144875	8.29
14	7.5	120	160	5649	686869	39232	7499	3318102	1379018	2797038	146996	4.89
15	7.5	120	120	6078	679464	29600	7473	3294734	1340289	2794989	144829	6.06
16	7.5	120	120	5778	678785	28420	7521	3200693	1302290	2745161	146361	5.65
17	7.5	120	120	6385	770765	28136	7386	3238644	1325301	2812756	144582	5.81

A: HNO<sub>3</sub> volume; B: decomposition time; C: temperature of digester block; <sup>a</sup>values in % for residual carbon.

**Table S4.** Analysis of variance (ANOVA) for central composite design

Analyte	Source	Sum of square	Df <sup>a</sup>	Mean square	<i>F</i> -value	<i>F</i> -tab
Ca	regression	$7.88 \times 10^{10}$	2	$3.94 \times 10^{10}$		
	residual	$4.20 \times 10^{10}$	14	$3.00 \times 10^9$	13.14	2.73
	total	$1.21 \times 10^{11}$	16			
Mg	regression	$2.64 \times 10^{10}$	1	$2.64 \times 10^{10}$		
	residual	$4.30 \times 10^{10}$	15	$2.87 \times 10^9$	9.20	3.07
	total	$6.94 \times 10^{10}$	16			
Na	regression	$2.21 \times 10^{10}$	1	$2.21 \times 10^{10}$		
	residual	$9.82 \times 10^{10}$	15	$6.55 \times 10^9$	3.38	3.07
	total	$1.20 \times 10^{11}$	16			
C	regression	22.94	5	4.59		
	residual	1.65	11	0.15	30.52	2.48
	total	24.59	16			

<sup>a</sup>Degree of freedom.

**Table S5.** Figures of merit for the determination of Al, Ca, Cd, Cr, Cu, Fe, Hg, K, Mg, Na and Zn in chicken breast samples by MIP-OES using a conventional nebulization

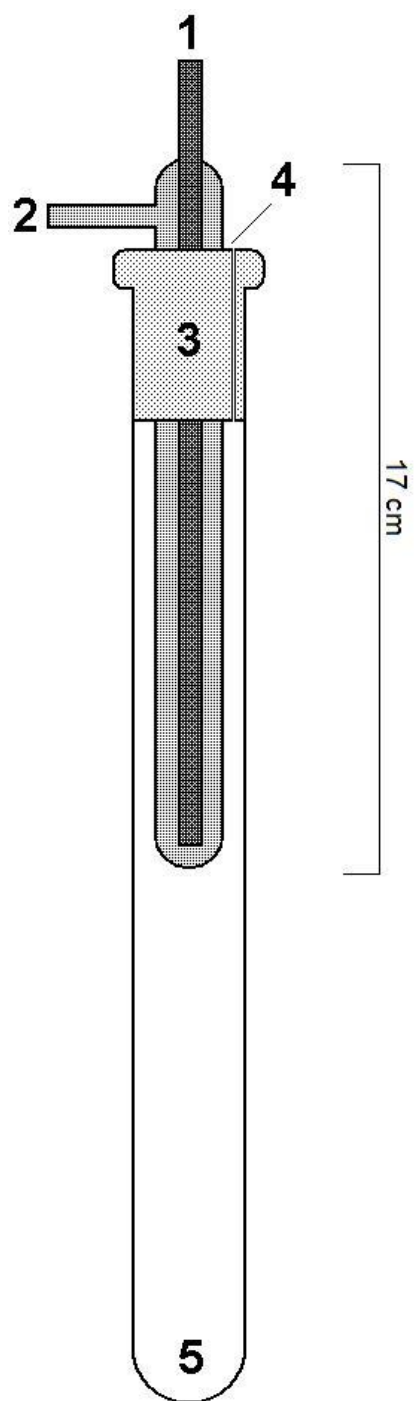
Analyte	a / (L mg <sup>-1</sup> )	R <sup>2</sup>	LOD <sup>a</sup> / (mg L <sup>-1</sup> )	LOQ <sup>a</sup> / (mg L <sup>-1</sup> )	LOD <sup>b</sup> / (mg kg <sup>-1</sup> )	LOQ <sup>b</sup> / (mg kg <sup>-1</sup> )
Al	51195	0.998	0.0006	0.002	0.03	0.10
Ca	713278	0.995	0.0005	0.002	0.024	0.08
Cd	28883	0.999	0.0001	0.0005	0.008	0.02
Cr	53743	0.996	0.00008	0.0003	0.004	0.014
Cu	201365	0.999	0.002	0.008	0.12	0.39
Fe	14773	0.999	0.006	0.02	0.31	1.02
Hg	2830	0.999	0.020	0.07	0.99	3.32
K	97111	0.999	0.002	0.007	0.11	0.36
Mg	311263	0.999	0.0009	0.003	0.04	0.14
Na	585630	0.999	0.003	0.01	0.17	0.58
Zn	18886	0.999	0.006	0.02	0.29	0.98

R<sup>2</sup>: linear correlation coefficient; a: slope of the calibration curve; LOD: limit of detection; LOQ: limit of quantification; <sup>a</sup>instrumental; <sup>b</sup>method.

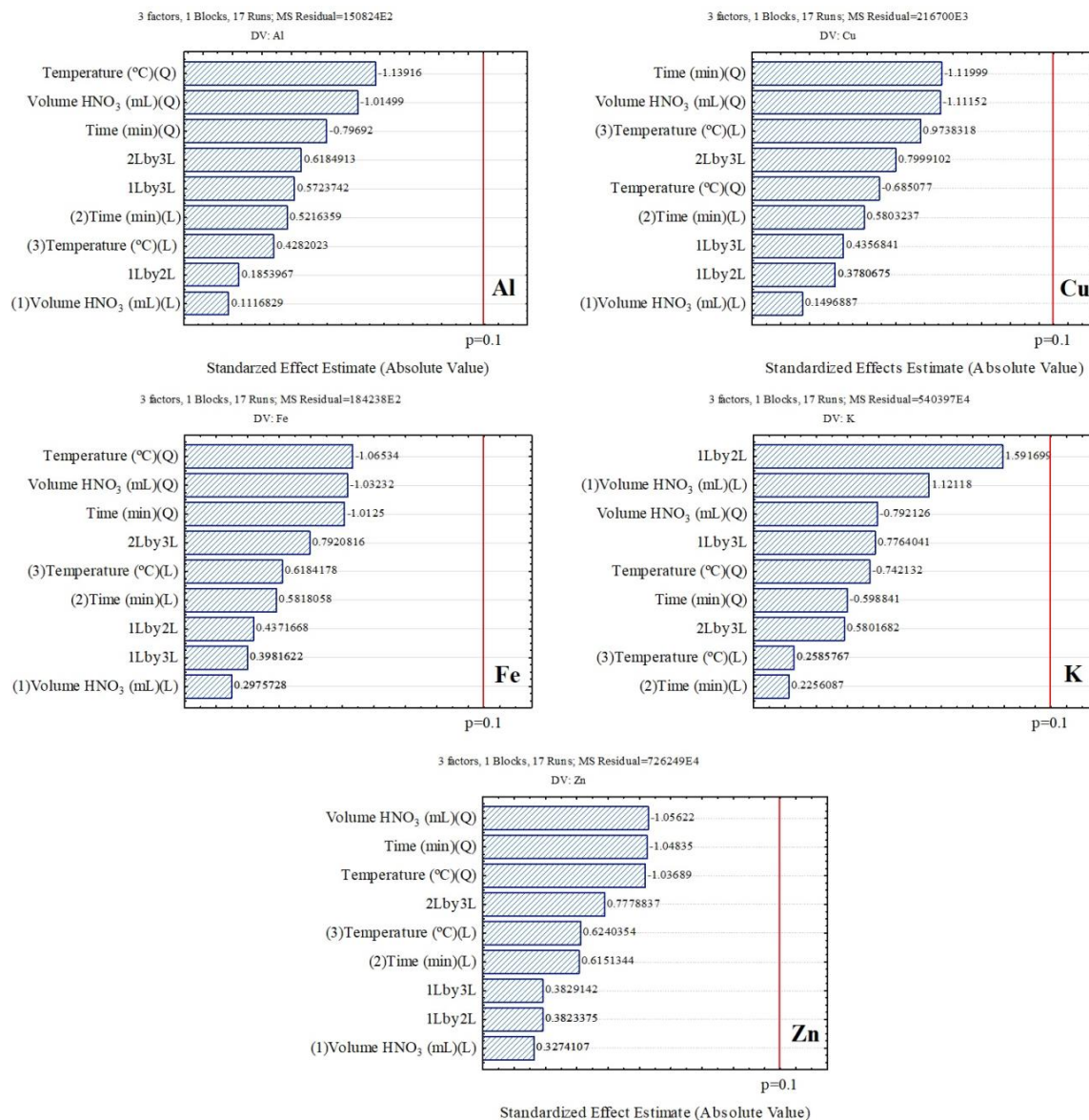
**Table S6.** Figures of merit for the determination of Al, Ca, Cd, Cr, Cu, Fe, Hg, K, K, Mg and Zn in chicken breast samples by MIP-OES using multimode sample introduction system

Analyte	a / (L $\mu\text{g}^{-1}$ )	R <sup>2</sup>	LOD <sup>a</sup> / ( $\mu\text{g L}^{-1}$ )	LOQ <sup>a</sup> / ( $\mu\text{g L}^{-1}$ )	LOD <sup>b</sup> / ( $\mu\text{g kg}^{-1}$ )	LOQ <sup>b</sup> / ( $\mu\text{g kg}^{-1}$ )
Al	37.33	0.992	0.27	0.90	27.06	90.18
Ca	688.71	0.993	0.01	0.035	1.06	3.53
Cd	37.16	0.999	0.045	0.15	4.51	15.03
Cr	76.35	0.999	0.004	0.015	0.45	1.49
Cu	297.71	0.999	0.006	0.02	0.65	2.17
Fe	26.08	0.993	0.14	0.47	14.13	47.09
Hg	120.53	0.998	0.005	0.02	0.26	0.87
K	91.30	0.998	0.09	0.31	9.34	31.14
Mg	492.31	0.999	0.003	0.01	0.34	1.13
Zn	22.67	0.992	0.32	1.06	31.77	105.92

R<sup>2</sup>: linear correlation coefficient; a: slope of the calibration curve; LOD: limit of detection; LOQ: limit of quantification; <sup>a</sup>instrumental; <sup>b</sup>method.

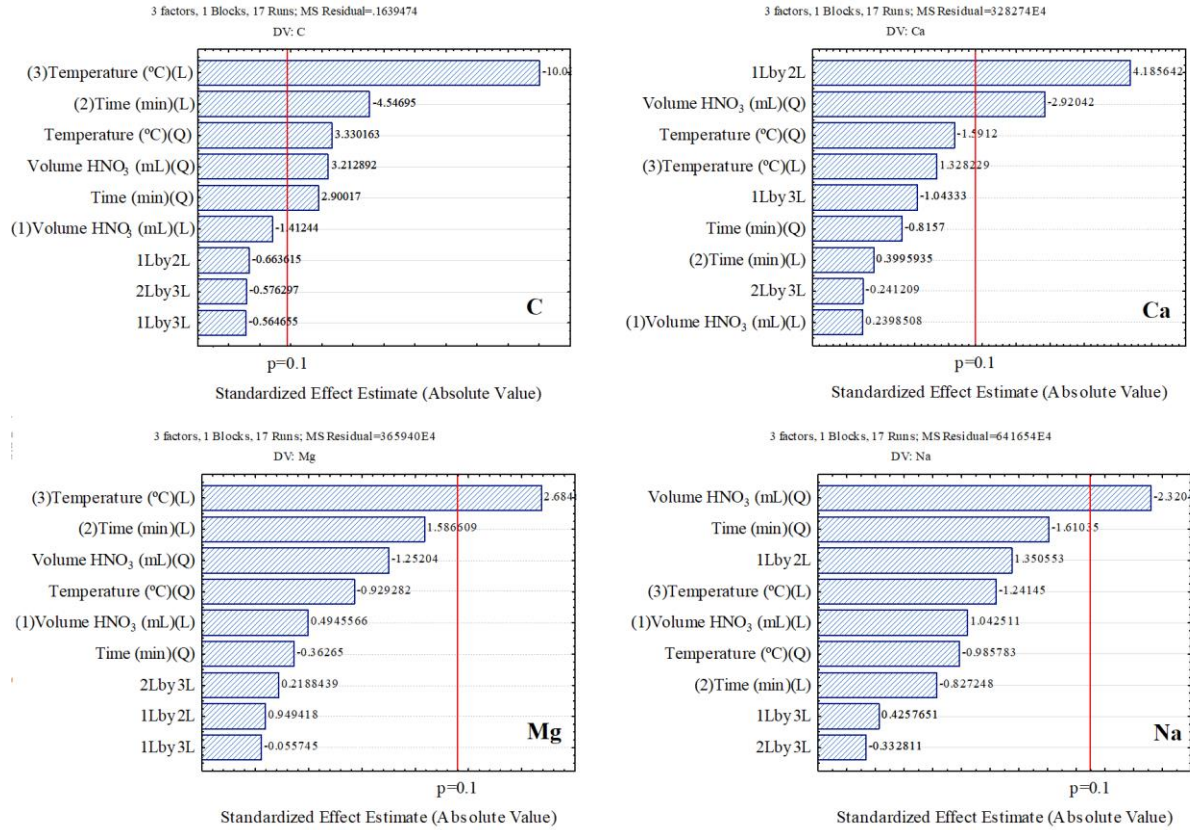


**Figure S1.** Schematic diagram of cold finger coupled to glass digester tube. 1: water inlet; 2: water outlet; 3: end cap of PTFE; 4: outlet to gas; 5: reaction flask.



**Figure S2.** Pareto chart obtained by central composite design for the optimization of the variables for Al, Cu, Fe, K and Zn determinations in chicken breast samples.





**Figure S3.** Pareto chart obtained by central composite design for the optimization of the variables for Ca, Mg, Na and C determinations in chicken breast samples.