

Mineral and heavy metal contents of ice-cream wafer, biscuit and gofret wafers

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Received: 29 August 2012; Accepted: 17 September 2012

Abstract

Macro- and micro elements of ice-cream wafer, biscuit and gofret wafers purchased from several local markets in Konya were determined by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES). Ca, K, Mg and Na contents of all samples were found at high levels. Micro element and heavy metal contents of samples ranged at levels between 0.25 mg/Kg to 540.01 mg/Kg. B levels of some ice-cream wafers were found at high levels. Heavy metal contents of creams were found low compared with individually biscuit and gofret wafers.

Keywords: ice-cream wafer, biscuit, gofret, heavy metal, ICP-AES

1. Introduction

Pollution in the environment and consequently in agricultural raw materials are emerging as safety major concerns across the world. A case of environmental pollution confronted very frequently and threatening food safety is due to heavy metals. The effect of environmental pollution on contamination of foods and on their safety for human consumption is a serious global public issue and widely addressed [1-4]. Heavy metals composition of foods is of interest because of the essential of toxic nature [5]. Metals such as lead, mercury, cadmium, and copper are cumulative poisons, which cause environmental hazards and are reported to be exceptionally toxic [6,7]. On consumption of food in the diet, the trace metal contents of food are directly take into the body [8-10].

Biscuits and gofret are important ready to eat food products. Children also consume biscuits, gofret and ice-cream wafer in large amounts. Therefore the trace heavy metal ions content in biscuits, gofret and ice-cream wafers are important. Biscuits are an

important product in human diet and are usually eaten with tea and are also used as wearing food for infants. The school going children who are often under weight use them a snacks while at school [11]. The adults use them as snacks between meals. Biscuits are also used as refreshment item in meetings and for guests' entertainment [12].

In the present work, the levels of micro- and macro elements were determined in selected biscuits and their creams, gofret wafer and corresponding creams and ice-cream wafers by ICP-AES after wet digestion.

2. Materials and Method

2.1. Materials

All reagents used in experiment were of analytical reagent grade. Double deionized water was used for all solutions. In addition, sulphuric acid, nitric acid and hydrogen peroxide were of supra-pure quality (Merck-Darmstadt). Also, all the plastic and glass materials were cleaned by soaking in dilute H₂SO₄,

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and were rinsed with distilled water prior to use. Biscuits, ice-cream wafer and gofrets were purchased from several local markets for further processing. Cream was individually removed from biscuits and gofret. Biscuits, gofret wafer and ice-cream wafer were individually ground, and dried at 70 °C for 24 h. Each one material was analysed separately for mineral and heavy metals.

2.2. Determination of mineral contents

Collected samples were dried at 70 °C in a drying cabinet with air-circulation until they reached constant weight. Later, about 0.5 g dried and ground sample was digested by using 5 mL of 65% HNO₃ and 2 mL of 35% H₂O₂ in a closed microwave system (Cem-MARS Xpress). The volumes of the digested samples were completed to 20 mL with ultra-deionized water and mineral concentrations were determined by inductively coupled plasma-optical emission spectroscopy (ICP AES; (Varian-Vista, Australia). Measurements of mineral concentrations were checked using the certified values of the related minerals in the reference samples received from the National Institute of Standards and Technology (NIST; Gaithersburg, MD, USA) [13].

Working conditions of ICP-AES: Instrument: ICP-AES (Varian-Vista); RF Power: 0.7-1.5 kw (1.2-1.3 kw for Axial); Plasma gas flow rate (Ar): 10.5-15 L/min. (radial) 15 “ (axial); Auxiliary gas flow rate (Ar): 1.5 “; Viewing height: 5-12 mm; Copy and reading time: 1-5 s (max.60 s); Copy time: 3 s (max. 100 s).

2.3. Statistical analyses

Results of the research were analysed for statistical significance by analysis of variance [14]. This research was performed by three duplicates with a replicate.

3. Results and Discussion

Macro element contents obtained on the ice-cream wafer, gofret and biscuits are given as mean values and Standard deviations in Table 1.

Potassium contents of ice-cream wafers ranged at the levels between 1249 mg/Kg to 2019 mg/Kg. While Mg contents are found between 311.1 to 1032

mg/Kg, Na contents were established between 1352 mg/Kg to 5742 mg/Kg. Calcium contents of wafers were determined at the low levels.

K, Na and P contents of biscuits were found at high levels. While macro element contents of biscuits were found high, these data were established low levels in corresponding creams. In some biscuit creams, Ca, K and Mg could not be determined.

K, Na and P contents of gofrets were found at high levels. K content of gofrets changed between 10 mg/Kg to 2853 mg/Kg. Na contents of gofrets were found between 569 to 6708 mg/Kg. At the same form, gofret creams contained macro elements at the low concentrations. Some creams did not contain Ca and Mg. Both biscuits and gofrets contained macro elements at the high levels compared with corresponding creams.

Micro element and heavy metal concentrations of samples are presented in Table 2. B contents changed at levels between 1.67 mg/Kg to 540.01 mg/Kg. B levels of some ice-cream wafers were found high levels. Micro element and heavy metal contents of other samples ranged 0.25 mg/Kg (Cr) to 13.52 mg/Kg (Zn). Cu content changed between 1.77 mg/Kg to 6.82 mg/Kg. Mn contents of ice-cream wafers ranged between 4.04 to 10.60 mg/Kg. Zn values were found between 6.75 mg/Kg to 13.52 mg/Kg.

Micro element and heavy metal contents of biscuits were found at low levels. Zn contents of biscuits changed between 0.19 mg/Kg to 8.62 mg/Kg. In addition, B contents of biscuits ranged between 2.03 mg/Kg to 15.38 mg/Kg. Heavy metal contents of creams were found low compared with individually biscuits. In some biscuit creams, B, Cu, Fe and Mn could not be established.

Fe, Mn and Zn contents of gofret wafers were found partly high levels compared with other heavy metals. While Fe contents of gofret were found between 1.62 mg/Kg to 26.65 mg/Kg, Mn contents changed at levels between 4.64 mg/Kg to 13.50 mg/Kg. Zn contents changed between 0.23 mg/Kg to 9.52 mg/Kg. In addition, Zn contents of gofret creams ranged between 0.23 mg/Kg to 7.72 mg/Kg. Generally, heavy metals of gofret creams were found low levels compared with corresponding gofret wafers.

Gopalani et al. [7] reported 0.8-15.5 µg/g Zn, 3.296-10.5 µg/g Ni, 0.451-1.05 µg/g Co, 0.499-2.199 µg/g Mn, 0.699-23.501 µg/g Fe and 1.05-3.961 µg/g Cu

in potato chips. The same researchers established 3.25-13.4 µg/g Zn, 5.7-8.55 µg/g Fe and 14.35-126-518 µg/g Al in biscuit samples. Awan et al. [11] reported that biscuits contained 0.46-0.91 % ash.

Metals like iron, copper, zinc and manganese are essential metals for humans, since they play an important role in biological systems, but the essential heavy metals can produce toxic effects when their intake is excessively elevated [7,10,15,16].

4. Conclusion

As a conclusion, among the biscuit, ice-cream wafer and gofret wafers were partly poor in minerals particularly in Ca and Mg. The FAO/WHO expert committee, recommended that the daily intakes of iron for different age groups are between 5 to 10 mg for children, 5 to 9 mg for adult man and 14 to 28 mg for adult women [17]. In conclusion, the present study provides useful guide for biscuits, gofret wafer and ice-cream wafers and biscuit and wafer preparation taking into consideration the heavy metal toxicity effects. In general during biscuit and wafer production, the possible sources of contamination are metal surfaces in contact with the material and those present in air and environment. Kind of fuel is also influence on residues of heavy metals.

Acknowledgments: This work was supported by Selçuk University Scientific Research Project (S.U.-BAP. Konya-Turkey).

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Table 1. Macro element concentrations. Data are presented as means±SD, n = 4 replicates. (mg/kg; dry matter)

Samples:	Ca		K		Mg		Na		P		S	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Ice-Cream												
A	114.9 ± 5.6		2019 ± 39		534.5 ± 8.7		5742 ± 87		1720 ± 50		922 ± 16	
B	0.0 ± 0.0*		1270 ± 26		1032.7 ± 5.2		1352 ± 17		1248 ± 6		1101 ± 13	
C	69.6 ± 3.1		1387 ± 28		311.1 ± 4.1		2630 ± 36		1301 ± 28		1084 ± 31	
D	128.3 ± 2.1		1648 ± 23		463.4 ± 7.1		3889 ± 57		1520 ± 27		1291 ± 17	
E	21.1 ± 1.6		1297 ± 15		409.1 ± 1.0		2022 ± 52		1409 ± 15		1025 ± 10	
F	18.8 ± 1.5		1249 ± 16		341.9 ± 4.2		1700 ± 20		1129 ± 8		1066 ± 15	
G	21.1 ± 1.6		1297 ± 15		409.1 ± 1.0		2022 ± 52		1409 ± 15		1025 ± 10	
H	114.9 ± 3.0		1756 ± 9		376.7 ± 3.6		3543 ± 40		1303 ± 40		907 ± 6	
I	118.3 ± 4.4		1820 ± 9		393.3 ± 0.8		3411 ± 43		1303 ± 35		895 ± 2	
Biscuits with creams												
BC1	0.0 ± 0.0		1563 ± 22		352.8 ± 3.1		7287 ± 49		2698 ± 10		689 ± 6	
BC2	0.0 ± 0.0		274 ± 14		17.6 ± 0.9		1187 ± 142		1139 ± 42		100 ± 2	
BC3	0.0 ± 0.0		1494 ± 51		330.4 ± 10.3		6245 ± 178		2182 ± 18		568 ± 18	
BC4	442.5 ± 22.5		763 ± 30		40.3 ± 2.1		1674 ± 58		1216 ± 9		112 ± 11	
BC5	0.0 ± 0.0		1373 ± 12		304.2 ± 0.9		7211 ± 72		2136 ± 30		650 ± 5	
BC6	184.9 ± 11.7		460 ± 13		27.0 ± 2.2		916 ± 33		737 ± 15		89 ± 2	
BC7	0.0 ± 0.0		1443 ± 28		311.2 ± 2.4		3814 ± 125		1109 ± 35		541 ± 12	
BC8	0.0 ± 0.0		0 ± 0		0.0 ± 0.0		515 ± 25		467 ± 18		13 ± 1	
BC9	0.0 ± 0.0		1546 ± 17		362.8 ± 7.8		4608 ± 82		1521 ± 54		603 ± 19	
BC10	9.9 ± 0.6		316 ± 12		0.0 ± 0.0		1023 ± 31		994 ± 23		61 ± 0	
BC11	11.4 ± 1.2		1751 ± 14		460.5 ± 4.3		4607 ± 57		1930 ± 19		651 ± 12	
BC12	0.0 ± 0.0		28 ± 1		0.0 ± 0.0		484 ± 27		490 ± 8		17 ± 1	
BC13	92.2 ± 4.7		1507 ± 17		310.1 ± 3.8		2779 ± 36		1212 ± 19		776 ± 17	
BC14	0.0 ± 0.0		142 ± 6		16.4 ± 1.2		609 ± 8		567 ± 6		102 ± 5	

Table 1. (continued)**Gofrets**

G1	1473 ± 8.2	1843 ± 16	463.8 ± 2.5	4474 ± 42	2384 ± 22	859 ± 24
G2	0.0 ± 0.0	239 ± 7	29.4 ± 0.8	574 ± 15	647 ± 8	121 ± 1
G3	152.6 ± 2.2	2068 ± 20	523.0 ± 10.2	5845 ± 73	3263 ± 39	847 ± 22
G4	0.0 ± 0.0	312 ± 8	95.2 ± 3.0	789 ± 45	774 ± 21	199 ± 7
G5	73.1 ± 2.5	1737 ± 3	374.9 ± 1.7	2394 ± 9	1463 ± 2	677 ± 3
G6	0.0 ± 0.0	1067 ± 29	205.5 ± 2.0	1247 ± 62	1144 ± 31	253 ± 8
G7	241.5 ± 10.9	2154 ± 13	315.9 ± 2.1	4622 ± 67	1944 ± 13	792 ± 32
G8	1767.4 ± 18.0	2853 ± 75	265.1 ± 7.4	3049 ± 68	1909 ± 45	432 ± 13
G9	114.7 ± 3.5	2023 ± 23	528.2 ± 6.8	3703 ± 23	1480 ± 15	892 ± 4
G10	369.8 ± 7.9	991 ± 23	216.1 ± 5.3	1290 ± 57	987 ± 28	309 ± 11
G11	46.6 ± 2.3	1417 ± 10	403.1 ± 5.5	1415 ± 28	1176 ± 10	709 ± 12
G12	0.0 ± 0.0	239 ± 15	0.0 ± 0.0	985 ± 82	548 ± 12	47 ± 3
G13	47.6 ± 2.6	962 ± 36	250.0 ± 4.1	2142 ± 89	831 ± 26	618 ± 9
G14	0.0 ± 0.0	10 ± 1	0.0 ± 0.0	569 ± 35	465 ± 5	38 ± 3
G15	54.8 ± 1.0	2094 ± 28	434.5 ± 5.3	6708 ± 239	1520 ± 60	862 ± 9
G16	347.7 ± 18.0	616 ± 14	89.4 ± 1.1	1631 ± 80	1162 ± 39	86 ± 6
G17	38.3 ± 3.8	1554 ± 28	425.9 ± 6.8	1589 ± 59	1223 ± 34	757 ± 22
G18	0.0 ± 0.0	265 ± 12	5.6 ± 0.3	851 ± 23	540 ± 14	52 ± 1

*nonidentified

Table 2. Micro element and heavy metal concentrations. Data are presented as means±SD, n = 4 replicates. (mg/kg; dry matter)

Ice-Creams	B		Cr		Cu		Fe		Mn		Ni		Zn	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
A	4.50 ± 0.37		0.55 ± 0.01		2.44 ± 0.06		9.29 ± 0.69		10.39 ± 0.24		0.88 ± 0.07		9.17 ± 0.37	
B	7.55 ± 0.35		0.45 ± 0.05		2.61 ± 0.06		4.40 ± 0.04		4.63 ± 0.05		0.47 ± 0.04		7.29 ± 0.33	
C	2.94 ± 0.24		0.27 ± 0.03		2.48 ± 0.04		4.98 ± 0.38		5.32 ± 0.14		0.28 ± 0.02		9.29 ± 0.22	
D	1.67 ± 0.20		0.60 ± 0.04		3.17 ± 0.10		8.67 ± 0.93		10.60 ± 0.14		0.46 ± 0.02		13.52 ± 0.20	
E	536.63 ± 13.02		0.25 ± 0.03		6.82 ± 0.41		2.57 ± 0.16		5.78 ± 0.03		0.48 ± 0.03		11.59 ± 0.32	
F	540.01 ± 9.57		0.47 ± 0.04		2.36 ± 0.04		4.30 ± 0.14		4.04 ± 0.08		0.36 ± 0.03		8.33 ± 0.46	
G	536.63 ± 13.02		0.25 ± 0.03		6.82 ± 0.41		2.57 ± 0.16		5.78 ± 0.03		0.48 ± 0.03		11.59 ± 0.32	
H	24.94 ± 3.15		0.55 ± 0.02		1.77 ± 0.09		6.10 ± 0.29		7.95 ± 0.13		0.25 ± 0.03		6.77 ± 0.15	
I	18.97 ± 1.61		0.50 ± 0.01		1.87 ± 0.14		4.59 ± 0.23		6.94 ± 0.02		0.38 ± 0.04		6.75 ± 0.02	

Biscuits with creams														
	B		Cr		Cu		Fe		Mn		Ni		Zn	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
BC1	15.38 ± 1.89		0.35 ± 0.03		2.47 ± 0.10		3.81 ± 0.31		7.15 ± 0.05		0.53 ± 0.05		8.62 ± 0.23	
BC2	9.99 ± 0.60		0.66 ± 0.07		0.27 ± 0.03		0.00 ± 0.00		0.00 ± 0.00		0.42 ± 0.04		0.31 ± 0.04	
BC3	7.14 ± 0.50		0.35 ± 0.04		1.79 ± 0.09		0.74 ± 0.04		6.67 ± 0.34		0.35 ± 0.02		7.07 ± 0.24	
BC4	4.82 ± 0.54		0.60 ± 0.02		0.00 ± 0.00		0.00 ± 0.00		0.00 ± 0.00		0.25 ± 0.02		1.79 ± 0.14	
BC5	3.85 ± 0.46		0.31 ± 0.03		1.98 ± 0.07		6.23 ± 0.37		5.36 ± 0.05		0.50 ± 0.04		7.33 ± 0.19	
BC6	2.03 ± 0.16		0.30 ± 0.01		0.33 ± 0.04		0.00 ± 0.00		0.00 ± 0.00		0.27 ± 0.03		1.42 ± 0.16	
BC7	0.00 ± 0.00*		0.28 ± 0.02		2.08 ± 0.13		6.81 ± 0.29		6.17 ± 0.44		0.48 ± 0.02		6.13 ± 0.15	
BC8	0.00 ± 0.00		0.33 ± 0.02		1.02 ± 0.11		0.00 ± 0.00		0.00 ± 0.00		0.54 ± 0.04		0.66 ± 0.04	
BC9	0.00 ± 0.00		0.41 ± 0.02		2.28 ± 0.31		5.80 ± 0.40		7.84 ± 0.18		0.33 ± 0.04		9.04 ± 0.62	
BC10	0.00 ± 0.00		0.54 ± 0.03		0.38 ± 0.05		0.00 ± 0.00		0.00 ± 0.00		0.67 ± 0.02		1.02 ± 0.07	
BC11	0.00 ± 0.00		0.32 ± 0.01		2.17 ± 0.10		2.52 ± 0.15		11.85 ± 0.13		0.66 ± 0.03		8.85 ± 0.46	
BC12	0.00 ± 0.00		0.26 ± 0.03		1.61 ± 0.16		0.00 ± 0.00		0.00 ± 0.00		0.27 ± 0.03		0.19 ± 0.02	

Table 2. (continued)**Gofrets**

G1	0.00 ± 0.00	0.30 ± 0.02	1.77 ± 0.05	5.34 ± 0.34	6.69 ± 0.17	0.59 ± 0.03	6.04 ± 0.49
G2	0.00 ± 0.00	0.36 ± 0.01	0.22 ± 0.02	0.00 ± 0.00	0.00 ± 0.00	0.46 ± 0.04	0.23 ± 0.03
G3	0.00 ± 0.00	0.27 ± 0.01	1.87 ± 0.04	4.98 ± 0.21	7.85 ± 0.11	0.37 ± 0.03	8.16 ± 0.37
G4	0.00 ± 0.00	0.27 ± 0.01	0.27 ± 0.02	0.00 ± 0.00	0.00 ± 0.00	0.24 ± 0.01	0.60 ± 0.02
G5	0.00 ± 0.00	0.44 ± 0.04	3.88 ± 0.19	18.03 ± 0.99	8.94 ± 0.30	0.57 ± 0.05	9.52 ± 0.17
G6	0.00 ± 0.00	0.31 ± 0.02	1.00 ± 0.10	0.00 ± 0.00	0.00 ± 0.00	0.58 ± 0.05	2.29 ± 0.08
G7	0.00 ± 0.00	0.37 ± 0.03	1.63 ± 0.19	18.92 ± 0.49	4.85 ± 0.10	0.61 ± 0.04	5.60 ± 0.09
G8	0.00 ± 0.00	0.68 ± 0.05	1.71 ± 0.07	26.65 ± 0.69	0.40 ± 0.02	1.36 ± 0.12	3.52 ± 0.26
G9	0.00 ± 0.00	0.41 ± 0.01	1.41 ± 0.21	16.60 ± 1.03	5.77 ± 0.22	0.55 ± 0.02	7.39 ± 0.19
G10	0.00 ± 0.00	0.34 ± 0.02	0.39 ± 0.05	0.00 ± 0.00	0.00 ± 0.00	0.36 ± 0.02	7.72 ± 0.18
G11	89.63 ± 3.36	0.25 ± 0.00	2.29 ± 0.28	4.41 ± 0.42	13.50 ± 0.19	0.80 ± 0.04	9.04 ± 0.09
G12	8.03 ± 0.21	0.24 ± 0.02	0.92 ± 0.05	0.00 ± 0.00	0.58 ± 0.02	0.46 ± 0.04	2.80 ± 0.03
G13	1.42 ± 0.08	0.31 ± 0.02	2.30 ± 0.18	3.46 ± 0.22	8.27 ± 0.21	0.57 ± 0.01	7.61 ± 0.29
G14	0.00 ± 0.00	0.48 ± 0.02	0.47 ± 0.02	0.00 ± 0.00	0.00 ± 0.00	0.58 ± 0.05	1.02 ± 0.11
G15	0.00 ± 0.00	0.31 ± 0.02	1.40 ± 0.12	13.18 ± 0.60	4.64 ± 0.22	0.75 ± 0.03	3.83 ± 0.19
G16	0.00 ± 0.00	0.38 ± 0.03	0.55 ± 0.05	0.00 ± 0.00	0.00 ± 0.00	0.35 ± 0.05	0.46 ± 0.06
G17	0.00 ± 0.00	0.30 ± 0.02	2.51 ± 0.16	5.63 ± 0.28	6.34 ± 0.12	0.54 ± 0.04	7.75 ± 0.15
G18	0.00 ± 0.00	0.55 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.44 ± 0.04	0.00 ± 0.00
G1	0.00 ± 0.00	0.27 ± 0.03	1.83 ± 0.02	1.62 ± 0.18	9.04 ± 0.09	0.65 ± 0.04	7.20 ± 0.16
G2	0.00 ± 0.00	0.63 ± 0.05	0.72 ± 0.05	0.00 ± 0.00	0.00 ± 0.00	0.48 ± 0.04	0.79 ± 0.07

*nonidentified