

Instant coffee as a source of calcium and magnesium

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Abstract

Our study aimed at determining the content in Ca and Mg of different instant coffee brands and at determining their daily recommended mineral intake. We determined, by flame atomic absorption, total concentrations of Ca and Mg in five instant coffee brands marketed in different supermarkets in Timisoara, Romania. Experimental results show that the instant coffee brands we analysed contain important amounts of Ca and Mg: thus, their concentration limits ranged between 1.512-1.802 mg/kg (Ca) and 2.500-3.187 mg/kg (Mg). Calculus made to assess Ca and Mg supply to the daily recommended intake per 5 g of instant coffee powder show that the instant coffee brands we studied are not important sources of Ca and Mg despite the Mg supply slightly above normal values.

Keywords: essential elements, minerals, Ca, Mg, instant coffee, mineral

1. Introduction

Instant coffee (soluble coffee), a derivative of roasted coffee bean [1], is known particularly for its flavour and restorative and energising effects; it is also known for its important mineral content. Instant coffee contains, besides polysaccharides (50-60 g/100 g), oligosaccharides (5.2-7.4 g/100 g), proteins (12.6-21.0 g/100 g) and lipids (0.2-1.6 g/100 g), important amounts of minerals ranging within 8.8-10.0 g/100 g of produce [2]. The mineral profile of instant coffee brands is, in general, that of the coffee bean assortments they are made of, which contain over 30 mineral elements such as major elements (macronutrients) – Ca, K, Mg, Na, S, P, minor elements (micronutrients) – Cl, Co, Cr, Se,

Sr, Zn and oligoelements – Al, As, B, Ba, Br, Cd, Hg, Pb, Sn [3].

The analytic methods and practices used to analyse mineral elements in different types of coffee show that instant coffee brands contain important mineral elements such as (mg/kg) Al: <5-223.4; B: 13.3-21.3; Ba: 3.4-3.9; Ca: 110-2,650; Cd: 0.020-0.031; Co: 0.04-14.2; Cr: 0.002-52.0; Cu: 0.30-12.9; Fe: 6.3-451; K: 18.700-61.500; Mg: 840-5,540; Mn: 3.6-49.5; Na: 30-6,670; Ni: 0.04-5.93; P: 350-4,290; Pb: 0.09-0.91; S: 1,480-2,060; Sn: 6.4-11.6; Zn: 1.8-15.0 [3].

Literature on mineral element in instant coffee confirm that minerals are strongly unevenly distributed depending on the nature of the element

and on the coffee make [4, 5, 6, 7, 8, 9]. Analysing 18 samples of commercially available instant coffees by High-resolution continuum source flame atomic absorption (HR-CS-FAAS), Stelmach et al. (2016) [4] determined important amounts of Ca, Fe, Mg and Mn: 1.132-4.960 mg/kg Ca; 2.812-5.080 mg/kg Mg; 19.84-74.0 mg/kg Fe; 1.396-49.2 mg/kg Mn. Dos Santos E. J. and Oliveira E. (2001) determined (by ICP-AES method) a number of mineral elements in 21 brands of Brazilian soluble coffee, showing that they contain essential, toxic elements within the following limits: 3.2500-45.800 mg/kg K; 2.120-4.150 mg/kg Mg; 1.160-1.890 mg/kg Ca; 322-1.743 mg/kg Na; <5-233 mg/kg Al; 14.0-450.8 mg/kg Fe; 6.4-18 mg/kg Sn; 3.62-27.90 mg/kg Mn; 3.17-15.17 mg/kg Zn; 0.54-2.33mg/kg Cu; <2.5 mg/kg Ni; <1.0 mg/kg Pb; <0.25 mg/kg Cd; <0.1 mg/kg Cr [5]. To also note the study by Hernández et al. (2017) who, analysing mineral elements in ground coffee by X-ray Fluorescence (XRF), determined the mineral profile of the *Nescafé Dolca* brand [10]. According to these authors, *Nescafé Dolca* instant coffee has the following mineral profile: Cu (1.2 mg/kg) < Cr (1.7 mg/kg) < Zn (5.2 mg/kg) < Sr (9.2 mg/kg) < Mn (14 mg/kg) < (Rb (18 mg/kg) Br (32 mg/kg) < Na (42 mg/kg) < Fe (72 mg/kg) < S (960 mg/kg) < Ca (2.000 mg/kg) < P (2.100 mg/kg) < Mg (2.400 mg/kg) < K (47.000 mg/kg). similar values of mineral element concentrations were also obtained by Oliveira et al. (2012) [7] who, determining Ca, Mg, K, Na, P, Fe, Mn, Cr and Ni in 49 instant coffee and coffee substitutes, found out that instant coffee assortments are rich in K, Mg and P (> 1.000 mg/kg), moderately rich in Na, Ca and Fe (>10 mg/kg) and traces of Cr and Ni. In a study regarding concentration levels of metals in commercially available Ethiopian roasted coffee powders, Ashu R. and Chandravanshi B. S. (2011) cite the concentration levels of some mineral elements determined by Tortora G.J. (Introduction to Human Body; the Essential of Anatomy and Physiology, 4th ed., John Wiley and Sons: New York; 1997; pp. 472-474) upon analysis of 100 g of Brazilian soluble coffee: Na: 0.05 g; K: 4 g; P: 0.35 g; Ca: 0.35 g; Fe: 45 mg; Cu 0.5 mg; Zn 5 mg; Mg: 0.16-0.31 g [6]. As for the mineral profile (mean values) of instant coffee used to prepare coffee, it can be also found Danish Food Composition Data version 7 [8]. According to this database, total mean concentrations of mineral elements in instant café (powder) have the following values: 410 mg/kg Na;

40.000 mg/kg K; 1.600 mg/kg Ca; 3.900 mg/kg Mg; 3.500 mg/kg P; 44 mg/kg Fe; 5.7 mg/kg Zn; 1 mg/kg Cu; 0.005 mg/kg I; 0.81mg/kg Ni; 0.23 mg/kg Cr.

All this shows that different brands of coffee contain important amounts of essential mineral elements, particularly macroelements such as K, Mg, Ca, P, etc. This justifies the interest in knowing the content of Ca and Mg in instant coffee used to prepare coffee and in assessing their mineral intake. Literature points out that instant coffee is rich in Ca and Mg, essential bioelements playing a crucial role in human and mammal physiology [11]. Ca is a major bioelement contributing to bone growth, to muscle contraction, to the transmission of nervous impulses and to blood clotting [12]. Mg is essential in bone and tooth structure; it acts as cofactor in more than 300 body enzymes, including linking to ATP for kinetic reactions, and it affects excitable membrane permeability and neuromuscular transmission [13].

Our study aimed at determining the content of Ca and Mg in five instant coffee brands marketed in supermarkets in Timisoara, Romania – Amigo, Doncafee, Jakobs Kronung, Jakobs Velvet and Nescafe Brasero – and at assessing their daily recommended mineral intake.

2. Materials and Methods

2.1. Materials

In order to reach our objective, we sampled five instant coffee brands – Amigo, Doncafee, Jakobs Kronung Alint aroma, Jakobs Velvet and Nescafe Brasero – marketed by supermarkets in Timisoara, Romania, for the preparation of coffee. Instant coffee brands are marketed as paper bags containing 2 g of powder. We noted these samples as Instant A, Instant B, Instant C, Instant D and Instant E, which we used as work samples (2.5 g per instant coffee brand).

2.2. Reagents

- Super-pure nitric acid 65% - Merck ($d = 1.39 \text{ g/cm}^3$) to prepare a solution of 0.5 n HNO_3 ;
- Concentrated standard solution of Merck purity to prepare calibration solutions;
- Work standard solutions to dilute the concentrated standard solution: for each element analysed, we prepared six sets of standard solutions to cover the concentration intervals of the elements analysed;

- Distilled water.

2.3. Apparatus

- Spectrophotometer with flame atomic absorption Varian AA 240 FS;

- Thermal regulation electric stove Raypa;

- Calcination oven Nabertherm (max 3000°C);

2.4. Procedure

2.4.1. Determining Total Concentration

Total concentrations in Ca and Mg were determined by atomic absorption according to a protocol described by Gogoasă et al., 2015 [14]. Practically, 2.5 g of sample were calcinated at 550°C in two sessions of 4 hours each. After calcination, the solubilisation of inorganic matter was done in a solution of HNO₃ 0.5 N. To do so, ash samples were treated with 20 mL solution of HNO₃ 0.5 N, evaporated on the electric stove until almost dry, added another 20 mL solution of HNO₃ 0.5 N and the again evaporated; this was done twice, after which the sample was brought up to 50 ml. The clear solution thus obtained was used to determine total content in Ca and Mg by the FAAS method.

2.4.2. Determining Mineral Intake in Daily Recommended Intake

Mineral intake (MI), i.e. the coverage degree of the necessary Ca and Mg in the daily recommended intake was determined with the formula:

$$MI (\%) = \frac{m_c}{m_r} \cdot 100$$

where:

MI – mineral supply (%); m_c – bio-accessible amount of element in coffee instant consumed (g); m_r – amount of element recommended for the daily intake (g).

3. Results and Discussions

3.1. Total concentration of Ca and Mg in instant coffee

Results show that total concentrations of Ca and Mg in the studied instant coffee brands are as presented in Table 1 below.

Table 1. Concentration of Ca and Mg in some instant coffee brands

Coffee brands	Elemental content, mg/kg	
	Ca	Mg
Instant A	1.802	3.187
Instant B	1.512	2.500
Instant C	1.696	2.824
Instant D	1.621	2.736
Instant E	1.663	2.953
Mean values	1.659	2.840

Data presented in Table 1 show that the instant coffee brands analysed have different concentrations of Ca and Mg.

Mg is the best represented in all coffee samples: it has close values ranging with 2.500-3.185 mg/kg. A classification of coffee brands depending on their content in Mg would be inconclusive. However, there are slightly higher concentrations of Mg in Instant A (3.185 mg/kg) and Instant E (2.953 mg/kg). Instant B is poorer in Mg (2,500 mg/kg). Instant C and Instant D have very close concentrations of Mg (2.824 mg/kg and 2.736 mg/kg, respectively) and concentrations of Mg close to the mean of the five coffee brands (2.840 mg/kg).

Compared to Mg, Ca had clearly lower concentrations in all coffee samples we analysed. Ca distribution is even in all coffee brands analysed, ranging within 1.512-1.802 mg/kg, which make it difficult to establish a hierarchy depending on Ca content. There is a slightly higher content in Ca in Instant 1 (1.802 mg/kg), the other coffee sample having very close Ca contents: 1.512 mg/kg (Instant B), 1.696 mg/kg (Instant C), 1.621 mg/kg (Instant D) and 1.663 mg/kg (Instant E), close to the mean of analysed coffee brands (1.659 mg/kg). The measured levels of Ca and Mg do not allow the establishment of a hierarchy depending on these parameters. However, if we take into account the total amounts of Ca and Mg in our experimental instant coffee brands, we can say that the intake of these elements has the following descending trend: Instant A > Instant E > Instant > Instant C > Instant D > Instant B.

Comparing experimental results with the levels reported by other authors for similar instant coffee brands – Ca: 110-2.650 mg/kg and Mg: 840-5.540 mg/kg [3]; Ca: 1.132-4.960 mg/kg and Mg: 2.812-5.080 mg/kg [4]; Ca: 2.000 mg/kg and Mg: 2.400 mg/kg [10]; Ca: 3.500 mg/kg and Mg: 1.600-3.100 mg/kg [6]; Ca: 2.120-4.150 mg/kg and Mg: 1.160-1.890 mg/kg [5]; Ca: 1.160-1.890 mg/kg and Mg:

2.120-4.150 mg/kg [8] – we see that there are no notable differences.

3.2. Assessing Ca and Mg intake in instant coffee

Higher concentrations of Ca and Mg in instant coffee brands – 1.512-1.802 mg/kg (Ca) and 2.500-3.185 mg/kg (Mg) – allow us to determine the recommended daily intake of Ca and Mg from a certain coffee preparation. We aimed at assessing the degree of coverage of the necessary daily intake of Ca and Mg from supplementary sources such as coffee preparations.

When determining mineral intake, we took into account bioaccessible concentrations of Ca and Mg, i.e. amounts that can be really absorbed (after the gastrointestinal enzymatic digestion) and used for the body physiological functions [4]. To convert total experimental concentrations into bioaccessible concentrations, we used mean values of Ca and Mg bioaccessibility such as determined by Stelmach et al., 2016 [4] in popular instant coffee brews: 49.8% for Ca and 76.0% for Mg.

Bioaccessible concentrations of Ca and Mg (Table 2) and the necessary Ca and Mg in the recommended daily intake allowed the estimation of the mineral intake from the studied instant coffee brands.

Table 2. Concentration of Ca and Mg in coffee instant powders

Specification	Mineral content (mean values), mg/kg	
	Ca	Mg
Total content	8.32	14.77
Bioaccessible content	4.07	11.22

The necessary daily intake of Ca and Mg in people aged 19-50 is 1,000 mg Ca in men and women, or 400 mg Mg in men and 320 mg Mg in women [15].

The levels of Ca and Mg intake from coffee preparations for a daily consumption of two cups of coffee (the equivalent of 5 g of instant coffee powder) are shown in Table 3 below.

Table 3. Intake of Ca and Mg from instant coffee preparation (5 g of instant coffee powder) for men and women aged 19-50

Specification	Mineral intake, %	
	Ca	Mg
Men	0.41	2.81
Women	0.41	3.51

Data presented in Table 3 shows a low and very low degree of coverage of the necessary Ca and Mg: 2.81-3.51% in Mg and 0.41% in Ca. Therefore, given our experiment, instant coffee brands cannot be important sources of Ca and Mg despite the slight supplement of Mg. This finding is confirmed by Oliveira et al., 2012 [7], who showed that a consumption of coffee preparation from 4 g of instant coffee powder cannot be considered an important source of minerals, despite the supplementing of Mg and Mn.

4. Conclusions

Instant coffee brands marketed in Timisoara, Romania, contain important amounts of Ca and Mg ranging within 1.512-1.802 mg/kg in Ca and 2.500-3.187 mg/kg in Mg.

The degree of coverage of the necessary daily intake of Ca and Mg for a consumption of a coffee preparation from 5 g of instant coffee powder is low and very low: 2.81-3.51% in Mg and 0.41% in Ca.

Within the current study, instant coffee brands cannot be considered important sources of Ca and Mg, despite the slight supplementing of Mg.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

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