Iron and Magnesium Determination in Meat using Flame Atomic Absorption Spectroscopy

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Application Note 43190

Key Words
Food, iron, magnesium, meat

Goal

This application note describes the analysis of iron and magnesium in various meat samples by flame atomic absorption spectroscopy following microwave digestion.

Introduction

There are many minerals that are present in the diet that are of nutritional significance. These are divided into two groups; essential and trace minerals, which are related to the quantity required and found in the body. The essential minerals include magnesium, sodium and calcium; trace minerals include iron, copper and zinc. Iron is the central metal in the haemoglobin molecule used for transporting oxygen in the blood and is a portion of the myoglobin protein located in muscles[1,2]. Magnesium has many roles which include supporting the immune system, the synthesis of proteins, fat, nucleic acids and glucose metabolism, as well as being used in the membrane transport system of cells. Magnesium is also important for muscle contraction and cell integrity.

The Recommended Daily Intake (RDI) of metal requirements are continually being reviewed in the light of more research that is being undertaken by food regulating bodies[1,2].

Flame Atomic Absorption can provide a fast and easy solution to monitor essential and trace minerals in food samples such as meat which is a primary source for these important elements.

Method

Instrumentation

Flame Atomic Absorption Spectrometry (FAAS) is a recognised technique for iron and magnesium analysis in a variety of sample matrices. The Thermo Scientific™ iCE™ 3300 AA was used for the FAAS measurements of these metals in different meat samples. The system allows iron and magnesium determination in samples with a complex matrix without affecting the data obtained. Each measurement was performed in triplicate and the final set of spectrometer parameters used is shown in Table 1 and Figure 1.

Table 1. Instrument settings for the iCE 3300 AA.

Parameter	Iron	Magnesium
Wavelength	248.3 nm	285.2 nm
Band pass	0.2 nm	0.5 nm
Background Correction	D2	D2
Lamp Current	75%	75%
Signal Measurement	Continuous	Continuous
Measurement Time	4s	4s
Replicates	3	3

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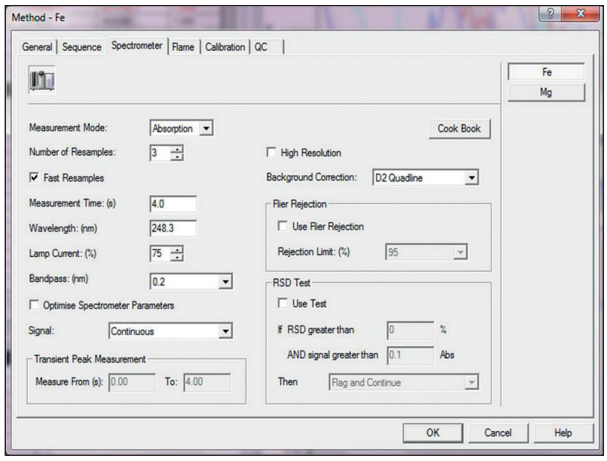

Figure 1: An example of Spectrometer parameters for iron.

Sample Preparation

Standards

Iron and magnesium stock standard solutions containing 1000 mg/L of each were diluted with a pre-mixed solution of deionised water and analytical grade concentrated nitric acid to provide a working standard of 5 ppm in 2% (w/v) HNO_3. The calibration blank solution used throughout was a 2% w/v HNO_3 solution.

Samples

Three different types of meat product were investigated in this study; beef, chicken and pork. The meat was weighed (1g) and transferred into a digestion vessel. The microwave digestion vessels containing the samples were placed in a fume extraction hood before adding concentrated HNO_3 (5 mL) and DI ultra-pure water (4 mL). The vessels were left for at least 30 minutes without their lids to allow gases to escape. After this time the vessels were placed into a microwave digestion system and digested (Table 2). Spike samples were prepared in a similar manner to give the overall expected spike concentration of 2 ppm.

Table 2. Microwave digestion program used for the samples.

Step	Time (min)	Temp. 1 (°C)	Temp. 2 (°C)	Pressure (bar)	Power (W)
1	10	180	110	45	1500
2	15	180	110	45	1500

This procedure was used to prepare the sample blanks and spikes. All the samples were prepared in duplicate unless stated otherwise. After digestion, the samples were further diluted to ensure that the expected concentration fell within the calibration range.

Results

The calibration curve was obtained using the manually prepared standards using the normal method of quadratic least squares fit. A typical calibration curve obtained during the analysis using this method had an R2 factor of 0.999 or greater. An example of the calibration curve is given in Figure 2.

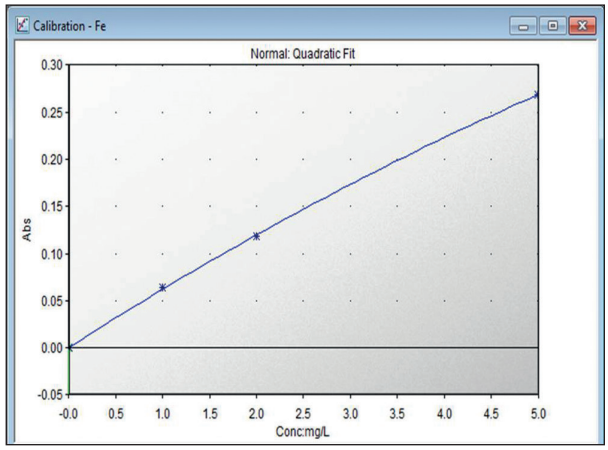

Figure 2: An example of a calibration curve for iron.

The results indicate that these meat samples do not exceed the recommended daily intake (RDI) of 15 mg/kg for iron and 350 mg/kg for magnesium.

Table 3. Results to show the measured concentration of Iron and Magnesium measured in the meat samples.

Sample ID	Measured concentration Iron (mg/kg)	Measured concentration Magnesium (mg/kg)
Beef*	1.865	17.353
Chicken*	0.436	19.579
Pork*	1.387	16.395

Table 4. Results show the expected and measured concentrations with the percentage spike recovery in the meat samples.

Sample ID	Expected spike concentration (mg/kg)		Measured spike concentration (mg/kg)		Spike recovery (%)	
	Iron	Magnesium	Iron	Magnesium	Iron	Magnesium
Beef	3.865	19.353	3.791	19.438	96.3	104.3
Chicken	2.436	21.579	2.296	21.555	93	98.8
Pork	3.387	18.395	3.454	18.24	103.4	92.3

*All data was calculated from 3 replicate readings for each solution using transient peak height measurements.

Conclusion

The Thermo Scientific iCE 3300 AA is an ideal solution for iron and magnesium determination in digested meat samples as demonstrated by the results. The optimization wizards within the Thermo Scientific™ SOLAAR™ software make method development simple and ensure optimum analytical conditions. Significant background effects were accurately corrected for by the D2 background correction which is standard on the iCE 3300 AA.

References

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2. "Understanding Nutrition" by Whitney, E.N, and S.R Rofles, eds. 2002, edited by Thomas Learning, Inc.

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AN43190-EN 0416C