Low-Level Analysis of Arsenic Species

in Apple Juice by LC-ICP-MS

Trace Elements in Foods and Beverages

The presence of potentially toxic chemicals in foodstuffs is of intense public interest, and food producers and regulators strive to ensure that such chemicals are monitored and controlled at concentrations below the levels where they might be harmful.

In the case of some trace elements, such as arsenic (As), tin (Sn) and mercury (Hg), the element's chemical form (or species) has a dramatic influence on toxicity, so simple quantification of the total amount of the element does not give sufficient information to assess food safety. For example, the inorganic forms of As (arsenite (As(III)) and arsenate (As(V)) are much more toxic than the common organic forms. For these elements, chromatographic separation of the different species followed by species-specific quantification using ICP-MS is now widely accepted as the preferred analytical approach.

Arsenic in Apple Juice

Recently, concern has been expressed over the levels of inorganic As in apple juice, with some reports stating that the levels can exceed the USEPA limit for As in drinking water (10 ug/L or ppb). Arsenic in apple juice may be derived from the historical use of the As-based pesticides lead hydrogen arsenate and calcium arsenate. Widespread use of these chemicals ceased in the 1970s, but they are persistent and may still affect crops grown on contaminated land.

In this study, we used an Agilent 1200 Infinity LC coupled to an Agilent 7700x quadrupole ICP-MS to separate and measure the As species in six commercial apple juices purchased from a Japanese supermarket. The apple juice samples were prepared by simple filtration and a 2x dilution in deionized water, ensuring that species inter-conversion was minimized and detection limits were maintained. The species of interest, As(III), As(V) and the organic forms arsenobetaine (AB), dimethylarsinic acid (DMA) and monomethylarsonic acid (MMA) were separated using an Agilent anion exchange column (guard column: P/N G3154-65002, speciation column P/N G3288-80000).

Calibrations for the toxic inorganic As species are shown in Figure 1. The calibration range was from 10 to 500 ng/L (ppt) illustrating the good sensitivity and linearity at these sub-ppb levels. Overlaid chromatograms for four of the samples are shown in Figure 2, and concentrations for each species in all six apple juice samples are shown in Table 1. The results are corrected for the 2x dilution factor applied during sample preparation. From these results, it is clear that all the samples contained some inorganic As, but the levels were low (less than half the USEPA limit for drinking water).

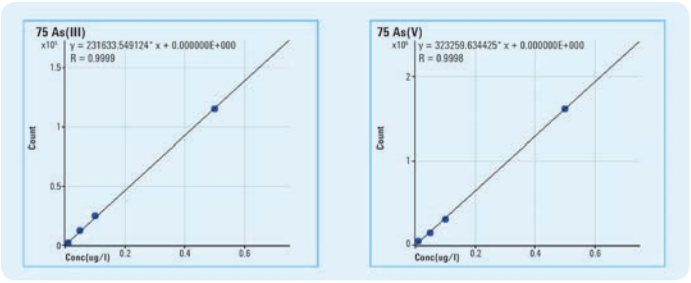

Figure 1. Calibrations for As(III) and As(V) from 10 to 500 ng/L (ppt).

Concentration		AB	DMA	As(III)	MMA	As(V)
Sample Name	Dilution	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Apple Juice 1	2	0.036	0.189	0.724	N/D	0.651
Apple Juice 2	2	0.026	0.022	0.041	N/D	0.058
Apple Juice 3	2	0.02	0.267	0.883	1.587	0.758
Apple Juice 4	2	0.039	0.208	0.992	1.466	1.958
Apple Juice 5	2	0.043	0.209	1.256	0.785	0.709
Apple Juice 6	2	0.036	0.235	1.098	N/D	0.068

Table 1. Concentrations of five As species in six apple juice samples

Low-ppt Level Analysis of As Species

The data presented here demonstrates that the Agilent 7700x ICP-MS is suitable for the analysis of As species at low 10s ppt levels in apple juice. The simple sample preparation, low dilution and rapid, reliable chromatographic separation ensure that this method is suitable for routine monitoring of As species in beverages.

See Agilent application note 5991-0622EN relating to the same method run on the Agilent 8800 ICP-QQQ.

For more information on the 7700 Series visit the Agilent Technologies web site at: **www.agilent.com/chem/icpms**

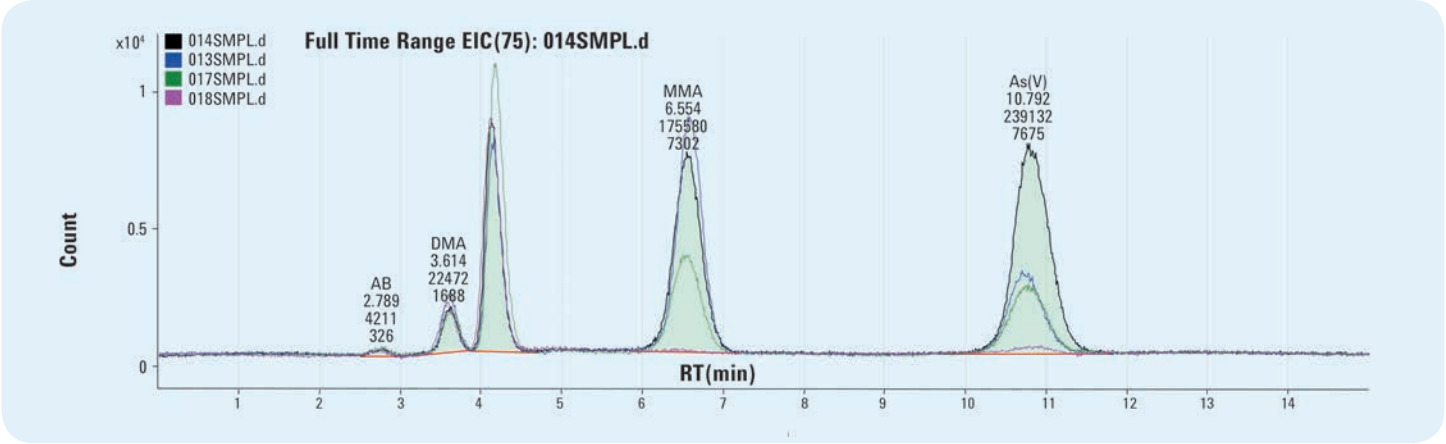

Figure 2. Overlaid chromatograms of As species in four apple juice samples

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