Application Brief

Food

Agilent

Trusted Answers

Analysis of Trace Elements in Palm Oil using ICP-MS

Future proof the quality control of vegetable oils with an Agilent 7800 ICP-MS

Authors

Li Shuping

Agilent Technologies, Inc.

Global demand for palm oil

Palm oil is used in a wide range of food, household, personal, and industrial products. To ensure its quality, refiners of crude palm oil (CPO) typically carry out elemental analysis at different stages of the refining process. Agilent offers a range of atomic spectroscopy instruments that are suitable for the determination of metals and other elements in palm oil. Choosing the best technique for the application may well depend on factors such as regulatory requirements, number of elements, sample matrix, number of samples, lab resources, and detection limit requirements.

Analysis of palm oil samples using ICP-MS

Four palm oil sample types were prepared using two different methods: dilution in xylene and acid digestion. Bleached palm oil (BPO), refined bleached deodorized palm oil (RBDPO), and refined bleached deodorized hydrogenated palm stearin (RBDHPS) were diluted 10 times in xylene, and CPO was diluted 50 times. About 0.5 g of each sample was digested in 6 mL HNO_3 and 2 mL H_2O_2 using a microwave digestion system held at 175 °C for 10 minutes. The volume of the digests was then made up to 50 mL with de-ionized water before analysis by ICP-MS. Calibration standards for the quantification of the digested samples were prepared in 5% HNO_3, while standards for the diluted samples were prepared in xylene.

An Agilent 7800 ICP-MS was used for the analysis. The instrument includes the High Matrix Introduction (HMI) system and the ORS^4 collision/reaction cell. The standard MicroMist nebulizer, Scott-type spray chamber, and one-piece quartz torch with 2.5 mm id injector were used. Ni cones and aerosol dilution (using HMI) were used for the analysis of the sample digests. A 1.5 mm i.d. one-piece torch and Pt cones were used for the analysis of the solvent-diluted samples.

ICP-OES is widely used for the multi-element analysis of vegetable oils. However, if the method detection limit (MDL) requirements for elements such as As, Cd, Hg, and Pb become more stringent, the 7800 ICP-MS provides significantly lower MDLs, as shown in Table 1. The MDLs are based on three sigma of 10 replicate measurements of the calibration blank solutions taken during the analytical run.

Quantitative results by ICP-MS

Quantitative results for eight elements in the palm oil samples were acquired using the 7800 ICP-MS. Since As, Cu, Hg, and Pb were measured below the MDL, results are reported only for Ca, Fe, Mg, and P, which were measured above the MDL (Table 2). There is good agreement between the results for all the 'diluted' and 'digested' palm oil samples, suggesting that the samples can be prepared for analysis following dilution in a suitable solvent.

ICP-OES or ICP-MS?

Generally, ICP-OES is a faster, more robust, and lower-cost technique than ICP-MS. It can easily handle a varied sample workload including samples with varying viscosity content. While ICP-OES is widely used for the multi-element analysis of vegetable oils (*1*), the DL requirements for some elements are expected to become more stringent. As shown, the 7800 ICP-MS offers higher sensitivity and much lower DLs than ICP-OES. Also, the 7800 is more tolerant of high and variable sample matrices than competitive ICP-MS instruments due to its robust plasma (low CeO/Ce ratio) and HMI technology. These features ensure that a stable plasma can be maintained during the analysis of complex sample digests, allowing reliable data to be obtained.

The choice of technique would depend on the specific analytical needs and requirements relating to sample matrix, sample throughput, lab resources, budget, and sensitivity. Generally, Agilent ICP-OES systems are easy to learn, quick to set up, and simple to use. They are also lower in initial capital investment than ICP-MS and have lower operating and maintenance costs. However, Agilent ICP-MS systems have lower DLs, a wider dynamic range, and simpler interference control techniques. Also, auto-optimization tools and preset methods simplify routine analysis, improving performance, ease-of-use, and reliability.

Table 1. Comparison of 7800 ICP-MS and 5110 ICP-OES MDLs in solution for diluted and digested palm oil samples. All units (µg/L).

	Diluted		Digested	
Element	**ICP-MS MDL**	**ICP-OES MDL**	**ICP-MS MDL**	**ICP-OES MDL**
^{24}Mg	0.27	2.0	0.15	0.04
^{31}P	1.6	25	0.65	6.0
^{40}Ca	0.22	1.0	0.037	0.20
^{56}Fe	0.03	11	0.058	1.0
^{63}Cu	0.21	6.0	0.031	0.70
^{75}As	0.036	11	0.013	4.0
^{201}Hg	0.067	11	0.017	2.0
^{208}Pb	0.044	9.0	0.006	4.0

Table 2. ICP-MS results for elements measured at levels above the LOQ in the palm oil samples (mg/kg).

	Ca		Fe	
Sample	**Dilution**	**Digestion**	**Dilution**	**Digestion**
CPO	14.5	14.1	2.91	2.92
BPO	0.063	0.060	<0.001	<0.019
RBDPO	0.059	0.054	<0.001	<0.019
RBDHPS	<0.007	<0.012	<0.001	<0.019

	Mg		P	
Sample	**Dilution**	**Digestion**	**Dilution**	**Digestion**
CPO	3.32	3.42	21.5	21.3
BPO	0.030	<0.048	1.71	1.73
RBDPO	0.043	<0.048	1.05	1.10
RBDHPS	0.027	<0.048	0.15	<0.22

Acknowledgment

Thanks to PT Asianagro Agungjaya, Indonesia for providing the palm oil-based samples used in this study, www.apicalgroup.com/

Reference

1. Elemental Analysis of Palm Oil using ICP-OES, Agilent publication, 5994-1952EN

www.agilent.com/chem

DE.1597685185

This information is subject to change without notice.

© Agilent Technologies, Inc. 2020
Printed in the USA, May 18, 2020
5994-1953EN

Agilent
Trusted Answers