Simultaneous Determination of Content of Ten Heavy Metals in Detergents from China by ICP-MS

ZHANG HONGXING*, XU FANG† and RUI YU-KUI‡

Department of Food Science, Beijing Agricultural College, Beijing 102206, P.R. China
Tel: (86)(10)80794124; E-mail: hxzhang511@163.com

The safety of detergents is attracting increasing attention. The content of heavy metals in four primary brand detergents from the Beijing market were analyzed by ICP-MS. The results show that the heavy metal content of detergents is high, with the Ti content being higher than the other heavy metals. However, heavy metal content varied significantly from brand to brand. The data suggest that consumers should decrease the use of detergents and select brands containing less heavy metal if they must be used. The department with responsibility for the hygiene of detergents should investigate all detergent products to ensure the safety of consumers.

Key Words: Detergent, Heavy metals, Food safety, ICP-MS.

INTRODUCTION

Detergents are indispensable industrial products for washing tableware, vegetable and fruits, upon which modern people increasingly depend. Investigations showed that in 2003, per capita consumption of detergent was 29 kg in the United States, 10 kg in Japan and more than 2 kg in China[1,2]. The large amounts of detergent discharged to the environment and subsequently release many organic pollutants and heavy metals, which damage the environment and human health. It is therefore important to investigate the content of hazardous substances in detergents.

The detection methods for determining heavy metals include atomic absorption spectrometry, atomic fluorescence spectrometry, inductively coupled plasma atomic emission spectrometry (ICP-AES)[3] and inductively coupled plasma mass spectrometry (ICP-MS)[4]. Of these methods, ICP-MS has many advantages, such as the ability to detect many elements simultaneously and high accuracy[5] and has become the most important technique for detecting heavy metals[6-8]. In this study, the ICP-MS method is applied to determine heavy metals in detergents obtained from the Chinese market.

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† Experiment Center of Forest Biology, Beijing Forestry University, Beijing 100083, P. R. China.
‡College of Resources and Environmental Sciences, China Agricultural University, Beijing 100193, P.R. China.

EXPERIMENTAL

Four kinds of detergents were bought from the Chaoshifa supermarket, Beijing. The ICP-MS instrument was the PQ Excell instrument (ELAN DRCII, PE Company, USA).

Sample preparation: The samples were prepared by microwave digestion, detailed methods for which were given by Li[9].

Instrument parameters were as described in the literature[10-12] with some modifications are given in Table-1.

TABLE-1
OPERATING PARAMETERS FOR ICP-MS

Method parameters	Value	Method parameters	Value
Power (W)	1250	Pump rate (rpm)	20
Plasma flow (L/min)	13.0	Rinse time (s)	10
Nebulizer flow (L/min)	0.98	Replicates	5
Auxiliary flow (L/min)	1.25	Replicate read time (s)	8
Sampling depth (mm)	2.0	Instrument stabilization (s)	8
Scanning times	180	Sample delay uptake (s)	60
Exit plate (V)	0	–	–

RESULTS AND DISCUSSION

The correlation coefficients of all detected elements were higher than 0.940. Limits of detection were lower than 1.00 µg/g, except Ti and the relative standard deviations ranged from 1.20 to 8.91 % for all elements (Table-2). These results show that this method for detecting 10 heavy metals simultaneously is simple and precise.

TABLE-2
CORRELATION COEFFICIENT, LIMITS OF DETECTION AND
RELATIVE STANDARD DEVIATIONS OF DETECTED ELEMENTS

Heavy metals	Correlation coefficient	Limits of detection (µg/g)	Relative standard deviations (%)
Ti	0.991	1.06	1.25
Cr	0.987	0.08	2.34
Mn	0.999	0.12	1.50
Ni	0.976	0.23	2.65
Cu	0.994	0.58	5.40
Cd	0.999	0.07	1.20
Pb	0.999	0.05	2.04
Fe	0.989	0.42	3.76
Zn	0.991	0.36	2.42
Se	0.946	0.58	8.91

All detergents were high in the following heavy metal contents: Ti, Cr, Mn, Ni, Cu, Cd, Pb, Fe, Zn and Se. The Ti content was much higher than any other heavy

metals but the heavy metal content differed amongst brands and Brand 3, whose raw material came from plant tissue, contained the lowest heavy metal content. The results from the four brands showed that the order of the four highest heavy metal contents was Ti (6.162-871.676 ng/g), Pb (0.041-249.835 ng/g), Fe (3.293-174.450 ng/g), Se (102.060-147.340 ng/g). The detergents contained little Cd (0.025-0.206 ng/g) (Table-3).

TABLE-3
CONTENT OF HEAVY METALS IN DETERGENT FROM BEIJING MARKET (ng/g)

Heavy metals	Brand 1	Brand 2	Brand 3	Brand 4
Ti	740.206	871.676	6.162	828.820
Cr	73.938	28.934	0.000	21.767
Mn	20.331	29.897	0.000	10.968
Ni	27.537	45.936	0.502	26.241
Cu	52.097	45.907	12.703	41.471
Cd	0.206	0.157	0.025	0.195
Pb	249.835	39.047	0.041	15.230
Fe	74.380	174.450	3.293	150.469
Zn	18.641	12.737	31.057	94.224
Se	117.450	147.340	117.590	102.060

Small quantities of heavy metals can adversely affect environmental safety and human health, because they are easily accumulated in the environment and the body and are difficult to metabolize. Heavy metals can result in carcinogenesis, teratogenesis, mutagenesis and especially embryonic malformation in human beings. Therefore, it is important to monitor the heavy metal content in industrial products, especially products related to foods and humans, such as detergents.

One survey shows that people pay much more attention to the safety of a detergent than its washing effect[13] but the focus is mainly on organic ingredients, rather than heavy metals[14].

Present data show that despite the fact that all detergent brands meet safety standards, they still contain many heavy metals. Consequently, consumers should decrease the use of detergents and if detergent is used, they should select brands with less heavy metal content. Finally, to ensure the safety of consumers, it is believed that the department with responsibility for the hygiene of detergents should investigate all detergent products to ensure the safety of consumers.

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