Detection and Evaluation of Heavy Metal in Lentinus Edodes from Shenyang's Market

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***Abstract*—Adopting microwave digestion and ICP-AES method while detecting Ni Cr Pb Cd As and Hg in lentinus edodes of Shenyang, results show that the average content of the elements is respectively Ni＞Cr＞Cd＞Pb＞As＞Hg, Hg was not detected and in some particular samples Cr Cd Pb exceed standard. So the excess of Cr Cd Pb is the main factor leads to the unqualified of heavy metals in edible fungus in shenyang.**

Keywords-Lentinus edodes; Microwave digestion; ICP-AES; Heavy metal

I. INTRODUCTION

Edible fungus industry is an emerging industry since reform and opening-up. Edible fungus, which contain a lot of nutritious such as amino acids, protein, vitamins, are a delicious and healthy food [1-4]. However, with the emission of industrial wastes and the use of pesticides and herbicides that containing different heavy metals and it is identified that heavy metals are much easier to be accumulated in edible fungus fruit bodies [5-8]. As a result of this, heavy metal pollution has seriously influenced the quality and food safety of edible fungus. Therefore, we need to control the content of heavy metals in edible fungus to enhance the food safety of edible fungus.

In this study, the content of six kinds of heavy metals, including Ni Cr Pb Cd As and Hg of lentinus edodes in different seasons of Shenyang were analyzed by using microwave digestion and ICP-AES.

II. MATERIALS AND METHODS

A. Sample Collection

As shown in table1 we collected the samples of lentinus edodes in different seasons in representative farmer's market in the main district of Shenyang during 2012 and 2013.

TABLE I. THE COLLECTION OF THE SAMPLES OF LENTINUS DEODES

number of samples	season	producing area	acquisition time
1	spring	Shenyang	2012.3.4
2	spring	Shenyang	2013.3.16
3	summer	Shenyang	2012.7.14
4	summer	Shenyang	2013.8.10
5	autumn	Shenyang	2012.9.9
6	autumn	Shenyang	2013.9.13
7	winter	Shenyang	2012.12.18
8	winter	Shenyang	2013.11.20

B. Sample Pretreatment

The samples of lentinus edodes was washed by 0.15% detergent and deionized water first, then dried to constant weight in 78℃ drying cabinet and grinded into powder through 80 mesh sieve. Putting 0.1g lentinus edodes powder into the bottom of PTFE digestion tank and adding 3.00 mL-1 concentrated nitric acid and 1.00 mL-1 H2O2 then placed it in the microwave digestion system. The paramenters are shown in table2. After digestion and digestion tank cooling to room temperature, digestive juices was poured out and transferred to 25 mL volumetric flask preparing to test. The parameters of microwave digestion are shown in Table2.

TABLE II. MICROWAVE DIGESTION PROGRAM

parameter	Time/min	Temperature/℃	Microwave power/w	Pressure/ 10^5Pa
1	10	100	900	0.1
2	10	130	900	0.6
3	20	160	900	1.3

C. Preparation of Standard Solution

1000μg mL-1 standard solution diluted by 2% nitric acid, and then mixed with Ni, Cr, Pb, Cd, As, Hg. And the concentration were respectively 0.00, 0.10, 0.2, 0.50, 1.00μg mL-1.

D. Working Parameter

Power 1.0 KW, argon gas pressure 0.55 Mpa, cooling gas flow 15 L·min-1, atomizer pressure 374.06 Pa, lifting capacity mL ·min-1.

III. RESULTS AND COMMENTS

A. The Establishment of Standard Curve

The results are shown in table 3.

TABLE III. THE ESTABLISHMENT OF STANDARD CURVE

Element	**Wavelength(nm)**	**Detection limit(μg mL^{-1})**	**Linearity range (μg g^{-1})**	**Regression equation**	**Correlation coefficient(r)**
Ni	341.476	0.002	0.002-10^4	$C=-0.1+1.5*10^{-4}I$	0.999
Cr	206.149	0.001	0.001-10^4	$C=-0.11+2.5*10^{-5}I$	0.999
Pb	220.353	0.01	0.01-10^4	$C=-1.4+1.2*10^{-5}I$	0.998
Cd	214.438	0.0005	0.0005-10^4	$C=-0.1+4.7*10^{-6}I$	0.993
As	193.695	0.008	0.008-10^4	$C=-0.6+1.5*10^{-4}I$	0.997
Hg	194.163	0.01	0.01-10^4	$C=-0.59+1.2*10^{-4}I$	0.991

B. Sample Recovery Rate Experiment

Taking 0.25 g NO.3 lentinus edodes sample for sample preparation, parallel determination of 3 times. The results are shown in table 4.

As shown in Fig.4, the recovery rate was between 94.07% and 107.58%, and RSD was between 0.84% and 3.25%, which indicate this method has higher accuracy.

TABLE IV. THE RESULT OF RECOVERIES

Element	**Added value**	**Recovered value**			**recovery**			**Average recovery rate**
Ni	2.00	2.0582	2.0062	1.8382	102.91	100.31	91.91	98.38
Cr	10.00	10.9880	10.4680	10.8180	109.88	104.68	108.18	107.58
Pb	2.00	2.0040	1.9210	2.0830	100.20	96.05	104.15	100.13
Cd	1.00	1.0443	1.0393	0.9958	104.43	103.93	99.58	100.26
As	1.00	1.0111	1.0291	1.0601	101.11	102.91	106.01	103.34
Hg	1.00	0.9320	0.9794	0.9106	93.20	97.94	91.06	94.07

C. The Determination of the Sample

We measured the content of heavy metal in lentinus edodes by adopting ICP-AES method. Each sample was measured 3 times and averaging. The results are shown in table 5.

TABLE V. AVERAGE VALUE OF HEAVY METAL CONTENT (MG KG^{-1})

Sample number	**Ni**	**RSD%**	**Cr**	**RSD%**	**Pb**	**RSD%**	**Cd**	**RSD%**	**As**	**RSD%**	**Hg**	**RSD%**
1 Spring	-		0.4		1.1		0.4		-		-	
2 Spring	-		0.5		0.9		0.35		-		-	
3 Summer	-		0.35		0.8		0.51		-0.4		-	
4 Summer	-		0.51		0.6		0.42		-		-	
5 Autumn	0.8	1.6	0.32	3.25	0.75	0.84	0.2	1.15	-	1.21	-	
6 Autumn	-		0.4		0.8		0.25		-		-	
7 Winter	-		-		0.86		0.31		0.3		-	
8 Winter	1.0		0.5		0.75		0.51		-			
Average	0.9		0.43		0.82		0.37		0.35		-	

"-"Not check out

As shown in Fig 5, the same edible fungi have quite different heavy metal enrichment ability. The content of Cr and Cd in the selected lentinus edodes samples is higher than other heavy metal elements. significantly higher than other heavy metal enrichment, Hg was not detected, and As is only appear in two samples,which illustrate there is barely no Hg pollution in lentinula edodes of Shenyang.

Overall, in this study the average content of heavy metal elements are successively Ni ＞ Cr ＞ Cd ＞ Pb ＞ As ＞ Hg. Furthermore, the same element's content is quiet different in lentinus edodes samples that bought form different producing area, which indicate the content of heavy metal elements in lentinus deodes are related to producing area, atmospheric components, irrigation water and culture medium. The out of limits of Cr and Cd is the main factor in edible fungus' heavy metal pollution.

IV. CONCLUSIONS

ICP-AES method was adopted to test the content of heavy metal elements in lentinus edodes. In order to ensure the reliability of the testing results, the linear relation, accuracy, repeatability and recovery rate were studied in this method. The results showed each element has a good linear relationship, the determination results have good repeatability and recovery rate, the relative standard deviation is smaller.

The results of the determination of Cr, Cd, Pb, As, Hg and Ni in lentinus edodes samples of Shenyang showed the average content of heavy metal elements are successively Ni ＞ Cr ＞ Cd ＞ Pb ＞ As ＞ Hg. Hg was not detected, and in some exceptional samples the content of Cr Cd and Pb are out of limits, Ni only detected in two samples, and As only detected in respective samples, which conform to the range of allowable standard. The out of limits of Cr, Cd and Pb is the main factor in edible fungus' heavy metal pollution.

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