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The monitoring of heavy metals (lead and cadmium) in honeys consumed in Incheon region

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Abstract

This study was conducted to investigate the contents of lead (Pb) and cadmium (Cd) in honeys (n=60) from April to May in 2004 and to provide the scientific basis for heavy metal regulations of Korea Food Code. The samples were digested with acids, then analyzed for the contents of Pb and Cd by an inductively coupled plasma spectrometer (ICP).

The contents of Pb and Cd [minimum-maximum (mean)] were 0.189 - 1.82 ㎎/㎏ (0.568) and not detected (ND) - 0.016 ㎎/㎏ (0.0008) in domestic acacia honeys (n=20), ND - 1.702 ㎎/㎏ (0.329) and ND - 0.243 ㎎/㎏ (0.013) in domestic wild flower honeys (n=18), ND - 0.322 ㎎/㎏ (0.073), ND - 0.027 ㎎/㎏ (0.002) in imported honeys (n=13), ND - 3.754 ㎎/㎏ (0.671) and ND - 0.658 ㎎/㎏ (0.073) in foreign honeys (n=9) brought by Korean travellers, respectively. According to the results, foreign honeys brought by Korean travellers were detected with the highest level of Pb and Cd. Therefore, we recommend that heavy metals of domestic and foreign honeys should be continuously monitored. It is also thought that these results could be the important references to establish the standard of Pb and Cd in honey.

Key words : Honey, Lead, Cadmium

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Introduction

Honey is the natural sweet substances produced by bees from the nectar of plants or from secretions of living parts or excretions of plant-sucking insects on the living parts of plants. The bees mix these substances with their materi-

als and store in honeycomb. Honey goes through the process of dehydration, ripening and maturation. It is mainly composed of fructose, glucose and water. It also contains other sugars as well as trace enzymes, minerals, vitamins and amino acids. Color and flavor of honey could be determined by the nectar source of plants.

When placed on the market as honey or used in any production for human consumption, any food ingredient including food additives should not been added to it. i.e., honey has to be free from foreign materials[1]. Cadmium (Cd) and lead (Pb) do not include in veterinary medicines. They are found in the environment and can be accumulated in the body tissues of animals.

The contamination sources of honey can roughly be divided into environmental and apicultural ones. The environmental sources can be further divided into agricultural and non-agricultural ones. Air and water could be polluted by heavy metals from industry and traffic which can also contaminate the bee colony and its products. The air can contain Pb and Cd, while Cd can also be transported through water and soil to the plants and it can reach the nectar and the honeydew[2]. Apicultural sources are as follows : varroa and foulbrood control, control of other bee pests, wax moth control, repellents in honey harvest, wood protectant and honey recipients[3].

If small amounts of Pb accumulates for long times in the body, it may lead to chronic toxicosis. The symptoms of chronic Pb poisoning are anorexia and headache. A prolonged exposure can cause the pains of arm, leg and joint, and disturbance of hematopoietic, nervous and digestive system.

Cd poisoning is well known to Itai-Itai disease occurred in Japan. Clinical signs of chronic poisoning are albuminuria, diabetes mellitus, disturbance of nervous system, deformation and fracture of bone.

The European law requires them to be analyzed for in the National Surveillance Scheme[4]. The Maximum Residues Limit (MRL) of Pb and Cd proposed by the EU is below 1 ㎎/kg and 0.1 ㎎/kg in honey, respectively[2]. Many countries including the EU established the quarantine limits of the country regulations and guidelines of heavy metals in honey[2-9], but, Korea did not established[10].

As honeys are suspicious of contamination with Pb and Cd, it is necessary to establish legal limits for these metals and monitor any progress of their contamination.

This work was conducted to examine the levels of Pb and Cd in honeys in Incheon region, and to provide the scientific basis for heavy metal standardization of Korea Food Code.

Materials and Methods

Samples

As like Table 1, two different types of honey, domestic honeys (acacia; 20, wild flower; 18) and 22 foreign honeys were tested for determination of 2 trace elements (Pb and Cd) from April to May in 2004. Domestic honeys (n = 38) and imported honeys (n = 13) were collected

from supermarkets and department stores in Incheon region, and nine foreign honeys were obtained from Korean travellers from October in 2003 to February in 2004.

Sample pretreatment for ICP analysis

One gram of honey was digested with 9 ㎖ of nitric acid [distilled water-nitric acid for heavy metal (50 : 50, *v/v*)] using Microwave (Q Lab 6000, Questron, USA), and evaporated. Sample was added to diluted nitric acid and a total volume of 10 ㎖ was made as treated fluid.

Heavy metal analysis

Treated fluid were analyzed for the contents of Pb and Cd by an Inductively Coupled Plasma (ICP) spectrometer with Ultra Sonic Nebulizer (USN)-700 (Integra XL, GBC, Australia). All used chemicals were pharmaceutical or special analytical grade [standard reagents of Lead and Cadmium-ICP/AA (AccuStandard, Inc. USA)] . Analytical conditions of ICP were shown as Table 2.

Table 1. Sample size of the experiment

Item	Domestic honey (n = 38)		Foreign honey (n = 22)		Total
	Acacia	Wild flower	Imported	Brought by travellers	
No of tested	20	18	13	9	60
%	33.3	30.0	21.7	15.0	100.0

Table 2. Analytical conditions of ICP

Item	Wavelength (㎚)	Gas flow (ℓ / min)		
		Nebulizer	Plasma	Auxiliary
Pb	220.353	0.55	10.00	0.50
Cd	228.802	0.55	10.00	0.50

Results and Discussion

Honey is one of the good qualified foods, because it possesses numerous nutrition, healing, and prophylactic properties. These are a direct consequence of its chemical composition. In order to show a beneficial effect, honey must be free from any contaminating agents. If the level of polluted heavy metals in honey are over the approved standard, human health can be threatened due to negative effect of the contaminants.

As seen in the Table 3, the contents of Pb [minimum-maximum (mean)] were 0.189 - 1.82 ㎎/kg (0.568) in domestic acacia honeys, ND - 1.702 ㎎/kg (0.329) in domestic wild flower honeys, ND - 0.322 ㎎/kg (0.073) in imported honeys, ND - 3.754 ㎎/kg (0.671) in foreign honeys brought by travellers, respectively. That is, the contents of honey brought by travellers from foreign country and domestic acacia honey were higher than those of others.

As shown in Table 3 and 4, the highest level of Pb in honeys was ones carried from foreign countries (3.754 ㎎/kg), followed by domestic acacia honeys, domestic wild flower honeys. In the mean contents of Cd, foreign honey brought by travellers was the top (0.073 ㎎/kg), followed by domestic wild flower one (0.013 ㎎/kg).

In tea products and drinks, Korea limit of Pb is below 5.0 ㎎/kg in soaking tea, below 2.0 ㎎/kg in extracted and fruit tea, and below 0.3 ㎎/kg in fruit and vegetable drink. In the view of Pb limit in extracted and fruit tea, 1.7%(1/60) of honeys exceeded the Korean standard (Table 4). Of the 60 samples, however, 3 were over the proposed standard of EU (1 ㎎/kg) in the analysis of Pb.

In Korea, limited concentration of Cd in honeys and tea products was not established. However, it is below 0.1㎎/kg in fruit and vegetable drink. Of 60 samples, two (3.3%) were above the relevant MRL proposed by EU (0.1㎎/kg). One(0.243㎎/kg) was detected in domestic wild flower honey (n=18) and the other (0.658㎎/kg) was identified in foreign honey brought by travellers (n=9).

All of the domestic acacia and imported honeys were evaluated as below of 0.03 ㎎/kg in the analysis of Cd contents. The levels of heavy metals (Cd) in the samples were negligible (Table 5).

In total, imported honeys were not free from heavy metals, but all of their levels were below the MRL proposed by EU.

Total honey production of the EU in 2003 was 138,354 (108,901$^{M/T}$ in 2002) and the total number of targeted samples in 2004 was 4,428 (2,760$^{M/T}$ in 2003) : Two targeted non-compliant results were found for chemical elements (compared to 21 in 2003)[4].

According to the summary of 2003 Sweden results[6], all of 10 samples contained no detectable levels of heavy metals. The Pb and Cd values of honey marketed in Switzerland (2002) were well below the MRL of EU[2]. Residues of Cd were detected in 1 (45 ㎍/kg) of 105 samples of imported honey in the rolling programme in United Kingdom (2002)[4]. In Kahramanmaras city (Turkey)[7], the mean value for Cd in honey samples was 0.32 ppm.

In 1998[8], residues of Cd were not detected in 98 samples in Australia and residues of Pb were detected in 5 of 98 (5.1%). Five samples contained Pb at greater concentrations than the Australian standard. In 2001 – 2002[9], residues of heavy metal were not detected in 403 samples.

The above were report on the levels of Pb and Cd in honey of various countries. Our results generally showed higher than others in the level of heavy metals except in Kahramanmaras city (Turkey) compared with those reported by other countries. The detection of heavy metals in honey are used for not

Table 3. Contents of heavy metal in domestic and foreign honey (unit : ㎎/㎏)

Items	Domestic honey		Foreign honey	
	Acacia (n = 20)	Wild flower (n = 18)	Imported (n = 13)	Brought by travellers (n = 9)
Pb	0.568* (0.189 – 1.82)**	0.329 (ND – 1.702)	0.073 (ND – 0.322)	0.671 (ND – 3.754)
Cd	0.0008 (ND – 0.016)	0.013 (ND – 0.243)	0.002 (ND – 0.027)	0.073 (ND – 0.658)

* Mean, ** Minimum – Maximum, ND : not detected

Table 4. Results of examination for heavy metal (Pb)

Items Concentration(㎎/㎏)	Domestic honey		Foreign honey		Total (n = 60)
	Acacia (n = 20)	Wild flower (n = 18)	Imported (n = 13)	Brought by travellers (n = 9)	
< 0.05	–	3	8	1	12
0.05 – 0.25	5	4	3	2	14
0.25 – 0.5	4	9	2	4	19
0.5 – 1.0	10	1	–	1	12
> 1.0	1*	1**	–	1***	3

* 1.82 ㎎/㎏, ** 1.702 ㎎/㎏, *** 3.754 ㎎/㎏

Table 5. Results of examination for heavy metal(Cd)

Items Concentration(㎎/㎏)	Domestic honey		Foreign honey		Total (n = 60)
	Acacia (n = 20)	Wild flower (n = 18)	Imported (n = 13)	Brought by travellers (n = 9)	
Not detected	19	17	12	8	56
0.001–0.03	1	–	1	–	2
0.03 – 0.1	–	–	–	–	–
0.1 – 0.3	–	1*	–	–	1
> 0.3	–	–	–	1**	1

* 0.243 ㎎/㎏ ** 0.658 ㎎/㎏

only quality control, but also determination of environmental contamination. If the quality of bee honey are changed by the contamination with micro-pollution agent, it could cause toxicity to consumers.

Heavy metal contamination in honey is increased in areas of industrial and heavy traffic. The Pb contamination has diminished due to the increased world-wide use of car-engine catalysts[2].

Some studies[11-14] reported difference in the amount of heavy metals between honey samples from the possibly contaminated areas and pollution free areas.

On the other hand the amount of

honeys produced in Korea is very low compared to those of the other countries. In 2000, total Korea honey production was 16,509 of 1,260,000$^{M/T}$(1.3%) in the world, and importation of honey has been increased from 274.8$^{M/T}$ in 2000 to 1,162.8$^{M/T}$ in 2005[15,16].

However, Korea has many problems such as increasing of foreign honeys brought by Korean travellers and imported, environmental pollution by industrial and heavy traffic, and use of pesticides in agriculture. Therefore, heavy metals of domestic and foreign honeys should be continuously monitored. Furthermore, overall assessment of exposure to heavy metals from all sources including foods, air, drinking water and occupation should be made in order to confirm the dietary risk factors and to assure the safety of food resources.

Conclusively, to effectively control, the heavy metal contamination in beekeeping should be further surveyed and also national guidelines (MRL) should be obligatory to honey products.

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