Original Article

Determination of Lead Amount in Noodle Soup

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ABSTRACT

Objective: To determine amount of lead in noodle soup prepared in the old-style noodle soup boiling pot. **Method:** Noodle soup from 10 places in Muang district of Chiagmai province was sampled 3 times with one week apart. Each sample was digested and measured for lead amount using absorbance by atomic absorption spectroscopy. **Results:** The method to determine lead amount in noodle soup was found to have a high linearity (r^2 = 0.999) with a concentration range of 0.25 - 10 ppm, a limit of detection of 0.25 ppm, limit of quantitation of 1 ppm, %RSD of 4.37 - 7.6%, and % recovery of 100 – 104%. The amount of lead in the noodle soup samples ranged from 0.1 – 1.25 ppm (Table 3). The amount of lead in many samples was over the limit in food recommended by the Thai Food Act, which is 1.0 ppm. In addition to the inorganic lead from the soup pot, lead in noodle soup could come from the organic lead in flavoring agents added into the soup. **Conclusion:** Lead in noodle soup was over the recommended limit. It may be harmful to consume noodle soup frequently. The source of lead in noodle soup could be inorganic (soup pot) as well as organic ones (flavoring agents).

Key words: lead, noodle soup

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Introduction

The principal sources of lead for the general human population are food, lead-glazed earthenware, lead-based paints, and gasoline. The absorption of ingested inorganic lead is about 10% whereas that of organolead compound (tetraalkyl lead in gasoline) may be up to 75%, with less than 5% of the absorbed lead retained. In children, both absorption and retention are higher than adults. In general, absorption is higher through the pulmonary route and lower by the skin than via the gastrointestinal tract. Absorbed inorganic lead is transported in blood mostly bound to red blood cell. Organolead exposure, major accumulation takes place in the liver and kidney. Metabolism of tetraalkyl lead to trialkyl and inorganic lead, mainly by P-450-dependent oxidation dealkylation in the liver and subsequent transport of trialkyl lead to the critical organ, the brain, seems to be responsible for the neurotoxic effects.[1]

The neurotoxicity of organolead compounds appears to be brought about by a change in the choloride/hydroxide distribution across the nerve cell membrane, resulting from the induction of electrically silent anion exchange. Urine is the major excretory route for inorganic lead whereas two-thrids of organic lead is excreted via feces. The biologic half-life of organic lead compounds appears to be only 1 - 7 days whereas half-lives as long as 1 year have been estimated in the brain following low level exposure. In addition to neurotoxic effects, lead is known to effect the hematopoietic, renal, gastrointestinal and reproductive systems.[1]

Acute inorganic lead poisoning in adults usually results from accidental ingestion or from drinking wine made

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and/or stored in poorly glazed earthenware, and manifests as abdominal pain, nausea and vomiting. Occupational exposure has been reported to cause wrist drop and foot drop associated mainly with motor nerve dysfunction resulting from decreased nerve conduction velocities. Subclinical effects of lead exposure in children (blood lead of 30 - 50 μg/dL) include hyperactivity, poor class room behavior and small decrements in I.Q. scores.[1]

Organic lead appears to cause reduced sexual potency with decreased spermatogenesis in humans. Extremely high dose of lead can increase fetal deaths and reduce fetal body weight.[1]

Lead in cord blood, although slightly lower correlating with lead in maternal blood, may be a transfer of lead to the fetus as pregnancy progresses. Lead induced immuno-suppression in animals, increased susceptibility of children to fetal illness, mutagenic and carcinogenic effects in man and animals have been reported. Although carcinogenic effects in human (respiratory and digestive tract tumors) and animals (kidney) have not been correlated, it appears the lead induced inhibition of microsomal enzymes may enhance the carcinogenic potential of other chemicals.[1]

Toxic effects of lead are enhanced by dietary deficiencies of calcium, iron, and zinc, all of which enhance lead absorption and tissue storage. Conversely, excess of these metals decreases toxic effects of lead by mechanisms involving absorption as well as reversal of some calcium and iron dependent physiologic functions adversely altered by lead. Both chronic and acute cases of lead intoxication can benefit from chelation combination therapy of calcium EDTA and BAL. Kidney function and blood calcium levels have to be carefully monitored during chelation therapy.[2]

Standards have been developed for most environmental source of lead. The upper limit for ambient air is 2 $\mu g/m^3$ by the Environmental Protection Agency (EPA) of the USA, and for industry the threshold limit value is 150 $\mu g/m^3$. The maximum permissible lead concentration in gasoline ranges from 0.15 g/L for West Germany to 0.45 g/L in the United Kingdom. The United States limit has been set at 0.10 g/gallon. The joint Food and Agriculture Organization World Health Organization (FAO/WHO) expert committee on food additives suggested a tolerably weekly lead intake from food and drinks of 3 mg/person, with lower limits (e.g., 0.5 mg/kg of food as in the UK) advisable for foods intended for infants and young children. The EPA recommends a limit of 0.05 mg/L for all drinking water, whereas WHO recommends a level of 0.30 mg/L.[1]

In Thailand, it has been long known that old type of noodle soup is one of the major sources of inorganic lead.[1] However the exact extent of lead in the noodle soup has not been known. Therefore, the objective of this study was to determine amount of inorganic lead in the noodle soup made in the old style noodle soup pot.

Materials and Methods

1. Sample preparations[3]

Ten famous noodle restaurants around Muang district of Chiangmai province were selected for noodle soup samples. Noodle soup from each place was sampled 3 times with an interval of 1 week between each sampling.

To prepare each sample for lead determination, 25.0 mL was pipetted and 0.3 mL nitric acid (1+1) was added. The sample was heated to dryness, and cooled. The sample was then digested with 3.0 mL concentrated nitric acid until colorless.

2. Calibration curve[3]

2.1 Stock standard solution

Lead nitrate was accurately weighed for 0.1599 gm and dissolved with 1.0 mL nitric acid (1+1), then adjusted to 100.0 mL. This stock standard solution concentration was equivalent to 1000 ppm lead metal. The stock standard solution was pipetted for 5.0 mL and diluted to 200.0 mL to achieve a 25 ppm of lead concentration.

2.2 Working standards

The working standards were prepared for 0.25, 0.5, 0.75, 1.0, 2.0, 5, 7 and 10 ppm of lead by pipetting 1, 2,

3, 4, 8, 20, 28 and 40.0 mL of the 25 ppm lead concentrated solution, adding 0.15 mL nitric acid (1+1), and finally adjusting to 100.0 mL.

3. Determination of lead trace element[3]

Each of the samples was dissolved with 2.0 mL hydrochloric acid (1+1) then adjusted to 25.0 mL. Atomic absorption spectrums of working standards and samples were measured by using GBC hallow cathode lead lamp and atomic absorption spectrometer, GBC Avanta V.1.33 with a set wavelength of 217.0 nm, using oxidizing air-acetylene flame. Three replicates of each sample were measured for absorbance. To determine percent recovery, 1.0 ppm and 1.5 ppm of lead was added into each of the prepared samples (0.5 ppm). Absorbance of each sample was measured three times.

Results and Discussion

The analysis method showed a high linearity of calibration curve at 0.25 - 10 ppm of lead concentrations (r^2 = 0.999) (Table 1 and Figure 1). The method resulted in a limit of detection of 0.25 ppm, limit of quantitation of 1 ppm, % relative standard deviation (%RSD) of 4.37 - 7.6, and % recovery of 100 – 104% (Table 2).

The amount of lead in the noodle soup samples ranged from 0.1 – 1.25 ppm (Table 3). This wide range of lead, even among samples from the same place, was probably in part because noodle soup was prepared by using approximate and varied amount of water to boil the pork bone. However, the amount of lead in many samples was over the limit in food recommended by Thai Food Act, which is 1.0 ppm. The amount of lead found in the soup could come from the inorganic lead from the boiling soup pot and the organic lead from flavoring agents which was added into the soup.[1,4]

Table 1 Data of calibration curve.

Standard concentrations	Lead conc. (ppm)	% RSD	Mean absorbance	Replicate absorbance		
				1	2	3
1	1.000	8.29	0.0308	0.0305	0.0335	0.0284
2	2.000	5.74	0.0485	0.0460	0.0515	0.0482
3	5.000	2.89	0.1265	0.1223	0.1279	0.1293
4	7.000	0.98	0.1723	0.1740	0.1721	0.1707
5	10.000	2.30	0.2470	0.2503	0.2404	0.2502
r^2 = 0.999						

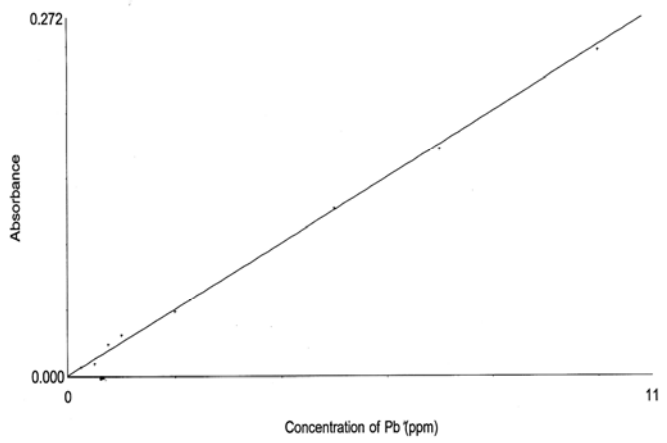

Figure 1 Calibration curve of standard lead nitrate.

Table 2 Percent relative standard deviation and percent recovery.

	Prepared Conc. (ppm)	Observed Conc. (ppm)
Sample 1	0.50	0.53
Sample 2	0.50	0.52
Sample 3	0.50	0.55
Sample 4	0.50	0.50
Sample 5	0.50	0.50
% RSD = 7.60; % Recovery = 104.00		
Sample 1 + Standard lead nitrate	1.50	1.50
Sample 2 + Standard lead nitrate	1.50	1.60
Sample 3 + Standard lead nitrate	1.50	1.40
Sample 4 + Standard lead nitrate	1.50	1.50
Sample 5 + Standard lead nitrate	1.50	1.50
% RSD = 4.67; % Recovery = 100.00		
Sample 1 + Standard lead nitrate	2.0	2.0
Sample 2 + Standard lead nitrate	2.0	2.0
Sample 3 + Standard lead nitrate	2.0	2.0
Sample 4 + Standard lead nitrate	2.0	2.2
Sample 5 + Standard lead nitrate	2.0	2.1
% RSD = 4.37; % Recovery = 103.00		

Table 3 Lead concentration (ppm) in samples of noodle soup from 10 places from 3 consecutive weeks sampling.

Place number	Lead conc. (ppm) in each sample from each three consecutive weeks		
	First week	Second week	Third week
1	0.300 ± 0.041	0.600 ± 0.050	0.10 ± 0.040
2	0.500 ± 0.045	1.250 ± 0.054	0.300 ± 0.045
3	0.650 ± 0.049	0.750 ± 0.059	0.850 ± 0.055
4	0.800 ± 0.053	0.900 ± 0.054	0.600 ± 0.053
5	0.800 ± 0.051	0.700 ± 0.052	1.100 ± 0.056
6	0.700 ± 0.057	0.700 ± 0.054	1.200 ± 0.055
7	0.700 ± 0.053	0.600 ± 0.050	1.100 ± 0.057
8	0.800 ± 0.055	0.700 ± 0.058	1.100 ± 0.052
9	0.650 ± 0.052	0.200 ± 0.040	1.100 ± 0.054
10	0.900 ± 0.059	0.400 ± 0.043	0.800 ± 0.054

It was worthy noting that lead amount in samples from place number 9 (0.2 ppm on second week and 0.1 ppm on third week) could probably indicate the extent of lead mainly from inorganic source (Table 3). This was because the two samples were from the soup that was prepared without adding any flavoring or seasoning and under the investigators' close observation. Again, the lead amounts in other samples were probably from inorganic and organic lead as mentioned before.

Conclusion

Thai Food Act recommends a limit of lead in food at 1.0 ppm and the Environmental Protection Agency of the US recommends a limit of lead in drinking water at 0.05 ppm, whereas WHO recommends a level at 0.3 ppm. In this study, some amounts of lead were over the recommended limit.[1,4]

From the result, it may be harmful from consuming noodle soup frequently because the lead amount may accumulate and could lead to long-term toxicity. The result brings an intriguing point of view that consumers may receive organic lead from flavoring agents in food. This result has a potential to concern the Ministry of Public Health about the harm of using flavoring agents in food.

References

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