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Trace Metal Contaminants in Iranian Flat Breads

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ABSTRACT

Flat breads such as Lavash, Barbari, Taftoon and Sangak bread are mainly produced from soft white wheat flours in Iran. Bread samples were collected from Tehran city and analyzed by flame atomic absorption spectrophotometry for three potentially hazardous heavy metals, Lead (Pb), Cadmium (Cd) and Nickel (Ni). The mean concentrations of Pb levels in Lavash, Barbari, Taftoon and Sangak breads were 0.42, 0.27, 0.38 and 0.52 mg kg^{-1} dry weight, respectively. Also, the mean concentrations of Cd levels at these breads were 0.65, 0.42, 0.12 and 0.50 mg kg^{-1} dry weight, respectively. The mean concentrations of Ni were 0.45, 0.47, 2.67 and 0.96 mg kg^{-1} dry weight, respectively. The high levels of daily intake of Pb, Cd and Ni, may cause public health problems, especially the high Cd level in Lavash and Ni in Taftoon breads. Monitoring heavy metals is imperative during wheat production, storage, mill flour and baking bread for reduction of public health concerns.

Key Words: Pb; Cd; Ni; Iranian flat breads; Bakeries; Public health concern

INTRODUCTION

In line with industrial development, pollution in the environment and consequently in agricultural raw materials are emerging as safety major concerns across the world. A case of environmental pollution confronted very frequently and threatening food safety is due to heavy metals. As a result of soil, atmosphere, underground and surface water pollution, foods and beverages are getting contaminated by heavy metals. The effect of environmental pollution on contamination of foods and on their safety for human consumption is a serious global public issue and widely addressed (Alegeria *et al.*, 1990; Ahmed *et al*., 2000; Moffat & Whittle, 1999). Lead (Pb) is present in the environment because of air, soil and water pollution. Major sources of lead are exhaust fumes from vehicles, industrial gases and liquid effluents, some phosphate fertilizers and pesticides. Cadmium (Cd) may increase in the biosphere due to emissions from batteries, coatings, electroplating steel and cast iron, pigments, plastic stabilizers constituent of low melting or easily fusible alloys, electronic and optics and solder for aluminum, reactor control rods, hardener for copper and catalysts. Moreover, it is presented as a contaminant in phosphatic fertilizer and sewage sludge and is dispersed by mining activities (Hu, 2002; Mahindru, 2004). These metals are not only toxic to humans, but they are persistent in the environment once discharged, and when absorbed stay in the human body with a long half-life of about one year. Several reports have focused on residues of numerous heavy metals in food stuffs (Cabrera *et al*., 1995; Liobet *et al*., 1998). Other reports have delineated on the heavy metal contamination of cereal and cereal products (Zhang *et al*., 1997, 1998). Hubbard and Lindsay in 1979 reported that the major route of man's exposure to heavy metal was ingestion. Some heavy metals such as Pb, Cd and Ni are extensively used in various industries. Their level with an anthropogenic origin is much higher than from natural sources. These elements are non-essential for almost all living organisms. The largest amount of trace elements found in human body has been absorbed via food. Pb and Cd can enter wheat flour and then bread from environment. Pb and Cd content in bread samples are valuable as general indicators of environmental pollution (Rowland *et al*., 1997). Ni can be released in small amounts from Ni vessels during food cooking (Thimothy *et al*., 1989).

Bread is an important diet cereal products provide as much as 50-90% of total caloric and protein intakes. Iranian flat breads such as Lavash, Barbari, Taftoon and Sangak are mainly produced from soft white wheat flours. The aim of this study is to investigate and measure the levels of Pb, Cd and Ni in flat breads of Tehran city in Iran in order to improve of bread quality. Moreover, the daily intake of these metals, based on bread consumption was ascertained.

MATERIALS AND METHODS

Sample collection. In Iran, there are several types of traditional bakeries. These bakeries produce flat breads such as Lavash, Barbari, Taftoon and Sangak breads from wheat flour. Six bread pieces of Lavash, Barbari, Taftoon and Sangak bread samples were randomly collected from bakeries at different bakes in 2004.

Flame conditions for the AAS measurements of Pb, Cd and Ni. Bread samples were analyzed by flame atomic absorption spectrophotometry for three potentially hazardous heavy metals Pb, Cd and Ni, using at least two standard solutions for each metal. Flame conditions for these elements are given in Table I.

Sample examination. For Pb, Cd and Ni analyses bread samples were left to air dry before sub-samples (50 g each)

were taken from each group, ground with Titanium knives and stored in high density polyethylene bottles, 100 mL capacity, with screw caps. Bottles were pre-washed with nitric acid, rinsed with de-ionized water, dried and tested for contamination by leaching with 5% nitric acid. The bottles contained no metal liners that can contaminate the samples.

Sample extraction. Finely ground samples (1g each) were precisely weighed in test tubes and 3mL of nitric acid was added. Tubes were allowed to stand overnight at room temperature, protected from dusts. Tubes were heated up to 130°C for 4 h using a metal block thermostat unit, and cooled before adding 2mL of nitric acid, 0.7 of perchloric acid and 43 mL of distilled water to each tube. A programmable circuit was used to raise temperature up to 230°C within 33.5 h. The clear wet ash in each tube was dissolved in 2mL of distilled water and tubes were stored until the flame atomic absorption spectrophotometry was performed. The samples were analyzed by atomic absorption spectrophotometer (Alpha 4, Chem Tech Analytical Co. England) using an air–acetylene flame. The certified standard reference material (Alpha- Line, Chem Tech Analytical, Ltd, England) was used to check the accuracy and the analytical values within range of certified values. The recovery of all the metals was over 95%.

Statistical analysis. The index was used for correlations between the specimens and metal levels. ANOVA was applied after logarithmic conversion to find differences between kinds of consumption bread in the 17 zones of Tehran city and spatial distribution. Multiple regression was applied for kinds of consumption bread and different amounts of studied metals using SPSS, version 11.5.

RESULTS

All of four flat breads showed the high content of Cd, Pb and Ni (Table II). Cd content was lower in Taftoon and Barbari breads than Lavash and Sangak breads. The highest content of Cd was observed in Lavash bread. Pb levels were lower in Barbari bread than other breads. The highest content of Pb was showed in Sangak bread with 0.52 mg kg-1 dry weight ($P<0.05$). Among the most collected breads, Lavash bread contained more Cd about 0.65 mg kg^{-1} dry weight, whereas the Taftoon bread contained lower Cd about 0.35 mg kg^{-1} dry weight, all $P<0.05$. Ni levels of Taftoon, Barbari, Lavash and Sangak bread were showed 0.43, 0.50, 2.28 and 0.97mg kg^{-1} dry weight, respectively. Greater amount of Ni was found in Taftoon bread. Distributions of Pb, Cd and Ni in different types of flat breads indicated that the latter had the highest levels among other trace elements in Taftoon bread.

Estimated daily intake of Pb, Cd and Ni based on flat bread consumption with using of market basket indicated that a highest value of Ni in Taftoon bread (Table III).

DISCUSSION

This study summarizing the Pb, Cd and Ni Contents in flat breads collected from bakeries of Tehran, suggested a relatively high degree of metal pollution. Ni levels in flat breads compare with other were very high. Cd was high after Ni and it can be harmful to consumers. Pb level is intermediate but it has been a public health concern. In a study conducted in Romania, Pb levels in wheat bread have been obtained 0.22 mg kg^{-1} (Nicoleta *et al.*, 1996). Pb levels in flat bread samples of our study are higher than Romania study. Lowest level of Pb was noted in Barbari bread (0.27 mg kg^{-1}) and it was the highest in Sangak bread (0.27 mg kg^{-1}). This variation may be related to contamination of wheat flour and bread making. Cd levels in Lavash bread were higher than others, while Taftoon bread has lower Cd level. Alberti-Fidanza *et al.* (2002) determined some trace elements in foods and meals consumed by student attending the faculty cafeteria in Italy. They found high levels of Pb, Cd and Ni in bread (21.5, 5.6, & 55.6 µg 100 g^{-1} of edible portion, respectively). The levels of Pb, Cd and Ni in present study are higher than bread consumed by Italian students (Table II). Survey research conducted in Turkey showed a metallic contamination in a pasta production plant. Cd levels ranged from 33.41 to 65.16 ng g^{-1} in wheat and 127.38 to 142.84 ng g^{-1} (Demirozu & Saldamli, 2002).

Estimated daily intake of Pb, Cd and Ni based on consumption of different flat breads using market basket was calculated (Table III). The daily intake of Pb, based on Lavash, Barbari, Taftoon, and Sangak bread consumption is 0.057, 0.021, 0.015 and 0.022 µg $person^{-1}$ day^{-1}, respectively. This value for Cd from flat bread consumption was 0.088, 0.032, 0.014 and 0.021 µg $person^{-1}$ day^{-1}, respectively. The daily intake of Pb, based on Lavash, Barbari, Taftoon, and Sangak bread consumption is 0.058, 0.038, 0.091 and 0.042 µg $person^{-1}$ day^{-1}, respectively. The average estimated intake of Pb, Cd and Ni based on bread consumption can be 0.31, 0.19 and 0.24 µg $person^{-1}$ day^{-1}, respectively.

Wheat plants may be contaminated by trace metals and transferred to bread. The embryo, bran and the aleurone

Table I. Flame conditions for the AAS* measurements of Pb, Cd and Ni

Elements	Wave Length (nm)	Slit	Lamp current (mA)	Gain	Oxidant A= air	Acetylene flow	Berner Height	Sensitivity µg/ml	Detection limit µg/ml	Calibration range at 1 scale Exp.µg/ml
Pb	217.0	3	4	8	A	2.4	6	0.12	0.004	0.4-40
Cd	228.8	3	2	7	A	2.1	7	0.02	0.002	0.05-5
Ni	232.0	1	8	8	A	2.0	7	0.07	0.05	0.2-15

*Flame Atomic Absorption Spectrophotometer- ALPHA 4, Chem Tech Analytical Co. England)

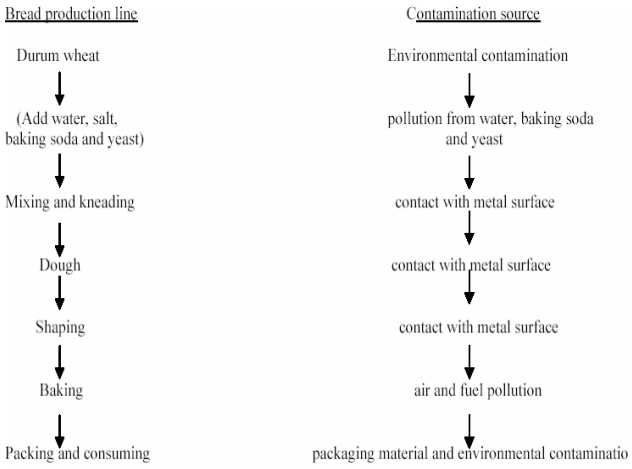
Table II. Content of trace elements in Iranian flat breads collected from bakeries of Tehran city (mg/kg dry wt).

Kind of flat bread	No. of samples	Cd	Pb	Ni
		Mean± SD	Mean± SD	Mean± SD
Lavash	6	0.65± 0.31	0.42± 0.13	0.43± 0.27
Barbari	6	0.42±0.31	0.27±012	0.50± 0.41
Taftoon	6	0.35±0.12	0.38±0.32	2.28± 0.90
Sangak	6	0.50±0.27	0.52±0.26	0.97 ±1.16

Table III. Estimated intake (µg person $^{-1}$ day $^{-1}$) of Pb, Cd and Ni based on consumption of Iranian flat breads.

Type of bread	Daily intake(µg person^{-1} day^{-1})		
	Pb	Cd	Ni
Lavash	0.06	0.09	0.06
Barbari	0.21	0.03	0.04
Taftoon	0.02	0.05	0.10
Sangak	0.02	0.02	0.04
Total	0.31	0.19	0.24

Fig. 1. Possible Contamination sources during flat bread production



layer of wheat are richer in minerals and metals than the endosperm. About 61% of all minerals in grain are contained in the aleurone layer (Hoseney, 1994). As a result of the separation of these parts in wheat flour that used for making Lavash, Barbari and Taftoon bread, an expected decrease was observed in these breads than Sangak bread.

Heavy-metal food intoxications are generally associated with one of three patterns of occurrence, environmental pollution, accidental inclusion during processing and contamination during processing or storage of food (Moffat & Whittle, 1999). Elimination of contamination sources in the production stage and replacement of old equipment can decrease the level of Pb contamination. Generally, the locations of bakeries in indoor city and near to industrial zones and the traffic density of city are important to contamination problems. In the light of the results, the possible contamination sources along the processing line are schematically represented in Fig. 1.

CONCLUSION

In conclusion, the present study provides useful guide for bread choices and bread preparation taking into consideration the heavy metal toxicity effects. In general during bread production, the possible sources of contamination are metal surfaces in contact with the material and those present in air and environment. Kind of baking fuel is also influence on residues of heavy metals.

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