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The effect of the milling process on the level of aluminum contamination in wheat and flour of Alborz province

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Abstract

Wheat is one of the most widely consumed cereals in the world, especially in Asian countries. There is always a possibility to have carcinogenic toxic agents during the bread preparation process. This study aimed to investigate the influence of the milling process on aluminum contamination levels in produced flours in Alborz province.After preparing 60 samples of wheat, Sangak flour, Lavash or Taftoon flour from flour milling factories in Alborz province, the concentration of aluminum was quantified by ICP-OES. Data analysis was performed using Prism and SPSS software.The milling machine affected the amount of aluminum level in the samples in the present study. The contamination level of aluminum has increased after the milling process. The highest average concentration of aluminum was 1.959 ± 0.560 mg/kg. Bread is considered the main food source for the Iranian people. To preserve food security and decreasing the food contamination, Continuous monitoring and Enforce strict regulation is essential to maintain the quality of wheat and flour in the market. In the present study, the average concentration of aluminum in wheat and flour samples of Alborz province was in agreement with the standard set by the EU, Codex, and Iran.

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Introduction

Cereals and cereal-based products play an important role in human nutrition. The most important grains are wheat, rice, corn, barley, oats, rye and millet. Among them, wheat is the most widely consumed cereal and constitutes approximately 25% of the annual cereal production. Two types of soft wheat, TriticumVulgare and hard wheat, Triticum durum, comprise the most cultivation area. TriticumVulgare is generally the most frequently consumed wheat by millers to produce suitable flour for bread production. The Wheat grain consists of three parts: endosperm, shell and germ. Wheatgrass contains the nutrients B vitamins in bran and vitamin E and unsaturated fatty acids in sprouts. During the milling process, the protective layers are destroyed and vitamins and unsaturated fatty acids are exposed to oxidation. Excessive storage of flour causes nutritional value loss, rancid taste and yellowing of flour. During the white flour preparation process, the wheat germ is removed [1]. The cultivation and distribution of wheat helps to improve the social and economic status of producing countries. The top wheat-producing countries are China, Europe, India and the United States [2]. Due to the spread of environmental pollutants and their incensement in the human food chain, studying about the types of food contamination has become one of the major issues around the globe [3]. Aluminum is naturally present in soil, air and is also released into the environment by human activity. The toxic effects of aluminum on living organisms have been well studied [4]. The tolerable weekly intake for aluminum, according to the World Health Organization and the FAO, is 7 mg / kg body weight [5]. Aluminum, like calcium, can be replaced in bone tissue and bonded with phosphate. It also has the ability to bind to biological molecules such as DNA and ATP. Aluminum is transported by transferrin in the bloodstream and is rapidly removed from body by Fecal Excretion. Although aluminum plays a role in physiological processes, there is no evidence that aluminum has an essential role in living organisms.

Aluminum is a toxic metal that causes bone disease (osteomalacia), anemia and encephalopathy. High levels of this element in the body cause nervous system disorders such as ataxia and muscle contraction, speech and swallowing problems, seizures, Alzheimer's and dementia [4]. So far, several studies have been conducted on heavy metals quantity in wheat and bread, determining the health risk of consuming these products in Iran and other countries. Several studies have shown that the amount of aluminum in flour has increased after the milling process [6-8]. Findings from various studies show that the milling process can lead to different aluminum contamination levels. Bread is the main food consumed by the Iranian people, so it seems necessary to investigate the quality of consumed wheat and flour in the country to maintain the health of the community. Therefore, because of the importance of heavy metals contamination in grains, especially wheat and flour, this study aims to investigate the influence of the wheat milling process on the amount of aluminum in flour.

Materials and Methods

Chemicals

Standard solutions of iron, copper and zinc (Romil, UK) and 65% nitric acid (Merck, Germany) were used in this study. During the preparation process of samples and standard solutions, double distilled water with a resistance of more than 18 MΩ was applied.

Devices

The devices used to measure copper, zinc and iron include the Atomic absorption spectroscopy (ICP - OES, Spectrum Arcos) and the digital scale with an accuracy of 0.1 mg (Sartorius, Germany). The water required for solution was prepared Using distilled (Table1).

Table1. R2 Values, wavelength of test elements, LOD * and LOQ

LOQ (ppb)	LOD (ppb)	Wavelength (nm)	R2	element
0.129	0.99984	167/078	0.043	0.129

Sample collection

Iranian National Standard No. 2305 called random sampling methods was used to collect samples. From 22 flour mills in Alborz province only 10 mills contained Sangak flour production line. 30 samples were collected from these 10 factories and then coded from A to J. In different factories of Alborz province, 30 samples of wheat and 30 Sangak flours and Lavash or Taftoon flours were randomly collected.

Preparation of samples

the preparation process consisted of homogenization, weighing, acid dissolving, smoothing, and bulking. Initially, 100 grams of flour and wheat samples were stored separately from each factory in a container to perform the desired test. For the final preparation, 1 g of the weighing sample was used and for acidic digestion, the 999/11 AOAC standard was used [9].

1 g of flour prepared by accurate scales was weighed and then 10 ml of 65% nitric acid, 2.5 ml of 70% Perchloric acid, and 2.5 ml of 98% sulfuric acid were added to the sample container. It was then placed on the heater at 130 ° C for 1 hour to obtain a clear liquid. The container was then removed from the heater to cool and distilled water was used to bring the solution to a volume of 10 ml [10].

Standard curves

to measure the amount of aluminum element in unknown samples, the first standard solutions were prepared. The standard curve for each element was plotted using 3 repetitions for each standard concentration and according to the proposed method in the atomic spectrum absorption device manual. The detection limit of the measurement for aluminum was equal to 0.129 mg/kg flour. It should be noted that the standard solutions for each day of measurement are freshly prepared.

Data analysis

the normality of the data distribution was determined using the Kolmogorov-Smirnov test. Statistical analysis of the data was performed using SPSS software (Version 16.0). Excel software has been used to draw graphs and tables. Analysis of variance was used to assess the presence or absence of significant differences between the experimental groups.

Results

The results of reading the accumulated concentration of the aluminum element in wheat and flour samples in mg/kg are presented in Table 2 and Table3, respectively.

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Table2. Aluminum concentration level in bread and wheat samples Results (mg/kg) (A, B, C, D and E)

Factory	A	B	C	D	E
Wheat	0.380±0.084	0.177±0.081	0.261±0.082	0.252±0.072	0.370±0.00
Sangak	0.640±0.113	0.341±0.041	0.362±0.109	0.329±0.154	0.428±0.161
Lavash	0.680±0.169	0.352±0.494	0.423±0.142	0.532±0.127	0.579±0.242

Table3. Aluminum concentration level in bread and wheat samples Results (mg/kg) (F, G, H, H, I and G)

Factory	F	G	H	I	G
Wheat	0.440±0.201	0.427±0.007	0.345±0.289	0.595±0.037	0.641±0.164
Sangak	0.506±0.210	0.540±0.028	0.451±0.000	0.695±0.080	1.612±0.121
Lavash	0.649±0.276	0.672±0.066	0.521±0.028	1.021±0.014	1.959±0.560

The results showed that the minimum and maximum mean concentrations of aluminum in wheat and flour samples were 0.177 ± 0.081 and 1.959± 0.560 mg / kg, respectively, for wheat of factory B and lavash flour (respectively). Tafton) was factory J. The results of flour and wheat samples aluminum level data normalization showed a normal distribution of aluminum. The results of Kolmogorov-Smirnov test showed that there is no significant difference in aluminum level between the samples collected from participating facotries which include: Tak Karaj factory, Roshan factory in Tehran, Zar semolina factory, Zar industrial factory, Movadat Iranian factory, Karaj Ittihad factory, Helianeh factory, Karaj Amin factory and, Zarrin Khosheh factory ($p > 0.05$).

Discussion

the results of the present study show an increase in aluminum after the milling process in all factories, which is consistent with previous studies [6-8]. It seems that the possibility of contamination of Lavash flour (Tafton) with aluminum can be due to the aluminum metal surfaces of the mill and can be considered as a possible source for the high amount of this metal in Lavash flour. In a study by Vrček et al., The concentration of aluminum in wheat flour was between 0.69 -2.76 µg/kg [8]. Stahl et al. showed that the concentration of aluminum in flour is 4 mg/kg [7]. The results of Ertl and his colleague's study indicate that the concentrations of aluminum in wheat and flour were 0.45 and 9.7 mg/kg, respectively [6]. The increase in the amount of aluminum after grain processing (mill) can be due to the transfer of contamination from food processing equipment (mill) along the production line, flour storage and storage containers and transportation equipment [11].

Conclusion

the findings of this study indicate that the milling process increases the amount of aluminum in the grain, which based on the previous studies can be a result of milling devices aluminum coating. Designing and conducting other studies on other heavy metals and the effect of bread baking steps is suggested.

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Conflict of interest

No conflict of interest has been expressed by the authors.

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