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ACRYLAMIDE LEVELS OF FAST FOOD PRODUCTS

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ABSTRACT

Acrylamide is a carcinogenic contaminant found in foodstuffs from 2002. Acrylamide presence in a large number of popular foods has become one of the most difficult problems faced by the food industry and the supply chain. Food and food products that are cooked at high temperatures and have high carbohydrate and protein content cause acrylamide formation. Among the food products that are likely to form acrylamide, foods containing carbohydrates have found more research areas than other foods with high protein content. In this study, determination of acrylamide in these three different group foods (154 product) were examined using HPLC. Box-and-whisker graphics were used to determine the distribution of acrylamide content in food products and potential sources of variability that could explain variation of acrylamide. The highest acrylamide content among the fried potato products were observed in ready-made potato chips (536.21 µg/kg; group mean 500±22.80). The lowest acrylamide content of meat and meat products group were determined among the 20 µg/kg kokorec samples (group mean 26.40±5.03). The tulumba alone constitutes the most risky food product of cereal group with its 22.28% acrylamide content. In addition, dietary acrylamide intake was calculated for all food products. As a result, acrylamide prevention processes that threaten public health should be emphasized and necessary measures should be increased for food safety.

KEYWORDS:
Acrylamide, Fast food, Potato chips, Grilled meat, HPLC, Food safety

INTRODUCTION

Acrylamide (CH_2=$CHCONH_2$, 2-Propenamide) toxicity has been investigated for many years. The fact that people become more and more conscious about health today has increased the interest in research on this toxic compound [1]. Different mutagenic forms of acrylamide (glycidamide) have been associated with genotoxicity and characterized as neurotoxic [2]. Acrylamide is evaluated in a possible carcinogen group (Group 2A). Exposure margins have been reported to be a concern as a result of in vivo studies [3].

Acrylamide, which can form during the heating of carbohydrate and protein foods, is basically part of the maillard reaction. Reducing sugars, (glucose and fructose) reaction with amino acids at high temperatures are among the principles of food chemistry. Thermal processes other than boiling (above 120ºC) are high acrylamide levels thermal food processes such as frying, baking and roasting. [4, 5].

International Cancer Agency (IARC) was classified acrylamide as a probable carcinogen. This important chemical structure that threatens public health has been the focus of researchers. In the studies (in April 2002) conducted, it has been observed that the foods with rich carbohydrate and protein content are investigated for acrylamide levels that may occur in high thermal processes and processes type (such as frying and baking). As a result of this situation, it has been brought to the literature that acrylamide formation is a trend [6]. Acrylamide contents in foods are significantly higher than other foods of the same food product category, suggesting that the processing and production methods used by food operators can significantly affect acrylamide levels in foods [7].

Potato products such as french fries, potato chips and chips are among the primary sources of dietary acrylamide. This group is followed by cereal products such as breads, traditional breads, breakfast cereals and various biscuits. In addition, cereal based roasted coffee and coffee substitutes have been included in researches that it may contain high levels of acrylamide [8, 9]. There are many analysis methods for determining the acrylamide content in foods. Traditional instrumental analysis methods, new rapid immunological tests and sensor detection are among the various analysis Technologies [10]. Studies on acrylamide content in different countries have been the focus of researchers. Research results show that acrylamide values in foods change according to the consumption habits of each country. This study focuses on the often-preferred fast food products among the people in Turkey. For this purpose, three different groups (Meat and its products, potato products, cereal products) were selected and the acrylamide content of different numbers of fast food products (154 products) representing these groups is determined.

MATERIALS AND METHODS

All samples were taken from the local markets and shopping centers of Sivas province. While sampling was determined, literature review was made. Taking advantage of these results, studies of acrylamide content of different countries in foods were taken into consideration [11,12,13]. Generally, three different groups were determined considering that they are fast food foods (Including in subgroups). A total of 154 samples were studied. All collected samples were placed in polyethylene bags under normal conditions. Stored at 4°C until laboratory analysis. Work planning; all food samples were made in triplicate, and 462 packaging was done.

Reagents: Acrylamide, acetonitrile (99.8%), formic acid (98-100%), acetic acid, hexane, potassium hexacyanoferrate and zinc sulfate were purchased from Merck (Merck KGaA, Germany). All solvents used were of HPLC quality and other chemicals used were of analytical HPLC grade. Acrylamide solutions prepared in different concentrations were prepared in water to form HPLC standard curves. Diluted acrylamide solutions were before use prepared and stored in the 4°C. Carrez 1 solution (15 g K_4 [$Fe(CN)_6$]) and Carrez 2 solution (30 g $ZnSO_4$) were prepared by dissolving in 100 ml of water.

Determination of acrylamide content Acrylamide concentrations in samples were determined using a HPLC chromatographic method. The characterization of acrylamide was determined using an HPLC (Agilent 1200) system. The column used was Zorbax SB-C18 (4.6 mm×250 mm, 5 µm). HPLC parameters and other conditions are given in Table 1.

Acetic acid was used after Carrez 1 and Carrez 2 solutions in order for the acrylamide molecule to be high polarity and to extract more water. All solid samples were first homogenized using a laboratory grinder. Due to the high oil content of the samples, homogenized samples were treated with hexane. By taking 1g of homogenized samples, Carrez 1 (0.1mL), Carrez 2 (0.1mL) and acetic acid (9.8 mL 0.2 mM) solutions were added. The resulting mixture was vortexed for 2 minutes. Then, the suspension was centrifuged (10 min, 5000 rpm; -5°C) The supernatant was analyzed by filtering through a 0.45 µm syringe filter.

Acrylamide standard (10 mg) was completed with 10 mL of water and acrylamide main stock solution was prepared. Five different concentrations of the stock solution were injected into the system. $y = ax + b$ (x, y distribution) formula was used with the obtained chromatograms (same retention time) (Figure 1) and acrylamide standard curve was obtained (Figure 2). Concentrations were calculated using average peak areas by comparison with the acrylamide standard.

RESULTS

The highest acrylamide content was evaluated as product groups and subgroups. High acrylamide content in other meat and meat products group was found in nugget (194.03 µg/kg; group mean 172.83±13.32) samples. The lowest acrylamide content of this group was determined among the 20 µg/kg kokorec samples (group mean 26.40±5.03) (Table 2).The highest acrylamide content among the fried potato products was observed in ready-made potato chips (536.21 µg/kg; group mean 500±22.80) (Table 3). The overalls, which were subjected to frying at high temperature among the cereal products, showed the highest acrylamide content at 266.21 µg/kg (group average 259.04±4.66). Plain bread has the lowest content of this group (30.34 µg / kg; group average is 40.23 ± 7.55). (Table 4)

When the three analyzed groups were compared, the highest group was potato products (Table 3) with high heat treatment followed by meat products (Table 2). The group with the lowest acrylamide is the cereal products group (Table 4). Meat and meat products represent 38.31% of the samples whose acrylamide contents are determined. This group covered 26.95% of the total acrylamide content. Total acrylamide content in samples taken from potatoes and products is 36.84%. Samples represent 19.48% of the total number of analyzed samples. In the cereal products group (42.21%), this rate was recorded as 36.22%. When the results were evaluated among themselves, the group with the lowest sample rate was recorded as the group with the highest acrylamide content.

In literature studies conducted in different countries, it was observed that the acrylamide content of potato chips obtained from the market and analyzed was similar to our study findings. Pugajeva et al. [12] potato chips acrylamide level 564 µg/kg; Elias et al. [13] 529 µg/kg are some of them. Opinions and suggestions of scientific authorities on acrylamide levels were examined. These values for ready potato chips and french fries are 389 and 308 µg/kg, respectively [3]. This was found to be in line with the average acrylamide level for frying the current study. In a different study investigating average acrylamide exposure levels, pizza (250 µg/kg) and french fries (724 µg/kg) were identified as risky foods [14]. When the frequency of consumption and the amount of acrylamide intake are compared the dose limits taken are close to the limit values creating a risk. Demirhan et al. [15] acrylamide levels of meat samples were determined the range of 24.6-71.3 µg/kg. In a study, it was stated that acrylamide concentrations of grilled meat samples varied between 23-250 µg/kg according to the type of meat (beef or chicken) and the type of grilled sample [15]. Method validation, sample and analysis method of these results are considered to be effective.

TABLE 1
HPLC parameters

Mobile phase	0.01 mmol/L Acetic acid in 0.2% formic acid and 0.2% acetic acid in acetonitrile (98:2 v/v)
Mobile phase flow rate	0.2 mL/min; 8 min
Column	Brownlee Analytical C18 column (4.6 mm×250 mm, 5 µm)/10°C
Injection volume	60 µL

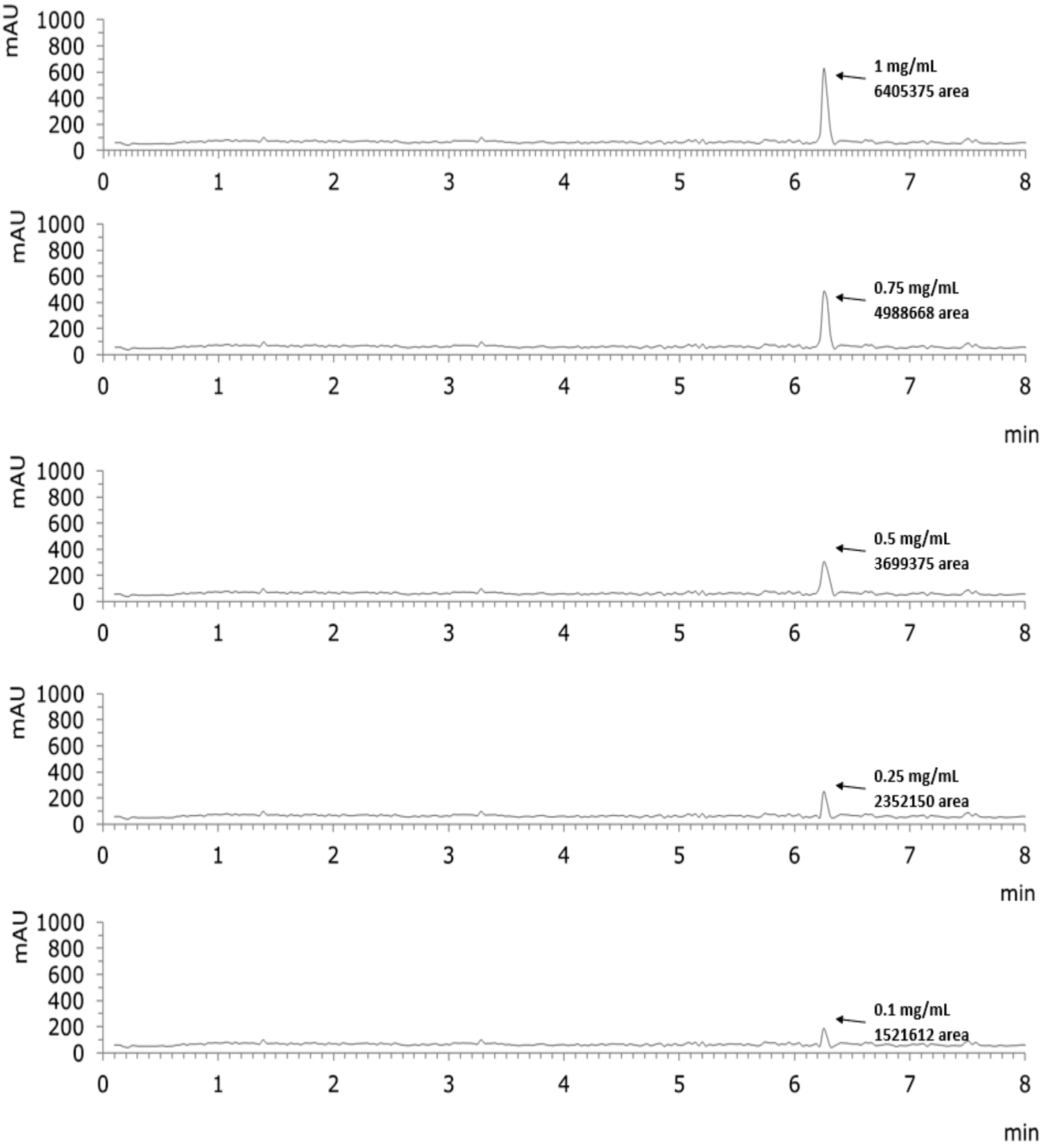

FIGURE 1
HPLC chromatograms of different concentrations acrylamide solutions for standard curve

There were a total of 65 samples in the cereal group, another group of our study. 35 of the cereal products consisted of plain bread, Turkish bagels, Turkish pastry and toast (Table 4). At least one of these products is consumed by the public during the day. While the total acrylamide level of these products, which is higher than the others, is 10.31%, the tulumba alone constitutes the most risky food product of this group with its 8.07% acrylamide content.

The mean acrylamide indicator value of Tulumba samples did not exceed the reported value [3]. Compared to our study, cereal group acrylamide levels in different countries showed differences in each of the 65 samples [16]. Another food group with high consumption habits is biscuit samples. Average acrylamide concentrations of these samples ranged from 100-180 µg/kg. Our study results were far below the values stated for cereal-based snacks such as biscuits [7].

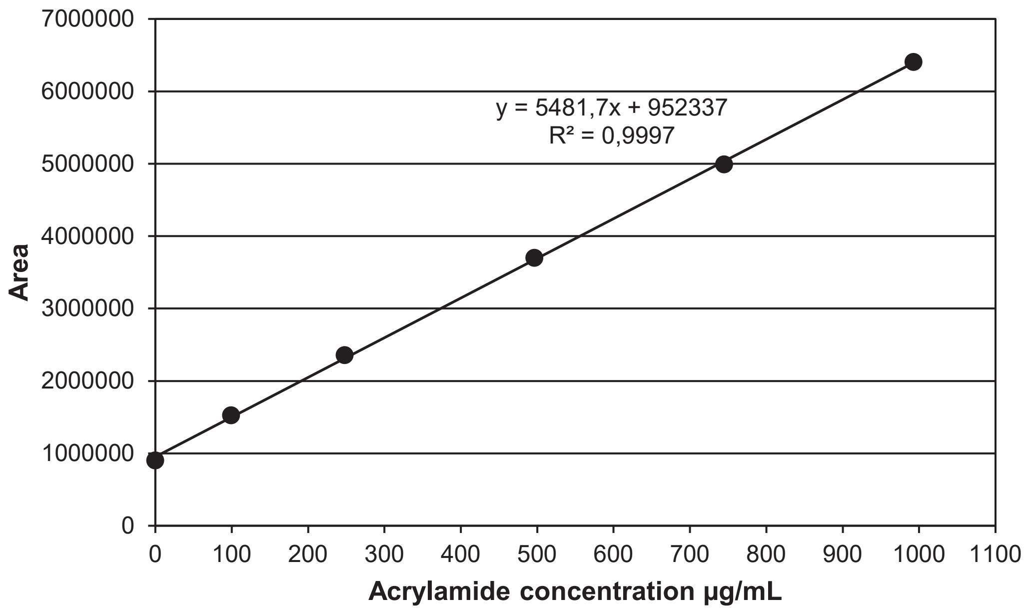

FIGURE 2
Calibration chart for different acrylamide concentrations

TABLE 2
Acrylamide in meat and meat products

Product	No.	Mean (µg/kg)	Serving/g*
Grilled beef (Doner Meat)	7	71.29±7.32	0.017
Grilled beef (Meatball)	8	98.13±12.09	0.025
Grilled beef (Hamburger Meatball)	5	150.60±11.61	0.034
Grilled beef (Doner Chicken)	7	32.57±4.72	0.008
Grilled chicken breast	6	30.83±6.27	0.003
Nugget	6	172.83±13.32	0.035
Scnitzel	5	149.60±6.07	0.030
Tantuni (Grilled meat product)	5	96.00±8.72	0.022
Kokorec (Grilled meat product)	5	26.40±5.03	0.006
Grilled fish	5	37.00±3.81	0.008
Total	59		

The results are Mean values (µg/kg)±Standard deviation; n=3.
No: Number of samples. * Daily intake (1 servings)

TABLE 3
Acrylamide in potato products

Product	No.	Mean (µg/kg)	Serving/g*
Potato crisps and snacks	10	500.00±22.80	0.05
French fries	10	387.20±21.87	0.04
Potato wedges	10	295.80±14.04	0.03
Total	30		

The results are Mean values (µg/kg)±Standard deviation; n=3.
No: Number of samples. * Daily intake (1 servings)

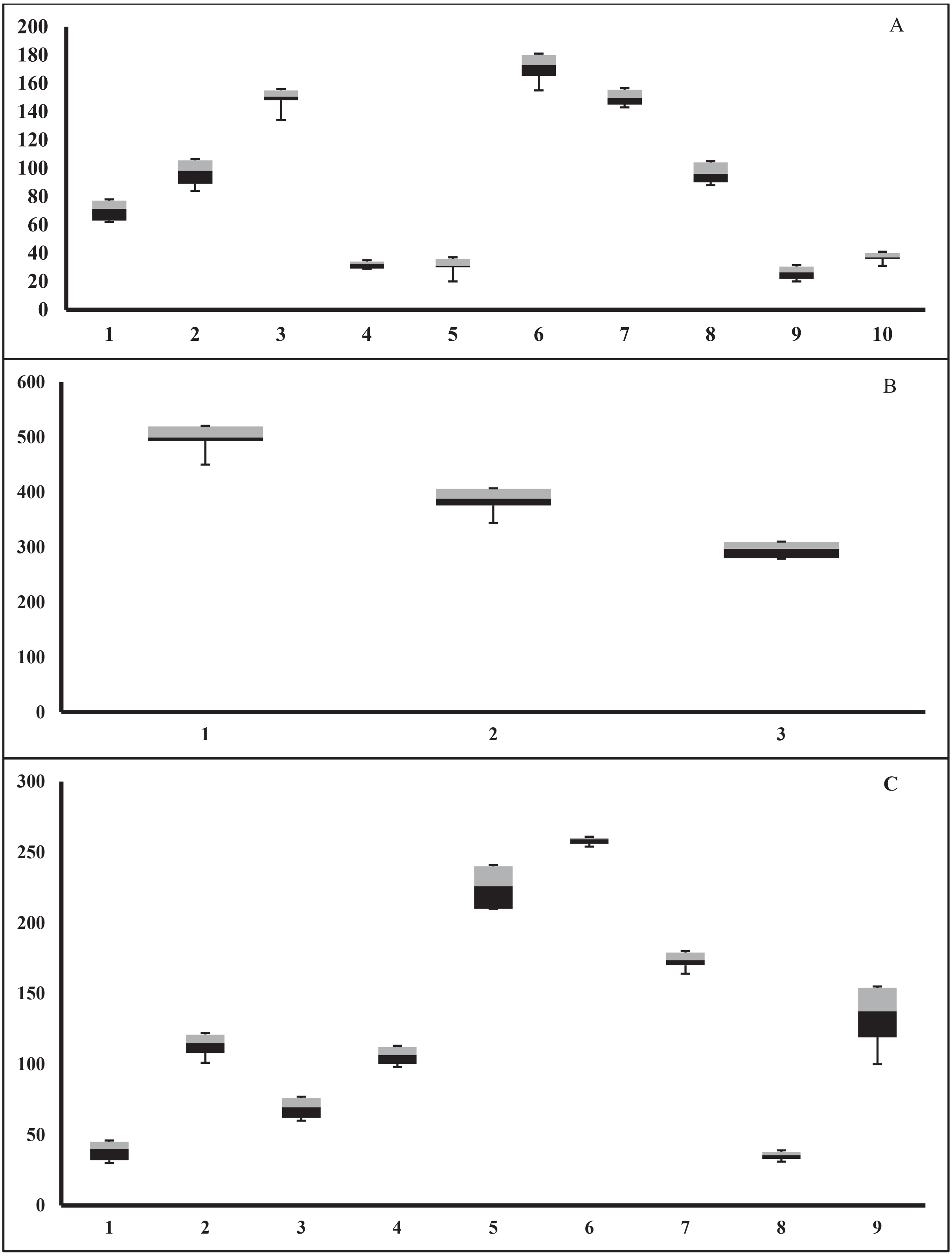

FIGURE 3
Box-and-whisker plot for (A) acrylamide (µg/kg) in meat and meat product (B) acrylamide (µg/kg) in potato products (C) acrylamide (µg/kg) in cereal products

TABLE 4
Acrylamide in cereal products

Product	No.	Mean (µg/kg)	Serving/g*
Plain bread (Somun)	10	40.23±7.55	0.003
Turkish Bagel (Simit)	9	114.89±7.85	0.005
Turkish Pastry (Puaca)	9	69.44±7.33	0.003
Toast	7	106.57±6.90	0.009
Turkish Donut Sweet (Halka)	5	226.00±18.17	0.023
Tulumba	5	259.04±4.66	0.010
Turkish Bite Sweet (Lokma)	5	173.60±6.66	0.007
Halvah	5	35.60±3.65	0.002
Biscuits	10	137.50±26.99	0.005
Total	65		

The results are Mean values (µg/kg)±Standard deviation; n=3.
No: Number of samples. * Daily intake (1 servings)

Although the maximum limits for the presence of acrylamide in foods have not been precisely determined, it is found in research findings that an individual's daily intake of approximately 100 µg of acrylamide can cause toxicity and be carcinogenic [16]. In addition, studies have reported that the acrylamide levels of protein-rich foods are not at a level of concern, but the acrylamide levels of carbohydrate-containing foods pose a risk. Research is generally focused on foods that contain carbohydrates and are treated with high heat [9, 10]. The distribution of acrylamide content in food samples has been studied in more detail to identify potential sources of variability that can explain the variation of acrylamide (Figure 3). For this, Box-and-Whisker graphic was used. Min: Minimum, Max: Maximum, median, Q1: First quartile, Q3: Third quartile, Box1-3, Whisker top and Whisker bottom values were calculated. Figure 3 is given Box-and-whisker plot for (Figure 3A) acrylamide (µg/kg) in meat and meat product (Figure 3B) acrylamide (µg/kg) in potato products (Figure 3C) acrylamide (µg/kg) in bread products. When different variations were evaluated, potential variability was observed between foods exposed to high temperatures. Variations in food containing acrylamide have been evaluated. Each group was found significant in the distribution. It may be possible to relate these differences between studies to the processing of food. The parallels and differences that arise when the acrylamide contents of our study are compared with the studies conducted in three different food groups are linked to the following results. These; It is thought to be traditional cooking techniques with the process temperature and duration applied to food products.

Dietary acrylamide intake The limits set by the food authorities are important. It was observed that the analyzed samples did not exceed these limits [3]. The calculations have been made by considering the portion amounts of the fast food products consumed. The portion amounts of traditionally consumed food products have been calculated. Daily intakes were determined separately for all analyzed samples. It has been observed that the daily intake limits of potatoes and their products that are consumed in high amounts are higher. When the risk assessment is made, the consumption of potatoes and their products is high in all age groups and they are included in the high risk foods class. The other analyzed food grade dessert group can be counted among the risky foods.

CONCLUSIONS

This study on the determination of acrylamide content in traditional and common fast foods are provided useful data that can be added to the acrylamide food database. Considering the data obtained in our study, it could compare with acrylamide studies of different countries. Acrylamide levels in foods, acrylamide formation can be prevented, and detailed studies involving acrylamide analysis methods are required. Attention should be paid to the traceability, quality and control principles of food products that are likely to form acrylamide. In order to reach safe food, attention should be paid to the food processing process. Food preferences that threaten public health should be avoided.

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