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ACRYLAMIDE CONTENT IN HEAT–TREATED CARBOHYDRATE–RICH FOODS IN POLAND

ZAWARTOŚĆ AKRYLOAMIDU W PRODUKTACH WYSOKOWĘGLOWODANOWYCH W POLSCE

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Acrylamide levels were analyzed in heat-treated carbohydrate-rich products collected at randomly selected shops and restaurants in Poland. The analysis was performed by gas chromatography tandem mass spectrometry (GC/MS/MS) using deuterium–labeled acrylamide as internal standard.

Keywords: acrylamide, potato crisps, French fries
Słowa kluczowe: akryloamid, chipsy ziemniaczane, frytki

INTRODUCTION

Acrylamide is a compound that one may not come across in a natural form in nature, but for more than fifty years now it is produced on industrial scale as a substrate for polyacrylamide polymer synthesis. Numerous studies [4, 6, 8, 13] showed that acrylamide demonstrated neurotoxic activity and causes damage of central and peripheral nervous systems of both laboratory animals and human beings. In laboratory animals the genotoxic and carcinogenic [2, 5, 11, 12] activity of acrylamide was also proven.

In April 2002 a group of scientists from Stockholm University acting jointly with the Swedish National Food Administration (Livsmedelsverket) announced that acrylamide is produced during thermal processing of food and can be found in fried and baked products [15]. At present it is known that acrylamide is formed primarily in heat-treated carbohydrate-rich foods as one of the products of *Maillard`s* reaction taking place between free asparagine and reducing sugars [10, 16]. The following are reported as the factors contributing to the formation of acrylamide in food: temperature above 120°C, high content of free asparagine and reducing sugars, humidity below 30% and relatively inactive matrix such as starch in the case of potato-derived products.

The aim of our study was the estimation of acrylamide content in the randomly selected samples of heat - treated carbohydrate - rich foods all over Poland.

MATERIAL AND METHODS

Testing material included 24 samples of potato crisps collected at randomly selected shops and 18 samples of fried French fries taken randomly from selected restaurants all over Poland in 2004 (potato crisps) and in 2005 (French fries) by the employees of the State Sanitary Inspection. One sample of potato crisps means two original commercial packages of the product in quantity not lower than 250 g. The potato crisps samples represented 14 crisps types and were produced by four manufacturers. One sample of French fries means two portions of the product collected immediately after frying in the restaurant. Quantity of French fries sample was not lower than 300 g. French fries samples were prepared in 10 types of different restaurants. All samples were immediately delivered to the National Food and Nutrition Institute, then French fries samples were homogenised, kept frozen and stored at – 20^{0}C until analysis. Potato crisps samples were stored until analysis at room temperature. Analytical sample of such product was prepared by mixing two packages (portions) and by homogenisation of the product.

To the homogenised sample of product the internal standard solution (d_3-acrylamide) was added and then it was extracted with water at temperature of 60^{0}C (ultrasonic bath), then it was centrifuged (12.000 rpm) and shaken together with hexane to remove fat. The water phase was subject to all-night-bromination (KBr, HBr + $KBrO_3$), then excessive bromine was removed with sodium hyposulphite and extracted twice with a ethyl acetate. The accumulated organic layers were evaporated to dryness and dissolved in ethyl acetate [3,17]. Samples (1 µl each) were analysed with Finnigan GCQ instrument equipped with Restek capillary column Rtx-5 (30 m x 0.25 mm ID x 0.25 µm film thickness) in splitless mode, carrier gas was helium at constant flow: 40 cm/s; injector temperature: 250°C; transfer line: 250°C, the oven temperature was programmed from 65°C for 1 min., thereafter temperature was increased by rate 15°C/min. up to 250°C and final time was 10 min. Ion trap MS/MS conditions were: for acrylamide dibromo derivative precursor ion was m/z 152 and product ion was m/z 135, for d_3 labelled acrylamide dibromo derivative internal standard precursor ion was m/z 155 and product ion was m/z 137. Collision energy was 1 volt and temperature of ion source was 180°C.

To quantify the acrylamide content in foods the ratio of area of ion peaks m/z 135 and m/z 137 (IS) was estimated. Individual result was calculated as a mean from three parallel samples of the same product.

RESULTS AND DISCUSSION

The mean content of acrylamide in tested samples of potato crisps amounted to 998 µg/kg of the product, however, the values ranged from 352 to 3647 µg/kg depending on crisps type. In more than 70% of samples tested the acrylamide content did not exceed 1000 µg/kg of the product; in seven samples it was below 500 µg/kg, and in ten samples ranged from 500 to 1000 µg/kg of the product (Fig. 1). Only two (slightly above 8%) of tested samples contained acrylamide in the quantity exceeding 3000 µg/kg of the product. Similar results were obtained in other countries [1, 7, 15].

In tested samples of French fries the mean content of acrylamide was lower than in crisps samples and amounted to 337 µg/kg of the product and it ranged from 88 to 799 µg/kg of the product (Fig. 2). In most (55.6%) tested French fries the acrylamide content ranged from 200 to 400 µg/kg of the product and in approx. 17% it ranged from 400 to 600 µg/kg of the product, and in two samples (11%) the determined acrylamide content exceeded 600 µg/kg

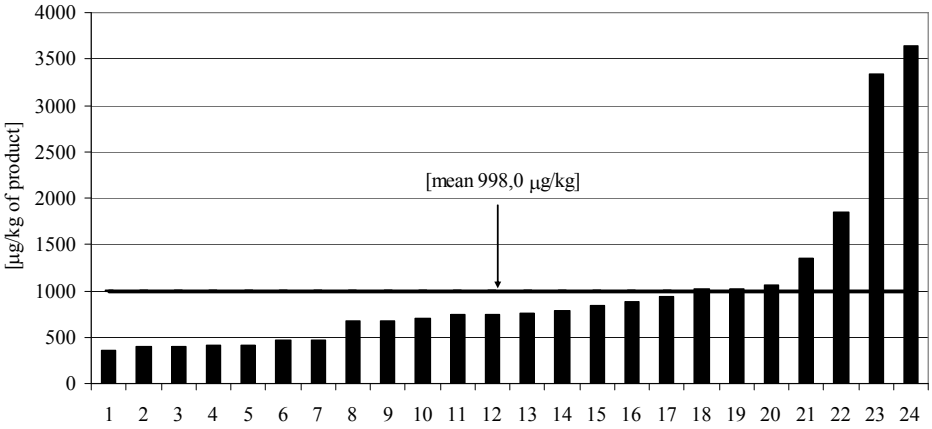

Fig. 1 Acrylamide content in potato crisps, randomly selected from Polish stores in 2004 (n=24)

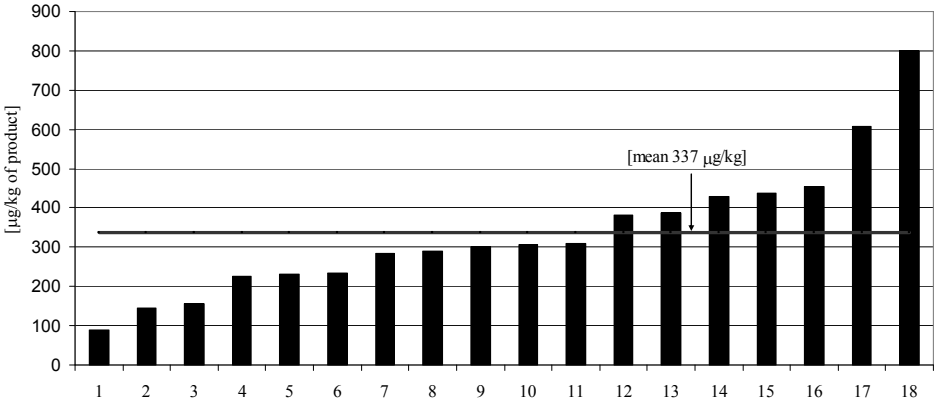

Fig. 2 Acrylamide content in French fries, randomly selected from Polish restaurants in 2005 (n=18)

of product. Slightly lower acrylamide content in French fries, however in individual product categories very similar to our results, was found out in Austria [9] and in the Netherlands [7]. The acrylamide content in French fries in Sweden [15] was higher than that found out in Poland and ranged from 300 to 1100 µg/kg of the product. Higher acrylamide content values were also obtained in Canada [1] with the values ranging from 200 µg/kg to even 1900 µg/kg of the product.

Due to potentially harmful influence of acrylamide it is important to continue research on its content in other foodstuffs. In order to assess health hazards connected with the presence of acrylamide in food it is necessary to estimate the intake of acrylamide from diet, taking into consideration representative data about food consumption and the results of acrylamide content in foods.

CONCLUSIONS

The mean acrylamide level in potato crisps amounted to 998 μg/kg (352 – 3647 μg/kg) but only two samples contain acrylamide in very high quantity, exceeding 3000 μg/kg. Acrylamide content in fried French fries was about three times lower than in potato crisps and amounted to 337 μg/kg. Our results were similar to the results obtained by researchers from other European countries. Due to potentially disadvantageous influence of acrylamide on human health it is important to assess health hazards connected with intake such compound from diet.

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Summary

The objective of the study was to determine the content of acrylamide in randomly selected samples of potato crisps and French fries using GC/MS/MS. The mean content of acrylamide in tested crisps amounted to 998 μg/kg (range from 352 to 3647 μg/kg) and was almost three times higher than in French fries - 337 μg/kg (range from 88 to 799 μg/kg). Differences (even ten times) in the level of acrylamide in individual product samples, testifying the impact of raw materials and technological process running conditions on the content of acrylamide in the final product. The results of our study were close to those obtained in other countries.

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Streszczenie

Celem badań było oznaczenie zawartości akryloamidu w losowo pobranych próbkach chipsów i frytek ziemniaczanych metodą GC/MS/MS. Przeciętna zawartość akryloamidu w badanych chipsach wynosiła 998 μg/kg (zakres 352 – 3647 μg/kg) i była około trzykrotnie wyższa niż we frytkach - 337 μg/kg (zakres 88 – 799 μg/kg). Stwierdzono znaczne różnice (nawet dziesięciokrotne) w poziomie akryloamidu w poszczególnych próbkach produktów, świadczące o wpływie surowców i warunków prowadzenia procesu technologicznego na zawartość badanego związku w produkcie finalnym. Wyniki naszych badań były zbliżone do uzyskiwanych w innych krajach.

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