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Short Communication

Acrylamide levels in cooked rice, tomato sauces and some fast food on the Italian market

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Abstract

This study reports the results of evaluation of acrylamide levels in some foods that are common on the Italian market. Three foods commonly found in the national diet (rice, tomato sauce and fast food), were examined with the gas chromatograph (GC)/mass spectrometer (MS) analytical method. Results show that rice differs from *risotto* with respect to acrylamide levels: values of less than 50 μg/kg, for boiled rice, increase to 113 μg/kg when various ingredients are added to produce *risotto*. Similar results were found for tomato sauce on the Italian market: acrylamide values were less than 50 μg/kg for simple tomato sauce, to 124 μg/kg when other ingredients such as olives and capers were added. Fast foods (e.g., fried potatoes) contained the highest observed acrylamide levels, probably from cooking methods and acrylamide-rich precursors. For two fried potatoes of the same type, very differentiated values resulted (136 and 294 μg/kg).

Keywords: Acrylamide; Rice; Fast food; Tomato sauces; Food safety

1. Introduction

Based on numerous studies, the International Agency for Research on Cancer has classified acrylamide as "probably carcinogenic to humans" (IARC, 1994). Animal experiments have shown that acrylamide might play a role in heightened incidence of cancers of the brain and nervous system, thyroid and other endocrine glands, and reproductive organs of mice (Bull et al., 1984). In a previous study, acrylamide was shown to produce adducts with haemoglobin (Törnqvist et al., 1998). In 2002, researchers at Swedish National Food Administration and Stockholm University distributed data concerning the presence of acrylamide in several foods prepared by frying and baking (Tareke et al., 2002).

The US Food and Drug Administration (Center for Food Safety and Applied Nutrition) has begun presenting experimental data concerning the acrylamide content in a selected cluster of foods, and in 2004 the CFSAN/Office of Plant & Dairy Foods posted experimental data evaluating the effects of acrylamide on the consumer for a wider spectrum of foods including bread and bread-like products, cereals and snacks (FDA, 2004). The aim of the FDA study was to evaluate the health risks associated with acrylamide consumption through food, inform the public of the FDA's progress in this area of research and stimulate research on the formation of acrylamide in food.

From the point of view of chemistry, biochemistry and the safety of acrylamide, Friedman reports that acrylamide in food is largely derived from heat-induced reactions between the amino group of the free amino acid asparagine and the carbonyl group of reducing sugars such as glucose, during baking and frying (Friedman, 2003). Other amino acids have also been found to produce low amounts of acrylamide, including alanine, arginine, aspartic acid, cysteine, glutamine, methionine, threonine and valine (Ezeji et al., 2003). Foods rich in these precursors are derived mainly from plant sources such as potatoes and cereals (barley, rice and wheat). Processed foods with high levels of acrylamide (French fries, potato chips, crispbread and various baked products and cereal formulations) show

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a wide range of acrylamide levels, both in different food categories and in different brands of the same food category. The amounts of precursors and variations in processing conditions could explain the different levels of acrylamide. Finally, the first data concerning acrylamide levels in baby food sold on the Italian market were reported in 2003 (Tateo and Bononi, 2003).

The study presented here reports data concerning foods found in the common Italian diet (rice, *risotto* and tomato sauce), not included in previous studies or data published by the FDA. Data concerning some fast food from the Italian market are also reported here because of the high prevalence of these foods in the diets of young people.

2. Materials and methods

2.1. Chemicals

Acrylamide (99 + %) (catalog number: 14.866-0) was obtained from Sigma Aldrich (Milan, Italy); *n*-hexane (98 + %), 2-propanol (99.8%) and sodium sulphate anhydrous were obtained from Merck (Darmstadt, Germany).

2.2. Equipment

The quantification of acrylamide levels in food was performed on a Shimadzu 2010 gas chromatograph (GC) coupled to a Shimadzu QP2010 quadrupole mass spectrometer (MS). The GC column was a Supelcowax^{TM}-10 fused silica capillary column (30 m × 0.25 mm i.d., 0.25 μm film thickness) (Supelco, Milan, Italy).

2.3. Samples

Two well-known Italian brands of rice were analysed after being boiled or cooked as *risotto* with various other ingredients commonly used for seasoning. Nine tomato sauces from the Italian market were also analysed, and four samples of each brand were considered. Ten products purchased from two well-known fast-food distributors in Milan were considered. Ingredients used to prepare all *risotto* samples and special ingredients declared in labels for tomato sauces are listed in Table 1.

The data reported here cover only a limited number of brands, because the aim of this work is to obtain exploratory data and not to allow absolute comparison or statistical data representative of the standard products. The same criterion was adopted by the FDA in "Exploratory data on acrylamide in food" (FDA, 2004).

2.4. Analysis by GC/MS of acrylamide

Samples of fast food were analysed using the original method previously published (Tateo and Bononi, 2003). In addition, the matrix was defatted with hexane at room temperature and extracted at room temperature with methanol. This method was also applied to boiled rice, *risotto*, and tomato sauce (Bononi et al., 2005). Approximately 10 g of homogenized sample was weighed and dehydrated, adding 10–50 g of sodium sulphate anhydrous, based on the water content of the sample. Each sample was defatted with 80 mL of hexane at room temperature, stirring for 30 min. Most of the solvent was removed by Pasteur pipette, and the residual solvent was removed by vacuum. Some 100 mL of 2-propanol were added to the defatted sample in a sealed flask, then stirred for 15 min and shaken for 1 min in an ultrasonic bath. The 2-propanol phase was recovered by filtration (approximately 70 mL) and subsequently concentrated in a rotary evaporator to less than 2 mL. The residue was carefully transferred to a graduated vial, then diluted to 2 mL and fast filtered. Using an autosampler, 1 μL of the sample was injected in splitless mode (15 s) and then splitting 1:20.

The temperature program for the GC was as follows: isothermal for 1 min at 60 °C, increased at a rate of 5 °C/min to 240 °C, then isothermal for 10 min. Analysis was performed using EI (70 eV) and selected ion monitoring. The ions monitored for identification of the analyte were m/z 55, 71 and 72 at room temperature for 22.9 min, using m/z 71 for quantification.

Quantification was performed through comparison with a calibration curve (150–1000 μg/L of standard acrylamide in 2-propanol) corresponding to 40 and 285 μg/kg, if 70 mL of 2-propanol extract were concentrated. Corrections for percent recovery need to be made. Recovery tests were repeatedly performed by quantification of acrylamide in fresh tomato before and after the addition of acrylamide. Samples containing more than 400 μg/kg of acrylamide were diluted up to a factor of 2 in the first extraction step.

3. Results

The calibration curve was linear ($R^2 = 0.9926$) in the 150–1000 μg/kg range, and the limit of detection (LOD) value was found to be 25 μg/kg. Assuming the quantitation limit to be three times LOD, the resulting value of the limit of quantitation (LOQ) was 75 μg/kg. However, in single ion monitoring (SIM) mode, detectable levels are evidenced at lower levels, from 50 μg/kg (still corrected with the recovery value). The adopted method proved useful for routine analysis, and the LOQ of 50 μg/kg was considered a reasonable and satisfactory target for the matrices which are the object of this work.

It is important to consider that the highest value reported for bread (the most common product in the diet) is approximately 49 μg/kg (Tateo and Bononi, 2003). The consumption of tomato sauce, rice and *risotto* in Italian diet are lower than that of bread, and for this matrix the value of 50 μg/kg was considered a reasonable target. For this reason, quantitation values of less than 50 μg/kg were not considered significant. Recovery was evaluated by quantitation of acrylamide in fresh tomato before and after the addition of acrylamide between 148 and 1049 μg/kg. Using 50 mL of 2-propanol twice in the extraction step, we