Effect of commercial processing on fumonisin concentrations of maize-based foods

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Abstract

Fumonisin-contaminated maize was used to study the effect of three cooking and food processing methods and residual contamination of the food product. Frying, autoclaving and extrusion were examined with naturally-contaminated maize meal, maize flour and sweet maize kernels, all at two fumonisin concentrations. High Pressure Liquid Chromatography determination of fumonisins B1 and B2 and hydrolized fumonisin B1 (AP1) were performed in unprocessed materials and at the end of the experimental runs. Reductions of fumonisins concentration in processed products were obtained for fried polenta and from one of the two runs of extruded maize batter. These reductions were consistent with previous studies of the thermal degradation of fumonisins. Autoclaving sweet maize kernels apparently resulted in reductions of fumonisin concentrations that were highly temperature dependent, but this needs further study. The unexpectedly large reduction in fumonisin concentrations in the extrusion processing of batter with high initial concentrations also needs further investigation. There was no evidence that AP1 was formed under any of the conditions tested.

Introduction

Fumonisins are mycotoxins produced by Fusarium verticilloides (formerly F. moniliforme), F. proliferatum and related species (1,2). F. verticilloides colonizes maize worldwide and causes the most important ear disease of maize, including in South America, fusarium kernel rot (3,4,5,6). In nature, fumonisins B1 and B2 are the dominant compounds accumulated in affected maize worldwide including in South America (7,8,9,10,11,12,13,14,15,16).
Acute exposures to fumonisin cause equine leukoencephalomalacia (17) and porcine pulmonary edema in swine and there are toxic effects at low exposures that affect animal production (2,18,19). Fumonisin B1 and culture material of F. verticilloides cause liver tumours in rats and mice (9). Ingestion of maize affected by F. verticilloides containing fumonisin is associated with esophageal cancer in the Transkei, South Africa and in northeastern Italy (2,9). Uruguay and southern Brazil have elevated rates of esophageal cancer in rural populations. This has been associated with drinking “mate”, a local herbal infusion sipped very hot through a metal straw (20,21). However, the possible association between fumonisin exposure and esophageal cancer in these populations, for whom maize is a part of the staple diet, has not been studied.

A survey of fumonisin levels in Uruguay’s most important maize and maize-based foods demonstrated widespread occurrence in products sampled from local markets (22). Sweet maize and milled maize products such as maize flour, meal or polenta were the foods which had the highest fumonisin concentrations. Grain maize products containing fumonisins are the main nutrient source in Uruguay in much of the population. In addition to fumonisins, deoxynivalenol and zearalenone occur in high prevalence in maize and other grains in Uruguay (23,24,25).

Thermally-processed maize products generally contain lower concentrations of fumonisins than unprocessed products (22,26,27). Several studies have focused on the effect of thermal processing on fumonisins (28,29,30,31, 32,33,34). These suggest that when foods are heated at temperatures encountered in boiling or retorting foods (100-125°C), little change in fumonisin content can be expected. But foods that reach temperatures of >150°C during processing (baking or frying) may have some losses of fumonisins.

Another treatment of maize, treating with base to prepare tortilla flours, destroys fumonisin B1 but converts it to the amino pentol product AP1. Some or possibly all of the toxicities of FB1 are retained by the breakdown product AP1 (35,36). Thermal degradation of fumonisin produces breakdown products including, possibly, AP1 (33).

The objective of the present study was to investigate the effects of three commonly used maize processing methods on the content of fumonisins and AP1 in the products: frying of maize meal, extrusion of maize flour, and autoclaving of sweet maize kernels.

Materials and methods

Sampling and sample preparation:
The source of naturally contaminated samples for maize meal and flour was pooled material of the 5 most popular national brand products (San Salvador, Manzanares, Puritas, Cefa, Adria). These were purchased and sampled at random from local commercial retail markets, five packages of each type for a total of 3 kg. They were homogenized in a Romer mill prior to analytical subsampling.

Naturally contaminated maize samples were collected from four different fields in different geographical areas of Uruguay (Colonia, Mercedes, Canelones and San Jose), 3 kg from each, mixed and homogenized in a Romer mill into one batch prior to subsampling for processing.

Determination of fumonisin contamination:
The natural contamination of sweet maize, maize meal and flour was determined by the liquid chromatography method described below. Depending on the values obtained, each product was grouped into low and higher concentration lots (levels 1 and 2),