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Editorial

A new polemic to acrylamide toxicity

Nutrition is the most important environmental factor that plays a crucial role in short- and long-term health outcomes. Growing evidence exists that some ingredients of preserved foods can induce epigenetic phenomena in genotoxic and non-genotoxic ways, with long-term effects on human health. Conversely, the short-term effects of harmful food components can cause structural damage to various systems and organs from the direct toxic tissue effects the cause functional failure [1]. Genotoxic and non-genotoxic pathways have been suggested for the carcinogenic effect of acrylamide. Of the possible non-genotoxic mechanisms, acrylamide may influence the redox status of cells and thus gene transcription or it may interfere with DNA repair or hormonal balance [2].

According to Dybing et al. [3], 6 of 10 000 people will develop cancer as a result of ingesting acrylamide in foodstuffs. In rats, increased cases of thyroid and mammary gland tumors and scrotal mesothelioma have been noted [4]. In humans, increased risks of renal, ovarian, endometrial, and breast cancers and oral cavity cancer in non-smoking women have been reported [4]. Some cancer types have been observed in rats and humans, e.g., endometrial cancer, but there have been some inconsistencies [4]. Interestingly, in humans, some indications for inverse associations have been observed for lung and bladder cancers in women and for prostate, hypopharynx, and oropharynx cancers in men [4]. These observations indicate that genotoxicity may not be the only mechanism by which acrylamide causes cancer and other pathologies. The estimated risks based on the epidemiologic studies for the sites with an observed positive association were considerably higher than those based on extrapolations from the rat studies [4]. These results and the fact that acrylamide is present at high levels in different everyday foods stress the design research into a low-dose rate of exposure of dietary acrylamide and the possible risk for long-term and short-term health outcomes.

In addition to essential nutrients and harmful molecules, human foodstuffs also contain substances with protective properties such as lectins, digestive enzyme inhibitors, glycoalkaloids, and fiber from fruits and vegetables. Dietary fiber is a complex of substances that are not digested and not absorbed in the digestive tract. The proven health benefits of a high-fiber diet include prevention of constipation, regulation of cholesterol and glucose levels in the blood, and anticancer activity. This idea is based on information that soluble and insoluble dietary fibers restrict absorption and help to eliminate toxins, heavy metals, and carcinogenic substances from the organism by an acceleration of intestinal passage. Soluble fibers, e.g., pectins and gums found inside plant cells forming a jelly-like structure in the intestines, also offer anti-inflammatory and protective effects of the intestinal wall by absorbing toxic substances [5,6]. This is why the protective activity of potato fiber against acrylamide toxicity was considered by Dobrowolski et al. [7]. For this purpose, they checked whether acrylamide had any toxic influence on the structure and absorptive activity of the small intestinal wall and, if so, whether there was a substance that could prevent this effect. When acrylamide is taken orally, the gastrointestinal tract is exposed to considerable amounts of this substance. Acrylamide passes through the gastrointestinal barrier by passive diffusion, and in this situation a high bioavailability can be present in the circulatory system [8]. Because the acrylamide molecule is small and hydrophilic, it reaches each organ and practically all tissues in the body [9]. For this reason, all tissues are hypothetical targets for its toxicity. Dobrowolski et al. [7] reported that acrylamide changed the structure of the small intestinal wall by decreasing the proliferation, the myenteron and submucosal thickness, villi length, fractal dimension, crypt depth, crypt number, and the small intestinal absorptive surface. Conversely, apoptosis, hemoglobin adducts, the number of enterocytes, the epithelium thickness of the villi, and crypt width and parameters associated with the nerve ganglia were increased.

The toxic effects of acrylamide result in villus atrophy, and crypt hyperplasia and damage to the surface epithelium in the small bowel causing an acrylamide-induced enteropathy result in a decreased absorptive function, as shown by Dobrowolski et al. [7], and probably the digestive capacity of the small intestinal surface area as well. Because the digestive and absorptive functions of the small intestine are essential for life and development, the pattern of deficiencies that results from structural damage of the small intestine causes the malabsorption syndrome, usually resulting in multiple nutritional deficiencies with marked body wasting [10].

Potato fiber has been found to suppress the structural influence of acrylamide on the small intestinal wall but to have no effect on the acrylamide level in hemoglobin adducts. In general, the toxic impact of acrylamide on the structure, innervation, regeneration, and absorptive activity of the small intestine can be eliminated by the addition of dietary fiber. Dobrowolski et al. [7] found that potato fiber did not decrease the bioavailability of acrylamide, whereas Woo et al. [11] previously suggested a decreased bioavailability of acrylamide. Dobrowolski et al. [7] observed an influence of acrylamide on

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the small intestinal nervous system, which may be a predominant source of small intestinal damage, as reported previously [12]. The results of Dobrowolski et al. [7] were contrary to the data presented by Woo et al. [11], in which no protective effects of potato fiber against acrylamide toxicity were found in rats. The experiments of Woo et al. [11] with high-dose acrylamide in drinking water showed testicular toxicity and neurotoxicity. In addition, evident gait abnormalities were observed in their study. The difference between the studies by Dobrowolski et al. [7] and Woo et al. [11] can be explained by the low dose of acrylamide (∼40 times lower) in the drinking water, different organs, and different models that were used for their investigations.

The study by Dobrowolski et al. [7] has clear strengths and advantages. It is the first study to present the effects of acrylamide on the structure and absorption of the small intestinal wall, which probably is extremely important in other forms of acrylamide toxicity, thus influencing short-term health outcome. They described the different positive effects of raw and heated potato fiber. The raw fiber according to previous investigations, presented activity against cancer, but these effects were not expected for the heated potato fiber. These data indicated various possible mechanisms of action of the heated and raw potato fiber, indicating a need for study and analysis. It is likely that the heating resulted in the destruction of potato fiber cells, releasing the pectins or resulting in the generation of new molecules that had a protective activity against acrylamide toxicity in the small intestinal wall. Further study is also needed for the identification of these likely new molecules and to elucidate their protective effects on the gastrointestinal tract.

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