

Acrylamide: A Hidden Danger

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Acrylamide, which is known to exist in a range of foodstuffs at different rates is a heat treatment contaminant and has been labeled by the International Agency for Research on Cancer as a probable carcinogenic substance for humans. Acrylamide is readily absorbed by the body and it spreads to the tissues. The fact that acrylamide is highly prone to react with DNA and RNA has brought forward various health problems as well. Many studies have proved the relation between acrylamide and diseases related to the nervous system, notably cancer. The most important mechanism in the formation of acrylamide in foodstuffs is the Maillard reaction. The level of acrylamide in foodstuffs shows an increase in high temperatures especially in the presence of reducing sugar and asparagine amino acid. However, no legal legislation has yet been defined on the level of acrylamide in foodstuffs.

Keywords: acrylamide; coffee; asparagine; maillard reaction, cancer

Introduction

Acrylamide (AA) is a compound in the amide group which is also known to be called acrylic acid amide, 2-propenamide, acrylamide monomer and propionic acid amide. The AA substance which is frequently used in the textile sector, dam and tunnel construction and the paper industry, is currently classified by the International Agency for Research on Cancer (IARC) as a Group “2A” probable carcinogenic substance. On the other hand, the presence of AA in foodstuffs was first demonstrated in 2002 by a group of scientists in Sweden. A great number of different foodstuffs that we consume habitually in our daily lives are known to contain the AA substance at different rates which is why it causes lifelong exposure in humans due to nutrition requirements. Therefore, AA has gained prominence in the world of science recently.

The Toxicokinetic Character of Acrylamide

Since AA is readily soluble in water, it can be rapidly absorbed completely. In their study involving human subjects, (Fennel et al., 2005) detected 34 % of AA in urine metabolites in 24 hours. Similarly, (Fuhr et al., 2006) detected 60% of AA in urinary metabolites in 72 hours.

AA is subject to spreading rapidly in tissues no matter how the exposure happens, whether orally or dermally. An experiment on laboratory animals conducted by Marlowe et al., (1986) presented that AA, after being administered orally, was efficiently absorbed by the stomach and spread to the other tissues, and pass to the placenta rapidly. Another study by Sumner (2003) showed that acrylamide in mice was found mostly in blood, skin, spleen and lungs.

AA is metabolized in two different ways: The first is that AA is conjugated by glutathione-S transferase (GST) to N-acetyl-S-(3-amino-3-oxopropyl) and S-(3-amino-oxopropyl) cysteine metabolites. The second is that AA reacts with cytochrome P450E1 (CYP2E1) and produces glycidamide metabolite which is crucial for all species. On the other hand, glycidamide is conjugated by epoxide hydrolases 2,3- dihydroxy propionamide and GST enzyme to form N-acetyl-S-(3-amino-2-hydroxy-3-oxopropyl) and N-acetyl-S-(1-carbonyl-2-hydroxyethyl) cysteine metabolites (Sumner et al., 2001).

According to a study conducted on laboratory animals by Sumner et al., (1999), it was measured that 44% of AA was removed by urine in mice and 51% was removed in rats. Studies conducted on volunteer human subjects showed that AA elimination rate from the body was lower compared to animals (Watzek et al., 2012).

Acrylamide and Health

The presence of AA in foodstuffs and its widespread use in the industry has called for the need of research related to health issues. Therefore, a great number of studies have been carried out on dietary AA intake and its relation with various diseases.

There is, however, no absolute consensus on the existence of the relationship between dietary AA intake and cancer. No meaningful correlation was detected between dietary AA intake and cancer types around the reproductive area (Mucci et al., 2005; Kotemori et al., 2018), the respiratory area (Pelucchi et al., 2006; Schouten et al., 2009), the urinary area (Larsson et al., 2009; Hirvonen et al., 2010) and the gastrointestinal area (Mucci et al., 2006; Obón-Santacana et al., 2013). However, some scientists have represented the positive correlation between AA and various types of cancer (Hogervorst et al., 2007; Hirvonen et al., 2010; Bongers et al., 2012; Liu et al. 2017). Besides, it has been expressed that AA exposure may have an effect on the peripheral, central and autonomic nervous system of human beings and trigger muscle weakness and numbness in hands, feet, legs and arms (Hagmar et al., 2001; Goffeng et al., 2011)¹.

Foods and Acrylamide

In spite of the fact that AA formation in foodstuffs still continue to bear uncertainties, some specific mechanisms have been proposed in this context. Among these mechanisms, the Maillard reaction is regarded as the basic mechanism. Other than that, some studies have shown that acrolein, aspartic acid, carnosine, B-alanine and pyruvic acid conjugates to acrylic acid and then to AA in various reactions (Guenther et al., 2007).

Lots of institutions and researchers have focused on research aimed at determining the content of acrylamide in various foodstuffs soon after it became evident that acrylamide was formed in foodstuffs in certain conditions. The AA content in foodstuffs can range from µg/kg (ppb) levels

to mg/kg (ppm) levels depending on many variables such as the type and content of the food, processing technique and storage conditions. Studies that have been conducted so far have built consensus on the fact that AA is found with a strikingly high content in fried potatoes, potato chips, bread, biscuits, cereals, infant formula and coffee (EFSA, 2015).

Legal Limitations on Acrylamide

According to EU Commission Regulations, it is allowed to establish maximum tolerances for pollutants and natural plant toxins when necessary in order to protect public health. However, no regulations have been proposed up to now on the abovementioned 12 food groups which are known to be rich in AA content. As a partial solution, it is recommended that EU member states monitor AA levels in certain foodstuffs and report to EFSA annually all the data such as sampling points, procedures, sample numbers/frequencies, and analytical approaches.

Conclusions

Today, there is a strikingly wide range of research on the content of AA in foodstuffs. However, taking into account the rich diversity of foods in the world, it can easily be said that even the current research which seem to be extremely rich is not enough. The fact that AA is present at considerably high rates in foods that we can easily access in our daily lives and are part of our dietary habits is a clear manifestation of how we are confronted with a hidden danger. It should not be forgotten that dietary exposure to AA lasts a lifetime. For that reason, how the foods are processed and how frequently they are consumed is extremely important for our human health. Periodical implementations to monitor the level of AA in various foods and to share the data with the public is of great importance in that such actions would be helpful in guiding global health policies.

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Акриламид: скрытая опасность

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Акриламид, который, как известно, присутствует в ряде пищевых продуктов в разных количествах, является загрязняющим веществом термообработки, и был маркирован Международным Агентством по исследованию рака как вероятное канцерогенное вещество для людей. Акриламид легко усваивается организмом и распространяется по тканям. Тот факт, что акриламид очень склонен реагировать с ДНК и РНК, также вызывает различные проблемы со здоровьем. Много исследований доказали взаимосвязь между акриламидом и болезнями, связанными с нервной системой, особенно раком. Самый важный механизм в формировании акриламида в продовольствии - реакция Майяра. Уровень акриламида в продовольствии увеличивается при высоких температурах особенно в присутствии редуцирующего сахара и аминокислоты аспарагина. Тем не менее, до сих пор отсутствует правовое законодательство об уровне содержания акриламида в пищевых продуктах. Однако до сих пор не было разработано ни одного законодательного акта об уровне содержания акриламида в пищевых продуктах.

Ключевые слова: акриламид, кофе, аспарагин, реакция Майяра, рак

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