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Pilot Screening of Acrylamide Level in Some Egyptian Brands of Potato and Corn Products

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Abstract

Background*:** Acrylamide is a chemical compound produced in starchy foods that have been cooked at high temperatures. Acrylamide is proven to be carcinogenic in rodents and a probable human carcinogen, with increasing evidence of positive associations with human cancers. Acrylamide is formed in potato crisps, chips, bread and crisp bread. It was first discovered by scientists in Sweden in 2002.Objective*:** To determine the level of acrylamide in popular Egyptian brands of potato crisps and corn products produced by domestic food industrial factories. ***Methods*:** Seven brands of potato and eight brands of corn products were collected, crashed and after preparing the extracts of each sample, high performance liquid chromatography (HPLC) was used for measuring the amount of acrylamide. ***Results*:** The amounts of acrylamide ranged 247–1677µg/kg in potato brands and <35–419µg/kg in corn products. ***Conclusion*:** As acrylamide is a dangerous toxin for human health, its level in these products, that are used extensively by people especially children, should be strictly traced and reduced.

Key words: Acrylamide, potato, corn.

INTRODUCTION

High concentrations of acrylamide in common heated starch-rich foodstuffs has been detected by the Swedish National Food Administration in 2002. It attained considerable public health concern since it has been found to be carcinogenic in rodents and classified as a probable human carcinogen.[1] Potato products, such as French fries and chips, were among the food items containing the highest amounts of acrylamide. However, no maximum permitted concentration has been established for acrylamide in processed foods yet. Maillard reaction of reducing sugars with asparagines at temperatures above120℃was the main mechanism of acrylamide formation.[2-5] Acrylamide was not found in boiled or unheated foods. It was not possible to stop acrylamide being produced or to remove it from foods once it has been produced.[1]

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Therefore extensive research is being carried out to find out how the levels of acrylamide produced in food can be reduced. Available researches revealed that acrylamide induce nerve terminal damage,[6] increase the production of reactive oxygen radicals by leukocytes and increase plasma C-reactive protein.[7] It also ha a toxic effect on male reproduction,[8] decrease the level of dopamine,[9] and has genotoxic and carcinogenic effect.[10-12] On the other hand, some studies showed that acrylamide intake was not associated with cancer development.[13-15] A limited Norwegian exposure assessment study revealed that the daily mean intakes of acrylamide in foods and coffee had been estimated to be 0.49 and 0.46 µg/kg body weightin males and females respectively.[16] Safedietary intake level of acrylamide, including tolerable daily intake (40 µg/kg/day) and margins of exposure (300 µg/kg/day), were also estimated for humans.[17] Because there were no data regarding level of acrylamide in potato crisps and corn products that are produced in domestic factories, the purpose of the current study was to determine the level of this toxin in these products.

MATERIAL AND METHODS

Study design: Cross sectional study

1. Chemicals

Acrylamide (99%) was purchased from Sigma (Taufkirchen, Germany) and deuterium-labelled acrylamide-d3 (>99%) from LCG Promochem (Wesel, Germany).HPLC-grade acetonitrile was supplied by Aldrich (Seeze, Germany). All other reagents used for the analysis of acrylamide were of analytical grade.

2. Sampling

Seven popular Egyptian brands of potato products and eight brands of corn products were collected randomly from the local market (10 each). Samples P1, P2, P3, P4 and P7 were crisps, sample P5 was potato sticks and sample P6 was potato pellet. All potato products samples were the fried products except P5 that was a mixture of potato powder and corn meal. Samples C5 and C6 were popcorn and others were snacks. Samples C1 and C2 were fried snacks and samples C3, C4, C7 and C8 were cheese covered snacks.

3. Determination of acrylamide

Extraction, purification, and determination of the levels of acrylamide were carried out using the high performance liquid chromatography (HPLC) method.

3.1. Preparation of Standard Acrylamide

Standard analytical grade acrylamide was purchased from Sigma Chemical Company. Stock acrylamide solution was prepared by dissolving 10 mg of standard acrylamide in 10 ml HPLC water with vigorous agitation for one minute using vortex mixer. Different concentrations were prepared from this stock solution. The absorbance of the obtained solutions was determined by measuring at 230 nm using a SHIMADZU -160a UV – visible spectrophotometer.

3.2. Sample preparation

One gram of each minced and homogenized samples was blended with 9 ml HPLC water, mixed for 10 minutes on a rotating shaker and then centrifuged at 9000 rpm for 30 min. A portion of the clear aqueous phase was promptly removed for filtration. The filtrates were re-centrifuged at 4000 rpm for 10 min then the clarified aqueous solution was filtrated.

3.3. Column clean up

Clean up of column was carried out by using chromatography tube (25 mm internal diameter, 350 mm length) filled with fine granules of silica gel. The mobile phase (aqueous 0.1 % acetic 0.5% methanol 1:1) was passed.

3.4. Detection of acrylamide using HPLC

Twenty µL of the extract was introduced into the injection unit of the HPLC under the following conditions.

- Column: C18-CLC/ODS reversed phase.
- Detector: UV-VIS. Spectrophotometer (SHIMADZU SPD- 6AV)
- Injection volume: 20 µ L
- Flow rate: 0.5 ml/min
- Wave length: 230 nm

- Column temperature: 26℃
- Mobile phase: aqueous 0.1% acetic acid and 0.5 % methanol 1:1

3.5. Calculations

Concentrations of detected acrylamide were determined by comparing with a known concentration of standard acrylamide injected under the same conditions.

4. Statistical analysis

The differences among treated groups were analyzed by one-way ANOVA followed by Tukey test. *p value of less than* 0.05 was considered statistically significant.

RESULTS

Data showed that in different brands of potato products, levels of acrylamide were between 247 and 1677µg/kg for the samples P2 and P6 respectively (Figure 1). There were no differences between samples P1, P4, P5 and P7. Amount of acrylamide in samples P3 and P6 was significantly higher than in other samples (p< 0.001).

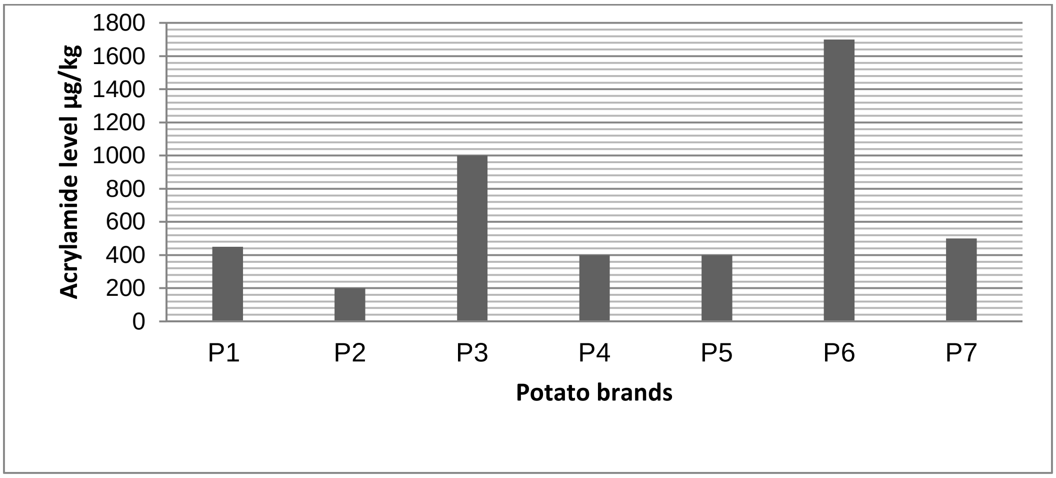

Figure1. Acrylamide levels in Egyptian brands of potatos

Data shown as n = 10 for each sample. P1, P2, P3 and P4: unflavored crisps. P5: potato stick. P6: unflavored potato pellet. P7: salted crisp. P1 versusP2 (p< 0.05), P1 versus P3 and P6 (p< 0.001). P2 versus P3, P6 and P7 (p< 0.001), P3 versusP4, P5, P6 and P7 (p< 0.001), P4versusP6 (p< 0.001), P5 versusP6 (p< 0.001), P6 versus P7 (p< 0.001).

The level of Acrylamide in different brands of corn products was between35 µg/kg (samples C1 andC3) and 419µg/kg (sample C6),,figure 2. Amount of Acrylamide in samples C5 and C6was significantly higher than other samples (*p*< 0.001). There was no difference between samples C1, C3, C4, C7 and C8.

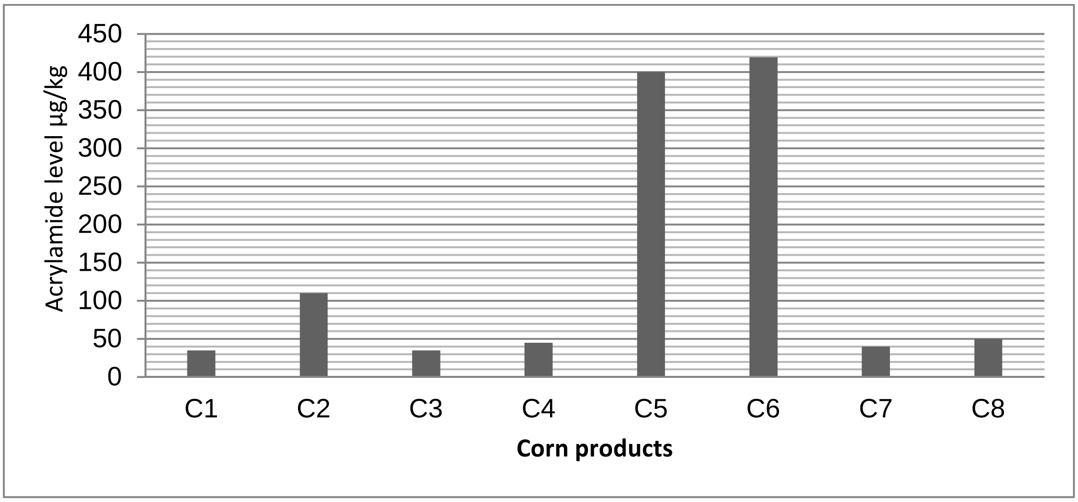

Figure 2. Acrylamide levels in Egyptian brands of corn products

Data shown n = 10 for each sample. C5 and C6: popcorn C2, C1: flavored fried snack,C3, C4, C7 andC8: flavored and cheese covered snack C8 versusC5 and C6 (p< 0.001). C8 versusC2 (p< 0.01). C5versus C2, C1, C3, C4 and C7 (p< 0.001). C6 versus C2, C1, C3 and C4 (p< 0.001). C2 versusC7 (p< 0.01).

DISCUSSION

The current study revealed that different amounts of the chemical acrylamide in some popular Egyptian potato and corn products that had been produced at high temperatures were found and reported. These products included crisps, stick and pellet from potato and popcorn and snacks from corn. Data showed that the amount of acrylamide in corn products is significantly lower than that of potato products, minimum 35µg/kg for corn compared to 247µg/kg for potato products, and maximum 419compared to 1677µg/kg, for corn and potato products respectively. The results of the current study agreed with other studies. This could be explained by the fact that potato contains more reducing sugar and asparagine amino acid than corn and other cereals. Acrylamide is known to cause cancer in animals and its presence in some foods may harm people’s health. Minimum amount (247µg/kg) of acrylamide was detected in sample P2 (crisps) and maximum amount (1677µg/kg) in sample P6 (Pellet), with a mean of 666µg/kg. Different amounts of acrylamide in samples may be due to frying temperature, duration of frying, type of frying oil, variety of potato and amount of sugar in raw potato. Sample P3 was stick potato chips that undergoes higher temperature for production, therefore the amount of acrylamide is warrantable compared to normal crisps. Sample P6 was pellet, its ingredients were unknown and must be identified whether it contains potato powder, corn powder or wheat powder. As pellets are produced in two steps, they must be identified. Higher amount of acrylamide is due to exposure toprimary temperature during the first step or due to exposure to secondary temperature in the second step of production, so the amount of acrylamide in the first step needed to be measured to compare it with the final product.

Data showed that in corn products, the amount of acrylamide in samples C5 and C6 is higher than others which may be due to the difference in the method of production. Popcorns undergo 200–220° C for 2 minutes whereas samples C3, C4, C7 and C8 were produced under conditions of 80–120° C for less than one second. Samples C1 and C2 after extruding were fried in temperatures between 160 and 165° C for 15 seconds (C1) and 4 minutes (C2), therefore, different amounts of acrylamide between C1 and C2 were warrantable. Worldwide, some studies have been carried out about the level of acrylamide in different food stuffs. In Austria, maximum amount of this toxin was in potato crisps (1500 µg/kg), cookies (99 µg/kg),bread (69 µg/kg), rice and popcorn (97µg/kg) and coffee (169 µg/kg).[18] Selected carbohydrate-rich foods available inthe Brazilian market showed alevel of acrylamide between 20 and 2528 µg/kg.[19] In Poland, the level of acrylamide in potato crisps was between 352 and 3647 µg/kg, depending on the type of crisps.[20] In Japan, most potato chips and whole potato-based fried snacks showed an acrylamide concentration higher than 1000 µg/kg. In the current study, the maximum amount of acrylamide was 1677µg/kg which is less than Brazilian and Polish but more than Austrian and Japanese crisps. Some studies showed that various cooking conditions such as type of frying oil, frying period and temperature affected the levels of acrylamide in foodstuffs.[21-23] Studies showed that there were two basic ways to reduce acrylamide in potato crisps. First, through the raw material itself (the potato). Potatoes have a considerable potential to form acrylamide. Fried potato was the food category which has probably chalked up the highest concentrations of acrylamide recorded.[24] Second, the level varied depending on the type of potato,[25-26] several other factors (e.g. fertilization, climate, location), or due to the specific asparagines levels. With regards to the formation of acrylamide, the industry is currently in the process of selecting the most suitable types of potatoes. Storage of the potatoes also had a very big impact on the formation of acrylamide. By optimizing the storage conditions (in particular, maintaining a storage temperature below10℃), the levels of reducing sugars released due to starch degradation using storage can be minimized.[27-28] Another fundamental way to reduce acrylamide concentrations in the end product is by influencing the technology used in the production of potato crisps.

CONCLUSION

The level of acrylamide in potato products is higher than in corn products. Also levels of acrylamide in Egyptian potato products are comparable with some other countries. Because the amount of acrylamide is high in some potato crisps that are produced in domestic factories, there is a need to reduce the level of acrylamide in these products that are consumed extensively by people especially children.

REFERENCES

1. Tareke E, Rydberg P. Analysis of acrylamide, a carcinogen formed in heated foodstuffs. J Agric Food Chem. 2002; 50: 4998.
2. Becalski A, Lau B, Lewis D, Seaman SW. Acrylamide in foods: occurrence, sources, and modeling. J Agric Food Chem. 2003; 51: 802–8.
3. Mottram DS, Wedzicha BL, Dodson AT. Acrylamide is formed in the Maillard reaction. Nature.2002; 419: 448–9.
4. Stadler RH, Blank I, Varga N, Robert F, Hau J, Guy PA, et al. Acrylamide from Maillard reaction products. Nature.2002;419: 449–50.
5. Weisshaar R, Gutsche B. Formation of acrylamide in heated potato products model experiments pointing to asparagine as precursor. Deut. Lebensm Rundsch. 2002;98: 397–9.
6. Lopachin RM, Gavin T. Acrylamide-induced nerve terminal damage: relevance to neurotoxic and neurodegenerative mechanisms. J Agric Food Chem. 2008; 56: 5994–6003.
7. Naruszewicz M, Zapolska-Downar D, Kos´mider A, Nowicka G, Kozłowska-Wojciechowsk M. Chronic intake of potato chips in humans increases the production of reactive oxygen radicals by leukocytes and increases plasma C-reactive protein: a pilot study. Am J Clin Nutr. 2009; 89: 1951.
8. Song HX, Wang R, Cao SX, Liu TZ. Toxicity of acrylamide on male reproduction. Zhonghua NanKeXue. 2008;14: 159–62.
9. Tareke E, Lyn-Cook BD, Duhart H, Newport G, Ali SF. Acrylamide decreased dopamine levels and increased 3-nitrotyrosine (3-NT) levels in PC 12 cells. Neuro sci Lett. 2009; 458: 89–92.
10. Dybing E, O'Brien J, Renwick AG, Sanner T. Risk assessment of dietary exposures to compounds that are genotoxic and carcinogenic. ToxicolLett. 2008;180:110–7.
11. Tareke E, Lyn-Cook B, Robinson B, Ali SF. Acrylamide: a dietary carcinogen formed in vivo? J. Agric. Food Chem. 2008;56: 6020–3.
12. Klaunig JE. Acrylamide carcinogenicity. J. Agric. Food Chem. 2008;56: 5984–8.
13. Hogervorst JG, Schouten LJ, Konings EJ, Goldbohm RA, van den Brandt PA. Dietary acrylamide intake and the risk of renal cell, bladder, and prostate cancer. Am J Clin Nutr. 2008; 87: 1428–38.
14. Hogervorst JG, Schouten LJ, Konings EJ, Goldbohm RA, Van den Brandt PA. Lung cancer risk in relation to dietary acrylamide intake. JNatl CancerInst. 2009; 101: 651–62.
15. Larsson SC, Akesson A, Wolk A. Dietary acrylamide intake and prostate cancer risk in a prospective cohort of Swedish men. Cancer Epidemiol Biomarkers Prev. 2009; 18: 1939–41.
16. Dybing E, Sanner T. Risk assessment of acrylamide in foods. Toxicol Sci. 2003; 75:7–15.
17. Tardiff RG, Gargas ML, Kirman CR, Sweeney LM. Estimation of safe dietary intake of acrylamide for humans. Food ChemToxicol. 2010; 48: 658–67.
18. Murkovic M. Acrylamide in Austrian foods. Biochem. Biophys. Methods.2004; 61:161–7.

19. Arisseto AP, Toledo MC, Govaert Y, Loco JV, Fraselle S, Weverbergh E, Degroodt JM. Determination of acrylamide levels in selected foods in Brazil. Food Addit. Contam. 2007;24: 236–41.
20. Mojska H, Gielecin´ ska I, Szponar L, Chajewska K. Acrylamide content in potato crisps in Poland. Rocz Panstw Zakl Hig. 2006;57: 243–9.
21. Yoshida M, Ono H, Chuda Y, Yada H, Ohnishi-Kameyama M, et al. Acrylamide in Japanese processed foods and factors affecting acrylamide level in potato chips and tea. Adv Exp Med Biol. 2005;561: 405–13.
22. Elmore JS, Koutsidis G, Dodson AT, Mottram DS, Wedzicha BL. The effect of cooking on acrylamide and its precursors in potato, wheat and rye. Adv Exp Med Biol. 2005; 561: 255–69.
23. Palazoglu TK. Reduction of acrylamide level in French fries by employing a temperature program during frying. J. Agric. Food Chem. 2008; 56: 6162–6.
24. Ozkaynak E, Ova G. Effects of various cooking conditions on acrylamide formation in rolled patty. Food Addit. Contam. Part A, Chem. Anal Control Expo Risk Assess. 2009;26: 793–9.
25. Friedmann M. Chemistry, biochemistry, and safety of acrylamide. JAgric Food Chem. 2003; 51: 4504–26.
26. Biedermann M, Noti A, Biedermann-Brem S, Mozzetti V, Grob K. Experiments on acrylamide formation and possibilities to decrease the potential of acrylamide formation in potatoes. Mitt. LebensmHyg. 2002; 93: 668–87.
27. Haase NU, Matthäus B, Vosmann K. Acrylamide formation in foodstuffs minimizing strategies for potato crisps. Deutsche Lebensm. Rund. 2003; 99: 87–90.
28. Noti A, Biedermann-Brem S, Biedermann M, Grob K, Albisser P, Realini P. Storage of potatoes at low temperature should be avoid to prevent increased acrylamide during frying or roasting. MittLebensm Hyg. 2003;94: 167–80.
29. Grob K, Biedermann M, Biedermann-Brem, S, Noti A, Imhof D, Amrein T. French fries with less than 100 lg/kgacrylamide. A collaboration between cooks and analysts. Eur Food ResTechnol. 2003; 217: 185–94.