Behrouz Akbari-adergani et al /J. Pharm. Sci. & Res. Vol. 9(6), 2017, 994-996

ISSN:0975-1459
Journal of Pharmaceutical Sciences and Research
www.jpsr.pharmainfo.in

Polycyclic Aromatic Hydrocarbons in Shell and Kernel of Roasted Sunflower Seeds

Behrouz Akbari-adergani[1], Toran Khaki[2], Gholamreza Jahed[2], Reza Ahmadkhaniha[3], Sadegh Rezapour[4], Parisa Sadighara[2*]

[1]*Food & Drug Laboratory Research Center, Food & Drug Administration, Ministry of Health and Medical Education, Tehran, Iran*
[2]*Department of Environmental Health, Food Safety Division, Faculty of Public Health, Tehran University of Medical Sciences, Tehran, Iran*
[3]*Department of Human Ecology, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran,*
[4] *Razi Herbal Medicines Research Center, Lorestan University of Medical Sciences, Khorramabad, Iran*

Abstract

Background:
Polycyclic aromatic hydrocarbons (PAHs) are important in food contamination. The present study was carried out to assess PAHs in shell and kernel of roast and raw sunflower seeds (*Helianthus annus L.*).
Methods: Analytical methods included saponification using methanolic potassium hydroxide, extraction using cyclohexane and assessment using GC-Mass apparatus.
Results: Of 16 PAHs studied in roasted and raw sunflower seeds, four PAHs were detected in roasted seeds, including anthracene, benzo[a]pyrene, fluoranthene and phenanthrene. Concentration of the total PAHs was calculated at 15.9 ±4.8 µg/kg in shell of roasted seeds. Results showed no contaminations in shell and kernel of raw sunflower seeds. Assessment of the PAH distribution in shell and kernel of roasted seeds showed that PAH concentration in shells was significantly higher than that in kernels ($p < 0.05$).
Conclusion: For the first time, results of this study suggested the presence of PAHs in roasted sunflower seeds. This can be a potential health risk for consumers and is necessary to be considered in food control regulations.

Keywords: PAHs, roasted and raw sunflower seeds, GC-MS analysis

1. INTRODUCTION

Polycyclic aromatic hydrocarbons (PAHs) are chemical compounds known as carcinogen agents and persistence organic pollutants (POPs). They can be transferred indirectly to food from some sources such as engine exhausts, petroleum distillates and coal-derived products. Polycyclic aromatic hydrocarbons may directly contaminate foods as a result of heating processes such as roasting and smoke drying and hence include health hazards for the consumers. Presence of PAHs in human foods is a highly concerning issue because of their potential carcinogenic effects. The carcinogenic effects of some PAHs are now well established [1, 2]. Polycyclic aromatic hydrocarbons have been demonstrated to cause skin, lung, bladder, breast and colon cancers [3]. These compounds interfere with the normal function of DNA and have been described as mutagenic and genotoxic compounds[4]. They are highly lipid-soluble and absorbed in the gut; facilitated by the bile salts. Foods have been shown as the major source of PAHs. Therefore, a majority of research and strategies consists of assessing PAHs in foods to reduce their potential health risk [5]. One of these foods, roasted sunflower seed, and is a popular dried nut. The consumption size of this nut is high in some people. Roasting of seeds at high temperatures may generate PAHs. The content of PAHs in foods is maybe come from air, soil or water and/or resulted from food processing such as grilling, roasting and smoking [1]. Therefore, the final PAH content of roasted sunflower seeds depends on the contamination rate of raw sunflower seeds and contaminations produced in roasting processes. In the present study, the shell and kernel of roasted and raw sunflower seeds were analyzed to assess the potential health hazard of PAHs. Reports by The Joint FAO/WHO Expert Committee on Food Additives (JECFA) conclude that 13 PAHs are clearly genotoxic and carcinogenic. In the current study, 16 important EPA PAHs, including naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benz[a]anthracene, chrysene, benzo[k]fluoranthene, benzo[b]fluoranthene, benzo[a]pyrene, benzo[ghi]perylene and indeno[1,2,3-cd]pyrene, were assessed in shell and kernel of roasted sunflower seeds.

2. MATERIALS AND METHODS

Sampling

Samples of sunflower seeds were divided into four parts, including shells of roasted sunflower seeds; kernels of roasted sunflower seeds; shells of raw sunflower seeds and kernels of raw sunflower seeds. The sunflower seeds were cultured in Ardabil Province (north west of Iran) and collected randomly from retail markets in Tehran, Iran. Half of raw samples were roasted using gas oven at 200 ◦C for 10 min.

Pre-analytical treatment

Samples were powdered using hand-held blender. Fifty grams of the powdered sample were mixed with 90 ml of methanol and 10 ml of distilled water. After mixing well, KOH and pyrene were respectively added to the mixture as

internal standards. Samples were extracted using Soxhlet extractor for 3 h then rinsed with 20 ml of methanol:water (9:1, v/v). Samples were extracted twice using 50 ml of iso-octane; shaken for 5 min. The organic layer was transferred into a flask. For removing residual water, 10 g of Na_2SO_4 were added to the mixture. The extracts were further reduced to 2 ml using rotary evaporator.

GC-MS analysis

Detection and analysis of PAHs in raw and roasted sunflower seeds were carried out using Agilent 5977A Gas Chromatography/Mass Spectrometer (GC/MS) apparatus. All GC-MS analyses were carried out using CP-Sil 5 CB Low Bleed/MS Capillary Column with dimensions of 30 m × 0.53 mm × 0.4 μm. The inlet temperature was set at 275 °C. A constant flow of hydrogen at 2.4 ml/min was set in the column. The oven temperature was set at 80 °C (held for 2 min) ramping at 50 °C/min to 230 °C, then 2 °C/min to 260 °C and then 8 °C/min to 340 °C (held for 5 min). The total run time included 35 min. the peak spectra were compared with the mass spectra of PAH standards.

3. Results and Discussion

Sixteen PAHs were assessed in the shell and kernel of roasted and raw sunflower seeds. Table 1 shows the influence of roasting on the formation PAHs in sunflower seeds. Phenanthrene, anthracene, fluoranthene and benzo[a]pyrene were the major PAHs in samples. The total contents of these PAHs in the shell and kernel of roasted sunflower seeds were significantly different (p = 0.035). Shell of the roasted sunflower seeds contained the highest concentration of PAHs. Food, water and air are the exposure resources of PAHs. Smoked and roasted foods and those submitted to severe thermal treatments are the highest PAH sources [6]. In this study, seed samples were roasted at 200 °C; therefore, contamination was mainly due to the pyrolysis of macronutrients [7]. In west of Iran, roasted sunflower seeds are widely consumed as popular snack. These could be contaminated by pesticides, heavy metals, PCBs and PAHs. Roasted sunflower seeds are usually produced using gas oven-roasting. However, no surveys on the content of PAHs in roasted sunflower seeds have been published.

Data from the analysis of roasted and raw sunflower seeds are shown in Table 1. In the current study, three low molecular-weight PAHs were reported in the shell and kernel of roasted sunflower seeds, including anthracene, fluoranthene and phenanthrene. Furthermore, a high molecular-weight PAH, benzo[a]pyrene, was reported. High molecular-weight PAHs are generally more stable and toxic than light molecular-weight PAHs [8]. Of the 16 carcinogenic PAHs studied, anthracene and fluoranthene were detected with the highest level in the shell and phenanthrene was detected mainly in the kernel of sunflower seeds. Quantity of benzo[*a*]pyrene in the shell of sunflower seeds was also considerable. No PAH is eligible in roasted sunflower seeds. According to European food safety regulations, the maximum accepted level of benzo[*a*]pyrene is 5 μg/kg in smoked meats [9]. The acceptable content of this PAH is usually below 2 μg/kg in oils [5]. In this study, the benzo[*a*]pyrene level in shell of roasted seeds (3.32 ±2.9 μg/kg) was greater than its maximum tolerable level in oils. The benzo[*a*]pyrene has been classified as Group 1 (human carcinogen) by the International Agency for Research on Cancer (Gul et al., 2015). In a previous study, the total PAHs in popcorn samples were reported as 3.36 ±0.18 μg/kg[2].

Table 1. Average concentrations of PAHs (μg/kg) in the shell and kernel of roasted (time, 10 min; temperature, 200 ºC) and raw sunflower seeds

PAH	Roasted sunflower seed shell	Roasted sunflower seed kernel	Raw sunflower seed shell	Raw sunflower seed kernel
Naphthalene	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND
Phenanthrene	3.1 ±1.6	6.1 ±1.8	ND	ND
Anthracene	5.56 ±2.4	4.1 ±2.3	ND	ND
Fluoranthene	3.9 ±1.8	1.3 ±0.9	ND	ND
Pyrene	ND	ND	ND	ND
Benz[a]anthracene	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND
Benzo[b]fluoranthene	ND	ND	ND	ND
Benzo[a]pyrene	3.32 ±2.9	1.52 ±1.8	ND	ND
Dibenz[a,h]anthracene	ND	ND	ND	ND
Benzo[ghi]perylene	ND	ND	ND	ND
Indeno[1,2,3-d]pyrene	ND	ND	ND	ND
Total PAHs	15.9 ±4.8	9.5 ±5	-	-

In the current study, the PAH level in the shell of roasted sunflower seeds were more than that reported by Olabemiwo et al. Furthermore, the total PAHs in the present study was greater than that (10.12 µg/kg) previously reported in coffee [10]. The Canadian legislation fixed a limit of 3 µg/kg for the total heavy PAHs (benz[a]anthracene, chrysene, benzo[k]fluoranthene, benzo[b]fluoranthene, benzo[a]pyrene, benzo[g,h,i]perylene, indeno[1,2,3-cd]pyrene) [11]. Polycyclic aromatic hydrocarbons are environmental contaminants which are widespread in air and soil. Despite their hydrophobic properties, they are found in water [5]. Results reveal that raw sunflower seeds did not constitute a health risk due to PAHs. The rate of PAHs in raw sunflower seeds usually reflects its rate of contamination in air, soil and water. However Ardabil Province is the major producer of sunflower seeds in Iran; the environmental contamination with PAHs is not monitored. Polycyclic aromatic hydrocarbons contaminate directly sunflower seeds as a result of roasting process. The people who take roasted sunflower seed are likely to have considerable intake of PAHs.

CONCLUSION

In the current study, raw sunflower seeds were naturally free of PAHs in contrast to roasted sunflower seeds; possibly due to the lack of PAHs in environment, including air, soil and water. However, roasted seeds could strongly be contaminated by PAHs during heating processes. Roasting process could result in contamination of foods, especially the shell of seeds. In general, a significant difference was seen between the PAH concentrations in the roasted shell and roasted kernel of the sunflower seeds.

ACKNOWLEDGMENTS

Authors with to thank Research Deputy of Tehran University of Medical Sciences for the financial support of this study (Project No: 301008). Authors also thank laboratory staff within the Food Additives Laboratory of the Reference Food and Drug Control Laboratories, Ministry of Health And Medical Education, Tehran, Iran.

FUNDING: This study was supported by Tehran University of Medical Sciences, Tehran, Iran.

REFERENCES

1) C. Naccari, M. Cristani, F. Giofre, M. Ferrante, L. Siracusa, D. Trombetta, PAHs concentration in heat-treated milk samples. *Food Research International*, **44**,716–724(2014).
2) O.M. Olabemiwo, A.C. Tella, N.B. Omodara, A.O.Esan, A.Oladapo, Polycyclic aromatic hydrocarbons in three local snacks in ogbomoso. *American Journal of Food and Nutrition*,**3**, 90–97(2013).
3) O. Gul, M. Dervisoglu, M. Mortas, O. Aydemir, E. Ilhan, K. Aksehir, Evaluation of polycyclic aromatic hydrocarbons in Circassian cheese by high-performance liquid chromatography with fluorescence detection. *Journal of Food Composition and Analysis*, **37**, 82–86(2015).
4) A.L.V. Escarrone, S.S. Caldas, E.B.Furlong, V.L. Meneghetti, C.A.A. Fagundes, J.L.O. Arias, E.G. Primel, Polycyclic aromatic hydrocarbons in rice grain dried by different processes: Evaluation of a quick, easy, cheap, effective, rugged and safe extraction method. *Food Chemistry*,**146**, 597–602(2014).
5) Z. Zelinkova, T. Wenzl, The occurrence of 16 EPA PAHs in food – A Review. *Polycyclic Aromatic Compounds*, **15**, 248–28(2015).
6) L. Rey-Salgueiro, M.S.Garcia-Falcon, E. Martinez-Carballo, Simal-Gandara J. Effects of toasting procedures on the levels of polycyclic aromatic hydrocarbons in toasted bread. *Food Chemistry*,**108**, 607–615(2008).
7) T.A. Kumosani, S.S. Moselhy SS, Asseri AM, Asseri A.H. Detection of polycyclic aromatic hydrocarbons in different types of processed food. *Toxicology and Industrial Health*, **29**,300–4(2013).
8) A. Farhadian, S.Jinap S, Abas F, Sakar Z.I. Determination of polycyclic aromatic hydrocarbons in grilled meat. *Food Control*, **21**, 606–610(2010).
9) A. Gomes, C. Santos C, Almeida J, Elias M, Roseiro LC. Effect of fat content casing type and smoking procedures on PAHs contents of Portuguese traditional dry fermented sausages. *Food and Chemical Toxicology*, **58**,369–374(2013).
10) L.L.A. H. Veiga, H. Amorim, J. Moraes, M.C.Silva, R.S.L. Raices, S.L. Quiterio. Quantification of polycyclic aromatic hydrocarbons in toasted guarana (Paullinia cupana) by high-performance liquid chromatography with a fluorescence detector. *Food Chemistry*, **152**,612–618(2014).
11) G. Purcaro, S. Moret, Conte LS. Overview on polycyclic aromatic hydrocarbons: Occurrence, legislation and innovative determination in foods. *Talanta*, **105**,292–305(2013).