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ACRYLAMIDE, THE HEALTH ENEMY FROM FOOD PRODUCTS THAT ARE PROCESSED AT HIGH TEMPERATURES

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Abstract

Even if the modern man prefers food products with optimum nutrient content, with superior sensory properties, obtained by technologies that do not affect the nutritional value of the nutrients, however, the consumption of foods rich in acrylamide is increasing as fast- food type of products are preferred, products created to excite the taste buds. Acrylamide is a chemical that naturally forms in starchy food products during baking and frying, in the crust of the French fries, in roux, potato crisps, breaded products, toast, biscuits. The level of acrylamide in food products may be a risk factor for cancer and a concern for health authorities. Studies conducted on laboratory animals have shown the neurotoxic and carcinogenic potential of acrylamide, its genotoxic nature and its toxicity in reproduction.

Key words: acrylamide, fried foods, neurotoxic potential, carcinogenic effect

INTRODUCTION

Acrylamide is particularly found in food products derived from raw materials that are rich in carbohydrates and low in proteins and that have been thermally processed at temperatures of over 170^0C (Ötles S. et al., 2004, Zyzak, D. et al., 2003, Abdelaziz E. et al., 2006, Friedman M., 2003). The main foods with high acrylamide content are: french fries, potato crisps, coffee, biscuits, pastry products, bread, breakfast cereals, instant products for children.

The foreign specialized literature has published numerous data on the acrylamide contained by marketed foods (Stadler, R. et al., 2002, Nail, 2010, Sams C. et al., 2015, Tofană M. et al., 2006). Currently, the content of acrylamide in food products is not known in Romania.

Scientists say that acrylamide is highlighted when processing food products at temperatures above 120°C (Zyzak, D.,et al., 2003, Bungău S., 2015). Acrylamide is not found in foods that have been boiled or in foods

that have not been heated as it is formed in the process of baking, frying and roasting the food (Herehoiu R. T., 2009, Hariri E., et al., 2015). Acrylamide is particularly found in food products derived from raw materials that are rich in carbohydrates and low in proteins (Ötles S.et al., 2004). The main foods with high acrylamide content are: French fries, potato crisps, coffee, biscuits, pastry products, bread, breakfast cereals, instant products for children (Anca P.et al, 2011, Shipp A.et al., 2006).

Thermally processed foods with a low content of acrylamide (5-50 µg/Kg) are rich in proteins, those with a high content (100-4000 µg/Kg) are rich in carbohydrates. Foods that lack acrylamide are those that are boiled or non-thermally treated (CAST., 2006).

Besides its carcinogenic action, the neurotoxic effects exerted by this substance have also been demonstrated (Gerhard E., 2007, Arisseto, A.P., et al., 2007, Mojska, H. et al., 2010, Svensson K. et al.,2003). The study performed by the Chinese scientists relies on previous findings according to which acrylamide contributes to the increase of the amount of free radicals and causes DNA damage and neoplasms (Chuang, W. H., 2006, Konings, E. J. M., 2003).

In the UK, it is suggested that traces of acrylamide have been found in the brain of the victims of Alzheimer's disease, probably due to high consumption of snacks and potato crisps (Konings, E. J. M., 2003). It affects the peripheral and central nervous system as well as the reproductive system. It causes irritation to skin, eyes and respiratory tract (Fuhr U., Boettcher M.I., 2006).

The risk of developing cancer depends on the level and duration of exposure. It may also lead to mutations in new-borns (Konings, E. J. M., 2003). It is thermally unstable. The acceptable daily intake is 1 µg/acrylamide/day (David R. Lineback 2006, Stadler et. al., 2003, Chuang, W. H., 2006), amount exceeded in many regular food products.

MATERIAL AND METHOD

An assessment survey has been set up containing questions about the knowledge of those interviewed on the existence of acrylamide in food, its toxicity and its formation in certain thermally processed foods and questions about the frequency of consumption of such foods by the interviewed people. The study has been performed in Oradea, Bihor County. It has been conducted in two stages, baseline and at six months (table 1 and 2).

In order to assess the acrylamide intake through food consumption, we have conducted an open, randomized, non-interventional comparative study

on a group of 94 people aged between 19 and 30 years, both women and men group known as frequent consumer of thermally processed foods rich in acrylamide. In our study group, women prevailed (56.38%), aged 21-25 years, urban (65.89%) (table 3).

Table.1.

Assessment survey 1

Questions	Yes		No	
	No.	%	No.	%
Baseline				
Do you know what acrylamide is?	49	52.13	45	47.87
Do you know where acrylamide is found?	35	37.23	59	62.77
Are you aware of the toxicity of acrylamide?	21	22.34	63	67.02
Would you like to know more on acrylamide?	57	60.64	37	39.36
Would it be beneficial for the population to have the content of acrylamide written down on food products?	61	64.89	33	35.11
At 6 months				
Do you know what acrylamide is?	80	85.11	14	14.89
Do you know where acrylamide is found?	72	76.60	22	23.40
Are you aware of the toxicity of acrylamide?	44	46.81	50	53.19
Would you like to know more on acrylamide?	75	79.79	19	20.21
Would it be beneficial for the population to have the content of acrylamide written down on food products?	88	93.62	6	6.38

Tabel.2.

Assessment survey 2

Food with acrylamide content	Very often		Often		Rarely		Very rarely	
	No.	%	No.	%	No.	%	No.	%
	Baseline							
Potato crisps	22	23.40	20	21.28	24	25.53	28	29.79
French fries	17	18.09	46	48.94	21	22.34	10	10.64
Popcorn	12	12.77	12	12.77	30	31.91	40	42.55
Toast	26	27.66	34	36.17	15	15.96	19	20.21
At 6 months								
Potato crisps	7	7.45	9	9.57	42	44.68	36	38.30
French fries	9	9.57	22	23.40	43	45.74	20	21.28
Popcorn	4	4.26	6	6.38	38	40.43	46	48.94
Toast	12	12.77	16	17.02	31	32.98	35	37.23

Very often = at least 3 times/week, **Often** = 1 time/week, **Rarely** = 1 time/month, **Very rarely** = occasionally/never

Tabel.3.

Assessment survey 3

Characteristics of group	%
Female/Male	56.3/43.6
Age	
<=20 years	29.79
21-25 years	45.74
26-30 years	24.47
Urban/Rural	64.89/35.11

RESULTS AND DISSCUSIONS

The results obtained from the analysis of the surveys (fig.1 and 2) reveal that: out of 94 people surveyed 49 knew what acrylamide was (52.13%), 35 were aware of its presence in thermally processed food (37.23%) and only 21 had information on the toxicological profile of acrylamide (22.34%).

Noteworthy is the fact that of all interviewed people 57 were interested in finding out more on acrylamide, representing 60.7%, and an even higher percentage of 66.7% wanted the information written down on food products. At the survey that took place 6 months later, 32.98% of the interviewed people remembered what acrylamide was, 39.37 knew where it was found and 24.47 were aware of its toxicity.

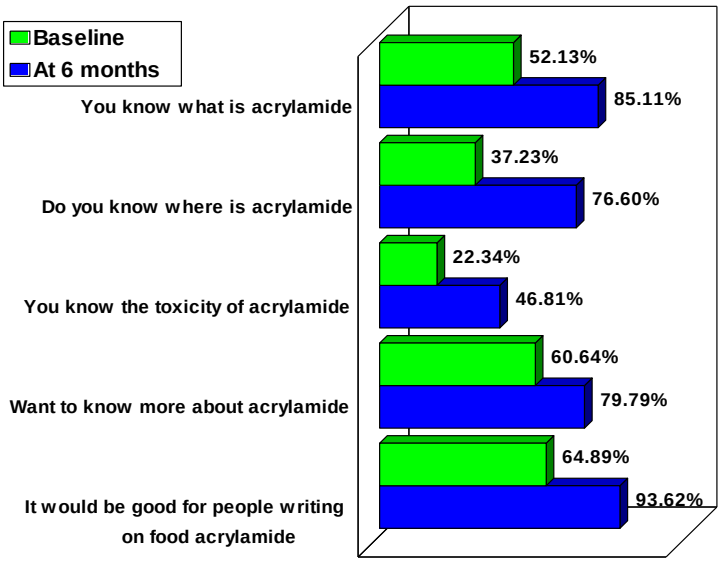

Fig.1.Evolution of the level of information on acrylamide

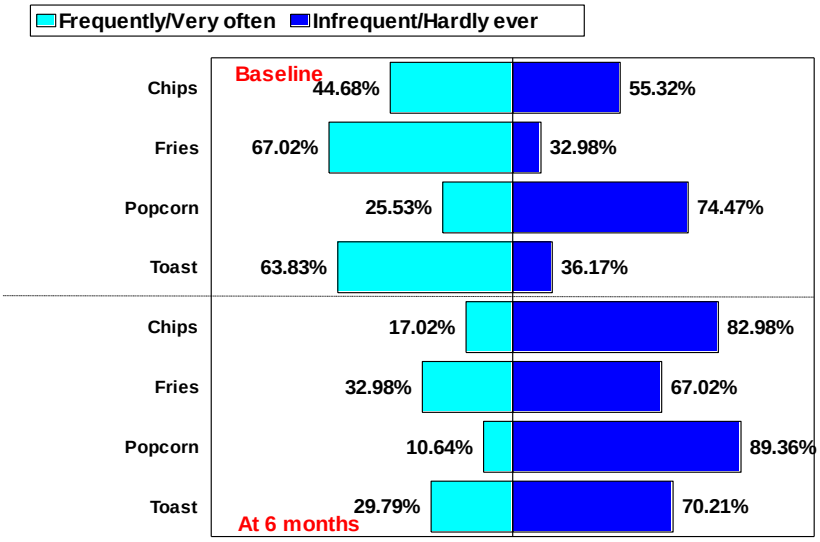

Fig. 2.Development of consumption of foods containing acrylamide

Knowledges of acrylamide were acquired significant percentage of men and women different. Thus, between 24.53% and 41.51% of women and between 24.39% and 36.59% of men have learned what is acrilamida, where it can be found and the degree of its toxicity (p = 0.628, p = 0.307 , p = 0.974) (fig. 3).

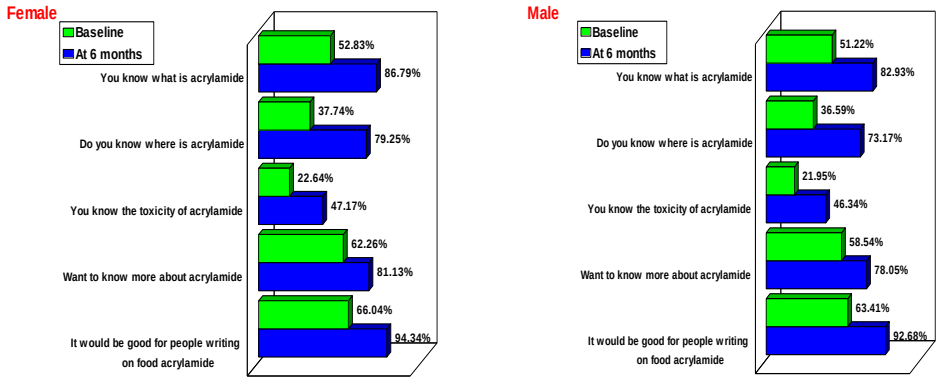

Fig.3.Evolution of the level of information on acrylamide

Frequent use (very often and often) of food containing acrylamide was not significantly different between women and men (p = 0.146 to 0.879). After

six months, frequent consumption of such foods was significantly lower in women than in men (p = .002-.045), fact that suggests a slower change of diet in men than in women (fig.4).

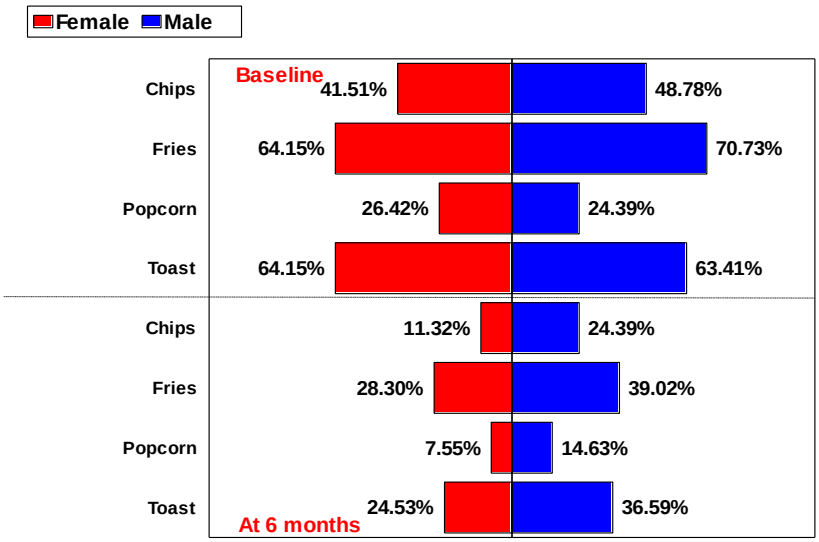

Fig.4.The evolution of consumption of products containing acrylamide by gender

Familiar with the toxicity of acrylamide (carcinogenic action), we estimate that a very high percentage of survey participants (48.93%) may be exposed to the toxic effects of acrylamide as a result of frequent consumption (often and very often) of French fries. A smaller percentage (15.95%) of the respondents may be exposed as a result of frequent consumption of potato crisps. The percentage of those who frequently consume popcorn is lower (13.83%). The risks due to chronic intake by frequent consumption of toast (23.4% of survey participants) or biscuits (30.85%) cannot be overlooked.

The often and very often consumption of food products with high level of acrylamide has significantly diminished at the 6 months later evaluation as compared to the initial one (p<0,001). Thus, the often and very often consumption of potato crisps has diminished from 44.68% to 17.02%, of French fries from 67.02% to 32.98%, of popcorn from 25.53% to 10.64% and of toast from 63.83% to 29.79%. The most consumed food products were the French fries and toast, initially as well as 6 months later.

CONCLUSIONS

Based on the answers of the respondents to the survey, we can assess that people aged between 19 and 30 years are exposed to the chronic effects due to ingestion of food products that contain acrylamide, especially due to the frequent consumption of French fries, the product with the highest level of the substance incriminated for its carcinogenic potential.

It is recommended to keep out of food products rich in acrylamide or, at least, to reduce their consumption, respectively to introduce several days when all sources of acrylamide be excluded from the menu as to avoid its accumulation in the organism.

It is necessary that people become aware of the danger they are exposed when consuming food products rich in acrylamide, especially since the negative impact of acrylamide on the human body increases in inverse ratio to the age.

REFERENCES

1. Arisseto A.P., Toledo M.C., Govaert Y., Loco J.V., Fraselle S., Weverbergh E., Degroodt J.M., 2007, Determination of acrylamide levels in selected foods in Brazil. Food Addit. Contam no. 24 (3), pp. 236–241 ·
2. Bungău S., Copolovici D., Copolovici., 2015, Instrumental Analitical Methods, Ed. Italian Academic Publishing
3. Chuang W. H., Chiu C. P., Chen B. H., 2006, Analysis and Formation of Acrylamide in French Fries and Chicken Legs during Frying, Journal of Food Biochemistry no. 30, pp. 497–507
4. Council for Agricultural Science and Technology (CAST), 2006, Acrylamide in Food, Issue Paper 32, CAST, Ames, Iowa
5. Friedman M., 2003, Chemistry, biochemistry, and safety of acrylamide. A review. J Agric Food Chem no. 51 pp. 4504-4526.
6. Fuhr U., Boettcher M.I., 2006, Toxicokinetics of acrylamide in humans after ingestion of a defined dose in a test to improve risk assessment for acrylamide carcinogenity, Cancer Epidemiol Biomarkers Prev no. 15(2), pp. 266-271
7. Gerhard Eisenbrand, 2007, Contribution Senate Commission on Food Safety SKLM, Karl-Hein Engel, Werner Grunow Thermal Proccesing of Food: Potential Health Benefits and Risks" Pub by Wiley-VCH
8. Hariri E., Abboud M., Demirdjian S., Korfali S., Mroueh M., Taleb R., 2015, Carcinogenic and neurotoxic risks of acrylamide and heavy metals from potato and corn chips consumed by the Lebanese population, Journal of Food Composition and Analysis no. 42, pp. 91-97
9. Ibrahim A., Kareem R., Sheir M., 2015, Elucidation of Acrylamide Genotoxicity and Neurotoxicity and the Protective Role of Gallic Acid and Green Tea, J Forensic Toxicol Pharmacol no 4, pp.1
10. Konings E. J. M., Baars A. J., van Klaveren J. D., Spanjer M. C., Rensen P. M., Hiemstra M., van Kooij J. A.,Peters, P. W. J. 2003, Acrylamide exposure from foods of the Dutch

population and an assessment of the consequent risk, Food Chem Toxicol no. 41(11), pp.1581
11. Mojska H., Gielecinska I., Szponar L., Oltarzewski M., 2010, Estimation of the dietary acrylamide exposure of the Polish population, Food Chem. Toxicol. no. 48 (8–9), pp. 2090–2096
12. Nail A., 2010, Biochemical Studies on Acrylamide in Egyptian Food, American Journal of Biochemistry and Biotechnology no. 9, pp. 90-101
13. Ötles, S., Ötles, S., 2004, Acrylamide in Food (Chemical Structure of Acrylamide), Electron. J. Environ. Agric. Food Chem. no. 3 (5), pp. 723-730
14. Sams C., Jones K., Warren N., Cocker J., Bell S., Bull P., Cain, M., 2015, Towards a biological monitoring guidance value for acrylamide, Toxicology letters no. 237 (1), pp. 30-37
15. Shipp A., Lawrence G., Gentry R., McDonald T., Bartow H., Bounds J., Macdonald N., Clewell H., Allen B., Van Landingham C., 2006, Acrylamide: review of toxicity data and dose-response analyses for cancer and noncancer effects. Crit. Rev. Toxicol. no. 36 (6-7), pp. 481–608
16. Stadler A, Nutrition reviews, 2004, Journal of Agricultural and Food Chemisrty no. 62, pp. 449-467
17. Stadler, R., Blank, I., Varga, N., Robert, F., Hau, J., Guy, P., Robert, M., Riediker,S., 2002, Acrylamide from Maillard reaction products. Nature no. 419, pp. 449 – 450
18. Svensson K., Abramsson L., Becker W., Glynn A., Hellenas K.E., Lind Y., Rosen J., 2003, Dietary intake of acrylamide in Sweden, Food Chem. Toxicol. no. 41 (11), pp. 1581–1586
19. Tofană M., Muste S., Modoran D., 2006, Acrylamide in food – implication for the food industry, Buletin USAMV-CN, 62, pp.293-296
20. Zyzak D., Sanders R., Stojanovic M., Tallmadge D., Eberhart L. B., Ewald D. K., Gruber, D. C., Morsch T. R., Strothers M. A., Rizzi G. P., Villagran M. D., 2003, Acrylamide Formation Mechanism in Heated Foods. J. Agric. Food. Chem. no. 51 pp. 4304-4326