THE INVOLVEMENT OF FOODS CONTAINING HIGH ACRYLAMIDE LEVELS IN THE PROTEOSYNTHETIC FUNCTION OF THE LIVER

IMPLICAȚIILE ALIMENTELOR CU UN CONȚINUT BOGAT ÎN ACRILAMIDĂ ÎN FUNCȚIA DE PROTEOSINTEZĂ A HEPATOCITULUI

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Abstract. *Acrylamide is a process-induced food toxicant found in fried, roasted, baked and grilled foods. The present experiment evaluates the hepatic proteosynthesis function after the intake of foods containing high acrylamide levels (fried potatoes and toast), by determining total proteins, albumins, and cholinesterase. The experiment included 4 groups of Wistar rats: reference group (standard food), control group (standard food and acrylamide solution 0.1 μg/L), FP group (fried potatoes and standard food), T group (toast and standard food). The results reveal that the intake of foods containing high acrylamide levels leads to: decrease of total proteins for control group, FP group, and T group; increase of albumins and cholinesterase for control group, FP group, and T group. In conclusion, the intake of foods with high acrylamide levels has a negative impact upon total serum proteins, the results not being sustained by the albumin and cholinesterase activities, unless a nephrotic syndrome is present.*

Keywords: acrylamide, fried potatoes, toast, hepatic proteosynthesis.

Rezumat. *Acrilamida este un toxic alimentar prezent în alimentele prelucrate termic prin prăjire sau coacere. Prezentul experiment evaluează capacitatea de proteosinteză a ficatului după consumul de alimente cu un conținut bogat în acrilamidă (cartofi prăjiți şi pâine prajită), prin determinări biochimice (proteine totale, albumină, colinesterază). Experimentul include 4 loturi de şobolani Wistar: lotul referință (hrană standard), lotul control (hrană standard şi soluție apoasă de acrilamidă 0.1 g/L), lotul FP (cartofi prăjiți şi hrană standard), lotul T (pâine prăjită şi hrană standard). Rezultatele analizelor biochimice relevă faptul că ingestia alimentelor cu un conținut bogat în acrilamidă determină: scăderea proteinelor totale pentru lotul control, lotul FP şi lotul T; creşterea albuminelor şi colinesterazei pentru lotul control, lotul FP şi lotul T. În concluzie, ingestia alimentelor cu un conținut bogat în acrilamidă are o influență negativă asupra proteinemiei totale, rezultatele nefiind susținute de valorile albuminemiei şi colinesterazei serice decât prin prisma unui sindrom nefrotic.*

Cuvinte cheie: acrilamidă, cartofi prăjiti, pâine prăjită, proteosinteză hepatică.

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INTRODUCTION

Nowadays, nutrition has revealed its tremendous importance in our lives. Acrylamide is a process-induced food toxicant found in fried, roasted, baked and grilled foods (Mottram et al., 2002). The neurotoxic and carcinogenic potential of acrylamide has been known ever since the first years of production and use (McCollister et al., 1964). Later, the carcinogenic action was re-confirmed through experimental researches on laboratory animals (CERHR, 2005), but the epidemiologic studies did not reveal such conclusive results (Mucci et al., 2003). This is why the "acrylamide" subject has lately been discarded from the research field.

The present experiment brings the exposure to acrylamide into the forefront and evaluates the proteosynthetic function of the liver consequently to the intake of foods containing high acrylamide levels (fried potatoes and toast), by the means of biochemical analysis (total proteins, albumins, and cholinesterase).

MATERIAL AND METHOD

Analysis instruments

The biochemical analysis was achieved with an open system EOS 880 PLUS semi-automatic analyzer.

Experimental model

All the experimental proceedings in this experiment were achieved according to the international ethic reglementations and were approved by the Ethics Commission of the University of Medicine and Pharmacy "Gr. T. Popa" Iaşi.

A total number of 24 male rats, Wistar strain, having body weights comprised between 180 and 220 g, were divided into 4 groups, as follows:

- reference group - fed with standard food and drinking water;
- control group - received the same diet as the reference group, except for the drinking water, which was replaced by an acrylamide solution 0.1 µg/L (the maximum allowed limit regarding the presence of acrylamide in the drinking water, according to the European Union legislation);
- FP group - the food supply was made up of French fries (given in the morning, around 8.00 o'clock), and the reference group's diet (at 14.00 o'clock);
- T group – the diet consisted of sliced white bread, toasted for 3 minutes into the electric toaster (8.00 o'clock) and the reference group's diet (at 14.00 o'clock).

The animals were housed in separate cages, in order to control their diets. The experiment was conducted over a period of 90 days.

Biochemical investigation

At the end of the experiment the animals were anesthetized with ketamine i.p. (75mg/kg) and blood samples were collected by the punction of the cord with a Vacuette ® system and submitted to biochemical analysis, which aimed to evaluate the proteosynthesis function of the liver (by determining the total proteins - TP, the serum concentration of albumins – ALB and the serum cholinesterase – ChE).

Statistical interpretation

Statistical data were processed by program StatsDirect version 2.7.2 (2008). The accepted significance threshold is 95%, i.e. $p<0.05$. The value of p is inversely proportional to the statistical significance. Statistical interpretation of data considered the differences corresponding to a significant threshold as follows: $p> 0.05$ statistically

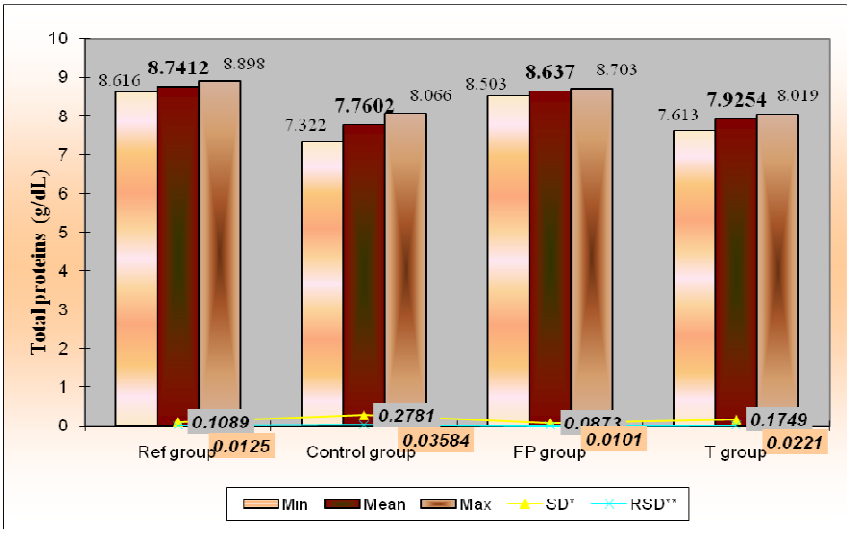
insignificant; p <0.05 statistically significant; p <0.01 highly statistically significant; p<0.001 very highly statistically significant.

RESULTS AND DISCUSSIONS

Determination of total proteins

Most of the proteins are synthesized in the liver and have additional functions as compared to the other proteins. Such proteins maintain the osmotic pressure of the plasma, participate into the coagulation and fibrinolysis processes and provide the protein reserve which is necessary for the tissue development and repair.

The results obtained from the quantitative determination of the total proteins in the serum of the animals from the present experiment are given in fig. 1. The study of the values shows a decrease of the total proteins from 8.7412 ± 0.1089 g/dL, a concentration which corresponds to the reference group, to 7.7602 ± 0.2781 g/dL, value which is characteristic for the control group that was given the acrylamide solution instead of the drinking water. This significant decrease of the proteinemia of the animals in the control group suggests the negative impact of acrylamide upon the proteosynthetic function of the liver. Carrying on the study on the third group, which was fed with Fried potatoes, one can ascertain a discretely diminished concentration in comparison with that of the reference group, and a significantly increased one as compared to that of the control group (8.6370 ± 0.0873 g/dL) (fig. 1). A damage of the proteosynthetic function at the level of liver may be translated from the decreased value of the proteinemia of the group which was fed with toast, value which ranges at 7.9254 ± 0.1749 g/dL (fig. 1).



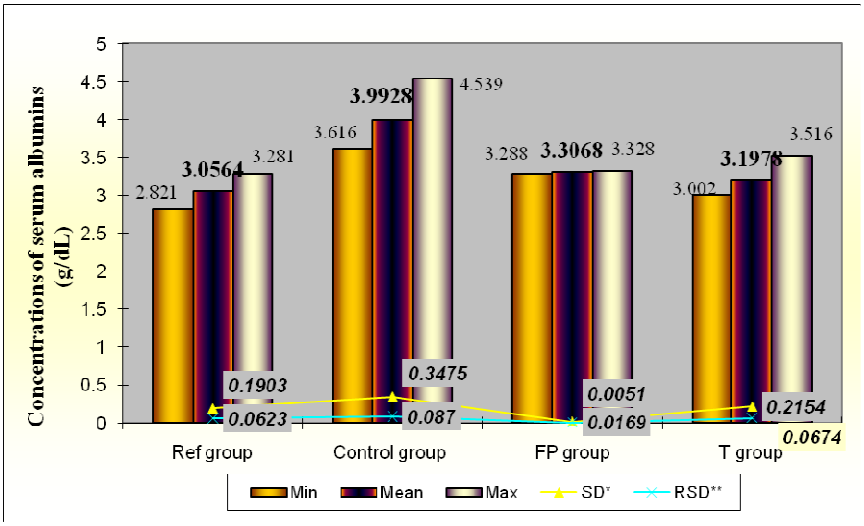
SD* = standard deviation; RSD ** = relative standard deviation

Fig. 1 – Serum concentrations of total proteins (g/dL)

Determination of serum albumins

Another biochemical parameter relevant for the functional integrity of the liver is the serum concentration of albumins, the values of which are mentioned in fig. 2. The results reveal an increase of the albuminemia of the control group from 3.0564 ± 0.1903 g/dL (reference group) to 3.9928 ± 0.3475 g/dL. Lower values, however increased as compared to the reference group, can also be noticed in the serum of the animals fed with French fries (3.3068 ± 0.0051g/dL) and toast (3.1978 ± 0.2154g/dL). Such variations of the albuminemia, although they seem inconclusive for the assessment of the proteosynthetic function of the liver, may be correlated with the existence of a nephrotic syndrome.

The plasmatic level of albumin doesn't depend only on the hepatic synthesis, but also on the volume of distribution and its degradation. The synthesis of albumin is regulated by: the nutritional status, osmotic pressure, inflammatory status, and hormone balance, loss through urine or intestin (Buligescu et al., 1999; Szanto, 2004). The synthesis of albumin is stimulated by certain amino acids: tryptophan, phenylalanine, glutamine, and lysine (Buligescu et al., 1999). The albumin synthesis is also dependent on the availability of the amino acids, mainly tryptophan (Kirsch et al., 1968) and may be suppressed by the alcohol consumption and by the decrease of food protein intake (Friedman et al., 2003).



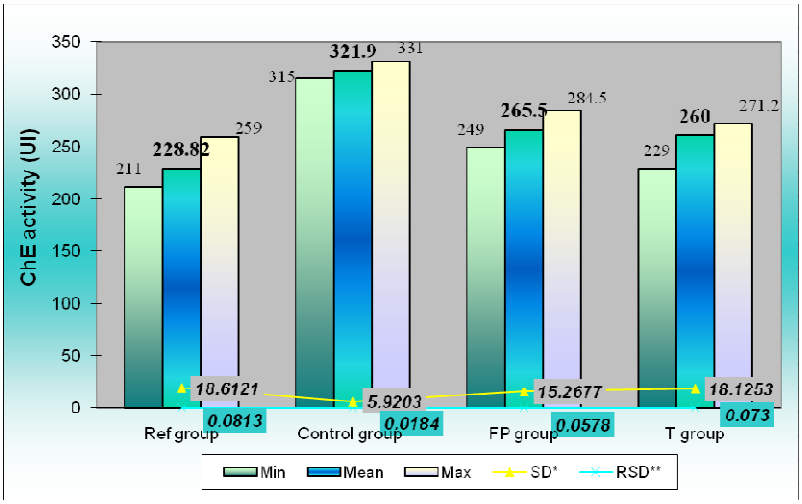
SD* = standard deviation; RSD ** = relative standard deviation

Fig. 2 – Serum concentrations of albumins (g/dL)

Determination of serum cholinesterase

Serum cholinesterase, an enzyme which is synthesized in the liver, offers accurate information in the toxicological investigations, due to its slow turnover (T1/2 is comprised between 14 and 20 days). The oscillation of this parameter (fig. 3) is surprising due to the fact that in the serum of the control group, the ChE's

activity increases from 228.82 ± 18.6121 UI (the value of the reference group) to 321.90 ± 5.9203 UI. The increase of ChE activity from 228.82 ± 18.6121 UI up to 265.50 ± 5.9203 UI (FP group), and 260.00 ± 18.1253 UI (T group) does not suggest any affection of the hepatic proteosynthetic function. Even though the ChE evolution was surprising due to the increased values for all the experimental groups, this increase may be correlated to the existence of a nephrotic syndrome, a phenomenon which is present in the case of intoxication with acrylamide (Konings et al., 2003; Atanasiu et Mohora, 2004).



SD* = standard deviation; RSD ** = relative standard deviation

Fig. 3 - Activity of the serum cholinesterase (UI)

CONCLUSIONS

1. The study of the total proteins concentrations for the experimental groups shows a significant decrease for the control group and for the group which was fed with toast, suggesting the negative impact upon the hepatic proteosynthesis function.

2. The variation of the albuminemia of the experimental groups, although it seems inconclusive for the assessment of the proteosynthetic function of the liver, may be correlated with the existence of a nephrotic syndrome.

3. The evolution of cholinesterase was surprising due to the occurrence of increased values in the case of the animals treated with acrylamide, either as an aqueous solution, or as thermally-processed foods; this increase may not be correlated with the damage of the proteosynthetic function of the liver, however it may be correlated with the existence of a nephrotic syndrome, a phenomenon which is present in the case of intoxication with acrylamide.

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