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CARCINOGENIC SUBSTANCES NATURRALLY OCCURING IN THE HUMAN DIET

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Abstract

Oncogenesis is a result of the combined action of numerous factors peculiar to the body and the environment (the latter are more effective). Among dietary factors directly implied in the occurrence of malignant tumors we can mention: food additives, contaminated food, polycyclic aromatic hydrocarbons, nitrosamines and some components which are naturally present in food. Moreover, food-related malignancies are a consequence of the increased consumption of fats, proteins, alcohol in parallel with decreases in the consumption of dietary fibers and some micronutrients. Carcinogenic substances naturally present in food are of a particular interest for both nutritionist's and patient's, usually not being perceived as being harmful.

key words: *onconutrition, cycasin, pyrrolizidine alkaloids, large quantity of caffeine.*

Introduction

Malignancies may be associated with different endogenous factors (i.e. age, gender, genetics, concomitant diseases) and environmental factors. The latter are presumed to have a degree of causality with cancer disease in a proportion of 60-90% [1].

Among environmental factors, *nutrition seems to have a key role in the occurrence and evolution of malignant tumors*. The importance of nutrition in inducing malignant tumors is highlighted by the increased number of carcinogenic factors introduced into the digestive tract [2] opposed with introducing them in the body through other pathways (skin, lungs). The proportion between carcinogenic substances from food and the quantity introduced by lungs or skin is 1000000/1000/1.

Typical for food products is the fact that they are consumed during the entire life of a human, thus exposing the organism for a long period of time to carcinogenic substances. So, even if ingested in small doses, they can become harmful because the carcinogenic effect is cumulative, and the malignant response can appear after a period of many years.

So, onconutrition was marked out, initially, at aborigines in Australia that from the transition to Australian traditional food to modern nutrition patterns, reached a level of gastric cancer [3] identical with the one of the Australian population. The type of nutrients influences the types of cancer that can emerge. Lately it has been observed that it's impossible to completely

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avoid contact with carcinogens from food. In this context, we can find breathable air, drinkable water and some foods that contain malignant substances. Being a particular group, we will refer to them as follows

Direct carcinogenesis

Chemical substances that are present in food and that are directly involved in carcinogenesis are represented by food additives (i.e. colorants, appetizers), food contaminants (i.e. pesticides, insecticides, PVC) pollution substances from the environment (aromatic polycyclic hydrocarbons) and carcinogenic substances naturally present in food.

Chemical carcinogens are substances with a large structural variety. The only common element is the strong electrophilic character imprinted by the atoms with an electron deficit, contained by carcinogenic molecules [4]. They form covalent connections with targeted intracellular molecules (nucleic acids and proteins) that contain nucleophilic areas rich in electrons.

Almost all chemical carcinogens are unable to initiate cancer in their initial form, being in fact pre-carcinogens [5]. Their metabolic activation (mediated by the microsomal oxidative system from the liver and other organs) may lead to the occurrence of the electrophilic carcinogen.

A more restrained category of carcinogens don't require metabolic activation or spontaneously forms, on a non-enzymatic pathway, extremely reactive decomposing products.

The necessity of metabolic activation explains tissue specificity for some carcinogens, that might be linked with the localization of enzymatic systems used to activate pre-carcinogens. The main moment of chemical carcinogenesis is the interaction between the activated carcinogen with the nucleic acid and proteins engaged in cellular replication, which is disturbed. The electrophilic reactants potential to induce neoplasia is conditioned by the location where metabolites are formed, their possibility to contact and reaction with cellular targets. The main target for chemical mutagens is the DNA. If the nucleic acid sequence is modified, new cells with an altered informational content are formed which don't react appropriately to the mechanisms that control normal cellular replication [6].

The appearance of the mutation is compensated if an enzymatic system exists to repair the DNA. The lack of *operativity* of these systems induced by carcinogenic substances is a critic moment in the inception of *neoplasia*. Even in these conditions the process can be decelerated though the intervention of immunological inactivation mechanisms. If the repressive phenomena are inefficient, the cell starts to multiply uncontrollably and enters an irreversible development phase [7].

Natural substances with carcinogenic effects from food

Carcinogenic substances that are naturally present in food represent a heterogeneous group of substances. We will refer to only a few of them in the following paragraphs.

Cycasin is a substance isolated from the bread tree's fruits. When exposed to the action of intestinal bacterial enzymes, it is transformed in carcinogenic precursors [8]. Pyrrolizidine Alkaloids, derived from plants like *Senecio, Crotalaria, Heliotropium* are considered potential candidates of malignancies induced by food in humans [9]. It is estimated that malignant influence of natural carcinogenic substances is exerted in high concentrations. Furthermore, experimental studies made with cysteine [10] (aminoacid naturally present in some foods) showed that at concentrations of 10^{-1}

it has carcinogenic effects, oddly no modifications were found at concentrations of 10^{-2} -10^{3}. The same pattern is found regarding arginine [11] and valine [12].

Caffeine, although with carcinogenic effects in vitro, in vivo it didn't present the same consequences. Taking into consideration the fact that it passes very easily through the placenta, it is recommended that pregnant women should decrease consumption. Its usage should be limited due to the carcinogenic effects resulted from roasting it (polycyclic aromatic hydrocarbons pyrolysis of proteins, fats and sugars) [13].

It seems that even polycyclic aromatic hydrocarbons occur naturally in some products. Most plants have the capacity to synthesize aromatic polycyclic hydrocarbons, some of them with carcinogenic proprieties. Benzoapyrene and similar compounds were found in young rice plants and germinated wheat seeds. Analyzing salad leaves, potatoes [14], apples, apricots, eight aromatic polycyclic compounds have been identified from which six were carcinogenic. In plants benzoapyrene accelerates growth and the metabolism comparatively with the animal cells where it stimulates uncontrolled proliferation. Small quantities of aromatic polycyclic hydrocarbons have been found in some vegetables (besides the above-mentioned potato), margarine, vegetal oils [15,16], bread [17,18].

Diet treatment

Nutrition for patients with nutrition carcinogenic risk has an important prophylactic role for reducing or removing substances from food (with direct or indirect role) that may cause malignancies. Moreover, it's important to encourage the consumption of anti-carcinogenic foods for protection.

However, if carcinogenesis is already present, nutrition has to make the patient feel better, to prolong his life, to prevent denutrition.

Conclusions

Oncogenesis is a pathologic process that implies a large number of factors, many of them unknown, and even if they are identified, alimentation habits prevent a minimum limitation of these substances in the human body. Larger difficulties can occur when carcinogenic substances are present naturally in food, in a large range of nutritive products. So, the recommendation is that they should be avoided, especially by reading the product label (additives, contaminations, nitrosamines, excess fat, low fiber, etc.)

REFERENCES

1. **Preetha A, Ajaikumar BK, Chitra S et al**. Cancer is a Preventable Disease that Requires Major Lifestyle Changes. *Pharm Res* 25: 2097-2116, 2008.

2. **Katherine DC, Alfred IN**. Epidemiology of gastric cancer .*World J Gastroenterol* 12: 354-362, 2006.

3. **Arnold M, Moore SP, Hassler S, Ellison-Loschmann L, Forman D, Bray F**. The burden of stomach cancer in indigenous populations: a systematic review and global assessment *Gut* 63: 64-71, 2014.

4. **Miller JA, Miller EC**. Carcinogens occurring naturally in foods. *Fed Proc* 35: 1316-21, 1976. (Abstract)

5. **Sen R**. Cancer etiology. *Principles and Management of Cancer – A practical Guide.* BI Publications Pvt Ltd, 2004.

6. **Wogan GN, Hecht SS, Felton JS, Conney AH, Loeb LA**. Enviromental and chemical carcinogenesis. *Seminars in Cancer Biology* 14: 473-486, 2004.

7. **Lenz G**. Endogenous anticancer mechanisms (EACMs). *Front Biosci (Schol Ed)* 4: 1017-1030, 2012.

8. **Sieber SM, Correa P, Dalgard DW, McIntire KR, Adamson RH**. Carcinogenicity and hepatotoxicity of

cycasin and its aglycone methylazoxymethanol acetate in nonhuman primates. *J Natl Cancer Inst* 65: 177-89, 1980.

9. Edgar JA, Molyneux RJ, Colegate SM. Pyrrolizidine alkaloids: potential role in the etiology of cancers, pulmonary hypertension, congenital anomalies, and liver disease. *Chem Res Toxicol* 28: 4-20, 2015.

10. Oikawa S, Yamada K, Yamashita N, Tada-Oikawa S, Kawanishi S. N-acetylcysteine, a cancer chemopreventive agent, causes oxidative damage to cellular and isolated DNA. *Carcinogenesis* 20: 1485-1490, 1999.

11. Feun L, You M, Wu CJ et al. Arginine deprivation as a targeted therapy for cancer. *Curr Pharm Des* 14: 1049–1057, 2008.

12. Yin-Cheng H, Jun C, Ji-Wei C, Ding-Yu P, Ya-Kui Z. Influence of methionine/valine-depleted enteral nutrition on nucleic acid and protein metabolism in tumor-bearing rats. *World J Gastroenterol* 9: 771–774, 2003.

13. Tfouni SAV, Serrate CS, Leme FM et al. Polycyclic aromatic hydrocarbons in coffee brew: Influence of roasting and brewing procedures in two Coffea cultivars. *LWT - Food Science and Technology* 50: 526-530, 2013.

14. Lee BM, Shim GA. Dietary exposure estimation of benzo[a]pyrene and cancer risk assesment. *J Toxicol Environ Health A* 70(15-16): 1391-1394, 2007.

15. van der Wielen JCA, Jansen JTA, Martena MJ, De Groot HN, In't Veld PH. Determination of the level of benzo[a]pyrene in fatty foods and food supplements. *Food Additives&Contaminants* 23: 709-714, 2007.

16. Alomirah H, Al-Zenki S, Hussain A et al. Benzo[a]pyrene and total polycyclic aromatic hydrocarbons (PAHs) levels in vegetable oils and fats do not reflect the occurence og the eight genotoxic PAHs. *Food Addit Contam Part A Chem Anal Control Expo Risk Assess* 27: 869-78, 2010.

17. Eslamizad S, Yazdanpanah H, Javidnia K et al. Validation of an Analytical Method for Determination of Benzo[a]pyrene Bread using QuEChERS Method by GC-MS. *Iran J Pharm Res* 15: 465-474, 2016.

18. Zelinkova Z, Wenzl T. The occurence of 16 EPA PAHs in Food – Review. *Polycycl Aromat Compd* 35(2-4): 248-284, 2015.