

## CONSIDERATIONS REGARDING THE TOXICITY OF NITROSAMINES IN FOOD

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**ABSTRACT:** *The development of the food industry provides consumers with finished products that are much modified both nutritionally and organoleptically, compared to natural raw materials. In general, the processing consists of mixing, concentrating, refining, heat treatment, adding additives to provide stability or very attractive organoleptic properties. Often, as a result of processing, imbalances are achieved by concentrating some nutrients and removing or destroying others as well as contamination with toxic chemicals that lead to the risk of food becoming a harmful factor for consumers. This paper presents issues related to the causes and effects of food contamination with nitrosamines.*

**KEY WORDS:** nitrosamines, toxicity, food

### 1. INTRODUCTION

The human-food relationship is based on the fact that food provides the body with the nutrients it needs to provide the energy necessary for vital processes (energy role), to synthesize its own substances and repair wear (plastic and morphogenetic role), and to form active substances, which favors the normal development of metabolic processes (catalytic role). In modern society, man has a profound effect on food as well as on the natural environment. Food hygiene aims at knowing and highlighting the favorable effects of food on health and to reduce or eliminate the risk of food becoming harmful factors for consumers. Food is rational if it provides optimal amounts of all the nutrients that the human body needs in different physiological states and environmental conditions. Food must be wholesome and offered in a form accepted by the consumer [1].

According to their nature and role in the body, nutrients are divided into five groups: proteins, lipids, carbohydrates, minerals and vitamins. Each nutrient fulfills well-defined roles, and cannot be replaced by each other. Nutritional needs vary greatly from one individual to another, depending on age, body size, sex, type and intensity of activity (physical, intellectual), environmental conditions (hot, cold, the presence of toxic chemicals). Therefore, in order to ensure a rational diet, these differences must be taken into account and a permanent balance must be struck between the body's needs and the quantities brought in by food. When this balance is not maintained, diet becomes irrational, with a negative impact on increasing work capacity and health. From this point of view, it is a mistake not only not to provide sufficient quantities of one or more nutrients, but also their excessive consumption compared to the real needs of the body.

The risk is even higher when the abusive consumption of one substance is associated with the insufficiency of another. [2]

In some cases, food may contain harmful agents to consumers, which can lead to disease-causing factors. Some agents are biological (bacteria, viruses, parasites), others are toxic, mutagenic or carcinogenic chemicals. Harmful chemicals can come from:

- the normal chemical composition of the product concerned. Examples: amygdalin from peach, apricot, plum, almond kernels, solanine from sprouted potatoes, toxins from poisonous substances;
- alteration of foods that cause the appearance of toxic substances: cadaverine, putrescein, histamine, peroxides, aldehydes, ketones;
- the elaboration by some microorganisms of certain toxic or carcinogenic substances: mycotoxins, staphylococcal toxin, botulinum toxin;
- chemical pollutants: pesticide residues, toxic metals and metalloids (lead, mercury, cadmium, selenium, copper, zinc, fluorine, arsenic, etc.), nitrites, nitrosamines, polycyclic aromatic hydrocarbons, toxic plastics monomers;
- food additives allowed or permitted use of the excess, preservatives, synthetic dyes and flavorings, emulsifiers and others. [3.4]

Foods that carry these diseases are called unhealthy, and their consumption can cause specific microbial or viral diseases (typhoid fever, dysentery, epidemic hepatitis, polio), food poisoning, acute or chronic poisoning, mutagenic or carcinogenic effects. In order to avoid sanitation, it is necessary to know the sources and routes of contamination, the means of recognition of contamination and the measures for the protection of foodstuffs (including those relating to the hygiene of the preparation, storage, disposal and consumption units).

The biological, and therefore nutritional, adaptation of the organism to the new environmental conditions is done at a slower pace than the socio-economic and food changes. This situation was strongly reflected in the structure of human pathology. Statistics show that in developed countries and especially in industrialized ones the frequency of chronic degenerative, nutritional and maladaptive diseases has increased alarmingly (obesity, dyslipidemia, atheromatosis with its cardiac and cerebral complications, diabetes, chronic degenerative rheumatism, cancer, neurosis). In the etiopathogenesis of these morbid conditions, the diet occupies an important place. Many of these diseases and their complications can be avoided or mitigated by establishing a rational diet which therefore has both prophylactic and curative virtues. [5]

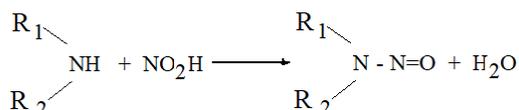
## **2. THE NITROZAMINS IN FOOD - SOURCES AND EFFECTS OF THEM**

Foods may contain a number of toxic chemicals or pathogenic microorganisms to consumers. In this case, the food product loses its quality as a favorable factor of the external environment, even if it is nutritionally valuable. Consumption of such chemically or biologically unhealthy foods causes intoxication (including mutagenic, teratogenic and carcinogenic effects) or microbial, viral and parasitic diseases. Toxic infections are a group of acute diseases, with predominantly digestive manifestations, caused by some microorganisms or toxins developed by them. [6]

Nitrosamines have become known for their carcinogenic properties. They were found in most foods, cigarette smoke, urban air, agricultural chemicals, cosmetics and medicines. They are compounds that can be formed "in vitro" but also "in vivo" having as precursors

substances that are normally found in food.

The risk of nitrosamines, substances with high carcinogenic potential and mutagenicity, is due to the presence of nitrates and nitrites in food. Nitrosamines are the result of a reaction between secondary amines and nitric acid. Schematically, the process is performed as follows:



Nitrates in food and nitrites have a dual origin:

- they are natural components of plant foods, especially vegetables and fruits, but after fertilizing with large amounts of nitrogen fertilizers the land on which these plants are grown, their nitrogen content can increase greatly. Vegetables generally have the ability to accumulate higher amounts of nitrates than fruits. Among the vegetables, the richest are spinach, beets, carrots, celery, dill, parsley, salad, cabbage. In such plants the amounts of nitrates can be between 500 and 4000 mg/kg. Potatoes, onions, tomatoes and peppers usually accumulate small amounts of nitrates (generally below 200 mg/kg). [7]

Unlike nitrates, the nitrate content of vegetables and fruits is very low. However, the preservation, after harvesting, of the products in unsuitable conditions that favor the development of degradation microorganisms, can determine the passage of nitrates into nitrites.

- these nitrogen compounds are also widely used as additives in the meat and sometimes cheese industry, with the dual purpose of nitrosomyoglobin and nitrozo-hemoglobin. For both roles, nitrates must be reduced to nitrites.

This conversion is performed under the influence of reductases, microorganisms existing in products.

Nitrates as such have a very low toxicity and large amounts (up to 10-20 grams) must be ingested to cause disorders. They are easily excreted in the urine. Nitrogen, on the other hand, is much more harmful. Derived as such from food or resulting from the action of the intestinal microflora on nitrates, they exert methemoglobinizing effects.

Nitrates and nitrites cause other adverse effects if ingested in large quantities: delays in the development of stature and weight of children, increased overall morbidity, decreased liver reserves of vitamin A and tissue levels of thiamine, pyridoxine and folic acid. Some of these vitamins may be inactivated by nitrites in food or in the digestive tract.

The tolerable daily dose of nitrite accepted worldwide is 30mg nitrite/70 Kg human body. [8]

Nitrosamines can participate in the synthesis process as secondary amines: dimethylamine, diethylamine, dipropylamine, dibutylamine, piperidine, pyrrolidine, morpholine, etc. Such amines and the corresponding nitrous compounds have been found frequently in food, pesticides, including drugs used in various therapies, such as oxytetracycline. Meat and fish preparations treated with nitrates-nitrites (sausages, ham, bacon, preserves, smoked foods) take precedence over the presence of nitrosamines. Intensive thermal processes such as frying and frying accelerate the formation of these compounds.

In both animal and food organisms, the synthesis of nitrosamines can be achieved in two ways:

- by chemical reaction in acidic environment;
- through the metabolic activity of some microorganisms.

The synthesis by chemical reaction in an acid medium was performed in vitro

starting from nitrates and secondary amines after incubation with gastric juice from different animal species. Nitrosamines have also been found in the stomachs of rats, cats, rabbits and other animals following the consumption of foods containing nitrites and secondary amines. The formation reaction is slow and the amounts of nitrosamines are very small, especially in the case of amines with high alkalinity (such as dimethyl- or diethylamine). Thiocyanates, bromides, citrates and acetates appear to catalyze the reaction. On the contrary, some reducing or antioxidant agents such as ascorbic acid and its salts, sorbic acid, propyl gallate inhibit the formation of nitrosamines in vitro [6-8]. Nitrosamine synthesis through the activity of microorganisms. It has been shown that a number of bacteria can catalyze the production of nitrosamines even at neutral or alkaline pH, if nitrates-nitrites and secondary amines are found in the medium. Such properties have for example: *Escherichia coli*, *Lactobacillus*, *Streptococcus*, *Staphylococcus*, *Clostridium* or *Proteus*. Secondary amines are permanently present in the large intestine, in relatively large quantities, coming from both ingested foods in which they are found as such and from the microbial degradation of intestinal residue (especially when the diet is rich in protein and fat). In order for nitrosamines to form, the third partner, the nitrogen, should coexist in the colon. Normally, in a healthy subject, this simultaneous presence is not achieved because nitrogen is resorbed in the upper segments of the small intestine. The existence of large amounts of nitrates-nitrites in food, as well as the exaggeration and ascension of the flora in the digestive tract (as in enterocolitis, hypo- and anachlorhydria, gastric resection etc.), create conditions for the formation of nitrosamines. [9]

Amines and secondary amides can be easily nitrosated in the presence of

sodium nitrite, especially in the acidic environment of gastric juice, and thus can give rise to carcinogenic compounds for humans.

In animal experiments, most nitrosamines have been shown to be carcinogenic and mutagenic. They have organ specificity, depending on the animal tested, the chemical structure of the substance and the dose used.

Thus, nitrosodimethylamine, given in repeated low doses, causes liver tumors in rats, but if administered in a single high dose, the target organ is the kidney. Nitrosodibutylamine and nitrosopiperidine, also in rats, increase the risk of bladder and esophageal tumors, respectively. [10]

Some epidemiological studies have shown that humans are also sensitive to the carcinogenic effects of nitrosamines. Several studies have shown that in localities where drinking water contains a lot of nitrates, the incidence of gastric cancer is higher than in the control localities. It is generally accepted that patients with pernicious anemia (i.e. achlorhydria) have an increased mortality from gastric cancer. Chile is the second largest country in the world after Japan in terms of mortality due to stomach cancer, due to the increased exposure of the population to nitrates through drinking water (groundwater contains a large amount of nitrates) and extensive use in agriculture (cereals and vegetables contain a considerable amount of nitrates).

It was found that the formation of nitrosamines is favored by heating, roasting and smoking food, especially canned food. The level of nitrosamines increases significantly by frying salami, because these compounds are heat labile. Also, the intake of nitrosamines from different foods is different. A study carried out on the German market, on a batch of 3000 products, showed that, in the first place is beer, responsible for 64% of ingested nitrosamines, then meat

and meat products, 10%, and the rest of the food contributed 25%.

The high toxicity of nitrosamines and their carcinogenic potential have required finding solutions to limit their formation, by removing their precursors have reduced their concentration. Thus, the concentration of nitrates in the environment can be reduced by the rational use of nitrogen fertilizers, the main source of nitrite in soil, plants and water, reducing the use of nitrite as a preservative in the meat preparation industry, especially sausages or replacement with substances with similar properties. [10,11]

### 3. CONCLUSIONS

The essential problem in nutrition is to achieve a permanent and dynamic balance between what the body metabolizes or loses in various physiological or pathological conditions and what it receives through food. By adapting the diet to the metabolic peculiarities and by providing everything necessary as an energetic, plastic and catalytic material for the formation and continuous renewal of the organism and for the normal development of its functions, it contributes to a better physical and mental development and amplifies work capacity and adaptation to environmental factors. At the same time, the consumption of healthy foods prevents the appearance of diseases by biological or chemical agents (microbial, viral and parasitic diseases, intoxications, mutagenic and carcinogenic effects).

Increasing environmental pollution, as well as the excessive use of additives, has increased the risk of many chemicals entering the food that can have negative effects on consumers.

The carcinogenic potential of nitrosamines makes the problem of their research and their precursors a topical

one, and finding solutions to reduce their formation must be a priority.

In order to establish a rational diet, it is necessary, on the one hand, to take into account the nutritional needs of the individual or community, and on the other hand to know the composition of natural foods and those processed industrially or culinary.

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