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Mutagens Found In Food and Their Ill Effects

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ABSTRACT
Mutagens that promote the development of cancer are called carcinogens. An array of evidences has proved that some of the dietary components or the compounds produced during processing of food have been the sources of mutagens. Exposure to these mutagens could be intentional in terms of food additives and adulterants or unintentional in the case of contaminants such as mycotoxins, pesticides, and metals. The mechanism of action of these chemicals is mainly through DNA damage, which causes mutagenic effects such as chromosomal aberrations, point mutations, frameshift mutation, and cellular transformations, thereby altering the genetic information. In the long run, these changes get translated into various pathologies such as tumor and cancer of various vital organs, thereby posing great threat to the health of consumers. Therefore, this review paper aims to depict the probable mutagens during the normal and processed food and their consequences on consumption. Mutagens are also present in the environment and include sunlight and a multitude of chemicals that may be ingested in the foods that we eat or in the air that we breathe.
Key words: *Mutagens, Food, Diet, Cancer, DNA, health, diseases, nutrition, chemical.*

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I. Introduction

Mutagens are agents that damage DNA and can, depending on the ability of an organism to repair the damage, lead to permanent changes (mutations) in the DNA sequence. But agents that damage DNA can also damage deoxynucleotide triphosphates which are used by DNA polymerases to replicate DNA. Mutations are produced if the damaged nucleotides are incorporated into DNA incorrectly. Alternatively, mutagens may inhibit DNA repair as observed for the action of cadmium on the mismatch repair pathway.

Most mutagens are endogenous agents that are present in the cell under normal physiological conditions and include reactive oxygen species and alkylating agents. Mutagens are also present in the environment and include sunlight and a multitude of chemicals that may be ingested in the foods that we eat or in the air that we breathe. Mutagens that promote the development of cancer are called carcinogens. **(L.J. Reha-Krantz *et al.,* 2013)**

Mutagenic effects in the offspring of irradiated women may be manifested years after the birth of the infant. Mutagenic effects presumably explain the 50% increased risk of leukemia in children exposed in utero to radiation during maternal pelvimetry examinations compared with nonirradiated controls. However, the clinical consequence is almost nil. If one were to recommend that pregnancies be terminated whenever exposure from diagnostic radiation occurred because of the increased probability of leukemia in the offspring, 1699 exposed pregnancies would have to be terminated to prevent a single case of leukemia. Radiation exposures should be minimized, but fear of radiation should never prevent a patient from having a necessary diagnostic procedure. A consent form has been developed for use with pregnant women. **(Mark B. Landon MD *et al*., 2021)**

Mutagens in Food

As interest in the possible relationship between diet and cancer has increased in recent years, so have attempts to determine whether chemical carcinogens may be present in our foods. The foods that we eat contain a vast number of separate chemical entities: several thousand as additives and many times this number as natural constituents. Of course, most of these chemicals are present in relatively low concentrations, but if potent carcinogens exist, even at low concentrations in commonly consumed foods, they may warrant concern. The problem, therefore, is how to test the very large number of chemicals present in the complex mixtures we call food to determine whether or not they may be contributing to our risk for cancer.

As discussed elsewhere in this report, initiation of the carcinogenic process may involve an alteration in the genetic material of a cell. Therefore, it is reasonable to suppose that chemicals that alter DNA (e.g., cause mutations) will have a high probability of being initiators of carcinogenesis. The fact that DNA is chemically

similar in all living organisms means that even chemicals that cause mutations in bacteria can be suspected as potential carcinogens in humans. **(C. Fritsch *et al.,* 2020)**
The mutagenic activity in the broiled fish and beef could also be detected in S. typhimurium strain TA98, implying that the agent could induce frameshift mutations. Positive results in these assays depended on the presence of an in vitro metabolic activation system utilizing the post mitochondrial supernatant from homogenized livers of rats pretreated with polychlorinated biphenyls. **(Bjeldanes *et al.,2020).***

Effects of mutagens on human health

In order to survive, flourish and successfully reproduce, organisms rely on a high degree of genetic stability. Mutagenic agents, which can threaten the integrity of the genetic code by causing mutations in DNA, pose a serious risk to human health. They have long been implicated in a range of genetically inherited afflictions, as well as cancer, aging and neurodegenerative diseases like Alzheimer's. **(C. Fritsch *et al.,* 2020)**

Cells under threat

Due to their important role in disease processes, mutagenic compounds have long been a topic of intensive scientific study. Such agents include sunlight and other sources of radiation, chemotherapeutics, toxic byproducts of cellular metabolism, or chemicals present in food and water.

Mutagens can inflict damage to the DNA, which can later snowball when cells divide, and DNA replication multiplies these errors. Such mutations, if not corrected through DNA proofreading mechanisms, can be passed to subsequent generations and depending on the location at which they appear along the human DNA strand's three billion letter code may seriously impact health, in some cases, with lethal result. **(C. Fritsch *et al.,* 2020)**

RNA: a string of errors

While the existence of transcription errors has long been recognized, their quantification has been challenging. The new study describes a clever technique for ferreting out transcription errors caused by mutagens and separating these from experimental artifacts -- mutations caused during library preparation of RNA transcripts through processes of reverse-transcription and sequencing. **(C. Fritsch *et al.*,2021)**

Random Mutations Induced with Chemical Agents

The advantage of using chemical agents is the possibility to improve one or two traits while avoiding undesirable changes the chemical mutagens ethyl methane sulfonate (EMS), methyl methane sulfonate (MMS), hydrogen fluoride (HF), sodium azide (SA), N-methyl-N-nitrosourea (MNU), and hydroxylamine (H_3NO) are the chemicals most frequently used in plants. The effects of chemical treatment are silent or missense mutations (50%) while only 5% of nonsense mutations are observed. **(Nawaz and Shu *et al.,* 2014.)**

Mutagens in charred meat and fish are produced during the pyrolysis of proteins that occurs when foods are cooked at very high temperatures. Normal cooking of meat at lower temperatures can also result in the production of mutagens. Any agent causing mutation is called mutagen. Mutagens can be physical mutagens, chemical mutagens, or biological mutagens. The ability of a substance to induce the alterations in the base pairs of DNA or mutation is known as mutagenicity.

Prevention from mutagens

Some chemical mutagens have not been linked to cancer. If they are not 100% known to cause cancer, these chemicals are just referred to as mutagens, not carcinogens. To avoid mutations, we need to limit exposure to these chemicals by using protective equipment, like masks and gloves, when working with them. If they are not 100% known to cause cancer, these chemicals are just referred to as mutagens, not carcinogens. To avoid mutations, we need to limit exposure to these chemicals by using protective equipment, like masks and gloves, when working with them.

Possible means for preventing mutagen formation in cooked meats and in heated model systems are described. One way to reduce mutagenicity in cooked meats is to control cooking temperature, time and method. Another way is to increase water content or to avoid loss of water in meats during cooking. Addition of an excessive amount of reducing sugars to meats before cooking is effective in minimizing mutagen formation, which may be due to suppression of generation of the pyrazine cation radical Maillard intermediate of heterocyclic amines. Addition of a small amount of ascorbate or erythorbate is also effective, which may be the result of scavenging the intermediary pyrazine cation radical.

II. Conclusion

If mutagens that are widely distributed in common foods are consistently found to cause cancer in animals, many factors should be considered before action is taken to reduce exposure. For example, cooking of meat and fish produces mutagens, but it also destroys pathogenic microorganisms and parasites.

Growing evidence indicates that some nonnutritive plant constituents might, in fact, inhibit carcinogenesis, reducing the risk of developing certain cancers. Practical dietary recommendations to help reduce cancer incidence have not changed in recent years. These include reducing the consumption of fat; increasing the consumption of fruits, vegetables, dietary fibre, and some micronutrients; and minimizing consumption of salt preserved foods.

Furthermore, some foods contain mutagenic flavonoids but also have high nutritional value. Important methods to artificially induce mutations are the use of chemical and physical agents. Most chemical mutagens are alkylating agents and asides. Physical mutagens include electromagnetic radiation, such as a rays, X rays, and UV light, and particle radiation, such as fast and thermal neutrons, ` and _ particles. Mutagenic treatment of seeds is the most convenient and, therefore, the standard method inside propagated crops. Seeds can be treated in large quantities and are easily handled, stored & shipped.

It is fairly easy to repeat the conditions of mutagenic treatment, pre- and post-treatment, and hence, to obtain reproducible results within practical limits.

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