Review Article

Y-isomer of Hexachlorocyclohexane (C6H6Cl6) in Modern Human Life and Its Influence on the Processes of Oncogenesis

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Abstract

Today, more than two and a half thousand compounds are known that are used in the production of food products. This is usually done to increase the preservation and storage period and improve organoleptic parameters. However, some of these toxic compounds may inadvertently enter food through packaging material and technological additives. Residues of toxic chemicals and industrial pollutants in food are a serious problem for a healthy body, which can lead to oncogenetic processes. Among such persistent organic pollutants are organochlorine pesticides, polychlorinated biphenyls, as well as by-products of chemical production and combustion processes, such as dioxins and furans. One of the most toxic pesticides is the organochlorine pesticide γ-isomer of hexachlorocyclohexane (C6H6Cl6). Pure hexachlorocyclohexane is a hydrophobic white powder with a crystalline structure that has strong acid-resistant parameters. To date, it is known for sure that hexachlorocyclohexane is a polytropic toxic chemical that primarily affects the central and autonomic nervous system of mammals. Hexachlorocyclohexane has been widely used in agriculture for pest control. Now the substance is banned everywhere. This article is devoted to the effect of hexachlorocyclohexane on the human body.

Keywords: *Hexachlorocyclohexane, Toxicity, Health, Oncogenesis*

Introduction

Pesticides are an extensive heterogeneous group consisting of organochlorine, organometallic, phosphoorganic substances and alkaloids, differing in mechanism and degree of action on target cells.[1] An important and unambiguous axiom applies to this group of substances: the long-term effect of using pesticides is equivalent to a decrease in species diversity, since one of the most striking properties of pesticides is their total reproductive toxicity for all animals, including humans.[2-4]

In 2017, the United Nations declared the falsity of the statement about the need to use pesticides to ensure food safety. Data on more than two hundred thousand cases of deaths due to pesticide poisoning were given as proof. It was noted that constant contact with toxic chemicals is subsequently associated with oncological diseases, Alzheimer's and Parkinson's diseases, endocrine pathologies, disorders of physical and mental development in children and reduced fertility.[5, 6] High levels and/or prolonged exposure to hexachlorocyclohexane may also affect an increase in the frequency of miscarriages in women. In particular, there is information that hexachlorocyclohexane lindanes have an antiandrogenic effect on men, which leads to insufficient development of the reproductive system: from a decrease in the size of the testicles and normal production of sperm fluid to a violation of the production of sex hormones.[7]

Today, there is indisputable evidence that pesticides play a role in the development of cancer.[8] For example, in February 2019, researchers found that the accumulation of dichlorodiphenyltrichloroethane compounds in young women dramatically increases the likelihood of developing breast cancer at a more mature age due to the pathotransformation of cell physiology. In addition, dichlorodiphenyl trichloroethane is very stable and is almost not excreted from the tissue structures of the body, for which it was also banned in many states at one time.[9] There are whole lists compiled by doctors about the correlative relationship between certain substances and side effects caused by them.[10, 11] Thus, the use of pesticides in the food industry should be clearly and smoothly controlled at the legislative level in order to avoid mass poisoning of people.

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The history of discovery and physico-chemical properties of the γ-isomer of hexachlorocyclohexane

Organochlorine pesticide γ-isomer of hexachlorocyclohexane (C6H6Cl6) was widely used early in agriculture to control harmful insects of feed stocks, now banned everywhere.[12] The famous scientist Michael Faraday obtained hexachlorocyclohexane under laboratory conditions in 1825. Almost a century later, another researcher G. Bender discovered insecticidal properties in one of the isomers of hexachlorocyclohexane. Thus, the now famous hexachlorocyclohexane was discovered, whose mass production began in 1949. According to some data, hexachlorocyclohexane still ranks second in terms of production and use after dichlorodiphenyltrichloroethane.

Pure hexachlorocyclohexane is a hydrophobic white powder with a crystalline structure that has strong acid-resistant parameters. It was usually obtained by the chemical reaction of benzene chlorination and the chlorination reaction of cyclohexane and cyclohexene.

Technical lindane hexachlorocyclohexane **(Figure 1)** has a persistent smell of musty mold, dirty yellow color due to impurities of pentachlorocyclohexene and tetrachlorocyclohexadiene. It is hydrophobic, but it dissolves quite effectively in organic nonpolar solvents, such as acetone, benzene, kerosene, etc.[10]

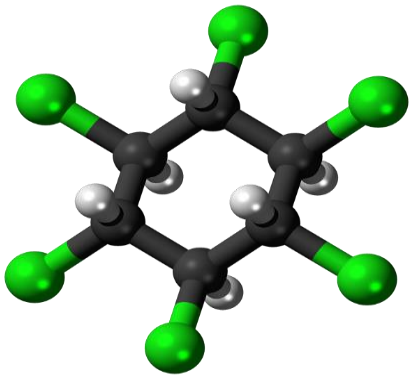

Figure 1. Model of lindane hexachlorocyclohexane.

This pesticide served as one of the main means of combating some insects and was widely used for fumigation of warehouses, because its lindane has powerful insecticidal properties, being a strong contact, systemic, intestinal and fumigant poison.[7] To date, it is known for sure that hexachlorocyclohexane is a polytropic toxic chemical that primarily affects the central and autonomic nervous system of mammals. Back in 1985, the Soviet scientist Professor Melnikov wrote that "all isomers of hexachlorocyclohexane have pronounced cumulative properties, especially α-, β- and γ-isomers of hexachlorocyclohexane, therefore they are characterized by chronic poisoning, which in the future may be complicated by the appearance and growth of malignant neoplasms".[13, 14]

Hexachlorocyclohexane was produced (and is still being produced in some countries with agricultural economies) in the form of dust (12% content), powder on phosphorous flour (25% content), emulsions, aerosols and smoke bombs. In industrially developed countries, hexachlorocyclohexane and its lindanes are considered as extremely dangerous compounds that cause total harm to the environment and the health of living organisms.[15, 16] As a result, they are either prohibited in production and use, or severely restricted.

The impact on the human body and the risks of oncopathology

The effect of large amounts of hexachlorocyclohexane can harm the central and autonomic nervous system, causing a whole symptom complex: from headaches and dizziness to convulsions and convulsions. Also, the most common side effects are a burning sensation, itching, dryness and the appearance of a skin rash.[17] There was no clear evidence in animal experiments that hexachlorocyclohexane affects immunity, and it is not considered genotoxic. Prenatal exposure to β-hexachlorocyclohexane and a by-product of production is associated with changes in thyroid hormone levels and may affect the development of the central nervous system. It is reported that people can be exposed to hexachlorocyclohexane in the workplace by inhalation, contact, ingestion and contact with mucous membranes, and up to 50 mg/m3 it does not pose too serious a danger at the moment.[18]

Based mainly on the results of animal studies, most assessments of lindane have concluded that it may still be capable of causing cancer. In 2001, experts from the US Environmental Protection Agency concluded that there was "suggestive evidence of carcinogenicity, but insufficient to assess the carcinogenic potential of humans".[19] And almost 15 years later, WHO has accurately classified hexachlorocyclohexane as a strong carcinogen.

Researchers have found associations with oncopathologies such as leukemia, brain cancer, lymphoma and melanoma of the skin. Also, the kidneys, mammary gland in women, prostate in men, and digestive tract organs become target organs for oncopathogenesis.[20] An increased level of carcinogenicity has been found among agricultural workers who still use these hexachlorocyclohexane, in some countries. Studies suggest a link between the effects of hexachlorocyclohexane on the central nervous system with the development of glioma and meningioma, diffuse large-cell B-cell lymphoma.[21] Occupational exposure to pesticides on a woman during her pregnancy is associated with an increased risk of leukemia, Wilms tumor and brain cancer in a child.[22]

The putative molecular mechanism of hexachlorocyclohexane action and carcinogenesis is damage to genetic materials at the chromosome level: DNA and histone proteins.[6] There is evidence of damage to cellular organelles, such as the endoplasmic reticulum, the mitochondrial complex and nuclear receptors in cells.[23]

If we talk about the prevention of cancer risks induced by the

gamma-isomer of hexachlorocyclohexane, then the "precautionary principle" in the use of pesticides plays a significant role here, which is directly regulated by environmental law. WHO recommends limiting the use of pesticides, in particular hexachlorocyclohexane has proven its oncotoxicity and therefore the global agricultural industry should completely remove it from use in work.[24] It is also important to increase literacy among the population in the field of nutrition, food hygiene and epidemiology.[25-27]

Conclusion

Today, there is indisputable evidence that pesticides play a role in the development of cancer, and the gamma isomer of hexachlorocyclohexane is involved in carcinogenesis (damage to genetic materials at the chromosome level). However, some of these toxic compounds may inadvertently enter food through packaging material and technological additives. If we talk about the prevention of cancer risks induced by the gamma-isomer of hexachlorocyclohexane, then the "precautionary principle" in the use of pesticides plays a significant role here, which is directly regulated by environmental law. WHO recommends limiting the use of pesticides, in particular, hexachlorocyclohexane has proven its oncotoxicity and therefore the global agricultural industry should completely remove it from use in work. It is also important to increase literacy among the population in the field of nutrition, food hygiene and epidemiology.

Residues of toxic chemicals and industrial pollutants in food are a serious problem for a healthy body, which can lead to oncogenetic processes. Among such persistent organic pollutants are organochlorine pesticides, polychlorinated biphenyls, as well as by-products of chemical production and combustion processes, such as dioxins and furans. One of the most toxic pesticides is the organochlorine pesticide γ-isomer of hexachlorocyclohexane (C6H6Cl6). hexachlorocyclohexane has been widely used in agriculture for pest control. now the substance is banned everywhere.

Thus, the use of pesticides in the food industry should be clearly and smoothly controlled at the legislative level in order to avoid mass poisoning of people.

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Conflict of interest
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Ethics statement
None.

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