



STUDY OF ENVIRONMENTAL TOXIC CHEMICALS DIOXINS

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ABSTRACT:

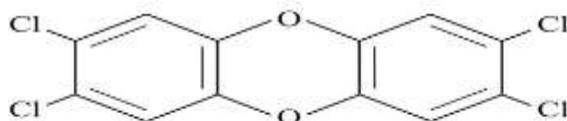
Dioxins pose a chemical hazard due to their presence in the environment, where they accumulate in the food chain, particularly in the fatty tissues of animals. They are harmful to live organisms, including humans. Dioxins can cause a range of health problems, including cancer, hormonal imbalances, and reproductive issues. Given their widespread distribution and persistence in the environment, dioxins continue to be a concern for public health and environmental safety. Consequently, measures are needed to mitigate the presence of dioxins and to reduce their exposure to animals and humans.

KEYWORDS:

Dioxins, TCDD, Agent Orange, POPs

INTRODUCTION:

Dioxins are **Persistent organic pollutants** [POPs] which are environmental pollutants that can remain for many years. ⁽¹⁾ In the US the dioxins in the industry have been not used but the by-products of dioxins are used. These are stable solid substances and insoluble in water, have high thermal stability that can be completely decomposed at temperatures above 1200⁰ C and is resistant to strong acids and alkalis. ⁽²⁾



STRUCTURE OF DIOXIN

STEREOCHEMISTRY OF DIOXIN STRUCTURE

2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) is a polychlorinated dibenzo-p-dioxin (sometimes shortened, though inaccurately, to simply 'dioxin') with the chemical formula $C_{12}H_4Cl_4O_2$. Pure TCDD is a colorless solid with no distinguishable odour at room temperature. It is usually formed as an unwanted product in burning processes of organic materials or as a side product in organic synthesis ⁽²⁾.

MECHANISM OF DIOXINS:

TCDD and dioxin-like compounds act via a specific receptor present in all cells: the aryl hydrocarbon (AH) receptor. This receptor is a transcription factor which is involved in the expression of genes; it has been shown that high doses of TCDD either increase or decrease the expression of several hundred genes in rats. ⁽³⁾ Genes of enzymes activating the breakdown of foreign and often toxic compounds are classic examples of such genes (enzyme induction). TCDD increases the enzymes breaking down, e.g., carcinogenic polycyclic hydrocarbons such as benzo(a)pyrene. ⁽⁴⁾

WHERE DOES DIOXIN COME FROM?

- They are found in both natural and anthropogenic environments.
- The main sources of dioxins are Drinking water, chlorination process, incineration of municipal wastes and production of certain herbicides. ⁽⁵⁾

Industrial process and natural events:

Natural phenomena, such as volcanic activity and forest fires. Industrial wastes E.g., Paper, chemical manufacturing and biological processes can also cause dioxin production. ⁽⁶⁾ The dioxins are also produced during the combustion of organic compounds in the presence of chlorinated materials. In chemical manufacturing also DLCs are produced mainly by three processes bleaching of wood pulp in chemical manufacturing, chlorine and chlorine derivatives manufacturing and halogenated chemical manufacturing. ⁽⁷⁾

Food, Water and Air:

Dioxin and dioxin like compounds have a low concentration in water due to their insolubility. However, there are released into the air and known to bioaccumulate through the food chain. This means that these harmful substances can accumulate in the bodies of animals that consume contaminated plants. As a result, humans can also be exposed to these compounds through the consumption of contaminated food products. Dioxins and Dioxin like compounds have been linked to a range of negative health effects, including Cancer, Immune system damage, and Reproductive issues. ⁽⁸⁾

Waste Disposal:

Incineration of waste at low to moderate temperatures:

Improper incineration of household and medical waste leads to their accumulation while improper disposal of electronic waste results in the release of Dioxins. These toxic substances can cause serious harm to human health and the Environment. Therefore, it is crucial to ensure proper waste management practices to minimize the release of harmful chemicals and pollutants. These may include using safer methods of waste disposal such as Recycling, Composting, and Landfills equipped with gas recovery systems to eliminate the negative impact of waste disposal on the Ecosystem. ⁽⁹⁾

Over 90% of our exposure to dioxins comes from our food through milk, meat, fish, and fatty substances. By natural phenomena such as volcanic activity and forest fires, Smoking, Dismantling and Recycling of Electronic products. ⁽¹⁰⁾ The dioxins concentration in fish is 100,000 times higher in the surrounding environment. Dioxins are the impurities of certain herbicides. ⁽¹¹⁾

METHODOLOGY:

As we have collected the information from previously published articles. In the Vietnam War, our government employed ⁽¹²⁾ Agent Orange defoliant containing high levels of dioxins, during this time 5million people are directly exposed to dioxin through their skin into the body this time the dioxin is completely absorbed are the Vietnam people through their food or by herbicides as the dioxin damage can lead to serious health damages. ⁽¹³⁾



DIOXIN CLEAN UP PROGRAM IN VIETNAM

Over 3 million people are suffered from serious health damage which is more profound once it enters in to the human cell. It takes 7 to 11 years in the body to reduce its toxicity from its original level to half of level. ⁽¹⁴⁾

The dioxin molecule combines with the A8 receptors in cell. A8 receptor is a protein which regulates cell growth. The newly formed combination is then preceded as their own hormone and therefore penetrate the protective barrier once inside the nucleus it activates the DNA sequences and damages the gene. Since the war caused over 150000 people have been born with 1 congenital malformations due to dioxin traces. The 17,000,000 million people have come and contact with dioxin since the war ended.

The dioxins continuously produce new victims through the contaminated environment and genetic inheritance. Women's breast milk has higher levels of dioxins than others. ⁽¹⁵⁾

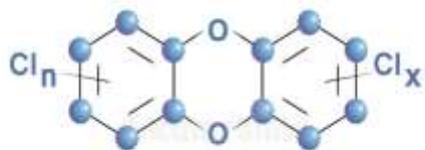
The side effects of dioxins and dioxin like compounds include cancer causing agents, type-2 diabetes, ischemic heart diseases, acne like skin diseases, developmental problems in children, reproductive and infertility problems in adults. In the world, each vertebrate is exposed to dioxins even from small wombs to large Vertebrates. ⁽¹⁶⁾



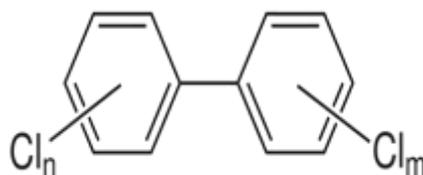
DIOXIN IMPACTS IN VIETNAM

Types of dioxins:

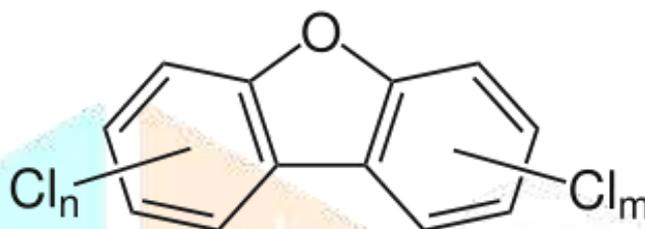
1. Chlorinated dibenzo-p-dioxins [CDDs]
2. Polychlorinated di benzo-furans [PCDFs]
3. Polychlorinated biphenyls [PCBs] ⁽¹⁷⁾



Chlorinated dibenzo-p-dioxins



Polychlorinated biphenyls



Polychlorinated dibenzo-furans

Effects of Dioxins on Spermatogenesis:

The group of chemical toxins that particularly disrupt the endocrine system is collectively known as Dioxins, Poly Chlorinated di Benzo P- dioxins (PCDPs), Poly Chlorinated di Benzo furans (PCDFs), acts as Endocrine Disruptor Chemicals (EDCs). Spermatogenesis, the process of sperm cell production, is affected by various factors. The Oxygen tension in testicular tissue is crucial for spermatogenesis as it promotes the growth and functional maturation of sperm cells. Temperature variation can also disturb the process, as the testes require a slightly cooler temperature than the rest of the body. Exposure to radiation can damage the DNA of developing sperm cells, leading to fertility issues. Hormonal balance is also crucial for spermatogenesis, with testosterone and follicle stimulating hormone playing important roles. ⁽¹⁸⁾ Overall, maintaining a healthy environment for spermatogenesis is crucial for male fertility. Unhealthy lifestyle choices such as poor nutrition are believed to be a common causes of male infertility along with other factors. Environmental and occupational hazards have been linked to an increased risk of infertility in men. Exposure to certain chemicals such as pesticides, solvents, dioxins and heavy metals can damage sperm DNA and reduce sperm count and motility. ⁽¹⁹⁾ Research on animals and humans shows that exposure to dioxins causes permanent and transgenerational harm to the male reproductive system. Both experimental and epidemiological studies have confirmed this association and negative effects of dioxin exposure cannot be reversed. ⁽²⁰⁾

Symptoms of dioxins:

1. Skin rashes.
2. Skin discolouration.
3. Mild liver damage.
4. Skin lesions known as chloracne.
5. Impairment of Immune system. ⁽¹⁰⁾

How to Remove Dioxins from the Body?

- Dioxins are so dangerous as they once enter in to the body they don't exit very easily. They set up a residence in the body and accumulate in our fat cells and remain for a longer time.
- Affect multiple organ systems because they interfere with basic biological systems.
- Dioxins are more toxic and so difficult to eliminate. There are no safe levels of dioxins human body.
- Limit your exposure to dioxin. Over 90% of our exposure to dioxin comes from our food supply.
- All human exposure to dioxin is mainly due to the consumption of Dairy products, fish, meat, and seal fish.

HOW DIOXIN COMES IN CONTACT WITH ANIMALS?

The industries and chemical companies dump toxic chemical directly in to the water as the dioxins are Hydrophobic and Lipophilic as once they settle in the water they stick to the particles and end up in sediment this sediment is eaten food chain and accumulate in the fatty tissue and cause harm.

→The studies have shown that Dioxin concentration in fish is 100,000 times higher than the surrounding environment.

HOW TO REDUCE THE EXPOSURE TO DIOXINS?

- *Limit your exposure by changing your diet.
- *The single celled green algae called Chlorella. The chlorella supplementation not only reduces dioxin levels in breast milk, but may also have a beneficial effect on nursing infants by increasing IgA levels in breast milk.
- *When cleaning avoids chlorine bleach.
- *Avoid Fatty meals, fish, meat etc.
- *Avoid bleaching paper products.
- *Follow best precautions when following backyard burning.



DIOXIN CLUES IN INDIANA COUPLE:

In a recent article by the New York Times, a couple from Indiana has been found to have high levels of dioxins in their blood. The Indiana Department of Environmental Management has been working to investigate the source of the dioxin, which is believed to be linked to a nearby industrial site. The couples have been greatly impacted by the exposure to dioxin, and there are known advocates for stricter regulations and oversight of industrial sight to prevent such incidences from occurring in the future.



CONCLUSION:

In Conclusion, Dioxins are a group of chemically related compounds which causes toxic effects on human beings. The Highest levels of these compounds are found in some soil sediments and food especially dairy products, fish, meat etc. very low levels in plants. It is important to be mindful of our consumption of animal products and to try to consume organic fruits and vegetables whenever possible. This can help reduce our exposure to harmful chemicals and pesticides, and promote a healthier life style. Making small changes, such as incorporating more plant-based meals in to our diet, can have a positive impact on both our personal health and the Environment. Proper incineration of contaminated material is the best available method of prevention and control exposure of dioxins the most dioxin is TCDD. Lastly, we should avoid too much eating of animal products and eat organic fruits and vegetables.

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REFERENCES:

1. Tanaka, T.; Morita, A.; Kato, M.; Hirai, T.; Mizoue, T.; Terauchi, Y.; Watanabe, S.; Noda, M. SCOP Study Group. Congener-specific polychlorinated biphenyls and the prevalence of diabetes in the Saku Control Obesity Program (SCOP). *Endocr. J* 2011, 58, 589–596. [Google Scholar]
2. Tuomisto, Jouko (2019) Dioxins and dioxin-like compounds: toxicity in humans and animals, sources, and behaviour in the environment. *WikiJournal of Medicine* 6(1)
3. Mandal PK (May 2005). "Dioxin: a review of its environmental effects and its aryl hydrocarbon receptor biology". *J. Comp. Physiol. B.* 175 (4): 221–30. doi:10.1007/s00360-005-0483-3. PMID 15900503. S2CID 20508397.
4. Okey AB (July 2007). "An aryl hydrocarbon receptor odyssey to the shores of toxicology: the Deichmann Lecture, International Congress of Toxicology-XI". *Toxicol. Sci.* 98 (1): 5–38. doi:10.1093/toxsci/kfm096. PMID 17569696.
5. A Review of Soil Contaminated with Dioxins and Biodegradation Technologies; Current Status and Future Prospects.
6. Institute of Medicine (US) Committee on the Implications of Dioxin in the Food Supply. *Dioxins and Dioxin-like Compounds in the Food Supply: Strategies to Decrease Exposure*. Washington (DC): National Academies Press (US); 2003. 3, Sources of Dioxins and Dioxin-like Compounds in the Environment.
7. Review of the current state and main sources of dioxins around the world Miguel Dopico & Alberto Gómez.

8. IPCS (2003). Polychlorinated biphenyls: Human health aspects. Geneva, World Health Organization, International Programme on Chemical Safety (Concise International Chemical Assessment Document 55; <http://www.inchem.org/documents/cicads/cicads/cicad55.htm>).
9. UNEP (2005). Standardized toolkit for identification and quantification of dioxin and furan releases, edition 2.1. Geneva, United Nations Environment Programme, UNEP Chemicals (http://www.pops.int/documents/guidance/toolkit/ver2_1/Toolkit-2005_2-1_en.pdf).
10. Brady B. All Irish pork is Recalled in Dioxin poison Alert. The Independent Dec 7, 2007.
11. C.L. Wilson Assessment of dioxin and dioxin-like compounds in mainstream smoke from selected US cigarette brands and reference cigarettes.
12. Institute of Medicine. Veterans and Agent Orange; The National Academy Press: Washington, DC, 2009; p 7. Google Scholar.
13. Henriksen, G.L.; Ketchum, N.S.; Michalek, J.E.; Swaby, J.A. Serum dioxin and diabetes mellitus in veterans of Operation Ranch Hand. *Epidemiology* 1997, 8, 252–258. [Google Scholar]
14. Michalek, J.E.; Tripathi, R.C. Pharmacokinetics of TCDD in veterans of Operation Ranch Hand: 15-year follow-up. *J. Toxicol. Environ. Health A* 1999, 57, 369–378. [Google Scholar]
15. Health Risks from dioxin and related compounds 2006 from National Research council of the National Academics.
16. Remillard, R.B.; Bunce, N.J. Linking dioxins to diabetes: Epidemiology and biologic plausibility. *Environ. Health Perspect* 2002, 110, 853–858. [Google Scholar]
17. WHO (2002). Polychlorinated dibenzodioxins, polychlorinated dibenzofurans, and coplanar polychlorinated biphenyls. In: Safety evaluation of certain food additives and contaminants. Geneva, World Health Organization. Assessment Document 55; <http://www.inchem.org/documents/cicads/cicads/cicad55.htm>).
18. Poland A, Knutson JC. 2,3,7,8-tetrachlorodibenzo-p-dioxin and related halogenated aromatic hydrocarbons: examination of the mechanism of toxicity. *Annu Rev Pharmacol Toxicol.* (1982) 22:517–54. doi: 10.1146/annurev.pa.22.040182.002505PubMed Abstract | CrossRef Full Text | Google Scholar
19. Institute of Medicine (US) Committee on the Implications of Dioxin in the Food Supply. Dioxins and Dioxin-like Compounds in the Food Supply: Strategies to Decrease Exposure. Washington (DC): National Academies Press (US); 2003. 3, Sources of Dioxins and Dioxin-like Compounds in the Environment.
20. Inhorn MC, Patrizio P. Infertility around the globe: new thinking on gender, reproductive technologies and global movements in the 21st century. *Hum Reprod Update.* (2015) 21:411–26. doi: 10.1093/humupd/dmv016 PubMed Abstract | CrossRef Full Text | Google Scholar.