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Triclosan

Abbreviations: ENR, enoyl-acyl carrier protein reductase; NHANES, national health and nutrition examination survey; LSGM, least square geometric mean; ECC, excitation-contraction coupling

Introduction

Triclosan (TCS) 5-chloro-2(2, 4 dichlorophenoxy) phenol, is the common name for a whitish crystalline powder that is a phenyl ether derivative. This chemical is added to products to prevent or reduce bacterial growth. In 1969, it was registered as a pesticide. Triclosan is a broad-spectrum antibacterial agent (Figure 1).

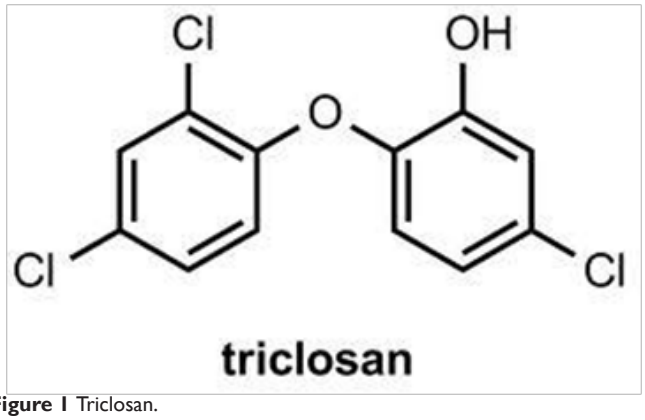

Figure 1 Triclosan.

"Triclosan works by blocking the active site of the enoyl-acyl carrier protein reductase enzyme (ENR), which is an essential enzyme in fatty acid synthesis in Bacteria. By blocking the active site, Triclosan inhibits the enzyme and therefore prevents the bacteria from synthesizing fatty acid, which is necessary for building cell membranes and for reproducing".[1] Humans do not have ENR enzymes, which has given scientists reason to believe that Triclosan is fairly harmless to them.

Uses

Triclosan has been used for more than 40 years and it can be found in soaps, floor waxes, detergents, kitchen ware such as cutting boards, toothpastes & toothbrushes, lotions, deodorants and other skin care products, fabrics such as mattress pads and shoes, toys, caulking compounds, sealants, rubber, conveyor belts, fire hoses, carpeting and hand sanitizers and other products. Triclosan has been proven to kill the bacteria that cause gingivitis. Triclosan is also used in HVAC coils to help prevent microbial growth. In 1998 it was estimated by the EPA that 1million pounds of Triclosan were produced annually.

Triclosan in toothpaste

In 2009 a study was done by Applied Environmental Science, Stockholm University, and Department of Dental Medicine. This study tested adult individuals that used toothpaste that had Triclosan and found that there was a significant amount of Triclosan found in these individuals after two weeks of use compared to levels before the use of the toothpaste that contained Triclosan. They were also asked to refrain from using any products that contained Triclosan for 2 weeks prior to starting the experiment. Blood samples were collected the day before the use of the toothpaste and the day after the use of the toothpaste ended. Another studying showed that Triclosan can remain in oral saliva for several hours after the use of toothpaste that contained Triclosan.[2]

Volume 2 Issue 2 - 2016

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Received: November 11, 2015 | **Published:** March 01, 2016

Levels of triclosan in the us population

A study that was done for the National Health and Nutrition Examination Survey (NHANES) 2003–2004 to assess the exposure of Triclosan in the U.S. population. They analyzed 2,517 urine samples from U.S. individual's ≥6 years of age. Triclosan concentration was found in 74.6% of the samples at concentrations of 2.4–3,790µg/L. The geometric mean and 95th percentile concentrations were 13.0µg/L (12.7µg/g creatinine) and 459.0µg/L (363.8µg/g creatinine), respectively. We observed a curvilinear relation between ages and adjusted least square geometric mean (LSGM) concentrations of triclosan. LSGM concentrations of triclosan were higher in people in the high household income than in people in low (p<0.01) and medium (p=0.04) income category. Concentrations differed by age and socioeconomic status but not by race/ethnicity and sex. Specifically, the concentrations of triclosan appeared to be highest during the third decade of life and among people with the highest household incomes.

Triclosan has been found in raw treated waste waters, natural steams, sewage sludge, and fish which raises the concern to how much Triclosan could be accumulating in the organisms.

Federal regulations

At this time the FDA reports that they have no scientific evidence that shows Triclosan as a harmful chemical to humans. The FDA is currently doing further scientific studies to determine the effects of Triclosan on humans.[3]

The FDA is responsible for regulating Triclosan if it intended to be used on the body as a cosmetic product but, if it is used in a product that makes the claim to "kill germs" (i.e., hand sanitizers) then it is considered a drug instead of a cosmetic.[3]

The FDA report on Triclosan was initially scheduled for release in spring 2011 but, has yet to be released.[3] Triclosan has not been classified on The International Agency for Research on Cancer, World Health Organization list. Until further research and data is collected Triclosan is considered to be an A4 Carcinogenesis, which means that there is a concern that it could be a carcinogenic for humans but, has not been confirmed due to lack of data.

Toxicokinetics

The human health effects from exposure to low environmental levels of Triclosan are unknown. Triclosan can be absorbed through the skin into the blood stream although, skin products containing Triclosan rarely have caused irritation[4] it is listed More research is needed to assess the human health effects of exposure to Triclosan.

Triclosan is rapidly absorbed into the GI tract and the concentration is reduced during the first pass metabolism before it can be circulated throughout the entire system. Everyone does not metabolize the chemical as quickly and it can remain in the blood for a longer period of time. The major route of excretion of Triclosan is through the urine. Triclosan has been found in human breast milk samples but, has not been found to bioaccumulate in the body.[5]

Triclosan highest concentration is in the liver followed by the adipose tissue. It has been found in the brain but, not often. The adipose tissue can have measurable amounts but, still seems to have low bioaccumulation potential.[5]

Endocrine disruptor

Animal studies have shown that Triclosan is an endocrine disruptor. If found that it is an endocrine disruptor in humans it could cause adverse developmental, reproductive, neurological, and immune effects in humans. Endocrine disruptors may pose risks to a developing fetus when organ and neural systems are forming. Although, the 2009 Fourth National Report written by the CDC claims that Triclosan is not a tetragon.[6]

Both animal and human studies have shown that it takes several days for the body to eliminate Triclosan in the feces and the urine. The Triclosan is not metabolized and remains in the same form as when entering the body.[5] If the body does not metabolize the chemical Triclosan it may deposit itself in the liver or in fatty tissue.

There have been other studies showing that Triclosan is contributing to making bacteria more resistant to antibiotics.[7]

Heart muscle cells and human skeletal study

Low concentrations of Triclosan were first tested on human isolated heart muscle cells and human skeletal muscle fibers to see the effects. A normal electrical stimulation that caused the muscle cells to contract was not observed in these cells and fibers. This normal electrical stimulation is a process known as "excitation-contraction coupling (ECC), it is the basic function that allows muscle movement.

A recent *in vivo* and *in vitro* animal study that was released in July 2012 that suggests that Triclosan affects muscle strength and blood flow in mice.[4] Triclosan might have the possibility of interfering with cardiac activity in exposed animals. This study also, suggests that the Triclosan can interfere with the transport of calcium into and out of cells.

Disruption of calcium channels is what is causing the heart muscles to refrain from contractions. In this study a mouse was given a dose that was less than 1% of what is considered to be lethal to animals. The mouse died within a minute of being given the dose of heart failure.[4] This is an important find because; disruption of Ca^{2+} signaling in humans can cause heart failure in humans as well. More studies need to be done to look at the defects excitation contraction coupling (ECC) in humans from exposure to Triclosan.

The researches of this study altered the dosage to a lesser than the previous 1% (>12.5um) and found that the Triclosan still altered the ability for the heart to move blood and weaken the strength of the leg muscles in the mice.[4]

These researchers turned to testing Triclosan effects on fish (fathead minnow). Triclosan was put in the fish tanks in a dosage of >.52um, greater than what was given to the mice. The fish were unable to swim as well as they did before the exposure to the Triclosan. Their ability to swim as well before the exposure showed signs of altered strength in muscles in the fish same as the mice. Triclosan also, blocks incoming nerve stimuli which also diminish the ability of muscles to contract.[8]

National health and nutrition examination survey study

A study conducted by the Norwegian Institute of Public Health found an association between Triclosan levels in the urine of children and allergies. Norwegian and U.S. children were tested for Triclosan in their urine. 623 urine samples were collected by the CDC in Atlanta. Both sets of children were found to have traces of Triclosan in their urine. 80% of U.S. children had measurable amounts and 50% Norwegian children had traceable amounts.[9]

Children with Triclosan in their urine were associated with elevated levels of Immunoglobulin E and rhinitis. The flora on the skin, mouth and intestines can be changed when it comes into contact with Triclosan. Which can cause the Immuniglobin E in children to be changed which can help trigger an allergic reaction.[10]

It is estimated that 20% of the population worldwide are suffering from some form of allergic disorder. The prevalence of U.S. childhood asthma has climbed from 50% from 1980 to 2000.[11] Many studies have suggested that environmental factors like Triclosan exposure are responsible for triggering some of the reactions. Triclosan can lower the exposure to microbes, which can change the intestinal flora. A lower amount of microbial exposure in children while their immune system is still developing can cause an allergic reaction.[12]

Discussion

There is a need for more studies on this chemical to make a more sound decision on what it does to the human body. The "Father of Toxicology", Paracelsus said, "The dosage makes it either a poison or a remedy" Right now it looks like a high dose of Triclosan can cause harm. From the limited amount of studies that are out, on Triclosan I think this is a chemical that can cause adverse effects on humans in larger dosages. Although, it is excreted from the body quickly and it does not bioaccumulate, it is used in so many products that human's use, chances of getting a high dosage on a regular basis from a combination of products containing Triclosan could be possible.

Triclosan used in Hospital settings where the need to help prevent the spread of microbes is an important area that it is used in. There are speculations that the use of Triclosan is helping MRSA to become more resistant.

Triclosan can also be found in waste waters from products being washed down the drain. It is being detected in streams across the U.S. As mention previously Triclosan limited the swimming speed of fish posing a potential risk to aquatic ecosystems and wildlife.

Until further studies are completed a reduction in products with Triclosan would be recommended.

Acknowledgements

None.

Conflict of interest

The author declares no conflict of interest.

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