PHTHALATES

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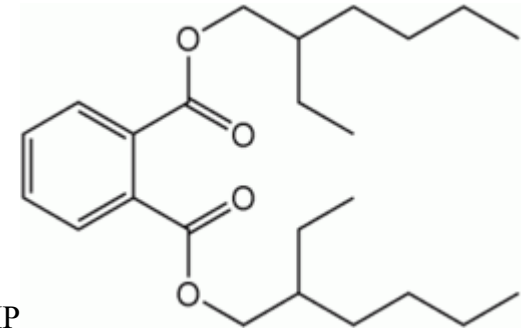
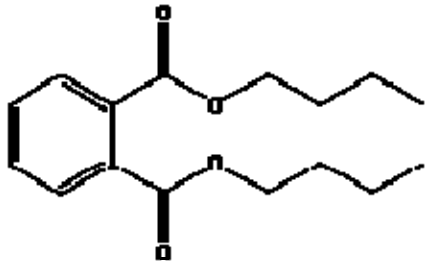
Phthalates are a class of chemicals developed within the last century. The oily chemical substance is never used alone but incorporated into other products. These chemicals persist in the environment because they have low electronegativity, therefore resisting oxidation and hydrolysis. Over 87% of phthalates produced are used as a plasticizer, polycarboxylic acids and esters, that give plastics its strength, flexibility, and durability. The estimated annual production of phthalic acid esters is more than 5 million tons(8). Because they are so widespread, their effects on humans have become controversial.

There are several different polycarboxylic acids and esters and too many to name. Two of the main ones that will be discussed are DEHP and DBP.



DEHP

DEHP is the common abbreviation for di-2-ethyl hexyl phthalate. Its chemical formula is $C_{24}H_{38}O_4$. DEHP is a colorless liquid with almost no odor. It has a boiling point of 230 (°C) at 5 mm Hg, and a melting point of -50 (°C). The vapor density is 16 (air = 1) and specific gravity is 0.9861 at 20/20 (°C). The vapor pressure is 1.32 mm Hg at 200 (°C). DEHP is insoluble in water, miscible with mineral oil and hexane, and soluble in most organic solvents (10,12).



DBP

DBP is the common abbreviation for di-*n*-butyl phthalate. It is also an odorless and colorless oily liquid. Its chemical formula is $C_{16}H_{22}O_4$ and the molecular weight is 278.35 g/mol. The vapor pressure for di-*n*-butyl phthalate is 1.0 H 10^{-5} mm of Hg at 25 EC. DBP is insoluble in water, miscible with mineral oil and hexane, and soluble in most organic solvents (10,12).

Dibutyl phthalate is used extensively throughout society and widespread in the environment, so common sources are every where. Most people are exposed to low levels by air, water, food, and product use. Phthalates are used in flexible polyvinyl chloride plastics such as plastic bags, food packaging, garden hoses, inflatable toys, blood-storage containers, intravenous tubing, children's toys, and some pesticide formulas. Phthalates are also used as industrial chemicals added to many consumer products such as vinyl flooring adhesives, detergents, lubricating soils, automobiles, home furnishings, solvents, food packaging, automotive plastics, construction, plastic clothing, and personal care products (3,6).

In many cases, the largest source of exposure is from food. Some of the dibutyl phthalate in food is from plastics used to wrap and store the food. Certain types of food, especially fish and shellfish, may absorb larger quantities of dibutyl phthalate. Air and water also contain small levels of dibutyl phthalate. Levels in city air are found to be 0.03 to 0.06 parts per billion. In drinking supplies it is found at 0.1 to 0.2 parts per billion (6). Exposure at higher levels may occur in a number of ways. Workers in industries that use or produce dibutyl phthalate are at risk of exposure, and consumers can be exposed to higher levels of dibutyl phthalate by exposure to air from production and processing facilities.

Phthalate exposure has a wide array of effects on the body. Specific diseases may occur depending on the route of exposure and target organ where it ends up. Data (4) has shown that phthalates are:

- estrogenic to breast cancer cell lines
- antiandrogenic: they block the action of dihydrotestosterone leading to genital defects
- lung irritants: they aggravate asthma
- known to induce kidney cysts
- endocrine disruptors
- known to induce hepatic hyperplasia
- known to increased rates of abortion, malformations, and decreased body weight

Because there is still much research left to be done regarding the effects of these chemicals on the human body, there may be other subacute health issues we have yet to discover.

The physiology associated with phthalates is different for each pathology. The hepatocarcinogenetic effect is proposed by two major mechanisms. The first is the induction of sustained oxidative stress to the liver, which translates as low exposure over long periods of time. The second is through peroxisome proliferation due to the presence of phthalates. Enhanced cell proliferation can then lead to cancer. Phthalates are also known to induce testicular atrophy. One possibility for this is the depletion of zinc in the testis. The other possibility is the reduction in testosterone synthesis in Leydig cells. Phthalates are also believed to cause embryolethality and teratogenic pregnancy. This is thought to be due to its anti-androgenic effect in male rats and decrease in 17beta-estradiol level in the blood of female rats. (9,11)

The main high risk populations for phthalates are children, workers who are continually exposed, and the people that live close to production areas. Workplace exposure occurs during production of phthalates and the products that contain them. Those that work in the phthalate industry have much greater exposure through dermal contact and inhalation. Because they are in such close proximity and encounter the chemicals on a daily basis, their body burden will be much higher than the average person. The people living near these production cites will also have greater exposure

because it will be more concentrated in the air. Children are at such high risk because their behaviors put them in close contact with toys and other products containing phthalates. They are chewing, mouthing, sniffing, swallowing, and cuddling these chemical, thereby increasing their exposure (3). Their cognitive ability plays a role in this too. Young children are probably unable to decipher the dangers associated with a particular toy and how it can affect them. They are unlikely to avoid hazards placed directly front of them. Therefore, phthalates are more likely to end up inside a child's body vs. an adult, at levels sufficient to cause harm, or perhaps during a time when even small does can be harmful (3).

Some studies have been able to support the science behind the toxic effects of phthalates. One of them was conducted in Russian where they took 147 workers, 87 women and 60 men, that worked at an artificial leather plant. The duration of employment was between 6 mo and 19 yrs. Beginning in the 6th to 7th year of work, pain, numbness, and spasms of the arms and legs were reported. This was followed by weakness of the extremities. Extensive neurological studies showed a 32 percent rate of polyneuritis among the workers. The women exposed to phthalates were reported to have more menstrual disorders, miscarriages, and reduced gestation and delivery rates compared to control groups (7).

Another study wanted to see if phthalate exposure had a impact on the anogenital distance in young boys. They obtained a standardized measure of AGD from 134 boys, ages 2-36 months. The study found that the associations between male genital development and phthalate exposure were consistent with the phthalate-related syndrome that was previously reported in prenatally exposed rodents. The level of phthalate exposure associated with short AGD was below the exposure of 25% of the U.S. female population, based on a nationwide study. The data supported the hypothesis that prenatal phthalate exposure at environmental levels can adversely affect male reproductive development in humans (13).

Although there have been many studies to support the phthalate toxicities, there is still some speculation. When a substance shows a tendency to be harmful in animals, it is necessary to determine if the results are relevant to humans? Most of the information on phthalate toxicities have been conducted on rats. Is the laboratory environment

congruent with real world situations? The majority of studies that show adverse health effects in rodents are at much higher exposures than would normally be encountered by people. Additionally, they are given at relatively shorter periods of time. Rodents and people are different in many important ways. Giving rodents large doses over various periods of time is not the ideal way to test for effects of small doses over long periods of time on humans. It will, however, offer clues and point out areas for further research. Based on its judgment that the rodent results were not relevant to humans, IARC changed its ranking of DEHP to "not classifiable" as a human carcinogen in 2000. Regulatory agencies in Europe and Canada have reached the same conclusion (8). Our government can't seem to make up its mind on how these chemicals affect us. This alone will cause uncertainty.

Those in favor of the phthalate industry do not believe there are any health concerns, and counter argue their toxicity for several reasons. They feel that concentrations in the environment are too low to have any significant impact on health, even with chronic exposure. They also see a tremendous benefit to risk ratio because plastics have been instrumental in saving so many lives (8). It is undeniable that the use of plastic enhances our every day living, and for many, the removal of plasticizers would not only take away these luxuries, but also have a greater negative impact on the health community than their risk could ever pose.

In evaluating the true risk of phthalates and their metabolites, they can be measured in the blood and urine to confirm recent exposure. In case of monitoring purposes, urine samples are preferred. Considering the lipophilicity of phthalates and its tendency to migrate toward adipose deposits, the best test for previous exposure to plasticizer would be to analyze the fat tissue itself, but this is difficult. There is a general lack of adequate human toxicity or epidemiologic studies to determine whether phthalate exposure is associated with adverse outcomes in humans, despite the compound's high volume production, documented human exposure, and documented adverse effects in animals. The lack of epidemiologic studies is due to several reasons. One, it is difficult to follow the high risk groups, such as premature infants, because of long latent periods between exposures and possible effects. Two, the impacts of phthalate exposure may be subtle, like partial loss of sperm production. Three, there is considerable variability in

the levels of human exposure and therefore it makes it difficult to measure them adequately. Lastly, phthalate exposure is so ubiquitous in the environment and humans are exposed through so many different routes, it's hard to distinguish between exposed and unexposed groups. For these reasons, there have been few studies delineating the exact true risk of these chemicals and more research is needed. Even still, after compiling all the information about phthalates, common sense can be a general guide as to how one might preferably interact with them. (5,6)

The best way to reduce exposure to phthalates is to educate your self on what it is, where to find it, and what the alternatives are. Because the phthalates make the vinyl chloride flexible, you'll want to check for any type of malleable plastic in your home, or fake leather, which is usually termed "plethor." It is simple to call the manufacturer of your clothes or you're child's favorite toy company and ask if they use phthalates.

It is also very important to read the labels on personal care products such as nail and hair care, perfumes, lotions, and deodorants. If these products don't list phthalates, it is still wise to contact the manufacturer to be sure. Many times they do not list them, and there will be no other way to know. If they are present, you can find several other natural cosmetics and hair products. They are generally in natural food stores, but checking the internet is also helpful. Instead of perfumes, pure essential oils are a great alternative, and this can turn into a whole other appreciation.

Drinking water can be another source of phthalates. If it is a community water system, DEHP in particular, is regulated and annual consumer reports are sent to every customer. If the DEHP exceeds the maximal limit, the law requires them to publicize this information. If your water comes from a well, you will not have this benefit, and the water will have to be tested privately (5). Should the water be contaminated with phthalates, buying bottled water is always an option. Of course you will have to call that company and ask the same questions, but a least it is an alternative.

Plastic containers and wraps are full of phthalates. Avoiding them all together and using glass whenever possible is preferable. In the event that you can't, do not microwave in them, as this enhances their release into you food.

In general, the best way to avoid phthalates is to go natural. Choosing natural alternatives to vinyl products will decrease your exposure, and you don't necessarily have

to compromise convenience or usefulness. You can purchase cloth back packs, wood or cork flooring, wooden window frames, paper-covered notebooks, and hemp or linen shower curtains. All of these can be very beautiful and useful products that won't necessarily damage your health.

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