Plastic additives may affect your fertility

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Popular science summary, independent work in biology 2013
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Human being is the creature who have had the most profound impact on nature and its versatile residents; biological life. From the building of roads and channels, that change the geography of nature, to the creation of chemicals with diverse functions, mankind has affected many other organisms and their habitats throughout time. Every year new compounds are identified to affect nature and living organisms through different mechanisms of actions. One of these compounds is bisphenol A, also known as BPA. It is a compound with endocrine-disrupting characteristics, often leading to hormonal imbalance in many organisms. Evidence shows that BPA may be strongly implicated with serious hormonal health problems due to its use in a variety of products, from children's toys to water bottles and also as a coating material in for example food cans. It is cheap and has multifaceted applications making it present practically everywhere in modern everyday life.

What is BPA?

BPA is a common synthetic organic compound that consists of two phenol groups bound by a propane chain. The compound is produced by a reaction between acetone and phenol and is mainly used in the production of polycarbonates and epoxy. The products mentioned are used in the production of food and drink containers, CDs, flooring materials, plastic coating in soda cans and paper cartons as well as dental fillings and in paper rolls used for receipts. Since it is abundant in such a diverse range of products it is very probable that you will come in contact with and be exposed to the compound.

BPA exposure occurs mainly by the intake of canned drinks and food and also through airways via inhalation of air contaminated by the compound. Since we live in a world surrounded by plastics, plastic paint on the walls, plastic flooring etc., is it very likely that dust-particles in such environments contain BPA. An American study found that 50% of all indoor air contained BPA and also that children from low-income families had 40% higher values of BPA in their urine, than children from the middle or high income families. An interesting socioeconomic correlation to the distribution of BPA.

How does BPA act inside our bodies?

BPA is a so called endocrine disruptor, a compound that affects the endocrine system due to its hormone like properties. Such compounds can block or activate hormone receptors that the hormone in question is supposed to bind to. Endocrine-disruptors may cause activation of certain regions of the DNA, therefore is it more probable that changes of its production of protein occur. BPA is structurally similar to the human sex steroid hormone 17β-estradiol (E2) since both are made up of a phenol-group and a OH-group on each end. Because of the similarity is it possible for BPA to bind to E2 receptors, though E2 has a higher affinity to them. BPA is also structurally similar to the thyroid hormone T3 and may inhibit the binding of T3 to thyroid receptors by blocking it. Thus leading to changes in the transcription of

genes.

How does BPA affect us and other organisms?

Since BPA is a common compound it may not only affect us humans, but also many other organisms when it leaks out into rivers, waste systems, lakes etc. The amphibians are a group of animals that may be extra affected by BPA leaking into watersheds. That is because they need water to lay their eggs in and many of them live large parts of their lives in it. They also have semipermeable skin that they use for gas exchange and therefor is it likely to believe that also BPA may diffuse through it. BPA has seen increasing the mortality rate in embryos of the common frog (*Rana temporaria*) when exposed to the compound. Other investigations have been performed on the model organism African clawfrog (*Xenopus laevis*), where the results showed a skewed sex ratio due to BPA exposure. A significantly higher number of females hatched when the eggs were exposed to the compound, thus was a ”feminization” seen in the frog population. In addition to the skewed sex ratio changes in thyroid hormone functions has been observed. Such disturbances were found end up in scoliosis, malformations in the head region of tadpoles as well as a retardation in the development of the nervous system and digestive tract. Changes in the sex ratio have also been recorded in caiman (*Caiman latirostris*), a reptile from the crocodile order. In addition to an increased number of females in eggs exposed to BPA, severe dysfunctionalities of the male reproductive organs were also found, showing that caimans may also be affected.

Effects have been seen in amphibians and reptiles, but also in mammals such as rats, mice and humans. Mice exposed to BPA via their mothers before delivery have as adults an increased risk to breast cancer as well as lowered levels of luteinizing hormone (LH), the hormone that among other things start the ovulation. Female rats exposed to the compound via their mothers before delivery, have also been found to have a higher degree of breast cancer as well as premature puberty. Additionally, mice exposed to BPA have an increased body weight and behavioral changes have been reported in both rats and mice. Such behavioral changes are for example increased activity level, decreased playfulness and a decreased interest for males among the females. Male offspring have been found to have a decrease in sperm production together with an increased fraction of sperm with lowered mobility. Changes in the prostate, in the form of increased size and weight with a decrease in testicular testosterone levels, have also been recorded.

A very disturbing thing is that it has been speculated that the placenta does not work as a barrier for BPA. BPA have been encountered present in the blood of rat fetuses where the mother had been exposed to the compound, thus indicating that BPA can pass the placenta and reach the fetus. BPA has also been encountered in the blood of pregnant women, as well as in the placenta and in blood of the unborn child. Fetuses have been seen to have lower concentrations of an enzyme involved in the metabolism of BPA, thus it is likely that they degrade the compound slower than adults. Another important factor that has to be taken into consideration is that the human liver, where the BPA metabolism occurs, metabolizes BPA less effectively than a rat liver. It is therefore important to take that into consideration, since experiments are conducted on rats and not on humans.

Rules and regulations

Since BPA has been found to have endocrine-disrupting properties, several countries have made regulations to decrease the emission and distribution of the compound. One of the pioneer countries in regulating BPA was Canada, who in September 2010 started regulating the compound by law when it was classified as a possible hazard to the human health as well as to nature. That, together with the prohibition of polycarbonates in baby bottles made Canada one of the first country regulating BPA by law. The European Union followed the example as they on the first day of March 2011 prohibited the production as well as the import and vending of baby bottles which contained BPA. Other countries, such as Australia and Japan have also implemented restrictions in production and usage of products containing the compound.

The European Union have set the acceptable daily intake (ADI) to 0.05 mg BPA/kg/day and the compound is not prohibited in products that are or will be in contact with food or drinks. After new research pointing towards that BPA have a higher impact on humans than previously thought, has the Connecting Europe Facility panel decided to revalue the risks of exposure in food in February 2012. Two groups were then formed, with the aims to investigate how human health is affected, what the human exposure looks like and how the compound should be classified.

What to do about it

It is still allowed for products that contain BPA to be in contact with food products, even though negative effects have been observed in different organisms. Therefore is it important to be aware of the side effects exposure of the compound may give. A recommendation would be to minimize the intake of food and drinks that are ready made or packed in plastic. To buy products in glass jars instead of canned food where it is possible, to avoid eating products that been in contact with it if you are pregnant and in general minimize the intake of BPA for both you and your family.

One thing we must be aware of is the fact that BPA is not the only compound that we are exposed to in our lives. There are several different compounds that have known endocrine-disrupting properties, and there are also compounds that have not yet been investigated thoroughly and thus it is hard to know their long term effects. Therefore it is recommended to try to eat as less processed food as possible, as well as organic food since the organic food contain much less and hopefully no endocrine-disrupting chemicals at all. Another important thing is to keep informed and up to date, to learn about what you are putting into your body when you are eating. Read up on the packages of paint when you are going to paint your house etc. It is very hard to live in an environment that is totally free from foreign compounds such as BPA, but it is possible to minimize the risks of exposure. It is also good to remember nature, try to pollute as little as possible and throw the plastic wrapping from the sweets in the litter-basket. We are not alone on this planet and therefore we should try to care for the other organisms as much as possible.

An important question to ask and to consider, is what is the origin of the information I receive. There are various pro-BPA information sites on the internet, made by plastics companies, ensuring that their product is not dangerous. There are suspicions that researches that have received grants from the plastics industry often show more less negative effects

from the compound in their research. Therefore is it important that objective and independent researchers have the possibility and monetary means to conduct their research and get non-bias results.

Further reading:

Bergström L. 2013. Hotet mot vår reproduktion - Bisfenol A. Independent Project in Biology. Uppsala University.