BISPHENOL A AND ITS EFFECT ON HUMAN HEALTH: A REVIEW

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ABSTRACT

Bisphenol A (BPA) is an industrial chemical produced in large quantities for use primarily in the production of polycarbonate plastics and epoxy resins, thermal paper, BPA-based products include DVDs, computers, home appliances, spectacles and optical lenses, reusable water bottles, food storage containers, sports safety equipment, medical equipment, construction materials, paints and coatings. BPA contamination may occur from many different sources, but the most common way of BPA contamination is through packaged foods or beverages where the packing material contains BPA human exposure to BPA may arise through BPA leaching from these materials into foods. Over the past few years, considerable scientific evidence indicates that there have been many issues raised all over the world on the use of BPA. BPA is known to possess estrogenic activities; hence, it mimics the role of estrogen once it enters in to living systems. Therefore BPA belongs to a group of chemicals termed “Hormone disruptors” or “Endocrine disruptors”. It can cause damage to reproductive organs, thyroid gland, urino-genital abnormalities in male babies, a decline in semen quality in men, early onset of puberty in girls, metabolic disorders including insulin resistant (type 2) diabetes and obesity, neurobehavioral problems, and most recently it has also been linked to cancer development in humans. Here, in this review, we aim to summarize various effects of BPA on human health.

KEY WORDS: Bisphenol A, BPA-based products, Endocrine disruptors.

INTRODUCTION

Bisphenol A (BPA) is the molecular building block for polycarbonate plastics and epoxy resins. U.S. production of BPA grew rapidly from 16 million pounds in 1991 to about 2.3 billion pounds in 2004, making it one of the most produced chemicals in the world [3]. BPA is a chemical recorded in the CAS (Chemical Abstract Service), number 00080-05-7 and its
chemical name as used in Europe is 2, 2-Bis (4-hydroxyphenyl) propane \(^{[23, 38]}\). There are a large number of synonyms to BPA like Bis(4-hydroxyphenyl)dimethyl methane; 4,4'-dihydroxydiphenyl propane; 4,4'-dihydroxy-2,2-diphenyl propane; Diphenylolepropene; 4,4'-isopropylidenediphenol. BPA is produced by the condensation of phenol and acetone in the presence of catalysts and catalyst promoters, it is completely soluble in organic solvents and partially soluble in water. It exists at room temperature in the form of a white solid flake or crystal \(^{[25, 39]}\).

### Table No.1: Chemical Properties

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formula</td>
<td>( \text{C}<em>{15}\text{H}</em>{16}\text{O}_2 ) or ((\text{CH}_3)_2\text{C(C}_6\text{H}_4\text{OH})_2)</td>
</tr>
<tr>
<td>Molecular Weight</td>
<td>228.29 g/mol</td>
</tr>
<tr>
<td>Boiling Point</td>
<td>220 deg C (at 4 mm Hg)</td>
</tr>
<tr>
<td>Melting Point</td>
<td>150-155 deg C (solidification range)</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.195 at ((25 / 25\text{°C}))</td>
</tr>
<tr>
<td>Octanol/Water Partition Coefficient</td>
<td>(\log K_{ow} = 3.32)</td>
</tr>
<tr>
<td>Water Solubility</td>
<td>(&lt;1 \text{ mg/mL at 21.5°C})</td>
</tr>
<tr>
<td>Vapor Pressure</td>
<td>(3.91 \times 10^{-7} \text{ mm Hg at 25 deg C})</td>
</tr>
<tr>
<td>Henry’s Law Constant</td>
<td>(1.0 \times 10 \text{ atm-cu m/mol at 25°C})</td>
</tr>
<tr>
<td>Color/Form</td>
<td>White crystals or flakes</td>
</tr>
<tr>
<td>Odor</td>
<td>Mild phenolic odor</td>
</tr>
<tr>
<td>Decomposition temperature</td>
<td>(&gt; 200\text{°C (392°F)})</td>
</tr>
</tbody>
</table>

Fig. 1: Chemical Structure of Bisphenol A

### BPA Uses

As BPA is one of the highest volume chemicals produced worldwide, with over 6 million pounds produced each year \(^{[3, 45]}\) BPA has been used in a wide variety of consumer products for several decades and continues to be manufactured in large quantities around the world. Humans are exposed to BPA through consumption of food and beverages contaminated with BPA, as well as environmental contamination. Polycarbonate plastic can become unstable
over time and with use, allowing BPA to leach into material in contact with the plastics. Other consumer items, such as carbonless paper, computers, home appliances, spectacles and optical lenses, reusable water bottles, food storage containers, sports safety equipment, medical equipment, construction materials, paints, coatings and DVDs, compact disks, sports safety equipment, toys, water pipes food can linings, thermal (fax) paper, safety helmets, bullet resistant laminate, plastic windows, car parts, adhesives, protective coatings, powder paints, polycarbonate bottles and containers (including returnable milk and water bottles) and the sheathing of electrical and electronic parts. BPA is now found nearly everywhere in the environment and commonly found in dust particles, surface water and drinking water. These uses result in consumer exposure to BPA via the diet. There are many reports on the contamination of BPA in the environment especially in water air and soil. Residues of BPA are also found in wastewater effluents. Production of BPA releases approximately two hundred thousand pounds of the chemical into the atmosphere annually.

**Human Exposure to BPA**

Human exposure can arise from a number of sources, particularly from the direct contact of food with BPA containing plastics. BPA leaching from the plastic material used to line food and drink cans has received particular attention. Other exposure routes that are a focus of attention include BPA leaching from baby feeding bottles, and BPA related compounds leaching from polycarbonate plastic bottles, microwave plastic containers, plastic wraps, paper towels, dental fillings, sealants and other minor sources of consumer exposure to BPA are epoxy-based surface coatings, adhesives, printing inks and thermal paper. According to the researchers BPA has been found in humans Brest milk, blood, urine and tissues.

**BPA Effects on human health**

BPA is found to rise multiple diseases including prostate and breast cancer, urino-genital abnormalities in male babies, a decline in semen quality in men, early onset of puberty in girls, metabolic disorders including insulin resistant (type 2) diabetes and obesity, neurobehavioral problems such as attention deficit hyperactivity disorder (ADHD) and bisphenol-A also can change endogenous hormone synthesis, hormone metabolism and hormone concentrations in blood.
BPA is classified as a xenobiotic disturbing hormonal balance in humans and other animals and it is an endocrine disruptor [20, 4, 41] The exposure during early development to xenoestrogens such as BPA may be the underlying cause of the increased incidence of infertility, genital tract abnormalities, and breast cancer observed in European and US human populations [21]. Numerous toxicological and biochemical studies have confirmed that BPA has estrogenic properties and an agonistic effect towards the estrogenic receptor [47]. The U.S. Food and Drug Administration (FDA) and the National Toxicology Program (NTP) have “some concern” for effects on the brain, behavior, and prostate gland in fetuses, infants, and children at current human exposures to BPA. Number of studies has examined BPA levels in other body fluids such as follicular fluid [12, 43, 44], urine [5] and semen [13, 15]. BPA is found in milk due to contact with plastic materials during food processing and storage [6, 49]. The Scientific Committee on Food (SCF), an advisory body of the European Commission on the safety of food, after comprehensive analysis of all aspects of BPA toxicity, has specified the tolerable daily intake (TDI) of BPA as 0.01 mg/ kg body mass per day [8]. Recent studies have shown that BPA can alter the gene expression (i.e. turned on or off) and the low-dose BPA exposure during pregnancy has multigenerational consequences and it may increase the likelihood of chromosomal abnormalities in F2 generation [26, 40]. Since BPA is acting as xenoestrogen its usage should be limited in consumer products and especially the usage in child care products should be restricted. As there is a controversy and public concern in the use of BPA in consumer products as it causes hazardous health effects, hence methods should be developed for production of alternate compounds.
CONCLUSION
The scientific literature published shows that BPA has various types of adverse effects on human health and Endocrine disrupting properties. BPA also causes human and environmental toxicity and scientists suggest a need to have a potential change in the perception. For the safe removal of BPA from environment, the regulatory community towards recognizing the fate of the BPA exposure and so many researches are required to evolve methods for its disposal.

REFERENCES


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