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Exposure to Bisphenol-A Through Excess Use of Polymer, With Environmental Toxicity

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ABSTRACT

Technology and new synthesis of new materials and their extreme applications and their adverse effects are worldwide, in recent scenario. This study tells us about the use of different polymers and their effect on environment. Due to the large number of applications of bisphenol-A (BPA), the human exposure routes are multiple. The study aimed to review shortly the food and non-food sources of BPA, and to evaluate their contribution to the human exposure. Food sources discussed here include epoxy resins, polycarbonate and other applications, such as paperboard and polyvinylchloride materials. Based on the available data for these exposure sources, it was concluded that the exposure to BPA is harmful to human and environment.

Keywords : Polycarbonates, Epoxy, Epoxyphenolic, Polysulphone, Flame retardants, Cancer, Endocrine disrupting chemical, Immune Effects, Obesity.

I. INTRODUCTION

Bisphenol A (BPA) is a carbon based hydroxyphenol compound with the chemical formula $(CH_3)_2C(C_6H_4OH)_2$ belonging to the group of diphenylmethane derivatives. Bisphenol A (BPA) is the common name for 2,2-(4,4′-dihydroxydiphenyl) propane, 4,4′-isopropyllidenediphenol, alternatively, 2,2′-bis(4-hydroxyphenyl) propane, an organic compound with two phenol moieties(Fig-1). It is a colourless amorphous solid that is soluble in organic solvents, but poorly soluble in water.Its important properties include low vapor pressure, moderate water solubility, and low volatility. It is a solid at room temperature.[1]

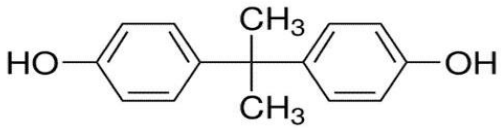

Figure 1 : Structure of Bisphenol - A

Bisphenol A was first synthesized from the condensation of acetone with two equivalents of phenol by the Russian chemist A P Dianin in 1891 . The reaction was catalyzed by either hydrochloric acid or a sulphonated polystyrene resin. However, commercially BPA is extracted from many resinous byproducts under high vacuum or solvent-based extraction using additional phenol followed by distillation.

II. METHODS AND MATERIAL

Physical and Chemical Charecterisation

vapour pressure [4]	5.3 □□10−6 Pa at 25 °C
density [5]	1.195 kg/dm3 at 25 °C
melting point [2,4]	150–158 °C
boiling point [2,4]	360–398 °C
low solubility [3,4]	120–300 mg/L in water at 25 °C,
pKa value [5]	between 9.59 and 11.30

Potential Sources of Exposure Of Bisphenol-A

Bisphenol A (BPA) (CAS number 80-05-7). More than 6 billion pounds of BPA are produced globally annually.[6] Bisphenol A (BPA) is an industrial chemical that is widely used as a monomer or additive for the manufacture of polycarbonate (PC) plastics and epoxy resins and other polymeric materials and also certain paper products (e.g. thermal paper).

Polycarbonates: PCs are a group of thermoplastic polymers produced by the condensation polymerisation reaction of BPA and carbonyl chloride or by melt-transesterification reaction between BPA and diphenylcarbonate. The production of PC is the main use for BPA.The properties of PC, e.g. rigidity, transparency and resistance, make these plastics particularly suitable for many technical applications.[7] Polycarbonate plastics have many applications including use in some food and drink packaging such as water and baby bottles, tableware (plates and mugs), microwave ovenware and reservoirs for water dispensers, and non-food applications such as toys and pacifiers with PC shields, compact discs, impact-resistant safety equipment, and medical devices including those used in hospital settings.[8]

Epoxy resins: Epoxy resins are thermosetting polymers are produced by the reaction of BPA with BPA diglycidyl ether (commonly abbreviated to BADGE, made from BPA and epichlorohydrin), that have good mechanical properties, as well as high temperature and chemical resistance. As such, these resins have a wide range of applications, including use as coatings applied to metal substrates in food contact materials, in dental fillings, in electronics/electrical components, in high-tension electrical insulators, in fibre-reinforced plastic materials, in structural adhesives and in the relining of aged water pipes.[9,10] BPA can also be found in certain thermal paper products, including some cash register and ATM receipts.[11]. Some dental sealants and composites may also contribute to BPA exposure.

Epoxyphenolic resins: BPA-based epoxyphenolic resins are used as protective linings for food and beverage cans and as a coating on residential drinking water storage tanks. BPA is also used in a number of non-food-related applications, e.g. epoxy resin-based paints, medical devices, surface coatings, printing inks, thermal paper and flame retardants and also in plastic materials such as CDs, DVDs and parts of electronic products.[12]

Polysulphone resins : Polysulphone resins are made by condensation of the disodium salt of BPA with 4,4-dichlorodiphenyl sulphone. They exhibit thermal stability, toughness, transparency and resistance to degradation by moisture. They are used in electrical components, appliances, transport, medical equipment, pumps, valves and pipes.[13]

Flame retardants :BPA may be used in the production of two flame retardants, tetrabromobisphenol A (TBBPA) and BPA bis(diphenyl phosphate) .TBBPA is used to impart flame resistance to epoxy resins used in printed circuit boards, to PC, to ABS resins and, to a lesser extent, to unsaturated polyester resins and other engineering thermoplastics.[14].

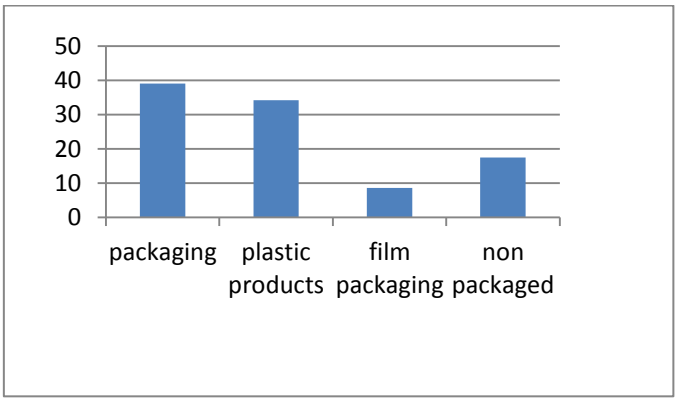

Figure 2. Percentile Usage of BPA

III. RESULTS AND DISCUSSION

Exposure Estimations

For each source of exposure (dietary; non-dietary oral, inhalation and dermal) and in each age group(infants (0–1 year), toddlers (1–3 years), children (3–10 years), adolescents (10–18 years), women(18–45 years), men (18–45 years), other adults (45–65 years), elderly and very elderly (over 65 years)(EFSA, 2011), a scenario for average exposure and a scenario for high exposure was developed.Average exposures from the different sources have been added together by route to assess average exposure. High exposures from the different sources have been added together by route to assess high exposure. In order to quantify the relative impact of each source, the assumptions made in the exposure assessments aimed to obtain a similar degree of conservativeness among the different sources.

Health Hazards and Toxicity

Cancer Levels of bisphenol A (BPA) in men's urine could be a marker of prostate cancer, and low levels of BPA exposure can cause cellular changes in both non-malignant and malignant prostate cells. This research

provides the first evidence that urinary BPA levels may help predict prostate cancer and that disruption of a cell duplication cycle through exposure to low-dose BPA may cause cancer development in the prostate. BPA, an environmental pollutant with estrogen activity, is used to make hard, clear plastic and is common in many food product containers.[15]

Endocrine disrupting chemical Bisphenol A is an endocrine disruptor - a substance which interferes with the production, secretion, transport, action, function and elimination of natural hormones. BPA can imitate our body's own hormones in a way that could be hazardous for health. Babies and young children are said to be especially sensitive to the effects of BPA.[16]

Immune Effects Industrial chemical bisphenol A (BPA) is a prevalent EDC in human products and environments.[17] The extensive use of BPA-containing products has resulted in high human exposure worldwide, with studies reporting that more than 90 percent of the US population has detectable levels in urine samples. It appears that increased temperature leaches BPA into food and water products as does acidic pH of liquids . BPA exposure leads to human immune dysfunction, potentially increasing its role in induced autoimmunity through immune dysregulation. BPA injected into mussels leads to significant lysosomal membrane destabilization and a dramatic decrease in phosphorylation of the stress-activated p38 mitogen-activated protein kinases (MAPKs) and CREB-like transcription factor (CAMP-responsive element-binding protein) in mussels.[18]

Obesity While improving dietary habits and increasing physical activity have been the focus in reducing obesity, the rapid increase in the prevalence of obesity/overweight in countries with differing dietary styles and patterns of physical activity suggests the possible existence of other environmental risk factors. Humans are widely exposed to BPA and animal studies have linked BPA to obesity.[19] Bisphenol-A (BPA) is a potential endocrine disruptor impacting metabolic processes and increasing the risk of obesity.[20]

IV. CONCLUSION

It has been found that BPA has the potential to have a wide range of health effects on humans and other organisms, especially involving reproductive health. There is still a lot of research to be done to determine what levels of BPA are safe for adults, children, and animals as well as the environment. Research also needs to be done on how to best detect and remove BPA from everyday products, especially related to food packaging and preparation. Lastly, it is important to find the best method to remove BPA from the environment.

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