Chapter 14
Bisphenol A and Phthalates Exhibit Similar Toxicogenomics and Health Effects

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ABSTRACT

Bisphenol A and phthalates are most frequently detected organic pollutants found in our surroundings because of their regular use as plasticizers in daily use polymeric products. BPA is used in manufacturing baby feeding bottles, water pipes, canned food linings, and food packaging materials. Phthalates are used in polyvinyl chloride products including clothing, toys, medical devices, and food packaging. These chemicals are not bound to the matrix and leach out into the surroundings on slight change in the environment, like alteration in pH, temperature, and pressure. Humans are continuously exposed to these chemicals through skin contact, inhalation, or ingestion when the leachates enter food, drinks, air, water, or soil. The Comparative Toxicogenomics Database (CTD) revealed that Bisphenol A has 1932 interactions with genes/proteins and few frequently used phthalates (DEHP, MEHP, DBP, BBP, and MBP) showed 484 gene/protein interactions. Similar toxicogenomics and adverse effects of Bisphenol A and phthalates on human health are attributed to their 89 common interacting genes/proteins.

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INTRODUCTION

Plastic Pollution

Plastics, being essential materials in modern civilization, are used widely, almost everywhere in the world. Plastics and many products manufactured from them promote risks to human health and environment (Thompson et al., 2009). Plastics contain many hazardous substances including Bisphenol A, pthalates, brominated flame retardants and poly-fluorinated chemicals, etc. that causes various human health issues like respiratory problems, liver dysfunction, vision failure, skin diseases, cancers, lungs problems, dizziness, headache, reproductive problems, birth defects, cardiovascular and gastrointestinal troubles (Proshad et al.,2018). BPA and phthalates are found in many widely used products including medical devices, perfumes, flooring materials, food packaging, toys, cosmetics, computers and CDs and hence, represent a considerable component of plastic (Meeker &Ferguson, 2012).

Bisphenol A

Bisphenol A (BPA, 2,2-bis (4-hydroxyphenyl)propane) is a monomer that was developed in 1890s as a synthetic estrogen. Later in 1930s, it was reported to have stimulatory effects on the female reproductive system of rats as that of estrone (Dodds, 1936). BPA has also been used in various consumer products, like polycarbonate plastic, PVC, dental sealants and food packaging. Humans are usually exposed to BPA through via their diet, inhalation and dermal route (Vandenberg et al., 2012). In 2008, it was estimated that 2.8 million metric tons of BPA were produced and subsequently 5.5 million metric tons were expected in 2011 (Bailin et al., 2008). BPA is an identified endocrine disruptor as it binds to estrogen receptors and hence produces estrogenic effects. Although BPA has a lower affinity for nuclear estrogen receptors as compared to 17-beta estradiol (E2) (Figure 1A), its estrogenic strength is equal to that of E2 for responses that are mediated by non-nuclear estrogen receptor (Vinas et al., 2012). BPA can also act as an anti-estrogen by blocking the estrogenic response while competing with endogenous estradiol (Richter et al., 2007; Bonefeld-Jorgensen et al., 2007). BPA directly bind to androgen receptors, and hence, possibly acts as anti-androgenic by blocking the endogenous androgen activity (Sohoni et al., 1998; Wetherill et al., 2007). BPA has also been found to bind thyroid receptors possessing both agonistic and antagonistic effects on thyroid function (Moriyama et al., 2002). BPA also interacts with CNS, pancreas and immune system (Wetherill et al., 2007). Various *in vitro*, *in vivo* and epidemiologic studies have shown that BPA is associated with several diseases, including coronary heart disease (Melzer et al., 2010), cardiovascular disease (Magliano and Lyons, 2013), diabetes (Shankar and Teppala, 2011) and obesity (Wang et al., 2012). It has also been employed as a model for determining the low dose and non-monotonic nature of hormones that regulate our endocrine system (Vandenberg et al., 2012). BPA has been reported to have significant effects at low doses, which may not be present at higher doses used in toxicology studies (Vandenberg et al., 2012). Since most of us are exposed to low doses of BPA regularly, it becomes necessary to determine the health effects of BPA on humans. There are ample studies that link BPA with various adverse health effects in mammalian and non-mammalian models (Richter et al., 2007; Bonefeld-Jorgensen et al., 2007; Saal et al., 2007; Crain et al., 2007). The results are obviously worrying as humans are ubiquitously exposed to BPA. The exposure to BPA starts