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IN THIS ISSUE

EDITORIAL

Plastic word comes from the Greek *plassein*, which means "to mold or shape". The material has deeply penetrated in almost all sphere of our life through various utility products. Plastics are typically organic polymers with high molecular mass and many times contain synthetic chemicals derived from petrochemicals to improve the performance and reduction in production cost. These additives include fire retardants to low the flammability of the materials or inert/ inexpensive materials as fillers to reduce the per unit weight cost. The amount of these additives ranges from 0 - 50% depends on the usages. In many cases, plastics additives are responsible for their toxicity, such as, adipates and phthalates that are often added to brittle plastics like PVC to make them pliable enough to used for food packaging, toys etc. Many of these additives leach out into the product and causes toxicity. European Union has already restricted the use of DEHP (di-2-ethaylhexyl phthalate) for its potential as an endocrine disruptor. Some of the additives leaching from polystyrene food containers were identified as human carcinogens in many experimental studies. World Health Organization's International Agency for Research on Cancer (IARC) has recognized vinyl chloride as human carcinogen which is the precursor of PVC. Bisphenol A (BPA), a primary building block of polycarbonates was identified as an estrogen-like endocrine disruptor. Many animal studies suggest that even low level exposure of BPA results in insulin resistance and can lead to inflammation and other heart diseases. Besides toxicity, plastics are posing serious problem on the environment due to their very slow degradation. Most of the city sites have heaps of polythene bags piled up and choking drains and sewer systems. Burning of plastic products at low temperature normally releases many toxic fumes. Recycling of the plastic material is also a challenge and require greater processing in comparison to glass and other metal. Health advocates recommend not reusing bottles made from plastic #1 (PET or PETE) generally used in disposable water, soda and juice bottles. These bottles generally safe for one time use as reusing may leach DHEP and other toxic chemicals. Reusing of plastic #3 (PVC) bottles can leach hormone-disrupting chemicals in to the liquid stored and also other synthetic carcinogens into the environment when incinerated. However, plastic #2, plastic #4 and plastic #5 bottles are comparatively safe for the reuse. It is very important to develop the awareness among the common masses for the proper use of plastic materials. The current newsletter highlights the toxic additives used in the plastics, the grading system of plastic materials for their proper use and also the mini toxicity profile of Bisphenol A.

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ENVIRONMENTAL AND HEALTH HAZARDS DUE TO PLASTIC ADDITIVES

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Plastic and polymeric materials are wide range of synthetic, semi-synthetic or natural organic solids that are moldable. Plastics are organic polymers of high molecular mass, but they often contain other substances. They are usually synthetic, most commonly derived from petrochemicals, and are partially natural. They are classified by their chemical structure of the polymer's backbone and side chains viz. acrylics, polyesters, silicones, polyurethanes, and halogenated plastics. Plastics may be classified by the chemical process used in their synthesis, such as condensation, polyaddition, and cross-linking.

Plastics contain several additives depending upon the composition, intended usage and tailor made requirements/specifications. These are organic or inorganic compounds blended into it to serve as plasticizer (Phthalates), stabilizer (organotin compounds), colorants (inorganic salts and dyes etc), flame retarders (PBDE, organo-phosphorous compounds and other new chemical entities) for increasing flame resistance at normal temperatures, fillers etc. The amount of additives ranges from zero percentage for polymers used to wrap foods to more than 50% for certain electronic applications. They are active ingredients of electronic waste materials i.e. e-waste. The average content of additives is 20- 25 % by weight of the polymer. Flame retardants may act at any of the steps involved in the combustion process depending on the mode of action. Flame retardants are designed to prevent the spread of fire and have thereby helped to save many lives while also dramatically reducing the economic impact of fires. However, flame retardants, particularly the class known as Polybrominated diphenyl ethers (PBDE's), may be contributing to the rising prevalence of developmental disabilities due to their widespread use and physiologically active properties including direct neurotoxicity and endocrine disruption. Environmental Protection Agency (EPA) noted that PBDEs are particularly toxic to the developing brains of animals and are similar to PCBs. There are over 209 different PBDE compounds, and the three most common commercial formulations are deca, penta and octa depending on the number of bromine atoms. Efforts are being taken worldwide to prepare new additives which are cost effective and environmental friendly.

PBDEs are comparatively more degradable than other persistent chemicals due to their weak carbon-bromine bond and are a matter of concern. They may degrade to smaller moieties and persist in environment. PBDEs enter the air, water, and soil when they are put into products or when they exit products as a result of degradation. They are now known to be ubiquitous in the environment and may biomagnified under exposure to biodiversity and organisms in turn. Biomagnifications refers to the accumulation of toxins through the trophic levels of a food chain which results in an increased concentration of the toxin in the higher organisms of the food chain.

Polybrominated diphenyl ethers [PBDEs] are organobromine compounds which are used as flame retardants. Brominated are used in wide array of products ranging from building materials, furnishings, motor vehicles, airplanes, electrical equipments and accessories, foams and/or textiles. They are quite similar to the PCBs and polyhalogenated compounds. PBDEs are classified according to the average number of bromine atoms in the molecule. The health hazards of these chemicals have attracted increasing scrutiny, and they have been shown to reduce fertility in humans at levels found in households. Their chlorine analogs are polychlorinated diphenyl ethers. Due to their toxicity, persistence industrial production needs to be restricted as a step to phase out major persistent organic pollutants (POPs). The photolysis, pyrolysis and bioaccumulation studies may be of interest in understanding the transformation of PBDEs. The humans are exposed to low levels of PBDEs through ingestion; inhalation and it may reveal bioaccumulation in blood, breast milk or tissues besides being its presence in dust, sewage sludge or effluents. The animal studies reveal behavioral changes on exposure to PBDEs, and neurological implications. The incineration of polymer and their composites release toxic gases on combustion.

Some commonly used products that have been treated with potentially toxic flame retardants

There is a vital need to investigate exposure to Polybrominated diphenyl ethers (PBDEs) or metabolites in urban population groups in the developing and underdeveloped countries. The prime focus may be on

potentially highly exposed children working informally as scrap scavengers at different municipal waste disposal sites located at the outskirts of the city under varied geographical locations and comparing with data of developed countries, if feasible. Although regulatory authorities, R & D institutions and NGOs are emphasizing on these aspects but more concerted efforts are needed through different sectors of the society.

RESEARCH HIGHLIGHTS

Higher Urinary Levels of Commonly Used Plastic Compound, BPA, Linked To Cardiovascular Disease, Diabetes

Plastics come in all sorts of shapes and colors to make our lives easier and more convenient, containing certain substances that improve their performance and also makes them less expensive. In general we are told that plastics have a low profile of toxicity due to its properties, for example water and relative chemical inertness. What we are usually not told is that plastics contain additional toxic substances bisphenol A (BPA) used to strengthen some plastics and phthalates used to soften others-which at small concentrations cause a lot of problems.BPA is found in baby and water bottles, can linings, laboratory flasks, plastic food containers, dental sealants, CD cases, eye glasses, soft drinks, and thousands of other household products. It is a “high production” chemical that is also used in plastic and epoxy resins. Phthalates are found in children's toys, vinyl shower curtains, salad dressings, cooking oil bottles, medical devices, building materials, personal-care products, food packaging, pharmaceuticals materials, some medication coatings such as -theophylline (for asthma and lung disease medication), omeprazole (an ulcer treatment), mesalamine (used to treat colitis)-and cleaning materials.

These chemicals are found everywhere in the environment and they enter our bodies through food, water, bits of household dust we consume, or they are absorbed through the skin. Eventually they get stored in fat cells making us unable to get rid of them. According to a Centers for Disease Control (CDC) study, BPA was found in the urine of 95% of the people tested and another study found that most newborns (9 out of 10) were born with BPA in their systems. Also when researchers examined the water of the Pacific Ocean they found it contained 6 times as much plastic as plankton by weight.

[Science Daily (Sep. 16, 2008) http://www.sciencedaily.com/releases/2008/09/080916100942.htm]

Receptor and Nonreceptor-Mediated Organ-Specific Toxicity of Di(2-ethylhexy1)phthalate (DEHP) in Peroxisome Proli fera tor- Activated Recep tora-Null Mice

The peroxisome proliferator-activated reccptora (PPARa) is the mediator of the biological effects of pcroxisome proliferators through control of gene transcription. To determine if the toxic effects of di(2-ethylhexy1)phthalate (DEHP) are mediated by PPARa, we examined its effect in PPARa-null micc. Male Sv1129 mice. PPARa-null (-/-) or wild-typc *(+/+)* were fed *nd libirirrn* either a control diet or one containing 12.000 ppm DEHP for up to 24 wk. Significant body weight loss and high mortality was observcd in (+/+) mice fed DEHP. By 16 wk, all DEHP-fed *(+/+)* mice had died of cystic renal tubular disease. In contrast, the (-/-) mice fed DEHP had no changes in body weight until later in the study nor increased mortality. Histologically, (+/+) mice fed DEHP had typical toxic lesions in liver, kidney, and testis while (-/-) mice fed DEHP had no toxic liver lcsions but did show cvidence of toxicity in kidney and testis after 4-8 wk of feeding, which progressed into moderate lesions by 24 wk. Analysis of hepatic and renal mRNAs showed a typical pleiotropic response in gene expression in the DEHP-fed (+/+) mice that was absent in the DEHP-fed *(-1-)* mice. These results provide evidence that PPARa mediates the subacute-chronic toxicity of DEHP in liver, kidney, and testis. However, because (-/-) mice did develop toxic lesions in kidney and testis. DEHP can also act through PPARa-independcnt pathways in mediating renal and testicular toxicity.

[TOXICOLOGIC PATHOLOGY 1998 Jun 12; 26(2): 240-246]

Di(2-ethylhexyl)phthalate (DEHP): human metabolism and internal exposure – an update and latest results

Di(2-ethylhexyl)phthalate (DEHP) is a reproductive and developmental toxicant in animals and a suspected endocrine modulator in humans. There is widespread exposure to DEHP in the general population. Patients can be additionally exposed through DEHP-containing medical devices. Toxicokinetic and metabolic knowledge on DEHP in humans is vital not only for the toxicological evaluation of DEHP but also for exposure assessments based on human biomonitoring data. Secondary oxidized DEHP metabolites like mono-(2-ethyl-5-hydroxyhexyl) phthalate (5OH-MEHP), mono-(2-ethyl-5-oxohexyl) phthalate (5oxo-MEHP), mono-(2-ethyl-5-carboxypentyl) phthalate (5cx-MEPP) and mono-[2-(carboxymethyl) hexyl] phthalate (2cx-MMHP) are most valuable biomarkers of DEHP exposure. They represent the major share of DEHP metabolites excreted in urine (about 70% for these four oxidized metabolites vs. about 6% for MEHP); they are immune to external contamination and possibly the ultimate developmental toxicants. Long half-times of elimination make 5cx-MEPP and 2cx-MMHP excellent parameters to measure the time-weighted body burden to DEHP. 5OH-MEHP and 5oxo-MEHP more reflect the short-term exposure. We calculated the daily DEHP intake for the general population (n = 85) and for children (n = 254). Children were significantly higher exposed to DEHP than adults. Exposures at the 95th percentile (21 and 25 μg/kg/day, respectively) scooped out limit values like the Reference Dose (RfD, 20 μg/kg/day) and the Tolerable Daily Intake (TDI, 20–48 μg/kg/day) to a considerable degree. Up to 20-fold oversteppings for some children give cause for concern. We also detected significant DEHP exposures for voluntary platelet donors (n = 12, 38 μg/kg/apheresis, dual-needle technique). Premature neonates (n = 45) were exposed to DEHP up to 100 times above the limit values depending on the intensity of medical care (median: 42 μg/kg/day; 95th percentile: 1780 μg/kg/day)

[International Journal of Andrology 2006 FEB 7; 29(1):155–165]

Phytotoxicity of Phthalate Plasticisers

The toxicity caused by a volatile constituent from certain samples of flexible polyvinyl chloride (PVC) was due to dibutyl or diisobutyl phthalate (DBP or DIBP) plasticisers. It has caused serious financial losses in the horticultural industry. The two phthalate esters have low volatilities, so any toxicity lasts for many years. Radish (*Raphanus sativus* L. cv. Cherry Belle) seedlings, exposed to an air stream containing 160–180 ng dm^{-3} of butyl phthalates developed chlorotic leaves within 3–4 d and died within 12 d. Neither dioctyl nor diisodecyl phthalate (DOP nor DIDP) produced damage in the test plants. Measurements of photosynthetic and respiratory gas exchange in intact shoots of affected radishes showed that photosynthesis was severely inhibited whilst respiration was virtually unaffected. Electron micrographs of sections from young leaves showed disruption of thylakoid formation and granai stacking. In mature leaves, thylakoids and grana were well formed but chloroplasts were swollen and the thylakoids were pushed towards the vacuolar side of the chloroplast. Sensitivity to toxic phthalates varies between species; all members of the Cruciferae tested were susceptible, tomato less so, and lettuce and ryegrass were resistant. Toxicity of DIBP, from PVC glazing strip, caused a reduction in crop value of £20 000 per acre per year in commercially grown, monocrop tomatoes.

[Journal of Experimental Botany 1985 Oct 16; 37(6):883-897]

Cationic Polystyrene Nanosphere Toxicity Depends on Cell-Specific Endocytic and Mitochondrial Injury Pathways

The exponential increase in the number of new nanomaterials that are being produced increases the likelihood of adverse biological effects in humans and the environment. In this study we compared the effects of cationic nanoparticles in five different cell lines that represent portal-of-entry or systemic cellular targets for engineered nanoparticles. Although 60 nm NH2-labeled polystyrene (PS) nanospheres were highly toxic in macrophage (RAW 264.7) and epithelial (BEAS-2B) cells, human microvascular endothelial (HMEC), hepatoma (HEPA-1), and pheochromocytoma (PC-12) cells were relatively resistant to particle injury. While the death pathway in RAW 264.7 cells involves caspase activation, the cytotoxic response in BEAS-2B cells is more necrotic in nature. Using fluorescent-labeled NH2-PS, we followed the routes of particle uptake. Confocal microscopy showed that the cationic particles entered a LAMP-1 positive lysosomal compartment in RAW 264.7 cells from where the particles could escape by lysosomal rupture. A proton pump inhibitor interfered in this pathway.Subsequent deposition of the particles in the cytosol induced an increase in mitochondrial Ca2_ uptake and cell death that could be suppressed by cyclosporin A (CsA). In contrast, NH2-PS toxicity in BEAS-2B cells did not involve the LAMP-1 endosomal compartment, stimulation of proton pump activity, or an increase in mitochondrial Ca^{2+}. Particles were taken up by caveolae, and their toxicity could be disrupted by cholesterol extraction from the surface membrane. Although the particles induced mitochondrial damage and ATP depletion, CsA did not affect cytotoxicity. Cationic particles were taken up into HEPA-1, HMEC, and PC-12 cells, but this did not lead to lysosomal permeabilization, increased Ca2_ flux, or mitochondrial damage. Taken together, the results of this study demonstrate the importance of cell-specific uptake mechanisms and pathways that could lead to sensitivity or resistance to cationic particle toxicity.

[ACS Nano 2008 Dec 27; 2(1): 85–96]

Chronic toxicity/oncogenicity study of styrene in cd-1 mice by inhalation exposure for 104 weeks

Groups of 70 male and 70 female Charles River CD-1 mice were exposed whole body to styrene vapor at 0, 20, 40, 80 or 160 ppm 6 h per day 5 days per week for 98 weeks (females) or 104 weeks (males). The mice were observed daily; body weights, food and water consumption were measured periodically, a battery of hematological and clinical pathology examinations were conducted at weeks 13, 26, 52, 78 and 98 (females)/104 (males). Ten mice of each gender per group were pre-selected for necropsy after 52 and 78 weeks of exposure and the survivors of the remaining 50 of each gender per group were necropsied after 98 or 104 weeks. An extensive set of organs from the control and high-exposure mice were examined histopathologically, whereas target organs, gross lesions and all masses were examined in all other groups.

Styrene had no effect on survival in males. Two high-dose females died (acute liver toxicity) during the first 2 weeks; the remaining exposed females had a slightly higher survival than control mice. Levels of styrene and styrene oxide (SO) in the blood at the end of a 6 h exposure during week 74 were proportional to exposure concentration, except that at 20 ppm the SO level was below the limit of detection. There were no changes of toxicological significance in hematology, clinical chemistry, urinalysis or organ weights. Mice exposed to 80 or 160 ppm gained slightly less weight than the controls. Styrene-related non-neoplastic histopathological changes were found only in the nasal passages and lungs. In the nasal passages of males and females at all exposure concentrations, the changes included respiratory metaplasia of the olfactory epithelium with changes in the underlying Bowman's gland; the severity increased with styrene concentration and duration of exposure. Loss of olfactory nerve fibers was seen in mice exposed to 40, 80 or 160 ppm. In the lungs, there was decreased eosinophilia of Clara cells in the terminal bronchioles and bronchiolar epithelial hyperplasia extending into alveolar ducts. Increased tumor incidence occurred only in the lung. The incidence of bronchioloalveolar adenomas was significantly increased in males exposed to 40, 80 or 160 ppm and in females exposed to 20, 40 and 160 ppm. The increase was seen only after 24 months. In females exposed to 160 ppm, the incidence of bronchiolo-alveolar carcinomas after 24 months was significantly greater than in the controls. No difference in lung tumors between control and styrene-exposed mice was seen in the intensity or degree of immunostaining, the location of tumors relative to bronchioles or histological type (papillary, solid or mixed). It appears that styrene induces an increase in the number of lung tumors seen spontaneously in CD-1 mice.

[Journal of Applied Toxicology 2001 May/June; 21(3): 185–198]

Oncogenic Response of Rat Skin, Lungs, and Bones to Vinyl Chloride

Rats (Ar/IRE Wistar strain) exposed for 12 months to vapors of vinyl chloride developed tumors of the skin, lungs, and bones. The cutaneous tumors, which always appeared in the area in which submaxillary and parotid glands are located, have been histologically recognized as epidermoid carcinomas, papillomas, and mucoepidermoid carcinomas. The morphological characteristics of lung tumors, which occurred in a lower percentage, were mainly of the adenocarcinoma type, with the exception of a single epidermoid tumor originating from the epithelial covering cells. In a minor number of rats, a large proliferation of cartilaginous tissue diagnosed as osteochondroma developed in the metacarpal and metatarsal regions of the four limbs.

[CANCER RESEARCH 1971 May; 31:516-522]

Plasticbacteria? Progress and prospects for polyhydroxyalkanoate production in bacteria

Polyhydroxyalkanoates (PHAs) are synthesized by numerous bacteria as carbon and energy storage compounds, and are good candidates for biodegradableplastic material. With the current advances in PHA research, PHA concentrations of greater than 80 gl^{-1} with productivities of greater than 2g $PHAl^{-1}h^{-1}$ can be routinely obtained by fed-batch cultivation of several bacteria. Metabolic engineering approaches have been used to expand the spectrum of utilizable substrates and to improve PHA production. These advances will lower the price of PHA from the current market price of ca. US$16 kg^{-1}, and will allow PHA to become a leading biodegradable plastic material in the near future.

[Trends in Biotechnology 1996, November 14(11), 431–438]

Production of Polyhydroxyalkanoates, a Family of Biodegradable Plastics and Elastomers, in Bacteria and Plants

In response to problems associated with plastic waste and its effect on the environment, there has been considerable interest in the development and production of biodegradable plastics. Polyhydroxyalkanoates (PHAs) are polyesters that accumulate as inclusions in a wide variety of bacteria. These bacterial polymers have properties ranging from stiff and brittle plastics to rubber-like materials. Because of their inherent biodegradability, PHAs are regarded as an attractive source of nonpolluting plastics and elastomers that can be used for specialty and commodity products. The possibility of producing PHAs in large scale and at a cost comparable to synthetic plastics has arisen from the demonstration of PHA accumulation in transgenic *Arabidopsis* plants expressing the bacterial PHA biosynthetic genes. Synergism between knowledge of the enzymes and genes contributing to PHA synthesis in bacteria and engineering of plant metabolic pathways will be necessary for the development of crop plants that produce biodegradable plastics.

[Nature Biotechnology 1995, 13, 142 - 150]

Plastics from bacteria and for bacteria: Poly(β-hydroxyalkanoates) as natural, biocompatible, and biodegradable polyesters

A wide variety of different types of microorganisms are known to produce intracellular energy and carbon storage products which have been generally described as being poly(β-hydroxybutyrate), PHB, but which are, more often than not, copolymers containing different alkyl groups at the β-position. Hence, PHB belongs to the family of poly(β-hydroxyalkanoates), PHA, all of which are usually formed as intracellular inclusions under unbalanced growth conditions. Recently, it became of industrial interest to evaluate PHA polyesters as natural, biodegradable, and biocompatible plastics for a wide range of possible applications such as surgical sutures or packaging containers. For industrial applications, the controlled incorporation of repeating units with different chain lengths into a series of copolymers is desirable in order to produce polyesters with a range of material properties because physical and chemical characteristics depend strongly on the polymer composition. Such “tailormade” copolymers can be produced under controlled growth conditions, in that if a defined mixture of substrates for a certain type of microorganisms is supplied, a well defined and reproducible copolymer is formed.

[Advances in Biochemical Engineering/Biotechnology 1990, 41, 77-93]

Biodegradability of Modified Plastic Films in Controlled Biological Environments

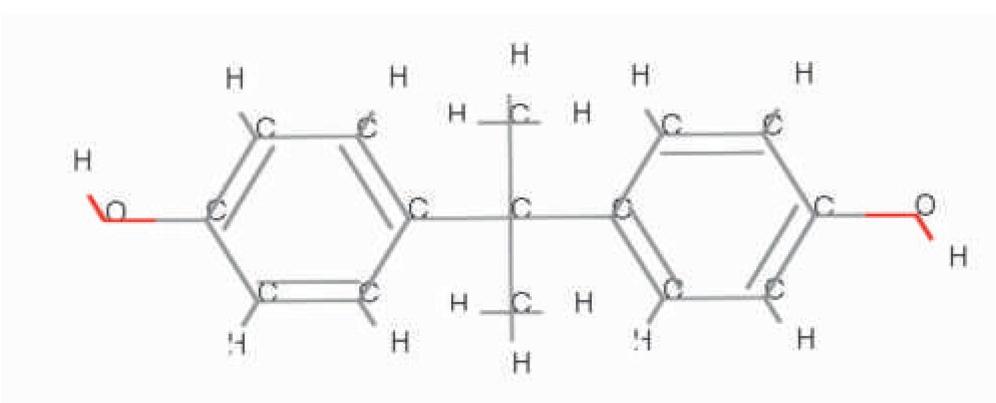
The disposal of over 10 million tons of plastic per year in the United States has raised the demand for "degradable" or "biodegradable" plastics as a means of reducing the environmental impact of these materials. Unfortunately, the promotion of the "degradable" concepts has evolved in the absence of standard tests and definitions. The biodegradabilities of 12 modified plastic films were tested by exposing the films to controlled and highly efficient microbial degrading anaerobic and aerobic bioreactors. Extended biochemical oxygen demand (BOD) testing was also used to assess film biodegradability. Two photodegradable films were exposed to sunlight prior to BOD, testing. Mass loss after bioreactor exposure and BOD exertion, which were strongly correlated, were used to assess biodegradability. Films containing starch showed no evidence that anything other than the starch component was biodegraded, despite, in two cases, disintegration caused by prooxidant activation. The mass of the starch addition and BOD exertion were strongly correlated. Sunlight exposure of photodegra-dable films caused significant disintegration of the films, but did not render the film fragments biodegradable. Only one test film, a poly(hydroxybutyrate)poly(hydroxyvalerate) copolymer, showed evide-nce of substantial biodegra-dation

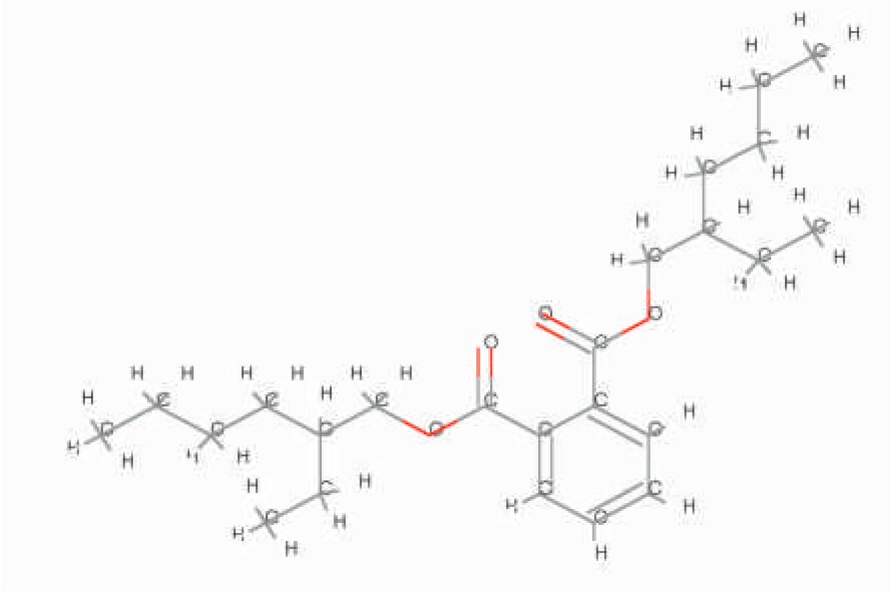
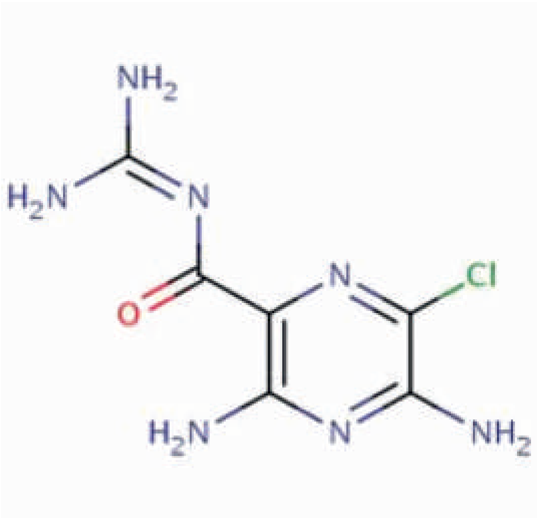
[Environ. Sci. Technol. 1992, 26, 193-198]

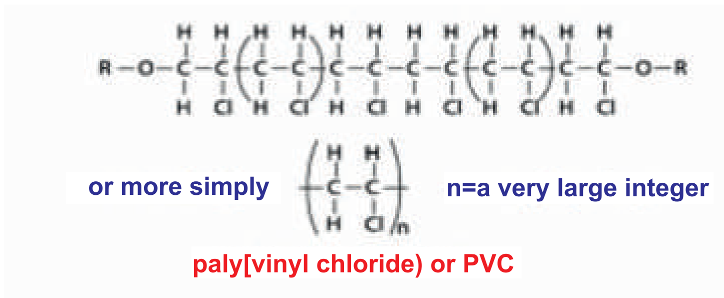
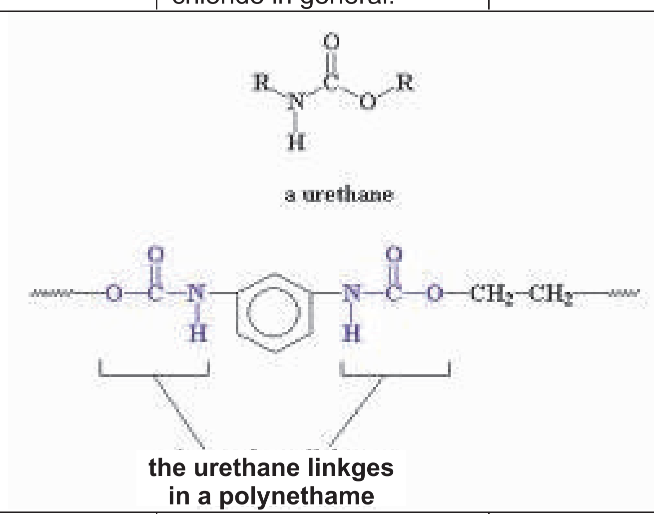
TOXIC CHEMICALS PRESENT IN PLASTIC PRODUCTS

We are subjected to plastics in our everyday life such as eating utensils, plates, and bowls as they are accessible, affordable and thought to be safe contain a variety of additives, some of which might contain dangerous toxins. The production of plastic has increased and the amount of chemicals that humans and the environment are exposed to. Plastics exist in different chemical compositions and are widespread in the society and the environment. Chemicals like BPA, DEHP, Polystyrene PVC and Urethanes are key ingredients in modern plastics which may disrupt the delicate endocrine system, leading to developmental problems. These plastics can leach out when heated and or by coming into contact with hot, oily or fatty food on a plate, bowl or fork. Plastic toxicity have also been shown to cause birth defects, breast cancer, early puberty, genital defects, obesity, and even infertility in men.

Different Toxic chemical constituents and their Health effects

Sl No.	Toxic Chemicals			
1	**bisphenol A (BPA)**			
		Uses	**Toxicity**	**Health effects**
		Baby bottles, water bottles, metal food cans, food storage containers etc.	**Low doses:** Producing effects such as insulin resistance, damaged DNA, miscarriage, decreased testosterone levels, early puberty, and the production of breast cancer and prostate cancer precursor cells. **High doses:** Toxic to rodents.	**Endocrine Problems:** The chemical communication system found in humans and animals. **Nervous Problems:** Heartbeat, breathing, and movement. **Neurobehavioral Problems:** Attention deficit hyperactivity disorder (ADHD) and autism, adult obesity

2	**Di(2-ethylhexyl) phthalate (DEHP)**			
		Uses	**Toxicity**	**Health effects**
		Present in plastic products such as wall coverings, tablecloths, floor tiles, furniture upholstery, shower curtains, garden hoses, swimming pool liners, rainwear, baby pants, dolls, some toys, shoes, automobile upholstery and tops, packaging film and sheets, sheathing for wire and cable, Medical tubing and blood storage bags etc.	Younger rats seem to be more susceptible than older ones. DEHP may induce cellular transformation, and it has been shown to be carcinogenic in rats and in mice. Acute toxicity of DEHP to algae, plants, and birds appears to be low.	Very limited information is available on the effects of DEHP on humans like mild gastric disturbances but mostly affects rats and mice when given high amounts of DEHP.
3	**Polystyrene**			
		Uses	**Toxicity**	**Health effects**
		Disposable cutlery, plastic models, CD and DVD cases, and smoke detector housings etc.	Polystyrene contains the toxic substances Styrene and Benzene, suspected carcinogens and	Styrene primarily exhibits its toxicity to humans as a neurotoxin by attacking the central and peripheral

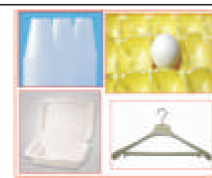
			neurotoxins that are hazardous to humans. Burning polystyrene on releases Carbon Monoxide and styrene monomers into the environment, which can be extremely hazardous to our health.	nervous systems. Also causes cancer in animals.
4	**Poly (Vinyl Chloride)**			
		Uses	**Toxicity**	**Health effects**
		Children's toys, plastic clothing, Automotive plastics, Plumbing fixtures, Pipelines in the water and sewage industries etc.	The processes of manufacturing PVC and burning waste PVC creates dioxins. These dioxins are threat to the entire world because dioxins can travel long distances and persist in the environment. Experimental studies have demonstrated the carcinogenicity and mutagenicity of vinyl chloride/polyvinyl chloride in general.	Hormonal imbalances, Reproductive and developmental problems, Allergies in children, Brain cancer, Hardening of connective tissue throughout the body, malignant tumor arising from a blood vessel etc.
5	**Poly (urethanes)**			
		Uses	**Toxicity**	**Health effects**
		Rigid foams, semi-rigid foams, flexible foams, rubbers and adhesives	Acute oral toxicity. In animals, it passes through placental barrier, excreted in maternal milk.	Toxic to kidneys, the nervous system, liver, gastrointestinal tract. Repeated or prolonged exposure can produce target organs damage.

UNDERSTANDING THE GRADING SYSTEM OF PLASTICS

As decided by the U.S. Food & Drug Administration (FDA) plastics used in food packaging should be of greater cleanliness than plastics used for non-food packaging. So they categorized plastics into different grades which are commonly referred to as **Food grade** Plastic. Food grade plastic is also about using the appropriate type of plastic during packaging of foodstuffs as foods that are highly acidic or that contain alcohol or fats that can leach plastic additives from the packaging or container into the food. As a result, plastic containers that are FDA approved should be used for the particular type of food that will come into contact with plastic.

Grading of Plastic according to their properties

Grades	Groups	Properties	Plastic Products	Images
1	PET: Polyethylene Terephthalate	PET is clear, tough, and has good gas and moisture barrier properties.	Commonly used in soft drink bottles.	
2	HDPE: High Density Polyethylene	A linear polymer (a polymer that does not branch or cross-link) generated from ethylene using a catalyzing process.	HDPE is used to make bottles for milk, juice, water and laundry products.	
3	PVC: Polyvinylchloride	The diverse slate of vinyl products can be broadly divided into rigid and flexible materials. Bottles and packaging sheet are major rigid markets	Widely used in the construction market for such applications as pipes and fittings.	
4	LDPE: Low Density PE/Linear LDPE/Polyethylene Medium Density/MDPE	Used predominately in film applications due to its toughness, flexibility and relative transparency.	Dry-cleaner bags, bread and frozen food bags, squeezable bottles, agricultural films, camera film, Lab wash bottles, rigid applications such light covers, stretch/shrink, and bags.	

5	PP :Polypropylene 	Polypropylene has been very successfully applied due to its good specific strength.	Automotive Applications, Household Goods, Containers, Appliances, Packaging, Electrical/Electronic Applications, Industrial Applications, General Purpose, Automotive Interior Parts.	
6	PS: Polystyrene 	Polystyrene is a rigid, transparent thermoplastic, which is present in solid or glassy state at normal temperature. But, when heated above its glass transition temperature, it turns into a form that flows and can be easily used for molding and extrusion. It becomes solid again when it cools off. This property of polystyrene is used for casting it into molds with fine detail.	Styrofoam, grocery store, meat trays, egg cartons, aspirin bottles, foam cups, cups, plates & cutlery and packaging.	
7		Products labeled as “other” are made of any combination of 1 to 6 or another less commonly used plastic. These are made of resin or from several resins mixed together.	Ketchup bottles, some juice bottles, toys etc.	

DID YOU KNOW ?

1. According to The Wall Street Journal, the U.S. goes through 100 billion plastic shopping bags annually. An estimated 12 million barrels of oil is required to make that many plastic bags.
2. Four out of five grocery bags in the US are now plastic.
3. Plastic bags cause hundreds of thousands of birds, sea turtle and other marine animal deaths every year because these creatures mistake plastic trash for food.
4. Countries like China, Ireland, Australia, Bangladesh have banned or have placed restrictions on single use plastic bags.
5. Taiwan banned plastic bag and plastic utensils as a way to reduce 60,000 metric tons of waste per year they deal with each year
6. According to the BBC, only 1 in 200 plastic bags in the UK are recycled. Our record in the US isn't any better.
7. Target, the second-largest retailer in the U.S. purchases 1.8 billion bags a year. They just announced a new program to give consumers a nickel back for each reusable bag they bring into their stores when they shop.
8. Target (Australia) completely banned single use plastic bags in their stores in 2008.
9. The average family accumulates 60 plastic bags in only four trips to the grocery store.
10. Each high quality reusable bag you use has the potential to eliminate an average of 1,000 plastic bags over its lifetime.
11. Americans use 2.5 million plastic bottles every HOUR. Each of us creates 1,500 lbs of trash every year that has to be disposed of that could be recycled with a little effort.

WEB LINKS

1. http://www.ecologycenter.org/iptf/ Provides information about the diverse and committed network of activists, waste management specialists and Non Governmental Organizations worldwide.

2. http://www.mindfully.org/Plastic/plastic.htm Provides information about the numerous scientific studies supplied on their website.

3. http://www.toxicslink.org/ Toxics related information into the public domain, both relating to struggles and problems at the grassroots as well as global information to the local levels.

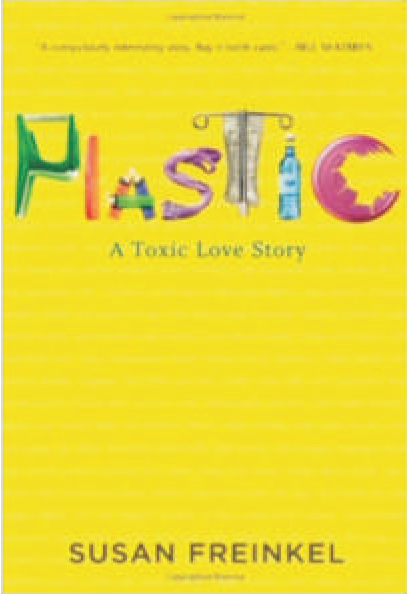
BOOK STOP

Author(s) : Susan Freinkel

Publisher : Dreamscape Media, LLC

ISBN10 : 1611200253

Pages : 336



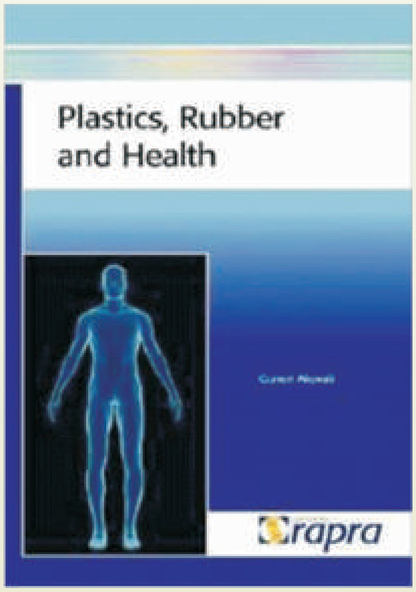
"What is plastic, really? Where does it come from? How did my life become so permeated by synthetics without my even trying?" Surrounded by plastic and depressed by the political, environmental, and medical consequences of our dependence on it, Freinkel (The American Chestnut) chronicles our history with plastic, "from enraptured embrace to deep disenchantment," through eight household items including the comb, credit card, and soda bottle (celluloid, one of the first synthetics, transformed the comb from a luxury item to an affordable commodity and was once heralded for relieving the pressure on elephants and tortoises for their ivory and shells). She takes readers to factories in China, where women toil 60-hour weeks for a month to make Frisbees to preemie wards, where the lifesaving vinyl tubes that deliver food and oxygen to premature babies may cause altered thyroid function, allergies, and liver problems later in life. Freinkel's smart, well-written analysis of this love-hate relationship is likely to make plastic lovers take pause, plastic haters reluctantly realize its value, and all of us understand the importance of individual action, political will, and technological innovation in weaning us off our addiction to synthetics.

Author(s) : Guneri Akovali

Publisher : Smithers Rapra

ISBN : 184735081X

Pages : 328



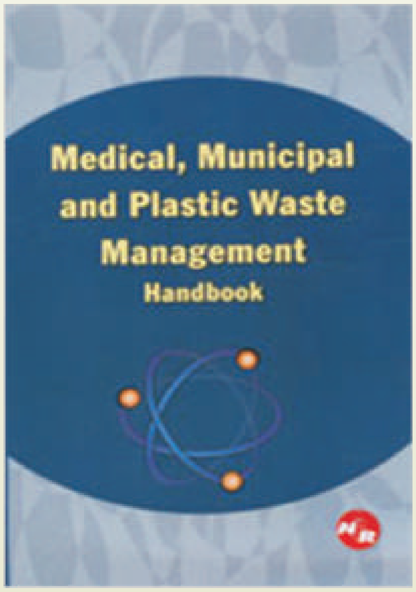
In recent years there have been certain scare stories about the possible negative effects on human health from some of these materials. However, today, it is realised that it is often not the polymers themselves, but their monomers or the additives used that are responsible for these negative effects. And the reality is that a lot of polymers are used in medical applications without adverse effects on patients. Hence, the dividing line between whether something is toxic and harmful to health or not (and if it is, under what conditions) is a very critical issue and therefore, there needs to be a better understanding of these systems. This book presents the available information on the eternal triangle of plastics and rubber and health, to enable a better understanding of the facts.

Author(s) : NIIR Board of Consultants & Engineers

Publisher : National Institute of Industrial Research

ISBN : 8186623914

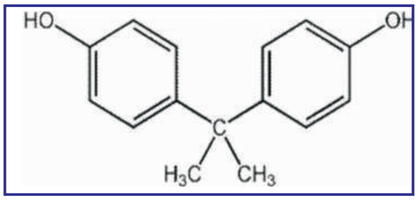
Pages : 544



Waste management is the collection, transport, processing, recycling or disposal, and monitoring of waste materials. Concern over environment is being seen a massive increase in recycling globally which has grown to be an important part of modern civilization. The consumption habits of modern consumerist lifestyles are causing a huge global waste problem. Rapid urbanization and industrial diversification has led generation of considerable qualities of municipal, plastic, hazardous and biomedical waste. Further the rapid industrial developments have, led to the generation of huge quantities of hazardous wastes, which have further aggravated the environmental problems in the country by depleting and polluting natural resources. Therefore, rational and sustainable utilization of natural resources and its protection from toxic releases is vital for sustainable socioeconomic development. Hazardous waste management is a new concept for most of the Asian countries including India. The utilization of resources and generation of waste is for beyond the limit that the biosphere was made to carry. Recycling of plastics should be carried in such a manner to minimize the pollution level during the process and as a result to enhance the efficiency of the process and conserve the energy. This book basically deals with characterization of medical waste, medical waste data collection activities, medical waste treatment effectiveness, gas sterilization , medical waste reuse, recycling and reduction, selection of waste management options, fundamental concepts related to hospital waste incineration , linkage of bio medical waste management with municipal waste management , waste identification and waste control program for the health care establishments, waste treatment and disposal : the rules and the available options , recycle spoiled photographic film and paper etc. Waste management is one of the essential obligatory functions of the country. This service is falling too short of the desired level of efficiency and satisfaction resulting in problems of health, sanitation and environmental degradation. This book provides overview of the status of medical, municipal and plastic waste management. A treatment technique includes sterilization, incineration and number of recycling methods.

MINIPROFILE OF BISPHENOL A

NAME OF CHEMICAL: BISPHENOL A



SYNONYMS: Bisferol A (Czech); 2,2-Bis-4'-Hydroxyfenylpropan (Czech); Bis(4-Hydroxyphenyl) Dimethylmethane; Beta,Beta'-Bis(P-Hydroxyphenyl)Propane; 2,2-Bis(P-Hydroxyphenyl)Propane; 2,2-Bis(4-Hydroxyphenyl)Propane; Bis(4-Hydroxyphenyl)Propane; Bisphenol; 4,4'-Bisphenol A; P,P'-Bisphenol A; Bpa; Dian; Diano; P,P'-Dihydroxydiphenyldimethylmethane; 4,4'-Dihydroxydiphenyldimethylmethane; P,P'-Dihydroxydiphenylpropane; 2,2-(4,4'-Dihydroxydiphenyl)Propane; 4,4'-Dihydroxydiphenylpropane; 4,4'-Dihydroxydiphenyl-2,2-Propane; Beta-Di-P-Hydroxyphenylpropane; 2,2-Di(4-Hydroxyphenyl)Propane; Dimethyl Bis(P-Hydroxyphenyl)Methane; Dimethylmethylene-P,P'-Diphenol; Diphenylolpropane; 2,2-Di(4-Phenylol)Propane; Ipognox 88; Isopropylidenebis(4-Hydroxybenzene); P,P'-Isopropylidenebisphenol; 4,4'-Isopropylidenebisphenol; P,P'-Isopropylidenediphenol; 4,4'-Isopropylidenediphenol; 4,4'-(1-Methylethylidene)Bisphenol; Nci-C50635; Parabis A; Phenol, 4,4'-Dimethylmethylenedi-; Phenol, 4,4'-Isopropylidenedi-; Phenol, 4,4'-(1-Methylethylidene)Bis-; Pluracol 245; Propane, 2,2-Bis(P-Hydroxyphenyl)-; Rikabanol; Ucar Bisphenol Hp

RTECS NUMBER (NIOSH): SL6300000

CAS NO: 80-05-7

MOLECULAR FORMULA: $C_{15}H_{16}O_2$

MOLECULAR WEIGHT: 228.31

PROPERTIES: Bisphenol A is a white to light brown flake or powder with a medicine or phenol-like odor. It is an intermediate used in making epoxy, polycarbonate and other resins and as an inhibitor in polyvinyl chloride(PVC) plastics.

USES:

1. Intermediate in manufacture of epoxy, polycarbonate, phenoxy, polysulfone and certain polyester resins; flame retardants, rubber chemicals.
2. Fungicide
3. Monomer used for polycarbonate and epoxy resins.

SOLUBILITIES: Soluble in acetic acid; Sol in aq alkaline soln, alc, acetone; slightly sol in carbon tetrachloride.

STORAGE CONDITION: Store away from heat and strong oxidizers and strong bases, acid chlorides, and acid anhydrides.

VAPOUR PRESSURE: 3.91×10^{-7} mm Hg at 25 °C

REACTIVITIES AND INCOMPATIBILITIES: Strong oxidizers, strong bases, acid chlorides, and acid anhydrides.

CLEANUP METHODS: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Vacuum cleaning is preferable to sweeping to keep dust levels down. Use special HEPA vacuum; not a shop vacuum. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your Department of Environmental Protection or your regional office of the federal EPA for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped.

TOXICITY/BIOMEDICAL EFFECTS

Antidote and emergency treatment: Immediate first aid: Ensure that adequate decontamination has been carried out. If patient is not breathing, start artificial respiration, preferably with a demand valve resuscitator, bag-valve-mask device, or pocket mask, as trained. Perform CPR if necessary. Immediately flush contaminated eyes with gently flowing water. Do not induce vomiting. If vomiting occurs, lean patient forward or place on the left side (head-down position, if possible) to maintain an open airway and prevent aspiration. Keep patient quiet and maintain normal body temperature.

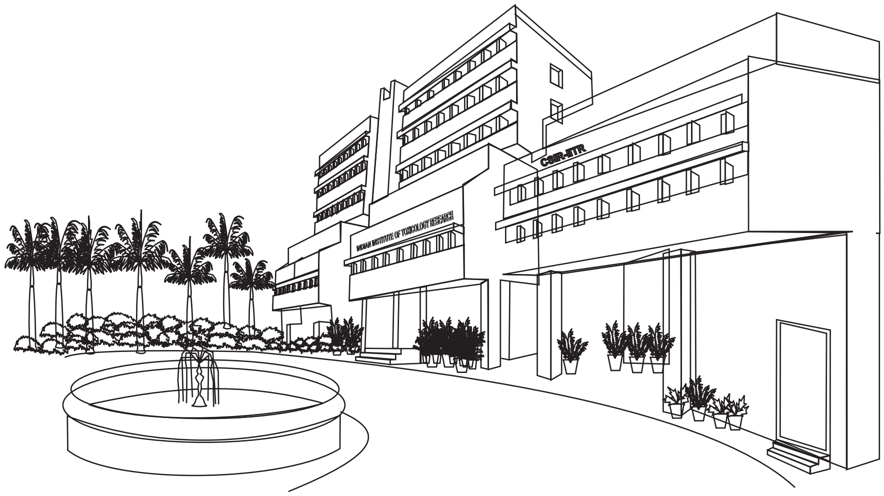
PHARMAKOKINETICS: The metabolism of bisphenol A [2,2-bis(4-hydroxyphenyl)propane] (BPA) by CD1 mice liver microsomal and S9 fractions was investigated. Nine metabolites were isolated and characterized using HPLC and mass spectrometry. Many of these metabolites were characterized for the first time in mammals, namely isopropyl-hydroxyphenol (produced by the cleavage of BPA), a bisphenol A glutathione conjugate, glutathionyl-phenol, glutathionyl 4-isopropylphenol, and BPA dimers.

BIOLOGICAL HALF-LIFE: Following a single oral or intravenous (iv) dose of 100 ug/kg (ring-(14)C(U)) radiolabeled bisphenol A ((14)C-BPA) to male and female cynomolgus monkeys ... the terminal elimination half-life was larger post-iv dose (t(1/2iv) = 13.5 to 14.7 hr) than post-oral dose (t(1/2oral) = 9.63 to 9.80 hr). After iv dose, the fast-phase half-life (t(1/2f)) of total radioactivity was 0.61 to 0.67 hr. The t(1/2f) of unchanged (14)C-BPA for females (0.39 hr) was smaller than that for males (0.57 hr).

MODE OF ACTION: The toxicity of bisphenol A was definitively characterized in the water flea (Daphnia magna) in an effort to discern whether this compound may elicit endocrine toxicity in an invertebrate species and to establish the mechanism by which this toxicity is elicited. The ability of bisphenol A to interfere with two ecdysteroid-dependent physiological processes-molting and embryonic development-was evaluated. Bisphenol A elicited antiecdysteroidal activity as indicated by its prolongation of the intermolt period and interference with embryonic development. This apparent antiecdysteroidal activity was not due to reduced availability of endogenous ecdysteroid nor due to ecdysteroid-receptor antagonism. The ability of bisphenol A to elicit antiecdysteroidal activity by functioning as a juvenoid hormone was next evaluated. Bisphenol A, alone, did not elicit juvenoid activity. However, bisphenol A did enhance the activity of the crustacean juvenoid hormone methyl farnesoate. A definitive assessment of the effects of bisphenol A on the reproductive capacity of daphnids revealed a concentration- response relationship that extended at least one order of magnitude below exposure levels that were overtly toxic to the maternal organisms. These results demonstrate that bisphenol A is chronically toxic to daphnids, probably through its ability to interfere with ecdysteroid/juvenoid regulated processes. However, effects are elicited at levels that are not likely to pose environmental concern.

TOXICITY DATA

Route	Symptoms	First aid	Target organs
Inhalation & Ingestion	Can irritate and even burn the skin and eyes, Nose and throat irritation with coughing and wheezing, Headache, nausea and vomiting	Remove the person from exposure. Begin rescue breathing if breathing has stopped and CPR if heart action has stopped. Transfer promptly to the medical facility.	Skin, eyes, throat, heart
Contact	Contact can irritate or even burn the skin and eyes.	**Eye contact:** Immediately flush with large amounts of water for atleast 15 minutes, lifting upper and lower lids. **Skin contact:** Quickly remove contaminated clothing. Immediately wash contaminated skin with large amounts of soap and water	Skin & Eyes



सी.एस.आई.आर.-भारतीय विषविज्ञान अनुसंधान द्वारा परीक्षित प्लास्टिक वस्तुएं

- बाइएक्सिली पॉलीप्रोपिलीन और प्लास्टिक फिल्म-चाय की पत्ती भरने के लिए।
- पाली एथलीन फिल्म-पानी भरने के लिए।
- काले रंग में रबराज्ड पानी की टंकी बनाने के लिए।
- सफेद प्लास्टिक फिल्म-पानी रखने की थैली।
- एच.डी.पी.ई. (हाई डेन्सिटी पॉली एथलीन) - पानी रखने के लिए बोतल।
- डिकोरेटिव लैमिनेट-रसोई में उपयोग आने वाली लकड़ी की मेज इत्यादि पर लगाने के लिए।
- प्लास्टिक थौलियाँ-अस्पतालों में रोगियों को चढ़ाने वाले ग्लूकोस भरने के लिए।
- पॉलीएथलीन कन्टेनर-कच्ची देशी शराब के लिए।
- प्लास्टिक थैलियां-खाद्य प्रयोग में आने वाले समान को भरने के लिए।
- पॉलीप्रोपलीन फिल्टर-गन्ने एवं फल के रस छानने के लिए।
- खून की बोतलें (थैलियाँ) - अस्पतालों में रोगियों को चढ़ने वाले खून को रखने के लिए।
- थैलियाँ-फल का रस भरने के लिए।
- ग्लास फाइबर रिनफोर्स्ड प्लास्टिक-वाटर टैंक, सर्फबोर्ड इत्यादि बनाने के लिए।
- पॉलीइथालिइन टेरीफ्थेलेट प्लास्टिक-सॉफ्ट ड्रिंक की बोतल बनाने के लिए।
- बायोडिग्रेडिबल प्लास्टिक-डिस्पोस्बल वस्तुएं बनाने के लिए।

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