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Review of Phthalates and its Compounds in Human and Freshwater Fish

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Abstract: ***Phthalates, are organic substances often called Phthalic acid esters, frequently used in many industries. Phthalic acid esters are well known peroxisome proliferators.They are used as the so-called plasticisers, substances that improve mechanical properties of plastic materials, mainly PVC. There is considerable concern about the adverse effects of these chemicals on wildlife and human. Phthalates are generally lipophilic, which influences their leaching and environmental partitioning characteristics. Human exposure to phthalates occur as a result of direct contact or use of a product containing phthalates, through the leaching of phthalates from one product into another, occur with food packaging or intravenous fluids, or by general contamination of the ambient environment. Skin may come into direct contact with phthalate containing clothing, cosmetics, sunscreens, insecticides, other personal care products, modelling clay, toys, yoga pads, waxes, cleaning products and denture material. Diethyl phthalate in aquatic environment originates from a variety of compounds of anthropogenic origin such as pesticides, detergents and plasticizers. Dimethyl phthalate and DBP have been used topically as insect repellants. DBP, DEP, DMP and DnOP are currently on the US EPA's list of 'potentially toxic inerts', DEHP are commonly used as plasticizers in plastic industry which can be exposed to human body through direct use or by indirect means after releasing into food and water, such as breathing, drinking water, diet and skin, raising public concerns. DCHP (dicyclohexyl phthalate), are being evaluated for endocrine disrupting properties. The phthalate plasticisers DINP (diisononyl phthalate), DIDP (diisodecyl phthalate) and DNOP (di-n-octylphthalate) in toys and child care articles which can be placed in the mouth (concentrations >0.1%) by mass. BBP is very toxic to aquatic organisms with long lasting effects. DEP was absorbed unchanged from the intestine and was hydrolysed to monoethyl phthalate (MEP) in kidneys. Dimethyl phthalate (DMP) and dibutyl phthalate (DBP) tend to be used as solvents and in adhesives, waxes, inks, cosmetics, insecticides and pharmaceutical. To this phthalate fish Tilapia mossambica were exposed and bioassay studies were evaluated and their toxicity were determined. The final results conclude that the toxicity depends upon the dosage of the toxicant.***

Keywords: Phthalates, DEHP, DBP, DEP, DMP, DNOP, DCHP, DINP, DIDP, BBP, MEP, Tilapia mossambica, Bioassay

1. Introduction

Phthalates, are organic substances often called Phthalic acid esters, frequently used in many industries. They are usually colourless or slightly yellowish oily and odourless liquids very slightly soluble in water. Phthalates are much more readily soluble in organic solvents, side chains are longer, and their lipo solubility and the boiling point are higher. Phthalates have a broad variety of uses. They are used as the so-called plasticisers, i.e. substances that improve mechanical properties of plastic materials, mainly PVC. They are also used in the manufacture of floorings, children toys, and are added to printing inks and to perfumes and nail varnishes. Such a broad range of applications in the industry brings about the problem of an extensive intact. Phthalates causes contamination in the environment where they are now a days ubiquitous. This is because phthalates are not chemically bound in plastics in any way, and they are relatively easily released from them to the external environment (water, air, soil, food,). Phthalates provide plasticity to rigid materials such as polyvinyl chloride and other polymers. They also lubricate, act as solvents, and impart favourable characteristics to the products (Rudel *et al.*, 2001). Phthalates are detectable in aquatic environments, in dust because of their volatility, in air. There is considerable concern about the adverse effects of these chemicals on wildlife and humans. In addition to the reliance on finite resources for plastic production, and concerns about additive effects of different chemicals, current patterns of usage are generating global waste management problems. Barnes *et al*. (2009) show that plastic wastes, including packaging, electrical equipment and plastics from undo life vehicles, are major components of both household and industrial wastes; the capacity for disposal of waste to landfill is finite and in some locations landfills are at, or are rapidly approaching capacity. So from several perspectives it would seem that our current use and disposal of plastics is the cause for concern (Meeker *et al.*, 2009).

The physicochemical characteristics of phthalates vary with the chemical structure and may include a vapour phase, although vapour pressures are generally low. Phthalates are generally lipophilic, which influences their leaching and environmental partitioning characteristics. Ingestion, inhalation, intravenous injection and skin absorption are potential pathways of exposure. Human exposure to phthalates occur as a result of direct contact or use of a product containing phthalates, through the leaching of phthalates from one product into another, as may occur with food packaging or intravenous fluids, or by general contamination of the ambient environment. Phthalates are exposed from blood bags, injection syringes, intravenous canellas and catheters, and from plastic parts of dialysers is also a possibility (Černá 2000). Phthalate ingestion may occur via food, including enteral nutritional formulas, pharmaceuticals, nutritional supplements, sucking children's toys and other mouthing objects (Hauser *et al.*, 2004). Dietary intake from contaminated food is likely to be the largest single source of phthalate exposure in the general population. Phthalate levels in food, however, are widely variable, and data are often old and may not reflect current

exposure levels. Indoor air and dust contains phthalates that leach from building products, household furnishings, toys, clothing, accessories (e.g. children's PVC backpacks), and inside automobiles from plasticized components. General environmental contamination with phthalates contributes to some unspecified degree to food, water and indoor dust levels. Rudel *et al*. (2001) reported total phthalate concentrations in dust from one office and five homes ranging from 0.3 to 524 lg/g dust. Phthalate air concentrations from samples and from other locations ranged from 0.005 to 28 lg/m3.

Skin may come into direct contact with phthalate containing clothing, cosmetics, sunscreens, insecticides, other personal care products, modelling clay, toys, yoga pads, waxes, cleaning products and denture material. In general, trans dermal absorption depends on chemical concentration, chemical structure, water solubility, octanol : water partition coefficient between the formulation vehicle and stratum corneum, the formulation vehicle, and the anatomic area of application. Skin absorption of chemicals from the face, axilla and scrotum, may be up to 10-fold higher than the arm. Studies using rodent skin show that absorption of phthalates is generally slow. An in vitro comparison demonstrated that human skin is less permeable to phthalates although studies of human skin are few. An in vivo study of DBP absorption through human upper arm skin showed a maximum flux of 10 lg/cm2/h (mean = 3.8) when applied as a saturated solution of DBP in propylene glycol. The authors concluded that the octanol : vehicle partition coefficient is the largest determinant of skin absorption. Dimethyl phthalate and DBP have been used topically as insect repellants. DBP, DEP, DMP and DnOP are currently on the US EPA's list of 'potentially toxic inerts', and may be used along with other ingredients in insecticides or repellants, causing dermal or inhalation exposures. Quantification of internal exposures to phthalates from commercially available products that are applied to the skin is not generally available (Barnes *et al*. 2009). Phthalate is an industrial chemical that originated from a variety of compounds of anthropogenic origin such as pesticides, detergents and plasticizers (Nivedita *et al*., 2002) used in products such insecticide, mosquito repellants, camphor substitute, plasticizer for cellulose, bathing soaps, cosmetics, pharmaceutical coal- tings, after shave-lotion, detergent, ester plastic film and sheets(Huang *et al*., 2008). Diethyl phthalate in aquatic environment originates from a variety of compounds of anthropogenic origin such as pesticides, detergents and plasticizers. (Many reports have discussed the impact of man- made xeno estrogenic compounds on man and wildlife. The empty DEP containers are washed in freshwater bodies such as rivers and lakes and the container are used for domestic water storage. There is a growing awareness of the critical role, which changes in the blood parameters, biochemical and tissue damage of fish could play in the assessment of the pollution status in aquatic environment. This is predicted on the fact that blood parameters respond rapidly to changes in water quality (Oluah and Njoku, 2001). The changes in the haematological parameters, biochemical is useful tools in assess of the physiological status of fish (Fatoki *et al*., 2010).

Anthorpgenic estrogenic compounds like phthalate esters have been used in the manufacture of plastics, pharmaceutical coatings. In India, DEP is also extensively used in the manufacture of license sticks, as a perfume binder reported that the blood parameters of diagnostic importance are erythrocyte and leucocytes counts, haemoglobin, haematocrit and leucocyte differential counts which would readily respond to incidental factors such as physical stress and environmental stress due to water contamination. Tilapia is a good biological model for toxicological and immunotoxicity studies (Giron-perez *et al*.,2007) due to diverse characteristics, namely their high growth rates, efficiency in adapting to diverse diets, great resistance to diseases and handling practices, easy reproduction in captivity at prolific rate and finally, good tolerance to a wide range of environmental conditions. In fish, exposure to chemical pollutants can induce either increases or decreases in haematological levels (Kori-Siakpere; Oboh, 2011). Exposure data are similar but less extensive. While average concentrations of phthalates in selected populations worldwide appear quite similar, there is evidence of considerable variability in daily intake rates among individuals, and even within individuals. Exposures through ingestion, inhalation and dermal contact are all considered important routes of exposure for the general population, the upper percentiles of di-butyl phthalate and DEHP urinary metabolite concentrations show that for some people daily intake might be substantially higher than previously assumed and could exceed estimated safe daily exposure levels. Current 'safe' exposure levels are typically based on the application of traditional toxicological assumptions regarding acute toxicants to calculate daily exposures for chemicals in a range of widely used plastic items. The toxicological consequences of such exposures, especially for susceptible subpopulations such as children and pregnant women, remain unclear and warrant further investigation. However, there is evidence of associations between urinary concentrations of phthalate metabolites and biological outcomes (Sonde *et al.*, 2000).

Phthalate esters (PAEs) are widely used as plasticizers in a large variety of daily products. However, they can be easily released into the water environment and are identified as one of the most prevalent organic pollutants. The amount of PAEs, including dibutyl phthalate (DBP) and di-2-ethylhexyl phthalate (DEHP) used for the industrial production all over the world is estimated to be about 4 million tons each year. Due to health concerns, the European Union has issued a ban on sales of PVC infant biting toys containing PAEs on November 20, 1999 and Japan has also made a decision to forbid using plastic gloves containing DEHP in food production since 2001 . DBP and DEHP are commonly used as plasticizers in plastic industry which can be exposed to human body through direct use or by indirect means raising public concerns. Thus the enzyme process takes place in the human body. During the enzyme process free radicals are produced and the enzyme, xanthine oxidase (XOD) is a vital catalytic enzyme. Under its catalytic action, xanthine and hypoxanthine can be oxidized to uric acid via giving single-electron or double electron to O2, simultaneously creating active oxygen radicals (Gille *et al*. 2001). Several polybrominated flame retardants are very persistent, very bio-accumulating and toxic, and are listed in

the Stockholm Convention on Persistent Organic Pollutants (POPs) (Secretary- general UN, 2009**).** Among the phthalate plasticisers the most hazardous ones, i.e. BBP, DEHP and DBP, are classified as toxic for reproduction (category 1B). BBP is also very toxic to aquatic organisms with long lasting effects (European Parliament and Council, 2008; European Commission, 2009). In addition, these phthalates, as well as DEP (diethyl phthalate) and DCHP (dicyclohexyl phthalate), are being evaluated for endocrine disrupting properties. The lead compounds used in heat stabilizers are classified as toxic for reproduction (category 1A), very toxic to the aquatic environment with long lasting effects (both acute and chronic), and may cause damage to organs (Silva *et al.*, 2003).

Structures and physical properties vary among phthalates which influences their chemo dynamics in the environment. Phthalates with lesser molecular weights, such as diethyl phthalate (DEP) have grater bioaccumulation factors (BAFs), while larger phthalates such as di-(2-ethy hexyl) phthalate (DEHP) tent to have lesser BAFs despite their greater water octanol partitioning coefficients(*kow),* phthalate esters do not have greater biomagnifications factors (BMFs) such that concentration of phthalates are not greater in higher tropic levels of aquatic food webs. This is probably due to the fact that phthalates have a fairly short half life in the environment with greater than 50% degradation occurring within 28 days, primarily via photo degradation. Further more, phthalates such as DEHP, are readily bio-transformed and excreted, which results in lesser bioaccumulation. In humans, phthalates have been detected in matrices such as blood, urine, saliva, amniotic fluid, breast milk and cord blood. The major pathway of exposure to phthalates is the oral route, though inhalation and dermal absorption may play a significant role in exposure (Adibi *et al*., 2003) Infants and toddlers are the most vulnerable receptors because, they exhibit more hand-to-mouth activity, consume the most food as a percent of their body weight. The situation is exaggerated by the fact that ubiquitous phthalates such as DEHP, which have been classified as endocrine disrupting chemicals (EDCs), exhibit an oral absorption factor of 0.55 and affect the most vulnerable receptors at critical stages of development (Latini *et al*.,2003b).

Phthalates have been reported to affect multiple biochemical processes in humans and wildlife. These include effects on reproduction, damage to sperm (Rozati *et al*., 2002),early onset of puberty in females (Wolff *et al*.,2010), anomalies of reproductive tract (Desdoits- lethimonier *et al*.,2012), infertility (Rozati *et al*.,2002; Tranfo *et al*.,2012) and adverse outcomes pregnancy (Latini *et al*.,2003b why at *et al*.,2009), to neuro developement (Miodovnik *et al*.,2011) and allergies (Bornehag *et al*.,2004). Because humans and wildlife can be exposed simultaneously to several phthalates any assessment of the risks posed by phthalates needs to consider combined effects of all of the phthalates in mixtures. To determine this study it requires a knowledge of the critical mechanisms of toxic action (CMTA) of each phthalate. Hence in the present investigation an attempt was made to study the impact of Phthalate and its compounds in the environmental and health hazards from a toxicological perspective. This was achieved by evaluations of toxicity by standardised toxicity tests and by identifying the hazards of chemicals phthalate and its compounds.

The phthalate plasticisers DEHP (di(2-ethylhexyl) phthalate), DBP (dibutyl phthalate) and BBP (benzyl butyl phthalate) in toys and child care articles, at concentrations >0.1% by mass. The phthalate plasticisers DINP (diisononyl phthalate), DIDP (diisodecyl phthalate) and DNOP (di-n-octylphthalate) in toys and child care articles which can be placed in the mouth (concentrations >0.1% by mass. Cadmium for giving colour to plastics, or used as stabilisers in PVC (flame retardants polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE) in electronic. Four of them are used in plastics, i.e. the phthalate plasticisers DEHP, BBP and DBP, mainly used in PVC, and 4,4'-methylenedianiline (MDA) used as a curing agent for expoxy resins. Acute toxicity of phthalates is very low. Low molecular phthalates, diethyl phthalate (DEP), may cause irritation of the skin, conjunctiva, and the mucous membrane of the oral and nasal cavities in animals. However, similar reactions are not as a rule encountered in humans. In the case of human exposure to phthalates, phthalate diesters are relatively rapidly hydrolysed to their respective monoesters in the intestine by pancreatic or liver hydrolases (the first stage of phthalate biotransformation). The monoesters thus produced are bioactive molecules responsible for the adverse effects of phthalates. Monoesters are absorbed in the blood stream and then metabolised in liver. They are subject in a varying degree to hydroxylation and oxidation reactions that enhance water solubility of the products. Phthalate monoesters with a short side chain are oxidised to a lesser extent. The second stage of phthalate biotransformation is conjugation with glucuronic acid mediated by the enzyme UDP-glucuronyl transferase. The conjugation affects mainly monoesters and their oxidised metabolites with a long side chain because the conjugation facilitates the excretion of relatively lipophilic metabolites. Both the conjugated and the free (non-conjugated) phthalate metabolites are excreted in urine and partly also faeces (Silva et al. 2003).

Diethyl phthalate (DEP) deviates in some respects from the above pattern. On the basis of their measurements, Silva *et al.* (2003) assumed that DEP was absorbed unchanged from the intestine and was hydrolysed to monoethyl phthalate (MEP) in kidneys. Because MEP is relatively readily soluble in water, it need not be transported to liver for conjugation and is excreted in urine mainly in the non-conjugate form. A mechanism similar to that described in the human takes place during phthalate metabolism. Some phthalic acid esters are well known peroxisome proliferators (PPs). A very potent peroxisome proliferator is di(2-ethylhexyl) phthalate (DEHP), while dibutyl phthalate, butyl benzyl phthalate, and diisononyl phthalate (DBP, BBP, DINP) are somewhat less effective. It should be stressed that adverse effects of diester phthalates are attributable to their monoesters produced when diesters are hydrolysed in the gastrointestinal tract (Silva et al. 2003). Peroxisome proliferators are bound by paraαpparδ, i.e. peroxisome proliferator activated receptors, which they activate (Valles *et al*., 2003). The intake of phthalates contained in food is the most significant source of exposure for humans. It has been established that the amount of phthalates found in foods or meals depends on the initial contamination of

ingredients used in the production of the food, food production technologies, the period of storage (the time of contact with packaging materials), storage temperatures, ways of preparing dishes, the fat content in foods, and the type of packaging material used. A factor which may significantly increase phthalate concentrations in animal tissues and, subsequently, in foods is their fat content. The lipophilic character of phthalates was also demonstrated by measurements of phthalate concentrations in water, milk and dairy products (Prokůpková *et al*., 2002). While the concentrations of DEHP in water samples varied from 0.49 µg/l (deionised water) to 9.78 µg/l (mineral water in glass bottles with metal caps and PVC seals) and reported total phthalate amounts between 0.06 and 0.32 mg/kg (of which DEHP < 0.01–0.09 mg/kg) in pooled milk samples and 19.00 mg/kg in cream samples (DEHP max. 2.70 mg/kg). The absolutely maximum concentration was found in cheese (114 mg/kg total phthalates, 17 mg/kg DEHP) (Prokůpková *et al*. 2002).

High concentrations of phthalates in some Japanese retail packed lunches were demonstrated in 1999 by Tsumura *et al*. (2002). The source of phthalates were disposable PVC gloves worn in the preparation of packed lunches as a protection against the spreading of diarrhoeal diseases caused by E. coli. The amount of phthalates released to the fishes further increased if the gloves had been disinfected with ethanol. Because DEHP levels found in foods and dishes repeatedly exceeded the tolerated daily intake (TDI), the Japanese government banned the use of disposable PVC gloves for the handling of foods and dishes. After the ban in 2001, phthalate levels in foods averaged 4% of the values found in foods before the ban (Tsumura et al. 2002). Phthalate levels are particularly closely monitored in baby foods and infant formulae. Phthalate concentrations in baby foods and infant formulae marketed in Denmark were investigated . The authors found at least one of the phthalates DBP, BBP or DEHP, in almost 50% of the samples of baby foods and infant for mule investigated, but their concentrations were relatively deep below. Phthalates in foods occur mainly as a result of contamination with phthalates from packaging materials and measured phthalate concentrations in materials used as packaging for foods. The authors found total phthalate concentrations in packaging materials from 5 to 8160 µg/g. The phthalate most frequently found was DEHP. It was detected in all investigated samples at concentrations from 2 to 7058 µg/g. DBP and BBP are also commonly found in packaging materials. The authors stated that the highest phthalate concentrations were found in the food packaging materials made of printed polyethylene and they assumed that the main source of food contamination were the phthalates from the printing inks used. It is very difficult to estimate the exposure of the Czech population to phthalates from foods because very few data are available. On the basis of the analytical determinations of DEHP and DBP in several samples of meat, milk and dairy products, estimated the exposure of the Czech population to those phthalates at about 7.6%. Issues relating to the existence of phthalates in foods have received more and more attention and a number of measures to reduce the risk of contamination of foods with phthalates (restrictions on the use of tools and tubing of plasticised PVC and other plastic materials in the food industry, monitoring of phthalate concentrations in foods and beverages) have been adopted. It is very positive that phthalate concentrations in foods have decreased considerably in recent years (Černá, 2000).

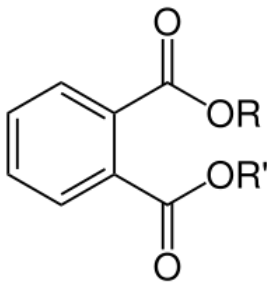
Phthalates are ubiquitous in the environment and the exposure to them is a potential health hazard, the industrial use of phthalates is being considerably regulated. A particularly sensitive approach is adopted with regard to the exposure of infants and children under three years of age. The most important document intended to reduce their exposure to phthalates is the decision of the EC Commission 1999/815/ES, which prohibited the placing on the market of toys and childcare articles intended to be placed in the mouth by children under three years of age made of soft PVC containing DINP, DEHP, DBP, BBP, di-iso- dodecyl phthalate (DIDP) or di-n-octyl phthalate (DNOP). Maximum concentrations of phthalates in foods were originally set down by decrees 298/97 Sb. and 53/2002 Sb. of the Ministry of Health of the Czech Republic (1 mg/kg for spirits, and 2 or 4 mg/kg for foods). Although there is no mention of any limit values for phthalates in foods in the currently effective decree 305/2004 Sb. setting down the types of contaminating and toxicologically important substances and their concentration limits in foodstuffs, phthalates are dealt with in decree 38/2001 on hygienic requirements for the products that come into contact with foods and foodstuffs. It follows from Appendix 3 to the decree that phthalates must not be used for the manufacture of plastic products intended to come into contact with food stuffs.

Tilapia Mossambica are important regarded as one of the most important fresh water fish in the world, considered prized food in Asia, Europe and the Middle East. While *Tilapia* are native to Asia, they are also widespread and abundant in Europe where they were introduced in the 11th or 12th century. With pressure from European immigrants to bring the fish to U.S. freshwaters, tilapia were first introduced into the Hudson River in New York. The tilapia is very adaptable and despite initial theories that cold waters would prevent its spread northward, carp have spread throughout most of the stream systems.

Scientific Classification

Kingdom : Animalia
Phylum : Chordata
Class : Actinopterygii
Order : Perciformes
Family : Cichlidae
Genus : *Tilapia*
Species : *Mossambica*
Binomial name : *Tilapia mossambica.*

Structure of Phthalate:



Physical properties:

Chemical name - Di-n-butyl phthalate
Chemical formula - $C_{16}H_{22}O_4$
Molecular weight - 278.34
Density - 1.04kg/L
Melting point - -35° c
Boiling point - 340°c
Solubility in water - 11.2mg/L
Odour - Slight ester like

Chemical properties

Phthalates have high values of K_{OA} suggesting that they will be appreciably sorbed to aerosol particles, soil and vegetation. Systematic differences in reactivity or half- life are apparent, with the primary biodegradation half- life tending to increase with increasing alkyl chain life. A series of evaluative modelling calculation is described to illustrate how the physical- chemical properties result in differences in environmental partitioning behaviour, persistence and transport potential. Phthalates in food occur mainly as a result of contamination with phthalates from packaging materials. The intake of phthalates contained in food is the most significant source of exposure for humans. It has been established that the amount of phthalates found in foods or meals depends on the initial contamination of ingredients used in the production of the food, food production technologies, the period of storage (the time of contact with packaging materials), storage temperatures, ways of preparing dishes, the fat content in foods, and the type of packaging material used. A factor which may significantly increase phthalate concentrations in animal tissues and, subsequently, in foods is their fat content.

Table 1: Physico-Chemical Parameters of Water Used for the Present Investigation

Physico-Chemical Parameters	Values
Temperature	26.**0** ± 1.2° C
Ph	7.0 ± 0.08
Dissolved oxygen	6.2 ±0.04mg/L
Total hardness	18.0 ±0.08mg/L
Salinity	0.2 ±0.02ppt
Calcium	4.0 ±0.3mg/L
Magnesium	2.3 ±0.06mg/L

Values are mean ±S.E. of five individual observation.

Materials and Methods

Two types of methods were identified, they are the Continous flow method and Static method (APHA, 1998) of the two types, the static method were followed for the mortality study.

2. Experimental Protocol

Two experimental serious were performed viz., acute and sublethal toxicity studies, in each study one control and five replicates of treatment groups were maintained.

Results obtained from this study show that percentage mortality of Tilapia mossambica fingerlings increased with increase in concentration of phthalate was dose dependent.

3. Discussion

Phthalates are a family of chemicals used in many consumer products, including building materials, household furnishings, clothing, cosmetics, personal care products, pharmaceuticals, nutritional supplements, herbal remedies, medical devices, dentures, children's toys, glow sticks, modelling clay, food packaging, automobiles, lubricants, waxes, cleaning materials and insecticides. Annually, more than three million metric tonnes of phthalates are produced globally. Uses of the various phthalates depend in part on their molecular weight (MW). Higher MW di(2-ethylhexyl) phthalate (DEHP), diisononyl phthalate (DiNP), and di isodecyl phthalate (DiDP) are the phthalates produced in highest volume for use in construction material, clothing and furnishings. By far, their largest application is to impart flexibility to polyvinyl chloride plastic (PVC). Relatively low MW phthalates such as diethyl phthalate (DEP), dimethyl phthalate (DMP) and dibutyl phthalate (DBP) tend to be used as solvents and in adhesives, waxes, inks, cosmetics, insecticides and pharmaceutical (Bizzari *et al*., 2000). Phthalates used as a mixtures in single application. Because of their widespread use, all populations of people, domestic animals, and wildlife regularly encounter opportunities for exposure to phthalates. This paper reviews data regarding various sources and pathways of human exposure to phthalates from consumer products. Data gaps are numerous, which makes it difficult to explain fully the relative contributions of various sources of phthalates to exposures reported in the general population. Phthalate esters are *o*- and *p*- dicarboxylic acid esters of benzenes. Diethyl phthalate (DEP), butyl phthalate (BP), dibutyl phthalate (DBP) and diethyl hexyl phthalate (DEHP) are extensively used in various industries for variety of purposes as alkylated resins, polymeric polyesters, drying or non-drying oils, plasticizers, insecticides, fibers, perfume fixative, alcohol denaturant, surface coating agents, moulding industries, and *p*- derivatives, terephthalic acid esters are used in synthetic textile industry. The annual productions of phthalates are over 25 billion tones. Phthalate esters were detected in seawater by author (Cumalı, 2008).

Di isobutyl phthalate were detected in the Dardanelles (Guven *et al.* 2003). In algae, orthophthalate esters were detected in Istanbul Strait (Gezgin, 2001), in the Black Sea and Dardanelles (Erakın, 2008). *p*-Phthalate ester was identified in the Black Sea coastal algae. A key conclusion from the paper by Talsness *et al.* (2009) is the need to modify the approach of chemical testing for risk assessment. As noted by these authors and others, there is a need to integrate concepts of endocrinology in the assumptions underlying chemical risk assessment. In particular, the

assumptions that dose–response curves are monotonic and that there are threshold doses (safe levels) are not true for either endogenous hormones or for chemicals with hormonal activity (which includes many chemicals used in plastics) (Talsness *et al*., 2009). The data indicate differences according to geographical location and age, with greater concentrations of some of these chemicals in young children. While exposure via house dust is extensive, it would appear that at least for some phthalates (diethylhexyl phthalate, DEHP), foodstuffs and to a lesser extent use of oral drugs probably present major uptake pathways. Koch (2003) & Calafat (2004) show that mean/median exposures for the general population were below levels determined to be the biomonitoring approach has demonstrated phthalates as well as other additives in plastics and their metabolites, are present in the human population. It has also demonstrated that the most common human exposure scenario is to a large number of these chemicals simultaneously.

Phthalates, which are esters of phthalic acid are primarily used to enhance plasticity of industrial polymers. They are used in a number of consumer end products such as toy, paints, adhesives, lubricants, packaging and building materials, personal care items, electronics, medical devices, and are an unavoidable part of modern life. A recent study estimated that 11 billion pounds of phthalates were produced worldwide every year. While these plasticizing agents impart beneficial properties to plastic, they are not bound to the polymer by a covalent linkage which makes them susceptible to leaching from the matrix. Once released into the atmosphere, they have the potential for long –range transport, eventually entering the food chain. Phthalate concentrations in foods are not currently monitored on a systematic basis, the monitoring of phthalates in spirits and bottled water continues. The regulatory bodies in charge of the food safety in the Czech Republic are the State Agricultural and Food Inspection Authority and the State Veterinary Administration. In the past, phthalate concentrations in foods were monitored by the State Veterinary Inspection. This monitoring is organised by the State Agricultural and Food Inspection Authority. Medical devices made of polyvinyl chloride softened with DEHP for administering i.v. solutions, blood, nutritional formulas and respiratory gases leach varying amounts of the phthalate. Solutions containing lipids facilitate leaching. Enteral formula containing lipid emulsion stored in a polyvinylchloride (PVC)/DEHP bag and delivered through PVC/DEHP tubing is estimated to result in a maximal daily DEHP exposure of about 9.5 mg/day, or 0.14 mg/kg/day in adults, whereas neonatal infants may be exposed to 2.5 mg/kg/day via this pathway.

Diethyl Phthalate (DEP) is used as a plasticizer, a detergent base, in aerosol sprays, as a perfume binder and after shave lotion. It is known to be a contaminant of fresh water and marine ecosystem. Therefore, a study was designed to determine the acute toxicity effects of DEP on a fresh water fish, Clarias gariepinus fingerlings. The fish was treated with 50, 75, 100 and 150 µg/l. DEP was dissolved in distilled water to determine the LC50. There was 100% mortality observed in 150 µg/l. The LC50 of DEP was estimated at log toxicant concentration as 2.217, 2.734, 3.435 and 3.931 µg/l at 24, 48, 72, 96 h and 1.871µg/l for the total death. This shows that the impacts are dose and time dependent with respect to marked reduction in mortality rate. At sub-lethal concentrations of the test substance at 30, 40, 60 and 80 µg/l in a renewal bioassay system, the water and the test compound were changed intermittently. One group was maintained as a control in dechlorinated water. This study shows that percentage mortality of Tilapia mossambicas fingerlings increased with increase in concentration of phthalate and was dose dependent. The LC50 reported in this study is less than the observed field concentration in the water column (0.16 to 3.53 mg/L) and sediment (0.16 to 0.32 mg/L) of DEP in the Venda region of South African waters (Fatoki *et al*., 2010) where similar indiscriminate discharge of DEP-laden effluents and wastes take place as in Nigeria. In Nigeria, there is dearth of information about the field levels of DEP but it is expected to be higher than the LC 50 reporte . The LC 50 of the carbofuran to juvenile fathead chubs was 1.96 mg/L, a data that is comparable to the result. Since DEP binds to the sediment and remains in the water column, it is possible that it could pose serious threat to fish and other aquatic life. The rapid opercula movement, erratic swimming and loss of balance observed in this study.

Results obtained from this study show that percentage mortality of Tilapia fingerlings increased with increase in concentration of phthalate and was dose dependent. Becker *et al*., (2004) reported levels of DEHP in the house dust of 254 children whose urinary metabolites of DEHP were also measured. The mean house dust level was 508 lg DEHP/gm dust, with no correlation between house dust levels and urinary levels of DEHP metabolites in the sample, suggesting that house dust is not a major contributor to total DEHP exposure. Another study of phthalate exposure via inhalation using personal air monitors also found no significant correlation between DEHP air levels and the urinary monoester metabolite, mono ethylhexyl phthalate (MEHP). However, a significant correlation for DEP, DBP and BBP was identified, suggesting that inhalation may be an important pathway of exposure for lower molecular weight phthalates (Adibi *et al*., 2003). A mean of 960 lg total phthalates/g dust in 38 homes in Norway (range 130–2920 lg/g dust). DEHP was the largest contributor (mean 640 lg/g dust; range 100–1610). They estimated mean adult inhalation exposure to DEHP from this source to be 0.76 lg/day. Ingestion of dust contaminated at 640 lg DEHP/g dust ·100 mg dust ingestion/day would yield a dose of 64 lg/day. Otake *et al*. (2004) analysed phthalate levels in indoor air of 27 houses in Tokyo. They reported median concentrations of DEP, DBP, BBP, dicyclohexyl phthalate, and DEHP of 0.10, 0.39, 0.01, 0.07, and 0.11 lg/m3 respectively. For an adult breathing 20 m3/day, these would result in inhalation exposures of 2, 78, 0.2, 1.4 and 22 lg/ day respectively. Inhalation of contaminated dust will result in larger inhalation exposures.

4. Conclusion

Phthalates may be present but unidentified in many consumer products, including cosmetics, personal care products, home furnishings, pharmaceuticals, nutritional supplements and insecticides. In some instances, these may

be important but unquantified sources of exposure. Oven baking of polymer clays may cause short-term, high-level inhalation exposures. Medical devices made of PVC containing DEHP are an important source of exposure to this reproductive and developmental toxicant in susceptible populations. Consumer products containing phthalates can result in human exposures through direct contact and use, by leaching into other products, or via general environmental contamination. Phthalate exposures in the general population and in subpopulations are ubiquitous and sources are widely variable. In the general population, the diet is generally considered the major pathway of exposure but all sources, path- ways, and their relative contributions to measured body burdens of phthalates are not well understood.

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