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The Privilege of Using Free-Phthalate Plasticizers for Dual Control of Both Public Health and Industry

Saad M Magdy*

Department of Food Safety & Contamination, NRC, Egypt

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***Corresponding author:** Saad M Magdy, Department of Food Safety & Contamination, NRC, Egypt,Email: Madgdy_saad6@yahoo.com

Abstract

A research project had been initialized in the National Research Centre (NRC) of Egypt, since 2013 and extended for 4 years aiming to study the "risk assessment of exposure to phthalate-contaminated foods". The work focused on bottled drinking water, bottle edible oils, bottled milk and some packaged dairy products. A simple and reliable method of analysis using GC-MS was validated and applied to detect the most common phthalate esters used in manufacturing of different sizes of bottles and/or packaging food containers. An applied method showed a detection limit of 25ng/ul with recovery percentages ranged between 90.6±6.9 depending upon the kind and type of the 6 studied phthalate esters. The 6 phthalates were dimethyl phthalate (DMP), diethyl phthalate (DEP), dibropyl phthalate (DBP), benzyl-bropyl phthalate (BBP), diethyl-hexyl phthalate (DEHP) and di-n-octyl phthalate (DnOP). The variables of bottle and container sizes, storage duration up to expiration date and storage temperature besides the nature of food were considered.

Data revealed that by advancing storage time up to 6 months or more, residues of both DEHP and/ or DnOP were reported in small size bottles of drinking water≤1 liter. So, the short alkyl chain phthalate esters were not detected, only long alkyl chain phthalates were released to the inner drinking water. Referring to bottled milk and the packaged dairy products of "Rayeb" and domuatti cheese, the positive results had no significance in general. The positive samples were qualitatively belonged to DEHP and/ or DnOP and quantitatively had concentrations ranged between 30-88ng/ml or gm. Search for phthalates in bottled edible oils showed no significance, while some bottled beverages and soft drinks revealed traces of DEHP. Such traces of phthalates reached its maximum with low pH beverages "orange juice" of small size bottles ≤1 liter after 3 months of packaging.

Exposure, Toxic Effects and Brief Risk Assessment

The plastic products are widely used in the daily life of all citizens including building materials, agriculture adjuvant, pharmaceutical pills, electronics, personal care products, detergents and surfactants, children toys, paints, inks, textiles as well as bottles and packaging food products. Plastic bottles and packaging food containers contained up to 60% by weight of plasticizers, most commonly phthalate esters. Exposure to phthalates could be happened through the major 3 routes of exposure;

I. Dermal exposure to many cosmetics, shampoo and other body care products.

II. Inhaling polished products and furniture used in indoor rooms and cars.

III. Ingestion of food, water and some pharmaceuticals.

However, it's agreed that consuming food and water is the major route of exposure for the general population Latini [1].

Children at high risk due to their mouthing behavior and the wide range of plastic products surrounded their lives. Moreover, infants and hospitalized children are in particular more exposed to phthalates, because most of medical devices and tubing contain more than 50% DEHP which could easily leached out when using warm saline and/ or blood (Sathyanarayana, 2008). Also, women may be at high risk for potential adverse health effects of phthalates due to increased and excessive cosmetic usage. However, the intake of phthalates contained in the food is still the most significant route of exposure for humans. The amounts of phthalates found in foods depends upon many factors involving:

a. The type and kind of plastic packaging materials.

b. The qualitative and quantitative properties of the adopted plasticizers.

c. The ingredients and components of certain packaged food.

d. Food production and processing treatments.

e. Food storage time (the actual extended time of interaction between food components and the filling and packaging materials.

f. Storage temperature and the pH of food media Saad et al. [2-4].

The cumulative effects of phthalates have similar mechanisms of action to other anti-androgens. There is an association between phthalates and endocrine disruption leading to development of breast cancer Lopez-Carillo [5]. The tolerance daily intake of DEHP was 37ug/kg body weight, as established by the Scientific Committee on Toxicity and Environment of the European Union (SCTEE-EU), while the corresponding figure of tolerance level established by Environmental Protection Agency (EPA) was 20ug/kg body weight Tzung-Hai et al. [6].

In brief, and on the basis of risk assessment, assuming that, the adult citizens consumed daily about 1.5 liter of bottled drinking water, besides 100-250gm packaged food, soft drinks and beverages. Referring to previous data obtained from the running project, the average concentration limits of phthalates contamination was 50ug/kg or liter, ranged between 33-88ug/kg., of 5% of the random samples. Thus, an adult male and female of 70 and 60kg body weight, respectively would be theoretically daily exposed to phthalate residues of 0.4ug/kg BW. Although, the expected calculated level of exposure (0.4ug/kg BW) is still far away the average tolerance level of daily intake recommended by either SCTEE (37ug/kg BW) or recommended by EPA (20ug/kg BW), but still risky due to the duration and repetitiveness of exposure to such hazards. As well, the calculated average of daily exposure is based only on the ingested route of exposure, while the inhaled and dermal contact routes are not easy to be calculated.

During the current study is running, some producers promote new innovative products of plasticizers as free-phthalate ones. The new products carrying not enough data, at least concerning safety criteria, only the attached leaflet indicating that such products are made from natural products, mainly soya oil. The project had the capability to get some samples of the 2 products carrying the commercial mark (AU-488 & D-80) aiming to assess their safety.

Preliminary data obtained from brine shrimp lethality bioassay showed promising results when no mortalities had been occurred up to the exposure to concentrations of 100ug/ml of the free-phthalate plasticizers. The 2 innovative plasticizer replacers are recommended by industry and plastic manufactories. So, it's worthy to proceed for advanced work to assess the new products and fulfill the required safety criteria, which leads us to design some in vitro work using normal tissue culture, and in vivo work on white Albino rats. Anyway, the usage of free-phthalate plasticizers is seemed, so far, that is industrially, economically and scientifically accepted.

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