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Research Paper

Phthalate Leachates in Selected Plastic Packed Food Products - A GC-MS Study

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Abstract: *Phthalates, an alkyl aryl esters of 1, 2 benzenedicarboxylic acids are widely used as plasticizer. They show low water solubility, high oil solubility, high octanol-to-water partition coefficient and low volatility. Phthalates are easily released into the packed food because there is no covalent bond between the phthalates and plastics in which they are mixed. Phthalates may cause major ill effects like endocrine disruption, asthma and cancer. A study was conducted on tea (aromatic beverage), sambar (an Indian dish) and alcohol packed in polythene covers and plastic cups used in routine hotels and beverage shops. The samples were analyzed for plastic residues through gas chromatography coupled with mass spectrometry (GC-MS). The result shows that, the tea filled in polythene cover and alcohol filled in plastic cup did not show any leachate of phthalates. However, the sambar packed in the polythene cover showed leachate of phthalates. The diethylhexyl phthalate was observed to be 20% of Total Ion Chromatogram in sambar. Future studies can be carried out to identify the leaching effect of phthalates in different plastic packed food materials under different conditions.*

Keywords: DEHP, Mass spectrometry, Polythene cover, Sambar, Tea.

Introduction

There is a worldwide fear for a number of modern things, like climate change, genetically modified foods and plastic pollution. Leaching of plasticizers into food from packaging is the potential danger of this era. In general, Bisphenol-A (BPA), added to make clear, hard plastic and phthalates, added to make plastic soft and flexible. Phthalates represent a broad chemical family containing a benzene ring, two carbonyl groups, and two alcohol groups to generate a diester structure. Phthalates move freely through the Polyvinyl Chloride (PVC) polymer to impart flexibility and other characteristics [1]. The oily, plasticizing properties of phthalates come from their chemical structures. Since they are not covalently bound to the polymer, they are fairly easily released to air, water, saliva, blood, nutritional formulas, and other extracting materials [2, 3]. Fatty foods such as milk, butter, and meats are the major foods susceptible to get leachates of plasticizers [4].

PAEs (Phthalate Acid Esters) in the environment and food chain can act as hormones, simulate the body's natural endocrine responses, interfere with the normal role of hormones, and affect the body's most basic physiological control mechanisms. Phthalates are reported to cause carcinogenic, teratogenic and mutagenic effects and constitute a health hazard to humans. Phthalates display a variety of toxic effects in animal studies following chronic exposure or even after short-term exposures in particularly vulnerable organisms. These effects include damage to the liver, kidney, heart, and lungs as well as adverse effects on reproduction, development, and blood clotting [5]. Phthalates are widely used as plasticizers in the manufacturing of plastics especially for food packaging. Since phthalates tend to be fat soluble, they leach more readily into lipid-containing solutions.

Depending on the circumstances of use, 2 - 50% of the phthalate content can emerge from products over their shelf life [6]. Contamination during food processing confirmed that phthalates levels increased in milk upon machine milking, in comparison to hand milking, due to contact of milk with the rubber parts of the milking machine [7]. Humans are exposed to phthalates by multiple routes, and the most likely route varies by phthalate. Exposures can be oral (e.g. DEHP via phthalate-contaminated food, water

and other liquids. Phthalates have been measured in foods, milk and drinking water[8].

There are debates about whether human male reproductive health is declining due to phthalates consumption by affecting sperm counts and histopathological alterations in the testes [9]. In addition, literature review reveals that there is a correlation between phthalate metabolite concentrations in maternal breast milk and sex hormone concentration in male offspring. Furthermore, fetal exposure to phthalate shows a relation with behavior and mental ability. Almost every country has a Food and Drugs Administration (FDA), responsible for food safety, and considering that these FDAs are very severe about the import and export of food and drinks. Thus, this study is an effort to unravel the potential dangers of packaging foods especially the oily foods in plastic containers.

Material and Methods

Sample Collection

Samples were collected from three major food and drink business centers around Thanjavur. Three kinds of major food products in our daily food habits with plastic packaging were selected. The tea and sambar packed in their routinely using poylthene cover in hot condition was collected from the tea shop and restaurant. The alcohol with plastic cups which they are regularly used for consumption was collected from a beverage shop.

Sample Preparation

The tea, sambar and alcohol in the polythene package were homogenized with a stirrer prior to sampling. The samples were extracted through liquid – liquid extraction with equal volume of n-hexane. Particularly, in case of water, alcohol, fatty samples hexane extraction is proved to be one of the most suitable solvent for non polar compounds. Samples of 100 ml each was shaken along with the 100 ml n-hexane for one hour in shaking incubator and then allowed for phase separation. The hexane extract was concentrated by nitrogen flushing to 2 ml for GC-MS analysis. The n-hexane was injected as a blank prior to the sample analysis as phthalates are very common lab contaminants.

GC-MS Analysis

The equipment details are as follows: GC Clarus 500 Perkin Elmer, Carrier gas: 1ml per min, Split: 10:1, Detector: Mass detector Turbo mass gold-Perkin Elmer, Software: Turbomass 5.2, Sample injected: 2µl, Column: Elite-5MS (5% Diphenyl / 95% Dimethyl poly siloxane), 30m x 0.25mm x 0.25µm df , Oven temperature programme: 110° C with 2 min hold ,Up to 200° C at the rate of 10 ° C/min without hold, Up to 280 ° C at the rate of 5° C / min with 9 min hold, Injector temperature 250° C, Total GC running time 36 min, Inlet line temperature 200°C, Source temperature 200°C Electron energy:70 eV, Mass scan (m/z): 45-450, Solvent delay: 0-2 min, Total MS running time: 36 min. In the MS Programme, NIST (National Institute Standard and Technology) Version 2.0 with library database having more than 62,000 patterns was used for identifying the chemical components. The spectrum of the unknown component was compared with the spectrum of the known components stored in the NIST library. The name, molecular weight and structure of the components of the test materials were ascertained.

Results and Discussion

The qualitative analysis for the presence of phthalates was performed on GC-MS chromatograph of the hexane extracts of sambar, tea and alcohol by comparing the retention times and the mass spectra registered for the compounds corresponding to the particular peaks with the mass spectra found in reference libraries. The tea and alcohol does not show any phthalate peaks. However, the sambar extract shows the phthalate peak with retention time of 19.95 minutes (Figure 1). The mass spectrum of DEHP (Di - Ethyl Hexyl Phthalate) is shown in Figure 2. The main ion is at m/z 149. The second most important ion is at m/z 167. The relative percentage of DEHP was found to be 20% of Total Ion Chromatogram among the other compounds. This study reveals the fact that the phthalates are highly soluble in oily food products. The Indian dish sambar is made up of various ingredients including oil. DEHP, a plasticizer can migrate from packaging into fatty foods, and exposure is restricted to keep the Total Daily Intake (TDI) below 0.3 mg/kg body weight [10, 11].

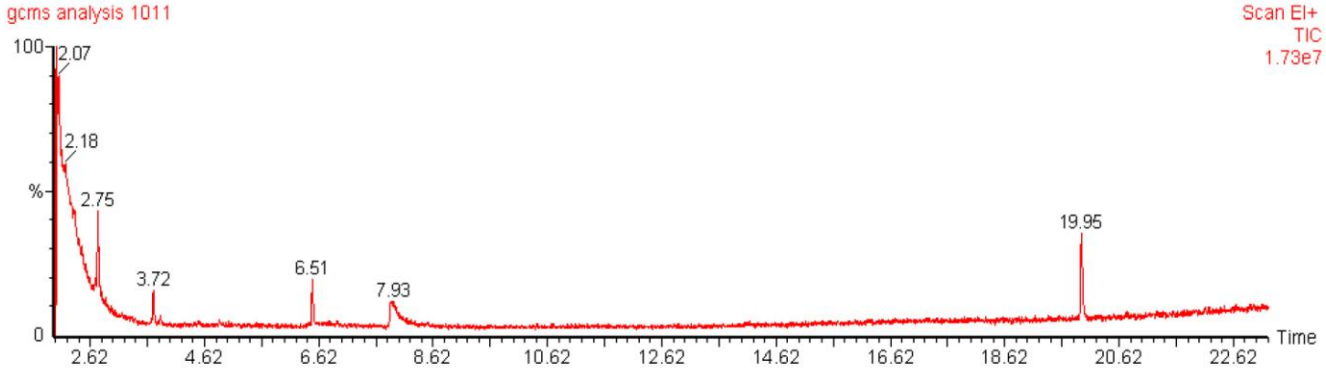

Figure 1: GC-MS Chromatogram of the sambar extract

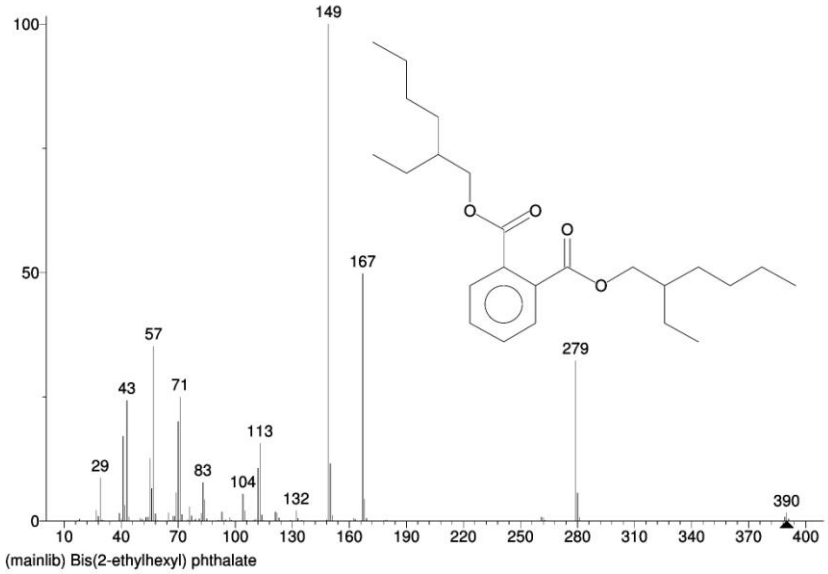

Figure 2: Mass Spectrum of diethylhexyl phthalate

Conclusion

In this study, the GC-MS determination of phthalate from food products packed in polythene covers was reported. The phthalate leachates in sambar emphasized the potential danger which threatens public health and the future generation. The presence of phthalates found in this study shown the necessity of further investigation on the influence of food package. Future studies are needed to establish regulation for health effect prevention in chemical exposure considering the growth of the plastic food package.

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