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Leaching of plastic into hot tea from plastic cups

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ABSTRACT

The present investigation was aimed to asses the amount of leaching plastic material, if any, into tea from disposable plastic cups. Fifty plastic cups were analyzed for the study, and thickness of cups was in the range of 70 – 90 µm (micron meter). The determination of leaching procedure was done through making difference in weight of used and unused cups through electronic weighing balance. First of all, weights of fresh unused cups were measured then measurements of weights of cups were taken after using hot tea. The tea was kept in cups for 10 minutes assuming that any person finishes tea after 10 minutes. The temperature of tea was measured 100°c at the time of serving. The weight of fresh unused cups and the weight of used served with hot tea cups were analyzed. The weight of used cups served with hot tea showed significant ($P < 0.05$) decreased in the weight as compared to fresh unused cups. The significant decrease in the weight of used cups showed the leaching of plastic material into tea. The results in this study indicated that the leaching of plastic material from cups into hot tea and the amount of plastic material leached was in the range of 1.5 – 2.0 mg per cup from < 1gram of cup.

Introduction

Due to the high-volume generation of plastics and low production costs, consumers typically use many plastic items only once before discarding them. Disposable plastic cup has become an indispensable item for serving tea/coffee at many shops in town, despite the fact that the usages of such cups are harmful to human health. Thousands of plastic cups are being used and they form part of the garbage heaps in the town, posing a threat to environment and health. Components used in plastics, such as bisphenol A (BPA), and phthalates, are released from plastic products, and are also known as endocrine-disrupting compounds (EDCs) owing to their ability to modulate the endocrine system. People are exposed to these chemicals not only during manufacturing, but also by using plastic packages, because some chemicals migrate from the plastic packaging to the foods they contain. Examples of plastics contaminating food have been reported with most plastic types, including Styrene from polystyrene, plasticizers from PVC (Polyvinylchloride) and Acetaldehyde from PET (Polyethelyne).

Plastic cups, specially made with Polystyrene are also a possible health hazard as chemicals may leach into the beverage. This is more likely to happen with warm drinks (hot chocolate, tea and coffee) than with cold drinks. Styrene monomer is one of the most widely used food packaged contact polymers. Increases in temperatures used in polymer processing may cause degradation and migration of polymers in food products [16]. A significant amount of the polystyrene plastic material is used in many foods–contact applications [12]. The main food contact applications of polystyrene are in dairy products including yogurt, cream, cottage cheese, ice cream and fruit juice, meat trays, biscuit trays, egg cartons, and drink cups (Modern Plastic 1991). In recent decades, styrene monomer has been markedly used in manufacturing of disposable drinking containers; however, the extent of migration of residue styrene from polystyrene cups under different conditions is interesting in order to predict potential exposure of consumers to styrene from food–contact polymers [15]. Packaging and disposable service wares have mostly used styrene plastics [19]. Several adverse health effects are attributed to styrene. Styrene has shown a toxic effect on the liver, and acts as a depressant on the central nervous system and cause neurological impairment [17; 18; 13, 4]. Chronic effects of styrene monomer and styrene epoxide (metabolite of styrene) are chromosomal aberrations in lymphocytes of humans and damage to the liver and nervous system. In recent years, studies of the toxic effect of styrene have given widespread concern on the haematopoietic, central nervous and peripheral nervous, ingestion, reproductive organs, and lymphatic system [5]. Other studies indicated that styrene may have effects on neurobehavioral development and neurotoxic actions [11, 3].

The present investigation was aimed to asses the amount of leaching plastic material, if any, into tea from disposable plastic cups.

Material & Method

Plastic cups – Plastic cups were procured from several tea stall where people used to have tea. 5 cups were taken of different size and thickness from ten shops and altogether 50 cups were used for the study.

Disposables cups are made out of polystyrene sheets. Sheets having thickness0.35mm to 18mm are used.

Methodology

Fifty plastic cups were analyzed for the study and thickness of cups was in the range of 70 – 90 µm (micron meter). Thickness of cups was done through Gauge machine of co. Mitutoyo (Japan) Model No -2046F. The surface of the cup was even and size (capacity) of the cup was 60 - 70 ml. 50 ml milk tea (white tea) was used in each cup as full cup tea is served by tea seller. The determination of leaching procedure was done through making difference in weight of used and unused cups through electronic weighing balance. First of all, weights of fresh unused cups were measured then measurements of weights of cups were taken after using hot tea. The tea was kept in cups

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for 10 minutes assuming that any person finishes tea after 10 minutes. The temperature of tea was measured 100°c at the time of serving. Tea was wiped of the cups and kept 10 minutes at R.T. for air dry before measuring the second time.

Statistical analysis

Data were analyzed with statistical software (Graphpad Prism 5) and values were expressed as Mean ± SEM and differences between the groups were statistically analyzed by paired t – test.

Results

The weight of fresh unused cups and the weight of used served with hot tea cups were analyzed. The weight of used cups served with hot tea showed significant ($P < 0.05$) decreased in the weight as compared to fresh unused cups. The significant decrease in the weight of used cups showed the leaching of plastic material into tea. It was observed that the amount of plastic material (styrene monomer) leached was in the range of 1.5 – 2.0 mg per cup. Since leaching range was observed 1.5 – 2.0 mg per cup from **< 1 gram** weight of cups, hence leaching material might be styrene monomer.

Data is showing below in the table and values are expressed as Mean ± SEM.

Table

Contents of leaching from plastic cups (mg) into hot tea in 100°c temperatures for 10 minutes n = 50	
Weight of unused fresh cups (**gram**)	Weight of used served with hot tea cups (**gram**)
0.7837 ± 0.0555	**0.7818 ± 0.0554**
Difference of mean = 0.0019(gram) 1.9 (mg)	

Discussion

In the present investigation, experiment was done on 50 plastic cups to determine the leaching of plastic material into hot tea. In all cups except in two cups leaching occurred and amount of plastic material leached was in the range of 1.5 – 2.0 mg per cup from <1 gram weight of cups. Since polystyrene are main constituent of plastic cups hence leaching of plastic material is styrene monomers, and styrene is entering into human being and metabolizes through different pathway. The most important metabolic pathway in humans is the conversion of styrene to styrene epoxide by the cytochromP450-mediated mono-oxygenize system in liver microsomes [9]. Biotransformation of styrene monomer to styrene epoxide and formation of peroxide radical is a dangerous problem for human health. For wider information on the pharmacokinetics; metabolism and general toxicity of styrene oxide, some reviews are available [14]. Much of the toxicity of styrene monomer has been attributed to styrene-7, 8-oxide or styrene epoxide, whereas there are few data on the occurrence of styrene epoxide in packaging materials [2]. Belvedere et al. (1984) have shown that isolated rat hepatocytes acted more efficiently in converting styrene oxide, suggesting that hepatocytes could be one of the most suitable systems for the study of indirect mutagens in vitro. Residual monomer in food–contact polymers determinate in compare to EPA (environmental protection agency) standards which include MCL (Maximum Contaminant level) and MCLG (Maximum contaminate Level goal) [6].

High performance liquid chromatography (HPLC) has become extremely popular and noticeable in recent years, and has been used to determine styrene in food products and in polystyrene packaging materials [8, 17]. Styrene monomer migration to the food products was analysed by GC-FID [10]. Similar study was done in the present investigation that amount of leached plastic material was analyzed through measuring weight of fresh and used cups. The reduced weight of used (served with hot tea) cups with compare to fresh unused cups showed process of leaching.

Flanjak and Sharrad (1984) [7] determined the migration of styrene monomer from polystyrene cups into different samples including fat products, suggesting that because of the hydrophobic nature of styrene, the migration of this monomer into fat beverages is higher than in aqueous drinks. The results of this study indicated that migration of styrene monomer from polystyrene cups into hot beverages when temperature increased is considerable. The present investigation was also in the favour of Flanjak and Sharrad (1984) that reduced weight of used cups showing leaching from polystyrene cups, the leached material was nothing but styrene monomer.

Conclusion

The results in this study indicated that the leaching of plastics into hot tea and amount of plastic material leached was in the range of 1.5 – 2.0 mg per cup from < 1gram of cup. The leaching of plastic into hot tea essentially depended upon the temperature, and time. However, temperature has an important role in leaching of plastic from cups. Thus plastic contaminated hot tea making health hazardous problem to human being.

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