International Journal of Dentistry and Oral Science (IJDOS)
ISSN: 2377-8075

Awareness Of Hazards Caused By Long-Term Usage Of Polyethylene Terephthalate (PET) Bottles

Research Article

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Abstract

Introduction: Plastic is an essential component of various consumer products such as water bottles, product containers and many more. Polyethylene terephthalate (PET) is the material most commonly used to manufacture plastic bottles in which water, beverage, condiments are commonly sold. Polyethylene terephthalate (PET) is a semi-crystalline polymer belonging to the family of polyesters.
Aim: The aim of this study was to survey the awareness about several hazards caused due to long term re-use of PET bottles.
Materials and methods: A questionnaire consisting on five questions was posted on an online website named Survey Planet (https://app.surveyplanet.com). This survey was completed by 214 subjects within an age limit between 16-40 years. The questions were based on the usage and re-usage of PET bottles and knowledge of various hazards caused by long term usage of PET bottles.
Results: The results were obtained from survey planet. They were statistically analysed.162(77.5%) subjects were aware about the ill effects of long term usage of PET bottles and 47(22.5%) were unaware about the various hazards, while the remaining 5 were unresponsive.
Conclusion: The awareness about several hazards caused due to long term re-use of PET bottles among the participants were high.This survey helped to increase awareness on the various harmful compounds released from PET bottles such as phthalates, antimony, bisphenol A and the various effects and several endocrine disorders caused by them.

Keywords: Polyethylene Terephthalate (PET); Antimony; Bisphenol A; Endocrine Disorders.

Introduction

The Plastic is an essential component of various consumer products such as water bottles, product containers and many more. Polyethylene terephthalate (PET) is the material most commonly used to manufacture plastic bottles in which water, beverage, condiments are commonly sold.[1] Polyethylene terephthalate (PET) is a semi-crystalline polymer belonging to the family of polyesters. PET is also used to manufacture shampoo bottles and other similar products. For more than 50 years, global production of plastic has continued to rise. According to collected data, a total of 299 million tons of plastics were produced in 2013 and there is quite a significant increase in the present date.[2] PET is one of the most inert polymers with good barrier properties against moisture, oxygen and carbon dioxide, and with a very low migration tendency of its constituents.[3] However, certain noticeable amounts of catalyst residues, degradation products, and polymerisation side-products are being migrated from the PET bottles into water, and other consumable products.[3, 4] The transfer is dependent on various factors such as temperature, storage time, concentration of the migrant, nature of the migrant in the polymer.SODIS (Solar Water Disinfection) is a simple water treatment procedure consisting of exposing PET bottled water to sunlight for 5-6 hours. However, on one hand destroying most if the bacteria, it also degrades the plastic material into various photoproduct [5, 6].

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Received: May 28, 2021
Accepted: June 16, 2021
Published: July 01, 2021

Citation: Edala Venkata Gana Karthik, Gayathri. R, Dhanraj Ganapathy. Awareness Of Hazards Caused By Long-Term Usage Of Polyethylene Terephthalate (PET) Bottles. *Int J Dentistry Oral Sci.* 2021;8(7):2976- 2980. doi: http://dx.doi.org/10.19070/2377-8075-21000605

The synthesis of PET takes place by the pre-polymerization of dimethyl terephthalate (DMT) or terephthalic acid (TPA) with ethylene glycol (MEG) is the first industrial step in the synthesis of PET. Both reactions generate low-weight oligomers and an intermediate compound named bis (hydroxyethyl) terephthalate(BHET). After this step,a second polycondensation is carried out with a Sb-, Ge- or Ti-based catalyst.Injection blow-molding is the preferred process for manufacturing PET bottles. [7]

Several compounds such as Formaldehyde, acetaldehyde, antimony, bisphenol A are clearly related to migration from PET into water [8, 9]. Many other studies have shown several unexpected substances in bottled water. The origin of these compounds has not been clearly established (PET container, cap-sealing resins, background contamination, water processing steps, NIAS, recycled PET, etc.).[10]

There are several endocrine disorders caused due to these chemicals in PET. Endocrine disruptors are compounds that mimic or antagonize the actions of natural estrogens, and are the most common form of endocrine disruptor activity. [11] These compounds alter the hormone system involved in many biological metabolisms and can produce many health-related problems, such as early puberty in females, reduced sperm counts, altered function of reproductive organs, obesity, altered gender-specific behaviors, and increased rates of some breast, ovarian, testicular, and prostate cancers [12-14].

This article is based on a survey conducted to increase the awareness about several hazards caused due to long term re-use of PET bottles.Our research experience has prompted us in pursuing this study. [15-24]

Materials And Methods

A questionnaire consisting on five questions was posted on an online website named Survey Planet (https://app.surveyplanet.com). This survey was completed by 214 subjects within an age limit between 16-40 years. The questions were based on the usage and re-usage of PET bottles and knowledge of various hazards caused by long term usage of PET bottles. The questions asked were as follows:

1) How often do you drink bottled water per week?
2) Do you reuse the PET bottles?
3) Do you drink bottled water which is left idle in the car?
4) If yes, within how much time would you decide to dispose it?
5) Are you aware of the various harmful effects of long-term usage of PET bottles?.

Results and statistics were obtained from Survey Planet.

Results

Results for each question are given below.

1.1. The First question was about how often they drink bottled water per week. There was scale given with a range of 0-20. The results showed that least number of PET water bottle used per week being 1 and the highest being 20 with an average 6.1 with N=214. The results are as shown in FIG.1

1.2. The Second question is about the re-usage of PET bottles with the options being a simple choice of yes or no. Out of 214 subjects, 174 (83.7%) said that they reuse PET bottles and 34 (16.3%) said they don't, while the other 8 were unresponsive. The results are as shown in FIG.2

1.3. The Third questions iswether the subjects would prefer drinking bottled water which is left idle in the car. 147(70.7%) subjects responded yes and 61(29.3%) subjects responded no, while the other 6 subjects were unresponsive. The results are as shown in FIG.3

1.4: The fourth question was about how long they would consider bottled water healthy to drink. 104(52.8%) subjects responded stating to dispose within one day, 70(35.5%) responded stating to dispose within two days, 17(8.6%) responded stating to dispose within three days and 6(3%) responded stating to dispose within a week and the remaining 17 were unresponsive. The results are

Figure 1.

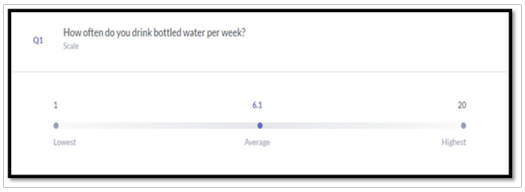
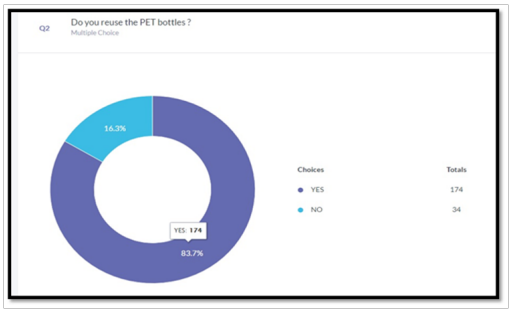


Figure 2.



as shown in FIG.4

1.5. The final question was about the awareness of hazards of long-term re-usage of PET water bottles among the subjects. 162(77.5%) subjects were aware about the ill effects of long term usage of PET bottles and 47(22.5%) were unaware about the various hazards, while the remaining 5 were unresponsive. The results are as shown in FIG.5

Discussion

The above obtained results were quite significant that people were re-using PET bottles for daily uses knowing the various types of chemicals released by them. Surprisingly, 77.5%(162) subjects were aware of the side effects and were they were still prepared for long-term usage due to various reasons such as laziness, or some subjects considering the harmful effects as a myth. However, proper awareness should be spread among people about the various harmful side effects of long-term usage of PET bottles. These chemicals released from PET might lead to various endocrine disorders. The various chemicals released are carbonyl compounds, Phthalates, antimony, UV Stabilizers, Bisphenol A and many more [25]. The compounds are given in the following table FIG.6, FIG.7, FIG.8.[11, 26-30]

Several endocrine disorders are caused due to Endocrine Disruptors. Endocrine disruptors are compounds that mimic or antagonize the actions of natural oestrogens, and are the most common form of endocrine disruptor activity [31]. These compounds alter the hormone system involved in many biological metabolisms and can produce many health-related problems, such as early puberty in females ,reduced sperm counts, altered function of reproductive organs, obesity, altered gender-specific behaviours, and increased rates of some breast, ovarian, testicular, and prostate. Alkyl phenols areKnown to be endocrine disrupters [31, 32]. Some authors have reported estrogenic activity in mineral water in PET bottles, using bioassays such as the E-screen assay (MCF-7 cell line) and yeast oestrogen assay (Saccharomyces cerevisae) expressing the human oestrogen receptor a (ERa). Estrogenic activity has also been evaluated using a reproduction test performed with mudsnails, Potamopyrgusantipodaru [32].

All these studies suggested the presence of endocrine disruptors in PET-bottled water.Pinto and Realireportedlow estrogenic activity, but with great variability, in nine Italian brands of PET-bottled water using a yeast oestrogen screen (YES) bioassay. The water samples were concentrated using C18 cartridges and the extracts were dissolved in dimethyl sulfoxide (DMSO).Although, higher estrogenic activity was observed in one brand of mineral water (23.1 ng/L estradiol equivalents (EEQ)),in the other brands, hormonal activity was often found to be in the same range as for tap and surface water (15e17 ng/L EEQ).[33, 34]

Figure 3.

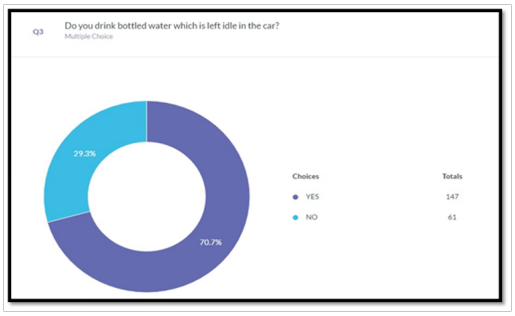


Figure 4.

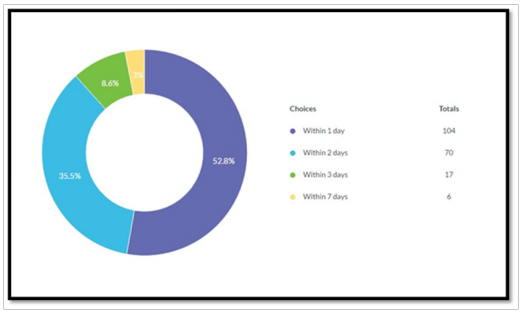


Figure 5.

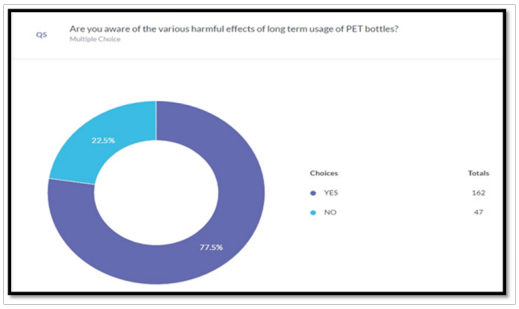


Figure 6: Carbonyl compounds released.

S.no	Compound name	Stimulant	Concentration Range(microgram/L)	References
1	Formaldehyde	Mineral water	<0.5 to 59	Sugaya et al. (2001)
2	Acetaldehyde	Still water in PET	<5.0 to 107.8	Mutsuga et al. (2006)
3	Propanal	Mineral water	<0.5 to 0.9	Sugaya et al. (2001)
4	Butanal	Mineral Water	<0.5 to 0.3	Sugaya et al. (2001)
5	Nonanal	Still water	0.9e11.3	Nawrocki et al. (2002)
6	Glyoxal	Still water	-	Nawrocki et al. (2002)
7	Methylglyoxal	Still water	0.9e15.8	Sugaya et al. (2001)]
8	Acetone	Still water	5.1e107.6	Nawrocki et al.(2002)

Figure 7. Pthalate ester compounds released.

S.no	Compound name	Stimulant	Concentration Range(microgram/L)	References
1	dimethyl phthalate	Mineral water	<0.04	Bo_snir et al. (2007)
2	diethyl phthalate	Mineral water	<0.04 to 1	Bo_snir et al. (2007)
3	dibutyl phthalate	Mineral water	<0.04 to 50	Bo_snir et al. (2007)
4	di-2- ethylbutyl phthalate	Dionised water,17hrs sunlight	0.10e0.38	Schmid et al. (2008)
5	dihexyl phthalate	Still water	<0.036	Cao (2008)

Figure 8: Other Compounds Present.

COMPOUND PRESENT	REFERENCE
Antioxidants	Zweifel, 2001
Alkyl phenols	Loos et al., 2007; Baugros et al., 2009)
UV stabilizers	EU, 2011
Lubricants	Zweifel, 2001
Bisphenol A	Berryman et al., 2004
Antimony	Nishioka et al. (2002) Shotyk et al. (2006) Cheng et al. (2010) Westerhoff et al. (2008)

Conclusion

This study concluded the participants were moderately aware of hazards of long-term usage of PET bottles. This article puts light on the various harmful compounds released and the various effects and several endocrine disorders caused by them.

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