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Gas Chromatography-mass Spectrophotometry Evaluation of the Concentration of Bisphenol-A (BPA) in Five Selected Canned Food Products Consumed in Lagos Area, Nigeria

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Authors' contributions

This work is a collaborated project by the authors. Author ISA designed, supervised the overall analyses of the study, interpreted and formatted the final manuscript. Author OH performed the experiments, literature search, statistical analysis and wrote the first draft of the manuscript. Author AA helped in manuscript writing. All authors read and approved the final manuscript.

Research Article

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ABSTRACT

Aims: This research was designed to evaluate the Bisphenol A (BPA) level in five selected canned food products (sweet corn, baked bean, green pea, tomato paste and sardine) on sale in Lagos markets, South West Nigeria.
Place and Duration of Study: Department of Biochemistry and Department of Chemistry, Faculty of Basic Medical Sciences, College of Medicine and Faculty of Science, University of Lagos, Nigeria between May 2012 and November 2012.
Methodology: The canned food products purchased from Oyingbo and Mushin markets in Lagos, Nigeria and stored at room temperature prior to analysis were carefully opened and oven dried at 60ºC for one week. They were then subjected to solid phase extraction with acetonitrile and derivatization with acetic anhydride. Gas chromatography and mass-spectrometry was carried out on the derivatized samples and compared with BPA standard.
Results: BPA in varied concentrations was detected in samples of all the canned products at levels ranging from 0.3 to 4.1µg/L, except for sardine in which BPA was not

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detected.
Conclusion: Consumers' exposure to BPA through consumption of these canned food products in Lagos area, Nigeria is low, well below the provisional tolerable daily intake of 25 µg/kg of body weight/day established by Health Canada and 50 µg/kg of body weight/day by the U.S. Environmental Protection Agency and the European Food Safety Authority. Consumption of these canned foods therefore is safe without fear of any adverse effect.

Keywords: Bisphenol A; gas Chromatography-mass spectrometry; canned foods.

1. INTRODUCTION

The substance 2, 2- *bis* (4-hydroxyphenyl) propane, more commonly known as bisphenol A (BPA), is used as a monomer in the manufacture of polycarbonates and epoxy resins, as an antioxidant in Polyvinylchloride (PVC) plastics and as an inhibitor of end polymerization in PVC. Polycarbonates are used in food-contact materials such as returnable beverage bottles, infant-feeding bottles, tableware (plates and mugs) and storage containers. Epoxy resins are used in protective linings for food and beverage cans and vats. A recent study by the US Center for Disease Control and Prevention discovered that, about 93% of the United States population have bisphenol-A in their body at a median concentration of 2.7 ppb [1].

Xenoestrogens are a structurally diverse group of naturally occurring and man- made chemicals that mimic the actions of the female sex hormone estrogen {estradiol}. In the last decade, an increasing effort has been made to investigate the interactions between these chemicals (including various phenolic compounds, phthalate esters, phytoestrogens and certain pesticides) and the endocrine system of humans as well as several wild life species. A causative link between the exposure to environmental xenoestrogens and deterioration in male reproductive health and function has been established [2].

One of the first chemicals discovered to mimic estrogen was the bi-cyclic aromatic compound bisphenol A (BPA). In 1936, BPA was found to stimulate growth of the rodent uterus [3], an indication of estrogenic action that has recently been confirmed by several *in vitro* and *in vivo* assays [4]. Presently, BPA is widely used in the production of polycarbonate, epoxy resins (i.e., dental sealants and lacquer coatings of food cans), flame retarders and other products.

Because BPA is a potential endocrine disruptor that mimics the action of the hormone estrogen (*1*), the specific migration limit for BPA in food or food stimulant was set at 0.6 *µ*g/g by the EC Directive in an amending document relating to plastic materials and articles intended to come into contact with foodstuffs (*2*). The maximum acceptable dose and tolerable daily intake (TDI) for BPA were established at 50 *µ*g/kg of body weight/day by the U.S. Environmental Protection Agency (*3*) and the European Food Safety Authority (*4*), respectively, whereas Health Canada established the provisional TDI for BPA at 25 *µ*g/kg of body weight/day. BPA is one of the 23000 chemical substances on the Canadian Environmental Protection Act (CEPA) domestic substance list which has been identified for further evaluation for safety purposes in items related to human consumption.

Surveys of BPA in canned foods were conducted in some countries such as Canada, United States of America and Japan among others. However such survey has not been done in Nigeria.

In this work, the concentration of BPA in canned food products consumed in Lagos metropolis, South-West region of Nigeria were evaluated.

2. MATERIALS AND METHODS

2.1 Materials and Reagents

Acetonitrile, *n*-Hexane and methanol (HPLC-grade), potassium carbonate (ACS grade), anhydrous sodium sulphate (Na_2SO4), acetic anhydride, Dimethyl-sulfoxide (DMSO) and Bisphenol A (99%) were obtained from Sigma.

Gas Chromatography- Mass spectrometry (GC-MS) was carried out in the Department of Chemistry, University of Lagos, Akoka, Nigeria.

2.2 Sample Collection

Samples of 5 canned food products (sweet corn, baked bean, green pea, tomato paste and sardine) within the weight of (195g-257g) were collected in May 2012 at Ojuwoye market, Mushin and Oyingbo market, in Lagos area, South West Nigeria. These products covered at least 5% market share of canned food products sold in Nigeria. All samples were stored at room temperature before analysis.

2.3 Extraction and separation of Samples

All glassware were conditioned in an oven at 260°C for at least 2 hours to eliminate environmental BPA that may be present.

The canned foods were opened carefully and their contents poured into labeled clean metal trays and oven dried at 60°C for 1week. After the samples were dried, it was then grinded into powder and 20g of each subsample was weighed into a beaker, then 20ml n-hexane and 20ml acetonitrile were measured and added to the subsamples which was then allowed to stay for 24hours at room temperature (for fat removal). After 24 hours, the mixture was filtered using a GF/C filter and a Buchner flask. Then hexane layer containing the fat in Sardine was removed using a pipette.

The acetonitrile filtrates were then treated with 2g anhydrous sodium sulphate for 1min and the solvent decanted into a 50-ml measuring cylinder. The procedure was repeated for other canned samples with a low fat content such as green peas, sweet corn and tomato paste but hexane was omitted from the procedure above. The filtrates were then separated into constituents as follows:

Ten millilitres of 72% w/v sodium carbonate and 5ml methanol were added and swirled to mix.

Then 5mL of acetic anhydride was added and swirled gently after reaction had subsided. The solution was left to stand for 15mins with occasional swirling and then extracted with 5mL *n*-hexane. The mixture was then filtered using whatman filter paper. Then hexane layer was collected using a separating funnel and analysed by GC-MS (5)

2.4 GC-MS Analysis of the Extract

An Agilent 6890 gas chromatograph (GC) coupled to a 5975 Mass Spectrometry was used for the analysis of the extract at the Department of Chemistry, University of Lagos. The flow rate of the helium carrier gas was 1.2 mL/min. The injector temperature was 280°C. One microliter of sample extract was injected into the GC system in splitless mode. The analytes were separated on a HP-5MS capillary column (30 m × 0.25 mm × 0.25 *μ*m).

1. RESULTS AND DISCUSSION

The five products selected for this study are some of the canned foods consumed by the people in this part of the world. These products included baked beans, sweet corn, green peas, Tomatoes, and Sardine. Levels of BPA in these products ranged from 0.3*μ*g/L to 4.1*μ*g/L. Figure 1 shows the gas chromatography/mass Spectrometry chromatogram of sample of canned tomato paste (400g) yielding 0.4μg/L BPA. Fig. 2. is the gas chromatography/mass Spectrometry chromatogram of sample of canned green peas (538g) producing 0.3μg/L BPA while Fig. 3. shows the BPA concentration of 4.1 μg/L BPA in (425g) of canned baked beans. Figs. 4. and 5 show 0.8 μg/L and 0.0 μg/L concentrations of BPA in 340g and 125g samples of sweet corn and sardine analyzed respectively.

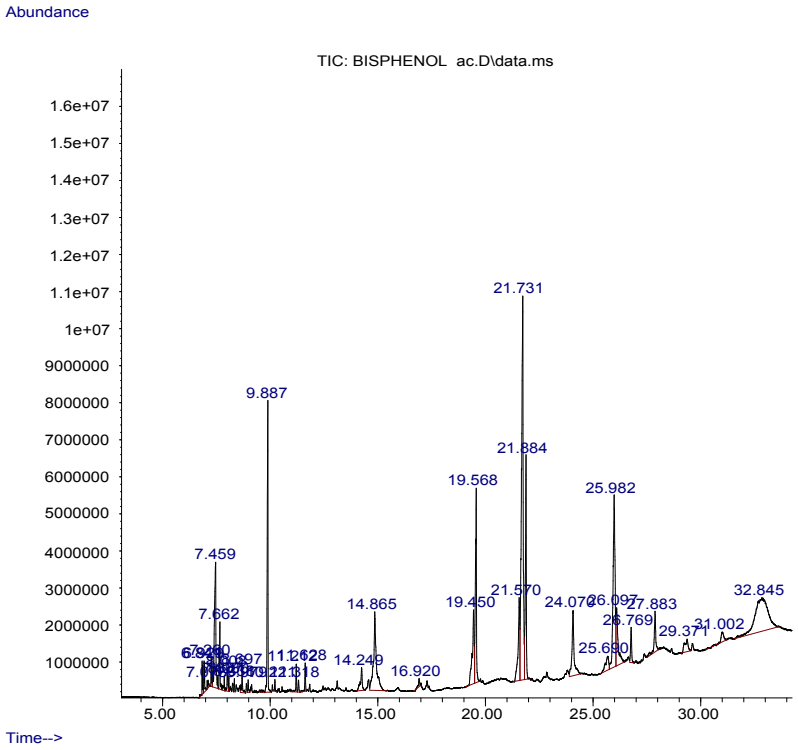

Fig. 1. Gas Chromatography/Mass Spectrometry chromatogram of Baked beans extract.

Retention Time: BPA – 14.87 min

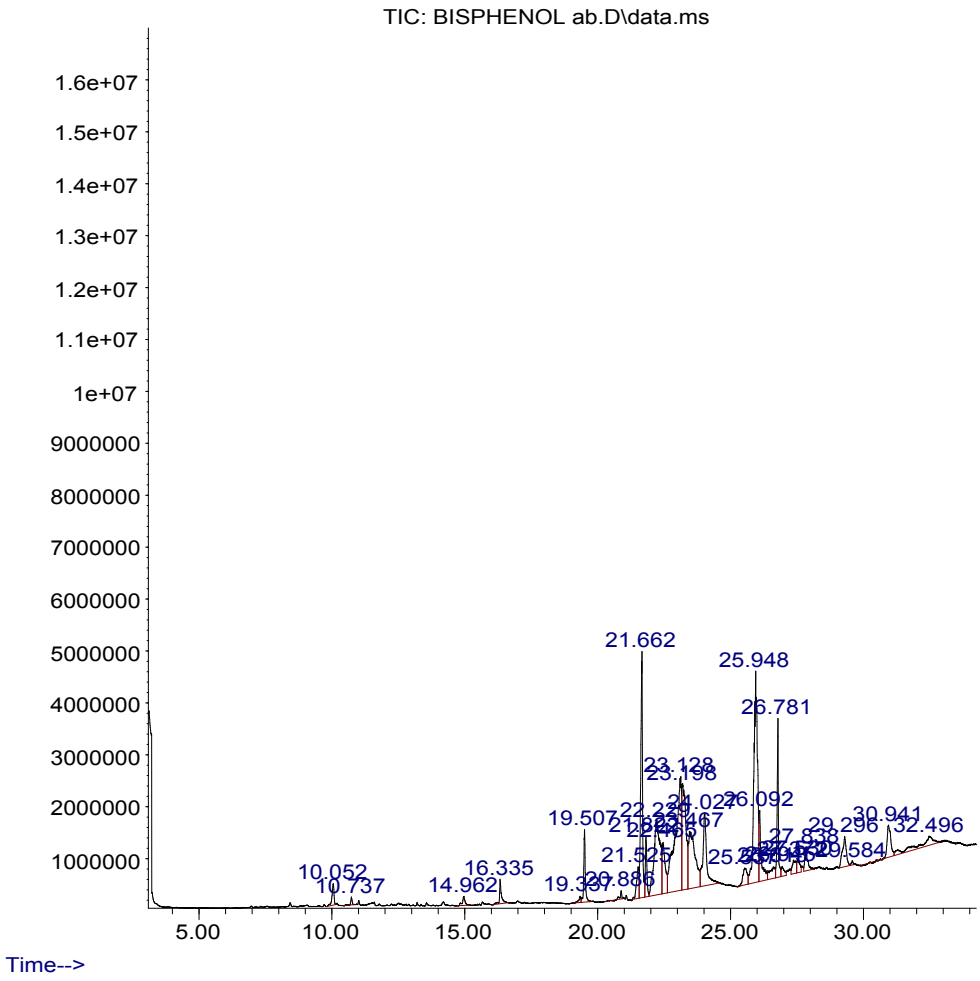

Fig. 2. Gas Chromatography/Mass Spectrometry chromatogram of Green peas extract

Retention Time: BPA – 14.96 min

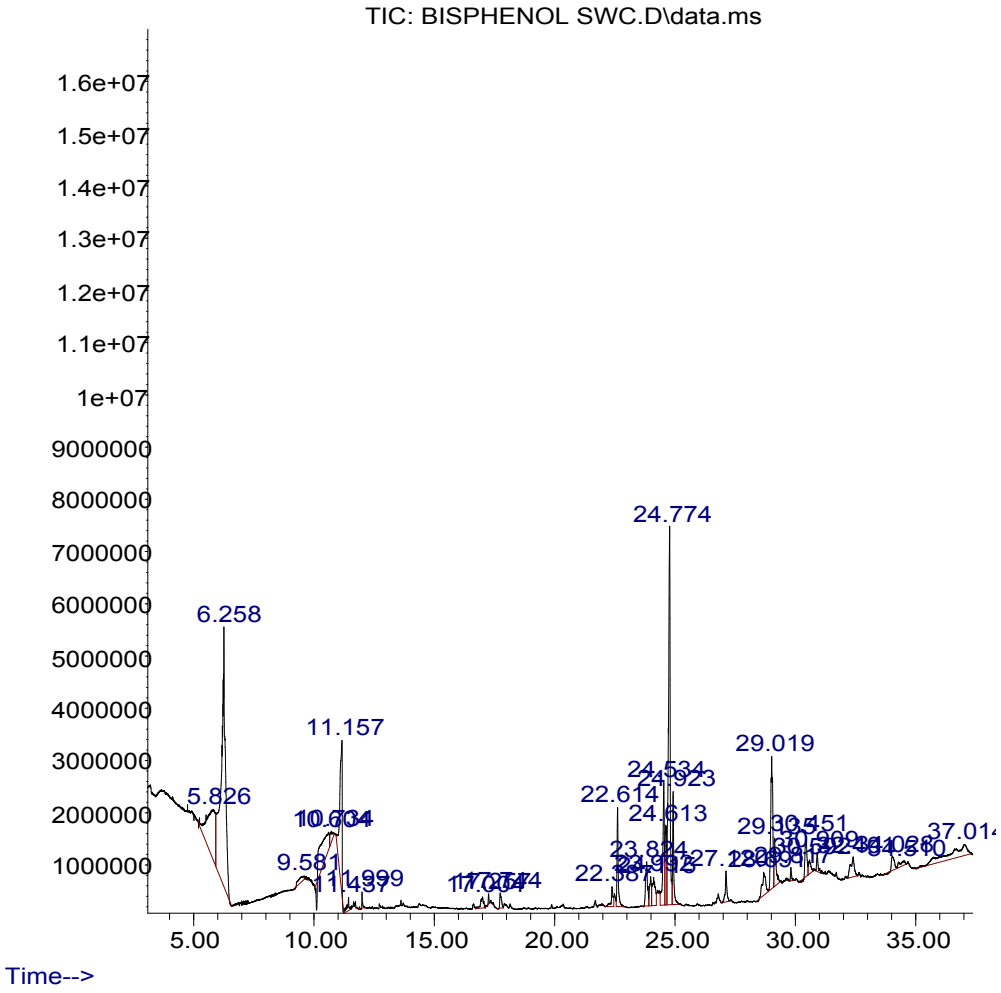

Fig. 3. Gas Chromatography/Mass Spectrometry chromatogram of sweet corn extract.

Retention Time: BPA – 17.0 min, BPA – 17.7 min.

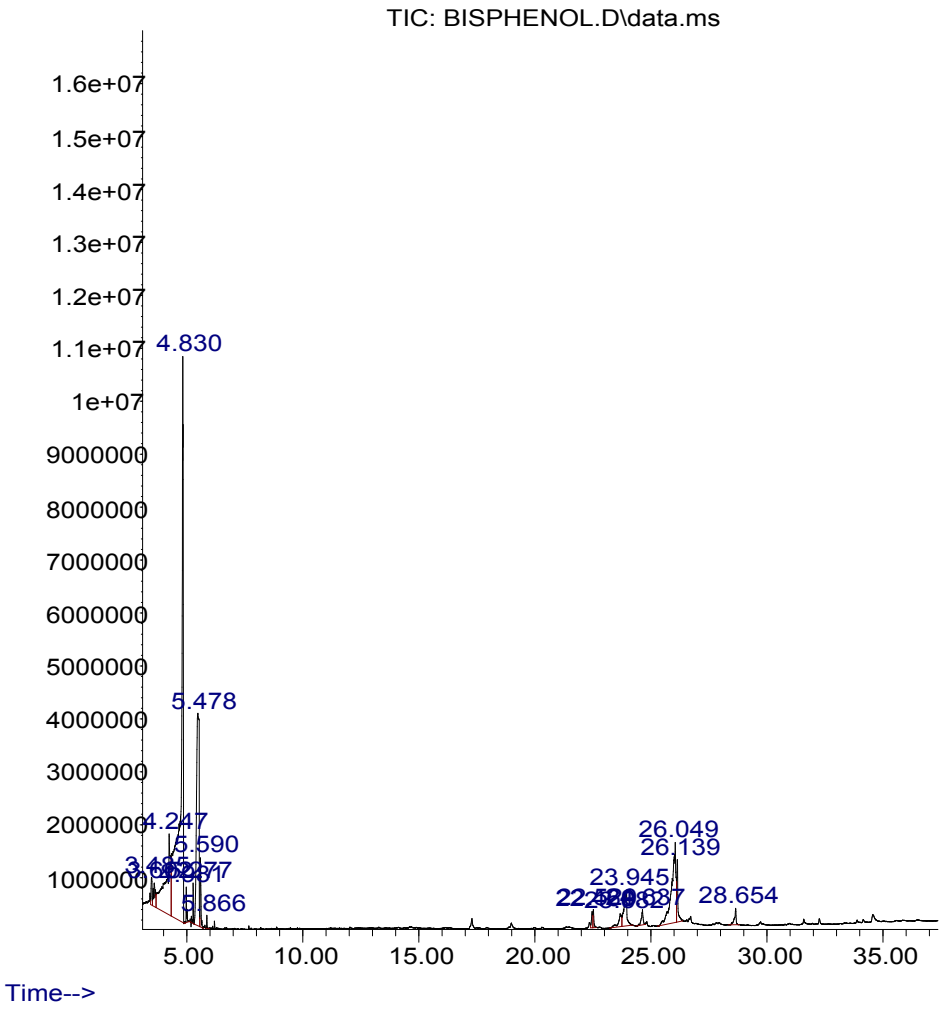

Fig. 4. Gas Chromatography/Mass Spectrometry chromatogram of Sardine Extract.
Retention Time: No presence of BPA

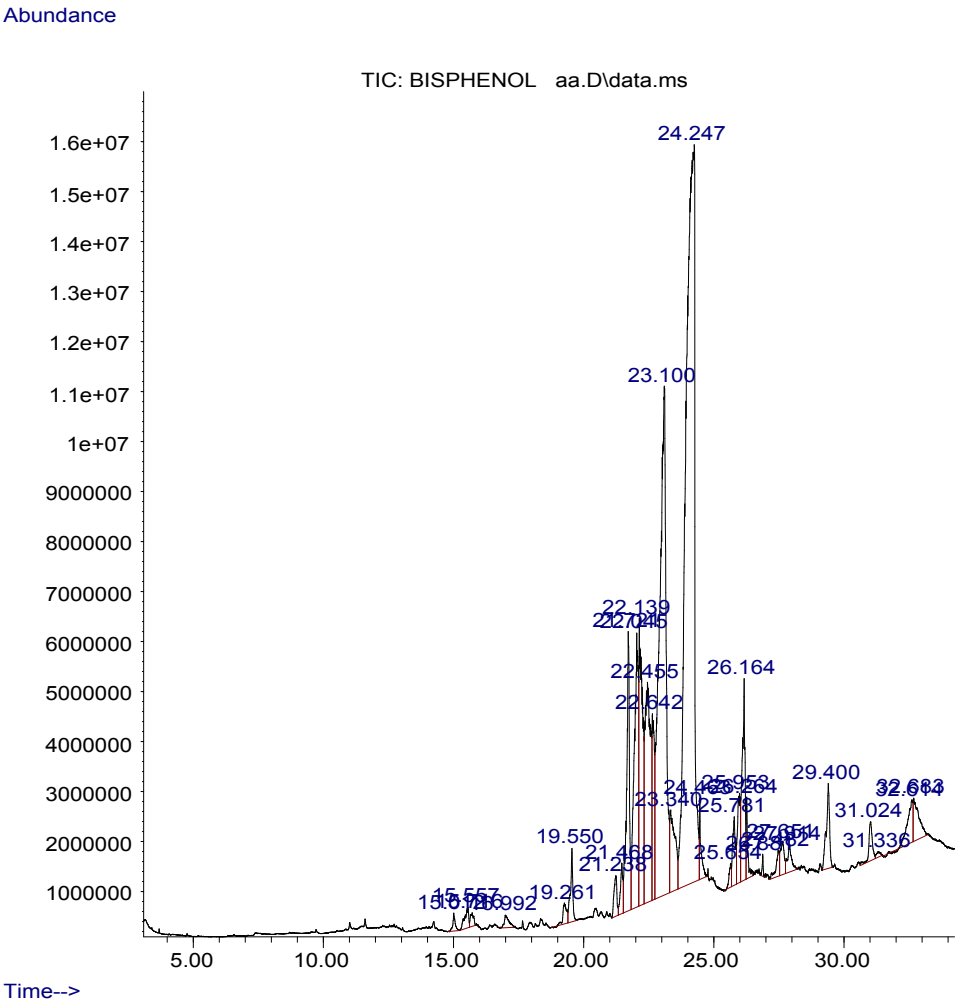

Fig. 5. Gas Chromatography/Mass Spectrometry chromatogram of Tomato paste extract.
Retention Time: BPA-15.0 min.

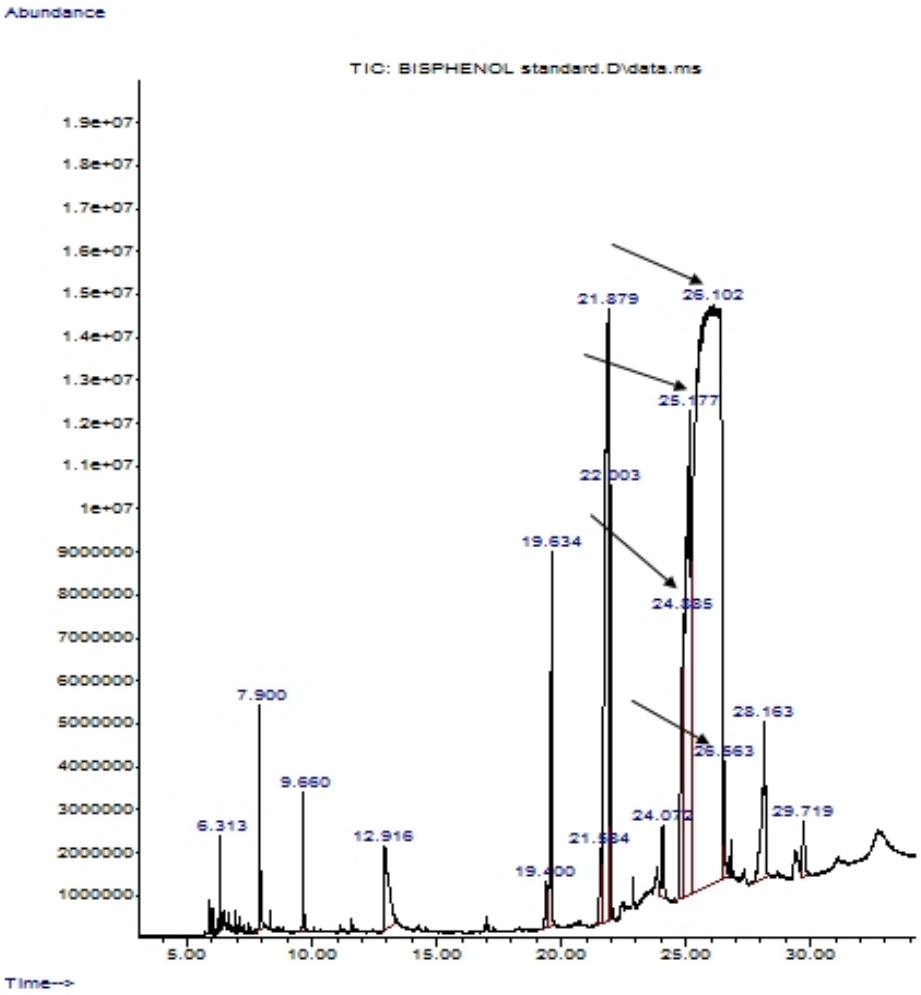

Fig. 6. Gas Chromatography/Mass Spectrometry chromatogram of standard bisphenol A.

Retention Time: BPA – 24.89 min, 25.18 min, 26.10min, 26.56min.

Health is a reoccurring concern in today's world. One key component to optimal health is a proper diet. However industrial by-products collectively called "endocrine disrupting chemicals" such as bisphenol A (BPA), which main exposure is through diet can be absorbed into foods and drinks. Even at low doses they can lead to various health issues such as cancer, metabolic disorders, heart disease, diabetes, fertility problems, and birth defects or miscarriages.

In this study, bisphenol A (BPA) was detected in four of the analyzed samples namely baked beans, green pea, tomato paste, sweet corn while the canned fish products (sardine) did not contain detectable BPA. BPA in the samples was in the concentration range of 0.3-4.1 *µ*g/L (Figs. 1-6). BPA that leached from the can into the food products may be as a result of the differences in can coatings or sterilization conditions used by different product companies; temperature appears to be a more important factor in leaching than the age of the container

[6,7]. It could also be as a result of accidental exposure of the canned food products to heat or acidity (e.g., sunlight) during storage and transportation [8]. Heat and contact with either acidic or basic compounds accelerate hydrolysis of the ester bond linking BPA molecules in polycarbonate and resins. Specifically, heating of cans to sterilize food, the presence of acidic or basic food or beverages in cans have all been shown to result in an increase in the rate of leaching of BPA. The reason canned fish (Sardine) did not give detectable BPA in this study may be as a result of the high concentration of oil which thus prevent the leaching of the BPA. When compared to the BPA levels in other canned products such as canned soft drinks and canned infant formula, BPA levels in canned fish, vegetables, etc are much lower and this could be because of the amount of the coatings applied to soft drinks and infant formula are lesser than that in canned foods. Bisphenol A is regarded as a potential endocrine disruptor that mimics the action of the hormone estrogen [9]. The specific migration limit for BPA in food or food stimulant is 0.6 *µ*g/g by the EC Directive in an amending document relating to plastic materials and articles intended to come into contact with foodstuffs [10]. The values of BPA concentrations obtained in the canned foods evaluated in this study satisfy this stipulated standard, showing that the consumption of these canned foods is safe. The oil in the canned sardines appears to have reduced the leaching of the BPA from the can's coating such that it was not detected in the canned sardine's samples. This perhaps explains one of the antioxidant roles of omega-3 oils in human diets.

4. CONCLUSION

Bisphenol A (BPA) exposure via consumption of canned food products is low, well below the provisional tolerable daily intake of 25 µg/kg of body weight/day established by Health Canada, and 50 µg/kg of body weight/day by the U.S. Environmental Protection Agency and the European Food Safety Authority. Human health therefore, is not under threat by consumption of canned foods. However, Food Safety Authorities require validation of this finding in animal models before definitive conclusions.

COMPETING INTERESTS

Authors declare that there are no competing interests.

REFERENCES

1. Commission Directive 2007/19/EC of 1 March 2007 amending Directive 2002/72/EC relating to plastic materials and articles intended to come into contact with foodstuffs. Off. J. Eur. Communities. 2007;L71,8-21.
2. Topari VA. Male reproductive health and environmental xenoestrogens. Environmental health perspectives supplements. 1996;104:54
3. Olea N, Pulgar R, Perez P, Olea-Serrano F, Rivas A, Novillo-Fertrell A, et al. Estrogenicity of resin-based composites and sealants used in dentistry. Environ Health Perspect. 1996;104:298–305.
4. Dodds EC, Lawson W. Synthetic oestrogenic agents without the phenanthrene nucleus. Nature. 1936;137:996.
5. Diel P, Schmidt S, Vollmer G, Janning P, Upmeier A, Michna H, et al. Comparative responses of three rat strains (DA/Han, Sprague-Dawley and Wistar) to treatment with environmental estrogens. Arch. Toxicol. 2004;78:183-193.

6. Ehlert KA, Beumer CWE, Groot MCE. Migration of Bisphenol A into water from polycarbonate baby bottles during microwave heating. Food additives and contaminants. 2008;25(7)904–910.
7. Mercea P. Physiochemical processes involved in migration of Bisphenol A from polycarbonate. J. Appl. Polymer Sc. 2009;112:579-593.
8. Welshons WV, Nagel SC, vom Saal FS. Large effects from small exposures. III. Endocrine mechanisms mediating effects of bisphenol A at levels of human exposure. Endocrinol. 2006;147:S56–S69.
9. Krishnan A, Stathis P, Permuth S, Tokes L, Feldman D. An estrogenic substance is released from polycarbonate flasks during autoclaving. Endocrinology. 1993;132:2279-2286.
10. Commission Directive 2004/19/EC of March 2004 amending Directive 2002/72/EC relating to plastic materials and articles intended to come into contact with foodstuffs. Off. J. Eur. Communitiies. 2004;L71:8-21.

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